

Intermediate System  
Administration for the Solaris™ 9  
Operating Environment  
SA-239

Student Guide



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Revision A



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## About This Course

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### Instructional Goals

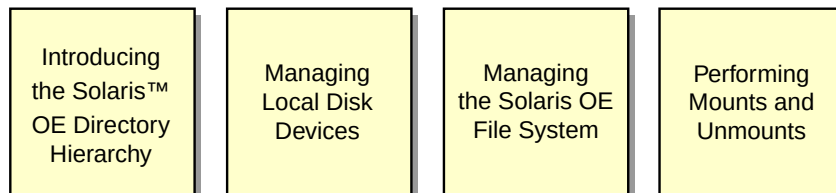
Upon completion of this course, you should be able to:

- Manage file systems
- Install software
- Perform system boot procedures
- Perform user and security administration
- Manage network printers and system processes
- Perform system backups and restores

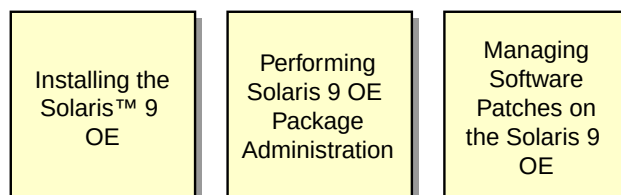
## Course Map

The course map enables you to see what you have accomplished and where you are going in reference to the instructional goals.

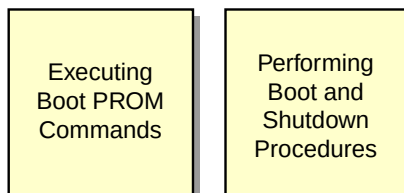
### Managing File Systems



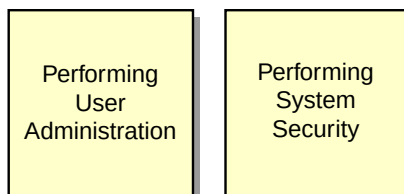
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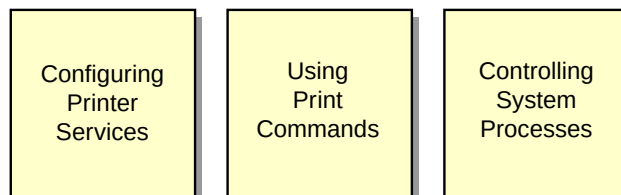
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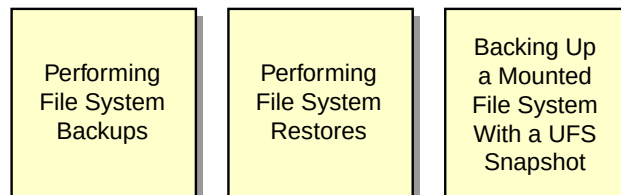
### Performing User and Security Administration



### Managing Network Printers and System Processes



### Performing System Backups and Restores



## Topics Not Covered

This course does not cover the following topics. Many of these topics are covered in other courses offered by Sun Educational Services:

- Basic UNIX<sup>®</sup> commands – Covered in SA-119: *UNIX<sup>®</sup> Essentials Featuring the Solaris<sup>™</sup> 9 Operating Environment*
- The vi editor – Covered in SA-119: *UNIX<sup>®</sup> Essentials Featuring the Solaris<sup>™</sup> 9 Operating Environment*
- Basic UNIX file security – Covered in SA-119: *UNIX<sup>®</sup> Essentials Featuring the Solaris<sup>™</sup> 9 Operating Environment*
- JumpStart<sup>™</sup> Procedure– Covered in SA-299: *Advanced System Administration for the Solaris<sup>™</sup> 9 Operating Environment*
- Network File System (NFS) environment configuration – Covered in SA-299: *Advanced System Administration for the Solaris<sup>™</sup> 9 Operating Environment*
- Naming services – Covered in SA-299: *Advanced System Administration for the Solaris<sup>™</sup> 9 Operating Environment*
- Troubleshooting – Covered in ST-350: *Sun<sup>™</sup> Systems Fault Analysis Workshop*
- System tuning – Covered in SA-400: *Solaris<sup>™</sup> System Performance Management*

Refer to the Sun Educational Services catalog for specific information and registration.

## How Prepared Are You?

To be sure you are prepared to take this course, can you answer yes to the following questions?

- Perform basic UNIX tasks
- Understand basic UNIX commands
- Use the `vi` text editor
- Interact with a windowing system

# Introductions

Now that you have been introduced to the course, introduce yourself to the other students and the instructor, addressing the items shown below:

- Name
- Company affiliation
- Title, function, and job responsibility
- Experience related to topics presented in this course
- Reasons for enrolling in this course
- Expectations for this course

## How to Use Course Materials

To enable you to succeed in this course, these course materials employ a learning module that is composed of the following components:

- Objectives – You should be able to accomplish the objectives after completing a portion of instructional content. Objectives support goals and can support other higher-level objectives.
- Lecture – The instructor will present information specific to the objective of the module. This information will help you learn the knowledge and skills necessary to succeed with the activities.
- Activities – The activities take on various forms, such as an exercise, self-check, discussion, and demonstration. Activities are used to facilitate mastery of an objective.
- Visual aids – The instructor might use several visual aids to convey a concept, such as a process, in a visual form. Visual aids commonly contain graphics, animation, and video.



---

**Note** – Many system administration tasks for the Solaris™ Operating Environment can be accomplished in more than one way. The methods presented in the courseware reflect recommended practices used by Sun Educational Services.

---



# Conventions

The following conventions are used in this course to represent various training elements and alternative learning resources.

## Icons



**Discussion** – Indicates a small-group or class discussion on the current topic is recommended at this time.



---

**Note** – Indicates additional information that can help students but is not crucial to their understanding of the concept being described. Students should be able to understand the concept or complete the task without this information. Examples of notational information include keyword shortcuts and minor system adjustments.

---



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**Caution** – Indicates that there is a risk of personal injury from a nonelectrical hazard, or risk of irreversible damage to data, software, or the operating system. A caution indicates that the possibility of a hazard (as opposed to certainty) might happen, depending on the action of the user.

---

## Typographical Conventions

**Courier** is used for the names of commands, files, directories, user names, host names, programming code, and on-screen computer output; for example:

```
Use the ls -al command to list all files.  
host1# cd /home
```

**Courier bold** is used for characters and numbers that you type; for example:

```
To list the files in this directory, type the following:  
# ls
```

*Courier italics* is used for variables and command-line placeholders that are replaced with a real name or value; for example:

```
To delete a file, use the rm filename command.
```

***Courier italic bold*** is used to represent variables whose values are to be entered by the student as part of an activity; for example:

```
Type chmod a+rw filename to grant read, write, and execute  
rights for filename.
```

*Palatino italics* is used for book titles, new words or terms, or words that you want to emphasize; for example:

```
Read Chapter 6 in the User's Guide.  
These are called class options.
```

# Introducing the Solaris™ OE Directory Hierarchy

---

## Objectives

Upon completing this module, you should be able to:

- Describe / (root) subdirectories
- Describe file components
- Describe file types
- Use hard links

The following course map shows how this module fits into the current instructional goal.

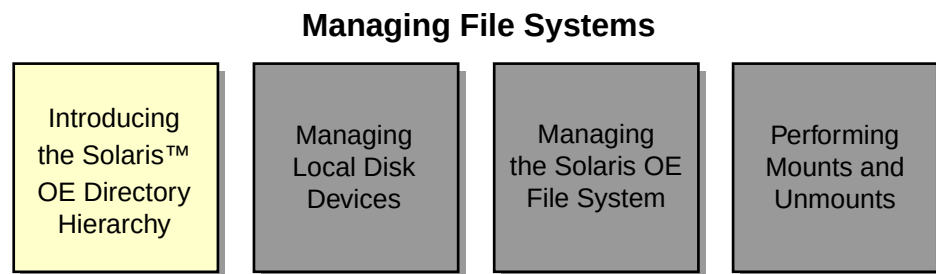


**Figure 1-1** Course Map

## Introducing / (root) Subdirectories

The directory hierarchy of the Solaris™ Operating Environment (Solaris OE) is organized for administrative convenience. Branches within this directory tree segregate directories that are used for different purposes. For example, directories exist to hold files that are private to the local system, files to share with other systems, and home directories.

Logically, all directories fall below the / (root) directory. Physically, however, directories can be located on a single file system or divided among multiple file systems. Every Solaris OE must have a root file system but can also have other file systems attached at points within the directory hierarchy. Most file systems are structures created on disk slices that contain or hold files and directories.

---

**Note** – Refer to `man -s5 filesystem` for information on file system organization.

---



## Introducing Important System Directories

The Solaris OE consists of a hierarchy of critical system directories and files that are necessary for the operating system to function properly. The following is a list of some of the critical system directories and subdirectories that are found in the Solaris OE.

|          |                                                                                                                                                                      |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| /        | The root of the overall file system namespace.                                                                                                                       |
| /bin     | A symbolic link to the <code>/usr/bin</code> directory. It is the directory location for the binary files of standard system commands.                               |
| /dev     | The primary directory for logical device names. The contents of this directory are symbolic links that point to device files in the <code>/devices</code> directory. |
| /devices | The primary directory for physical device names.                                                                                                                     |
| /etc     | The directory that holds host-specific configuration files and databases for system administration.                                                                  |

|                        |                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>/export</code>   | The default directory for commonly shared file systems, such as users' home directories, application software, or other shared file systems.                             |
| <code>/home</code>     | The default directory or mount point for a user's home directory.                                                                                                        |
| <code>/kernel</code>   | The directory of platform-independent loadable kernel modules that are required as part of the boot process.                                                             |
| <code>/mnt</code>      | A convenient, temporary mount point for file systems.                                                                                                                    |
| <code>/opt</code>      | The default directory or mount point for add-on application packages.                                                                                                    |
| <code>/platform</code> | The directory of platform-dependent loadable kernel modules.                                                                                                             |
| <code>/sbin</code>     | The single-user bin directory that contains essential executables that are used during the booting process and in manual system-failure recovery.                        |
| <code>/tmp</code>      | The directory for temporary files. This directory is cleared during the boot sequence.                                                                                   |
| <code>/usr</code>      | The directory that contains programs, scripts, and libraries that are used by all system users. The directory name is an acronym for UNIX <sup>®</sup> system resources. |
| <code>/var</code>      | The directory for varying files, which usually includes temporary, logging, or status files.                                                                             |

The following tables list primary subdirectories under key directories.

**Table 1-1** Primary Subdirectories Under the /dev Directory

| Subdirectory | Description                                                                                   |
|--------------|-----------------------------------------------------------------------------------------------|
| /dev/cua     | Dial-out device files for UNIX-to-UNIX Copy Protocol (UUCP) and Point-to-Point Protocol (PPP) |
| /dev/dsk     | Block disk devices                                                                            |
| /dev/fbs     | Frame buffer device files                                                                     |
| /dev/fd      | File descriptors                                                                              |
| /dev/md      | Logical volume management metadisk devices                                                    |
| /dev/pts     | Pseudo terminal devices                                                                       |
| /dev/rdisk   | Raw disk devices                                                                              |
| /dev/rmt     | Raw magnetic tape devices                                                                     |
| /dev/sound   | Audio device and audio-device control files                                                   |
| /dev/term    | Serial devices                                                                                |

**Table 1-2** Primary Subdirectories Under the /etc Directory

| Subdirectory | Description                                                                        |
|--------------|------------------------------------------------------------------------------------|
| /etc/acct    | Configuration information for the accounting system                                |
| /etc/cron.d  | Configuration information for the cron utility                                     |
| /etc/default | Default information for various programs                                           |
| /etc/inet    | Configuration files for network services                                           |
| /etc/init.d  | Scripts for starting and stopping services, used while changing between run levels |
| /etc/lib     | Dynamic linking libraries needed when the /usr file system is not available        |
| /etc/lp      | Configuration information for the printer subsystem                                |
| /etc/mail    | Configuration information for the mail subsystem                                   |

**Table 1-2** Primary Subdirectories Under the /etc (Continued)Directory

| Subdirectory | Description                                                    |
|--------------|----------------------------------------------------------------|
| /etc/nfs     | Configuration file for NFS server logging                      |
| /etc/opt     | Configuration information for optional packages                |
| /etc/rc#.d   | Scripts that are when entering or leaving a specific run level |
| /etc/skel    | Default shell initialization files for new user accounts       |

**Table 1-3** Contents of the /usr Directory

| Subdirectory | Description                                                                                                         |
|--------------|---------------------------------------------------------------------------------------------------------------------|
| /usr/bin     | Standard system commands                                                                                            |
| /usr/ccs     | C-compilation programs and libraries                                                                                |
| /usr/demo    | Demonstration programs and data                                                                                     |
| /usr/dt      | Directory or mount point for Common Desktop Environment (CDE) software                                              |
| /usr/include | Header files (for C programs, and so on)                                                                            |
| /usr/java    | Directories that contain Java™ technology programs and libraries                                                    |
| /usr/kernel  | Platform-independent loadable kernel modules that are not generally required during the boot process                |
| /usr/lib     | Architecture-dependent databases, various program libraries, and binaries that are not invoked directly by the user |
| /usr/opt     | Configuration information for optional packages                                                                     |
| /usr/sbin    | System administration commands                                                                                      |
| /usr/spool   | Symbolic link to the /var/spool directory                                                                           |

## Introducing File Components

All files in the Solaris OE make use of a file name and a record called an inode. Most files also make use of data blocks. In general, a file name is associated with an inode, and an inode provides access to data blocks.

Figure 1-2 shows the relationship between the file components.

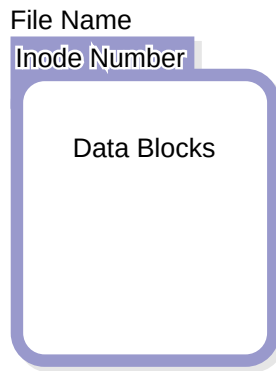


**Figure 1-2** File Names, Inodes, and Data Blocks

## File Names

File names are the objects most often used to access and manipulate files. A file must have a name that is associated with an inode.

## Inodes

Inodes are the objects the Solaris OE uses to record information about a file. In general, inodes contain two parts. First, inodes contain information about the file, including its owner, its permissions, and its size. Second, inodes contain pointers to data blocks associated with the file.

Inodes are numbered, and each file system contains its own list of inodes. When a new file system is created, a complete list of new inodes is also created in that file system.



## Data Blocks

Data blocks are units of disk space that are used to store data. Regular files, directories, and symbolic links make use of data blocks. Device files do not hold data.

## Identifying File Types

The Solaris OE supports a standard set of file types that are found in nearly all UNIX-based operating systems. In general, files provide a means of storing data, activating devices, or allowing inter-process communication. Of the different types of files that exist in the Solaris OE, there are four main file types:

- Regular or ordinary files
- Directories
- Symbolic links
- Device files

Regular files, directories, and symbolic links all store one or more types of data. Device files do not store data. Instead, device files provide access to devices.

Use the `ls` command to distinguish different file types from one another. The character in the first column of information that the `ls -l` command displays indicates the file type.

The following examples, taken from a SPARC<sup>®</sup> technology Ultra<sup>™</sup> 5 workstation, show partial listings of directories that contain a variety of different file types:

```
# cd /etc
# ls -l
total 428
drwxr-xr-x  2 adm      adm      512 Apr  3 10:42 acct
lrwxrwxrwx  1 root    root      14 Apr  3 11:05 aliases ->
./mail/aliases
drwxr-xr-x  2 root    bin       512 Apr  3 10:45 apache
-rw-r--r--  1 root    bin        50 Apr  3 10:45 auto_home
-rw-r--r--  1 root    bin       113 Apr  3 10:45 auto_master
(output truncated)

# cd /devices/pci@1f,0/pci@1,1/ide@3
# ls -l
total 0
brw-----  1 root    sys      136,  0 Apr  3 11:11 dad@0,0:a
crw-----  1 root    sys      136,  0 Apr  3 11:11 dad@0,0:a,raw
brw-----  1 root    sys      136,  1 Apr  4 11:06 dad@0,0:b
crw-----  1 root    sys      136,  1 Apr  3 11:11 dad@0,0:b,raw
(output truncated)
```

The character in the first column identifies each file type, as follows:

- Regular files
- d Directories
- l Symbolic links
- b Block-special device files
- c Character-special device files

## Regular Files

Perhaps the most common file types found in the Solaris OE are regular files, which enable the user to store many different types of data. Regular files can hold American Standard Code for Information Interchange (ASCII) text or binary data, including image data, database data, application-related data, and more.

There are many ways to create regular files. For example, a user could use the `vi` editor to create an ASCII text file, or a user could use a compiler to create a file that contains binary data. As another example, a user could use the `touch` command with a nonexistent file name to create a new, empty regular file.

Figure 1-3 shows a regular file called `file1`. As illustrated, the name `file1` is associated with inode number 1282. The data blocks associated with `file1` can hold one of many types of data, and the file could have been created in one of many different ways.

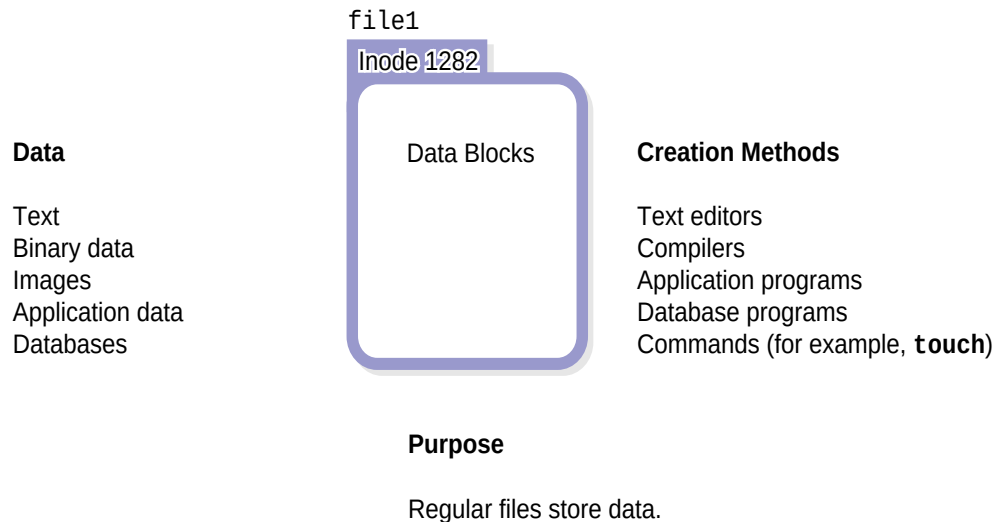


**Figure 1-3** Regular Files

## Directories

Directories store information that associates file names with inode numbers. Unlike regular files, which can hold many different types of data, directories only hold file name-to-inode associations.

A directory contains entries for files of all types that are logically found within that directory.

Figure 1-4 shows information about a directory called `dir1`. As illustrated in the figure, the name `dir1` is associated with inode number 4221. The data blocks associated with the `dir1` directory hold a list of file names and their associated inode numbers. The `mkdir` command is one way to create new directories.

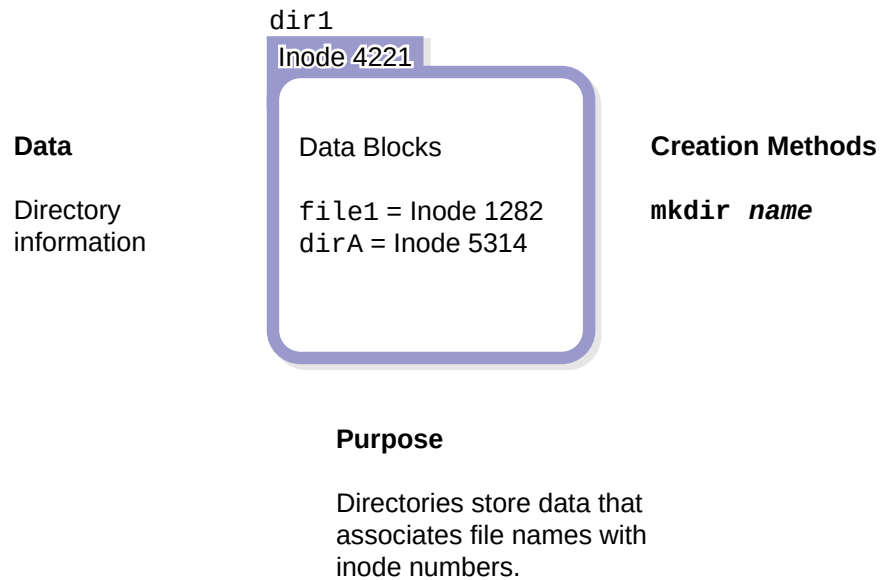


**Figure 1-4** Directories

Think of the information that directories hold as a list. Each entry in this list accounts for one file name. If the file called `file1` and the directory called `dirA` were logically located in the directory called `dir1`, then the `dir1` directory would contain an entry that associates the name `file1` with inode number 1282 and an entry that associates the name `dirA` with inode number 5314.

## Symbolic Links

A symbolic link is a file that points to another file. Like directories, which contain only directory information, symbolic links contain only one type of data.

A symbolic link contains the path name of the file to which it points. Because symbolic links use path names to point to other files, they can point to files in other file systems.

The size of a symbolic link always matches the number of characters in the path name it contains.

In the following example, the symbolic link called `/bin` points to the directory `./usr/bin`. The size of the symbolic link is 9 bytes because the path name `./usr/bin` contains 9 characters.

```
# cd /
# ls -l bin
total 135
lrwxrwxrwx 1 root      root          9 Mar 22 10:39 bin -> ./usr/bin
```

Symbolic links can point to regular files, directories, other symbolic links, and device files. They can use absolute or relative path names.

The `ln` command with the `-s` option creates a symbolic link.

```
# ln -s file1 link1
```

Symbolic links direct read and write operations to the file to which they point. The preceding command shows how using `link1` as a command-line argument causes the `ln` command to refer to the file called `file1`.

Figure 1-5 shows a symbolic link file called `link1`. As shown in the following figure, the `link1` file is associated with inode number 3561. The data block for the `link1` file contains the path name (`./file2`) to `file1`.

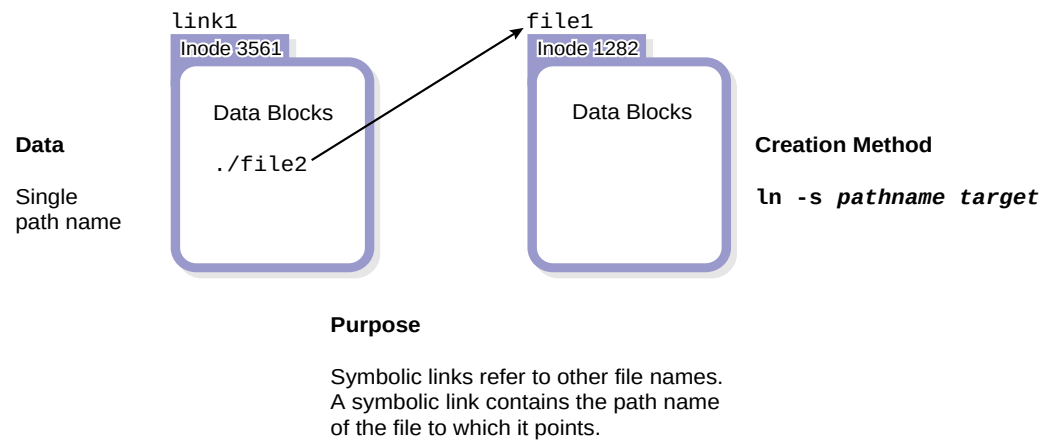


**Figure 1-5** Symbolic Links

## Device Files

A device file provides access to a device. Unlike regular files, directories, and symbolic links, device files do not use data blocks. Instead, the inode information of device files holds numbers that refer to devices. Use the `ls -l` command to display these numbers.

For example, a long listing of a regular file shows the file's size.

```
# cd /etc
# ls -al |more
total 510
drwxr-xr-x  51 root    sys      3584 Mar 14 07:35 .
drwxr-xr-x  29 root    root     1024 Mar 14 07:30 ..
drwxr-xr-x   2 adm     adm       512 Feb 13 12:15 acct
lrwxrwxrwx   1 root    root      14 Feb 13 10:37 aliases ->
./mail/aliases
drwxr-xr-x   3 root    bin       512 Feb 13 12:15 apache
-rw-r--r--   1 root    bin        50 Feb 13 10:40 auto_home
-rw-r--r--   1 root    bin       113 Feb 13 10:40 auto_master
lrwxrwxrwx   1 root    root      16 Feb 13 10:26 autopush ->
../sbin/autopush
dr-xr-xr-x   3 root    root       512 Feb 28 14:07 certs
lrwxrwxrwx   1 root    root      18 Feb 13 10:26 cfgadm ->
../usr/sbin/cfgadm
lrwxrwxrwx   1 root    root      18 Feb 13 10:35 chroot ->
../usr/sbin/chroot
```

```
lrwxrwxrwx  1 root      root          16 Feb 13 10:26 clri ->
../usr/sbin/clri
-rw-r--r--  1 root      other        314 Mar 14 07:06 coreadm.conf
-rw-r--r--  1 root      root         2236 Mar 14 07:06 .cpr_config
lrwxrwxrwx  1 root      root          16 Feb 13 10:26 cron ->
../usr/sbin/cron
(output truncated)
```

A long listing of a device file shows two numbers, separated by a comma. These two numbers are called major and minor device numbers. In the following example, the device file `dad@0,0:a` refers to major device number 136 and minor device number 0.

```
# cd /devices/pci@1f,0/pci@1,1/ide@3
# ls -l dad@0*
total 0
brw-r----- 1 root      sys         136,  0 Sep  6 15:40 dad@0,0:a
crw-r----- 1 root      sys         136,  0 Sep  6 15:40 dad@0,0:a,raw
brw-r----- 1 root      sys         136,  1 Sep  7 07:37 dad@0,0:b
crw-r----- 1 root      sys         136,  1 Sep  6 15:40 dad@0,0:b,raw
brw-r----- 1 root      sys         136,  2 Sep  6 15:40 dad@0,0:c
crw-r----- 1 root      sys         136,  2 Sep  6 15:40 dad@0,0:c,raw
brw-r----- 1 root      sys         136,  3 Sep  6 15:40 dad@0,0:d
crw-r----- 1 root      sys         136,  3 Sep  6 15:40 dad@0,0:d,raw
brw-r----- 1 root      sys         136,  4 Sep  6 15:40 dad@0,0:e
crw-r----- 1 root      sys         136,  4 Sep  6 15:40 dad@0,0:e,raw
brw-r----- 1 root      sys         136,  5 Sep  6 15:40 dad@0,0:f
crw-r----- 1 root      sys         136,  5 Sep  6 15:40 dad@0,0:f,raw
brw-r----- 1 root      sys         136,  6 Sep  6 15:40 dad@0,0:g
crw-r----- 1 root      sys         136,  6 Sep  6 15:40 dad@0,0:g,raw
brw-r----- 1 root      sys         136,  7 Sep  6 15:40 dad@0,0:h
crw-r----- 1 root      sys         136,  7 Sep  6 15:40 dad@0,0:h,raw
```

A major device number identifies the specific device driver required to access a device. A minor device number identifies the specific unit of the type that the device driver controls.



The device file `dad@0,0:a`, shown in Figure 1-6, occupies inode number 90681. The inode contains the major and minor device numbers that refer to a specific device, in this case, a slice on a disk.

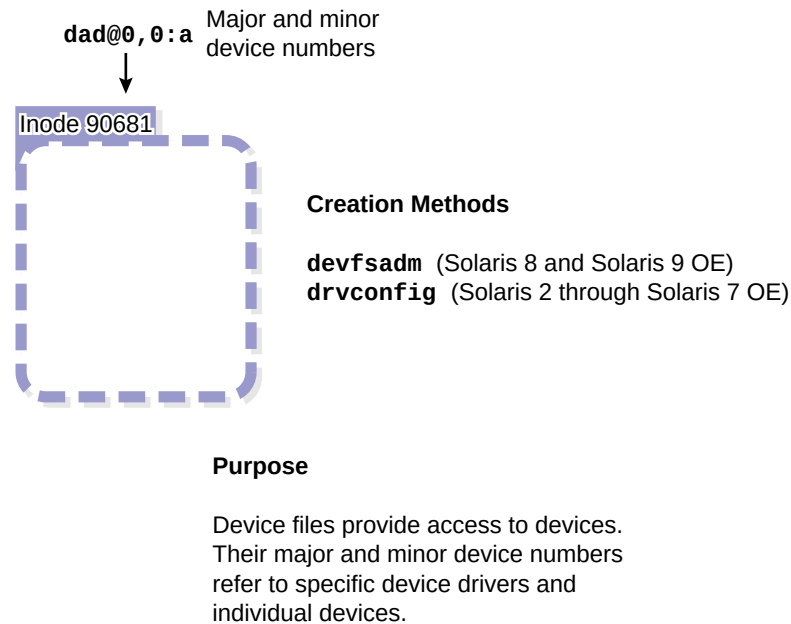


**Figure 1-6** Device Files

In general, a reconfiguration boot creates device files and symbolic links to the device files automatically. In both the Solaris 8 OE and Solaris 9 OE, you can use the `devfsadm` command to create new device files manually.

A direct relationship exists between the device file and the device it controls. The major and minor device numbers contained in the inode establish this relationship.

Figure 1-7 shows the relationship between the device file `dad@0,0:a` and the disk device it controls. The inode information for `dad@0,0:a` contains major number 136 and minor number 0. Major number 136 identifies the dad device driver. The dad device driver controls integrated device electronics (IDE) disk drives. Minor number 0, in this case, identifies Slice 0.

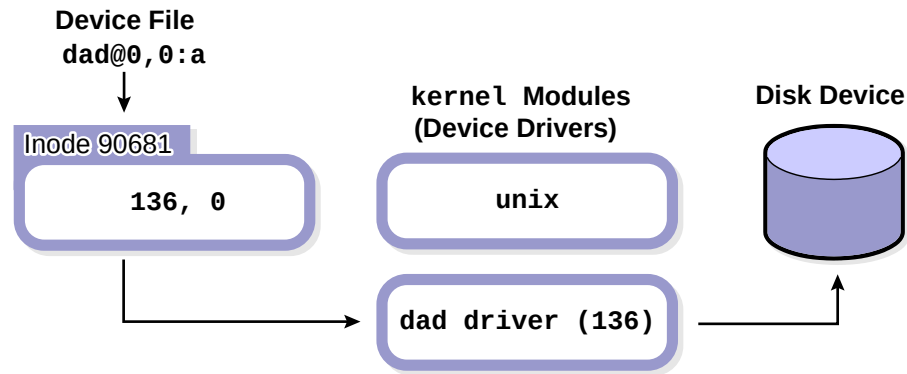


**Figure 1-7** Device File Example

Device files fall into two categories: character-special devices and block-special devices. Character-special devices are also called character or raw devices. Block-special devices are often called block devices. Device files in these two categories interact with devices differently.

### Character-Special Device Files

The file type “c” identifies character-special device files. For disk devices, character-special device files call for input/output (I/O) operations based on the disk’s smallest addressable unit, a sector. Each sector is 512 bytes in size.

The following example shows a character-special device file.

```
crw-r----- 1 root    sys      136,  0 Feb 14 11:05 dad@0,0:a,raw
```

### Block-Special Device Files

The file type “b” identifies block-special device files. For disk devices, block-special device files call for I/O operations based on a defined block size. The block size depends on the particular device, but for UNIX file systems (ufs), the default block size is 8 Kbytes.

The following example shows a block-special device file.

```
brw-r----- 1 root    sys      136,  0 Feb 14 11:05 dad@0,0:a
```

## Using Hard Links

This section defines hard links and describes how to use them.

### Introducing Hard Links

A hard link is the association between a file name and an inode. A hard link is not a separate type of file. Every type of file uses at least one hard link. Every entry in a directory constitutes a hard link. Think of every file name as a hard link to an inode. When you create a file, using the `touch` command, for example, a new directory entry is created that links the file name you specified with a particular inode. In this way, creating a new file creates a hard link.

In Figure 1-8, the file called `file1` is listed in the directory `dir1`. In `dir1`, the name `file1` is associated with inode number 1282. The hard link is the association between `file1` and inode number 1282.

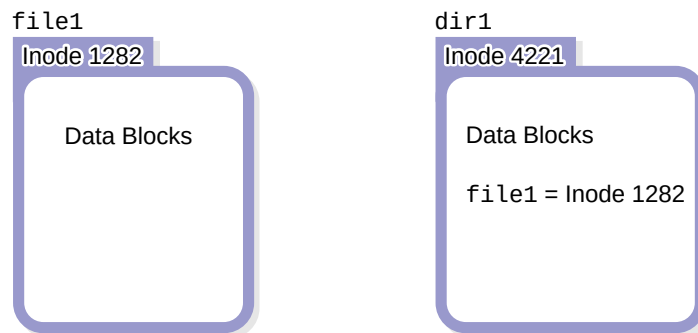


**Figure 1-8** Hard Link

Information in each inode keeps count of the number of file names associated with it. This is called a link count. In the output from the `ls -l` command, the link count appears between the column of file permissions and the column identifying the owner. In the following example, the file called `file1` uses one hard link.

```
# cd dir1
# touch file1
# ls -l
total 0
-rw-r--r--  1 root    other          0 Apr  7 15:26 file1
```

## Creating New Hard Links

A new hard link for a file name increments the link count in the associated inode.

In the following example, inode 1282 now has two hard links, one for `file1` and the other for `file2`. The `ls -li` command lists the inode number in the left-most column. The `find -inum` command locates files and directories that have the same inode numbers.

```
# ln file1 file2
# ls -l
total 0
-rw-r--r--  2 root    other          0 Apr  7 15:26 file1
-rw-r--r--  2 root    other          0 Apr  7 15:26 file2
# ls -li
total 0
 1282 -rw-r--r--  2 root    other          0 Apr  7 15:26 file1
 1282 -rw-r--r--  2 root    other          0 Apr  7 15:26 file2
# find . -inum 1282
./file1
./file2
```

The `ln` command creates new hard links to regular files.

For example, the `ln file1 file2` command creates a new directory entry called `file2`. The `file2` file is associated with the same inode that is associated with `file1`.

Figure 1-9 shows the result of the `ln` command. Two file names are associated with inode number 1282. Unlike symbolic links, hard links cannot span file systems.

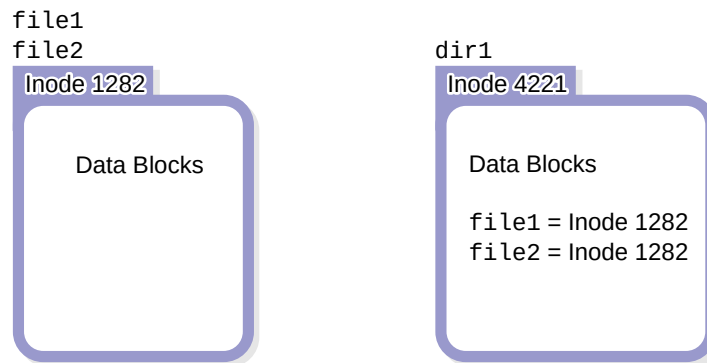


**Figure 1-9** File Names Associated With an Inode Number

## Removing Hard Links

Deleting one of the files has no effect on the other file. The link count decrements accordingly.

The following example shows how deleting `file1` from the previous example has no effect on `file2`.

```
# rm file1
# ls -li
total 0
1282 -rw-r--r--  1 root    other          0 Apr  7 15:26 file2
```

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine which commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Identifying File Types (Level 1)

In this exercise, you complete the following tasks:

- Navigate within the directory hierarchy
- Identify different types of files

### Preparation

Refer to the lecture notes as necessary to perform the following steps and answer the following questions.

### Tasks

Complete the following tasks:

- Identify the first symbolic link listed in the / (root) directory. Record the symbolic link's size and the name of the file it references. Identify the types of files found in the /dev/dsk directory and the types of files that the symbolic links reference, if any. Identify the types of files found in the /dev/pts directory and the types of files that the symbolic links reference, if any.

(Steps 1–5 in Level 2 lab)

- Identify the types of files found in the /etc/init.d directory. Record the inode number and link count for the nfs.server file. Use the find command to locate all other files below the /etc directory that use the same inode as nfs.server.

(Steps 6–8 in Level 2 lab)

- Create a directory called /testdir. In this directory, create a file and a symbolic link that points to the file. Determine if the two files use the same or a different inode.

Create a directory called newdir within the /testdir directory. Identify the inode it uses, its link count, and the name of any other file that uses the same inode as the newdir directory.

Create another directory below the newdir directory. Determine how the link count for the newdir directory changes, and find any new file that uses the same inode as the newdir directory.

(Steps 9–14 in Level 2 lab)

## Exercise: Identifying File Types (Level 2)

In this exercise, you complete the following tasks:

- Navigate within the directory hierarchy
- Identify different types of files

### Preparation

Refer to the lecture notes as necessary to perform the following steps and answer the following questions.

### Task Summary

Complete the following tasks:

- Identify the first symbolic link listed in the / (root) directory. Record the symbolic link's size and the name of the file it references. Identify the types of files found in the /dev/dsk directory and the types of files that the symbolic links reference, if any. Identify the types of files found in the /dev/pts directory and the types of files that the symbolic links reference, if any.
- Identify the types of files found in the /etc/init.d directory. Record the inode number and link count for the `nfs.server` file. Use the `find` command to locate all other files below the /etc directory that use the same inode as `nfs.server`.
- Create a directory called `/testdir`. In this directory, create a file and a symbolic link that points to the file. Determine if the two files use the same or a different inode.

Create a directory called `newdir` within the `/testdir` directory. Identify the inode it uses, its link count, and the name of any other file that uses the same inode as the `newdir` directory.

Create another directory below the `newdir` directory. Determine how the link count for the `newdir` directory changes, and find any new file that uses the same inode as the `newdir` directory.



## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. In the `/` (root) directory, perform a long listing and record the name of the first symbolic link listed.
2. What is the size in bytes of the link you found in Step 1? How many characters are there in the name of the file to which this link points?
3. Change to the `/dev/dsk` directory. Record the file types that you find in this directory.
4. Use the appropriate options for the `ls` command to display information for the files that are referenced by the files in the `/dev/dsk` directory. Record the file types reported.
5. Change to the `/dev/pts` directory, and use the same commands you used in Steps 3 and 4 for the `/dev/dsk` directory. Record the file types you find.
6. Change to the `/etc/init.d` directory, and identify the type of file in this directory.
7. How many hard links are associated with the `/etc/init.d/nfs.server` file? What is the inode number associated with this file?
8. Find the number of files in the `/etc` directory or below that have the same inode number as that used by the `/etc/init.d/nfs.server` file.
9. Create a new directory called `/testdir`. Create a file in this directory called `file1`. Create a symbolic link called `link1` that points to `file1`.
10. List `file1` and the `link1` symbolic link. Do these files use the same or different inodes?
11. In the `/testdir` directory, create a new directory called `newdir`. What is the number of hard links associated with the `newdir` directory? What is the inode number associated with the `newdir` directory?
12. List all files, including hidden files, that exist in the `newdir` directory. Which of these files uses the same inode as the `newdir` directory?

13. Create a new directory called `dir2` below the `newdir` directory. What happens to the link count for the `newdir` directory?
14. Use the `ls` command with appropriate options to find the new file name that uses the same inode as the `newdir` directory. Record the name of the new file.

## Exercise: Identifying File Types (Level 3)

In this exercise, you complete the following tasks:

- Navigate within the directory hierarchy
- Identify different types of files

### Preparation

Refer to the lecture notes as necessary to perform the following steps and answer the following questions.

### Task Summary

In this exercise, you accomplish the following:

- Identify the first symbolic link listed in the `/` (root) directory. Record the symbolic link's size and the name of the file it references. Identify the types of files found in the `/dev/dsk` directory and the types of files that the symbolic links reference, if any. Identify the types of files found in the `/dev/pts` directory and the types of files that the symbolic links reference, if any.
- Identify the types of files found in the `/etc/init.d` directory. Record the inode number and link count for the `nfs.server` file. Use the `find` command to locate all other files below the `/etc` directory that use the same inode as `nfs.server`.
- Create a directory called `/testdir`. In this directory, create a file and a symbolic link that points to the file. Determine if the two files use the same or a different inode.

Create a directory called `newdir` within the `/testdir` directory. Identify the inode it uses, its link count, and the name of any other file that uses the same inode as the `newdir` directory.

Create another directory below the `newdir` directory. Determine how the link count for the `newdir` directory changes, and find any new file that uses the same inode as the `newdir` directory.

## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. In the `/` (root) directory, perform a long listing, and record the name of the first symbolic link listed.

```
# cd /  
# ls -l
```

*The `/bin` symbolic link should be the first link listed in the `/` (root) directory.*

2. What is the size in bytes of the link you found in Step 1? How many characters are there in the name of the file to which this link points?

*The `/bin` symbolic link contains 9 bytes of data and points to `./usr/bin`.*

3. Change to the `/dev/dsk` directory. Record the file types that you find in this directory.

```
# cd /dev/dsk  
# ls -l
```

*The `/dev/dsk` directory contains symbolic links.*

4. Use the appropriate options of the `ls` command to display information for the files referenced by the files in the `/dev/dsk` directory. Record the file types reported.

```
# ls -lL
```

*The symbolic links in the `/dev/dsk` directory point to block-special device files.*

5. Change to the `/dev/pts` directory, and use the same commands you used in Steps 3 and 4 for the `/dev/dsk` directory. Record the file types you find.

```
# cd /dev/pts  
# ls -l  
# ls -lL
```

*The `/dev/pts` directory contains symbolic links.*

*The symbolic links in the `/dev/pts` directory point to character-special device files.*

6. Change to the `/etc/init.d` directory, and identify the type of file in this directory.

```
# cd /etc/init.d ; ls -l
```

*The `/etc/init.d` directory contains regular files.*

7. How many hard links are associated with the `/etc/init.d/nfs.server` file? What is the inode number associated with this file?

```
# ls -li nfs.server
```

*The `/etc/init.d/nfs.server` file has six hard links associated with it. The inode number varies among different systems.*

8. Find the number of files in the `/etc` directory or below that have the same inode number as that used by the `/etc/init.d/nfs.server` file.

```
# ls -li /etc/init.d/nfs.server
176603 /etc/init.d/nfs.server
# find /etc -inum 176603
```

*Six files, including `nfs.server`, use the same inode number. They are:*

```
/etc/init.d/nfs.server
/etc/rc0.d/K28nfs.server
/etc/rc1.d/K28nfs.server
/etc/rc2.d/K28nfs.server
/etc/rc3.d/S15nfs.server
/etc/rcS.d/K28nfs.server
```

9. Create a new directory called `/testdir`. Create a file in this directory called `file1`. Create a symbolic link called `link1` that points to `file1`.

```
# mkdir /testdir
# cd /testdir
# touch file1
# ln -s file1 link1
```

10. List `file1` and the `link1` symbolic link. Do these files use the same or different inodes?

```
# ls -li
```

*These two files use two different inodes.*

11. In the `/testdir` directory, create a new directory called `newdir`. What is the number of hard links associated with the `newdir` directory? What is the inode number associated with the `newdir` directory?

```
# mkdir newdir
# ls -ldi newdir
```

*The link count for the `newdir` directory is two. The inode number varies among different systems.*

12. List all files, including hidden files, that exist in the `newdir` directory. Which of these files uses the same inode as the `newdir` directory?

```
# ls -lia newdir
```

*The file called dot (.) uses the same inode as the newdir directory.*

13. Create a new directory called `dir2` below the `newdir` directory. What happens to the link count for the `newdir` directory?

```
# mkdir newdir/dir2
```

```
# ls -ldi newdir
```

*The link count increases from two to three.*

14. Use the `ls` command with appropriate options to find the new file name that uses the same inode as the `newdir` directory. Record the name of the new file.

```
# ls -laRi newdir
```

*The newdir/dir2/.. file uses the same inode as the newdir directory.*

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications





# Managing Local Disk Devices

---

## Objectives

Upon completion of this module, you should be able to:

- Describe the basic architecture of a disk
- Describe the naming conventions for devices
- List devices
- Reconfigure devices
- Perform hard disk partitioning
- Manage disk labels
- Describe the Solaris™ Management Console
- Partition a disk by using the Solaris Management Console

The following course map shows how this module fits into the current instructional goal.

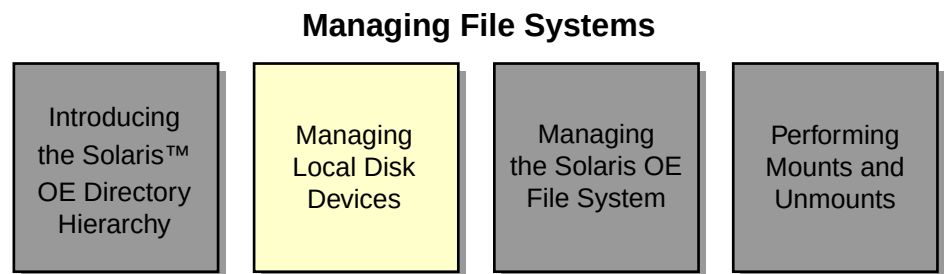


**Figure 2-1** Course Map

## Introducing the Basic Architecture of a Disk

A disk device has physical components and logical components. The physical components include disk platters and read/write heads. The logical components include disk slices, cylinders, tracks, and sectors.

### Physical Disk Structure

A disk is physically composed of a series of flat, magnetically coated platters that are stacked on a spindle. The spindle turns while the read/write heads move as a single unit radially, reading and writing data on the platters.

Figure 2-2 identifies the parts of a disk.

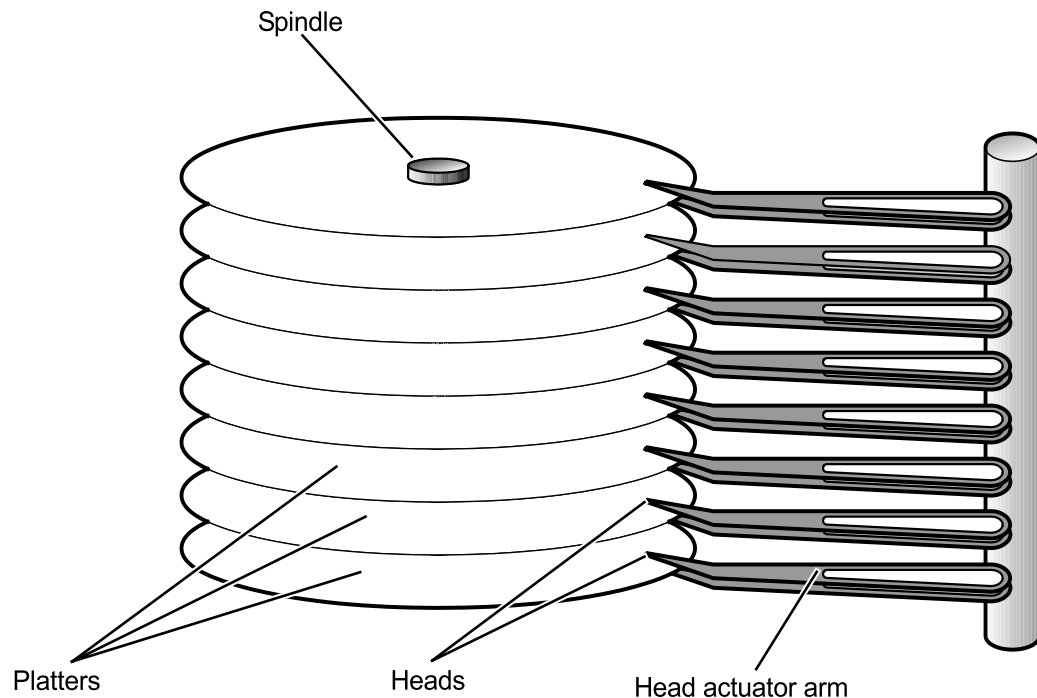


**Figure 2-2** Components of a Disk

The following list describes the physical components of a disk:

- The disk storage area is composed of one or more platters.
- The platters rotate.
- The head actuator arm moves the read/write heads as a unit radially.
- The read/write heads read and write data on the magnetic surface on both sides of the platters.

## Data Organization on Disk Platters

Figure 2-3 shows the logical components of a disk platter.

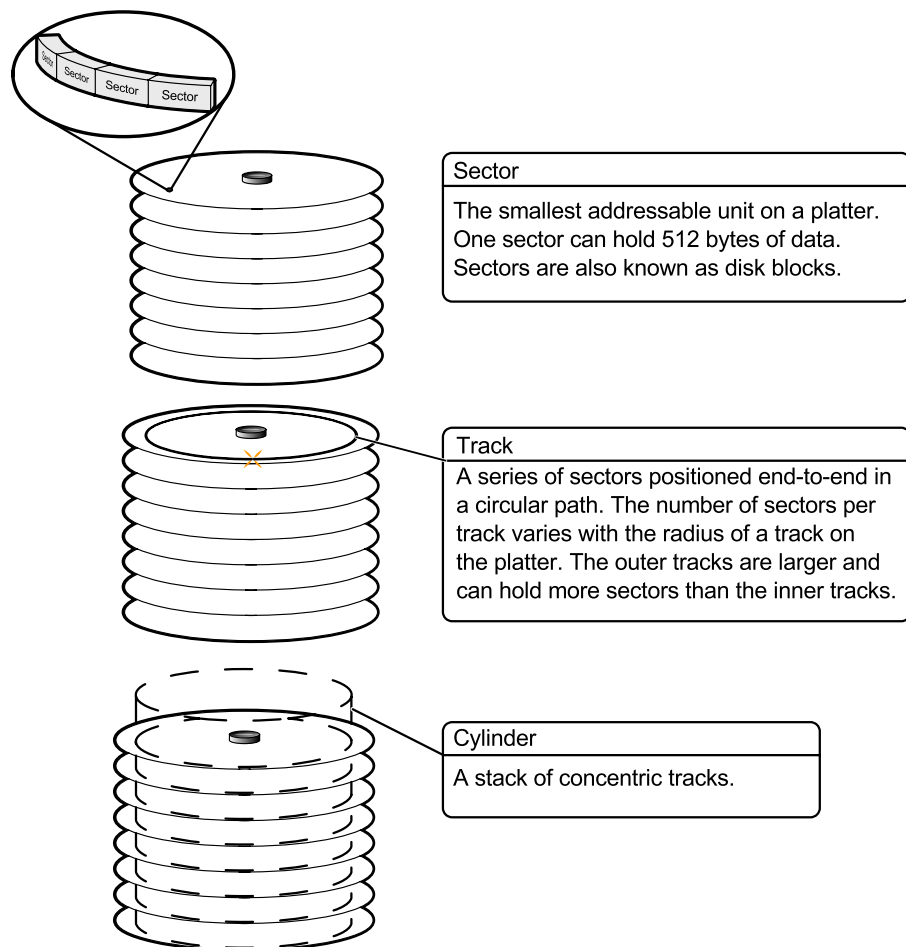


**Figure 2-3** Data Organization on Disk Platters

A disk platter is divided into sectors, tracks, and cylinders.

|          |                                                                                                                           |
|----------|---------------------------------------------------------------------------------------------------------------------------|
| Sector   | The smallest addressable unit on a platter. One sector can hold 512 bytes of data. Sectors are also known as disk blocks. |
| Track    | A series of sectors positioned end-to-end in a circular path.                                                             |
| Cylinder | A stack of tracks.                                                                                                        |

The number of sectors per track varies with the radius of a track on the platter. The outermost tracks are larger and can hold more sectors than the inner tracks.



---

**Note** – Disks present a fixed number of sectors per track to the Solaris OE even though, physically, the number of sectors per track varies by track location.

---

Because a disk spins continuously and the read/write heads move as a single unit, the most efficient seeking occurs when the sectors to be read from or written to are located in a single cylinder.

## Disk Slices

Disks are logically divided into individual partitions known as disk slices. Disk slices are groupings of cylinders that are commonly used to organize data by function.

For example, one slice can store critical system files and programs while another slice on the same disk can store user-created files.



---

**Note** – Grouping cylinders into slices is done to organize data, facilitate backups, and provide swap space.

---

A disk under the Solaris OE can be divided into eight slices that are labeled Slice 0 through Slice 7.

By convention, Slice 2 represents the entire disk. Slice 2 maintains important data about the entire disk, such as the size of the actual disk and the total number of cylinders available for the storage of files and directories.

A starting cylinder and an ending cylinder define each slice. These cylinder boundaries determine the size of a slice.

Figure 2-4 shows how disk slices might reside on a disk.

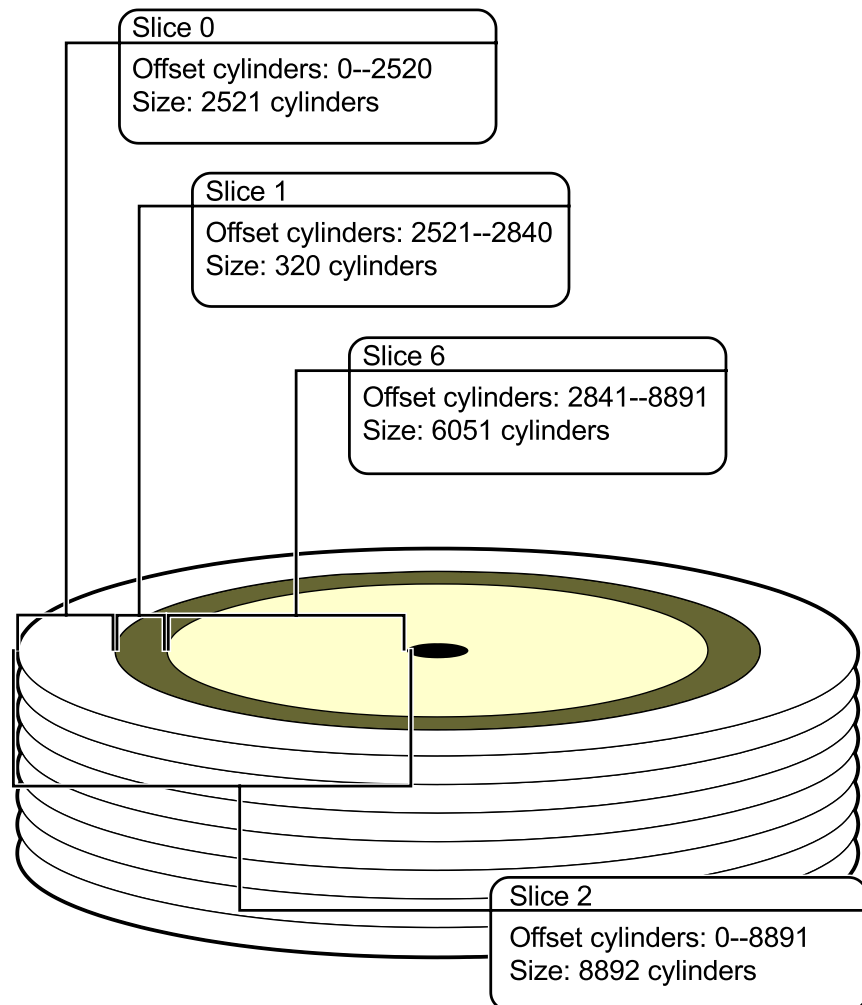


**Figure 2-4** Cylinders and Slices

Table 2-1 shows disk slices and the different file systems they could hold.

**Table 2-1** Disk Slices

| Slice | Name         | Function                          |
|-------|--------------|-----------------------------------|
| 0     | /            | The root directory's system files |
| 1     | swap         | Swap area                         |
| 2     |              | Entire disk                       |
| 5     | /opt         | Optional software                 |
| 6     | /usr         | System executables and programs   |
| 7     | /export/home | User files and directories        |

Figure 2-5 shows a possible configuration convention for organizing data. The example disk is divided into slices that logically organize the data on the boot disk.

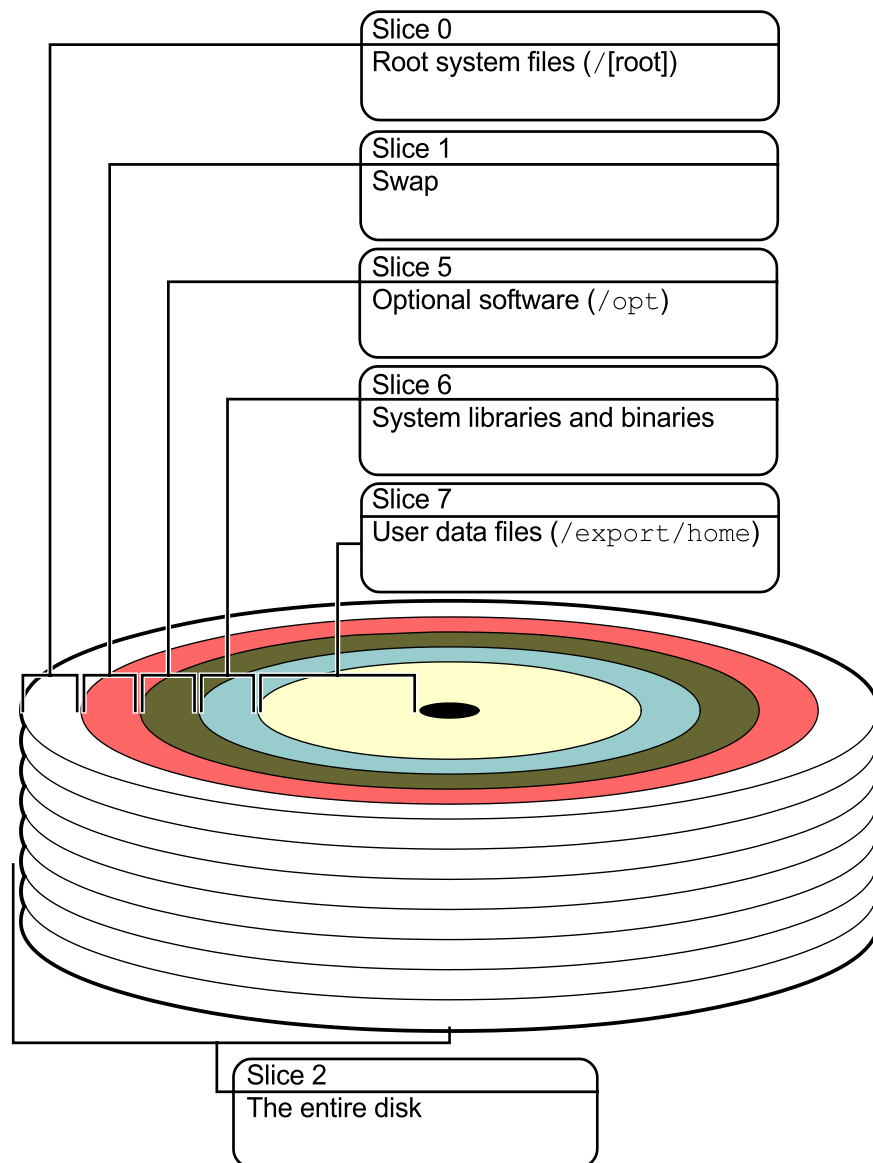


**Figure 2-5** Top View of Five Configured Disk Slices

## Disk Slice Naming Convention

An eight-character string typically represents the full name of a slice. The string includes the controller number, the target number, the disk number, and the slice number.

|                   |                                                                                                                                                                                                                                                                                                              |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Controller number | Identifies the host bus adapter (HBA), which controls communications between the system and disk unit. The HBA takes care of sending and receiving both commands and data to the device. The controller number is assigned in sequential order, such as c0, c1, c2, and so on.                               |
| Target number     | Target numbers, such as t0, t1, t2, and t3, correspond to a unique hardware address that is assigned to each disk, tape, or CD-ROM. Some external disk drives have an address switch located on the rear panel. Some internal disks have address pins that are jumpered to assign that disk's target number. |
| Disk number       | The disk number is also known as the logical unit number (LUN). This number reflects the number of disks at the target location.                                                                                                                                                                             |
| Slice number      | A slice number ranging from 0 to 7.                                                                                                                                                                                                                                                                          |

The embedded SCSI configuration and the integrated device electronics (IDE) configuration represent the disk slice naming conventions across two different architectures. The disk number is always set to d0 with embedded SCSI disks.

Figure 2-6 shows the eight-character string that represents the full name of a disk slice.

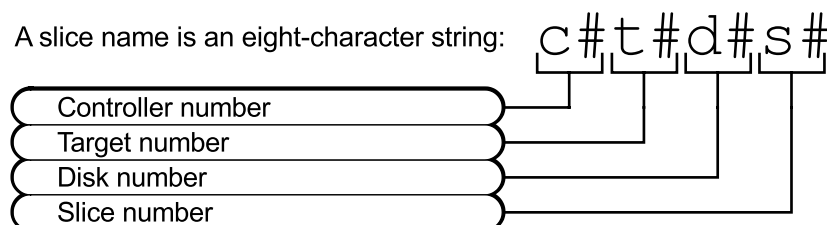


**Figure 2-6** Disk Slice Naming Conventions



Figure 2-7 shows the configuration of the SCSI architecture.

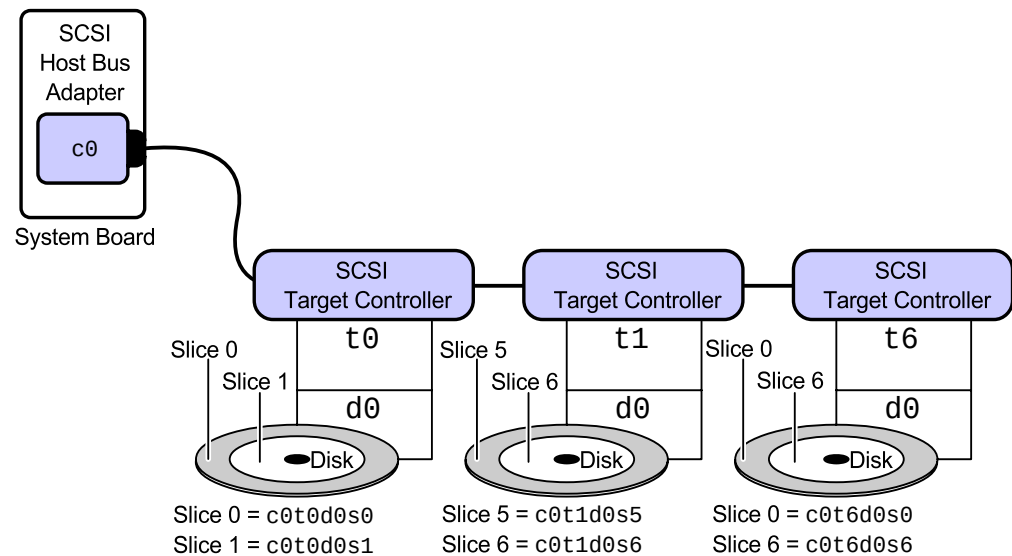


**Figure 2-7** Embedded SCSI Configuration

Figure 2-8 shows the configuration of the IDE architecture.

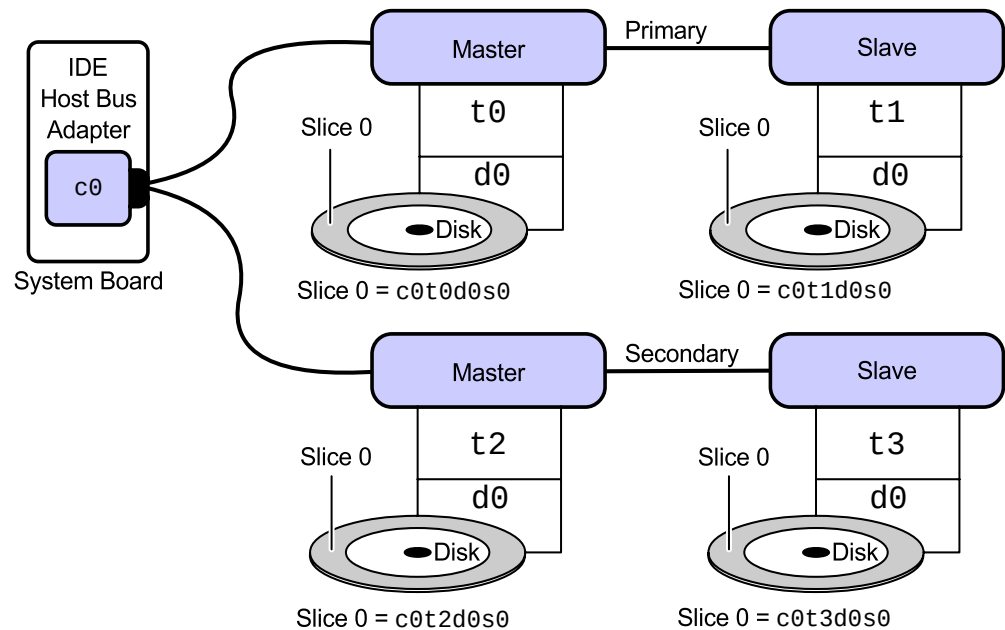


**Figure 2-8** IDE Configuration

## Introducing Solaris OE Device Naming Conventions

In the Solaris OE, all devices are represented by three different types of names, depending on how the device is being referenced:

- Logical device names
- Physical device names
- Instance names



---

**Note** – The Berkeley Software Distribution (BSD) device names exist in the Solaris OE if the BSD compatibility packages are installed with the Solaris Developer, Entire Distribution, or Entire Distribution Plus the original equipment manufacturer (OEM) Solaris software group. The BSD device names, for example `/dev/sd0a`, are typically used for backward compatibility with old scripts.

---

### Logical Device Names

Logical disk device names are symbolic links to the physical device names kept in the `/devices` directory. Logical device names are used primarily to refer to a device when you are entering commands on the command line. All logical device names are kept in the `/dev` directory. The logical device names contain the controller number, target number, disk number, and slice number.

Every disk device has an entry in both the `/dev/dsk` and `/dev/rdsk` directories for the block and character disk devices, respectively. To display the entries in the `/dev/dsk` directory, perform the command:

```
# ls /dev/dsk
```

```
c0t0d0s0 c0t0d0s4 c0t3d0s0 c0t3d0s4 c0t6d0s0 c0t6d0s4
c0t0d0s1 c0t0d0s5 c0t3d0s1 c0t3d0s5 c0t6d0s1 c0t6d0s5
c0t0d0s2 c0t0d0s6 c0t3d0s2 c0t3d0s6 c0t6d0s2 c0t6d0s6
c0t0d0s3 c0t0d0s7 c0t3d0s3 c0t3d0s7 c0t6d0s3 c0t6d0s7
```

- `c0t0d0s0` through `c0t0d0s7` – Identifies the device names for disk Slices 0 through 7 for a disk that is attached to Controller 0, at Target 0, on Disk Unit 0.
- `c0t3d0s0` through `c0t3d0s7` – Identifies the device names for disk Slices 0 through 7 for a disk that is attached to Controller 0, at Target 3, on Disk Unit 0.

- `c0t6d0s0` through `c0t6d0s7` – Identifies the device name for CD-ROM devices. Typically, CD-ROM devices are treated in the same way as disks. This indicates a device on Controller 0, at Target 6, and Disk Unit 0.

## Physical Device Names

Physical device names uniquely identify the physical location of the hardware devices on the system and are maintained in the `/devices` directory.

A physical device name contains the hardware information, represented as a series of node names, separated by slashes, that indicate the path to the device. To display a physical device name, perform the command:

```
# ls -l /dev/dsk/c0t0d0s0
lrwxrwxrwx  1 root      root 46 Jun 16 19:07 /dev/dsk/c0t0d0s0 ->
../../../../devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a
```

Figure 2-9 shows the device configuration hierarchy of an Ultra 5 workstation. Not all possible devices are included.

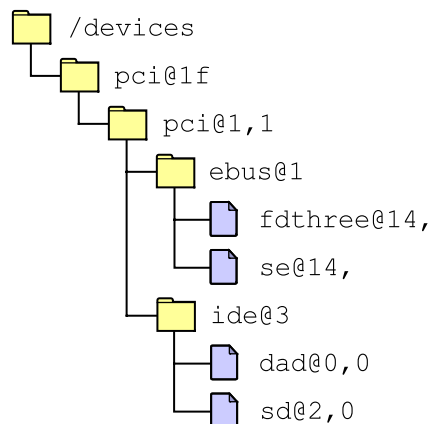


**Figure 2-9** The `/devices` Directory Structure




---

**Note** – Various hardware platforms have different device trees.

---

The top-most directory in the hierarchy is called the root node of the device tree. The bus nexus nodes and the leaf nodes below the root object have device drivers associated with them.

A device driver is the software that communicates with the device. This software must be available to the `kernel` so that the system can use the device.

During system initialization, the `kernel` identifies the physical location of a device. The `kernel` associates a node with an address, *nodename@address*, which is the physical device name.

In Figure 2-9, `dad@0` is the direct access disk device at address 0.

## Instance Names

Instance names are abbreviated names assigned by the `kernel` for each device on the system.

An instance name is a shortened name for the physical device name. Two examples are shown:

- `sdn`  
where `sd` is the disk name and *n* is the number, such as `sd0` for the first SCSI disk device.
- `dadn`  
where `dad` (direct access device) is the disk name and *n* is the number, such as `dad0` for the first IDE disk device.

## Listing a System's Devices

In the Solaris OE, there are several ways to list a system's devices, including:

- Using the `/etc/path_to_inst` file
- Using the `prtconf` command
- Using the `format` command

### The `/etc/path_to_inst` File

For each device, the system records its physical name and instance name in the `/etc/path_to_inst` file. These names are used by the kernel to identify every possible device. This file is read only at boot time.

The `/etc/path_to_inst` file is maintained by the kernel, and it is generally not necessary, nor is it advisable, for the system administrator to change this file.

The following example shows entries in the `/etc/path_to_inst` file. The text within the parentheses indicates what device is referred to by the entry and does not appear in the actual file.

```
# more /etc/path_to_inst
#
#      Caution! This file contains critical kernel state
(output edited for clarity)
"/pci@1f,0" 0 "pcipsy" (PCI bus controller, "psycho" chip)
"/pci@1f,0/pci@1,1" 0 "simba" (PCI bus B)
"/pci@1f,0/pci@1,1/ebus@1" 0 "ebus" (extended bus)
"/pci@1f,0/pci@1,1/ebus@1/power@14,724000" 0 "power" (power management bus)
"/pci@1f,0/pci@1,1/ebus@1/fdthree@14,3023f0" 0 "fd" (floppy disk)
"/pci@1f,0/pci@1,1/ebus@1/SUNW,CS4231@14,200000" 0 "audiocs" (crystal
semiconductor)
"/pci@1f,0/pci@1,1/ebus@1/su@14,3062f8" 1 "su" (mouse)
"/pci@1f,0/pci@1,1/ebus@1/se@14,400000" 0 "se" (serial ports A and B)
"/pci@1f,0/pci@1,1/ebus@1/su@14,3083f8" 0 "su" (keyboard)
"/pci@1f,0/pci@1,1/ebus@1/ecpp@14,3043bc" 0 "ecpp" (extended capability parallel
port)
"/pci@1f,0/pci@1,1/ide@3" 0 "uata" (ATA controller)
"/pci@1f,0/pci@1,1/ide@3/sd@2,0" 0 "sd" (CD-ROM)
"/pci@1f,0/pci@1,1/ide@3/dad@0,0" 0 "dad" (hard disk)
"/pci@1f,0/pci@1,1/network@1,1" 0 "hme" (Fast Ethernet)
```

```
"/pci@1f,0/pci@1,1/SUNW,m64B@2" 0 "m64" (color memory frame buffer)
"/pci@1f,0/pci@1" 1 "simba" (pci bus A controller)
"/options" 0 "options"
"/scsi_vhci" 0 "scsi_vhci"
"/pseudo" 0 "pseudo"
```

The device instance number, shown in the preceding example, appears to the left of the device instance name when recorded in this file.



---

**Note** – Different systems have different physical device paths. The preceding example shows an on-board peripheral component interconnect (PCI) bus configuration.

---

The following is a `/etc/path_to_inst` file from a system that has a different bus architecture. In this case, it is an example of a system that has an on-board Sun System bus (SBus).

```
# more /etc/path_to_inst
#
#      Caution! This file contains critical kernel state
#
"/sbus@1f,0" 0 "sbus"
"/sbus@1f,0/espdma@e,8400000" 0 "dma"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000" 0 "esp"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@3,0" 3 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@2,0" 2 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@1,0" 1 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@0,0" 0 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@6,0" 6 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@5,0" 5 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/sd@4,0" 4 "sd"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@3,0" 3 "st"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@2,0" 2 "st"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@1,0" 1 "st"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@0,0" 0 "st"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@6,0" 6 "st"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@5,0" 5 "st"
"/sbus@1f,0/espdma@e,8400000/esp@e,8800000/st@4,0" 4 "st"
... < remaining lines removed > ...
```

## The prtconf Command

Use the `prtconf` command to display the system's configuration information, including the total amount of memory installed and the configuration of system peripherals, which is formatted as a device tree.

The `prtconf` command lists all possible instances of devices, whether the device is attached or not attached to the system. To view a list of only attached devices on the system, perform the command:

```
# prtconf | grep -v not
System Configuration: Sun Microsystems sun4u
Memory size: 128 Megabytes
System Peripherals (Software Nodes):

SUNW,Ultra-5_10
  options, instance #0
  pci, instance #0
    pci, instance #0
      ebus, instance #0
        power, instance #0
        se, instance #0
        su, instance #0
        su, instance #1
        fdthree, instance #0
      network, instance #0
      SUNW,m64B, instance #0
      ide, instance #0
        dad, instance #0
        sd, instance #0
    pci, instance #1
      scsi, instance #0
      scsi, instance #1
  pseudo, instance #0
#
```




---

**Note** – The `grep -v not` command is used to omit all lines containing the word “not” from the output (such as `driver not attached`).

---

## The format Command

Use the `format` command to display both logical and physical device names for all currently available disks. To view the logical and physical devices for currently available disks, perform the command:

```
# format
```

```
Searching for disks...done
```

```
AVAILABLE DISK SELECTIONS:
```

- 0. c0t0d0 <SUN4.2G cyl 3880 alt 2 hd 16 sec 135>  
   /pci@1f,0/pci@1,1/ide@e/dad@0,0
- 1. c1t0d0 <SUN4.2G cyl 3880 alt 2 hd 16 sec 135>  
   /pci@if,0/pci@1/SUNW,isp2@4/sd@3,0

```
Specify disk (enter its number):
```



---

**Note** – Press Control-D to exit the `format` command.

---



# Reconfiguring Devices

The system recognizes a newly added peripheral device if a reconfiguration boot is invoked or if the `devfsadm` command is run.

## Performing a Reconfiguration Boot

For example, you can use a boot process to add a new device to a newly generated `/etc/path_to_inst` file and to the `/dev` and `/devices` directories.

The following steps reconfigure a system to recognize a newly attached disk.

1. Create the `/reconfigure` file. This file causes the system to check for the presence of any newly installed devices the next time it is powered on or booted.

**# touch /reconfigure**

2. Shut down the system by using the `init 5` command. This command safely powers off the system, allowing for addition or removal of devices. (If the device is already attached to your system, you can shut down to the `ok` prompt with the command `init 0`.)

**# init 5**

3. Turn off the power to all external devices.
4. Install the peripheral device. Make sure that the address of the device being added does not conflict with the address of other devices on the system.
5. Turn on the power to all external devices.
6. Turn on the power to the system. The system boots to the login window.
7. Verify that the peripheral device has been added by issuing either the `prtconf` or `format` command.

After the disk is recognized by the system, begin the process of defining disk slices.



---

**Note** – If the `/reconfigure` file was not created before the system was shut down, you can invoke a manual reconfiguration boot with the programmable read-only memory (PROM) level command: `boot -r`.

---

## Using the devfsadm Command

Many systems are running critical customer applications on a 24-hour, 7-day-a-week basis. It might not be possible to perform a reconfiguration boot on these systems. In this situation, you can use the `devfsadm` command.

The `devfsadm` command performs the device reconfiguration process and updates the `/etc/path_to_inst` file and the `/dev` and `/devices` directories during reconfiguration events.

The `devfsadm` command attempts to load every driver in the system and attach all possible device instances. It then creates the device files in the `/devices` directory and the logical links in the `/dev` directory. In addition to managing these directories, the `devfsadm` command also maintains the `/etc/path_to_inst` file.

To restrict the operation of the `devfsadm` command to a specific device class, use the `-c` option.

```
devfsadm -c device_class
```

The values for *device\_class* include `disk`, `tape`, `port`, `audio`, and `pseudo`. For example, to restrict the `devfsadm` command to the `disk` device class, perform the command:

```
# devfsadm -c disk
```

Use the `-c` option more than once on the command line to specify multiple device classes. For example, to specify the `disk`, `tape`, and `audio` device classes, perform the command:

```
# devfsadm -c disk -c tape -c audio
```

To restrict the use of the `devfsadm` command to configure only devices for a named driver, use the `-i` option.

```
devfsadm -i driver_name
```

The following examples use the `-i` option.

- To configure only those disks supported by the `dad` driver, perform the command:

```
# devfsadm -i dad
```

- To configure only those disks supported by the `sd` driver, perform the command:

```
# devfsadm -i sd
```

- To configure devices supported by the `st` driver, perform the command:

```
# devfsadm -i st
```

To print the changes made by the `devfsadm` command to the `/dev` and `/devices` directories, perform the command:

```
# devfsadm -v
```

To invoke cleanup routines that remove unreferenced symbolic links for devices, perform the command:

```
# devfsadm -C
```

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab is more difficult. Although each step describes what you should do, you must determine which commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Configuring and Naming Devices (Level 1)

In this exercise, you complete the following tasks:

- Identify logical, physical, and instance names for disk devices
- View the `/etc/path_to_inst` file for information about your boot disk
- Add a new disk or tape drive to a system
- Create new device files for the new disk or tape

### Preparation

This exercise requires a system that is configured with an external disk or tape drive. During system boot, this external disk must remain powered off to avoid creating links and device files.

### Tasks

Complete the following tasks:

- Identify the logical device name of your boot disk. Locate the logical device files in the `/dev/dsk` and `/dev/rdsk` directories for Slice 0 on this disk, and record their true file types.
- Locate the physical device names that are associated with both logical device names that you found for your boot disk. Record their true file types.

(Steps 1–5 in the Level 2 lab)

- In the `/etc/path_to_inst` file, identify and record the instance name for your boot disk.

(Steps 6–7 in the Level 2 lab)

- Confirm that no links or device files exist for the disk or tape device that you want to connect. Halt the system, and power on the device. Boot the system to its default run state. Run the `devfsadm` command in verbose mode to create new links and device files, and check the directories in which you created them to confirm that they exist.

(Task 1 Steps 1–2 and Task 2 Steps 1–4 in the Level 2 lab)

## Exercise: Configuring and Naming Devices (Level 2)

In this exercise, you complete the following tasks:

- Identify logical, physical, and instance names for disk devices
- View the `/etc/path_to_inst` file for information about your boot disk
- Add a new disk or tape drive to a system
- Create new device files for the new disk or tape

### Preparation

This exercise requires a system that is configured with an external disk or tape drive. During system boot, this external disk must remain powered off to avoid creating links and device files.

### Task Summary

Complete the following tasks:

- Identify the logical device name of your boot disk. Locate the logical device files in the `/dev/dsk` and `/dev/rdisk` directories for Slice 0 on this disk, and record their true file types.
- Locate the physical device names that are associated with both logical device names that you found for your boot disk. Record their true file types.
- In the `/etc/path_to_inst` file, identify and record the instance name for your boot disk.
- Confirm that no links or device files exist for the disk or tape device that you want to connect. Halt the system, and power on the device. Boot the system to its default run state. Run the `devfsadm` command in verbose mode to create new links and device files, and check the directories in which you created them to confirm that they exist.

## Tasks

Complete the following tasks.

### Task 1 – Identifying Device Files

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Expand the window so that it occupies the entire screen area. Change to the `/dev/dsk` directory.

2. List the files in this directory. Identify the files related to the boot disk of your system. Most systems use `c0t0d0`. Locate the item related to Slice 0 on this disk, and display a long listing of it.

Which type of file did you just locate? The file type indicator is the first character on the left side of the long listing.

Record the full path name to which this file points.

3. Highlight the path name you recorded in Step 2 by double-clicking the path name. Use the Copy and Paste keys to copy and paste this path name into a long listing command. If you are not using the CDE, you need to type the path name.

Which type of file is this?

The command `ls -lL c0t0d0s0` displays the same information but shows only the link file name, not the real device file name.

4. Change to the `/dev/rdisk` directory. Display a long listing of the same file name you selected in Step 2.

Which type of file is this?

Record the full path name to which this file points.

5. Highlight the path name you recorded in Step 4. Use the Copy and Paste keys to copy and paste this path name into a long listing command. If you are not using the CDE, you need to type in the path name.

Which type of file is this?

The `ls -lL c0t0d0s0` command displays the same information but shows only the link file name, not the real device file name.

6. Change the directory to the `/etc` directory. Display the contents of the `path_to_inst` file.

7. Use the information from the previous steps to locate and record the entry for your boot disk. An Ultra 5 workstation, for example, would use `c0t0d0` as its boot disk. This relates to the device file called `dad@0,0` and is listed in the `/etc/path_to_inst` directory.

The instance name is composed of the `dad` or `sd` tag and the number that precedes it in the `/etc/path_to_inst` file. What is the instance name for the device listed in this step?

### Task 2 – Adding a New Disk or Tape Device

Complete the following steps:

1. In the `/dev/dsk` and `/dev/rdisk` directories, confirm that no files exist for your external disk or tape device, for example, `/dev/dsk/c1t0d0s0` or `/dev/rmt/0`. If files for the external device do exist, ask your instructor to provide directions to remove them.
2. Shut down your system to run state 0.
3. Power on the external disk or tape drive attached to your system.
4. Boot the system to its default run state.
5. Log in as the `root` user, and open a terminal window. Run the `devfsadm` command with the `-v` option to create new links and device files for the new disk or tape drive. Observe the messages that the `devfsadm` command displays.
6. Confirm that new links and device files exist in the `/dev/dsk` and `/dev/rdisk` directories for disks or `/dev/rmt` for tape drives.



## Exercise: Configuring and Naming Devices (Level 3)

In this exercise, you complete the following tasks:

- Identify logical, physical, and instance names for disk devices
- View the `/etc/path_to_inst` file for information about your boot disk
- Add a new disk or tape drive to a system
- Create new device files for the new disk or tape

### Preparation

This exercise requires a system that is configured with an external disk or tape drive. During system boot, this external disk must remain powered off to avoid creating links and device files.

### Task Summary

Complete the following tasks:

- Identify the logical device name of your boot disk. Locate the logical device files in the `/dev/dsk` and `/dev/rdisk` directories for Slice 0 on this disk, and record their true file types.
- Locate the physical device names that are associated with both logical device names that you found for your boot disk. Record their true file types.
- In the `/etc/path_to_inst` file, identify and record the instance name for your boot disk.
- Confirm that no links or device files exist for the disk or tape device that you want to connect. Halt the system, and power on the device. Boot the system to its default run state. Run the `devfsadm` command in verbose mode to create new links and device files, and check the directories in which you created them to confirm that they exist.

## Tasks and Solutions

Complete the following tasks.

### Task 1 – Identifying Device Files

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Expand the window so that it occupies the entire screen area. Change to the `/dev/dsk` directory.

```
# cd /dev/dsk
```

2. List the files in this directory. Identify the files related to the boot disk of your system. Most systems use `c0t0d0`. Locate the item related to Slice 0 on this disk, and display a long listing of it.

```
# ls
```

```
# ls -l c0t0d0s0
```

Which type of file did you just locate? The file type indicator is the first character on the left side of the long listing.

*Files in this directory are symbolic links. The letter `l` in the left-most column identifies a symbolic link.*

Record the full path name to which this file points.

*Systems that use PCI bus architectures list path names similar to the following:*

```
../../../../devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a
```

*Systems that use SBus architectures list path names similar to the following:*

```
../../../../devices/iommu@f,e0000000/sbus@f,e0001000/espdma@f,400000/esp@f,800000/sd@3,0:a
```

3. Highlight the path name you recorded in Step 2 by double-clicking the path name. Copy and paste this path name into a long listing command. If you are not using the CDE, you need to type the path name.

```
# ls -l pathname
```

Which type of file is this?

*Files in this directory are device files. The `b` character in the left-most column identifies a block-special device file.*

The command `ls -lL c0t0d0s0` displays the same information but shows only the link file name, not the real device file name.

4. Change to the /dev/rdisk directory. Display a long listing of the same file name you selected in Step 2.

```
# cd /dev/rdisk
# ls -l c0t0d0s0
```

Which type of file is this?

*Files in this directory are symbolic links. The letter l in the left-most column identifies a symbolic link.*

Record the full path name to which this file points.

*Systems that use PCI bus architectures list path names similar to the following:*

```
../../devices/pci@1f,0/pci@1,1/ide@3/dad@0,0:a,raw
```

*Systems that use SBus architectures list path names similar to the following:*

```
../../devices/iommu@f,e0000000/sbus@f,e0001000/espdma@f,400000/esp@f,800000/sd@3,0:a,raw
```

5. Highlight the path name you recorded in Step 4. Use the Copy and Paste keys to copy and paste this path name into a long listing command. If you are not using CDE, you need to type in the path name.

```
# ls -l pathname
```

Which type of file is this?

*Files in this directory are device files. The c character in the left-most column identifies a character-special device file.*

The `ls -lL c0t0d0s0` command displays the same information but shows only the link file name, not the real device file name.

6. Change to the /etc directory. Display the contents of the path\_to\_inst file.

```
# cd /etc
# more path_to_inst
```

7. Use the information from the previous steps to locate and record the entry for your boot disk. An Ultra 5 workstation, for example, would use c0t0d0 as its boot disk. This relates to the device file called dad@0,0 and is listed in the /etc/path\_to\_inst directory.

*Systems that use PCI bus architectures list path names similar to the following:*

```
/pci@1f,0/pci@1,1/ide@3/dad@0,0
```

*Systems that use SBus architectures list path names similar to the following:*

`/iommu@f,e0000000/sbus@f,e0001000/espdma@f,400000/esp@f,800000/sd@3,0`

The instance name is composed of the dad or sd tag and the number that precedes it in the `/etc/path_to_inst` file. What is the instance name for the device listed in this step?

*dad0, sd3, or sd0, depending on the system architecture.*

### Task 2 – Adding a New Disk or Tape Device

Complete the following steps:

1. In the `/dev/dsk` and `/dev/rdisk` directories, confirm that no files exist for your external disk or device, for example, `/dev/dsk/c1t0d0s0` or `/dev/rmt/0`. If files for the external device do exist, ask your instructor to provide directions to remove them.
2. Shut down your system to run state 0.

**# init 0**

3. Power on the external disk or tape drive attached to your system.
4. Boot the system to its default run state.

**ok boot**

5. Log in as the `root` user, and open a terminal window. Run the `devfsadm` command with the `-v` option to create new links and device files for the new disk or tape drive. Observe the messages that the `devfsadm` command displays.

**# devfsadm -v**

6. Confirm that new links and device files exist in the `/dev/dsk` and `/dev/rdisk` directories for disks or `/dev/rmt` for tape drives.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications

## Partitioning the Hard Disk

The `format` utility is a system administration tool used primarily to prepare hard disk drives for use in the Solaris OE.

Although the `format` utility also performs a variety of disk-management activities, the main function of the `format` utility is to divide a disk into disk slices.



---

**Note** – You do not need to partition the disk before you install the Solaris OE.

---

### Introducing the Fundamentals of Disk Partitioning

To divide a disk into slices:

1. Identify the correct disk.
2. Plan the layout of the disk.
3. Use the `format` utility to divide the disk into slices.
4. Label the disk with new slice information.

Only the `root` user can use the `format` utility. If a regular user runs the `format` utility, the following error message appears:

```
$ format
Searching for disk...done
No permission (or no disk found)!
```

## Recognizing Disk Space and Undesirable Conditions

Disk slices are defined by an offset and a size in cylinders. The offset is the distance from Cylinder 0. Figure 2-10 shows an example of disk slice sizes and offsets.

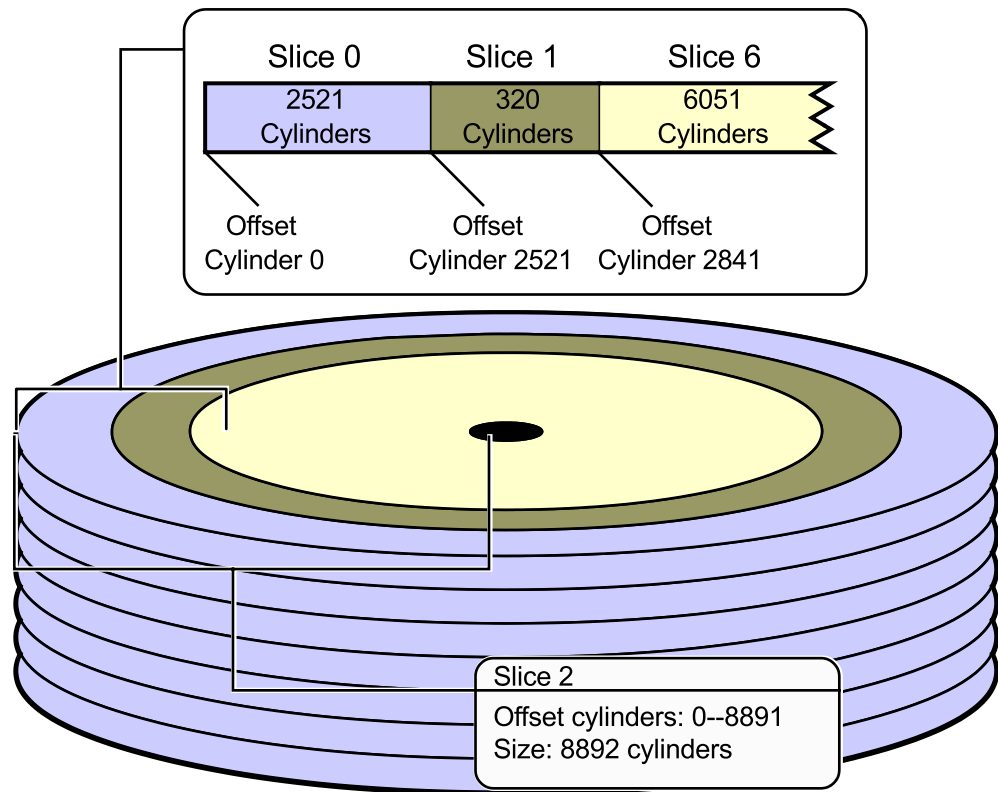


**Figure 2-10** Offsets and Sizes for Disk Partitions

The offset for Slice 0 is 0 cylinders, and its size is 2521 cylinders. Slice 0 begins on Cylinder 0 and ends on Cylinder 2520.

The offset for Slice 1 is 2521 cylinders, and its size is 320 cylinders. Slice 1 begins on Cylinder 2521 and ends on Cylinder 2840.

The offset for Slice 6 is 2841 cylinders, and its size is 6051 cylinders. Slice 6 begins on Cylinder 2841 and ends on the last available cylinder, which is Cylinder 8891.

## Recognizing Wasted Disk Space

Wasted disk space occurs when one or more cylinders are not allocated to a disk slice. Figure 2-11 shows a disk with cylinders that are not allocated.

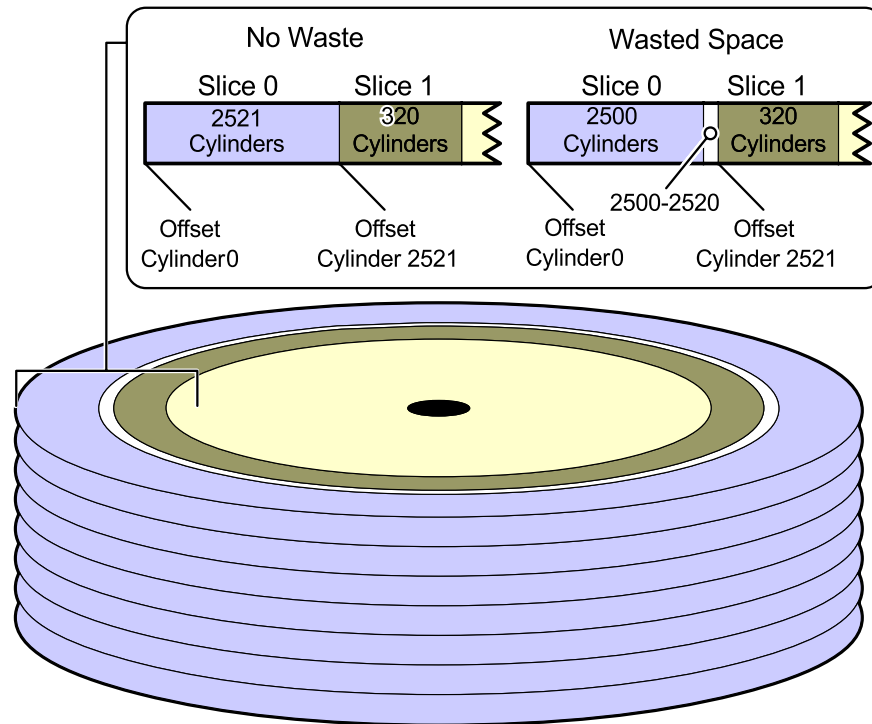


**Figure 2-11** A Disk Slice With Wasted Space

Because the cylinders are not allocated to the disk slice, Cylinders 2500 through 2520 are unusable.

Wasted disk space occurs during partitioning when one or more cylinders have not been allocated to a disk slice. This may happen intentionally or accidentally. If there are unallocated slices available, then wasted space can possibly be assigned to a slice later on.



## Recognizing Overlapping Disk Slices

Overlapping disk slices occur when one or more cylinders are allocated to more than one disk slice. Figure 2-12 shows a disk with cylinders allocated to more than one disk slice.

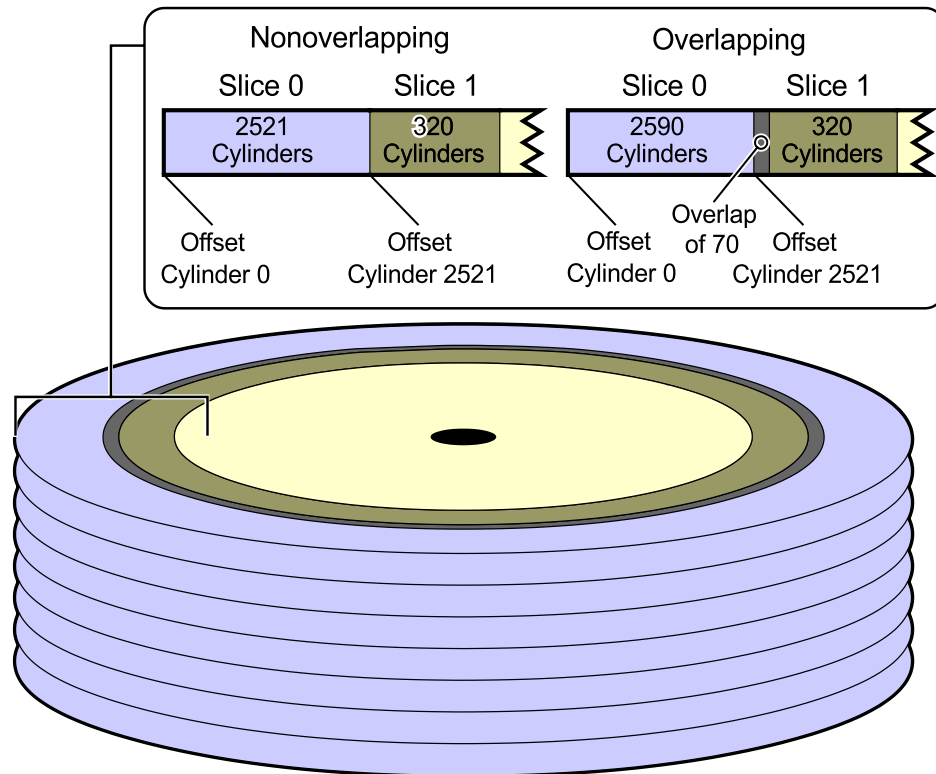


**Figure 2-12** Disk Slices With Overlapping Cylinders

In Figure 2-12, Cylinders 2521 through 2590 are overlapping two disk slices.

This type of condition occurs when the size of one disk slice is increased and the starting cylinder number of the next disk slice is not adjusted. Only the format utility's modify command warns you of overlapping disk slices.

```
partition> modify
Select partitioning base:
    0. Current partition table (unnamed)
    1. All Free Hog
Choose base (enter number) [0]? 0
Warning: Overlapping partition (1) in table.
Warning: Fix, or select a different partition table.
```



---

**Caution** – Do not change the size of disk slices that are currently in use.

---



---

**Caution** – When a disk with existing slices is repartitioned and relabeled, any existing data can become inaccessible. Copy existing data to backup media before the disk is repartitioned, and restore the data to the disk after the disk is relabeled and contains a new filesystem.

---

## Introducing Disk Partition Tables

As the `root` user, when you use the `format` utility and select a disk to partition, a copy of the disk's partition table is read from the label on the disk into memory and is displayed as the current disk partition table.

The `format` utility also works with a file called `/etc/format.dat`, which is read when you invoke the `format` utility.

The `/etc/format.dat` file is a table of available disk types and a set of predefined partition tables that you can use to partition a disk quickly.

## Introducing Disk Labels

The disk's label is the area set aside for storing information about the disk's controller, geometry, and slices. Another term used to describe a disk label is the volume table of contents (VTOC). The disk's label or VTOC is stored on the first sector of the disk.

To label a disk means to write slice information onto the disk. If you fail to label a disk after defining slices, the slice information is lost.

An important part of the disk label is the partition table, which identifies a disk's slices, the slice boundaries in cylinders, and the total size of the slices.

---

**Note** – The terms disk slice and disk partition are interchangeable.

---



Figure 2-13 shows the relationship among the label on the disk, the current label in memory, and the predefined label in the `/etc/format.dat` file.

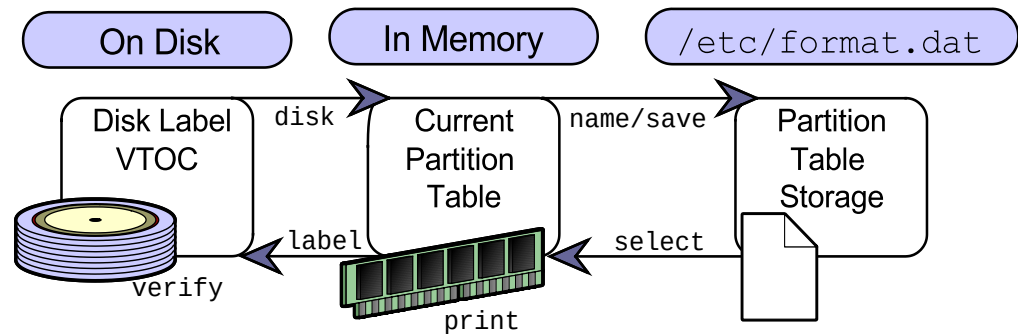


**Figure 2-13** Partition Table Locations

## Using the format Command

The `format` utility is organized into two tiers of commands.

When you type `format` on the command line, the first tier of commands appears. This set of commands allow you to, among other functions, select a disk, select a partition, save new disk and partition definitions, and write the label to the disk. The top tier of commands is denoted by the `format>` prompt.

The second tier of commands appears when you type `partition` from the `format>` prompt. This set of commands allow you to, among other functions, define the characteristics of the individual slices, print the existing partition table, and write the partition map and label to the disk.

Table 2-2 describes the terminology for disk partitioning.

**Table 2-2** Partition Table Terms and Usage

| Term      | Description                                                                                                                                                                                                                                                                                                    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Part      | The slice number. Valid slice numbers are 0 through 7.                                                                                                                                                                                                                                                         |
| Tag       | <p>A value that indicates how the slice is being used.</p> <p>0 = unassigned<br/> 1 = boot<br/> 2 = root<br/> 3 = swap<br/> 4 = usr<br/> 5 = backup<br/> 6 = stand<br/> 8 = home</p> <p>Sun StorEdge™ Volume Manager array tags:<br/> 14 = public (region)<br/> 15 = private (region)</p>                      |
| Flag      | <p>00 wm = The disk slice is writable and mountable.</p> <p>01 wu = The disk slice is writable and unmountable. <i>This is the default state of slices dedicated for swap areas.</i></p> <p>10 rm = The disk slice is read-only and mountable.</p> <p>11 ru = The disk slice is read-only and unmountable.</p> |
| Cylinders | The starting and ending cylinder number for the disk slice.                                                                                                                                                                                                                                                    |
| Size      | The slice size: Mbytes (MB), Gbytes (GB), blocks (b), or cylinders (c).                                                                                                                                                                                                                                        |
| Blocks    | The total number of cylinders and the total number of sectors per slice.                                                                                                                                                                                                                                       |

## Partitioning a Disk



**Caution** – Do not change the size of disk slices that are currently in use.

The following steps demonstrate how to divide a disk into slices:

1. As the root user, type `format` at the prompt, and press Return.

**# format**

Searching for disks...done

AVAILABLE DISK SELECTIONS:

- 0. c0t0d0 <ST34321A cyl 8892 alt 2 hd 15 sec 63>  
/pci@1f,0/pci@1,1/ide@3/dad@0,0
- 1. c1t0d0 <SUN1.3G cyl 1965 alt 2 hd 17 sec 80>  
/pci@1f,0/pci@1/scsi@1/sd@0,0

Specify disk (enter its number):

The format utility searches for all attached disks that are powered on. For each disk it finds, the format utility displays the logical device name, Sun marketing name, physical parameters, and physical device name.

2. Choose the second disk by selecting the number located to the left of that disk's logical device name. From the preceding display, the number chosen is 1. The format utility's main menu appears.

Specify disk (enter its number): **1**

selecting c1t0d0

[disk formatted]

FORMAT MENU:

|           |                                       |
|-----------|---------------------------------------|
| disk      | - select a disk                       |
| type      | - select (define) a disk type         |
| partition | - select (define) a partition table   |
| current   | - describe the current disk           |
| format    | - format and analyze the disk         |
| repair    | - repair a defective sector           |
| label     | - write label to the disk             |
| analyze   | - surface analysis                    |
| defect    | - defect list management              |
| backup    | - search for backup labels            |
| verify    | - read and display labels             |
| save      | - save new disk/partition definitions |
| inquiry   | - show vendor, product and revision   |
| volname   | - set 8-character volume name         |

```
!<cmd>    - execute <cmd>, then return
quit
format>
```

The specific menu selections that you can use to view, change, or commit disk slices include the following:

|                        |                                                           |
|------------------------|-----------------------------------------------------------|
| <code>partition</code> | Displays the Partition menu                               |
| <code>label</code>     | Writes the current partition definition to the disk label |
| <code>verify</code>    | Reads and displays the disk label                         |
| <code>quit</code>      | Exits the format utility                                  |

3. Type `partition` at the format prompt. The Partition menu appears.

```
format> partition
```

PARTITION MENU:

```
0      - change '0' partition
1      - change '1' partition
2      - change '2' partition
3      - change '3' partition
4      - change '4' partition
5      - change '5' partition
6      - change '6' partition
7      - change '7' partition
select - select a predefined table
modify - modify a predefined partition table
name   - name the current table
print  - display the current table
label  - write partition map and label to the disk
!<cmd> - execute <cmd>, then return
quit
```

The Partition menu enables you to perform the following functions:

|        |                                                                             |
|--------|-----------------------------------------------------------------------------|
| 0-7    | Specify the offset and size of up to eight slices                           |
| select | Choose a predefined partition table from the /etc/format.dat file           |
| modify | Change the current partition table in memory                                |
| name   | Provide a means to identify the partition table in the /etc/format.dat file |
| print  | Display the current partition table in memory                               |
| label  | Write the current partition table to the disk label                         |
| !<cmd> | Escape from the utility and execute a command from the shell                |

4. Type `print` at the partition prompt to display the disk label that was copied to random access memory (RAM) when the `format` utility was invoked.

```
partition> print
```

```
Current partition table (unnamed):
```

```
Total disk cylinders available: 1965 + 2 (reserved cylinders)
```

| Part | Tag        | Flag | Cylinders | Size   | Blocks             |
|------|------------|------|-----------|--------|--------------------|
| 0    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 1    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 2    | backup     | wu   | 0 - 1964  | 1.27GB | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 4    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 5    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 6    | unassigned | wu   | 0         | 0      | (0/0/0) 0          |
| 7    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |

The name of the partition table appears in parentheses in the first line of the table.

The columns of the table have the following meanings:

|           |                                                                          |
|-----------|--------------------------------------------------------------------------|
| Part      | The disk slice number                                                    |
| Tag       | The predefined, optional tag                                             |
| Flag      | The predefined, optional flag                                            |
| Cylinders | The starting and ending cylinder number for the slice                    |
| Size      | The slice size in blocks (b), cylinders (c), Mbytes (MB), or Gbytes (GB) |
| Blocks    | The total number of cylinders and the total number of sectors per slice  |

5. Select Slice 0 (zero) by entering 0.

```
partition> 0
Part      Tag      Flag      Cylinders      Size      Blocks
  0 unassigned   wm          0          0      (0/0/0)        0
```

6. When prompted for the ID tag, type a question mark (?), and press Return to list the available choices. You can change a tag by entering a new tag name.

```
Enter partition id tag[unassigned]: ?
Expecting one of the following: (abbreviations ok):
    unassigned    boot      root      swap
    usr           backup    stand     var
    home          alternates
```

```
Enter partition id tag[unassigned]:
```

7. Type the tag alternates, and press Return.

```
Enter partition id tag[unassigned]: alternates
```

8. When prompted for the permission flags, type a question mark (?), and press Return to list the available choices. You can change a flag by entering the new flag name.

```
Enter partition permission flags[wm]: ?
Expecting one of the following: (abbreviations ok):
    wm    - read-write, mountable
    wu    - read-write, unmountable
    rm    - read-only, mountable
    ru    - read-only, unmountable
```

```
Enter partition permission flags[wm]:
```



9. Press Return to accept the default flag.

Enter partition permission flags[wm]: **<return>**

10. Press Return to accept the starting cylinder of 0 (zero).

Enter new starting cyl[0]: **<return>**

11. Enter 400mb for the new partition size for Slice 0.

Enter partition size[0b, 0c, 0e, 0.00mb, 0.00gb]: **400mb**

12. Type print, and press Return. The Partition table appears.

partition> **print**

Current partition table (unnamed):

Total disk cylinders available: 1965 + 2 (reserved cylinders)

| Part | Tag        | Flag | Cylinders | Size     | Blocks             |
|------|------------|------|-----------|----------|--------------------|
| 0    | alternates | wm   | 0 - 602   | 400.43MB | (603/0/0) 820080   |
| 1    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 2    | backup     | wu   | 0 - 1964  | 1.27GB   | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 4    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 5    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 6    | unassigned | wu   | 0         | 0        | (0/0/0) 0          |
| 7    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |

The current partition table shows the change to Slice 0.

Now adjust the starting cylinder for Slice 1.

13. Select slice number 1 by typing **1**.

partition> **1**

| Part | Tag        | Flag | Cylinders | Size | Blocks    |
|------|------------|------|-----------|------|-----------|
| 1    | unassigned | wm   | 0         | 0    | (0/0/0) 0 |

14. Type the tag swap, and press Return.

Enter partition id tag[unassigned]: **swap**

15. Type wu at the permission flags selection, and press Return.

Enter partition permission flags[wm]: **wu**

16. Enter the new starting cylinder for Slice 1.

Enter new starting cyl[0]: **603**

17. Enter the new partition size for Slice 1.

Enter partition size[0b, 0c, 603e, 0.00mb, 0.00gb]: **60mb**

18. Type **print**, and press Return.

```
partition> print
```

Current partition table (unnamed):

Total disk cylinders available: 1965 + 2 (reserved cylinders)

| Part | Tag        | Flag | Cylinders | Size     | Blocks             |
|------|------------|------|-----------|----------|--------------------|
| 0    | alternates | wm   | 0 - 602   | 400.43MB | (603/0/0) 820080   |
| 1    | swap       | wm   | 603 - 693 | 60.43MB  | (91/0/0) 123760    |
| 2    | backup     | wu   | 0 - 1964  | 1.27GB   | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 4    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 5    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |
| 6    | unassigned | wu   | 0         | 0        | (0/0/0) 0          |
| 7    | unassigned | wm   | 0         | 0        | (0/0/0) 0          |

The current partition table shows the change to Slice 1.

The new starting cylinder for Slice 1 is one greater than the ending cylinder for Slice 0.

Now adjust the starting cylinder for Slice 7.

19. Type **7** to select Slice 7.

```
partition> 7
```

| Part | Tag        | Flag | Cylinders | Size | Blocks    |
|------|------------|------|-----------|------|-----------|
| 7    | unassigned | wm   | 0         | 0    | (0/0/0) 0 |

20. Type the tag **home**, and press Return.

Enter partition id tag[unassigned]: **home**

21. Press Return to select the default flag.

Enter partition permission flags[wu]: **<return>**

22. Type the new starting cylinder for Slice 7.

Enter new starting cyl[0]: **694**

23. Type the new partition size for Slice 7 by typing a dollar (\$) sign.

Enter partition size[0b, 0c, 694e, 0.00mb, 0.00gb]: **\$**

```
partition>
```




---

**Note** – Enter a dollar (\$) sign as a value for the last partition size to automatically assign the remaining space on the disk to this slice.

---

24. Type **print** to display the partition table.

```
partition> print
```

```
Current partition table (unnamed):
```

```
Total disk cylinders available: 1965 + 2 (reserved cylinders)
```

| Part | Tag        | Flag | Cylinders  | Size     | Blocks             |
|------|------------|------|------------|----------|--------------------|
| 0    | alternates | wm   | 0 - 602    | 400.43MB | (603/0/0) 820080   |
| 1    | swap       | wm   | 603 - 693  | 60.43MB  | (91/0/0) 123760    |
| 2    | backup     | wu   | 0 - 1964   | 1.27GB   | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 4    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 5    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 6    | unassigned | wu   | 0          | 0        | (0/0/0) 0          |
| 7    | home       | wm   | 694 - 1964 | 844.02MB | (1271/0/0) 1728560 |

Add up the cylinders in the Blocks column for Slice 0, Slice 1, and Slice 7. The number should equal the total number of cylinders contained in Slice 2.

25. After checking the partition table to ensure that there are no errors, label the disk by typing **label**.

```
partition> label
```

```
Ready to label disk, continue? y
```

```
partition>
```

## Saving a Partition Table to the /etc/format.dat File

Use this optional procedure to add the newly created partition table to the /etc/format.dat file. You can save customized partition tables to the /etc/format.dat file and use them to quickly partition other disks of the same type on the system.



**Note** – Remember that, by default, the system saves the new partition information to the ./format.dat file. You must enter the full path of the /etc/format.dat file to update the proper file.

To save a customized partition table, display the Partition menu and perform the following steps:

1. Type **name** to enter a unique name for the current partition table. Frequently, the disk manufacturer's name is used.

```
partition> name
Enter table name (remember quotes): SUN1.3G
```



---

**Note** – Quotes are only required if the partition table name is more than one word, for example, "SUN1.3G Generic."

---

2. Exit the Partition menu.

```
partition> quit
```

3. Type **save** to save the new partition table information, and enter the full path name for the `/etc/format.dat` file.

```
format> save
Saving new partition definition
Enter file name["./format.dat"]: /etc/format.dat
```

## Using the Customized Partition Table

To retrieve a customized partition table, display the format menu and perform the following steps:

1. Type **partition**.

```
format> partition
```

2. Type **select** to display a list of customized partition tables, and choose the desired table by entering its assigned number.

```
partition> select
  0. SUN1.3G
  1. original
  2. SUN4.2
```

```
Specify table (enter its number)[3]: 0
```

3. Label the disk with the selected partition table.

```
partition> label
Ready to label disk, continue? yes
```

4. Exit the Partition menu.

```
partition> quit
```

5. Read the new disk label.

```
format> verify
```

Primary label contents:

```
Volume name = <          >
```

```
ascii name  = <SUN1.3G cyl 1965 alt 2 hd 17 sec 80>
```

```
pcyl        = 3500
```

```
ncyl        = 1965
```

```
acyl        = 2
```

```
nhead       = 17
```

```
nsect       = 80
```

| Part | Tag        | Flag | Cylinders  | Size     | Blocks             |
|------|------------|------|------------|----------|--------------------|
| 0    | alternates | wm   | 0 - 602    | 400.43MB | (603/0/0) 820080   |
| 1    | swap       | wm   | 603 - 693  | 60.43MB  | (91/0/0) 123760    |
| 2    | backup     | wu   | 0 - 1964   | 1.27GB   | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 4    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 5    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 6    | unassigned | wu   | 0          | 0        | (0/0/0) 0          |
| 7    | home       | wm   | 694 - 1964 | 844.02MB | (1271/0/0) 1728560 |

6. Exit the format utility.

```
format> quit
```

## Managing Disk Labels

Every disk in the Solaris OE has a label set aside for storing information about the disk's controller, geometry, and slices.

### Viewing the Disk VTOC

You can use two methods for locating and viewing a disk's label or VTOC:

- Use the `verify` command from the `format` utility
- Invoke the `prtvtoc` command from the command line

#### Reading a Disk's VTOC Using the `verify` Command

The `verify` command enables you to view a disk's VTOC from within the `format` utility. To read a disk's VTOC, perform the following steps:

1. At the `format` prompt, enter the `verify` command, and press Return.

```
format> verify
```

Primary label contents:

```
Volume name = <          >
ascii name  = <SUN1.3G cyl 1965 alt 2 hd 17 sec 80>
pcyl        = 3500
ncyl        = 1965
acyl        =    2
nhead       =   17
nsect       =   80
```

| Part | Tag        | Flag | Cylinders  | Size     | Blocks             |
|------|------------|------|------------|----------|--------------------|
| 0    | root       | wm   | 0 - 602    | 400.43MB | (603/0/0) 820080   |
| 1    | swap       | wm   | 603 - 693  | 60.43MB  | (91/0/0) 123760    |
| 2    | backup     | wm   | 0 - 1964   | 1.27GB   | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 4    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 5    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 6    | unassigned | wm   | 0          | 0        | (0/0/0) 0          |
| 7    | home       | wm   | 694 - 1964 | 844.02MB | (1271/0/0) 1728560 |

2. Type `quit` or `q`, and press Return to exit the `format` menu.

## Reading a Disk's VTOC Using the prtvtoc Command

The `prtvtoc` command enables you to view a disk's VTOC from the command line. To view a disk's VTOC from the command line, type the following:

```
# prtvtoc /dev/rdisk/c1t0d0s2
* /dev/rdisk/c1t0d0s2 partition map
*
* Dimensions:
*   512 bytes/sector
*   80 sectors/track
*   17 tracks/cylinder
*  1360 sectors/cylinder
*  3500 cylinders
*  1965 accessible cylinders
*
* Flags:
*   1: unmountable
*  10: read-only
*
*
* Partition  Tag  Flags      First      Sector      Last
*           Tag  Flags      Sector      Count      Sector  Mount Directory
*     0       2   00         0      820080      820079
*     1       3   00      820080      123760      943839
*     2       5   00         0     2672400     2672399
*     7       8   00      943840     1728560     2672399
```

The disk label information includes the following fields:

|              |                                                                                                                                                  |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Dimensions   | Describes the logical dimensions of the disk.                                                                                                    |
| Flags        | Describes the flags that are listed in the partition table.                                                                                      |
| Partition    | A slice number. It is described further in Table 2-2 on page 2-36.                                                                               |
| Tag          | A value used to indicate how the slice is being used. It is described further in Table 2-2 on page 2-36.                                         |
| Flags        | The 00 flag is read/write, mountable; 01 is read/write, unmountable; and 10 is read only. These are described further in Table 2-2 on page 2-36. |
| First Sector | Defines the first sector of the slice.                                                                                                           |

|                 |                                                                                                                     |
|-----------------|---------------------------------------------------------------------------------------------------------------------|
| Sector Count    | Defines the total number of sectors in the slice.                                                                   |
| Last Sector     | Defines the last sector number in the slice.                                                                        |
| Mount Directory | If the field is empty, the slice is currently not mounted and no entry exists in the <code>/etc/vfstab</code> file. |

## Relabeling a Disk

Save a disk's VTOC to a file by using the `prtvto` command. This allows you to relabel the disk by using the `fmthard` command if one of the following situations occurs:

- The VTOC on the disk has been destroyed.
- You accidentally changed the partition information on the disk and did not save a backup label in the `/etc/format.dat` file.

To save a disk's VTOC to a file, perform the command:

```
# prtvtoc /dev/rdisk/c1t0d0s2 > /vtoc/c1t0d0
```

### The `fmthard` Command

To relabel a disk, you can save the output of the `prtvto` command into a file on another disk and use it as the `datafile` argument to the `fmthard` command.

```
fmthard -s datafile /dev/rdisk/c#t#d#s2
```



---

**Caution** – The `fmthard` command cannot write a disk label on an unlabeled disk. Use the `format` utility for this purpose.

---

If the need to relabel a disk arises and the VTOC was previously saved to a file, the following options are available:

- Run `format`, select the disk, and label it with the default partition table.
- Use the `fmthard` command to write the desired label information, previously saved to a *datafile* back to the disk.

```
# fmthard -s /vtoc/c1t0d0 /dev/rdisk/c1t0d0s2
```



## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab is more difficult. Although each step describes what you should do, you must determine which commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Working With Disks and Partitions (Level 1)

In this exercise, you complete the following tasks:

- Use the `format` utility to partition a disk
- Use the `prtvtoc` and `fmthard` commands to repair a corrupted disk label

### Preparation

This exercise requires a system configured with an external disk.

### Tasks

Complete the following tasks:

- Use the `format` command to list the disks currently attached to your system. Use the `prtvtoc` command to identify a disk that does not currently hold any mounted file systems. Examine the information that the `prtvtoc` command displays. Record the name of a disk that has no mount directory listed.  
(Steps 1–4 in the Level 2 lab)
- Use the `format` command to divide the unused disk into four slices of equal size. Use Slices 0, 1, 3, and 4. Set all other slices to size 0. Manually change the size of Slice 0 so that it ends 25 Mbytes into the space assigned to Slice 1.  
(Steps 4–11 in the Level 2 lab)

- Attempt to correct the overlap by using the Modify menu. Record the message that appears. Then correct the overlap by using the `all free hog` option. Verify your disk label with the `prtvtoc` command.  
(Steps 12–18 in the Level 2 lab)
- Create a directory called `/vtoc`. Run the `prtvtoc` command to read the label of the disk you modified, and save its output in a file in the `/vtoc` directory. Use the `dd` command from Step 21 of the Level 2 lab to destroy the label on the same disk. Attempt to read the disk label by using the `prtvtoc` command, and record the result. If required, use the `format` command to write a default label to the disk. Use the `fmthard` command to restore the label by using the output from the `prtvtoc` command that you saved earlier. Verify that the new label exists.  
(Steps 19–25 in the Level 2 lab)

## Exercise: Working With Disks and Partitions (Level 2)

In this exercise, you complete the following tasks:

- Use the `format` utility to partition a disk
- Use the `prtvto` and `fmthard` commands to repair a corrupted disk label

### Preparation

This exercise requires a system configured with an external disk.

### Task Summary

In this exercise, you accomplish the following:

- Use the `format` command to list the disks currently attached to your system. Use the `prtvto` command to identify a disk that does not currently hold any mounted file systems. Examine the `Mount Directory` field in the information that the `prtvto` command displays. Record the name of a disk that has no mount directory listed.
- Use the `format` command to divide the unused disk into four slices of equal size. Use Slices 0, 1, 3, and 4. Set all other slices to size 0. Manually change the size of Slice 0 so that it ends 25 Mbytes into the space assigned to Slice 1.
- Attempt to correct the overlap by using Option 0 from the `Modify` menu. Record the message that appears. Then correct the overlap by using the `all free hog` option. Verify your disk label with the `prtvto` command.
- Create a directory called `/vtoc`. Run the `prtvto` command to read the label of the disk you modified, and save its output in a file in the `/vtoc` directory. Use the `dd` command to destroy the label on the same disk. Attempt to read the disk label by using the `prtvto` command, and record the result. If required, use the `format` command to write a default label to the disk. Use the `fmthard` command to restore the label by using the output from the `prtvto` command that you saved earlier. Verify that the new label exists.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Run the `format` command.
2. Record the list of disks presented by the `format` command, for example, `c0t0d0` and `c1t0d0`.  
Press the Control-D keys to exit the `format` utility.
3. Use the `prtvtoc` command to list the VTOC for each of the disks that you found in the previous step. Examine the `Mount Directory` field in the information that the `prtvtoc` command displays. Record the name of a disk that has no mount directory listed. This is an unused disk.
4. Run the `format` command again. Select the unused disk from the list of disks presented.
5. Display the Partition menu. Print the current partition table, and record the number of megabytes assigned to Slice 2. For example, if the disk reports 4 Gbytes, record 4000 Mbytes.

Mbytes:

6. Divide the number of megabytes by 4. Use the result as the number of megabytes to assign as disk space to four slices. Round down to the next whole megabyte if the result includes a fraction.

Mbytes/4:

7. Display the Partition menu again. Select Slice 0. Accept the defaults for tags and flags. Start this first slice on Cylinder 0. Enter the resulting number of megabytes from the previous step for the slice size. Print the partition table again to verify the change.
8. Set the sizes of Slices 1, 3, and 4 so that they are the same as Slice 0. Begin each successive slice on the cylinder that follows the ending cylinder of the previous slice.
9. Set Slices 5, 6, and 7 to start at Cylinder 0, and assign them 0 Mbytes.
10. Print the partition table. Is there any overlap of ending and beginning cylinders for any of the slices listed? Proceed to the following steps to introduce this problem.

11. Add 25 to the number Mbytes/4 value listed in Step 6.  
(Mbytes/4) + 25:  
Change Slice 0 so that it uses the new size listed above.  
The partition table should now indicate that Slice 0 ends after Slice 1 begins.
12. Use the `modify` command from the Partition menu to attempt to fix this problem. Select Item 0 to modify the current partition table.  
Which warnings appear?
13. Modify the partition table. Select Item 1 to use the All Free Hog method.
14. The partition table appears. Observe the Cylinders and Size columns, and notice that they are all zero.
15. Respond to the prompts to continue the process. Select Slice 4 as the All Free Hog slice. Use the size listed in Step 6 for Slices 0, 1, and 3. Set the other slices to Size 0.  
At the end of this process, you should have three slices of equal size, where Slice 4 takes up any extra room if it exists.
16. Name the partition table SA239Partition. Quit the Partition menu.
17. Label and save your new partition table to the `/etc/format.dat` file. Carefully read the message that is displayed by the `format` utility, and enter the correct file name. Quit the `format` utility when you have finished. Use the `cat` command to view the contents of the `/etc/format.dat` file. Note that your information is appended to the file.
18. Verify your new partition table with the `prtvto` command.
19. Create a directory called `/vtoc`.
20. Use the `prtvto` command to print the partition table that you just created, and save its output to a file in the `/vtoc` directory. Name the file so that it corresponds with the disk you are examining. Use the `cat` command to verify that valid information exists in the file that you create.

21. Use the following `dd` command to destroy the disk label. Be certain to specify the correct disk device name for the `of=` argument. Enter all other arguments exactly as listed.

```
# dd if=/dev/zero of=/dev/rdisk/c1t0d0s2 bs=512 count=1
1+0 records in
1+0 records out
#
```

22. Attempt to read the label from the same disk by using the `prtvtoc` command.

What happens?

23. If the `prtvtoc` command reported an "Unable to read Disk geometry" message, use the `format` command to place a default label on the disk for which you destroyed the label earlier.

If the `prtvtoc` command reports that only Slice 2 exists on the disk, skip to the next step. Otherwise, perform the commands:

```
# format
Searching for disks...done

c1t0d0: configured with capacity of 4.00GB
```

AVAILABLE DISK SELECTIONS:

- 0. c0t0d0 <Seagate Medalist 34342A cyl 8892 alt 2 hd 15 sec 63>  
/pci@1f,0/pci@1,1/ide@3/dad@0,0
- 1. c1t0d0 <SUN4.2G cyl 3880 alt 2 hd 16 sec 135>  
/pci@1f,0/pci@1/pci@2/SUNw,isp2two@4/sd@3,0

```
Specify disk (enter its number): 1
selecting c1t0d0
[disk formatted]
Disk not labeled. Label it now? Y
```

(format menu)

```
format> q
#
# prtvtoc /dev/rdisk/c1t0d0s2
```

24. Use the `fmthard` command to write to the disk the label information you saved earlier.
25. Attempt to read the label from the same disk.  
Was this successful?



## Exercise: Working With Disks and Partitions (Level 3)

In this exercise, you complete the following tasks:

- Use the `format` utility to partition a disk
- Use the `prtvto` and `fmthard` commands to repair a corrupted disk label

### Preparation

This exercise requires a system configured with an external disk.

### Task Summary

In this exercise, you accomplish the following:

- Use the `format` command to list the disks currently attached to your system. Use the `prtvto` command to identify a disk that does not currently hold any mounted file systems. Examine the `Mount Directory` field in the information that the `prtvto` command displays. Record the name of a disk that has no mount directory listed.
- Use the `format` command to divide the unused disk into four slices of equal size. Use Slices 0, 1, 3, and 4. Set all other slices to size 0. Manually change the size of Slice 0 so that it ends 25 Mbytes into the space assigned to Slice 1.
- Attempt to correct the overlap using Option 0 from the `Modify` menu. Record the message that appears. Then correct the overlap by using the `all free hog` partition. Verify your disk label with the `prtvto` command.
- Create a directory called `/vtoc`. Run the `prtvto` command to read the label of the disk you modified, and save its output in a file in the `/vtoc` directory. Use the `dd` command to destroy the label on the same disk. Attempt to read the disk label by using the `prtvto` command, and record the result. If required, use the `format` command to write a default label to the disk. Use the `fmthard` command to restore the label by using the output from the `prtvto` command that you saved earlier. Verify that the new label exists.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Run the `format` command.

```
# format
```

2. Record the list of disks presented by the `format` command, for example, `c0t0d0` and `c1t0d0`.

Press Control-D to exit the `format` utility.

```
format> Control-D
```

```
#
```

3. Use the `prtvtoc` command to list the VTOC for each of the disks you found in the previous step. Examine the `Mount Directory` field in the information that the `prtvtoc` command displays. Record the name of a disk that has no mount directory listed. This will be an unused disk.

```
# prtvtoc /dev/rdisk/c1t0d0s2
```

Unused disk: *Your entry will depend on your system.*

4. Run the `format` command again. Select the unused disk from the list of disks presented.

```
# format
```

```
(list of disks)
```

```
Specify disk (enter its number): x
```

5. Display the Partition menu. Print the current partition table, and record the number of megabytes assigned to Slice 2. For example, if the disk reports 4 Gbytes, record 4000 Mbytes.

```
format> part
```

```
partition> print
```

Mbytes: *Your entry will depend on your system.*

6. Divide the number of megabytes by 4. Use the result as the number of megabytes to assign as disk space to four slices. Round down to the next whole megabyte if the result includes a fraction.

Mbytes/4: *Your entry will depend on your system.*

7. Display the Partition menu again. Select Slice 0. Accept the defaults for tags and flags. Start this first slice on Cylinder 0. Enter the resulting number of megabytes from the previous step for the slice size. Print the partition table again to verify the change.

```
partition> 0
```

| Part | Tag        | Flag | Cylinders | Size | Blocks    |
|------|------------|------|-----------|------|-----------|
| 0    | unassigned | wm   | 0         | 0    | (0/0/0) 0 |

```
Enter partition id tag[unassigned]: <Return>
Enter partition permission flags[wm]: <Return>
Enter new starting cyl[0]: 0
Enter partition size[0b, 0c, 0e, 0.00mb, 0.00gb]: 300mb
partition> print
(partition table)
```

8. Set the sizes of Slices 1, 3, and 4 so that they are the same as Slice 0. Begin each successive slice on the cylinder that follows the ending cylinder of the previous slice.

```
partition> ?
(Partition menu)
partition> 1
```

| Part | Tag        | Flag | Cylinders | Size | Blocks    |
|------|------------|------|-----------|------|-----------|
| 1    | unassigned | wm   | 0         | 0    | (0/0/0) 0 |

```
Enter partition id tag[unassigned]: <Return>
Enter partition permission flags[wm]: <Return>
Enter new starting cyl[0]: 452
Enter partition size[0b, 0c, 0e, 0.00mb, 0.00gb]: 300mb
partition> print
(partition table)
```

9. Set Slices 5, 6, and 7 to start at Cylinder 0, and assign them 0 Mbytes.

```
partition> ?
(Partition menu)
partition> 5
```

| Part | Tag        | Flag | Cylinders | Size | Blocks    |
|------|------------|------|-----------|------|-----------|
| 5    | unassigned | wm   | 0         | 0    | (0/0/0) 0 |

```
Enter partition id tag[unassigned]: <Return>
Enter partition permission flags[wm]: <Return>
Enter new starting cyl[0]: 0
Enter partition size[0b, 0c, 0e, 0.00mb, 0.00gb]: 0m
partition>
```

10. Print the partition table. Is there any overlap of ending and beginning cylinders for any of the slices listed? Proceed to the following steps to introduce this problem.

```
partition> print
```

11. Add 25 to the number Mbytes/4 value listed in Step 6.

(Mbytes/4) + 25: *Your entry will depend on your system.*

Change Slice 0 so that it uses the new size listed previously.

```
partition> ?
```

(Partition menu)

```
partition> 0
```

| Part | Tag        | Flag | Cylinders | Size     | Blocks           |
|------|------------|------|-----------|----------|------------------|
| 0    | unassigned | wm   | 0 - 451   | 300.16MB | (452/0/0) 614720 |

```
Enter partition id tag[unassigned]: <Return>
```

```
Enter partition permission flags[w]: <Return>
```

```
Enter new starting cyl[0]: 0
```

```
Enter partition size[614720b, 452c, 451e, 300.16mb, 0.29gb]: 325mb
```

```
partition> print
```

(partition table)

The partition table should now indicate that Slice 0 ends after Slice 1 begins.

12. Use the **modify** command from the Partition menu to attempt to fix this problem. Select Item 0 to modify the current partition table.

```
partition> ?
```

(Partition menu)

```
partition> modify
```

Select partitioning base:

0. Current partition table (unnamed)

1. All Free Hog

```
Choose base (enter number) [0]? 0
```

Which warnings display?

Warning: Overlapping partition (1) in table.

Warning: Fix, or select a different partition table.

13. Modify the partition table. Select Item 1 to use the All Free Hog option.

```
partition> modify
```

```
Select partitioning base:
```

```
0. Current partition table (original)
```

```
1. All Free Hog
```

```
Choose base (enter number) [0]? 1
```

14. The partition table appears. Observe the Cylinders and Size columns, and notice that they are all zero; for example:

| Part | Tag        | Flag | Cylinders | Size   | Blocks             |
|------|------------|------|-----------|--------|--------------------|
| 0    | root       | wm   | 0         | 0      | (0/0/0) 0          |
| 1    | swap       | wu   | 0         | 0      | (0/0/0) 0          |
| 2    | backup     | wu   | 0 - 1964  | 1.27GB | (1965/0/0) 2672400 |
| 3    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 4    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 5    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |
| 6    | usr        | wm   | 0         | 0      | (0/0/0) 0          |
| 7    | unassigned | wm   | 0         | 0      | (0/0/0) 0          |

15. Respond to the prompts to continue the process. Select Slice 4 as the All Free Hog partition. Use the size listed in Step 6 for Slices 0, 1, and 3. Set the other slices to Size 0.

```
Do you wish to continue creating a new partition
table based on above table[yes]? yes
```

```
Free Hog partition[6]? 4
```

```
Enter size of partition '0' [0b, 0c, 0.00mb, 0.00gb]: 300mb
```

```
Enter size of partition '1' [0b, 0c, 0.00mb, 0.00gb]: 300mb
```

```
Enter size of partition '3' [0b, 0c, 0.00mb, 0.00gb]: 300mb
```

```
Enter size of partition '5' [0b, 0c, 0.00mb, 0.00gb]: 0
```

```
Enter size of partition '6' [0b, 0c, 0.00mb, 0.00gb]: 0
```

```
Enter size of partition '7' [0b, 0c, 0.00mb, 0.00gb]: 0
```

At the end of this process, you should have three slices of equal size, where Slice 4 takes up any extra room if it exists.

16. Name the slice SA239Partition. Quit the Partition menu.

```
Okay to make this the current partition table[yes]? y
```

```
Enter table name (remember quotes): "SA239partition"
```

```
Ready to label disk, continue? y
```

```
partition>
```

```
partition> quit
```

```
(format menu)
```

```
format>
```

17. Label the drive and save your new partition table to the `/etc/format.dat` file. Carefully read the message that is displayed by the `format` utility, and enter the correct file name. Quit the `format` utility when you have finished. Use the `cat` command to view the contents of the `/etc/format.dat` file. Note that your information is appended to the file.

```
format> save
Saving new disk and partition definitions
Enter file name["./format.dat"]: /etc/format.dat
format> quit
#
# cat /etc/format.dat
```

18. Verify your new partition table with the `prtvtoc` command.

```
# prtvtoc /dev/rdisk/c1t0d0s2
```

19. Create a directory called `/vtoc`.

```
# mkdir /vtoc
```

20. Use the `prtvtoc` command to print the partition table that you just created, and save its output to a file in the `/vtoc` directory. Name the file so that it corresponds with the disk you are examining. Use the `cat` command to verify that valid information exists in the file that you create.

```
# prtvtoc /dev/rdisk/c1t0d0s2 > /vtoc/c1t0d0
# cat /vtoc/c1t0d0
```

21. Use the following `dd` command to destroy the disk label. Be certain to specify the correct disk device name for the `of=` argument. Enter all other arguments exactly as listed.

```
# dd if=/dev/zero of=/dev/rdisk/c1t0d0s2 bs=512 count=1
1+0 records in
1+0 records out
#
```

22. Attempt to read the label from the same disk by using the `prtvtoc` command.

```
# prtvtoc /dev/rdisk/c1t0d0s2
```

What happens?

*Different disk types present different results. SCSI disks might report messages that indicate that the disk label is unreadable, for example:*

```
prtvtoc: /dev/rdisk/c1t0d0s2: Unable to read Disk
geometry
```

*IDE disks might report a partition table where only Slice 2 remains defined, for example:*

| Partition | Tag       | Flags    | Sector | Count | Sector |
|-----------|-----------|----------|--------|-------|--------|
| Mount     | Directory |          |        |       |        |
|           | 2         |          | 5      | 01    | 0      |
|           | 17801280  | 17801279 |        |       |        |

23. If the `prtvtoc` command reported an “Unable to read Disk geometry” message, use the `format` command to place a default label on the disk for which you destroyed the label earlier.

If the `prtvtoc` command reports that only Slice 2 exists on the disk, skip to the next step. Otherwise, perform the commands:

```
# format
```

```
Searching for disks...done
```

```
c1t0d0: configured with capacity of 1.3GB
```

```
AVAILABLE DISK SELECTIONS:
```

```
0. c0t0d0 <Seagate Medalist 34342A cyl 8892 alt 2 hd 15 sec 63>
   /pci@1f,0/pci@1,1/ide@3/dad@0,0
```

```
1. c1t0d0 <SUN1.3G cyl 1965 alt 2 hd 17 sec 80>
   /pci@1f,0/pci@1/scsi@1/sd@0,0
```

```
Specify disk (enter its number): 1
```

```
selecting c1t0d0
```

```
[disk formatted]
```

```
Disk not labeled. Label it now? Y
```

```
(format menu)
```

```
format> q
```

```
#
```

```
# prtvtoc /dev/rdisk/c1t0d0s2
```

24. Use the `fmthard` command to write to the disk the label information you saved earlier.

```
# fmthard -s /vtoc/c1t0d0 /dev/rdisk/c1t0d0s2
```

```
fmthard: New volume table of contents now in place.
```

```
#
```

25. Attempt to read the label from the same disk.

```
# prtvtoc /dev/rdisk/c1t0d0s2
```

Was this successful?

*This command should successfully read the disk label.*

## Introducing the Solaris™ Management Console

The Solaris Management Console is a Java technology-based tool for the administration of systems. It provides a central integration point for the configuration and administration of important applications and services.

The Solaris Management Console software simplifies the job of configuring and administering servers. With point-and-click graphical user interface (GUI) tools, the Solaris Management Console makes the Solaris OE easy to administer, especially for administrators who are not familiar with the UNIX environment.

## Starting the Solaris Management Console

The Solaris Management Console can be started from the command line or from within the Application Manager by clicking the Solaris Management Console icon.

Log in to your system as `root`, and type **smc&** in a terminal window. You can start the Solaris Management Console as a normal user, but some tools and applications are not available to you. When you initiate the Solaris Management Console for the first time, it can take a few minutes to launch.



---

**Note** – The information provided in this course is only a small subset of the overall capabilities of the Solaris Management Console.

---



## Using the Solaris Management Console Tools

The default toolbox for a Solaris Management Console server includes the following folders and tools:

|                      |                                                                                    |
|----------------------|------------------------------------------------------------------------------------|
| System Status        | This category includes System Information, Log Viewer, Processes, and Performance. |
| System Configuration | This category includes Users, Projects, Computers and Networks, and Patches.       |
| Services             | This category includes Scheduled Jobs.                                             |
| Storage              | This category includes Mounts and Shares, Disks, and Enhanced Storage.             |
| Devices and Hardware | This category includes Serial Ports.                                               |

The Solaris Management Console enables local users and administrators to register remote Solaris Management Console servers and applications on the network they want to administer. When you access the Solaris Management Console, it dynamically configures tree views of those registered hosts and services. Point and click with the mouse to invoke an application remotely on a selected Solaris Management Console server and view the application's GUI on the local display.

### Introducing the Help Screen

The online help for the Solaris Management Console provides an alternative to standard documentation. The information panes that appear in both the Solaris Management Console and the Solaris Management Console Toolbox Editor provide the steps necessary to perform the tasks executed within these windows. In addition, the Help menu item Contents displays a window that further describes the features and functions of the window components.

Figure 2-14 shows the help functionality of the Solaris Management Console.

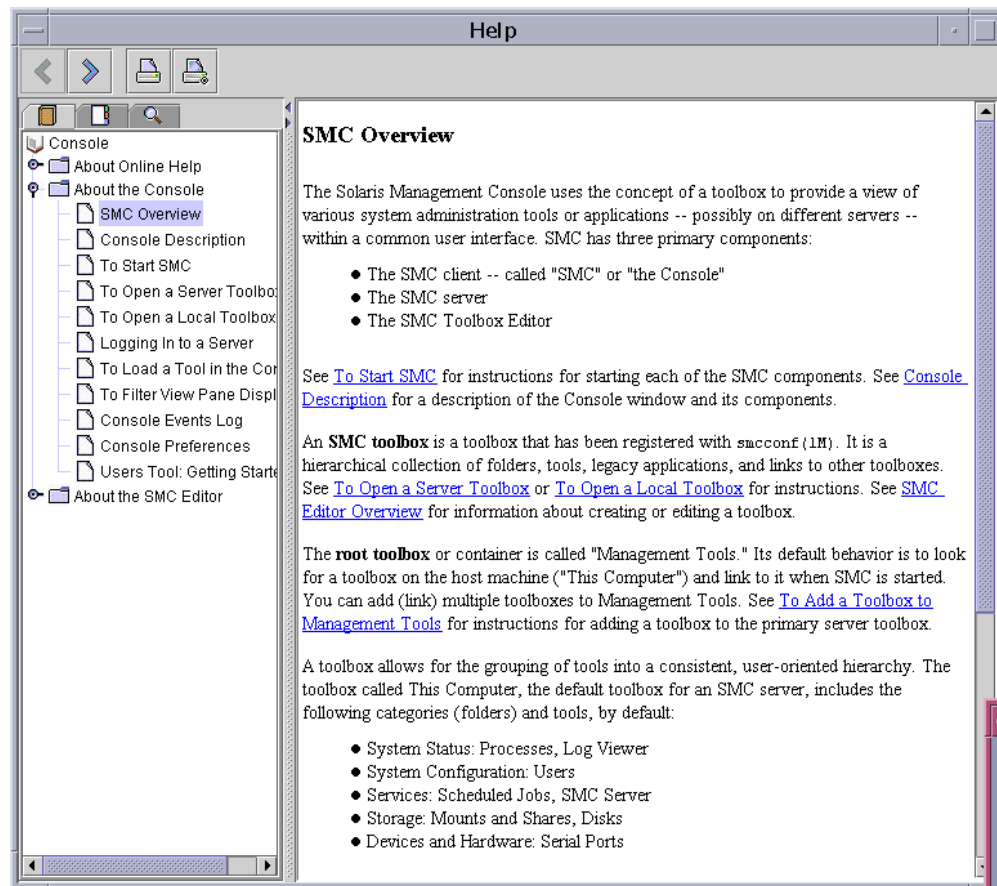


**Figure 2-14** Solaris Management Console Help View

## Restarting the Solaris Management Console

If you have trouble accessing Solaris Management Console, the reason might be that the Solaris Management Console server is not running or is in a problem state.

To determine if the Solaris Management Console server is running, as the root user, perform the command:

```
# /etc/init.d/init.wbem status
```

If the Solaris Management Console server is running, a response similar to the following returns: "Solaris Management Console server version 2.1.0 running on port 898."

To stop the Solaris Management Console server, as the root user, perform the command:

```
# /etc/init.d/init.wbem stop
```

The following response returns: "SMC stopped."

To start the Solaris Management Console server, as the root user, perform the command:

```
# /etc/init.d/init.wbem start
```

After a short time, the following response returns: "SMC server started."

## Identifying the Functional Areas of the Solaris Management Console

The Solaris Management Console and the Solaris Management Console Toolbox Editor windows are divided into functional areas as follows:

- Navigation pane
- View pane
- Information pane
- Location bar
- Status bar

Figure 2-15 shows these divisions.

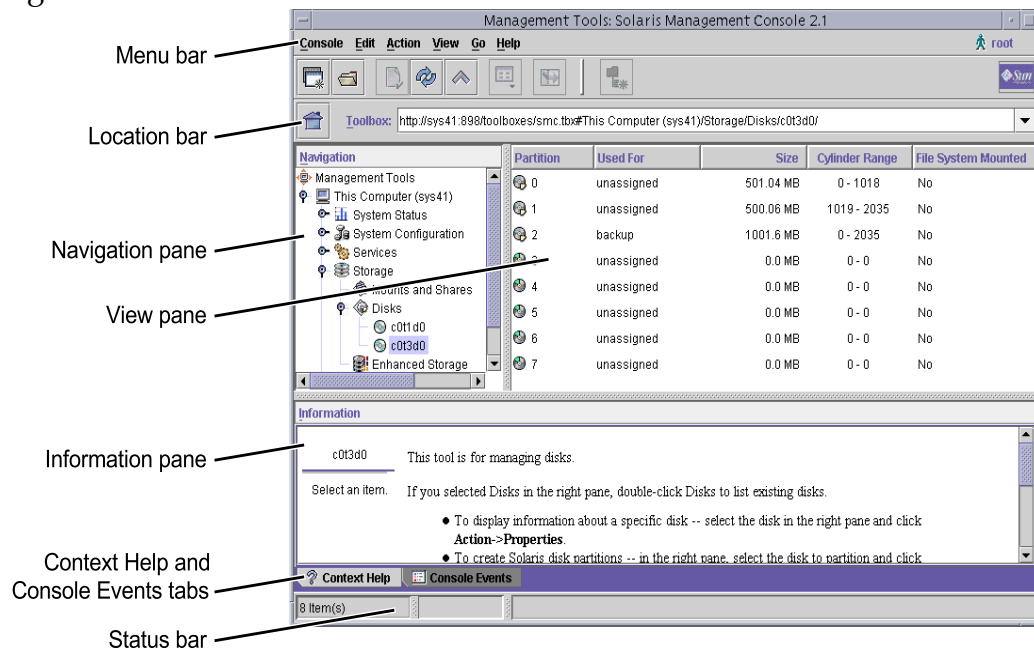


**Figure 2-15** Solaris Management Console Overview



**Note** – The Location bar does not appear by default when you first launch the Solaris Management Console. Click View on the Menu bar, select the Show option, and select the Location option to display the Location bar.

## Navigation Pane

The Navigation pane works like a frame in a web page. Clicking an item in the Navigation pane determines what appears in the View pane. The turner icon is displayed to the left of items that represent a group of items. Click the icon or the item to expand or collapse the group.

The Navigation pane is displayed or not displayed, depending on the Show setting in the View menu. Click View on the Menu bar, select the Show option, and select or deselect the Navigation option.

## View Pane

The View pane displays the contents of the node selected in the Navigation pane. The contents could be a folder or a tool.

If the node selected in the Navigation pane is a folder, the View pane displays the contents of that folder.

If the node selected is a simple tool, such as the Process tool, the View pane displays a list of current processes. If the node selected is a complex tool, such as User Manager, the View pane displays additional tools, such as the tools for user accounts and email accounts. Select one of the additional tools, such as the user accounts node, and the View pane displays the contents of the tool.

### Information Pane

The Information pane at the bottom of the Solaris Management Console window displays either context help for the object selected in the Navigation pane or a list of events and alarms for all Solaris Management Console events.

The Context Help tab and Console Events tab determine what is shown in the Information pane. Click the Context Help tab to display context help for the object selected. Click the Console Events tab to display a list of events and alarms for all Console events.

The Information pane is displayed or not displayed, depending on the Show setting in the View menu. Click View on the Menu bar, select the Show option, and select or deselect the Information option.

### Location Bar

The Location bar, beneath the tool bar in the Solaris Management Console window, displays a Home Toolbox icon and a Toolbox field. Click the Home Toolbox icon to open the home toolbox. The Toolbox field indicates the current toolbox and the item currently selected in the toolbox. Click the button to the right of the Toolbox field to display a pull-down menu of recent toolboxes visited. Select a toolbox from the pull-down menu to open that toolbox.

The Location bar is displayed or not displayed, depending on the Show setting in the View menu. Click View on the Menu bar, select the Show option, and select or deselect the Location option.

### Status Bar

The Status bar, located across the bottom of the Solaris Management Console window, displays three panes. The left pane of the Status bar indicates the number of nodes directly subordinate to the node selected in the Navigation pane. The center pane of the Status bar indicates Console activity. A moving bar inside the center pane functions as an activity indicator when Console activity occurs. The right pane of the Status bar provides progress information during some Console tasks.

The Status Bar is displayed or not displayed, depending on the Show setting in the View menu. Click View on the Menu bar, select the Show option, and select or deselect the Status bar option.

## Partitioning a Disk by Using the Solaris Management Console Disks Manager Tool

The following section describes how to partition a disk by using the Solaris Management Console Disks Manager Tool (from this point on, referred to as the Disks Tool).

### Partitioning the Disk Using the Disks Tool

To partition a disk by using the Disks Tool, you must first locate the Storage folder within the Navigation pane. The Storage folder consists of the Mounts and Shares folder, the Disks Tool, and the Enhanced Storage tools.

Use the Disks Tool to perform the following tasks:

- Display information about a specific disk
- Create Solaris OE disk partitions
- List partitions
- Copy the layout of one disk to another disk of the same type
- Change the disk's label

Perform the following steps to partition a disk by using Disks Tool:

1. Click the Disks Tool. The Log In: User Name window appears, prompting you to enter the `root` password.

Figure 2-16 shows the Log In: User Name window.

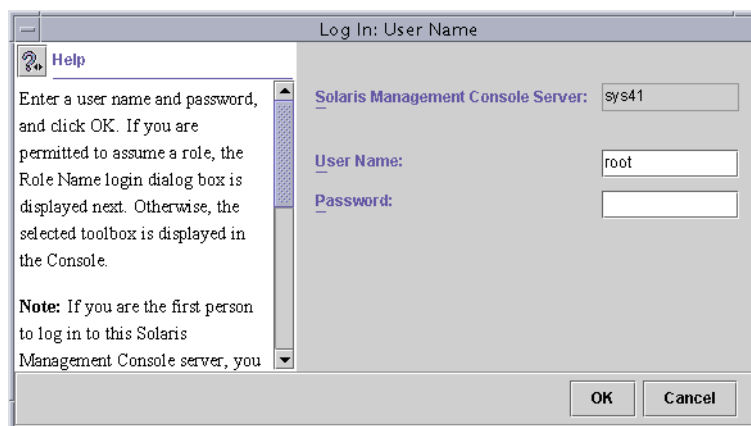


**Figure 2-16** Log In: User Name Window

Figure 2-17 shows the Solaris Management Console after you have opened the Storage folder and then the Disks Tool. The figure shows a system with two disks.

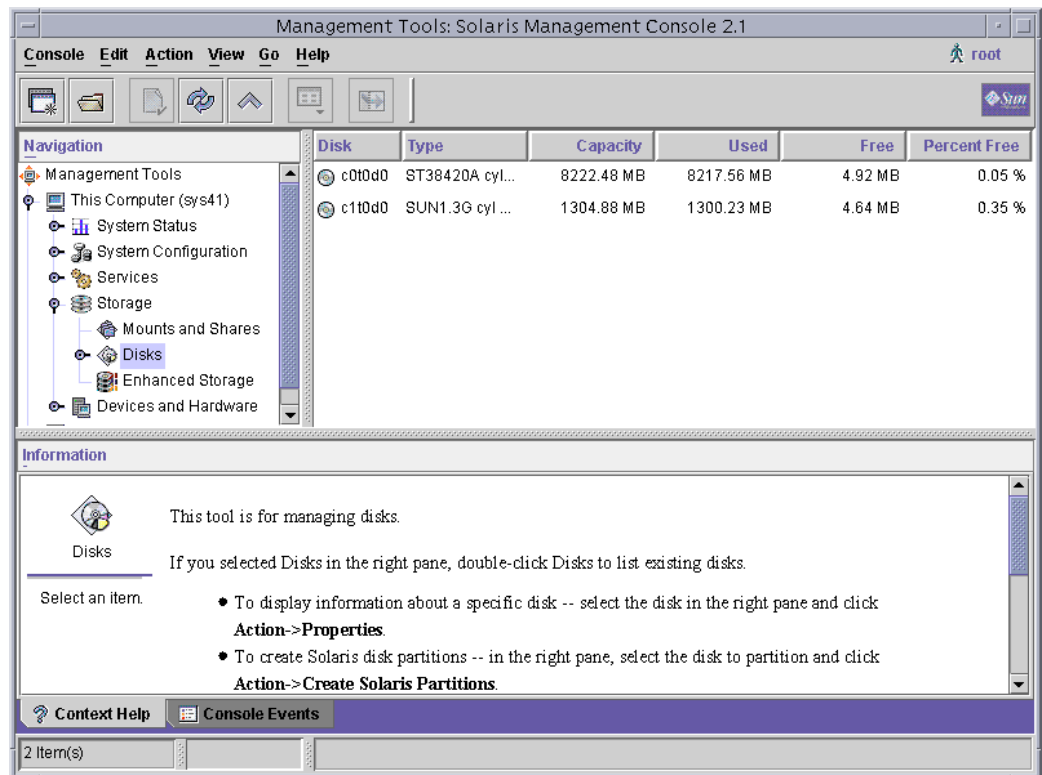


**Figure 2-17** Management Tools: Solaris Management Console Window

2. Click to select a specific disk. Then click the Action menu on the Menu bar.  
The Action menu displays a list of functions that this window performs.
3. To display a graphical representation of a disk's partitioning, select the Properties option from the Action menu.



Figure 2-18 shows a 1.3 Gbyte drive.

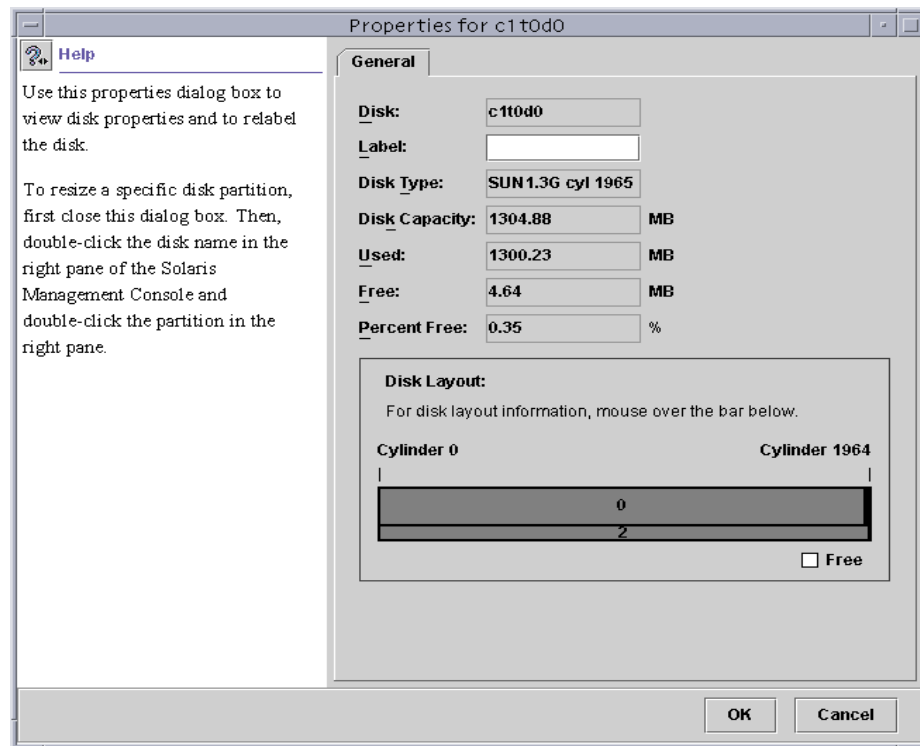


**Figure 2-18** Properties Window

Basic disk information, including size, address, and available free space, is reported. Move the cursor over any partition on the Disk Layout bar to see the size and geometry of the partition slice in a pop-up window.

4. To create a new partition map on a disk, select the Create Solaris Partitions option from the Action menu.

Figure 2-19 shows the first window that you use to create partitions on a disk. This window prompts you to choose between creating custom-sized partitions and creating equal-sized partitions. In the figure, Create Custom-Sized Partitions is selected.

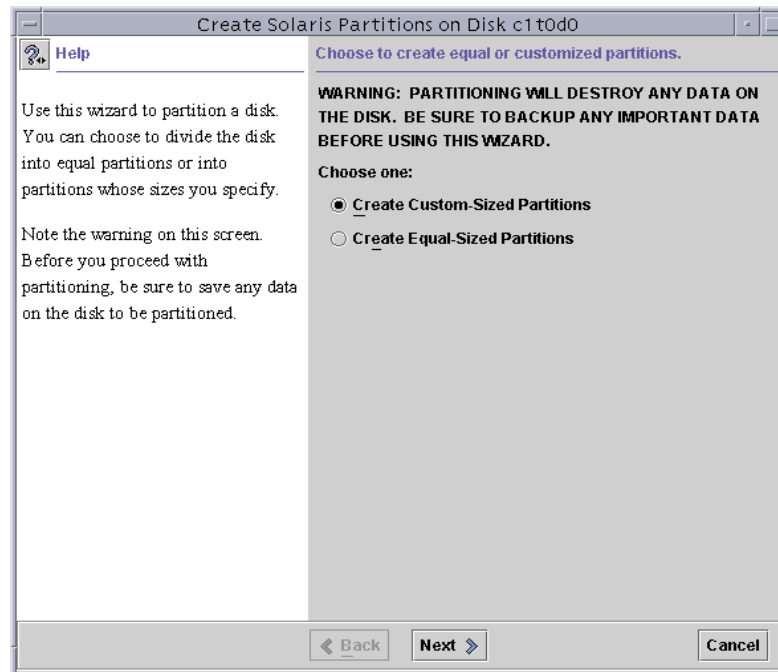


**Figure 2-19** Create Solaris Partitions on Disk Window

5. Click Next after choosing how to divide the disk.

Figure 2-20 shows the next window that you use to create partitions on a disk. You are prompted to select the number of partitions. You can select up to seven partitions. You can also create some of them as zero-length partitions.

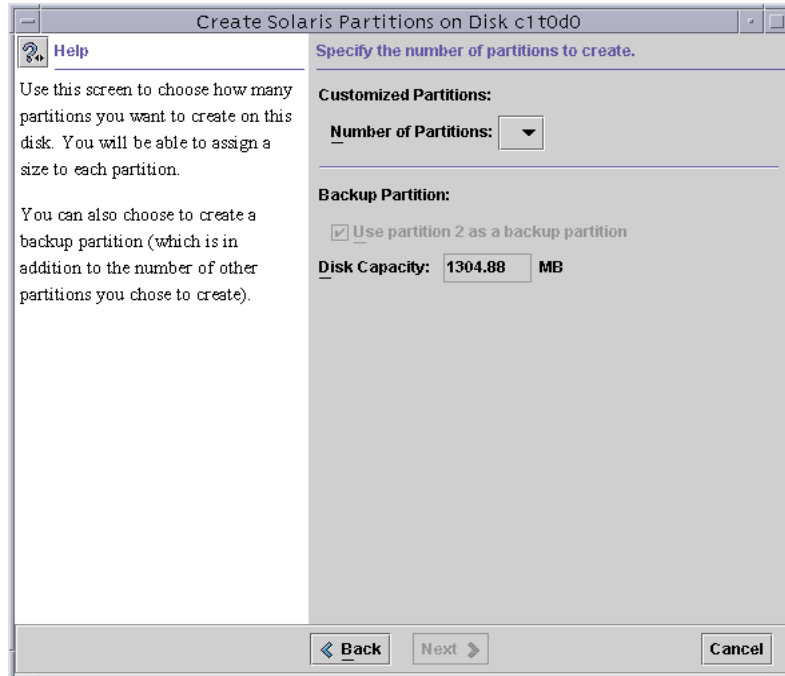


**Figure 2-20** Create Solaris Partitions on Disk Window – Specify Number of Partitions

6. After selecting the number of partitions, click Next.

Figure 2-21 shows the window that enables you to display each partition. When a partition is displayed, the size of the partition is also displayed. You can choose to display the size of the partition in either a percentage of the disk space or the total number of megabytes, and you can adjust the size of each partition. The disk layout bar graphically represents the disk partitions. Place the cursor over the bar to view the amount of space that remains to be partitioned.

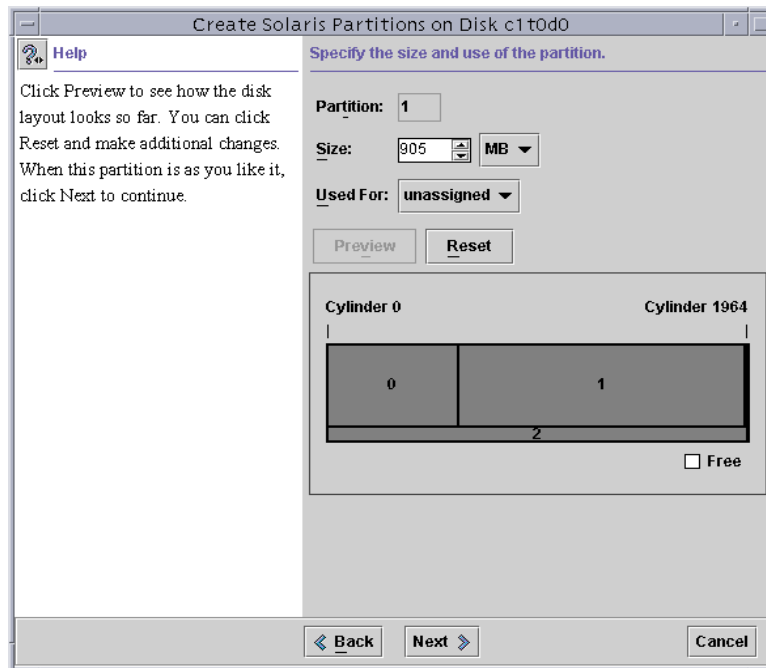


**Figure 2-21** Create Solaris Partitions on Disk Window – Specify Size and Use of Partitions

7. Use this window to adjust the size of each partition to the desired size. Click Next when you have finished sizing the partitions.

Figure 2-22 shows the window that allows you to specify the partitions on which to create file systems.

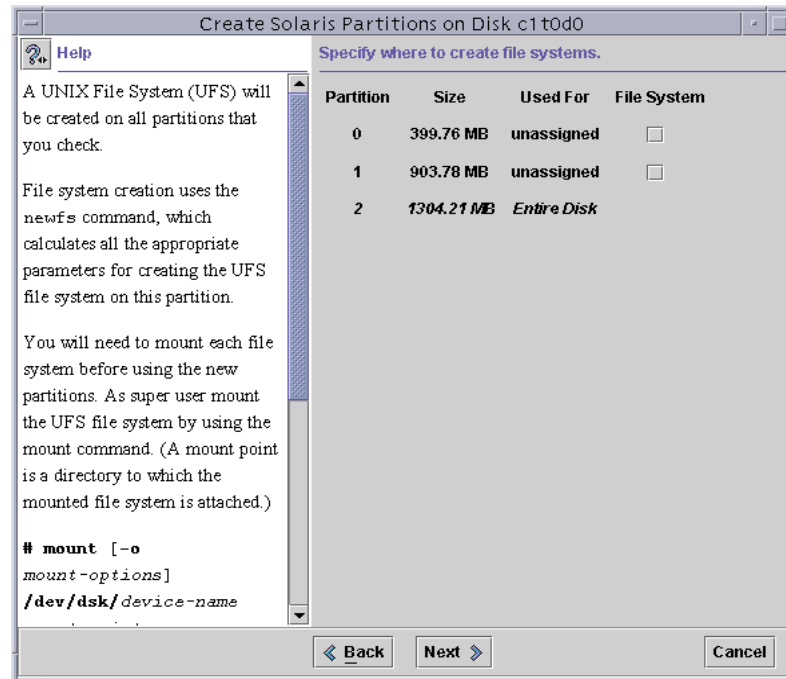


**Figure 2-22** Create Solaris Partitions on Disk Window – Specify Where to Create File Systems

8. In the Create Solaris Partitions on Disk window, check the box under the file system that corresponds to each partition you want to use. Click Next when you are finished making your selections.

Figure 2-23 displays a list of the disk partitions you have created.

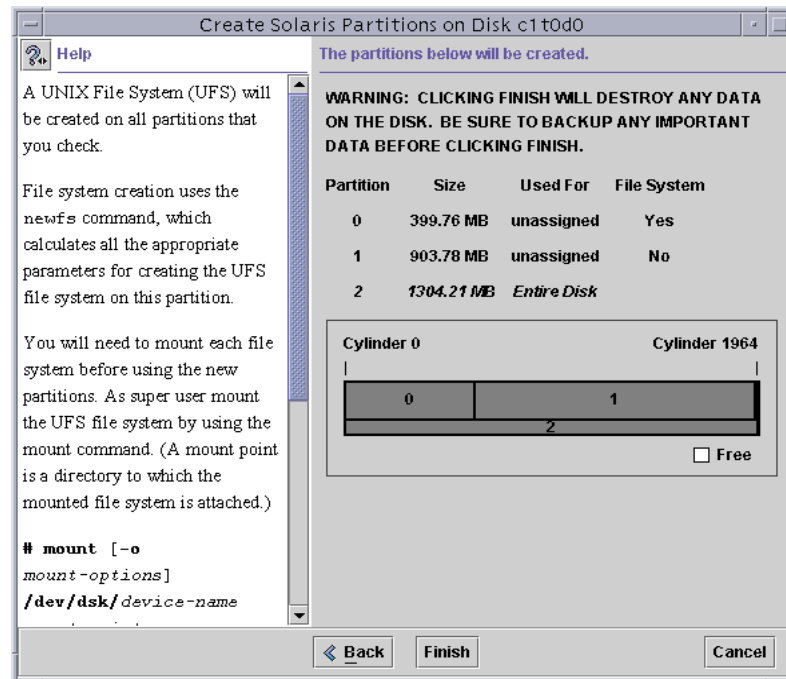


**Figure 2-23** Create Solaris Partitions on Disk Window – Confirmation

9. If you are satisfied with the partitions, click Finish. The new partitioning is written, and the `newfs` utility runs on the partitions you selected to create a new file system.

Figure 2-24 displays the disks window of the Solaris Management Console after you have completed partitioning the disk. The created partitions are displayed in the Management Tools: Solaris Management Console window.

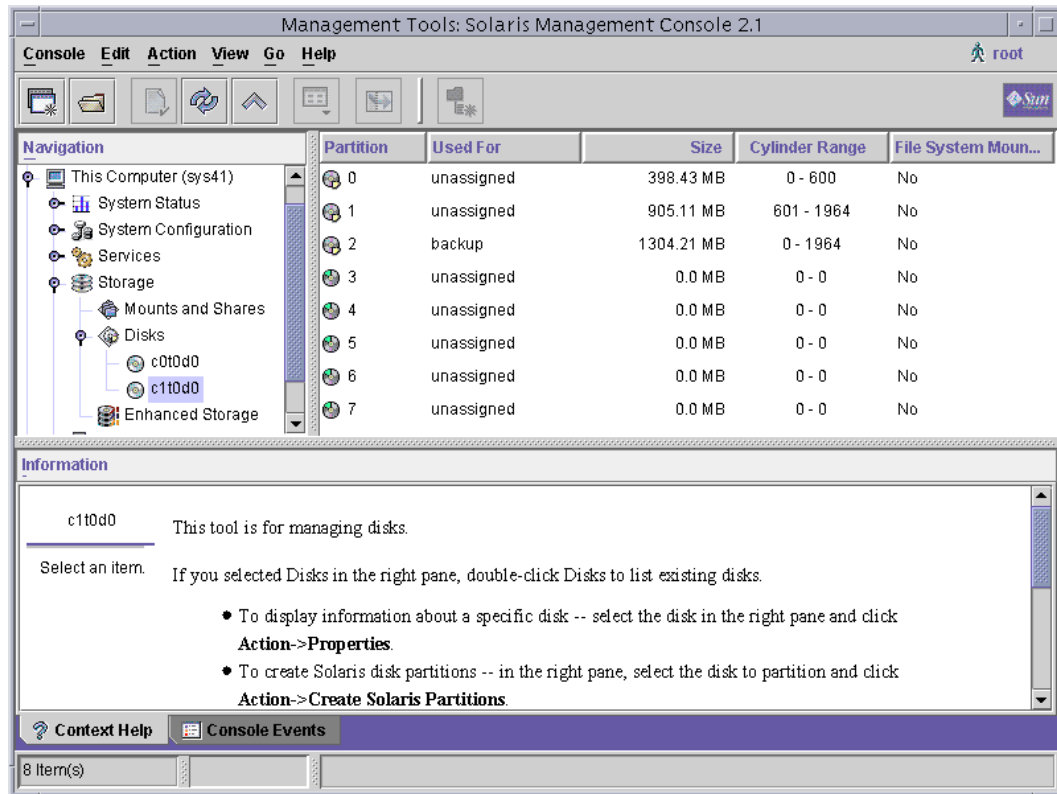


**Figure 2-24** Management Tools: Solaris Management Console Window – Partitioning Completed

## Performing the Exercises

You have the option to complete either of these labs. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab is guided. Although each step describes what you should do, you must determine which commands (and options) to input.

There are only two levels of this lab due to the nature of working within the Solaris Management Console GUI. Should you require assistance with any of the steps, consult the help functionality from the Solaris Management Console.



## Exercise: Working With the Solaris Management Console (Level 1)

In this exercise, you complete the following tasks:

- Launch the Solaris Management Console Disks Manager Tool
- Partition the second drive of your system to match the boot drive

### Preparation

This exercise requires a system with at least two disks, one of which is available for the student to re-partition.

### Tasks

Complete the following tasks:

- Launch the Solaris Management Console, and choose the Disks Tool from the Storage folder.
- Authenticate as the `root` user by typing the `root` password.
- View information about your boot drive from the Disks Tool, and make note of it.
- On your spare hard drive, make four equal sized partitions on Slices 0, 1, 3, and 4.

## Exercise: Working With the Solaris Management Console (Level 2)

In this exercise, you complete the following tasks:

- Launch the Solaris Management Console Disks Manager Tool
- Partition the second drive of your system to match the boot drive

### Preparation

This exercise requires a system with at least two disks, one of which is available for the student to re-partition.

### Task Summary

Complete the following tasks:

- Launch the Solaris Management Console, and choose the Disks Tool from the Storage folder.
- Authenticate as the `root` user by typing the `root` password.
- View information about your boot drive from the Disks Tool, and make note of it.
- On your spare hard drive, make four equal sized partitions on Slices 0, 1, 3, and 4.

### Tasks

Complete the following steps:

1. Launch the Solaris Management Console from the command line or by using Application Manager.
2. Open the Disks Tool.
3. Select your boot drive from the Disks Tool, and record the partition information listed.
4. Select your spare drive from the Disks Tool. Select Create Solaris Partitions from the Action menu.
5. Choose Create Equal-Sized Partitions, and click Next.

6. Specify Number of Partitions as 4. Click Next.
7. Verify that you have four equal-sized partitions on Slices 0, 1, 3, and 4. Click Next.
8. Check the box beside Slice 4 to create a File System, and click Next.
9. After reviewing your choices and verifying that they are correct, click Finish.

The Solaris Management Console window refreshes, and you should see the four equal-sized partitions listed in the View Pane.

10. Exit from the Solaris Management Console.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications

# Managing the Solaris OE File System

---

## Objectives

Upon completion of this module, you should be able to:

- Describe Solaris OE file systems
- Create a new ufs file system
- Check the file system by using the fsck command
- Resolve file system inconsistencies
- Monitor file system use

The following course map shows how this module fits into the current instructional goal.

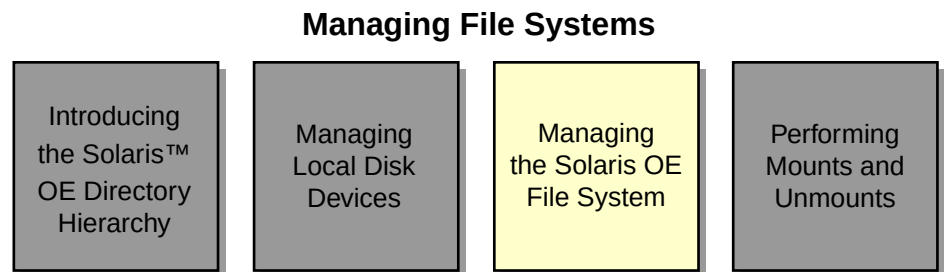


**Figure 3-1** Course Map

## Introducing Solaris OE File Systems

A file system is a collection of files and directories that make up a structured set of information. The Solaris OE supports three different types of file systems:

- Disk-based file systems
- Distributed file systems
- Pseudo file systems

### Disk-based File Systems

Disk-based file systems are found on hard disks, CD-ROMs, diskettes, and DVDs. The following are examples of disk-based file systems:

- `ufs` – The UNIX file system in the Solaris OE is based on the Berkeley fast file system.
- `hsfs` – The High Sierra file system is a special-purpose file system developed for use on CD-ROM media.
- `pcfs` – The PC file system is a UNIX implementation of the disk operating system (DOS) file allocation table (FAT32) file system. The `pcfs` file system allows the Solaris OE to access PC-DOS formatted file systems. Users can use UNIX commands for direct read and write access to PC-DOS files.
- `udfs` – The Universal Disk Format file system is used for optical storage targeted at DVD and CD-ROM media. The UDF file system allows universal data exchange and supports read and write operations.

### Distributed File Systems

Distributed file systems provide network access to file system resources.

- `NFS` – The network file system allows users to share files among many types of systems on the network. The NFS file system makes part of a file system on one system appear as though it were part of the local directory tree.

## Pseudo File Systems

Pseudo file systems are memory based. These file systems provide for better system performance, in addition to providing access to kernel information and facilities. Pseudo file systems include:

- **tmpfs** – The temporary file system stores files in memory, which avoids the overhead of writing to a disk-based file system. The tmpfs file system is created and destroyed every time the system is rebooted.
- **swapfs** – The swap file system is used by the kernel to manage swap space on disks.
- **fdfs** – The file descriptor file system provides explicit names for opening files by using file descriptors (for example, `/dev/fd/0`, `/dev/fd/1`, `/dev/fd/2`) in the `/dev/fd` directory.
- **procfs** – The process file system contains a list of active processes in the `/proc` directory. The processes are listed by process number. Information in this directory is used by commands, such as the `ps` command.
- **mntfs** – The mount file system provides read-only information from the kernel about locally mounted file systems.

## Creating a New ufs File System

This section describes the ufs file system in the Solaris OE.

### Viewing the Solaris OE ufs File System

The user views the ufs file system differently than the operating system does in the Solaris OE. To a user, a file system appears as a collection of files and directories used to store and organize data for access by the system and its users. To the operating system, a file system is a collection of control structures and data blocks that occupy the space defined by a partition, which allow for data storage and management.

The Solaris OE stores data in a logical file hierarchy often consisting of several file systems. This file hierarchy is referred to as the Solaris directory hierarchy.



Figure 3-2 shows the Solaris OE hierarchy beginning with the / (root) directory.

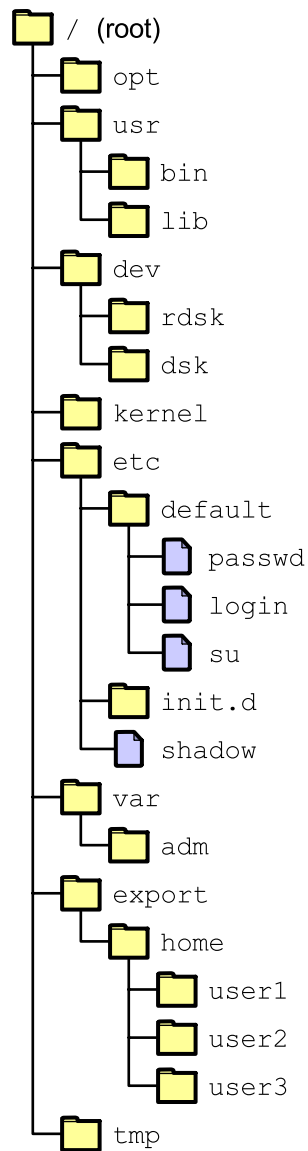


**Figure 3-2** Solaris OE Directory Hierarchy



**Note** – Figure 3-2 is not a complete representation of a Solaris OE directory hierarchy.

A ufs file system is created on a disk slice before it is used in the Solaris OE. Creating a ufs file system on a disk slice enables the Solaris OE to store UNIX directories and files.

Figure 3-3 shows how the ufs file systems are located on various disk slices.

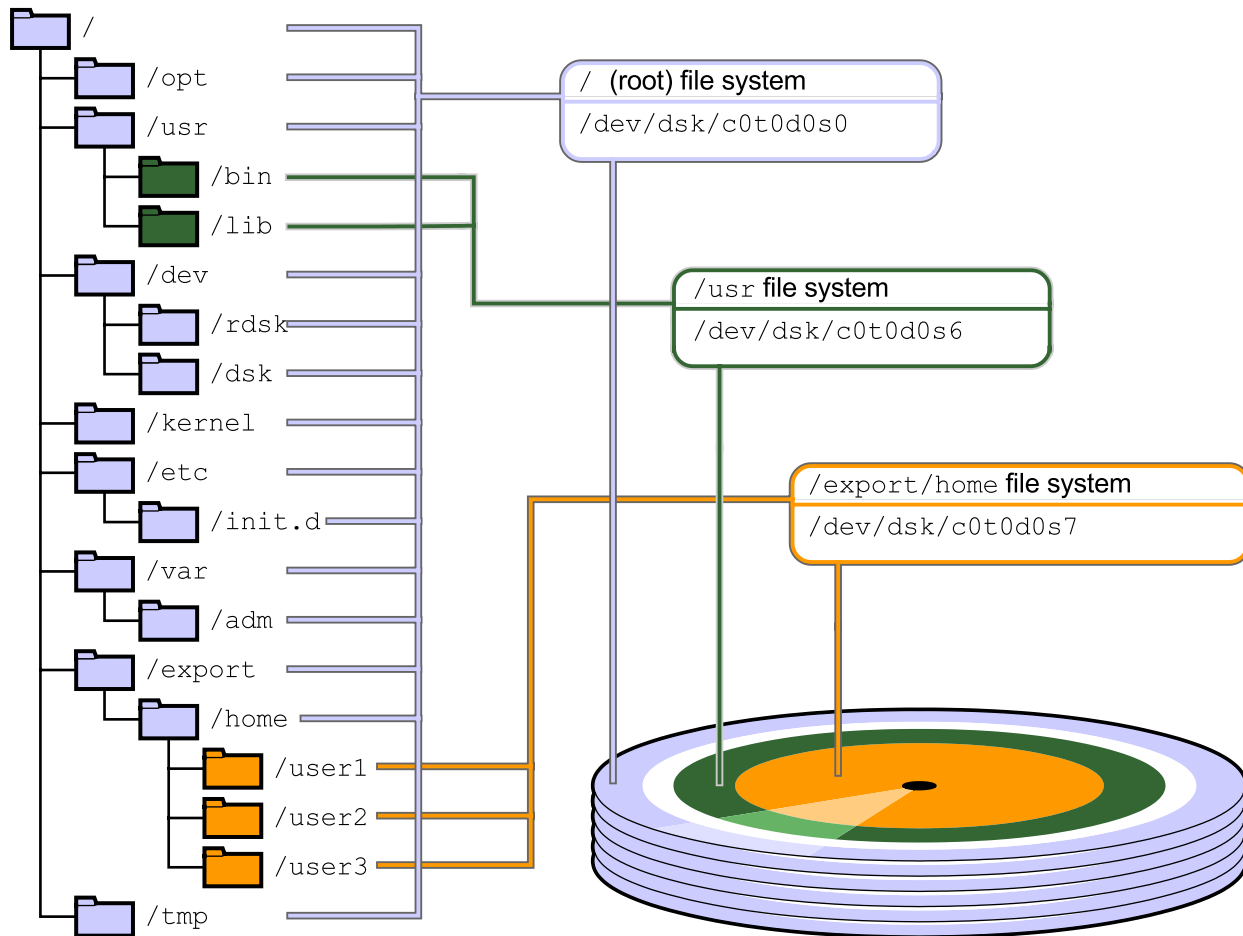


**Figure 3-3** Solaris ufs File Systems Residing on Disk Slices

The Solaris OE ufs file system contains the following basic support structures.

### Disk Label (VTOC)

The disk label (VTOC) contains the partition table for the disk. The VTOC resides in the first disk sector (512-byte blocks). Only the first disk slice contains a VTOC, although file systems created on any slice skip the first sector in case it might contain a VTOC.

## Boot Block

The bootstrap program (`bootblk`) resides in the 15 disk sectors (Sectors 1–15) that follow the VTOC. Only the / (root) file system has an active boot block. However, space is allocated for a boot block at the beginning of each file system.

## Primary Superblock

The superblock resides in the 16 disk sectors (Sectors 16–31) that follow the boot block. The superblock is a table of information that describes the file system, including:

- The number of data blocks
- The number of cylinder groups
- The size of a data block and fragment
- A description of the hardware, derived from the label
- The name of the mount point
- File system state flag: clean, stable, active, logging, or unknown

## Backup Superblocks

When the file system is created, each cylinder group replicates the superblock beginning at Sector 32. This replication protects the critical data in the superblock against catastrophic loss.

### Cylinder Groups

Each file system is divided into cylinder groups with a minimum default size of 16 cylinders per group. Cylinder groups improve disk access.

The file system constantly optimizes disk performance by attempting to place a file's data into a single cylinder group, which reduces the distance a head has to travel to access the file's data. The file system stores large files across several cylinder groups, if needed.

### Cylinder Group Blocks

The cylinder group block is a table in each cylinder group that describes the cylinder group, including:

- The number of inodes
- The number of data blocks in the cylinder group
- The number of directories
- Free blocks, free inodes, and free fragments in the cylinder group
- The free block map
- The used inode map

Figure 3-4 shows a series of cylinder groups in a ufs file system.

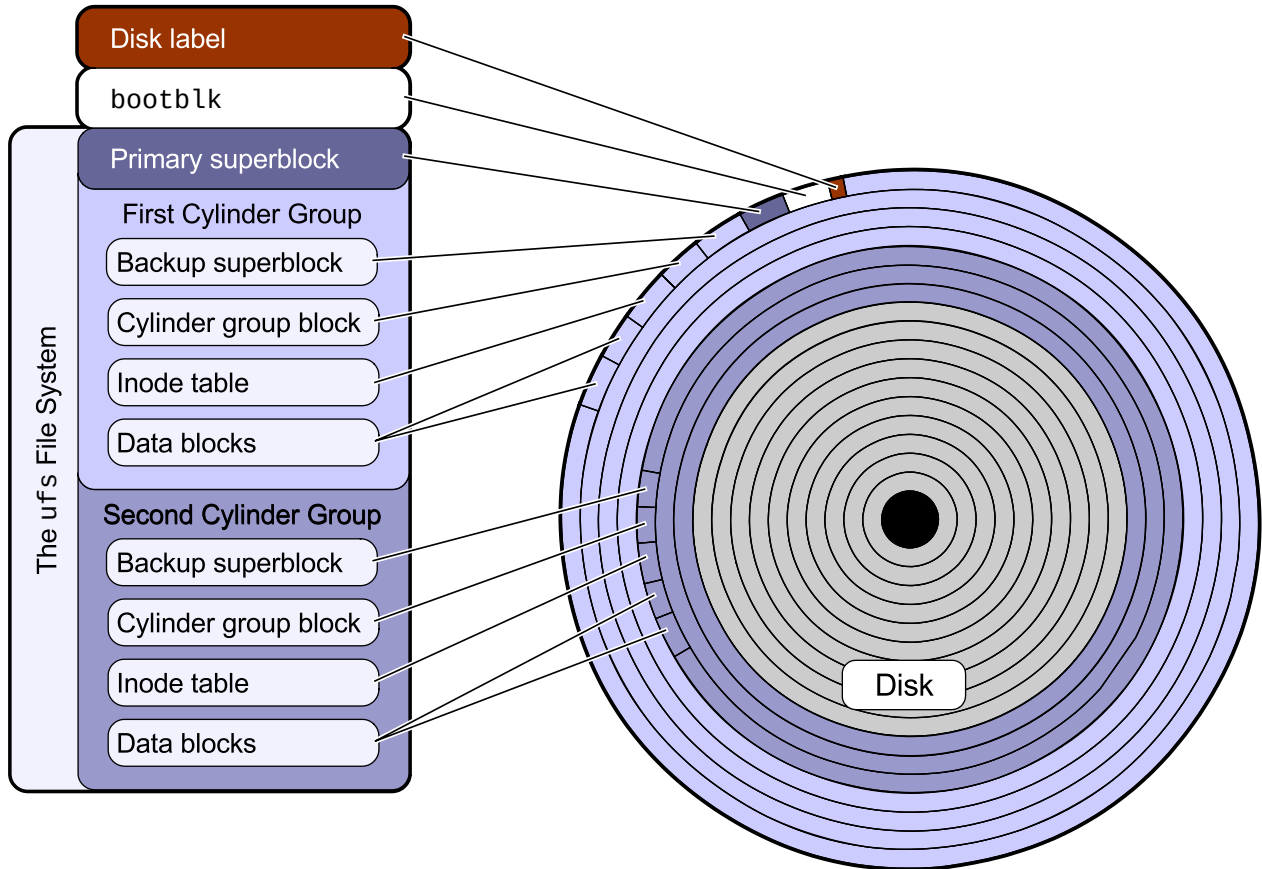


**Figure 3-4** Solaris ufs File System Structure

### The ufs Inode

An inode contains the following information about a file:

- The type of file and the access modes
- The user identification (UID) and group identification (GID) numbers of the file's owner and group
- The size of the file
- The link count
- The time the file was last accessed and modified and the inode changed
- The total number of data blocks used by or allocated to the file
- Two types of pointers: direct pointers and indirect pointers

Figure 3-5 shows some of the information contained in an inode.

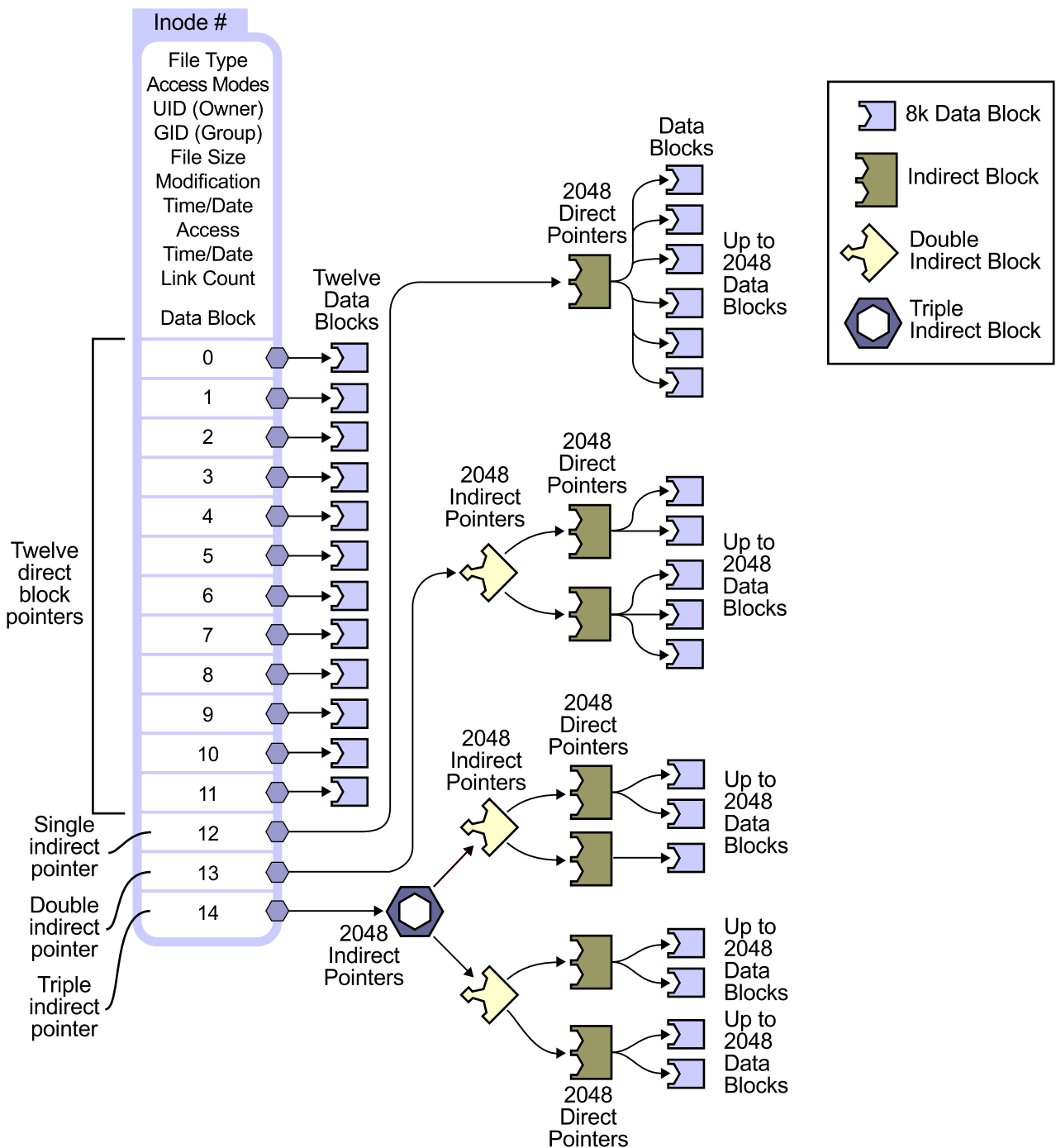


**Figure 3-5** Structure of a ufs Inode



---

**Note** – To view some of the information contained in a file or directory inode, use the `ls -l` command. To view the inode number assigned to the file or directory, use the `ls -li` command.

---

### Direct Pointers

Inside the inode there are 12 direct pointers, which contain addresses for the file's first 12 data blocks. The 12 direct pointers can each reference 8-Kbyte data blocks for a file that is up to 96 Kbytes.

### Indirect Pointers

The three types of indirect pointers within an inode are:

- Single indirect pointer – Refers to a file system block that contains pointers to data blocks. This file system block contains 2048 additional addresses of 8-Kbyte data blocks, which can point to an additional 16 Mbytes of data.
- Double indirect pointer – Refers to a file system block that contains single indirect pointers. Each indirect pointer refers to a file system block that contains the data block pointers. Double indirect pointers point to an additional 32 Gbytes of data.
- Triple indirect pointer – Can reference up to an additional 64 Tbytes of data. However, the maximum size of a ufs file system is limited to 1 Tbyte due to the maximum address space of 32-bits for the device drivers.

### Data Blocks

The remaining space allocated to the ufs file system holds data blocks. Data blocks are allocated, by default, in 8-Kbyte logical block sizes. The blocks are further divided into 1-Kbyte fragments. For a regular file, the data blocks contain the contents of the file. For a directory, the data blocks contain entries that associate the inode numbers and the file names of the files and directories contained in that directory.

Within a file system, those blocks that are currently not being used as files, directories, indirect address blocks, or storage blocks are marked as free in the cylinder group map. This map also keeps track of fragments to prevent disk performance from degrading.



## Fragmentation

Fragmentation is the method used by the ufs file system to allocate disk space efficiently. Files less than 96 Kbytes in size are stored using fragmentation.

By default, data blocks can be divided into eight fragments of 1024 bytes each. Fragments store files and pieces of files smaller than 8192 bytes. For files larger than 96 Kbytes, fragments are never allocated and full blocks are exclusively used.

Figure 3-6 shows a fragment in a data block.

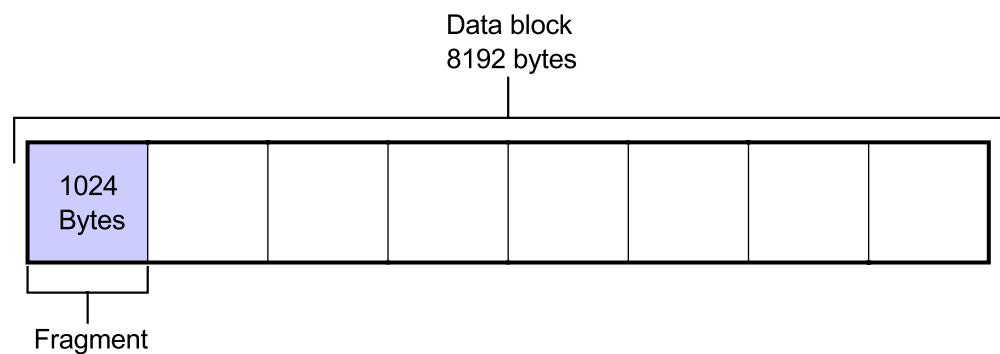


**Figure 3-6** Divided Data Block

If a file contained in a fragment grows and requires more space, it is allocated one or more additional fragments in the same data block.

Figure 3-7 shows the contents of two different files stored in fragments in the same data block.

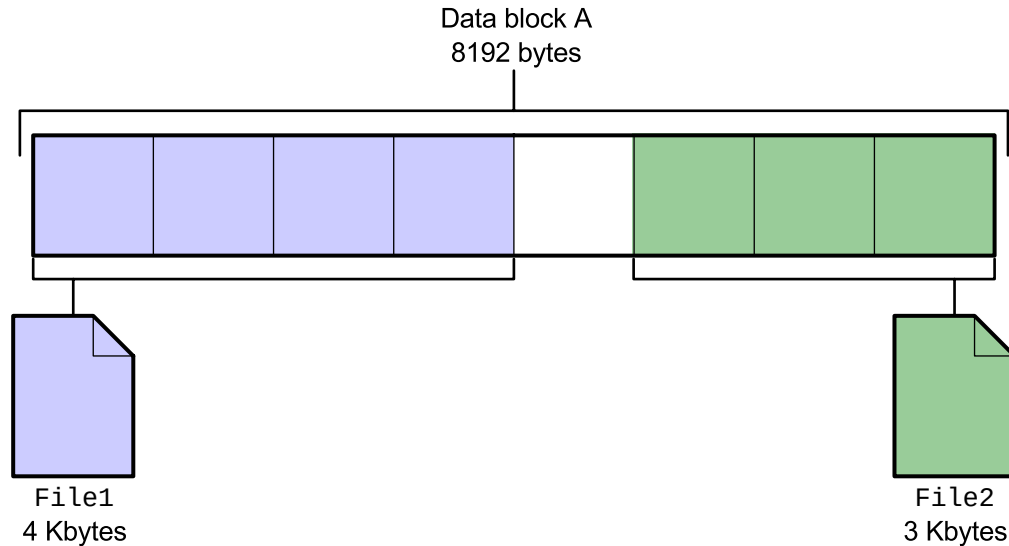


**Figure 3-7** Two Files Stored in One Data Block

For example, if File1 requires more space than is currently available in the shared data block, the entire contents of that expanding file are moved by the ufs file system into a free data block. This requirement by the ufs file system assures that all of a file's fragments are contained in a whole data block. The ufs file system does not allow fragments of the same file to be stored in two different data blocks.

## Using the newfs Command

To use the disk to store directories or files, a file system must be created on every disk partition. As the `root` user, you can construct a ufs file system on a disk slice by using the `newfs` command.

The `newfs` command is an easy-to-use front-end to the `mkfs` command, which you use to create file systems. The `newfs` command is located in the `/usr/sbin` directory.



---

**Caution** – The `newfs` command is destructive. The command overwrites data that resides on the selected disk slice.

---

To create a ufs file system, by using the `newfs` command, perform the following steps:

1. As the `root` user, create a file system on the first slice of a newly partitioned disk by entering the command:

```
# newfs /dev/rdisk/c1t3d0s0
```

2. The `newfs` command asks for confirmation before continuing. Verify that the correct disk slice on the correct disk is selected. To proceed, type `y`; to terminate the process, type `n`.

```
newfs: construct a new file system /dev/rdisk/c1t3d0s0: (y/n)? y
```

The `newfs` command displays information about the new file system being created.

```
/dev/rdisk/c1t3d0s0: 410720 sectors in 302 cylinders 17 tracks 80 sectors
                200.5MB in 19 cyl groups (16 c/g, 10.62MB/g, 5120 i/g)
super-block backups (for fsck -F ufs -o b=#) at:
 32, 21872, 43712, 65552, 87392, 109232, 131072, 152912, 174752, 196592,
218432, 240272, 262112, 283952, 305792, 327632, 349472, 371312, 393152
```

The first line printed by the `newfs` command describes the basic disk geometry. The second line describes the ufs file system created in this slice. The third and remaining lines list the beginning sector locations of the backup superblocks.




---

**Note** – This process also creates a `lost+found` directory for the ufs file system, which is a directory that is used by the file system check and repair (`fsck`) utility.

---

3. Repeat Steps 1 and 2 for every disk slice on any newly partitioned disk that needs to contain a file system.

The `newfs` command reserves between 1 and 10 percent of the file system space for maintenance of the file system. This free space, referred to as `minfree`, specifies the amount of space on the slice that is reserved or held back from regular users. You can use the `newfs -m %free` command to preset the percentage of free space when you create a new file system.

To show the value of `minfree` on a file system, use the `fstyp` command.

The following command shows the `minfree` value for the file system on the `c0t0d0s0` device.

```
# fstyp -v /dev/rdisk/c0t0d0s0 | head -10
ufs
magic    11954    format    dynamic  time      Fri Mar 15 07:53:40 2002
sblkno   16       cblkno    24       iblkno    32       dblkno    480
sbsize   3072     cgsiz     2048     cgoffset  32       cgmask    0xffffffff
ncg      17        size      121905   blocks    114000
bsize    8192     shift     13       mask      0xfffffe000
fsize    1024     shift     10       mask      0xffffffc00
frag     8        shift     3        fsbtodb   1
minfree  10%      maxbpg    2048     optim     time
maxcontig 16     rotdelay  0ms      rps       90
```

To change the minimum percentage value of free space on an existing file system, you can use the `tunefs -m %free` command.

The following command changes the minimum percentage of free space on the `/dev/rdisk/c1t3d0s0` device to 1 percent.

```
# tunefs -m 1 /dev/rdisk/c1t3d0s0
minimum percentage of free space changes from 10% to 1%
```

## Checking the File System by Using the fsck Command

A file system can become damaged if it is corrupted from a power failure, a software error in the kernel, a hardware failure, or an improper shutdown of the system. The file system check program, **fsck**, checks the data consistency of a file system and attempts to correct or repair any inconsistencies or damage found.



---

**Caution** – Never run the **fsck** command on a mounted file system. This could leave the file system in an unusable state. It could also delete data. The **/** (root), **/usr**, and **/var** file systems should have the **fsck** command run on them while in single-user mode.

---

Every time you boot a system, the operating system determines which file systems the **fsck** command should check. The **fsck** command checks and repairs any problems encountered in file systems before they are mounted.



---

**Note** – The status of a file system's state flag determines whether the file system needs to be scanned by the **fsck** command. When the state flag is "clean," "stable," or "logging," file system scans are not run.

---

## Data Inconsistencies Checked by the fsck Command

The **fsck** command makes several passes through a file system. During each pass, the **fsck** command checks for several types of file system inconsistencies.

### Superblock Consistency

The file system superblock is checked for inconsistencies involving such parameters as file system size, free block count, and free inode count.

### Cylinder Group Block Consistency

The **fsck** command checks any unallocated data blocks claimed by inodes, the unallocated data block count, and the unallocated inode count.

## Inode Consistency

The `fsck` command checks for the allocation state of inodes, as well as the type, the link count, duplicate blocks (blocks already claimed by another inode), bad blocks, the inode size, and the block count for each inode. Any unreferenced inode with a nonzero link count is linked to the file system's `lost+found` directory.

## Data Block Consistency

The `fsck` command cannot check ordinary data blocks, but it can check directory data blocks. In directory data blocks, the `fsck` command checks for inodes that point to unallocated blocks, unallocated blocks tagged as in use, allocated blocks tagged as free (incorrect inodes for `.` and `..`) and directories not connected to the file system. These directories are linked back to the file system in its `lost+found` directory.

## The lost+found Directory

The `fsck` command puts files and directories that are allocated but unreferenced in the `lost+found` directory located in that file system. The inode number of each file is assigned as the file name. If the `lost+found` directory does not exist, the `fsck` command creates it. If not enough space exists in the `lost+found` directory, the `fsck` command increases the directory's size.

## Noninteractive Mode

During a normal system boot, the `fsck` command operates in noninteractive mode, which is often referred to as `preen`, or silent mode. In this mode, the `fsck` command addresses only minor inconsistency problems that can be corrected. If a more serious inconsistency is found and a decision has to be made, the `fsck` program terminates and requests the `root` password to enter single-user mode. Execute the `fsck` command in interactive mode to continue.

## Interactive Mode

In interactive mode, the `fsck` command lists each problem it encounters, followed by a suggested corrective action in the form of a question that requires a yes or no response.

The following example shows how the `fsck` command displays a message that asks if you want to correct the block count.

```
# fsck /dev/rdisk/c0t0d0s7
** /dev/rdisk/c0t0d0s7
** Last Mounted on /export/home
** Phase 1 - Check Blocks and Sizes
INCORRECT BLOCK COUNT I=743 (5 should be 2)
CORRECT?
. . .
```

If you respond with `yes`, the `fsck` command applies the corrective action and moves on. If you respond with `no`, the `fsck` command repeats the message about the original problem and suggests corrective action. It does not fix the inconsistency until you respond `yes`.

The following examples demonstrate how you as the system's `root` user can run the `fsck` command to check the integrity of file systems.

- To check a single unmounted file system, perform the command:

```
# fsck /dev/rdisk/c0t0d0s7
```

This is the only way to check a file system that has not been entered in the `/etc/vfstab` file.

- To check a file system using the mount point directory name as listed in the `/etc/vfstab` file, perform the command:

```
# fsck /export/home
```

In the following example, the `fsck` command checks and repairs the file system with the force (`f`) and preen (`p`) options.

```
# fsck -o f,p /dev/rdisk/c0t0d0s5
/dev/rdisk/c0t0d0s5: 77 files, 9621 used, 46089 free
/dev/rdisk/c0t0d0s5: (4 frags, 57 blocks, 0.0% fragmentation)
```

The `f` option of the `fsck` command forces a file system check, regardless of the state of the file system's superblock state flag.

The `p` option checks and fixes the file system noninteractively (preen). The program exits immediately if a problem requiring intervention is found.



# Resolving File System Inconsistencies

If problems are located in a file system, you are alerted by the `fsck` utility. Some of the more common file system errors that require interactive intervention are:

- Allocated unreferenced file
- Inconsistent link count
- Free block count corruption
- Superblock corruption

## Reconnecting an Allocated Unreferenced File

If the `fsck` command discovers an inode that is allocated but unreferenced or not linked in any directory, the command sends a message that asks you if you want to reconnect the inode.

```
** Phase 3 - Check Connectivity
UNREF FILE I=788 OWNER=root MODE=100644
SIZE=19994 MTIME=Jan 18 10:49 1999
RECONNECT? y
```

A yes response causes the `fsck` command to save the file to the `lost+found` directory. The `fsck` command references the inode number.

To determine the type of file moved to the `lost+found` directory by the `fsck` command, perform the following steps:

1. List the contents of the file system's `lost+found` directory.

```
# ls /export/home/lost+found
#788
```

2. Determine the file type by using the `file` command.

```
# file /export/home/lost+found/#788
/export/home/lost+found/#788: ascii text
```

3. To view the contents of an ASCII text file, use the `more` or `cat` command. To view the contents of a binary file, use the `strings` command. If the file is associated with an application, such as a word processing document, use the application to view the contents of the file.

```
# cat /export/home/lost+found/#788
```

4. If the file is intact and you know where it belongs, you can copy the file back to its original location in the file system.

```
# cp /export/home/lost+found/#788 /export/home/user1/report
```

## Adjusting a Link Counter

If the `fsck` program discovers that the value of a directory inode link counter and the actual number of directory links are inconsistent, the command displays a message that asks you if you want to adjust the counter.

```
** Phase 4 - Check Reference Counts
LINK COUNT DIR I=2 OWNER=root MODE=40755
SIZE=512 MTIME=Jan 18 15:59 1999 COUNT 4 SHOULD BE 3
ADJUST? y
```

In the example, a **y** (yes) response causes the `fsck` command to correct the directory inode link counter from 4 to 3.

During this phase, you might also be asked to clear or remove a link.

```
BAD/DUP type I=200 OWNER=root MODE=40755
SIZE=512 MTIME=Mar 14 08:03 2002
CLEAR? y
```

## Salvaging the Free List

If the `fsck` utility discovers that the unallocated block count and the free block number listed in the superblock are inconsistent, the `fsck` command displays a message that asks if you want to salvage the free block count by rectifying it with the unallocated block count.

```
** Phase 5 - Check Cyl groups
CG 0: BAD MAGIC NUMBER
FREE BLK COUNT(S) WRONG IN SUPERBLK
SALVAGE? y
```

In the example, a **y** (yes) response causes the `fsck` command to update the information in the file system superblock.

## Using Backup Superblocks

Superblock corruption can cause a file system to be unmountable. A file system is unusable when the message such as “Can’t mount *file\_system\_name*” or “*device\_name* is not this fstype” appears.

```
Can't mount /dev/dsk/c0t0d0s7
```

This message can appear during a system boot or when you are manually mounting the file system.

If the `fsck` command fails because of a corrupted superblock, you see an error message that tells you to execute the `fsck` command using a superblock backup to recover the file system. Execute the `fsck` command with the `-o` option and with the `b` flag followed by a backup superblock number. Every file system has an alternative backup superblock at block number 32, which can be used with the `fsck` command to repair the primary superblock.

The following command uses a backup superblock.

```
# fsck -o b=32 /dev/rdisk/c1t3d0s0
Alternate super block location: 32.
** /dev/rdisk/c1t3d0s0
** Currently Mounted on
** Phase 1 - Check Blocks and Sizes
** Phase 2 - Check Pathnames
** Phase 3 - Check Connectivity
** Phase 4 - Check Reference Counts
** Phase 5 - Check Cyl groups
171 files, 3762 used, 5984 free (79 frags, 748 blocks, 0.1% fragmentation)
*****FILE SYSTEM WAS MODIFIED*****
#
```

The `fsck` utility compares the information in the backup superblock with the actual file system and attempts to rebuild the primary superblock. However, if the first backup superblock is part of the file system that was damaged, it may be unusable. Select another backup superblock to continue the `fsck` command.

To list the locations of all the alternative backup superblocks in the file system, run the `newfs -N` command.



**Caution** – This method works if the underlying file system was built using the `newfs` default parameters. If the file system was not built with these defaults, execute the `newfs -N` command, using the same parameters originally used, to generate identical superblock locations.

---

Use the `-N` option to view the file system parameters that you could use to create a new file system without actually creating the file system. A portion of the output is a list of the locations of all the alternative backup superblocks that can be used with the `fsck -o b=#` command.

```
# newfs -N /dev/rdisk/c0t0d0s7
newfs -N /dev/rdisk/c0t0d0s7
/dev/rdisk/c0t0d0s7: 3537040 sectors in 2327 cylinders of 19 tracks, 80 sectors
      1727.1MB in 73 cyl groups (32 c/g, 23.75MB/g, 5888 i/g)
super-block backups (for fsck -F ufs -o b=#) at:
 32, 48752, 97472, 146192, 194912, 243632, 292352, 341072, 389792,
487232, 535952, 584672, 633392, 730832, 779552, 828272, 876992,
925712, 974432, 1023152, 1071872, 1169312, 1218032, 1266752, 1315472,
1364192, 1412912, 1461632, 1510352, 1556512, 1605232, 1653952, 1702672,
1751392, 1800112, 1848832, 1897552, 1946272, 1994992, 2043712, 2092432,
2141152, 2189872, 2238592, 2287312, 2336032, 2384752, 2433472, 2482192,
2530912, 2579632, 2628352, 2677072, 2725792, 2774512, 2823232, 2871952,
(output truncated)
#
```

You can use any other alternative superblock number in the list with the `fsck` command.

```
# fsck -o b=535952 /dev/rdisk/c0t0d0s7
Alternate super block location: 535952
** /dev/rdisk/c0t0d0s7
** Last Mounted on
** Phase 1 - Check Blocks and Sizes
** Phase 2 - Check Pathnames
** Phase 3 - Check Connectivity
** Phase 4 - Check Reference Counts
** Phase 5 - Check Cyl groups
7 files, 14 used, 279825 free (17 frags, 347891 blocks, 0.0% fragmentation)
*****FILE SYSTEM WAS MODIFIED*****
#
```

## Monitoring File System Use

An important activity of a system administrator is to monitor file system use on a regular basis. There are three useful commands available for this task:

- **df** – Displays the number of free disk blocks
- **du** – Summarizes disk use
- **quot** – Summarizes file system ownership

### Using the df Command

Use the **df** command to display the amount of disk space used in file systems. This command lists the amount of used and available space and the amount of the file system's total capacity being used.

The format for the **df** command is:

**df** *-option mount\_point*

lists some of the more common options used with the **df** command.

**Table 3-1** Partial Listing of Options for the **df** Command

| Option | Description                                                                                                                                    |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------|
| -a     | Reports on all file systems, including those with entries in the <code>/etc/mnttab</code> file for which the <code>ignore</code> option is set |
| -b     | Prints the total number of Kbytes free                                                                                                         |
| -e     | Prints only the number of files free                                                                                                           |
| -k     | Displays disk allocation in Kbytes                                                                                                             |
| -h     | Acts like the <code>-k</code> option, except that sizes are in a more readable format, for example, 14K, 234M, 2.7G, or 3.0T                   |
| -l     | Reports on local file systems only                                                                                                             |

To display the capacity of file systems, perform the command:

```
# df -k
Filesystem      kbytes    used    avail capacity  Mounted on
/dev/dsk/c0t0d0s0 114000    69446    33154     68%      /
/dev/dsk/c0t0d0s6 1280269   990963   238096     81%     /usr
/proc            0         0         0         0%      /proc
mnttab           0         0         0         0%     /etc/mnttab
fd               0         0         0         0%     /dev/fd
/dev/dsk/c0t0d0s1  54861    45062     4313     92%     /var
swap             683232     48    683184      1%     /var/run
swap             683184      0    683184      0%     /tmp
/dev/dsk/c0t0d0s5  24114     550    21153      3%     /opt
/dev/dsk/c0t0d0s7 2101887    92 2038739      1%  /export/home
```

The same file system displayed with the `-h` option would appear in human-readable format.

```
# df -h
Filesystem      size    used    avail capacity  Mounted on
/dev/dsk/c0t0d0s0 111M    68M    32M     68%      /
/dev/dsk/c0t0d0s6 1.2G   968M   233M     81%     /usr
/proc            0K      0K      0K       0%      /proc
mnttab           0K      0K      0K       0%     /etc/mnttab
fd               0K      0K      0K       0%     /dev/fd
/dev/dsk/c0t0d0s1  54M    44M   4.2M     92%     /var
swap             667M    48K   667M      1%     /var/run
swap             667M      0K   667M      0%     /tmp
/dev/dsk/c0t0d0s5  24M   550K    21M      3%     /opt
/dev/dsk/c0t0d0s7 2.0G    92K   1.9G      1%  /export/home
```

Table 3-2 defines the fields displayed by the `df -k` command.

**Table 3-2** Fields for the `df -k` Command

| Field      | Definition                                         |
|------------|----------------------------------------------------|
| Filesystem | The mounted file system                            |
| kbytes     | The size of the file system in Kbytes (1024 bytes) |
| used       | The number of Kbytes used                          |
| avail      | The number of Kbytes available                     |
| capacity   | The percentage of file system capacity used        |
| Mounted on | The mount point                                    |

The amount of space that is reported as `used` and `avail` is typically less than the amount of total space in the file system. A fraction of space, from 1 to 10 percent, is reserved in each file system as the `minfree` value.

When all of the reported space on the file system is in use, the file system capacity is displayed as 100 percent. Regular users receive the message “File System Full” and cannot continue working. The reserved space is available to the `root` user, who can then delete or back up files in the file system.

## Using the du Command

Use the `du` command to display the number of disk blocks used by directories and files. Each disk block consists of 512 bytes.

The format for the `du` command is:

```
du -options directory
```

Table 3-3 describes the options for the `du` command.

**Table 3-3** Options for the `du` Command

| Option | Description                                                                                                                             |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------|
| -k     | Displays disk use in Kbytes.                                                                                                            |
| -s     | Displays only the summary in 512-byte blocks. Using the <code>s</code> and <code>k</code> options together shows the summary in Kbytes. |
| -a     | Displays the number of blocks used by all files in addition to directories within the specified directory hierarchy.                    |

To display disk usage in kilobytes, perform the command:

```
# cd /opt
# du -k
8      ./lost+found
3      ./SUNWits/Graphics-sw/xil/lib
4      ./SUNWits/Graphics-sw/xil
7      ./SUNWrtvc/man/man1
(some output removed for brevity)
19     ./SUNWrtvc/man/man3
27     ./SUNWrtvc/man
535    ./SUNWrtvc
550    .
```

To display disk usage including files, perform the command:

```
# du -ak /opt
8      /opt/lost+found
1      /opt/SUNWits/Graphics-sw/xil/lib/libxil.so
1      /opt/SUNWits/Graphics-sw/xil/lib/libxil.so.1
3      /opt/SUNWits/Graphics-sw/xil/lib
(some output removed for brevity)
27     /opt/SUNWrtvc/man
535    /opt/SUNWrtvc
550    /opt
```

To display only a summary of disk usage, perform the command:

```
# du -sk /opt
550    /opt
```

## Using the quot Command

Use the `quot` command to display how much disk space, in kilobytes, is being used by users.



---

**Note** – The `quot` command can be run only by the `root` user.

---

The format for the `quot` command is:

```
quot -options filesystem
```

Table 3-4 describes the options for the `quot` command.

**Table 3-4** Options for the `quot` Command

| Option | Description                         |
|--------|-------------------------------------|
| -a     | Reports on all mounted file systems |
| -f     | Includes the number of files        |



To display disk space being used by users on all mounted file systems, perform the command:

```
# quot -af
/dev/rdisk/c0t0d0s0 (/):
    14326    1284    root
    4792     37     bin
    31       27     lp
    1        1     sys
/dev/rdisk/c0t0d0s6 (/usr):
    197394   6962    root
    161203   11884   bin
    2140     232    lp
    1        1     adm
```

The columns represent kilobytes used, number of files, and owner, respectively.

To display a count of the number of files and space owned by each user for a specific file system, enter the following:

```
# quot -f /dev/dsk/c1t0d0s5
/dev/dsk/c1t0d0s5:
    134     62     root
    103     84     user1
    140     32     user9
```

## Using the Solaris Management Console Usage Tool

The Solaris Management Console Usage Tool provides a graphical display of the available space for all mounted file systems.

To use the Solaris Management Console storage Usage Tool, launch the Solaris Management Console by typing **smc&** at a command line, or select it from the Application Manager Window. To locate the Usage Tool, select This Computer, then select Storage, then select Mounts and Shares on the Solaris Management Console.

Figure 3-8 shows the Management Tools: Solaris Management Console window with the disk usage information.

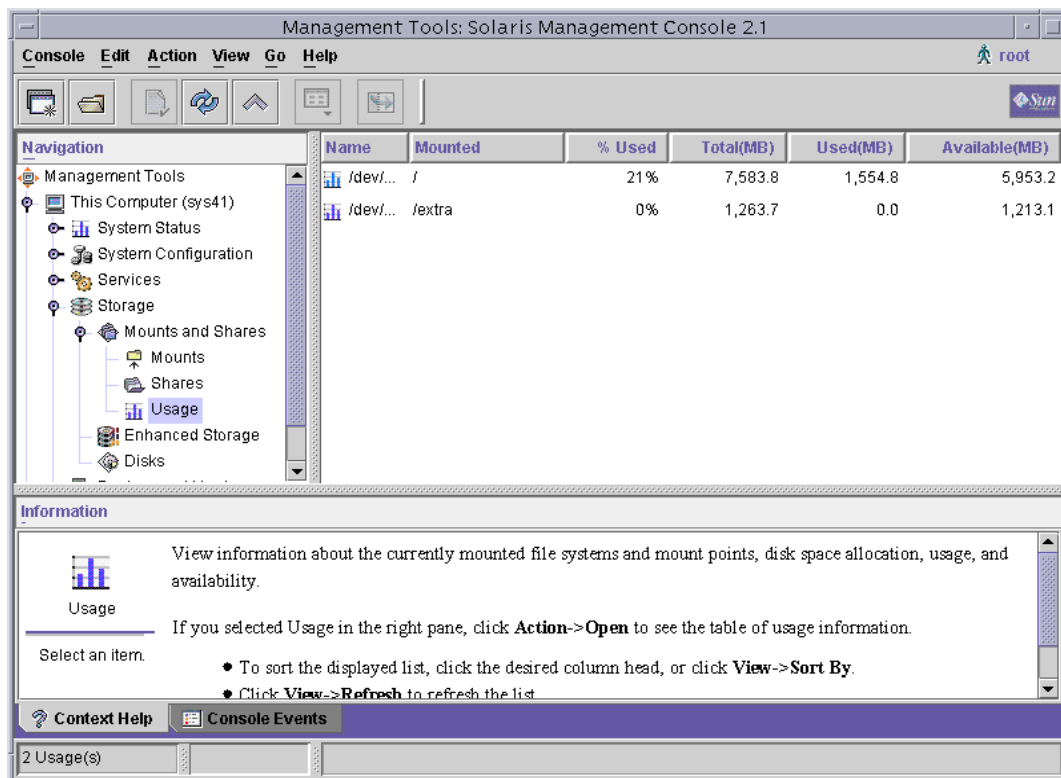


**Figure 3-8** Management Tools: Solaris Management Console Window

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine which commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Creating and Maintaining ufs File Systems (Level 1)

In this exercise, you complete the following tasks:

- Create ufs file systems
- Calculate and adjust minfree values
- Destroy the superblock on an unused file system and repair it using an alternative

### Preparation

This exercise requires an unused disk divided into four slices. Slices 0, 1, and 3 are equal in size, and Slice 4 takes up the remaining space on the disk. If it is necessary to partition the disk, this exercise requires an understanding of how to use the `format` utility. Refer to the lecture notes as necessary to perform the steps.

### Task

Perform the following tasks:

- Find a disk that is not in use and that is partitioned as specified in the preceding preparation description. If necessary, partition a disk accordingly. Create a new file system on Slice 0. Create a file system on Slice 1 with an inode ratio of 1 per 16,384 bytes of data space. Compare how quickly the `newfs` command makes the file systems. For both file systems, record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group. How do the file systems differ?

(Steps 1–6 in the Level 2 lab)

- Display the number of Kbytes used, the number available, and the number allocated to both file systems. Record these values. Which file system has more available space and why? For each file system, calculate how much larger the Kbytes value is than the sum of the used and available values, and express the result as a percentage. Use the `fstyp` command to verify the result.

(Steps 7–8 in the Level 2 lab)

- Adjust the `minfree` value up or down by 3 percent. Record the message that your command displays. Verify the change made by using the `tunefs` command.  
(Steps 9–10 in the Level 2 lab)
- Create new file systems on Slices 3 and 4 of your spare disk.  
(Step 11 in the Level 2 lab)
- Check the file system on Slice 3 with the `fsck` command, and record if it reports any errors. Use the `dd` command from Step 13 in the Level 2 lab to destroy the primary superblock of the new file system. Run the `fsck` command, and see if you get an error. Use the `fsck` command and the backup superblock found at Sector 32 to repair the file system and main superblock. Verify the repair by running the `fsck` command again.  
(Steps 12–16 in the Level 2 lab)

## Exercise: Creating and Maintaining ufs File Systems (Level 2)

In this exercise, you complete the following tasks:

- Create ufs file systems
- Calculate and adjust `minfree` values
- Destroy the superblock on an unused file system and repair it using an alternative

### Preparation

This exercise requires an unused disk, divided into four slices. Slices 0, 1, and 3 are equal in size, and Slice 4 takes up the remaining space on the disk. If it is necessary to partition this disk, this exercise requires an understanding of how to use the `format` utility. Refer to the lecture notes as necessary to perform the steps.

### Task Summary

In this exercise, you accomplish the following:

- Find a disk that is not in use and that is partitioned as specified in the preceding preparation description. If necessary, partition a disk accordingly. Create a new file system on Slice 0. Create a file system on Slice 1 with an inode ratio of 1 per 16,384 bytes of data space. Compare how quickly the `newfs` command makes the file systems. For both file systems, record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group. How do the file systems differ?
- Display the number of Kbytes used, the number available, and the number allocated to both file systems. Record these values. Which file system has more available space and why? For each file system, calculate how much larger the Kbytes value is than the sum of the used and available values, and express the result as a percentage. Use the `fstyp` command to verify the result.
- Adjust the `minfree` value up or down by 3 percent. Record the message that your command displays. Verify the change made by using the `tuneufs` command.

- Create new file systems on Slices 3 and 4 of your spare disk.
- Check the file system on Slice 3 with the `fsck` command, and record if it reports any errors. Use the `dd` command from Step 13 in the Level 2 lab to destroy the primary superblock of the new file system. Run the `fsck` command, and see if you get an error. Use the `fsck` command and the backup superblock found at Sector 32 to repair the file system and main superblock. Verify the repair by running the `fsck` command again.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change the directory to `/dev/rdisk`.
2. To find a spare disk, use the `ls` command to display a list of possible disks and the `prtvtoc` command to display the VTOC for each disk you find. Examine the partition list as well as the `Mount Directory` field that the `prtvtoc` command displays. Disks that are not in use have no mount directory listed. Record the name of the unused disk.

Unused disk:



---

**Note** – This procedure works for the classroom environment. A disk that does not appear in the `prtvtoc` display is not necessarily inactive.

---

3. If a spare disk exists but it is not divided into four slices, use the `format` utility to partition the disk. Make three slices exactly the same size, and use the fourth partition for the remainder of the available space. Exit from the `format` utility when you are finished. You can also use the Solaris Management Console to partition the drive.
4. Use the `newfs` command without options to create a new file system on Slice 0 on the spare disk. Observe how quickly the `newfs` command creates cylinder groups on this slice. Record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group.

Cylinder groups:

Cylinders per group:

Inodes per group:

5. Use the `newfs` command to create a new file system on Slice 1 on the spare disk. Use the `-i` option to create one inode per 16,384 bytes of data space. Observe how quickly the `newfs` command creates cylinder groups on this slice. Record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group.

Cylinder groups:

Cylinders per group:

Inodes per group:

6. According to the statistics you have gathered, how do the file systems on Slices 0 and 1 differ?
7. Mount the file systems, and use the `df -k` command to display statistics for the file systems on Slices 0 and 1 that you used in the previous steps. Record the values listed in the `kbytes`, `used`, and `avail` columns.

Which file system has the larger amount of available data space and why?

8. For each file system, add the `used` and `avail` values, and compare the sum to the `kbytes` value. Expressed as a percentage, how much larger is the `kbytes` value than the sum of `used` and `avail`? This percentage should approximately match the `minfree` value.

Use the `fstyp` command to verify your result.

9. Use the `tunefs` command to change the `minfree` value for the file system on Slice 0 of the spare disk. If the current `minfree` value is greater than 5 percent, reduce it by 3 percent. If it is less than or equal to 5 percent, add 3 percent.

What message does the `tunefs` command display?

10. Use the `df -k` command to verify that the `minfree` value has changed. Record the values listed in the `kbytes`, `used`, and `avail` columns.

Which value has changed from the information you gathered in Step 7?

11. Create new file systems on Slices 3 and 4 of your spare disk.
12. Run the `fsck` command interactively to check the new file system previously created on Slice 3 of the spare disk.

Did the `fsck` command report errors?



13. Use the `dd` command to destroy the main superblock of the file system on Slice 3.

```
# dd if=/dev/zero of=/dev/rdisk/c1t3d0s3 count=32 bs=512
```

14. Run the `fsck` command interactively to check the new file system.  
Did the `fsck` command report errors? If so, what corrective action does the `fsck` command suggest?
15. Run the `fsck` command, and specify an alternative superblock.  
Block 32 is always one of the alternatives available.
16. Run the `fsck` command again to verify that the file system was repaired.

## Exercise: Creating and Maintaining ufs File Systems (Level 3)

In this exercise, you complete the following tasks:

- Create ufs file systems
- Calculate and adjust `minfree` values
- Destroy the superblock on an unused file system and repair it using an alternative

### Preparation

This exercise requires an unused disk, divided into four slices. Slices 0, 1, and 3 are equal in size, and Slice 4 takes up the remaining space on the disk. If it is necessary to partition this disk, this exercise requires an understanding of how to use the `format` utility. Refer to the lecture notes as necessary to perform the steps.

### Task Summary

In this exercise, you accomplish the following:

- Find a disk that is not in use and that is partitioned as specified in the preceding preparation description. If necessary, partition a disk accordingly. Create a new file system on Slice 0. Create a file system on Slice 1 with an inode ratio of 1 per 16,384 bytes of data space. Compare how quickly the `newfs` command makes the file systems. For both file systems, record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group. How do the file systems differ?
- Display the number of Kbytes used, the number available, and the number allocated to both file systems. Record these values. Which file system has more available space and why? For each file system, calculate how much larger the Kbytes value is than the sum of the used and available values, and express the result as a percentage. Use the `fstyp` command to verify the result.
- Adjust the `minfree` value up or down by 3 percent. Record the message that your command displays. Verify the change made by using the `tuneufs` command.

- Create new file systems on Slices 3 and 4 of your spare disk.
- Check the file system on Slice 3 with the `fsck` command, and record if it reports any errors. Use the `dd` command from Step 13 in the Level 2 lab to destroy the primary superblock of the new file system. Run the `fsck` command, and see if you get an error. Use the `fsck` command and the backup superblock found at Sector 32 to repair the file system and main superblock. Verify the repair by running the `fsck` command again.

## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change the directory to `/dev/rdisk`.

```
# cd /dev/rdisk
```

2. To find a spare disk, use the `ls` command to display a list of possible disks and the `prtvtoc` command to display the VTOC for each disk you find. Examine the partition list as well as the Mount Directory field that the `prtvtoc` command displays. Disks that are not in use have no mount directory listed. Record the name of the unused disk.

```
# ls *s2
```

```
# prtvtoc /dev/rdisk/c1t3d0s2
```

Unused disk:



**Note** – This procedure works for the classroom environment. A disk that does not appear in `prtvtoc` display is not necessarily inactive.

3. If a spare disk exists, but it is not divided into four slices, use the `format` utility to partition the disk. Make three slices exactly the same size, and use the fourth partition for the remainder of the available space. You can also use the Solaris Management Console to partition the drive. Exit from the `format` utility when you are finished.

Example of the partition table:

| Part | Tag        | Flag | Cylinders   | Size   | Blocks              |
|------|------------|------|-------------|--------|---------------------|
| 0    | alternates | wm   | 0 - 1168    | 2.00GB | (1169/0/0) 4197879  |
| 1    | alternates | wm   | 1169 - 2337 | 2.00GB | (1169/0/0) 4197879  |
| 2    | backup     | wm   | 0 - 4923    | 8.43GB | (4924/0/0) 17682084 |
| 3    | alternates | wm   | 2338 - 3506 | 2.00GB | (1169/0/0) 4197879  |
| 4    | alternates | wm   | 3507 - 4922 | 2.42GB | (1416/0/0) 5084856  |

4. Use the `newfs` command without options to create a new file system on Slice 0 on the spare disk. Observe how quickly the `newfs` command creates cylinder groups on this slice. Record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group.

```
# newfs /dev/rdisk/c1t3d0s0
```

Cylinder groups:

Cylinders per group:

Inodes per group:

5. Use the `newfs` command to create a new file system on Slice 1 on the spare disk. Use the `-i` option to create one inode per 16,384 bytes of data space. Observe how quickly the `newfs` command creates cylinder groups on this slice. Record the number of cylinder groups, the number of cylinders per group, and the number of inodes per group.

```
# newfs -i 16384 /dev/rdisk/c1t3d0s1
```

Cylinder groups:

Cylinders per group:

Inodes per group:

6. According to the statistics you have gathered, how do the file systems on Slices 0 and 1 differ?

*The number of inodes per group is less on File System 1 than on File System 0.*

7. Mount the file system, and use the `df -k` command to display statistics for the file systems on Slices 0 and 1 that you used in the previous steps, for example:

```
# df -k /dev/dsk/c1t4d0s0
```

| Filesystem        | kbytes | used | avail  | capacity | Mounted on |
|-------------------|--------|------|--------|----------|------------|
| /dev/dsk/c1t4d0s0 | 288319 | 9    | 259461 | 0%       |            |

```
# df -k /dev/dsk/c1t4d0s1
```

| Filesystem        | kbytes | used | avail  | capacity | Mounted on |
|-------------------|--------|------|--------|----------|------------|
| /dev/dsk/c1t4d0s1 | 304559 | 9    | 274041 | 0%       |            |

Record the values listed in the `kbytes`, `used`, and `avail` columns.

Which file system has the larger amount of available data space and why?

*File System 1 has the larger amount of available data space because it holds fewer inode records.*

8. For each file system, add the `used` and `avail` values, and compare the sum to the `kbytes` value. Expressed as a percentage, how much larger is the `kbytes` value than the sum of `used` and `avail`? This percentage should approximately match the `minfree` value.

Use the `fstyp -v /dev/rdisk/c#t#d#s# | head -12` command to verify your result.

*To calculate the percentage difference between the sum of `used` and `avail` and the `kbytes` value, perform the following:*

- a. *Add the values listed as `used` and `avail`, for example:*  

$$9 + 1926799 = 1926808$$
- b. *Divide the sum of `used` and `avail` by the `kbytes` value, for example:*  

$$1926808 / 1986439 = 0.969981$$
- c. *Multiply the result of Step b by 100, for example:*  

$$0.969981 * 100 = 96.9981$$
- d. *Subtract the result of Step c from 100, for example:*  

$$100 - 96.9981 = 3.0019$$
- e. *Round the result of Step d to the nearest whole number, for example:*  

$$3.0019 = 3 \text{ percent}$$

9. Use the `tunefs -m 6 /dev/rdisk/c#t#d#s#` command to change the `minfree` value for the file system on Slice 0 of the spare disk. If the current `minfree` value is greater than 5 percent, reduce it by 3 percent. If it is less than or equal to 5 percent, add 3 percent, for example:

```
# tunefs -m 6 /dev/rdisk/c1t4d0s0
```

minimum percentage of free space changes from 10% to 6%

What message does the `tunefs` command display?

The minimum percentage of free space changes from x percent to x percent.

10. Use the `df -k` command to verify that the `minfree` value has changed. Record the values listed in the `kbytes`, `used`, and `avail` columns, for example:

```
# df -k /dev/dsk/c1t4d0s0
```

| Filesystem        | kbytes | used | avail  | capacity | Mounted on |
|-------------------|--------|------|--------|----------|------------|
| /dev/dsk/c1t4d0s0 | 288319 | 9    | 270993 | 0%       |            |

Which value has changed from the information you gathered in Step 7?

*The avail column changes but not the kbytes or used columns.*

11. Create new file systems on Slices 3 and 4 of your spare disk, for example:

```
# newfs /dev/rdisk/c1t3d0s3
```

```
# newfs /dev/rdisk/c1t3d0s4
```

12. Run the `fsck` command interactively to check the new file system previously created on Slice 3 of the spare disk.

Did the `fsck` command report errors?

*No.*

13. Use the `dd` command to destroy the main superblock of the file system on Slice 3.

```
# dd if=/dev/zero of=/dev/rdisk/c1t3d0s3 count=32 bs=512
```

14. Run the `fsck` command interactively to check the new file system.

Did the `fsck` command report errors? If so, what corrective action does the `fsck` command suggest?

*The fsck command indicates that the magic number in the superblock is wrong and suggests repairing it by using an alternative superblock, for example:*

```
** /dev/rdisk/c1t3d0s3
```

```
BAD SUPER BLOCK: MAGIC NUMBER WRONG
```

```
USE AN ALTERNATE SUPER-BLOCK TO SUPPLY NEEDED INFORMATION;
```

```
e.g. fsck [-F ufs] -o b=# [special ...]
```

```
where # is the alternate super block. SEE fsck_ufs(1M).
```

15. Run the `fsck` command, and specify an alternative superblock. Block 32 is always one of the alternatives available.

```
# fsck -o b=32 /dev/rdisk/c1t3d0s3
```

16. Run the `fsck` command again to verify that the file system was repaired.

```
# fsck /dev/rdisk/c1t3d0s3
```

*This time the `fsck` command output does not report that the file system was modified.*

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications



# Performing Mounts and Unmounts

---

## Objectives

Upon completion of this module, you should be able to:

- Identify mounting fundamentals
- Perform mounts
- Perform unmounts
- Access a mounted diskette or CD-ROM
- Restrict access to a mounted diskette or CD-ROM
- Access a diskette or CD-ROM without Volume Management

The following course map shows how this module fits into the current instructional goal.

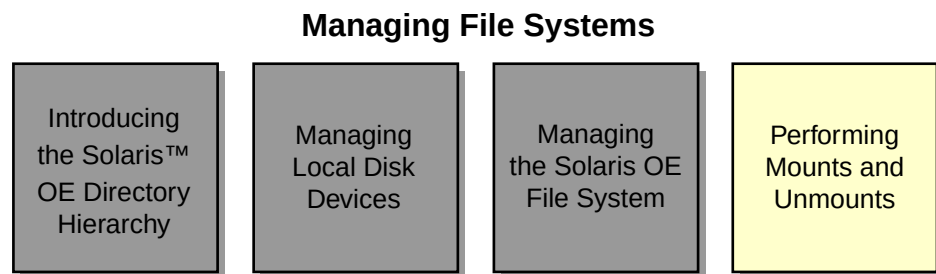


**Figure 4-1** Course Map

## Working With Mounting Fundamentals

In the Solaris OE, you use the mounting process to attach individual file systems to their mount points on the directory hierarchy. This action makes a file system accessible to the system and to the users.

You use the unmounting process to detach a file system from its mount point in the directory hierarchy. This action makes a file system unavailable to the system or users.

After you have created a file system by using the `newfs` command, you must attach it to the Solaris OE directory hierarchy at a mount point. A mount point is a directory that is the point of connection for a file system. File systems are commonly referred to by the names of their mount points, for example, the `/` (root) file system or the `/usr` file system.

Figure 4-2 shows how the directory hierarchy spans from one file system to the next.

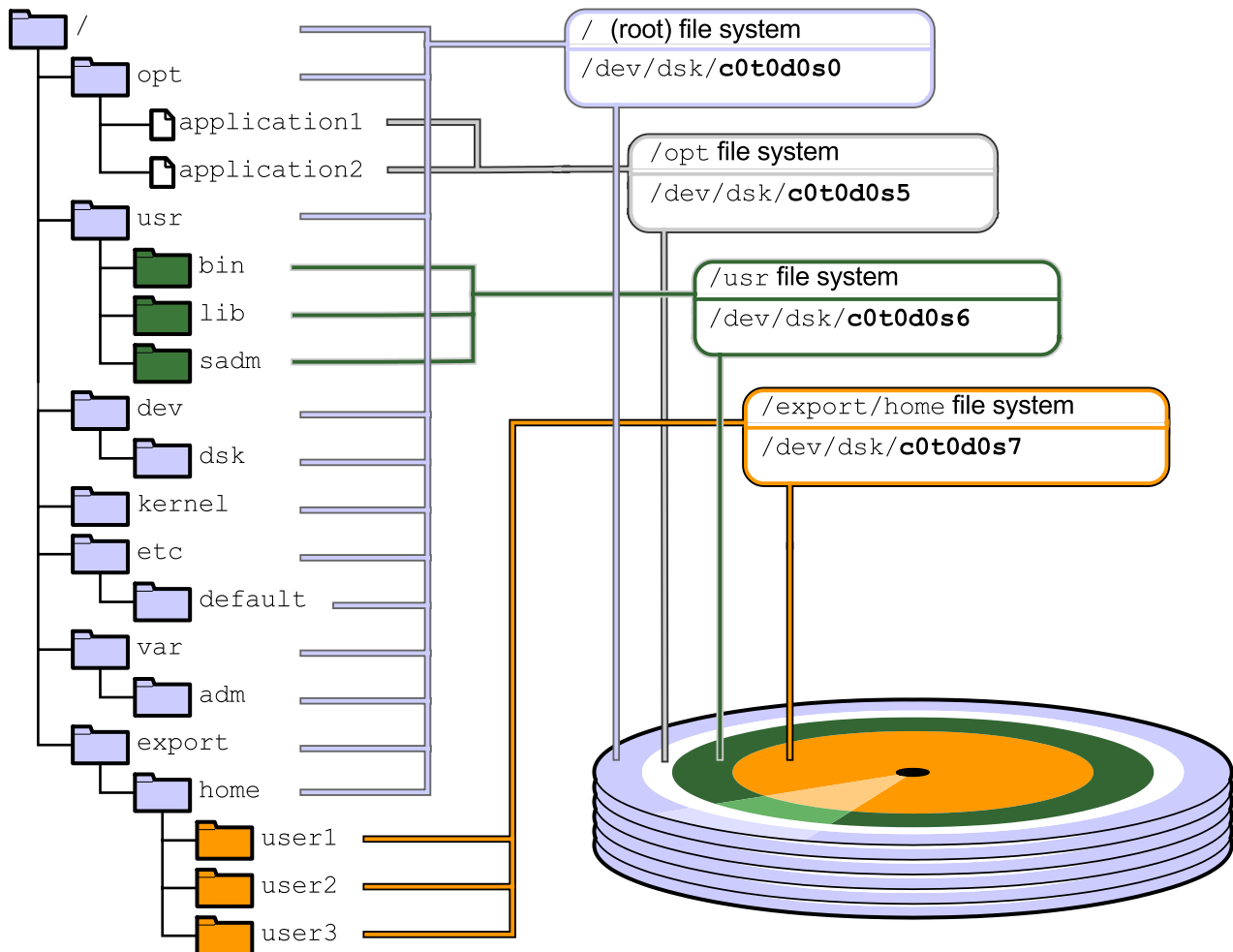


**Figure 4-2** File Systems and Mount Points

File systems do not contain their own mount point directories.

## Determining Which File Systems Are Currently Mounted

You can determine which file systems are currently mounted by using the `mount` command or the `df` command.

The `df` command displays the amount of disk space occupied by mounted or unmounted file systems and, depending on the options used, displays both locally mounted and virtual file system information.

The `mount` command, which is located in the `/usr/sbin` directory, maintains a table of currently mounted file systems in the `/etc/mnttab` file. When the `mount` command is used without arguments, it lists all of the mounted file systems in the `/etc/mnttab` directory. When used with only a partial argument list, the command searches the `/etc/vfstab` file for an entry that supplies the missing arguments.



---

**Note** – While system administrators typically use the `/usr/sbin/mount` command, the system boot scripts use the `/sbin/mount` command.

---

## Mounting a File System Automatically

The Solaris OE provides several methods for automating file system mounts.

The Solaris OE creates a default `/etc/vfstab` file during software installation, based on your selections. However, you can edit the `/etc/vfstab` file whenever file system entries need to be added or modified.



---

**Note** – The automounter can mount network file systems on demand.

---

## Introducing the Virtual File System Table: `/etc/vfstab`

The `/etc/vfstab` file lists all the file systems to be automatically mounted at system boot time, with the exception of the `/etc/mnttab` and `/var/run` file systems.

The file format includes seven fields per line entry. By default, a tab separates each field, but any whitespace can be used for separators. The dash (-) character is used as a placeholder for fields when text arguments are not appropriate. Commented lines begin with the hash (#) symbol.

To add a line entry, you need the following information:

|                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| device to mount | The device to be mounted. For example, a local ufs file system <code>/dev/dsk/c#t#d#s#</code> , or a pseudo file system <code>/proc</code> .                                                                                                                                                                                                                                                                                                                                                                                                            |
| device to fsck  | The raw or <i>character</i> device checked by the file system check program ( <code>fsck</code> ) if applicable. A pseudo file system has a dash (-) in this field.                                                                                                                                                                                                                                                                                                                                                                                     |
| mount point     | The name of the directory that serves as the attach mount point in the Solaris OE directory hierarchy.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| FS type         | The type of file system to be mounted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| fsck pass       | Indicates whether the file system is to be checked by the <code>fsck</code> utility at boot time. A 0 (zero) or a nonnumeric in this field indicates <code>no</code> . A 1 in this field indicates the <code>fsck</code> utility gets started for that entry and runs to completion. A number greater than 1 indicates that the device is added to the list of devices to have the <code>fsck</code> utility run. The <code>fsck</code> utility can run on up to eight devices in parallel. This field is ignored by the <code>mountall</code> command. |
| mount at boot   | Enter <code>yes</code> to enable the <code>mountall</code> command to mount the file systems at boot time. Enter <code>no</code> to prevent a file system mount at boot time.                                                                                                                                                                                                                                                                                                                                                                           |



---

**Note** – For `/` (root), `/usr`, and `/var` (if it is a separate file system) file systems, the `mount at boot` field value is specified as `no`. The kernel mounts these file systems as part of the boot sequence before the `mountall` command is run. The `mount` command explicitly mounts the file systems `/` (root) and `/usr` as specified in the `/etc/rcS.d/S30rootusr.sh` script and the `/var` file system as specified in the `/etc/rcS.d/S70buildmnttab` script.

---

|               |                                                                                                                                    |
|---------------|------------------------------------------------------------------------------------------------------------------------------------|
| mount options | A comma-separated list of options passed to the <code>mount</code> command. A dash (-) indicates the use of default mount options. |
|---------------|------------------------------------------------------------------------------------------------------------------------------------|



**Note** – Because the default is to use tabs to separate the fields in the `/etc/vfstab` file, the fields often do not line up under their respective headings. This can lead to some confusion when you are viewing this file in a terminal window.

---

An example of a `/etc/vfstab` file follows:

```
# more /etc/vfstab
#device      device      mount      FS      fsck      mount      mount
#to mount    to fsck    point     type     pass     at boot   options
#
fd           -           /dev/fd    fd       -         no        -
/proc        -           /proc      proc     -         no        -
/dev/dsk/c0t0d0s1 -         -          swap     -         no        -
/dev/dsk/c0t0d0s0 /dev/rdisk/c0t0d0s0 /  ufs     1         no        -
/dev/dsk/c0t0d0s7 /dev/rdisk/c0t0d0s7 /export/home ufs     2  yes    -
swap        -           /tmp      tmpfs    -         yes       -
#
```

## Introducing the `/etc/mnttab` File

The `/etc/mnttab` file is really an `mntfs` file system that provides read-only information directly from the kernel about mounted file systems on the local host.

Each time a file system is mounted, the `mount` command adds an entry to this file. Whenever a file system is unmounted, its entry is removed from the `/etc/mnttab` file.

|                         |                                                                                                                                                                               |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mount Point             | The mount point or directory name where the file system is to be attached within the <code>/</code> (root) file system (for example, <code>/usr</code> , <code>/opt</code> ). |
| Device Name             | The name of the device that is mounted at the mount point. This block device is where the file system is physically located.                                                  |
| Mount Options           | The list of mount options in effect for the file system.                                                                                                                      |
| <code>dev=number</code> | The major and minor device number of the mounted file system.                                                                                                                 |
| Date and Time Mounted   | The date and time that the file system was mounted to the directory hierarchy.                                                                                                |

The `/var/run` file system is a `tmpfs` mounted file system in the Solaris OE. It is the repository for temporary operating system files that are not needed across system reboots in this Solaris OE release. It is mounted as a pseudo file system rather than a disk-based file system.

The `/var/run` directory requires no administration. For security reasons, it is owned by the `root` user.

The `/tmp` directory continues to be a `tmpfs` mounted file system in the Solaris OE. It is the repository for temporary user and application files that are not needed across system reboots. It is a pseudo file system rather than a disk-based file system.

The following examples show two ways to display currently mounted file systems.

```
# more /etc/mnttab
/dev/dsk/c0t0d0s0      /          ufs
rw,intr,largefiles,xattr,onerror=panic,suid,dev=2200000 10164665
25
/proc /proc proc      dev=4300000 1016466524
mnttab /etc/mnttab mntfs dev=43c0000 1016466524
fd /dev/fd fd rw,suid,dev=4400000 1016466527
swap /var/run tmpfs xattr,dev=1 1016466529
swap /tmp tmpfs xattr,dev=2 1016466532
/dev/dsk/c0t0d0s7 /export/home ufs
rw,intr,largefiles,xattr,onerror=panic,suid,dev=2200007
1016466532
-hosts /net autofs indirect,nosuid,ignore,nobrowse,dev=4580001
1016466537
auto_home /home autofs indirect,ignore,nobrowse,dev=4580002
1016466537
-xfn /xfn autofs indirect,ignore,dev=4580003 1016466537
sys41:vold(pid248) /vol nfs ignore,dev=4540001 1016466554

# mount
/ on /dev/dsk/c0t0d0s0
read/write/setuid/intr/largefiles/xattr/onerror=panic/dev=2200000 on Mon Mar 18
08:48:45 2002
/proc on /proc read/write/setuid/dev=4300000 on Mon Mar 18 08:48:44 2002
/etc/mnttab on mnttab read/write/setuid/dev=43c0000 on Mon Mar 18 08:48:44 2002
/dev/fd on fd read/write/setuid/dev=4400000 on Mon Mar 18 08:48:47 2002
/var/run on swap read/write/setuid/xattr/dev=1 on Mon Mar 18 08:48:49 2002
/tmp on swap read/write/setuid/xattr/dev=2 on Mon Mar 18 08:48:52 2002
/export/home on /dev/dsk/c0t0d0s7
read/write/setuid/intr/largefiles/xattr/onerror=panic/dev=2200007 on Mon Mar 18
08:48:52 2002
```

## Performing Mounts

You can mount file systems manually by logging in as the `root` user and running the `mount` command, or the system can automatically mount file systems at boot time after consulting the `/etc/vfstab` file.

### Mounting a Local File System Manually

The `mount` command not only lists which file systems are currently mounted, it also provides you, as the `root` user, with a method for mounting file systems.

#### Default Behavior of the `mount` Command

To mount a local file system manually, you need to know the name of the device where the file system resides and its mount point directory name. Perform the command:

```
# mount /dev/dsk/c0t0d0s7 /export/home
```

In this example, the default action mounts the file system with the following options: `read/write`, `setuid`, `intr`, `nologging`, and `largefiles`, `xattr`, and `onerror`.

The following list explains the default options for the `mount` command.

|                          |                                                                                                                                       |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <code>read/write</code>  | Indicates whether reads and writes are allowed on the file system.                                                                    |
| <code>setuid</code>      | Permits the execution of <code>setuid</code> programs in the file system.                                                             |
| <code>intr/nointr</code> | Allows and forbids keyboard interrupts to kill a process that is waiting for an operation on a locked file system.                    |
| <code>nologging</code>   | Indicates that logging is not enabled for the <code>ufs</code> file system.                                                           |
| <code>largefiles</code>  | Allows for the creation of files larger than 2 Gbytes. A file system mounted with this option can contain files larger than 2 Gbytes. |
| <code>xattr</code>       | Supports extended attributes not found in standard UNIX attributes.                                                                   |





---

**Note** – Due to file system overhead, the largest file size that can be created is approximately 866 Gbytes.

---

`onerror=action` Specifies the action that the ufs file system should take to recover from an internal inconsistency on a file system. An action can be specified as:

`panic` — Causes a forced system shutdown. This is the default.

`lock` — Applies a file system lock to the file system.

`umount` — Forcibly unmounts the file system.

The `/etc/vfstab` file provides you with another important feature. Because the `/etc/vfstab` file contains the mapping between the mount point and the actual device name, the `root` user can manually mount a file system specifying only the mount point on the command line.

```
# mount /export/home
```

## Using the mount Command Options

When you are using `mount` options on the command line, remember that the options are preceded by the `-o` flag. When you are using multiple options, enter them as a comma-separated list following the `-o` flag.

```
mount -o option,option,... device_name mount_point
```



---

**Note** – Mount options are discussed in detail in the man page for the `mount_ufs` command.

---

Some options used to mount local file systems include: `ro`, `nosetuid`, `noatime`, `nolargefiles`, and `logging`.

- `ro` – Mounts the file system as read-only.

The following is an example using this option on the command line:

```
# mount -o ro /dev/dsk/c0t0d0s6 /usr
```

- `nosuid` – Prohibits the execution of `setuid` programs in the file system. This does not restrict the creation of `setuid` programs.

The following example shows the use of multiple options on the command line:

```
# mount -o ro,nosuid /dev/dsk/c0t0d0s7 /export/home
```

- `noatime` – Suppresses the time-last-accessed modification on inodes, which reduces disk activity on a file system where access times are not important. Specifying this option generally improves file access times and boosts overall performance, for example:

```
# mount -o noatime /dev/dsk/c0t0d0s7 /export/home
```

- `nolargefiles` – Prevents a file system that contains one or more “large files” from being mounted, for example:

```
# mount -o nolargefiles /dev/dsk/c0t0d0s7 /export/home
```

Use of the `nolargefiles` option fails if the file system to be mounted contains a large file or did contain a large file at one time.

If the file system currently contains a large file and the `root` user needs to mount it with this option, then the large file must be located and moved or removed from the file system. Then you must execute the `fsck` command manually to update the superblock information.

The mount also fails if the file system at one time contained a large file, even though it was moved or removed. You must execute the `fsck` command to clear the old information and allow the file system to be mounted.

- `logging` – Enables logging for a `ufs` file system, for example:

```
# mount -o logging /dev/dsk/c0t0d0s7 /export/home
```

UFS logging is a process of storing file system transactions or changes that make up a complete file or directory operation into a log before they are applied to the file system. After a transaction is stored, the complete transaction can be applied to the file system later.

The UFS log is allocated from free blocks in the file system. It is sized approximately 1 Mbyte per 1 Gbyte, up to a maximum of 64 Mbytes.

As a UFS log reaches its maximum size, it begins to write transactions to the file system. When the file system is unmounted, the entire UFS log is emptied, and all transactions are written to the file system.

UFS logging offers two advantages. First, it prevents file systems from becoming inconsistent, therefore eliminating the need to run lengthy `fsck` scans. Secondly, you can bypass `fsck` scanning, which reduces the time required to reboot a system if it was stopped by a method other than an orderly shutdown.

## Mounting All File Systems Manually

The `/etc/vfstab` file is read by the `/usr/sbin/mountall` command during the system boot sequence and mounts all file systems that have a `yes` in the `mount at boot` field.

The `root` user can use the `mountall` command to mount manually every file system in the `/etc/vfstab` file that has a `yes` in the `mount at boot` field, for example:

```
# mountall
```

To mount only the local file systems listed in the `/etc/vfstab` file, execute:

```
# mountall -l
```

During the boot sequence, the `fsck` utility checks each local file system in the `/etc/vfstab` file that has a `device to fsck` entry and an `fsck pass` number greater than 0. The utility determines if the file system is in a usable state to be safely mounted.

If the `fsck` utility determines that the file system is in an unusable state (for example, corrupted), the `fsck` utility repairs it before the mount is attempted. The system attempts to mount any local file systems that have a `-` (dash) or `0` (zero) entry in the `fsck pass` field without checking the file system itself.

## Mounting a New File System

To add a new disk to the system, prepare the disk to hold a file system, and mount the file system, perform these general steps:

1. Set up the disk hardware, which might include setting address switches and connecting cables.
2. Perform a reconfiguration boot or run the `devfsadm` utility to add support for the new disk.
3. Use the `format` utility to partition the disk into one or more slices.
4. Create a new file system on one slice by using the `newfs` command.
5. Create a mount point for the file system by using the `mkdir` command to create a new directory in the `/` (root) file system.

```
# mkdir /database
```

6. Mount the new file system manually by using the `mount` command.

```
# mount /dev/dsk/c1t4d0s0 /database
```

7. Use the `mount` command to determine if the file system is mounted.

```
# mount
```

```
/ on /dev/dsk/c0t0d0s0
read/write/setuid/intr/largefiles/xattr/onerror=panic/dev=2200000 on Mon
Mar 18 08:48:45 2002
/proc on /proc read/write/setuid/dev=4300000 on Mon Mar 18 08:48:44 2002
/etc/mnttab on mnttab read/write/setuid/dev=43c0000 on Mon Mar 18
08:48:44 2002
/dev/fd on fd read/write/setuid/dev=4400000 on Mon Mar 18 08:48:47 2002
/var/run on swap read/write/setuid/xattr/dev=1 on Mon Mar 18 08:48:49
2002
/tmp on swap read/write/setuid/xattr/dev=2 on Mon Mar 18 08:48:52 2002
/export/home on /dev/dsk/c0t0d0s7
read/write/setuid/intr/largefiles/xattr/onerror=panic/dev=2200007 on Mon
Mar 18 08:48:52 2002
/database on /dev/dsk/c1t4d0s0
read/write/setuid/intr/largefiles/xattr/onerror=panic/dev=800020 on Mon
Mar 18 09:15:26 2002
```

8. Edit the `/etc/vfstab` file to add a line entry for the new file system.

```
# vi /etc/vfstab
#device      device      mount      FS      fsck      mount      mount
#to mount    to fsck      point      type     pass      at boot    options
#
fd           -           /dev/fd    fd       -         no         -
/proc        -           /proc      proc     -         no         -
/dev/dsk/c0t0d0s1 -         -          swap     -         no         -
/dev/dsk/c0t0d0s0 /dev/rdisk/c0t0d0s0 / ufs     1         no         -
/dev/dsk/c0t0d0s7 /dev/rdisk/c0t0d0s7 /export/home ufs    2  yes     -
swap        -           /tmp       tmpfs    -         yes        -
/dev/dsk/c1t4d0s0 /dev/rdisk/c1t4d0s0 /database ufs     1  yes     logging
#
```

The file system automatically mounts whenever the system boots.

## Mounting Different Types of File Systems

Different file system types have unique properties that affect how the `mount` command functions.

By default, the `mount` command assumes it is mounting a `ufs`-type file system. However, when you are mounting a different type of file system, you might have to specify its type on the command line.

You use the `-F` option with the `mount` command to specify the type of file system mounted. The file system type must be determinable from the `/etc/vfstab`, `/etc/default/fs`, or `/etc/dfs/fstypes` files.

### Determining a File System's Type

Because the `mount` commands need the file system type to function properly, the file system type must be explicitly specified or determined by searching the following files:

- The `/etc/vfstab` file for the FS type field
- The `/etc/default/fs` file for a local file system type
- The `/etc/dfs/fstypes` file for a remote file system type

If the file system's type has not been explicitly specified on the command line using the `mount -F FStype` option, the `mount` command examines the `/etc/vfstab` file to determine the file system's type. The `mount` command makes this determination by using the file system's block device name, raw device name, or mount point directory name.

If the `mount` command cannot determine the file system's type by searching the `/etc/vfstab` file, the `mount` command uses the default file system type specified in either the `/etc/default/fs` file or the `/etc/dfs/fstypes` file, depending on whether the file system is local or remote.

The default local file system type is specified in the `/etc/default/fs` file by the line entry `LOCAL=fstype`.

`LOCAL=ufs`

The first line entry in the `/etc/dfs/fstypes` file determines the default remote file system type.

`nfs` NFS Utilities  
`autofs` AUTOFS Utilities  
`cachefs` CACHEFS Utilities

### Using the `fstyp` Command

You can also use the `fstyp` command with the raw device name of the disk slice to determine a file system's type.

```
# fstyp /dev/rdisk/c0t0d0s7  
ufs
```

### Specifying an `hsfs` File System Type

To mount a file system that resides on a CD-ROM when the Volume Management services are stopped, as the `root` user perform the command:

```
# mount -F hsfs -o ro /dev/dsk/c0t6d0s0 /cdrom
```

In this example, the file system type is `hsfs`, the file system resides on disk slice `/dev/dsk/c0t6d0s0`, and the mount point `/cdrom` is a pre-existing directory in the Solaris OE.

## Specifying a pcfs File System Type

To mount a file system that resides on a diskette when the Volume Management services are stopped, as the `root` user, perform the commands:

```
# mkdir /pcfs  
# mount -F pcfs /dev/diskette /pcfs
```

In this example, the file system type is `pcfs`. This file system resides on the device `/dev/diskette`, and the mount point is `/pcfs`.

## Performing Unmounts

A file system is commonly unmounted if it needs to be checked and repaired by the `fsck` command, or if it needs to be backed up completely.

### Unmounting a File System

Some file system administration tasks cannot be performed on mounted file systems.

To unmount a file system to prepare it for system maintenance, use the `umount` command.

Unmounting a file system by using the `umount` command removes it from the file system mount point and deletes its entry from the `/etc/mnttab` file.



---

**Note** – Notify users before unmounting a file system that they are currently accessing.

---

To unmount a file system manually by using the directory mount point, perform the command:

```
# umount /export/home
```

To unmount a file system manually by using the logical disk device name, perform the command:

```
# umount /dev/dsk/c0t0d0s7
```

### Unmounting All File Systems

The `/etc/mnttab` file is read by the `/usr/sbin/umountall` command during the system shutdown sequence or when `umountall` is invoked from the command line. The `umountall` unmounts all file systems specified in the `vfstab` file except `/` (root), `/usr`, `/proc`, `/dev/fd`, `/var`, `/var/run`, and `/tmp`.



Run the `umountall` command as the `root` user when you want to unmount manually all the file systems listed in the `/etc/mnttab` file, for example:

```
# umountall
```

To unmount only the local file systems listed in the `/etc/mnttab` file, perform the command:

```
# umountall -l
```

To verify that a file system or a number of file systems have been unmounted, invoke the `mount` command and check the output.

## Unmounting a Busy File System

Any file system that is busy is not available for unmounting. Both the `umount` and `umountall` commands display the error message:

```
umount: file_system_name busy
```

A file system is considered to be busy if one of the following conditions exists:

- A program is accessing a file or directory in the file system
- A user is accessing a directory or file in the file system
- A program has a file open in that file system
- The file is being shared

There are two methods to make a file system available for unmounting if it is busy:

- `fuser` command – Lists all of the processes that are accessing the file system and kills them if necessary
- `umount -f` command – Forces the unmount of a file system



---

**Note** – The `fuser` command displays the process IDs of all processes currently using the specified file system. Each process ID is followed by a letter code. These letter codes are described in the man page for this command.

---

### Using the `fuser` Command

To stop all processes that are currently accessing a file system, follow these steps:

1. As the `root` user, list all of the processes that are accessing the file system. Use the following command to identify which processes need to be terminated.

```
# fuser -cu mount_point
```

This command displays the name of the file system and the user login name for each process currently active in the file system.

2. Kill all processes accessing the file system.

```
# fuser -ck mount_point
```

A `SIGKILL` message is sent to each process that is using the file system.

3. Verify that there are no processes accessing the file system.

```
# fuser -c mount_point
```

4. Unmount the file system.

```
# umount mount_point
```

### Using the `umount -f` Command

As the `root` user, you can unmount a file system, even if it is busy, by using the `-f` (force) option with the `umount` command. The following is the format for this command:

```
# umount -f mount_point
```

The file system is unmounted even if it contains open files. A forced unmount can result in loss of data and in zombie processes that are left running on the system. However, it is particularly useful for unmounting a shared file system if the remote file server is nonfunctional.

## Repairing Important Files if Boot Fails

The following procedure describes how to boot from the Solaris OE Software CD-ROM to edit a misconfigured `/etc/vfstab` file.

1. Insert the Solaris 9 OE Software 1 of 2 CD-ROM into the CD-ROM drive.
2. Execute a single-user boot from the CD-ROM.

```
ok boot cdrom -s
```

```
Boot device: /pci@1f,0/pci@1,1/ide@3/cdrom@2,0:f File and args -s
```

```
SunOS Release 5.9 Generic 64 bit
```

```
Copyright 1983-2002 by Sun Microsystems, Inc. All rights reserved.
```

```
Configuring /dev and /devices
```

```
Use is subject to license terms
```

```
Using RPC Bootparams for network configuration information.
```

```
Skipping interface hme0
```

```
-
```

```
INIT: SINGLE USER MODE
```

```
#
```




---

**Note** – Performing a single-user boot operation from this software CD-ROM creates an *in-memory* copy of the `/var` file system, which supports your ability to perform administrative tasks.

---

3. Use the `fsck` command on the `/` (root) partition to check and repair any potential problems in the file system.

```
# fsck /dev/rdisk/c0t0d0s0
```

4. If the `fsck` command is successful, mount the `/` (root) file system on the `/a` directory to gain access to the file system on disk.

```
# mount /dev/dsk/c0t0d0s0 /a
```

5. Set and export the `TERM` variable, which enables the `vi` editor to work properly.

```
# TERM=sun
```

```
# export TERM
```

6. Edit the `/etc/vfstab` file, and correct any problems. Then exit the file.

```
# vi /a/etc/vfstab
```

```
:wq!
```

7. Unmount the file system.

```
# cd /  
# umount /a
```

8. Reboot the system.

```
# init 6
```

## Accessing Mounted Diskettes and CD-ROMs

To provide access to file systems on diskettes and CD-ROMs, the Solaris OE provides users a standard interface referred to as Volume Management.



---

**Note** – The Solaris 9 OE includes support for additional removable media such as DVDs, Jaz drives, Zip drives, and PCMCIA memory cards. (PCMCIA stands for Personal Computer Memory Card International Association.) For more information on using these devices, see the resources available on the Solaris 9 Documentation CD.

---

Volume Management provides two major benefits:

- It automatically mounts removable media for both the `root` user and non-`root` users.
- It can give other systems on the network automatic access to any removable media currently inserted in the local system.

The Volume Management service is controlled by the `/usr/sbin/vold` daemon. By default, this service is always running on the system so that it can automatically manage diskettes and CD-ROMs for regular users.

Volume Management features automatic detection of CD-ROMs. However, it does not detect the presence of a diskette that has been inserted in the drive until the `volcheck` command is run. This command instructs the `vold` daemon to check the diskette drive for any inserted media. Volume Management can mount `ufs`, `pcfs`, `hsfs`, and `udfs` file systems.

## Using Volume Management

To make working with diskettes and CD-ROMs simple for your users, each device is easy to mount and mounts at an easy-to-remember location.

If the `vol`d daemon detects that the mounted device contains a file system, then the device is mounted at the directory location.

Table 4-1 lists the directory locations of mounted devices that contain file systems.

**Table 4-1** Directory Locations

| Media Device              | Access File Systems On |
|---------------------------|------------------------|
| First diskette drive      | /floppy/floppy0        |
| First CD-ROM or DVD drive | /cdrom/cdrom0          |
| First Jaz drive           | /rmdisk/jaz0           |
| First Zip drive           | /rmdrive/zip0          |
| First PCMCIA card         | /pcmem0                |

If the `vol`d daemon detects that the mounted device does not contain a file system, the device is accessible through a path.

Table 4-2 lists the paths for mounted devices that do not contain file systems.

**Table 4-2** Paths for Accessing Devices

| Media Device              | Access Raw Device On     |
|---------------------------|--------------------------|
| First diskette drive      | /vol/dev/aliases/floppy0 |
| First CD-ROM or DVD drive | /vol/dev/aliases/cdrom0  |
| First Jaz drive           | /vol/dev/aliases/jaz0    |
| First Zip drive           | /vol/dev/aliases/zip0    |
| First PCMCIA card         | /vol/dev/aliases/pcmem0  |

When Volume Management is running on the system, a regular user can easily access a diskette or CD-ROM by following these basic steps:

1. Insert the media.
2. For diskettes only, enter the `volcheck` command.
3. Use the `cd` command to change to the directory of the mounted volume.
4. Work with files on the media.
5. Unmount the media.
6. Eject the media.

Table 4-3 shows the configuration files used by Volume Management.

**Table 4-3** Volume Management Configuration Files

| File                           | Description                                                                                                                                                                                                                                |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>/etc/vold.conf</code>    | The Volume Management configuration file. This file defines items, such as what action should be taken when media is inserted or ejected, which devices are managed by Volume Management, and which file system types are unsafe to eject. |
| <code>/etc/rmmount.conf</code> | The <code>rmmount</code> command configuration file. The <code>rmmount</code> command is a removable media mounter that is executed by the Volume Management daemon whenever a CD-ROM or diskette is inserted.                             |

## Restricting Access to Mounted Diskettes and CD-ROMs

To restrict regular users from accessing diskettes or CD-ROMs on the system, you can, as the `root` user, terminate the Volume Management service.

### Stopping Volume Management

To stop Volume Management from running on a system temporarily, as the `root` user perform the command:

```
# /etc/init.d/volmgt stop
```

To restart the Volume Management service, as the `root` user perform the command:

```
# /etc/init.d/volmgt start
```

### Troubleshooting Volume Management Problems

If a CD-ROM fails to eject from the drive, as the `root` user attempt to stop Volume Management. If this is unsuccessful, kill the `vold` daemon.

```
# /etc/init.d/volmgt stop
```

or as a last resort:

```
# pkill -9 vold
```

Push the button on the system to eject the CD-ROM. The CD-ROM tray ejects. Remove the CD-ROM, and leave the tray out. Then restart the Volume Management service.

```
# /etc/init.d/volmgt start
```

Wait a few seconds, and then push the CD-ROM tray back into the drive.



## Accessing a Diskette or CD-ROM Without Volume Management

When Volume Management is not running, only the `root` user can mount and access a diskette or CD-ROM. Follow these steps:

1. Insert the media device.
2. Become the `root` user.
3. Create a mount point, if necessary.
4. Determine the file system type.
5. Mount the device by using the mount options listed in the following sections.
6. Work with files on the media device.
7. Unmount the media device.
8. Eject the media device.
9. Exit the `root` session.

### Using the mount Command

To mount a file system that resides on a CD-ROM when the Volume Management services are stopped, as the `root` user, perform the command:

```
# mount -F hsfs -o ro /dev/dsk/c0t6d0s0 /cdrom
```

In this example, the file system type is `hsfs`, the file system resides on disk slice `/dev/dsk/c0t6d0s0`, and the mount point `/cdrom` is a pre-existing directory in the Solaris OE.

To mount a file system that resides on a diskette when the Volume Management services are stopped, as the `root` user, perform the command:

```
# mkdir /pcfs
# mount -F pcfs /dev/diskette /pcfs
```

In this example, the file system type is `pcfs`. This file system resides on the `/dev/diskette` device, and the mount point used is `/pcfs`.

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine which commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Mounting File Systems (Level 1)

In this exercise, you complete the following tasks:

- Create mount points
- Mount file systems
- Specify mount options

### Preparation

This exercise requires a spare disk that contains four unmounted ufs file systems on Slices 0, 1, 3, and 4. Refer to the lecture notes as necessary to perform the tasks listed.

### Tasks

Complete the following tasks:

- Record the default mount options that are used by the / (root) file system mounted on your system. Mount the file system found on Slice 4 of your spare disk on the /morespace directory. Verify the mount options applied to the /morespace file system.  
(Steps 1–3 in the Level 2 lab)
- Create a new file in the /morespace file system that contains one line of text. Record the modify time for this file. Use the `ls` command to display the last access time for this file. Record the time value. Wait one minute, and then display the file content. Again check and record the last access time for this file.  
(Steps 4–7 in the Level 2 lab)
- Unmount the /morespace file system. Remount the same file system as /morespace, and use the `noatime` mount option. Again display the content of your text file. Check and record the last access time for it. Add a line to the `/etc/vfstab` file that mounts the /morespace file system when the system reboots. Reboot the system by using the `reboot` command, and verify that the /morespace file system is mounted.  
(Steps 8–11 in the Level 2 lab)

- Mount the file system on Slice 0 as `/dir0`. Mount the file system on Slice 1 as `/dir0/dir1`. In a second terminal window, change to the `/dir0/dir1` directory. In the original terminal window, try to unmount the `/dir0/dir1` directory. Record the error messages. Attempt to forcibly unmount the `/dir0/dir1` directory. Record the result. Attempt to use the `pwd` command in the second terminal window. Record what happens.  
(Steps 12–17 in the Level 2 lab)

## Exercise: Mounting File Systems (Level 2)

In this exercise, you complete the following tasks:

- Create mount points
- Mount file systems
- Specify mount options

### Preparation

This exercise requires a spare disk that contains four unmounted ufs file systems on Slices 0, 1, 3, and 4. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Record the default mount options that are used by the / (root) file system mounted on your system. Mount the file system found on Slice 4 of your spare disk on the /morespace directory. Verify the mount options applied to the /morespace file system.
- Create a new file in the /morespace file system that contains one line of text. Record the modify time for this file. Use the `ls` command to display the last access time for this file. Record the time value. Wait one minute, and then display the file content. Again check and record the last access time for this file.
- Unmount the /morespace file system. Remount the same file system as /morespace, and use the `noatime` mount option. Again display the content of your text file. Check and record the last access time for it. Add a line to the `/etc/vfstab` file that mounts the /morespace file system when the system reboots. Reboot the system using the `reboot` command, and verify that the /morespace file system is mounted.

- Mount the file system on Slice 0 as `/dir0`. Mount the file system on Slice 1 as `/dir0/dir1`. In a second terminal window, change to the `/dir0/dir1` directory. In the original terminal window, try to unmount the `/dir0/dir1` directory. Record the error messages. Attempt to forcibly unmount the `/dir0/dir1` directory. Record the result. Attempt to use the `pwd` command in the second terminal window. Record what happens.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Use the `mount` command to list the file systems that are currently mounted on your system. What are the default mount options applied to the `/` (root) file system?
2. Create the directory `/morespace` to use as the mount point.
3. Mount the file system on Slice 4 of your spare disk to the `/morespace` directory. Record the default mount options that were applied to this mount.
4. Change to the `/morespace` directory, and create a new file that has one line of content.
5. Display a long listing for this file, and record the time value it reports. This time value represents when the file was last modified.
6. Add the `-u` option to the `ls` command to show when the file was last accessed. This time value is updated whenever you read the file.
7. Wait one minute or more, and then use the `cat` command to display the file. Again check and record the access time. The access time should differ from the access time indicated in the previous step.
8. Change to the `/` (root) directory. Unmount the `/morespace` file system. Remount the same file system to the `/morespace` directory, but add the option that prevents update of access time values. Verify that the options to the mount were applied.
9. Return to the `/morespace` file system, and use the `cat` command to display your test file. Again check and record the access time. The access time should match the access time that existed prior to your unmounting and mounting the `/morespace` file system.
10. Add a line to the `/etc/vfstab` file to make the mount for the `/morespace` file system happen when you boot the system.

11. Reboot your system. Log in as the `root` user, and open a terminal window. Use the `mount` command to verify that the `/morespace` file system is mounted.
12. Create a directory called `/dir0`. Mount the file system that resides on Slice 0 of your spare disk as `/dir0`.
13. Create a directory called `/dir0/dir1`. Mount the file system that resides on Slice 1 of your spare disk as `/dir0/dir1`.
14. Open a second terminal window. In this new window, change the directory to `/dir0/dir1`.
15. In your original terminal window, attempt to unmount the file system mounted below the `/dir0/dir1` directory. Which message is displayed? Does the file system unmount?



---

**Note** – To discover why you could not unmount the file system, use the `fuser -cu /dir0/dir1` command. The `fuser` command should show the process ID of the shell.

---

16. In your original terminal window, again attempt to unmount the file system mounted below the `/dir0/dir1` directory. Add the `-f` option to the `umount` command. Which message is displayed? Does the file system unmount?
17. In the second terminal window, attempt to determine your current working directory. Which message is displayed? Change the directory to `/` (root), and verify that the `pwd` command works.

## Exercise: Mounting File Systems (Level 3)

In this exercise, you complete the following tasks:

- Create mount points
- Mount file systems
- Specify mount options

### Preparation

This exercise requires a spare disk that contains four unmounted ufs file systems on Slices 0, 1, 3, and 4. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Record the default mount options that are used by the / (root) file system mounted on your system. Mount the file system found on Slice 4 of your spare disk on the /morespace directory. Verify the mount options applied to the /morespace file system.
- Create a new file in the /morespace file system that contains one line of text. Record the modify time for this file. Use the `ls` command to display the last access time for this file. Record the time value. Wait one minute, and then display the file content. Again check and record the last access time for this file.
- Unmount the /morespace file system. Remount the same file system as /morespace, and use the `noatime` mount option. Again display the content of your text file. Check and record the last access time for it. Add a line to the `/etc/vfstab` file that mounts the /morespace file system when the system reboots. Reboot the system using the `reboot` command, and verify that the /morespace file system is mounted.



- Mount the file system on Slice 0 as `/dir0`. Mount the file system on Slice 1 as `/dir0/dir1`. In a second terminal window, change to the `/dir0/dir1` directory. In the original terminal window, try to unmount the `/dir0/dir1` directory. Record the error messages. Attempt to forcibly unmount the `/dir0/dir1` directory. Record the result. Attempt to use the `pwd` command in the second terminal window. Record what happens.

## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Use the `mount` command to list the file systems that are currently mounted on your system. What are the default mount options applied to the `/` (root) file system?

```
# mount
read/write/setuid/intr/largefiles/xattr/onerror=panic/
dev=22000000
```

*Your dev= number depends on the architecture of your system.*

2. Create the directory `/morespace` to use as the mount point.

```
# mkdir /morespace
```

3. Mount the file system on Slice 4 of your spare disk to the `/morespace` directory. Record the default mount options that were applied to this mount.

```
# mount /dev/dsk/c1t3d0s4 /morespace
# mount
read/write/setuid/intr/largefiles/xattr/onerror=panic/
dev=80001c
```

4. Change to the `/morespace` directory, and create a new file that has one line of content.

```
# cd /morespace
# cat > testfile
This is a test.
<ctrl> d
#
```

5. Display a long listing for this file, and record the time value it reports. This time value represents when the file was last modified.

```
# ls -l
```

6. Add the `-u` option to the `ls` command to show when the file was last accessed. This time value is updated whenever you read the file.

```
# ls -lu
```

7. Wait one minute or more, and then use the `cat` command to display the file. Again check and record the access time. The access time should differ from the access time indicated in the previous step.

```
# cat testfile
This is a test
# ls -lu
```

8. Change to the `/` (root) directory. Unmount the `/morespace` file system. Remount the same file system to the `/morespace` directory, but add the option that prevents update of access time values. Verify that the options to the mount were applied.

```
# cd /
# umount /morespace
# mount -o noatime /dev/dsk/c1t3d0s4 /morespace
# mount
```

9. Return to the `/morespace` file system, and use the `cat` command to display your test file. Again check and record the access time. The access time should match the access time that existed prior to your unmounting and mounting the `/morespace` file system.

```
# cd /morespace
# cat testfile
This is a test
# ls -lu
```

10. Add a line to the `/etc/vfstab` file to make the mount for the `/morespace` file system happen when you boot the system.

```
/dev/dsk/c1t3d0s4 /dev/rdisk/c1t3d0s4 /morespace ufs 2 yes noatime
```

11. Reboot your system. Log in as the `root` user, and open a terminal window. Use the `mount` command to verify that the `/morespace` file system is mounted.

```
# init 6
(reboot messages & login prompts)
# mount
```

12. Create a directory called `/dir0`. Mount the file system that resides on Slice 0 of your spare disk as `/dir0`.

```
# mkdir /dir0
# mount /dev/dsk/c1t3d0s0 /dir0
```

13. Create a directory called `/dir0/dir1`. Mount the file system that resides on Slice 1 of your spare disk as `/dir0/dir1`.

```
# mkdir /dir0/dir1
# mount /dev/dsk/c1t3d0s1 /dir0/dir1
```

14. Open a second terminal window. In this new window, change the directory to `/dir0/dir1`.

```
# cd /dir0/dir1
```

15. In your original terminal window, attempt to unmount the file system mounted below the `/dir0/dir1` directory. What message is displayed? Does the file system unmount?

```
# umount /dev/dsk/c1t3d0s1
# mount
umount: /dir0/dir1 busy
```

*The file system does not unmount.*




---

**Note** – To discover why you could not unmount the file system, use the `fuser -cu /dir0/dir1` command. The `fuser` command should show the process ID of the shell.

---

16. In your original terminal window, again attempt to unmount the file system mounted below the `/dir0/dir1` directory. Add the `-f` option to the `umount` command. Which message is displayed? Does the file system unmount?

```
# umount -f /dev/dsk/c1t3d0s1
# mount
```

*No messages are displayed. The file system unmounts.*

17. In the second terminal window, attempt to determine your current working directory. Which message is displayed? Change the directory to `/` (root), and verify that the `pwd` command works.

```
# pwd
Cannot determine current directory.
# cd /
# pwd
/
```

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications

# Installing the Solaris™ 9 Operating Environment

---

## Objectives

Upon completion of this module, you should be able to:

- Identify the fundamentals of CD-ROM installation
- Install the Solaris™ 9 Operating Environment (Solaris 9 OE) from a CD-ROM

The following course map shows how this module fits into the current instructional goal.

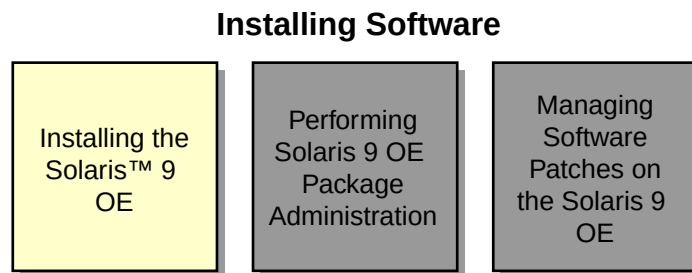


**Figure 5-1** Course Map

## Identifying the Fundamentals of the CD-ROM Installation

The following section describes the CD-ROM installation of the Solaris 9 OE.

### The Solaris 9 OE Installation and Upgrade Options

There are a number of ways to install the Solaris 9 OE on your system. They include:

- Solaris `suninstall` program
- Solaris™ Web Start Installation software
- Custom JumpStart™ procedure
- Solaris Web Start Flash installation
- Standard upgrade
- Solaris™ Live Upgrade method

This module focuses on the `suninstall` program.

### Solaris™ Web Start 3.0 Installation Software

The Solaris Web Start 3.0 Installation is a software application powered by Java™ technology. The Solaris Web Start program uses a graphical user interface (GUI). The GUI guides you through the installation of the Solaris 9 OE and other software on a single system from either a local or remote CD-ROM drive. Boot the system from the Solaris 9 Installation CD-ROM to invoke the Solaris Web Start program.

The Solaris Web Start program enables you to move easily forward and backward during the installation process to make changes as needed. Installation tasks are divided into panels that prompt you to enter system configuration information. The panels also offer you the opportunity to select default values.

You must interact with Solaris Web Start throughout the installation or upgrade procedure. Consequently, this method might not be the most efficient method when you need to install or upgrade several systems.

## Custom JumpStart™ Installation

The Solaris JumpStart procedure installs Solaris OE software on a system by referencing a user-defined profile. You can customize profiles for different types of systems.

A JumpStart installation provides a hands-off installation across the network and is based on a central-configured server. The JumpStart procedure is a command-line interface that enables you to incorporate shell scripts. The shell scripts include pre-installation and post-installation tasks. You choose the profile and the scripts to use for installation or upgrade. Then the custom installation method installs or upgrades the system.

## Solaris Web Start Flash Installation Software

The Solaris Web Start Flash Installation software enables you to install many systems based on a configuration that you install on a master system. After you have installed and configured the master system, you create a flash archive from the master system. You create as many flash archives as you need and choose which flash archive to install on each system.

The standard Solaris OE installation methods install each Solaris OE package individually. This method of package-based installation is time consuming because the installation must update the package map for each package. The Solaris Web Start Flash software's archive installs on your system much faster than when you install each of the individual Solaris OE packages, because you are only producing a copy of an already installed system.

Solaris upgrade options include both the standard upgrade and the live upgrade.

## Standard Upgrade to the Solaris OE

A standard upgrade merges the new version of the Solaris OE with the existing files on the system's disk. The methods available for a standard upgrade are Solaris `suninstall` program, the Solaris Web Start software, and the custom JumpStart procedure.

A standard upgrade saves many of the modifications that were made to the OE with the previous version of the Solaris OE. Because the Solaris OE is unavailable to users during the standard upgrade, the standard upgrade results in longer periods of downtime.

## Solaris™ Live Upgrade Software

The Solaris Live Upgrade Software upgrades a duplicate boot environment while the active boot environment is still running. This method eliminates downtime of the production environment. The Solaris Live Upgrade method can be run with either a GUI or a command-line interface. First, create a duplicate boot environment. After that has been created, upgrade or install a Solaris Web Start Flash archive on the inactive boot environment. When you are ready, activate the inactive boot environment. During the next reboot, the inactive boot environment becomes the active boot environment. If there is a failure, you can recover your original boot environment by reactivating it and rebooting the system.

Solaris Live Upgrade Software requires enough available disk space to create a duplicate of your boot environment. To estimate the file system size needed to create a boot environment, start the creation of the new boot environment. The file system size is calculated, and you can then abort the process.

## Hardware Requirements for Installation of the Solaris 9 OE

A Solaris 9 OE installation requires:

- A system based on an UltraSPARC® processor
- 64 Mbytes of memory
- 2.3 Gbytes of disk space
- A keyboard and monitor
- Access to a CD-ROM drive or an installation server



## Software Components of the Solaris OE

The Solaris OE software is organized into three components:

- Software packages
- Software clusters
- Software groups

Figure 5-2 shows the relationship among the Common Desktop Environment (CDE) software components.

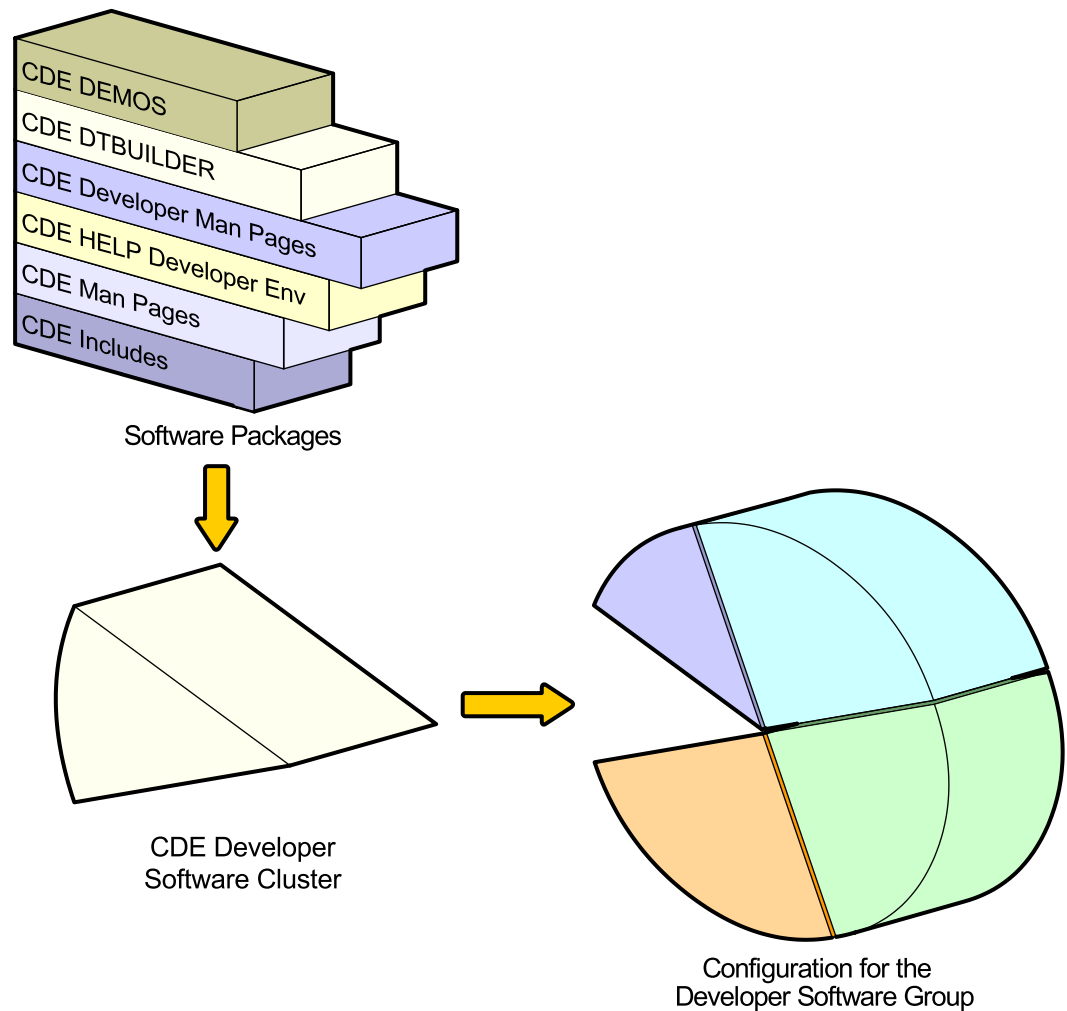


**Figure 5-2** Solaris OE Software Components

### Software Packages

A software package contains a group of software files and directories. The package also contains the related software installation scripts.

### Software Clusters

During the software installation process, software clusters group logical collections of software packages together. Table 5-1 shows the software packages that are grouped into the CDE software cluster.

**Table 5-1** Packages Included in the CDE Software Cluster

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| SUNWdtab  | SUNWdthed | SUNWdtmad | SUNWeudhr |
| SUNWdtbas | SUNWdthev | SUNWdtrme | SUNWeudhs |
| SUNWdtdem | SUNWdticn | SUNWdtn   | SUNWeudis |
| SUNWdtdmn | SUNWdtim  | SUNWeudba | SUNWeudlg |
| SUNWdtdst | SUNWdtinc | SUNWeudbd | SUNWmfman |
| SUNWdthe  | SUNWdtma  | SUNWeudda |           |

Some software clusters contain only one software package.

## Solaris OE Software Groups

Software groups are collections of Solaris OE software packages. Each software group includes support for different functions and hardware drivers. The Solaris OE is made up of five software groups:

- Core
- End User System Support
- Developer System Support
- Entire Distribution
- Entire Distribution Plus Original Equipment Manufacturers (OEM)

Figure 5-3 shows the software groups that compose the Solaris OE.

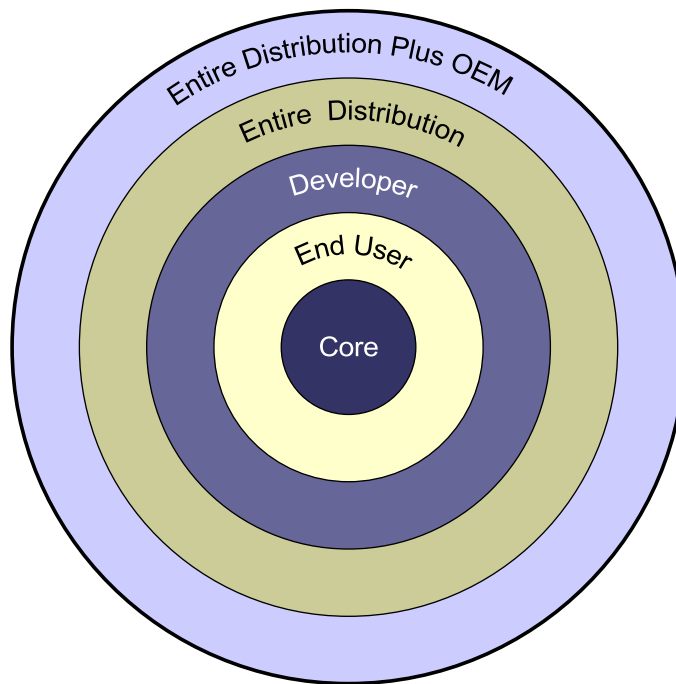


**Figure 5-3** Solaris OE Software Groups

### Core Software Group (SUNWCreq)

The Core software group contains the minimum software required to boot and run the Solaris OE in a minimum configuration, without the support to run many server applications. The Core software group includes a minimum of networking software, including Telnet, File Transfer Protocol (FTP), Network File System (NFS), Network Information Service (NIS) clients, and Domain Name Service (DNS). This software group also includes the drivers required to run the Common Desktop Environment (CDE) but does not include the CDE software. The Core software group also does not include online manual pages.

### End User System Support Software Group (SUNWCuser)

The End User System Support software group contains the Core software group and also contains the recommended software for an end user plus the CDE.

### Developer System Support Software Group (SUNWCprog)

The Developer System Support software group contains the End User System Support software group. It also contains the libraries, the include files, the online manual pages, and the programming tools for developing software.

### Entire Distribution Software Group (SUNWCa11)

The Entire Distribution software group contains the Developer System Support software group. It also contains additional software needed for servers. The software that is in the Entire Distribution software group is the entire Solaris OE software release minus OEM support.

### Entire Distribution Plus OEM Support Software Group (SUNWCXa11)

The Entire Distribution Plus OEM Support software group contains the entire Solaris OE software release. It also contains additional hardware support for OEMs. This software group is recommended when you are installing the Solaris OE software on non-Sun servers that use UltraSPARC processors.

To view the names of the cluster configurations, perform the command:

```
# grep METACLUSTER /var/sadm/system/admin/.clustertoc
METACLUSTER=SUNWCXa11
METACLUSTER=SUNWCa11
METACLUSTER=SUNWCprog
METACLUSTER=SUNWCuser
METACLUSTER=SUNWCreq
METACLUSTER=SUNWcmreq
```



---

**Note** – The metacluster SUNWcmreq is a hidden metacluster. It allows you to create a minimal core metacluster by de-selecting packages from the core metacluster.

---

To determine which cluster configuration has been installed on the system, perform the command:

```
# cat /var/sadm/system/admin/CLUSTER
CLUSTER=SUNWCXa11
```

# Installing the Solaris 9 OE From a CD-ROM

In the Solaris 9 OE, the `suninstall` program uses Tab Window Manager (TWM) for window management.

TWM provides the following features:

- Title bars
- Shaped windows
- Several forms of icon management
- User-defined macro functions
- A click-to-type and pointer-driven keyboard focus
- User-specified key and pointer button bindings

## Pre-Installation Information

Consider the following general guidelines while planning an installation:

- Allocate additional disk space for each language that you install.
- Allocate additional space in the `/var` file system if you plan to have your system support printing or mail.
- Allocate double the amount of physical memory in the `/var` file system if you plan to use the crash dump feature `savecore` on your system.
- Allocate additional space in the `/export` file system if you plan to provide a home directory file system for users on the Solaris 9 OE.
- Allocate space for the Solaris software group you want to install.
- Allocate an additional 30 percent more disk space for each file system that you create, and create a minimum number of file systems. This leaves room for upgrades to future software releases.



---

**Note** – By default, the Solaris OE installation methods create only the `/` (root) file system and the `swap` partition.

---

- Allocate additional disk space for additional software or third-party software.

Before installing the Solaris OE software on a networked standalone system, you must provide the following information:

|                                     |                                                                                                                                                                                                                             |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Host name                           | Determine a unique, and usually, short name for the networked system. You can use the command <code>uname -n</code> to find the host name on an existing system.                                                            |
| Host Internet Protocol (IP) address | Determine the software address that represents the host address and network address. You can use the <code>ifconfig interface</code> command (for example, <code>ifconfig hme0</code> ) to display your current IP address. |
| Name service type                   | Determine if the networked system is to be included in one of the following types of name service domains: Lightweight Directory Access Protocol (LDAP), NIS, Network Information Service Plus (NIS+), DNS, or none.        |
| Subnet mask                         | Determine if the networked system is included in a particular subnet. The subnet mask is stored in the <code>/etc/netmasks</code> file.                                                                                     |



---

**Note** – A subnet is used to partition network traffic. Segmenting network traffic over many different subnets increases the bandwidth available to each host.

---

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Geographic location and time zone | Determine the specific region where the networked system physically resides.                                                                                                                                                                                                                                                                                                                                                                                               |
| root password                     | Determine a password assigned to the <code>root</code> user. Use the <code>root</code> password to gain access to <code>root</code> privileges on the networked system.                                                                                                                                                                                                                                                                                                    |
| Language                          | Determine the language with which to install the Solaris OE. Use the CD-ROM labeled Solaris 9 Installation SPARC <sup>®</sup> Platform Edition. The installation software enables the user to choose from a list of languages. Prompts, messages, and other installation information are displayed in the chosen language. The language choices include English, German, Spanish, French, Italian, Japanese, Korean, Swedish, Simplified Chinese, and Traditional Chinese. |

As the last step in the pre-installation process, make sure the following Solaris 9 OE CD-ROM set is available:

- Solaris 9 Installation English SPARC Platform Edition or Solaris 9 Installation Multilingual SPARC Platform Edition
- Solaris 9 Software 1 of 2 CD-ROM SPARC Platform Edition and Solaris 9 Software 2 of 2 CD-ROM SPARC Platform Edition
- Solaris 9 Languages SPARC Platform Edition

Before performing a software installation, always back up any modifications or data that exist in the previous version of the Solaris OE, and restore them after completing the installation.

## Demonstration: Performing an Interactive Installation

In this demonstration, your instructor leads you through an interactive installation of the Solaris 9 OE.

### Preparation

The interactive installation demonstration requires a networked, standalone system configured with a 2-Gbyte, or larger, boot disk. Depending on the speed of CD-ROM devices in use, the complete installation process requires approximately one hour.

### Demonstration Summary

Boot the system from the Solaris 9 CD-ROM 1 of 2, and install the Solaris 9 OE software. Create a configuration as follows:

- Assign host name, IP address, subnet mask, routing, time zone, and naming service information compatible with the classroom configuration.
- Perform an initial installation, and use the Entire Distribution configuration cluster.
- Select the appropriate boot disk, and manually lay out your file system.
- Create slices for the / (root), swap, /opt, /usr, and /export/home file systems.
- Elect not to install additional software products.
- Set the root password to `cangetin`.



### Demonstration Instructions

Complete the following steps:

1. Insert the Solaris 9 OE CD-ROM 1 of 2 into the CD-ROM drive. If the current version of the Solaris OE is running, log in as `root`, and bring the system to run level 0.

```
# init 0
```

You can also abort the Solaris OE by pressing the Stop-A key sequence.

2. Boot the system from the CD-ROM. Ignore error messages, such as cable problem messages, that relate to network interfaces that are not attached.

```
ok boot cdrom
```

The installation program is loaded into random access memory (RAM), and the installation process begins automatically. However, no changes are made to the disk until you click the Begin Installation button at the end of the installation process.



3. When the installation software is finished loading, a list of languages appears. Prompts, messages, and other installation information are displayed in the chosen language. English is the default language choice. You can select a different language from the list of available languages.

Select a Language

- 0 English
- 1 French
- 2 German
- 3 Italian
- 4 Japanese
- 5 Korean
- 6 Simplified Chinese
- 7 Spanish
- 8 Swedish
- 9 Traditional Chinese

Please make a choice (0-9), or press h or ? for help:  
Respond by making your language selection.

4. A list of locales appears. Respond by making your locale selection.

Select a Locale

58 U.S.A. (en\_US.ISO8859-15)

... < remaining lines removed > ...

If the Solaris `suninstall` program detects a frame buffer for the system, it uses the GUI. If it does not detect a frame buffer, the `suninstall` program uses the command-line interface. The content and sequence of instructions in both are generally the same. This demonstration uses the GUI.

The system responds with:

Starting Window System

The TWM starts up, and two windows appear. Figure 5-4 shows the first of these windows to appear. The Solaris Install Console window remains open throughout the installation and provides information pertinent to the installation.

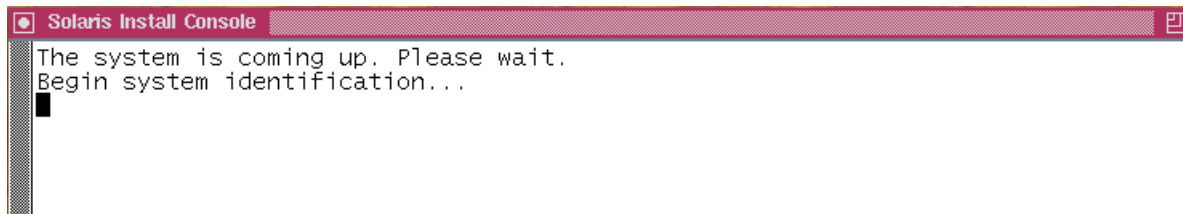


**Figure 5-4** Solaris Install Console Window

Figure 5-5 shows the second window that appears when the TWM starts. The Solaris Installation Program window provides a brief description of the installation process.

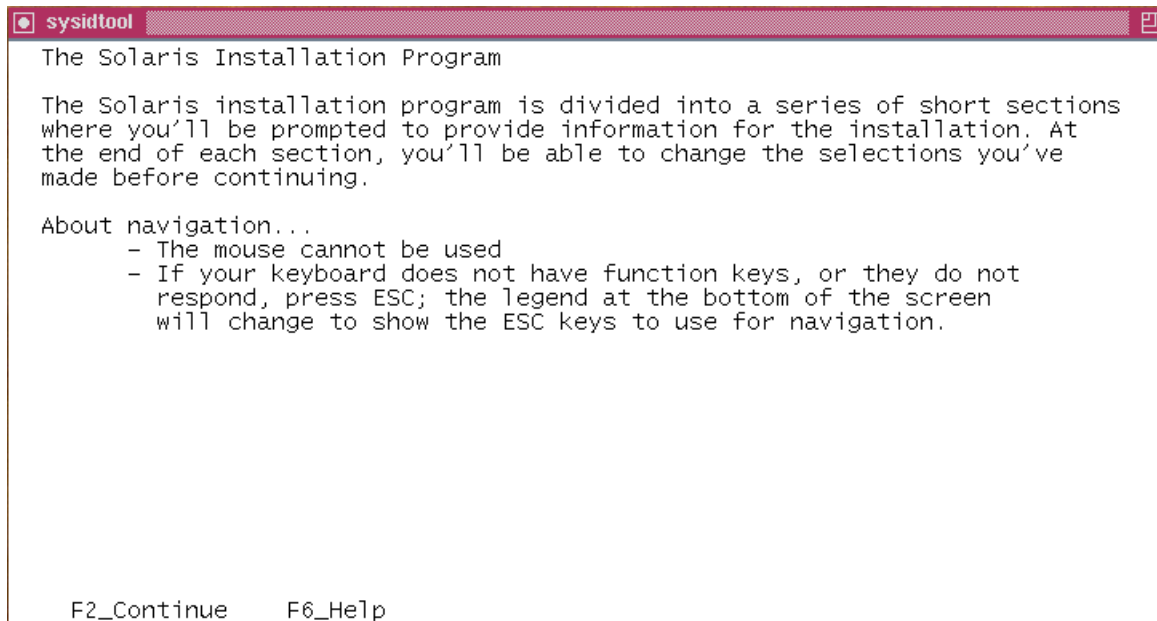


**Figure 5-5** Solaris Installation Program Window

5. When you have read the brief description, press F2.

Figure 5-6 shows the next window that appears.

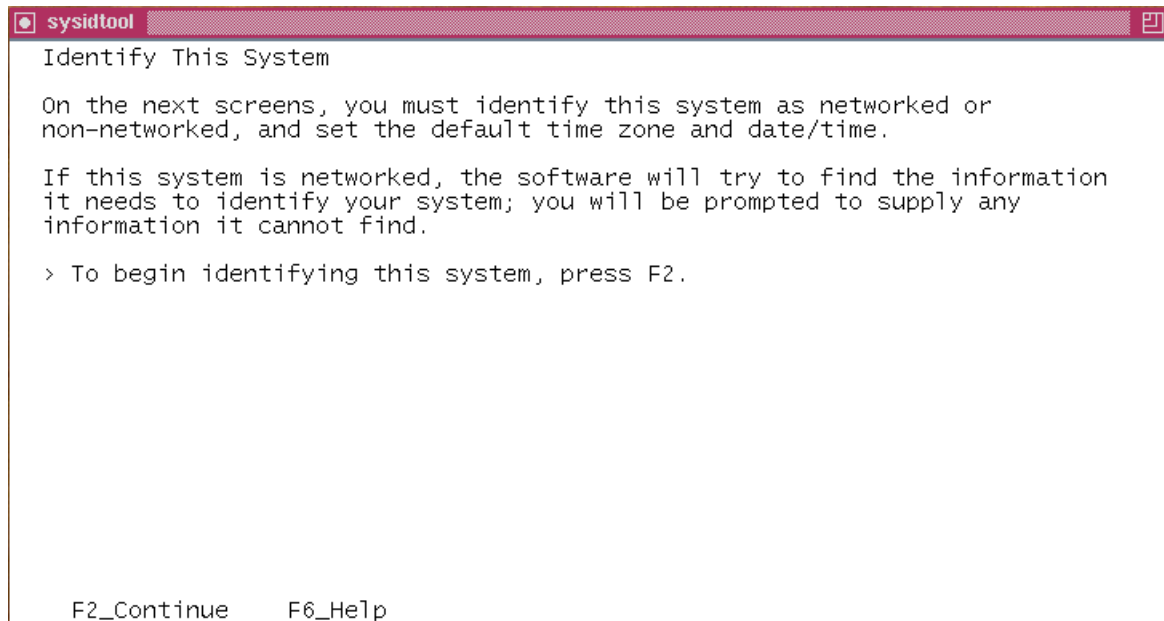


**Figure 5-6** Identify This System Window

6. Read the description of the identification process. When you are finished, press F2.

Figure 5-7 shows the next window that appears.

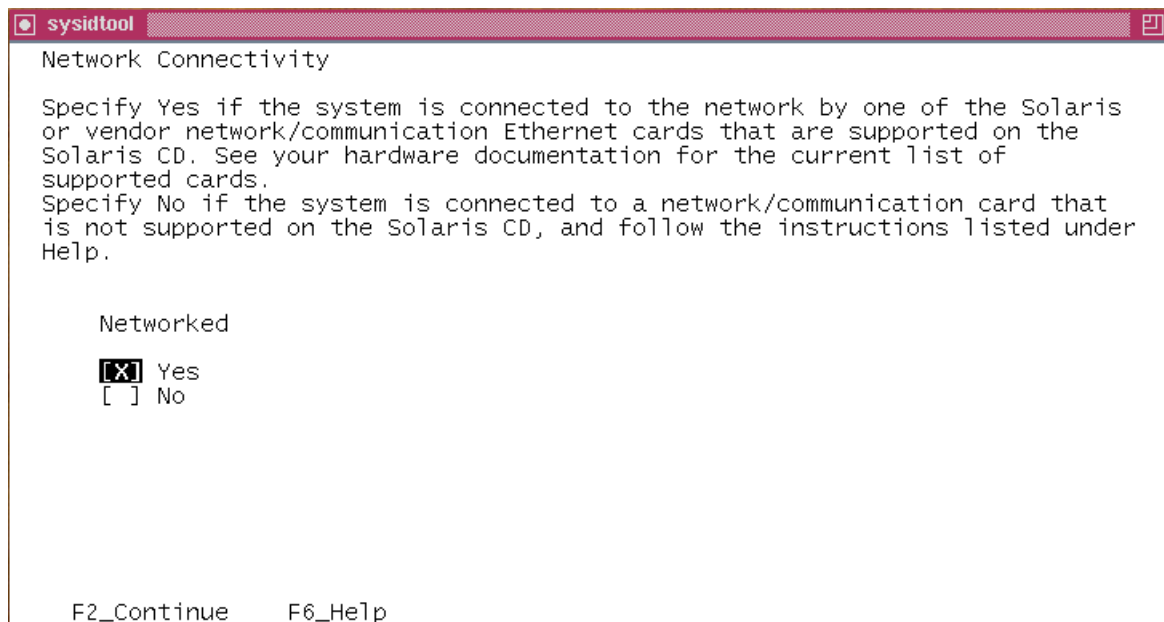


**Figure 5-7** Network Connectivity Window

7. Select **Yes** if your system is connected to a network. Use the arrow keys to move between choices, and press Return to select the choice. Use these steps to make selections for the remainder of the demonstration. When you have made your selection, press F2.

Figure 5-8 shows the next window that appears.

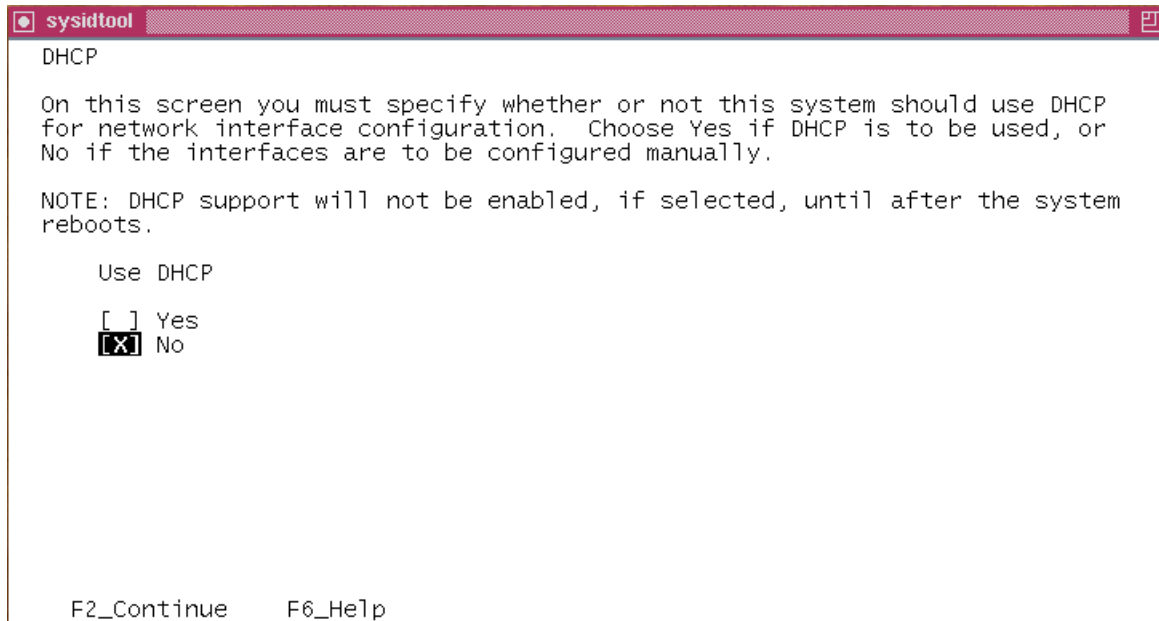


**Figure 5-8** DHCP Choice Window

8. Select **No** to confirm that the system is not using Dynamic Host Configuration Protocol (DHCP) for network interface information. To continue, press F2.

9. If your system has more than one network interface, Figure 5-9 appears.

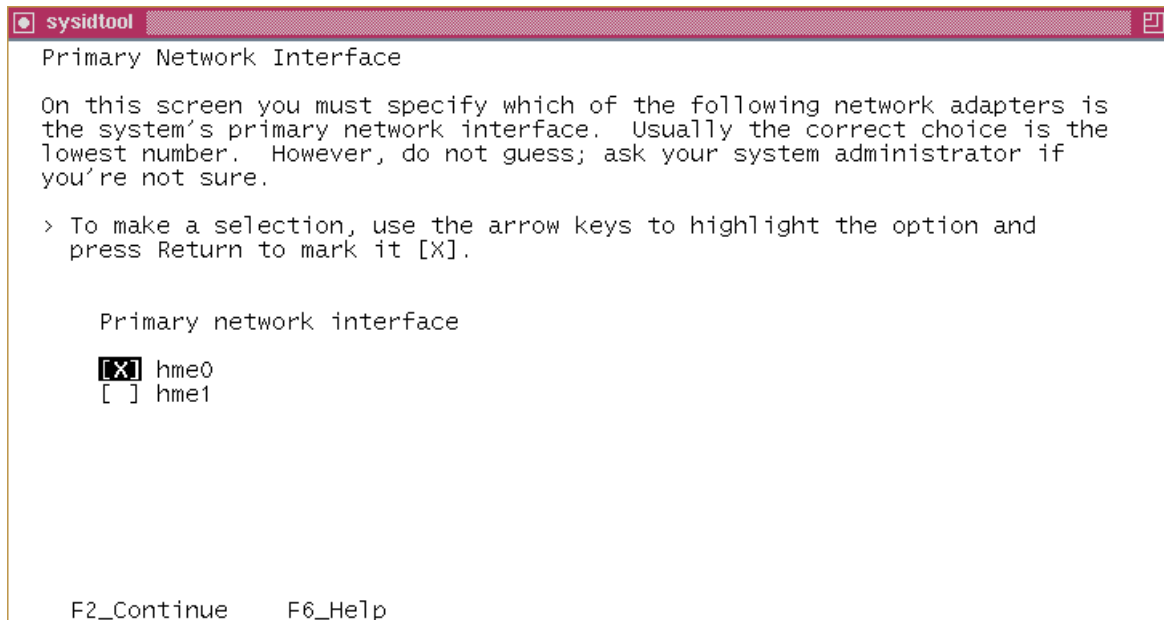


**Figure 5-9** Primary Network Interface Window

Select which network interface you want to make your primary interface (in this example, choose `hme0`). Press F2 to continue.

Figure 5-10 shows the next window that appears.

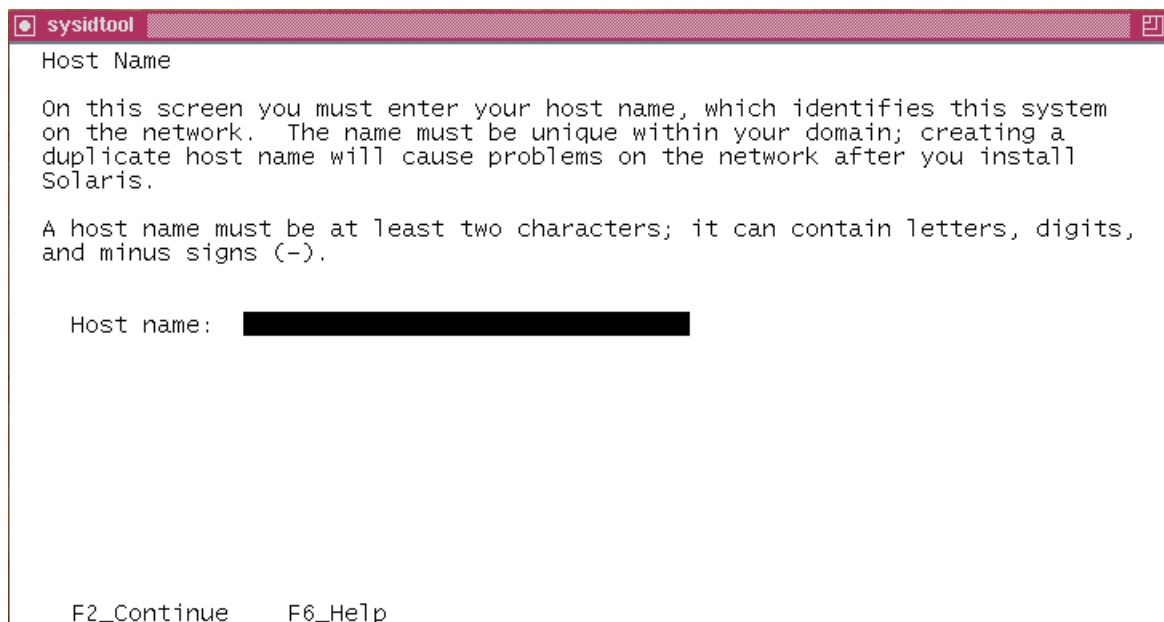


**Figure 5-10** Host Name Window

10. Enter the assigned host name for the system in the Host name field. To continue, press F2.

Figure 5-11 shows the next window that appears.

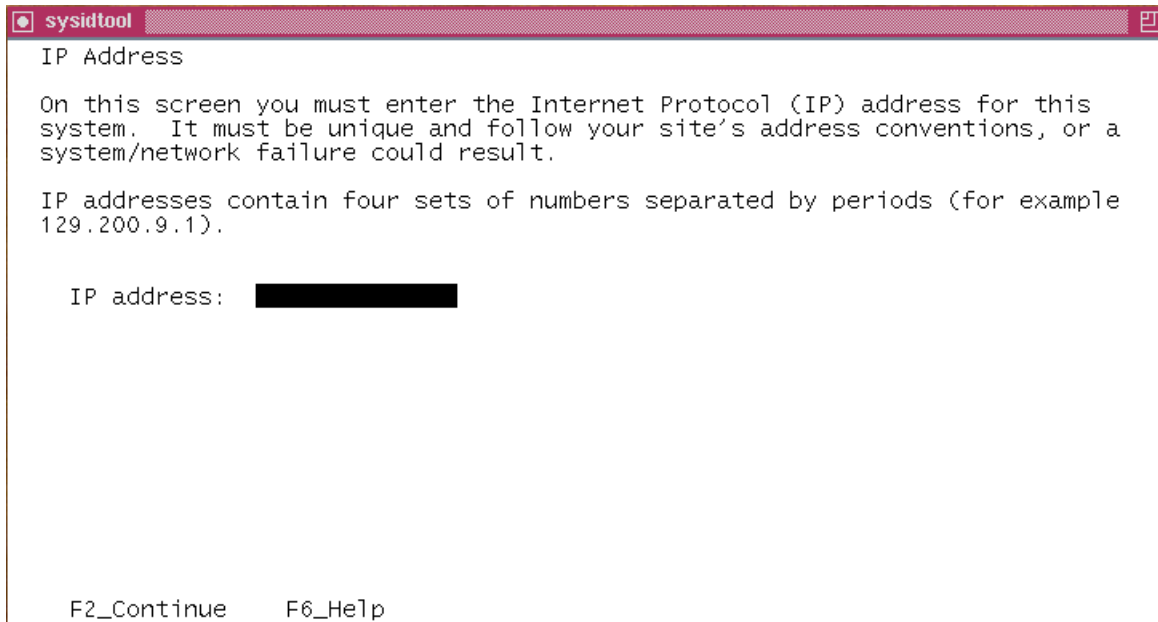


**Figure 5-11** IP Address Window

11. Enter the assigned IP address in the IP address field. To continue, press F2.

Figure 5-12 shows the next window that appears.

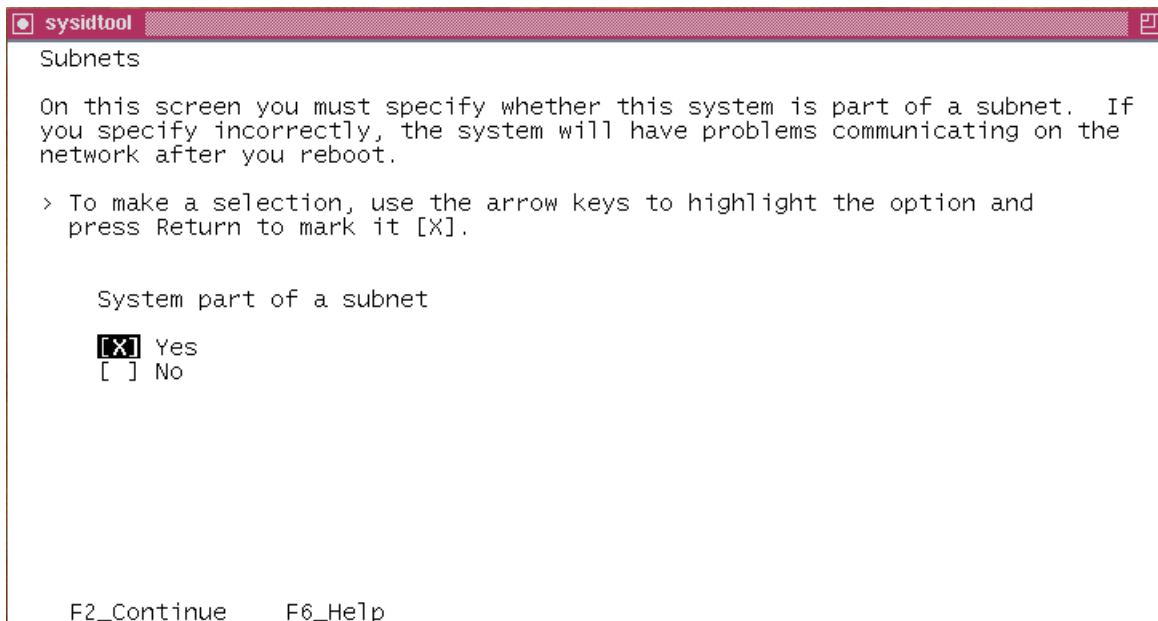


**Figure 5-12** Subnets Window

12. Select Yes to confirm that the system is part of a subnet. To continue, press F2.

Figure 5-13 shows the next window that appears.



**Figure 5-13** Netmask Window

13. For this demonstration, accept the default subnet mask of 255.255.255.0. To continue, press F2.

Figure 5-14 shows the next window that appears.

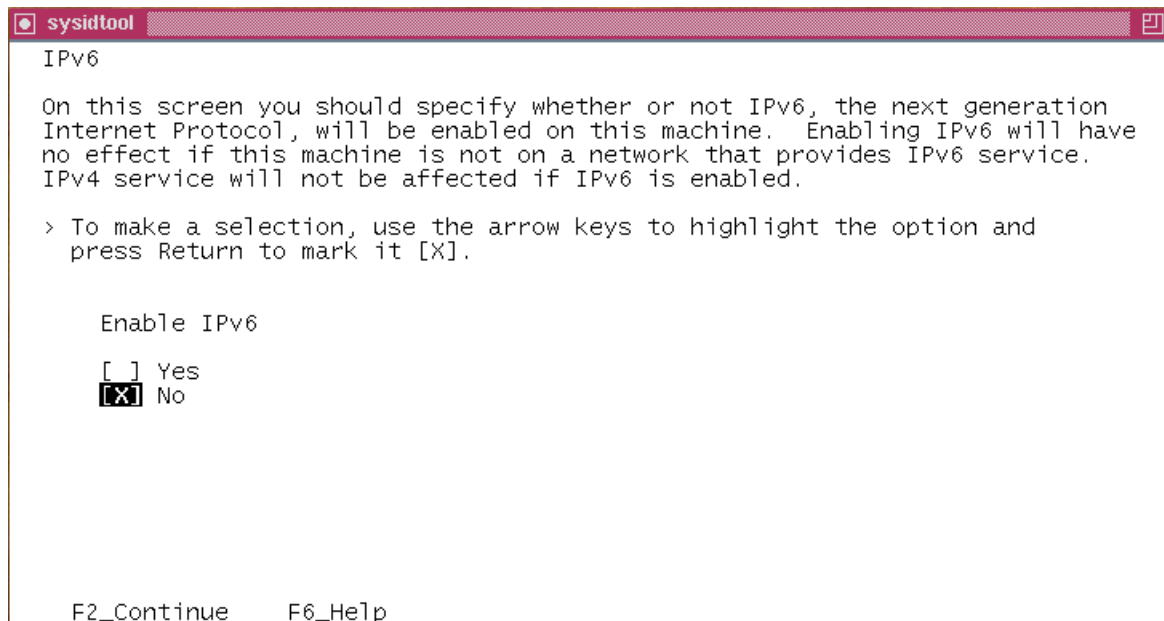


**Figure 5-14** IPv6 Window

14. Confirm that the system does not use Internet Protocol version 6. To continue, press F2.

Figure 5-15 shows the next window that appears. In this window, you can let the operating environment try to find a default route, or you can specify one.

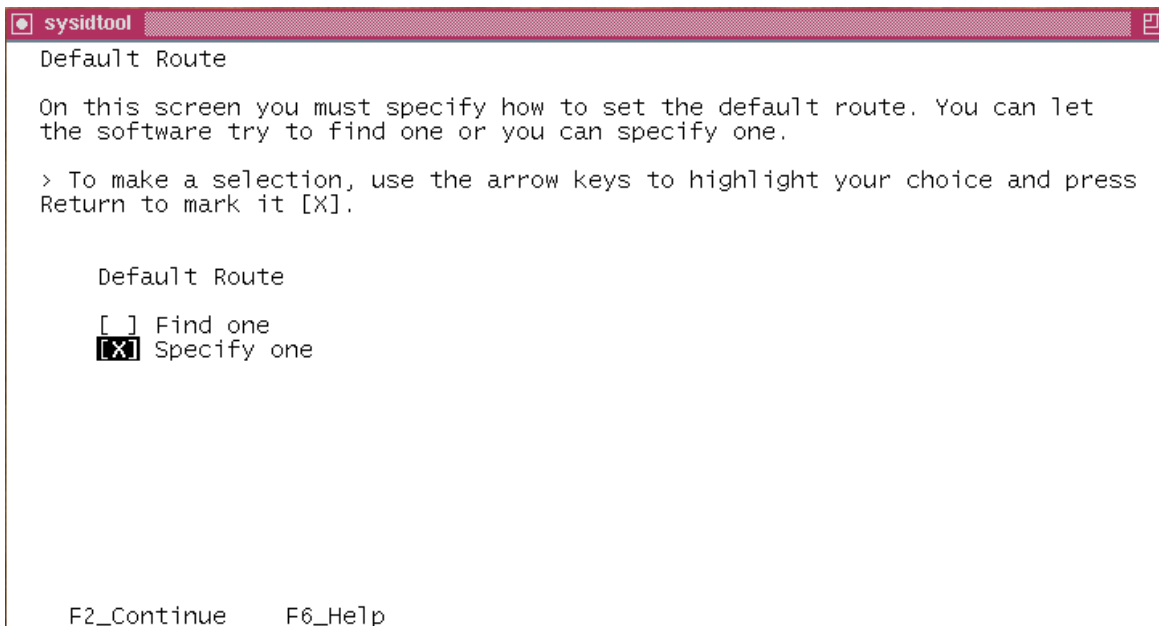


**Figure 5-15** Default Route Window

15. Select **Specify one**. To continue, press F2.



Figure 5-16 shows the next window that appears.

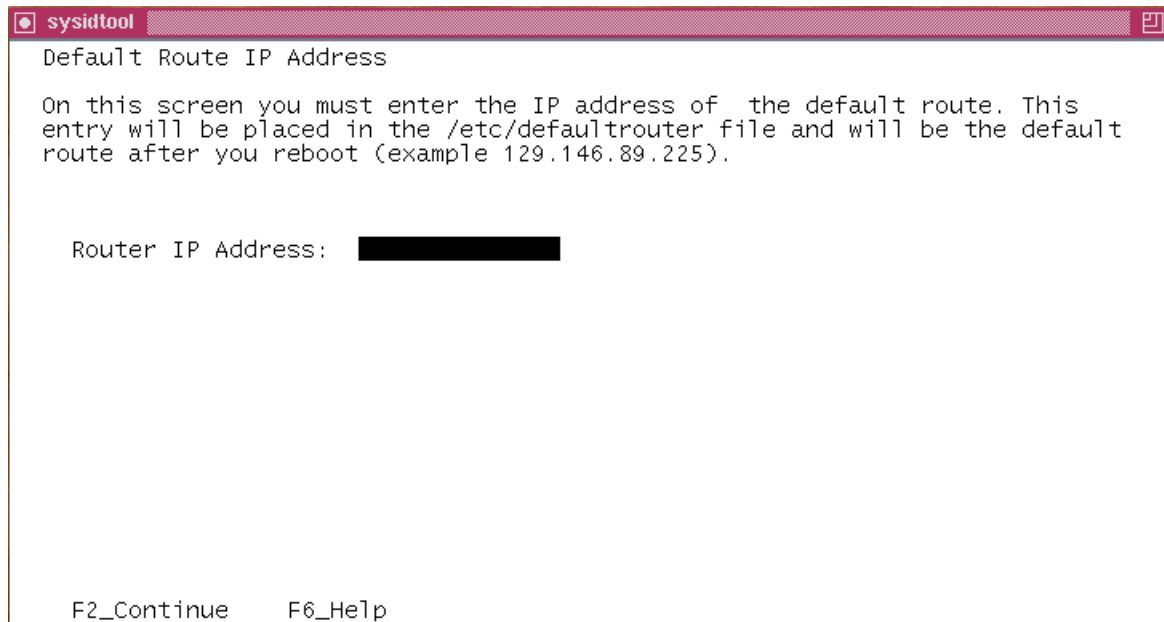


**Figure 5-16** Default Route IP Address Window

16. Enter the default route IP address provided to you by your instructor. To continue, press F2.

Figure 5-17 shows the next window that appears.

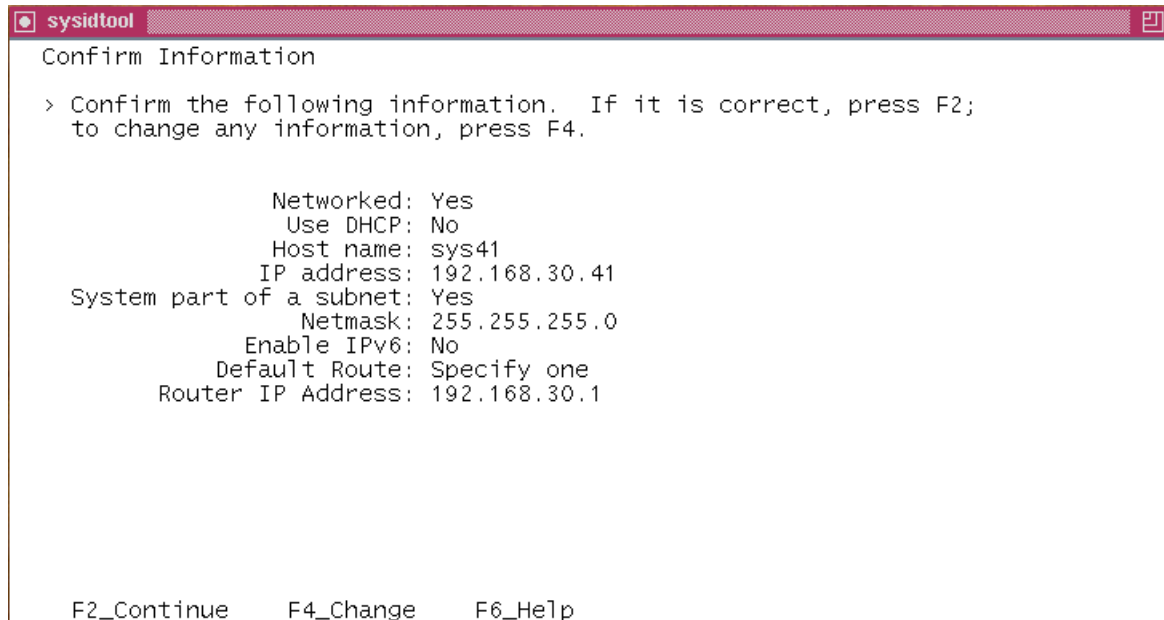


**Figure 5-17** Confirm System Identification Window

17. Verify your system configuration. Press F4 to go back and make changes or to correct errors. To continue, press F2.

Figure 5-18 shows the next window that appears.

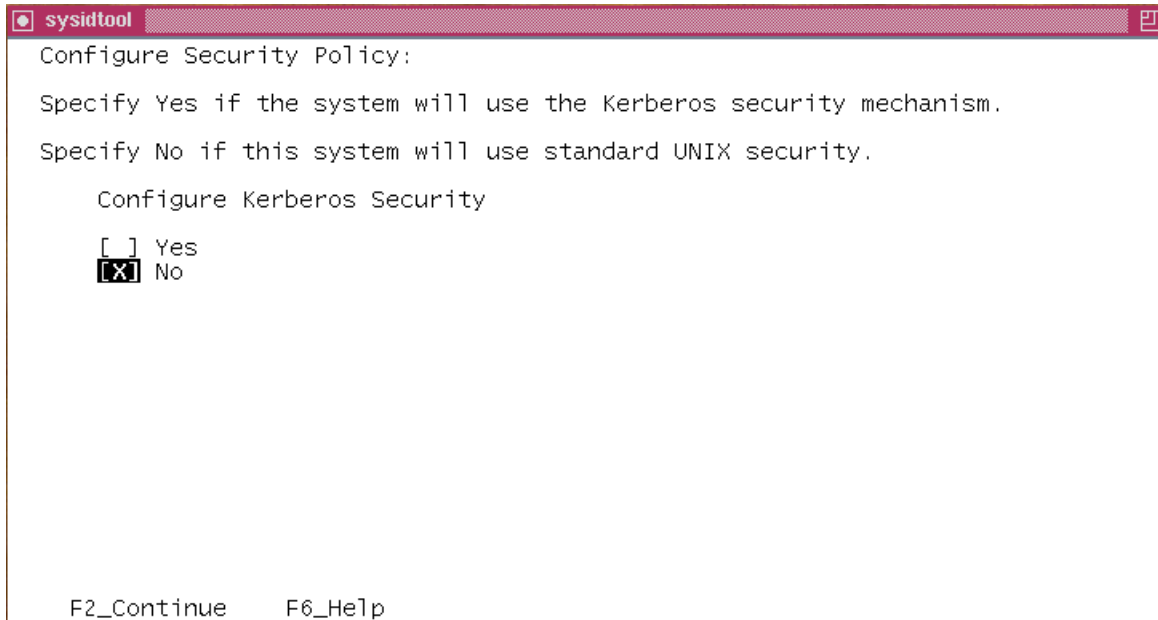


**Figure 5-18** Configure Security Policy Window

18. Select **No** to configure the Solaris 9 OE to use standard UNIX® security. To continue, press F2.

Figure 5-19 shows the next window that appears.

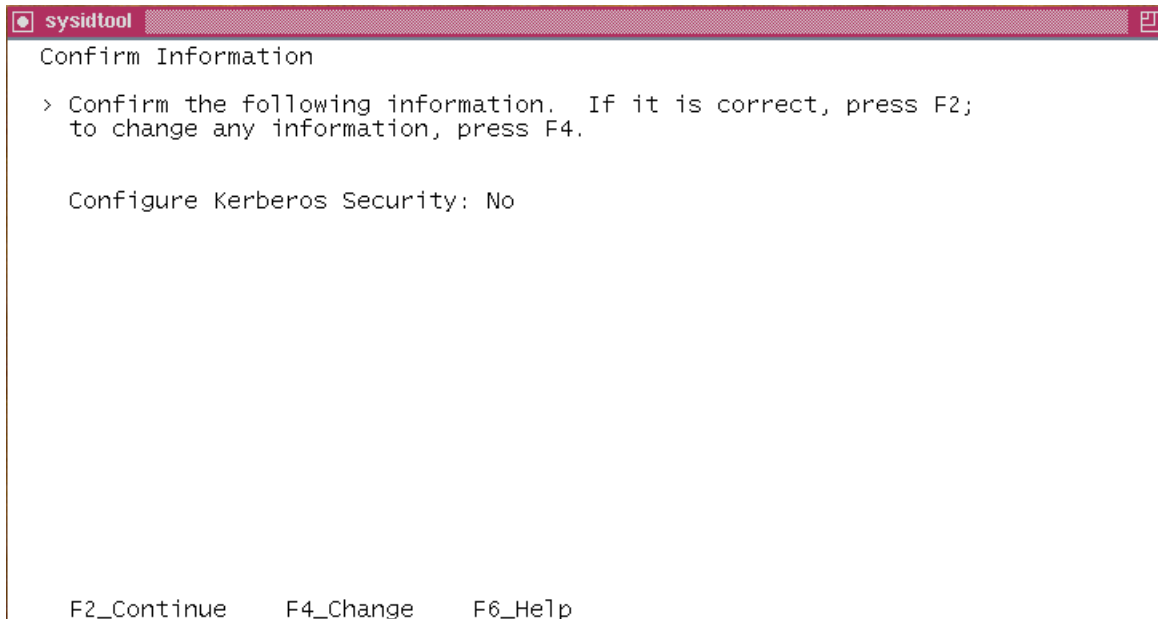


**Figure 5-19** Confirm Security Information Window

19. Press F2 to confirm the NO response and to display the next window.

Figure 5-20 shows the next window that appears.

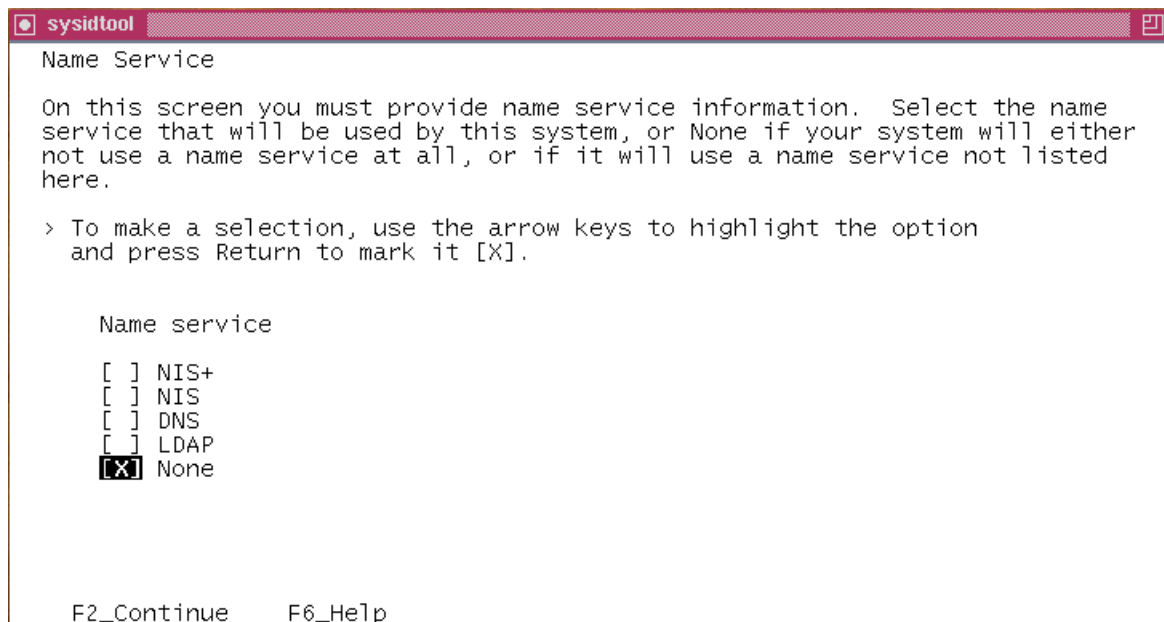


**Figure 5-20** Name Service Window

20. Select None as your name service. To continue, press F2.

Figure 5-21 shows the next window that appears.

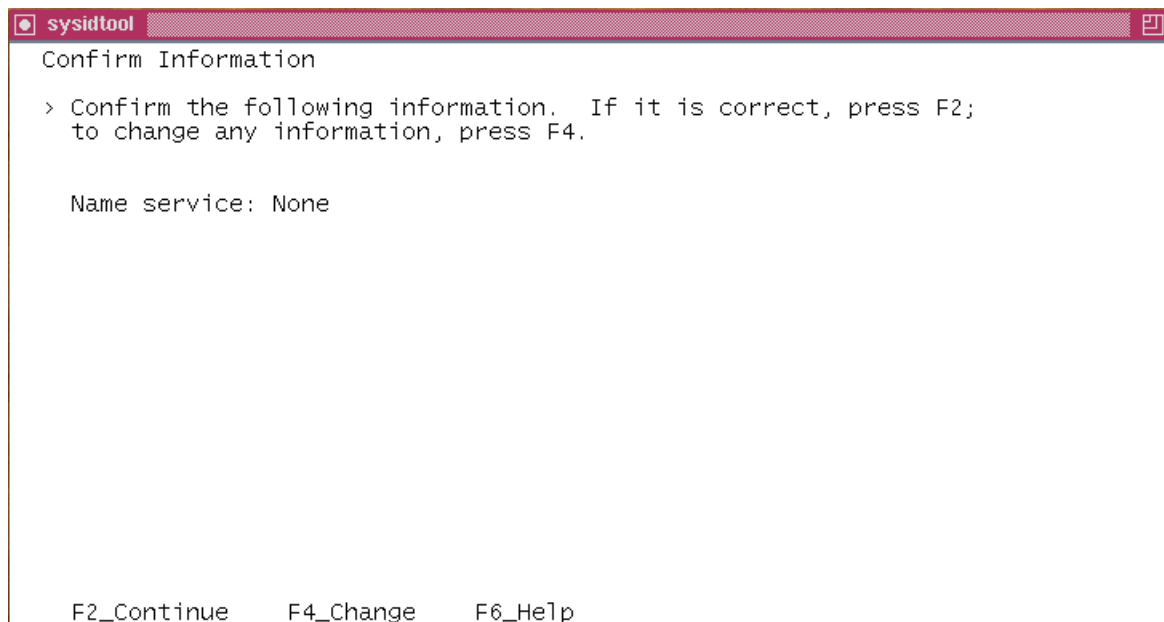


**Figure 5-21** Confirm Name Service Information Window

21. To change the information, press F4. To continue, press F2.

Figure 5-22 shows the next window that appears.

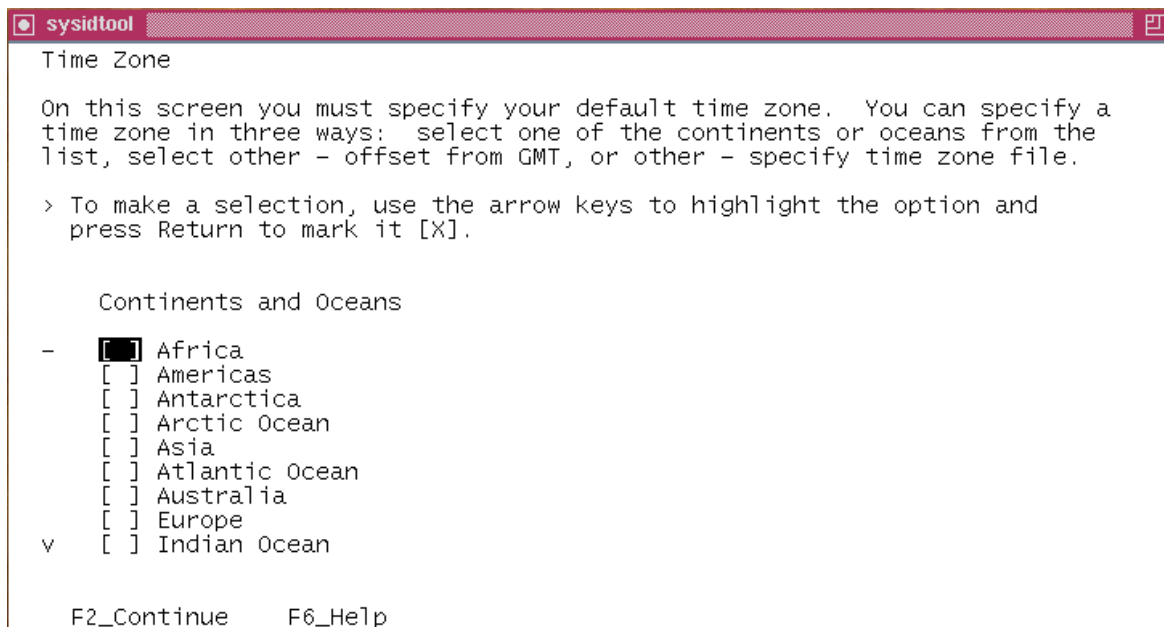


**Figure 5-22** Time Zone Window

22. Select the appropriate time zone continent. To continue, press F2.

Figure 5-23 shows the next window that appears.

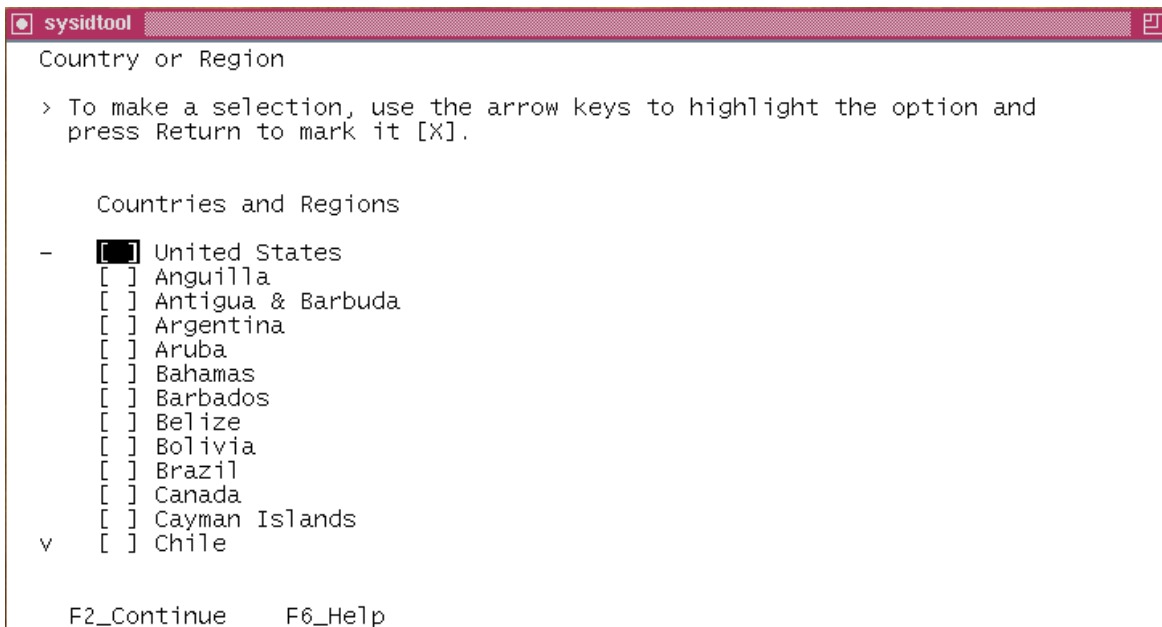


**Figure 5-23** Country or Region Window

23. Select the appropriate time zone country or region. To continue, press F2.

Figure 5-24 shows the next window that appears.

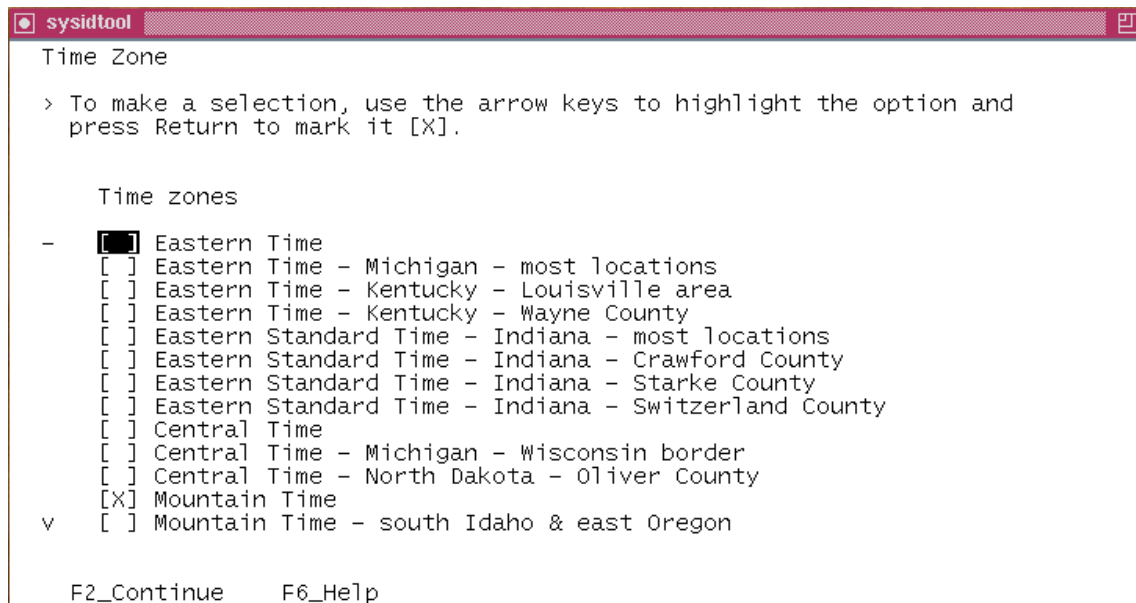


**Figure 5-24** Time Zone Window

24. Select the appropriate time zone for your area. To continue, press F2.

Figure 5-25 shows the next window that appears.

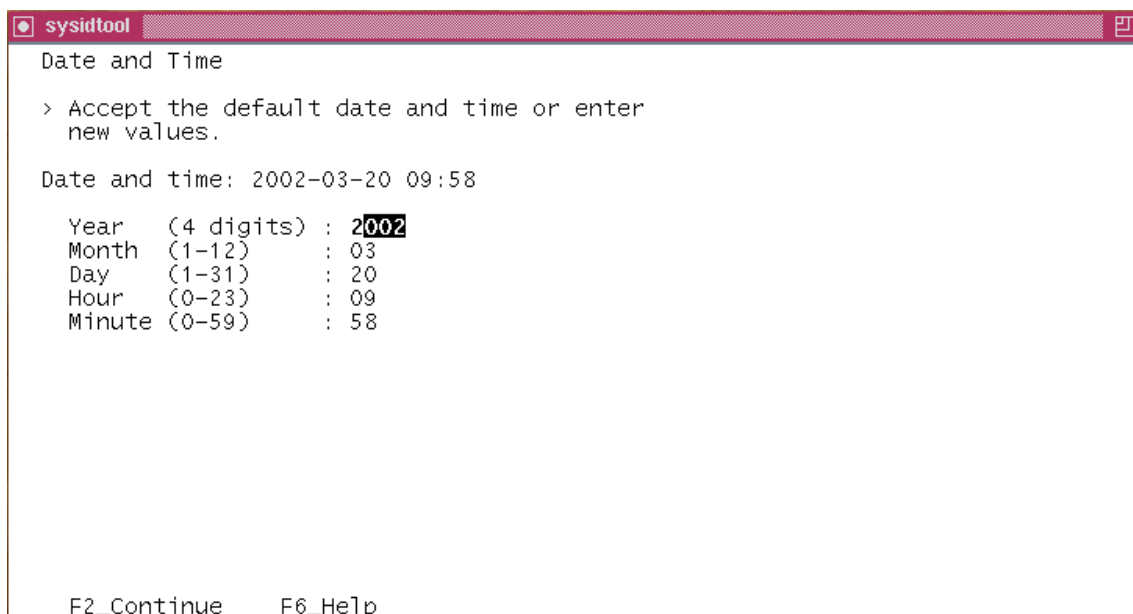


**Figure 5-25** Date and Time Window

25. Accept the default date and time, or enter new values. To continue, press F2.

Figure 5-26 shows the next window that appears.

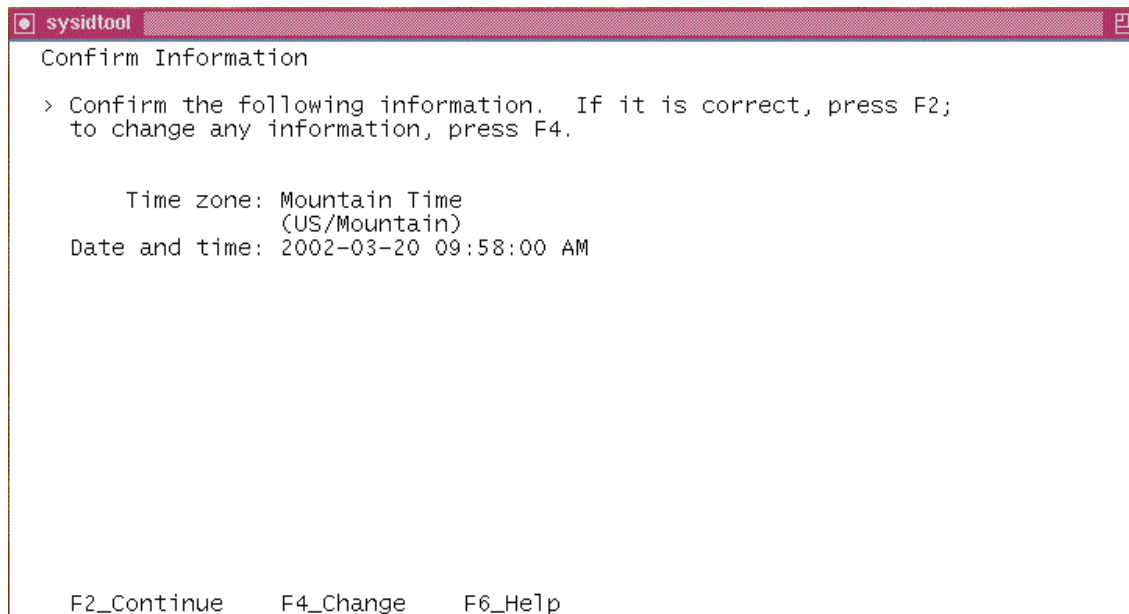


**Figure 5-26** Confirm Date and Time Information Window

26. Review the information. To change the information, press F4. To continue, press F2.

Figure 5-27 shows the next window that appears. The console window displays additional information while generating a software table of contents, checking the `rules.ok` file, and executing scripts.

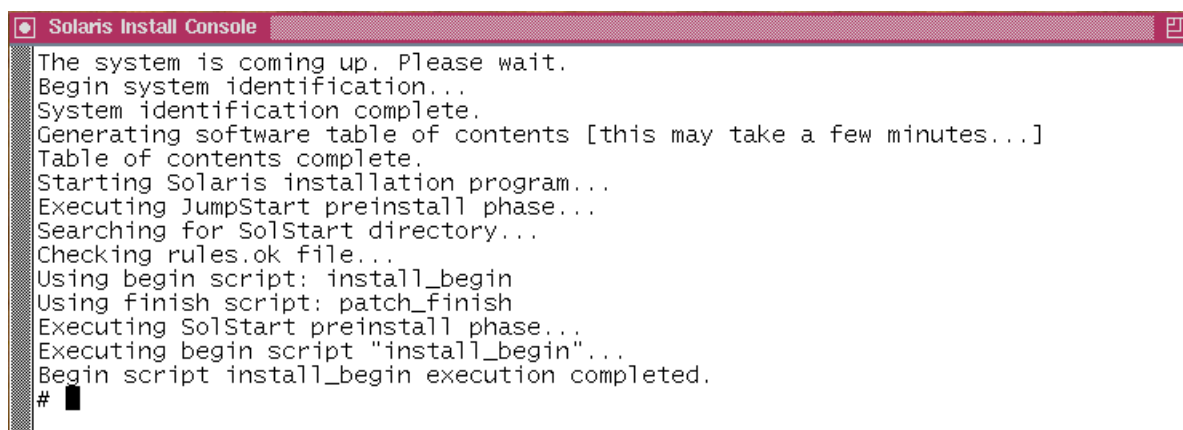


**Figure 5-27** Solaris Install Console Window

Figure 5-28 shows the next window that appears.

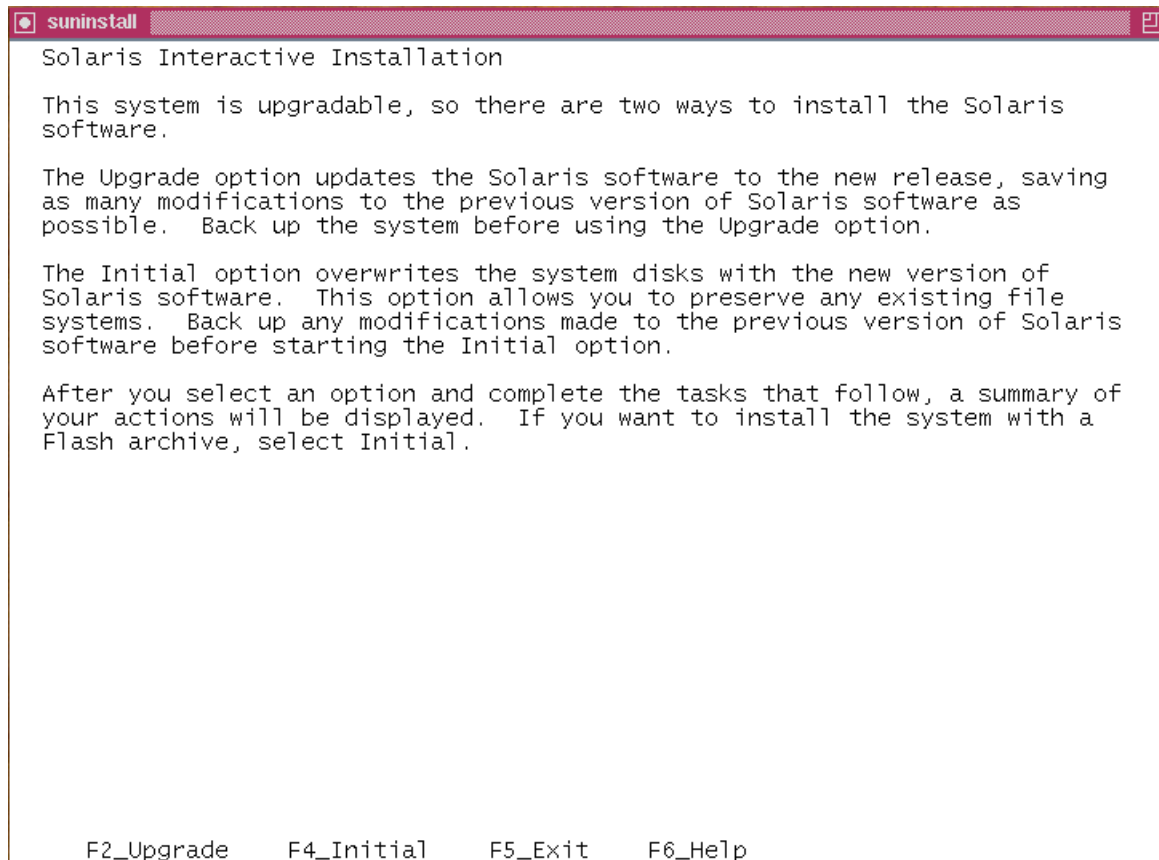


**Figure 5-28** Solaris Interactive Installation Window

If you have previously installed a version of the Solaris OE software on the system, the `suninstall` program advises you that the system can be upgraded. The upgrade procedure attempts to preserve local modifications to the system whenever possible. An upgrade procedure generally takes two or three times longer than the initial installation procedure because it does file comparisons.

Press F2 to bypass the initial procedure and to access the upgrade program. The first thing the upgrade program does is analyze the current Solaris OE files and disk configuration. The upgrade program then calculates the size of replacement packages to determine if the disk partitioning is adequate for the new software. If adequate space is allocated, the program prompts you to customize the software for the upgrade.

The upgrade program attempts to mount all file systems listed in the `/etc/vfstab` file. If any file system cannot be mounted, the upgrade program reports the failure and then exits.

If there is no need to preserve existing data on the system, you press F4 to perform the initial installation. The Initial option destroys the existing file systems as it performs an installation of the Solaris 9 OE.

27. For this demonstration, use the Initial installation method. Press F4 to select the Initial installation method.

Figure 5-29 shows the next window that appears.

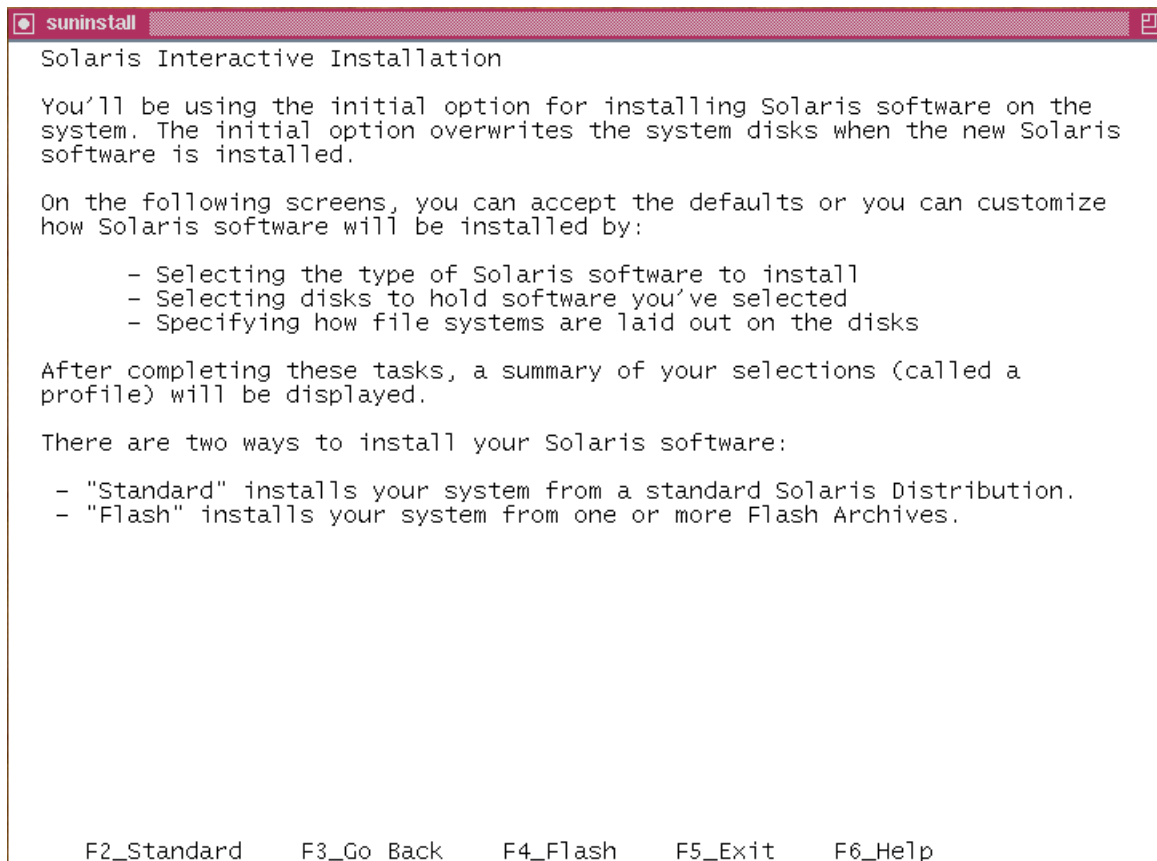


**Figure 5-29** Solaris Interactive Installation Window – Initial Option

The Standard method and the Flash method are the two methods available for installing the Solaris 9 OE.

28. Select the Standard method for this demonstration. To continue, press F2.



Figure 5-30 shows the next window that appears.

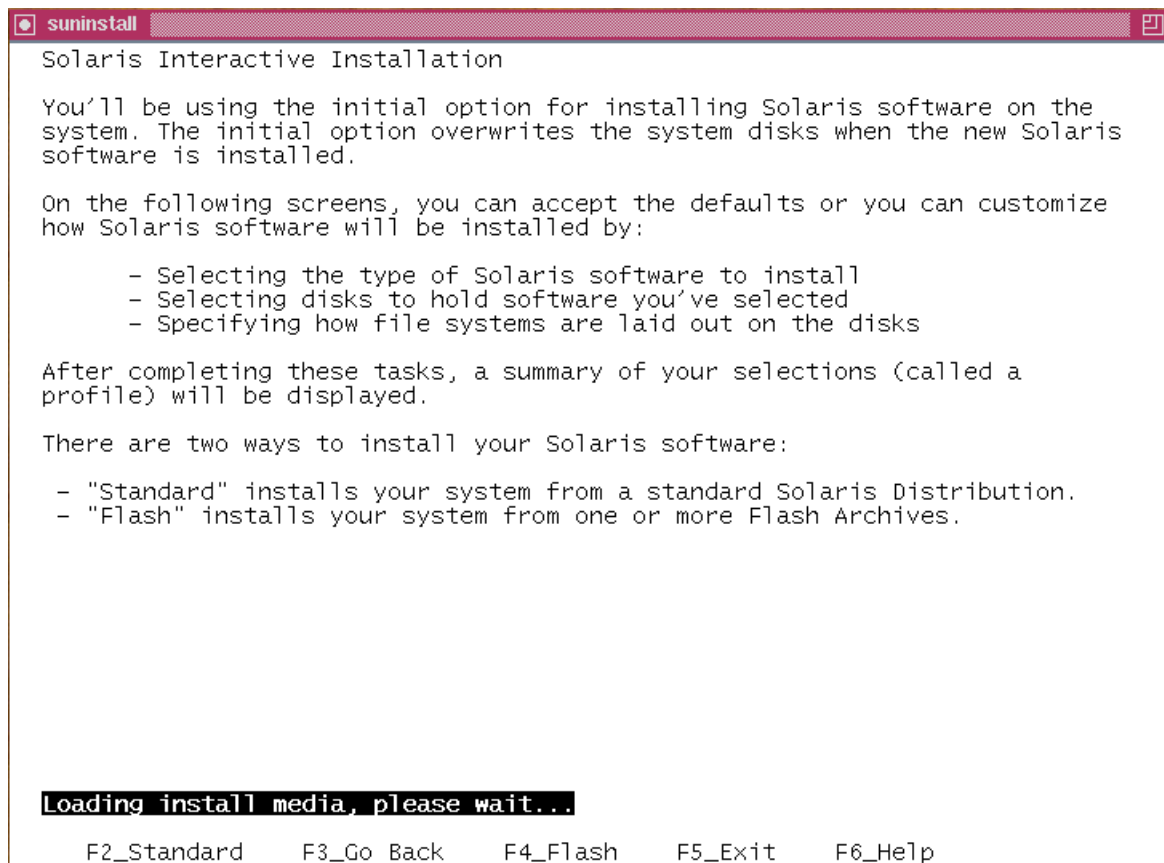


**Figure 5-30** Solaris Interactive Installation Window – Loading Installation Media

The Solaris Interactive Installation Loading Install Media window appears briefly to inform you that the `suninstall` program is loading the software.

Figure 5-31 shows the next window that appears.

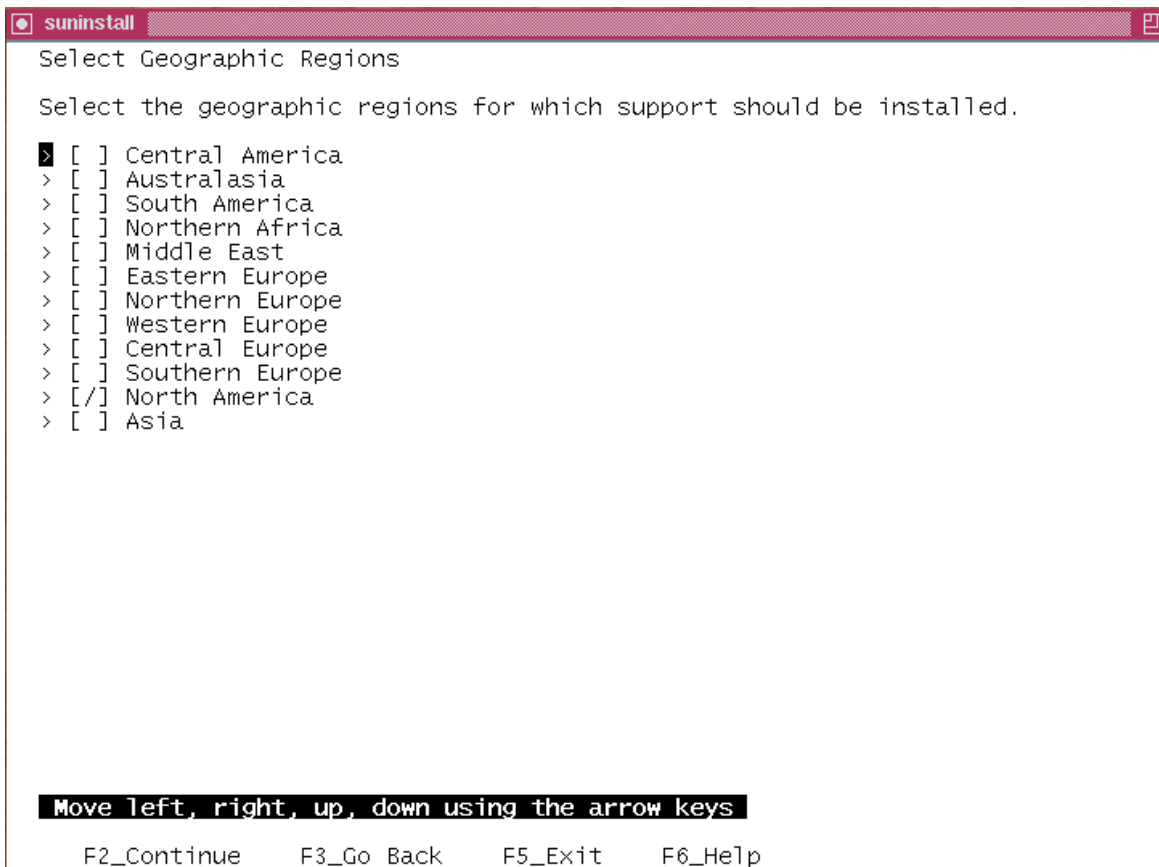


**Figure 5-31** Select Geographic Regions Window

Geographic regions are composed of locales and languages. You can select support for a portion of a region or an entire region. You can also select support for more than one region. An X means support for a region or locale is selected. A slash (/) means the region or locale is partially selected.

29. Make the appropriate selections. To continue, press F2.

Figure 5-32 shows the next window that appears.

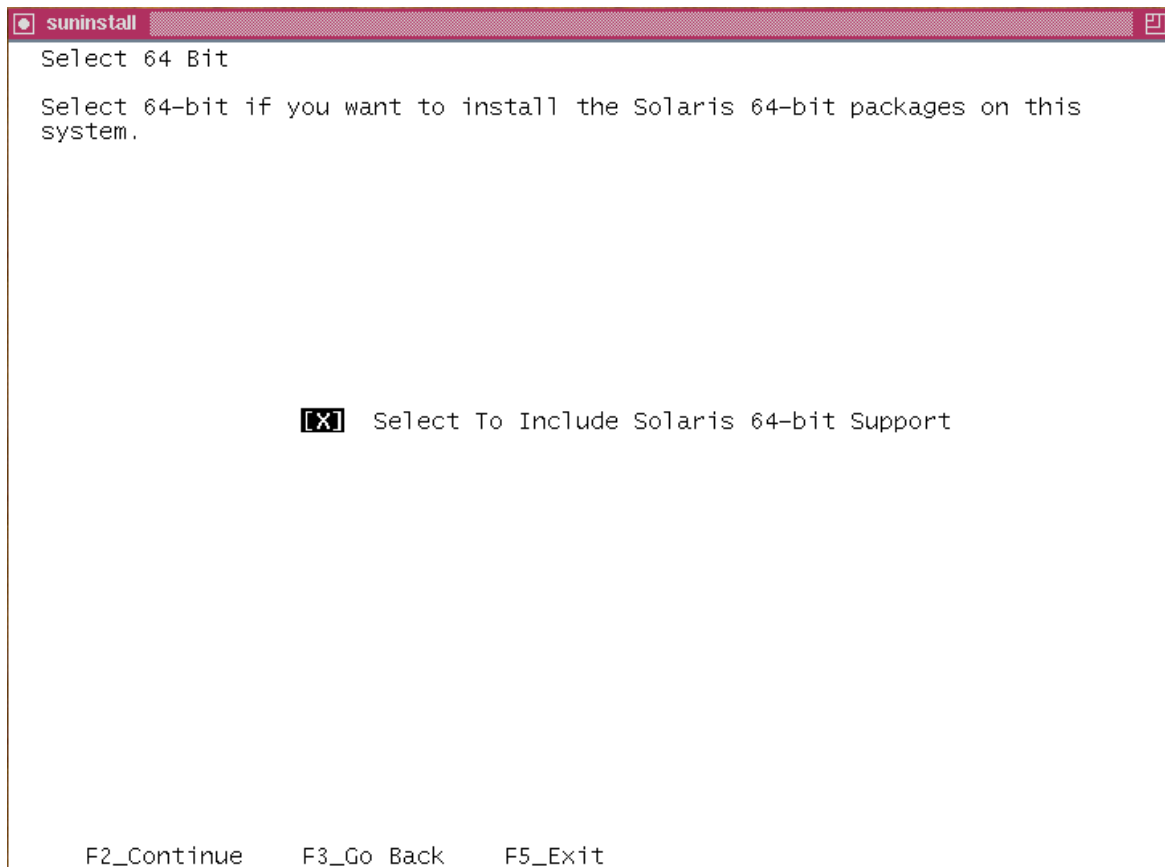


**Figure 5-32** Select 64 Bit Window

30. If your system is capable of supporting 64-bit applications, select the available option. To continue, press F2.

Figure 5-33 shows the next window that appears.

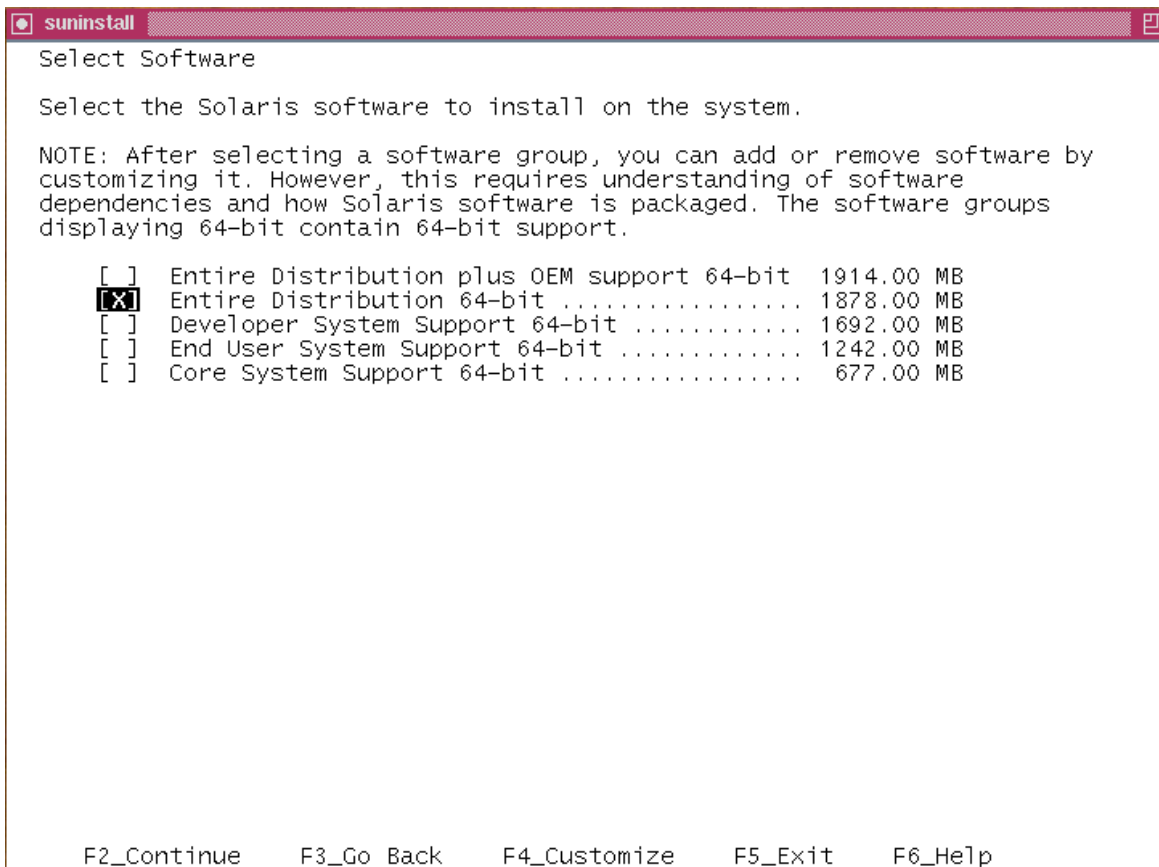


**Figure 5-33** Select Software

You can select the software group that most closely fits the specific needs of your system. Notice the recommended or estimated disk file size required to install each of the software groups. These sizes vary based on the system type and kernel architecture.

31. Select the Entire Distribution 64-bit. To continue, press F2.

Figure 5-34 shows the next window that appears.

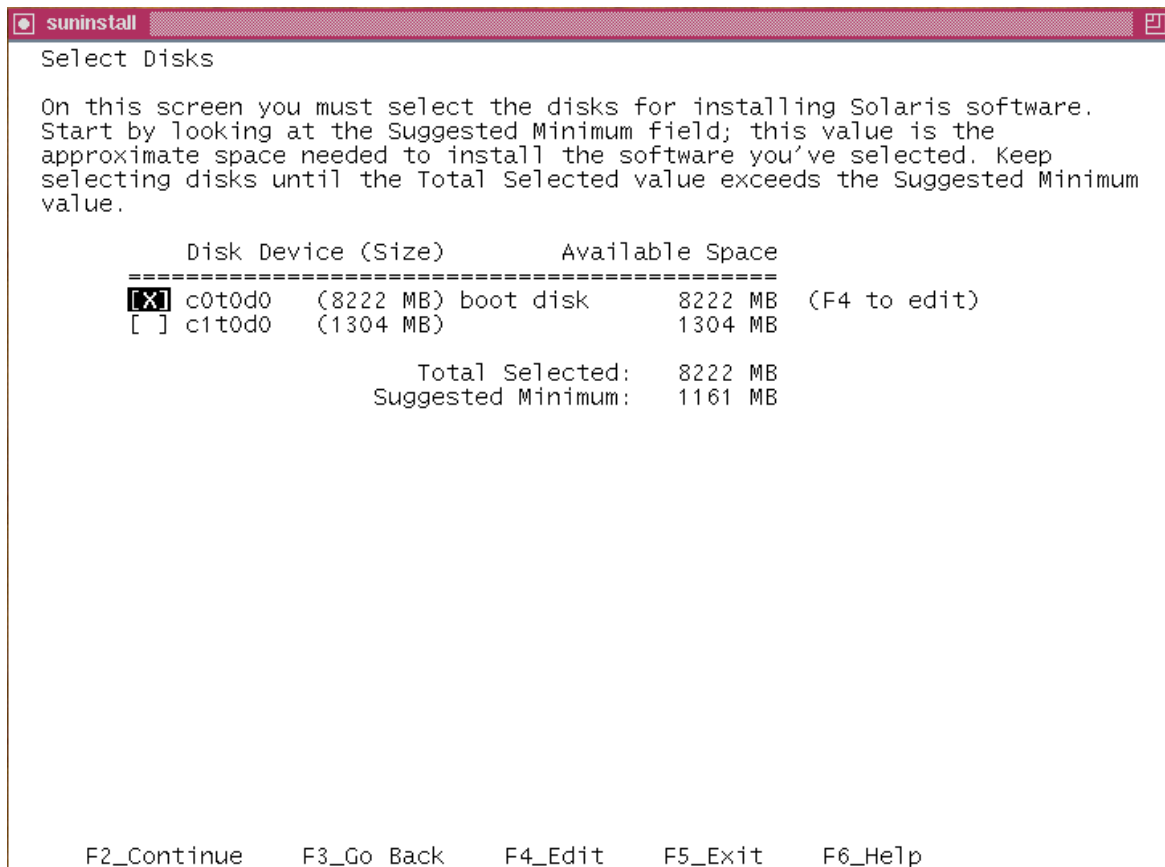


**Figure 5-34** Select Disks Window

32. Select the disk or disks on which you are installing the software.

The window displays values that reflect available space on the disk and the suggested minimum space. Recall that the size of the clusters varies and that there are other general considerations for determining disk slices and sizes. If you choose to change your boot drive, the `suninstall` program prompts you to verify the change and makes changes to your nonvolatile random access memory (NVRAM) parameters.

33. To continue, press F2.

Figure 5-35 shows the next window that appears.

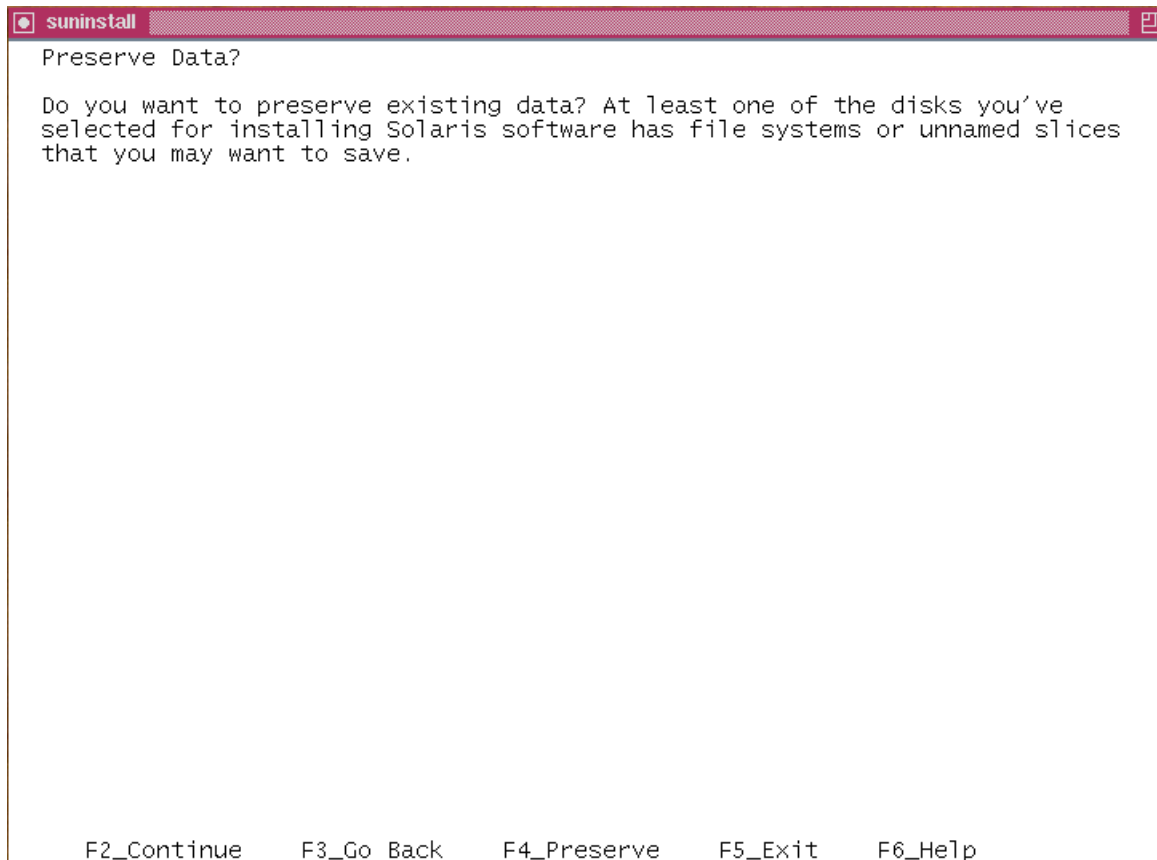


**Figure 5-35** Preserve Data Window

The initial installation preserves data only on demand.

34. To continue, press F2.



---

**Note** – If you select F4 to preserve data, the `suninstall` program displays a window that enables you to preserve data on a specific partition of the disk. If your system was previously a home directory server, you might want to preserve the `/export/home` file system.

---

Figure 5-36 shows the next window that appears.

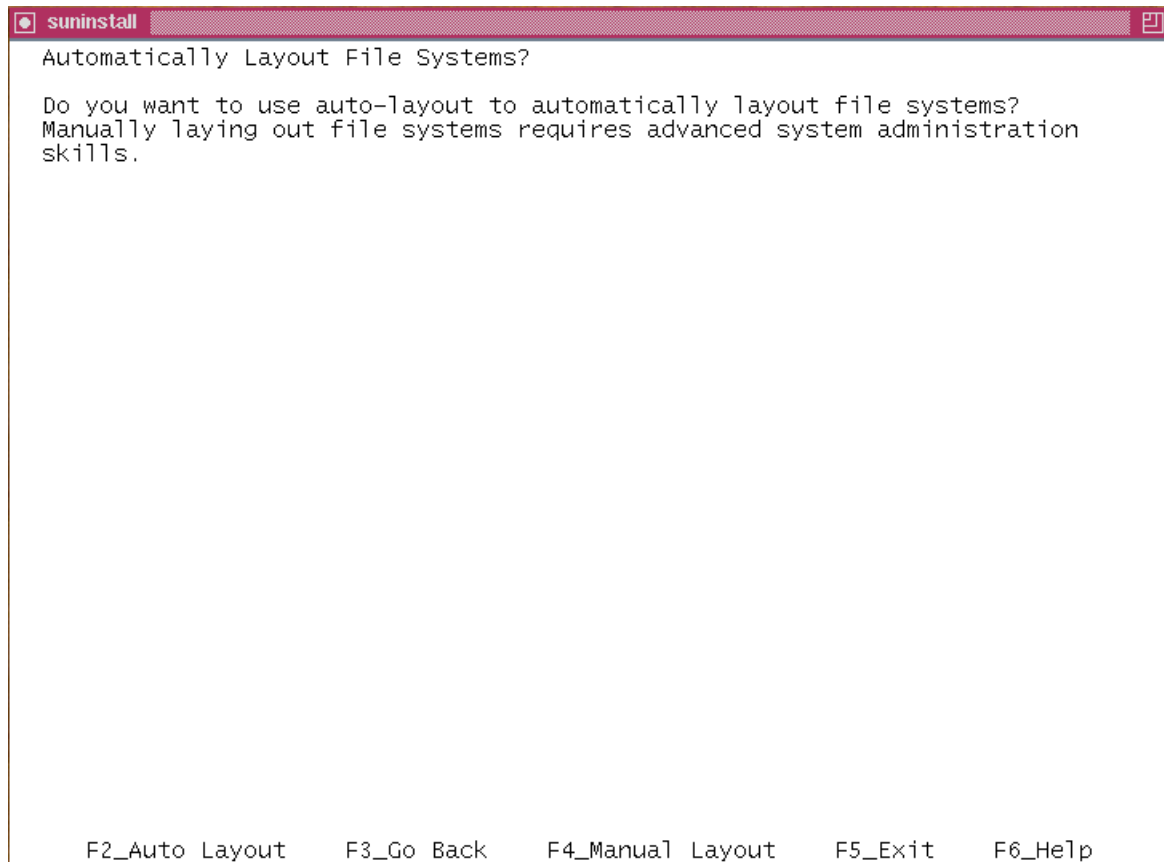


**Figure 5-36** Automatic Layout File System Window

The suninstall program can automatically lay out the file system arrangement, or you can select disks and slices manually.

35. Press F4 to select Manual Layout.

The Figure 5-37 shows the next window that appears.

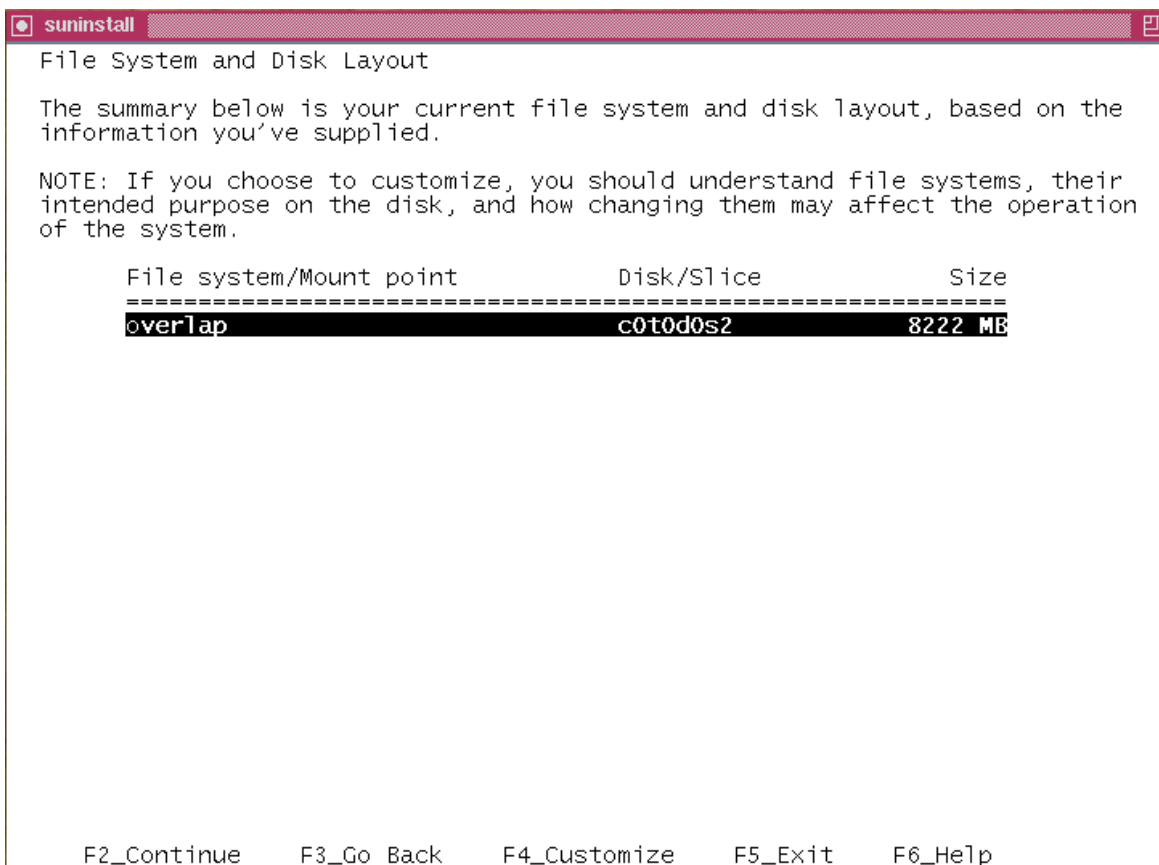


**Figure 5-37** File System and Disk Layout Window

This window summarizes the current file system and disk layout. The window generally reflects the overlap partition of the boot drive.

36. Press F4 to select Customize.



Figure 5-38 shows the next window that appears.

| Entry: | Recommended: | MB        | Minimum: | MB |
|--------|--------------|-----------|----------|----|
| Slice  | Mount Point  | Size (MB) |          |    |
| 0      |              | 0         |          |    |
| 1      |              | 0         |          |    |
| 2      | overlap      | 8222      |          |    |
| 3      |              | 0         |          |    |
| 4      |              | 0         |          |    |
| 5      |              | 0         |          |    |
| 6      |              | 0         |          |    |
| 7      |              | 0         |          |    |

Capacity: 8222 MB  
Allocated: 0 MB  
Free: 8222 MB

F2\_OK    F4\_Options    F5\_Cancel    F6\_Help

**Figure 5-38** Customize Disk Window

The Customize Disk window is a tool you use to reconfigure disk partitions for each disk selected. There are numerous ways to partition slices and to name file systems. Your instructor should inform you of the number of partitions and their sizes for this demonstration.

37. Select the disk slice you want to change. Enter the mount point for the file system that will reside on the slice and the size you want to apply to the slice. Press Return.

The Size (MB) column reflects your changes. The Allocated and Free Space variables change as you configure each slice of the disk. Recommendations and minimum size requirements are displayed at the upper right.

38. When you have finished reconfiguring the disk, press F4.

Figure 5-39 shows the next window that appears.

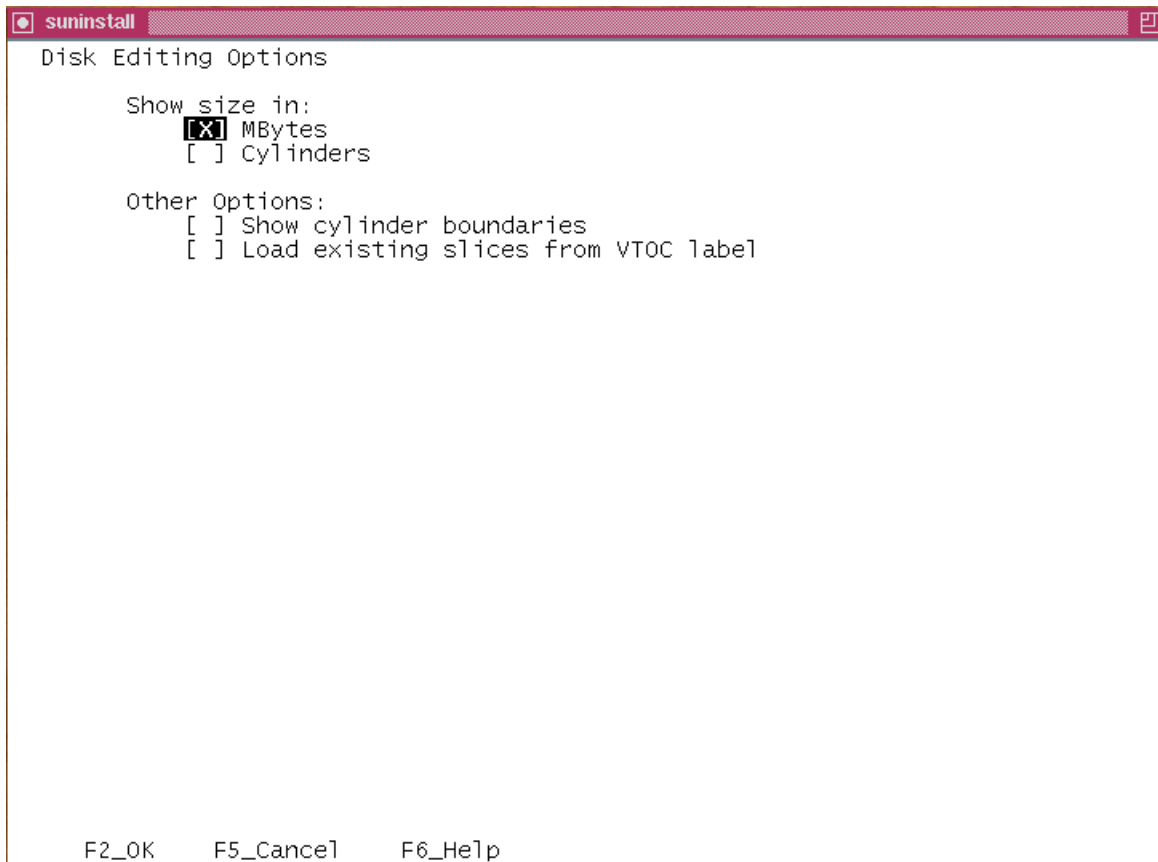


**Figure 5-39** Disk Editing Options Window

The Disk Editing Options window enables you to choose how disks are displayed and computed.

39. Make your selections. To continue, press F2.

Figure 5-40 shows the next window that appears.

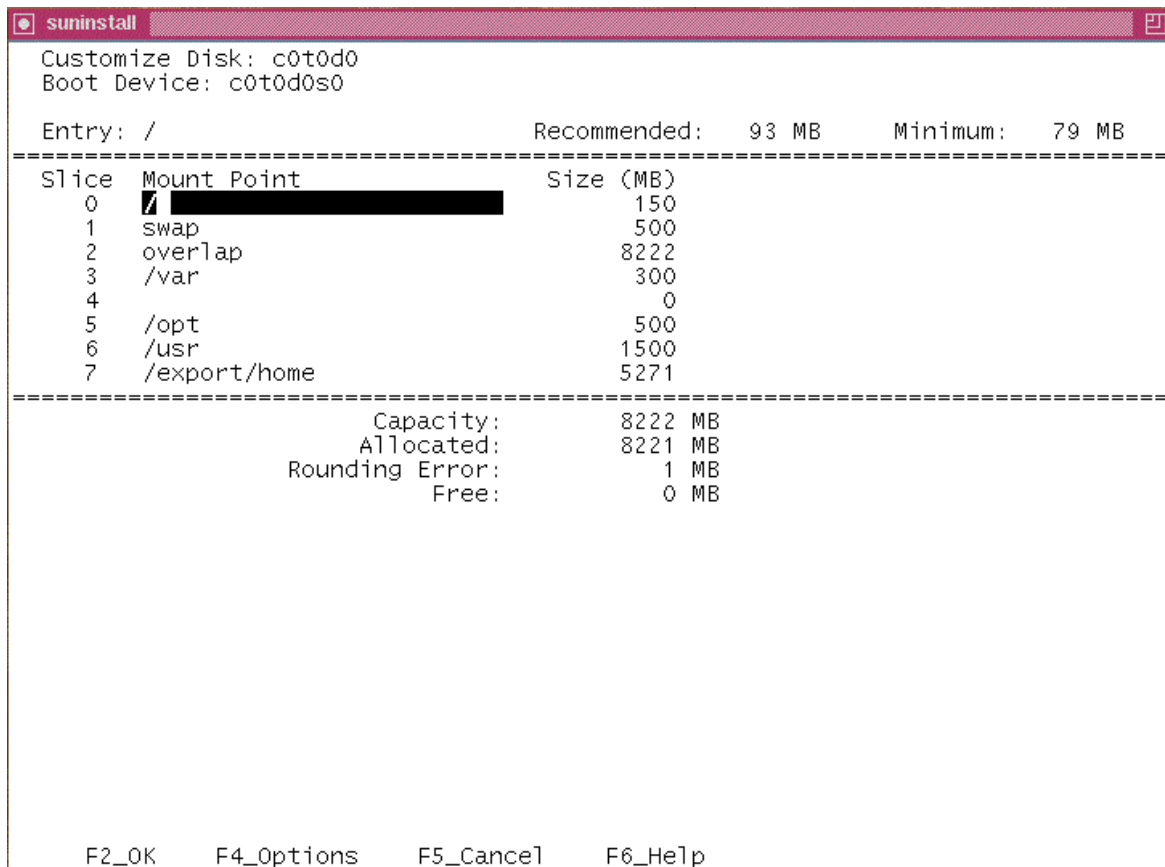


**Figure 5-40** Customize Disk Finished Window

The Customize Disk Finished window enables you to review and modify your changes.

40. To continue, press F2.

Figure 5-41 shows the next window that appears

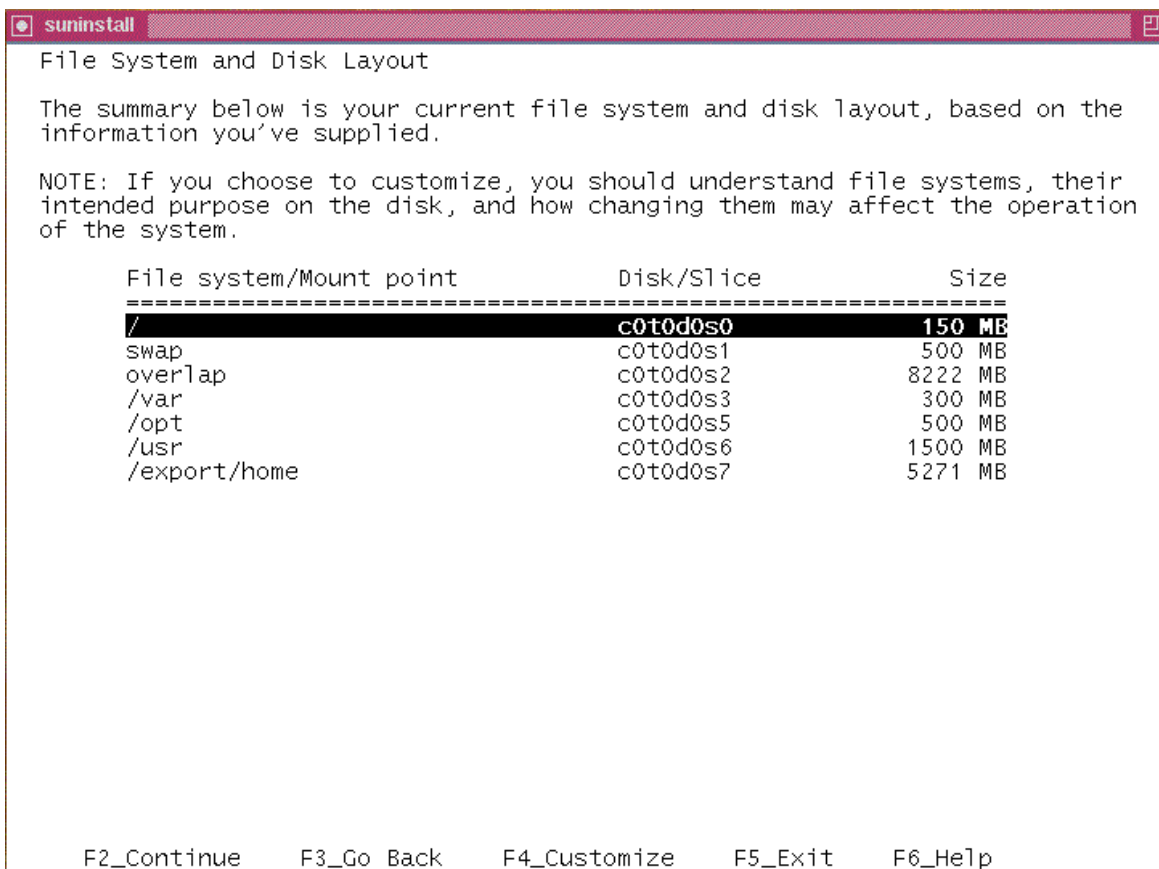


**Figure 5-41** File System and Disk Layout Window – Summary

The File System and Disk Layout Summary window is your final confirmation of what the disk layout looks like.

41. To continue, press F2.

Figure 5-42 shows the next window that appears.

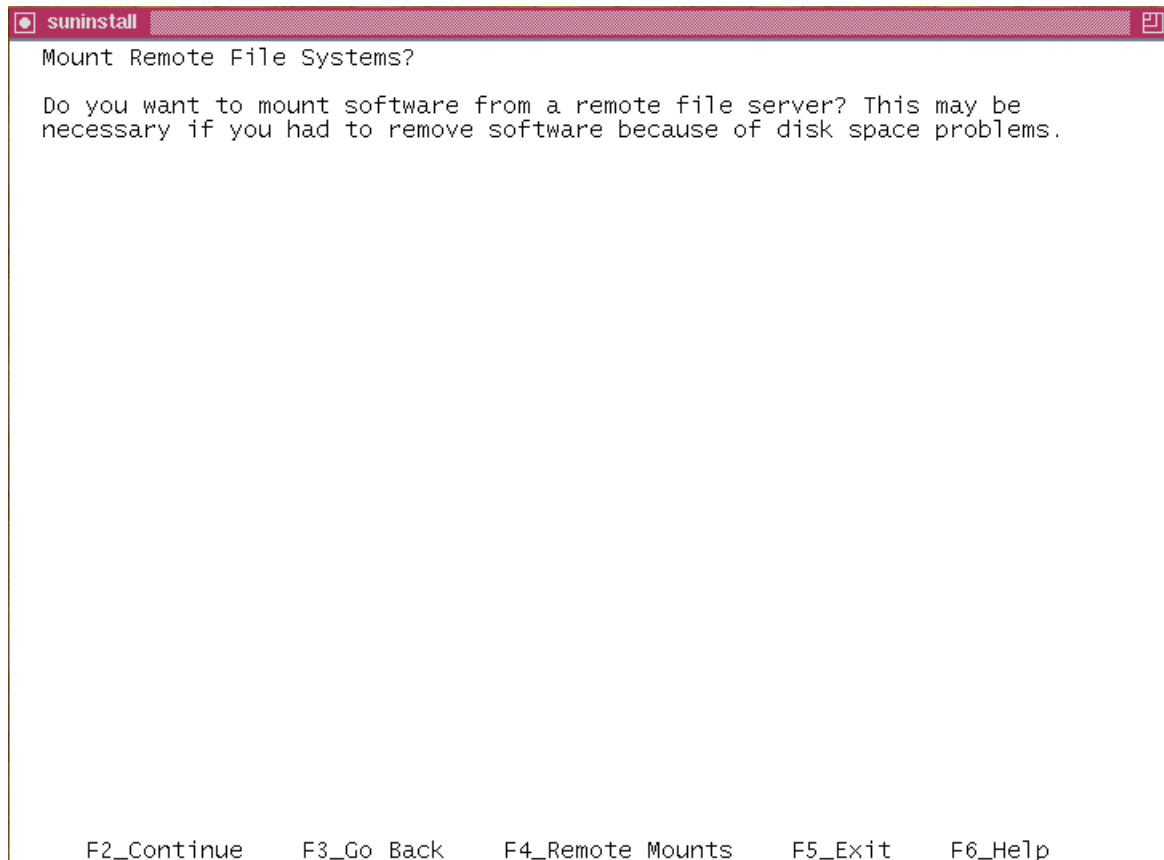


**Figure 5-42** Mount Remote File Systems Window

42. Press F4 to open a window that prompts you to enter a server name, an IP address, and a mount point to a location where you have stored data. To continue, press F2.

Figure 5-43 shows the next window that appears.

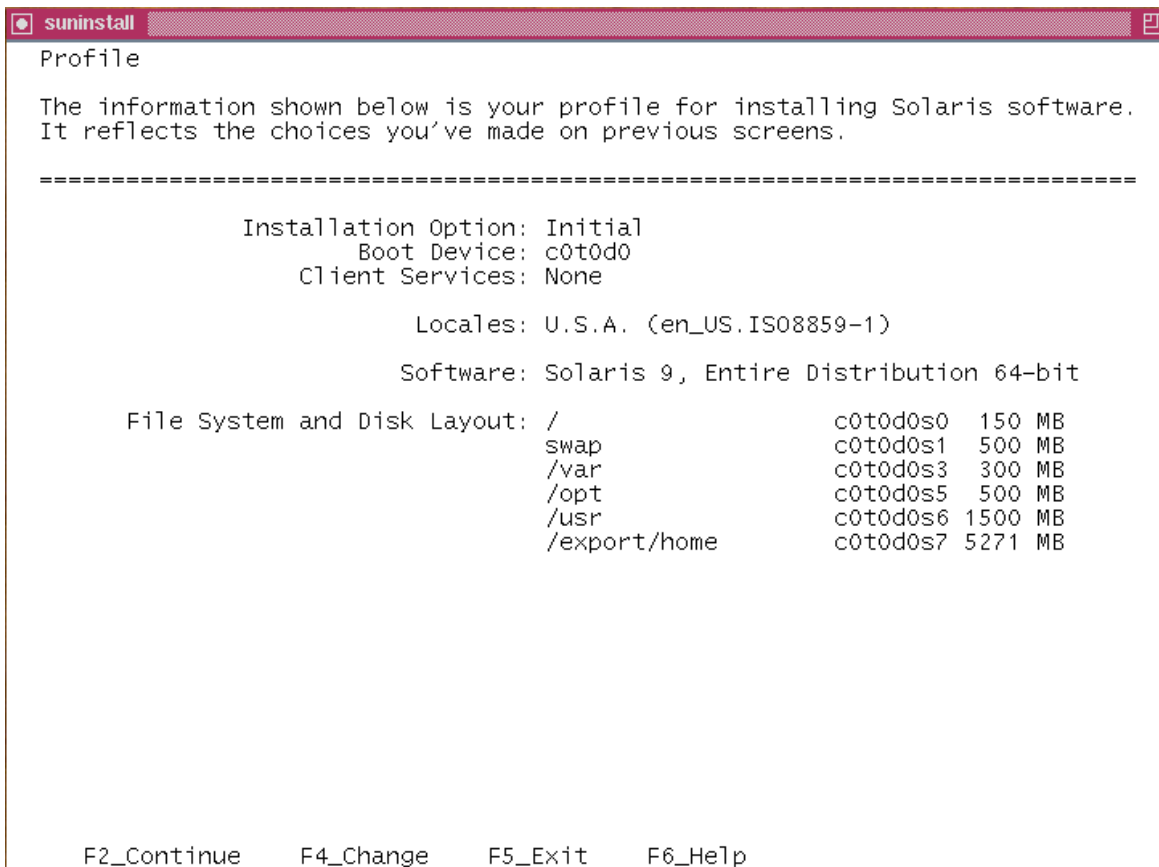


**Figure 5-43** Profile Window

The Profile window displays the installation choices you made in previous windows.

This is the last window that enables you to change the options you have selected.

43. When you are satisfied with your selections, press F2.

Figure 5-44 shows the next window that appears.

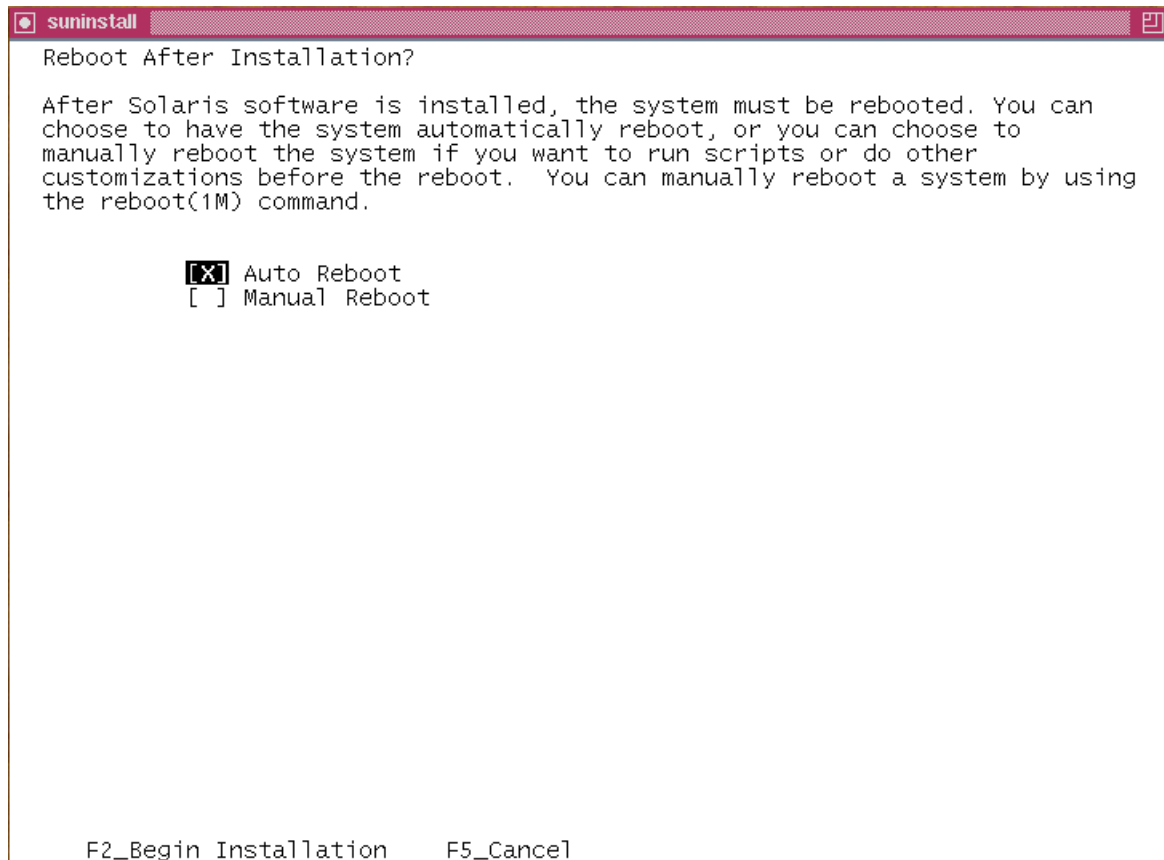


**Figure 5-44** Reboot After Installation Window

The Reboot After Installation window enables you to choose between an auto or a manual reboot.

44. After making your selection, press F2 to begin the installation process.

The system begins the installation by writing a Volume Table of Contents (VTOC) on the disk or disks selected and creating file systems.

Preparing system for Solaris install

Configuring disk (c0t0d0)

- Creating Solaris disk label (VTOC)

Creating and checking ufs file systems

- Creating / (c0t0d0s0)

Beginning Solaris Installation

Figure 5-45 shows the next window that appears.

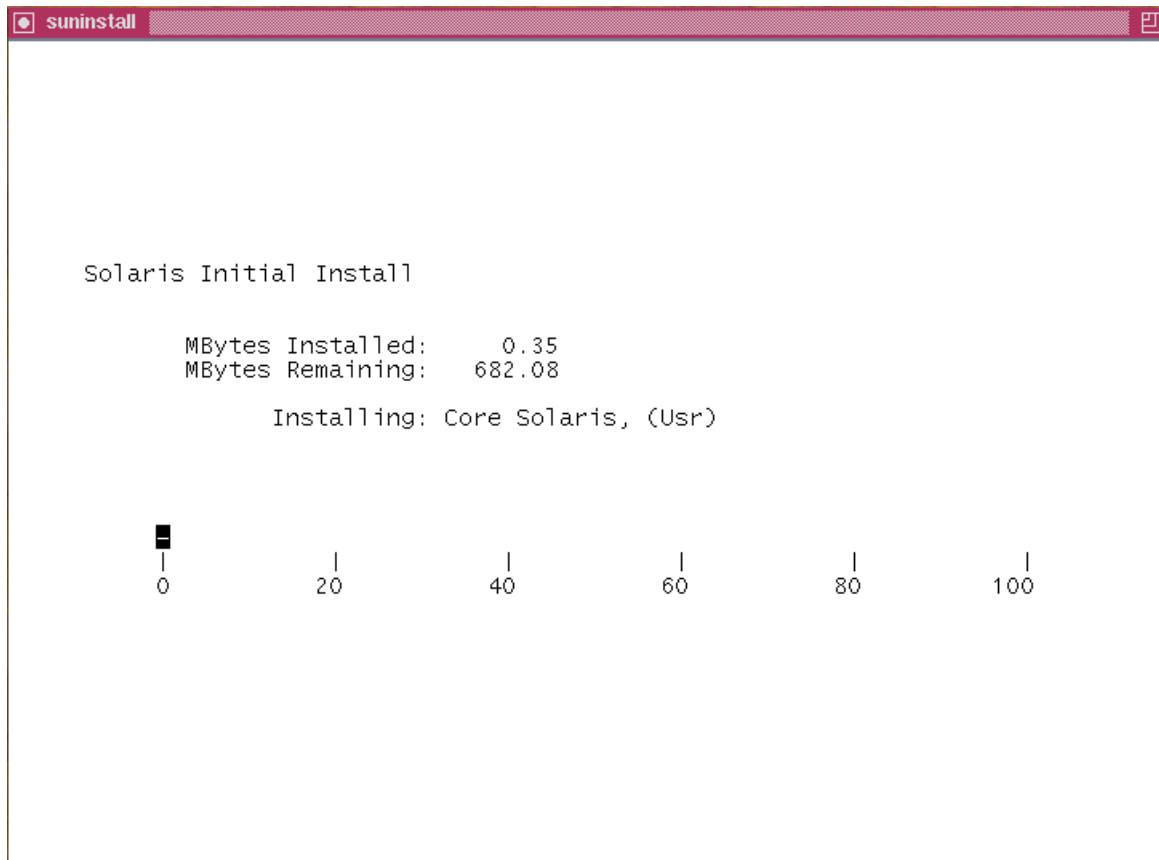


**Figure 5-45** Solaris Initial Install Window

The Solaris Initial Install window displays the software cluster currently being installed. The window indicates how many megabytes of the cluster have been installed and how many megabytes of the cluster remain to be installed.

At the end of the installation of the Solaris 9 CD-ROM 1 of 2, the system reboots and displays guidelines for creating a root password:

On this screen you can create a root password.

A root password can contain any number of characters, but only the first eight characters in the password are significant. (For example, if you enter 'a1b2c3d4e5f6' as your root password, then 'a1b2c3d4' could also be used to gain root access.)

You will be prompted to type the root password twice; for security, the password will not be displayed on the screen as you type it.



> If you do not want a root password, press RETURN twice.

Root password:

Press Return to continue.

45. Use cangetin as the root password on the newly installed system.

If your hardware supports it, the system displays a message that asks you if you want to select the automatic power-saving feature.

System identification is completed.

```
*****
```

```
This system is configured to conserve energy.
```

```
*****
```

```
After 30 minutes of idle time on this system, your system state
will automatically be saved to disk, and the system will power-off.
```

```
Later, when you want to use the system again, and you turn the power
back on, your system will be restored to its previous state,
including all the programs that you were running.
```

```
Do you want this automatic power-saving shutdown?
```

```
(If this system is used as a server, answer n) [y,n,?] n
```

46. Type n to disable automatic power saving.

The system responds with the following message:

Autoshutdown has been disabled.

```
Do you want the system to ask you about this again, when you next reboot?
(This gives you the chance to try it before deciding whether to keep it.)
[y,n,?] n
```

47. Type n to confirm permanent disabling of the automatic power-saving shutdown feature.

The system responds with the following message:

The system will not ask you again about automatic shutdown.

The "Using Power Management" AnswerBook describes more about how to change and set workstation energy-saving features.

During the next phase of the installation, the CDE starts, and the remainder of the windows are displayed.

Figure 5-46 shows the next window that appears.

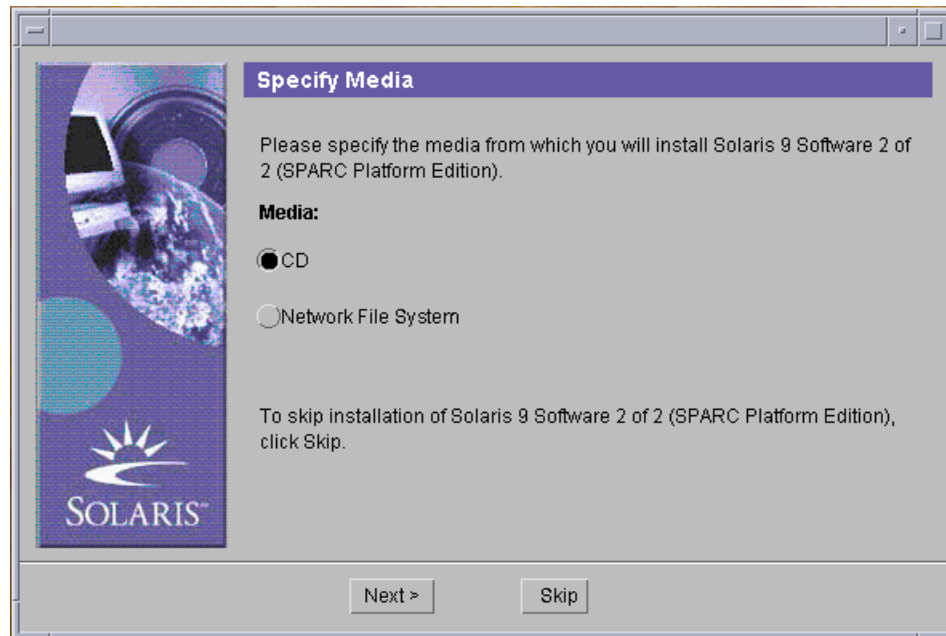


**Figure 5-46** Specify Media Window

48. Select the CD option. To continue, click Next.

Figure 5-47 shows the next window that appears.

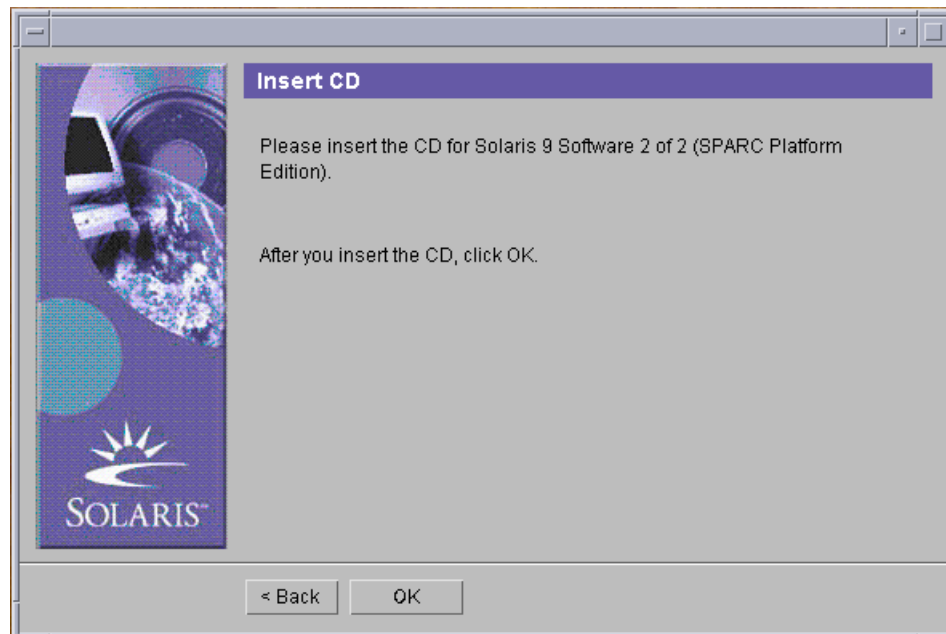


**Figure 5-47** Insert CD Window

49. Insert the Solaris 9 OE CD-ROM 2 of 2. To continue, click OK.

Figure 5-48 shows the next window that appears.

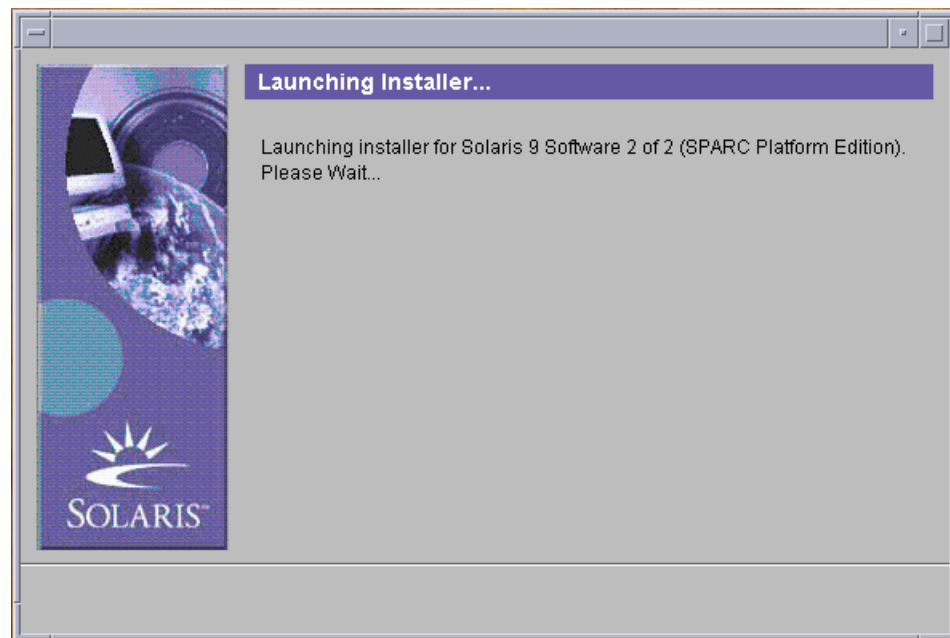


**Figure 5-48** Launching Installer Window

The Launching Installer window displays for a moment. Figure 5-49 shows the next window that appears.

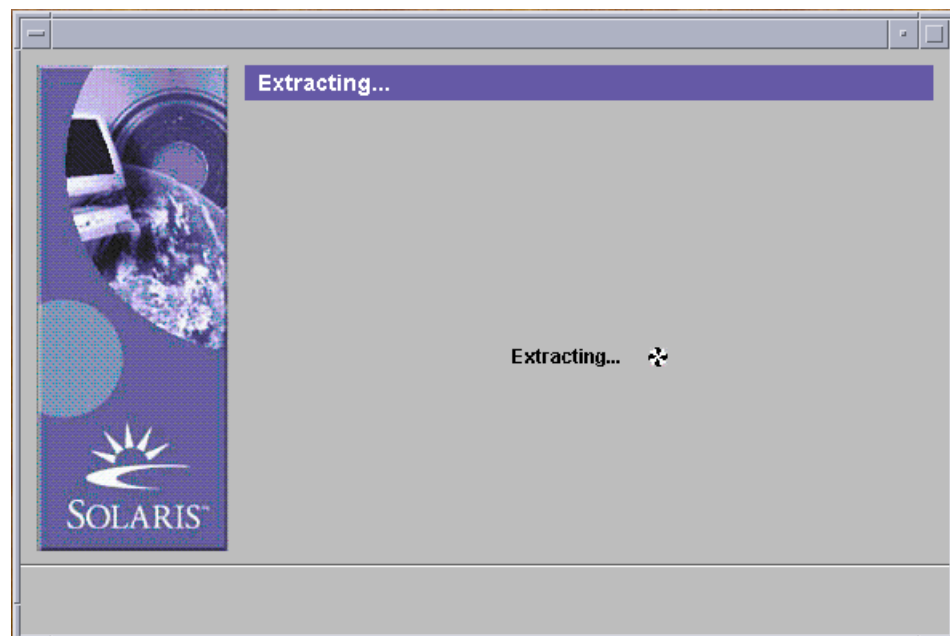


**Figure 5-49** Extracting Window

The Extracting window displays a message while the CD-ROM is read.

Figure 5-50 shows the next window that appears.

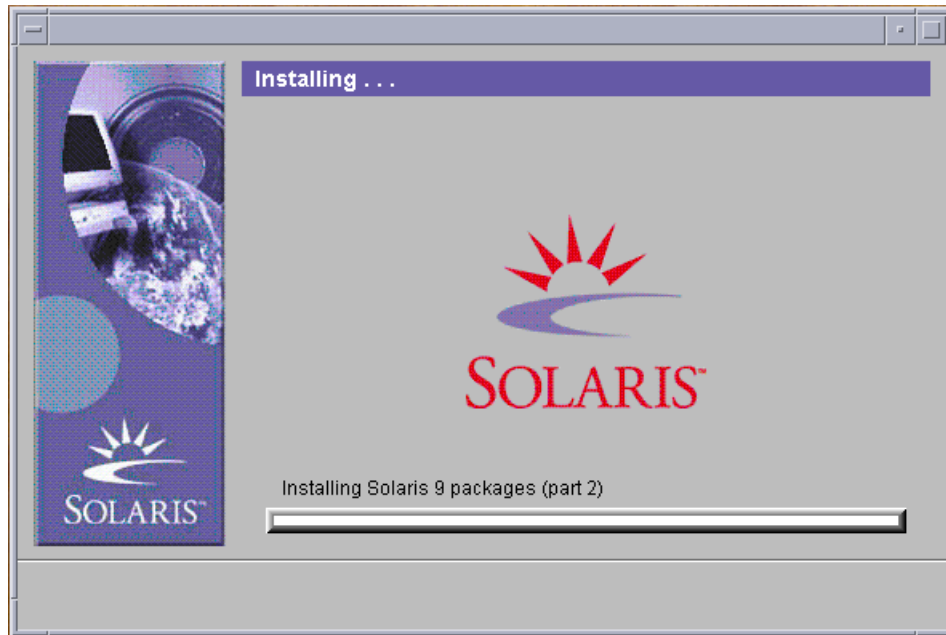


**Figure 5-50** Installing Window

While the system installs the packages from the second CD-ROM, the slide bar displays the progress of the installation.

Figure 5-51 shows the next window that appears.

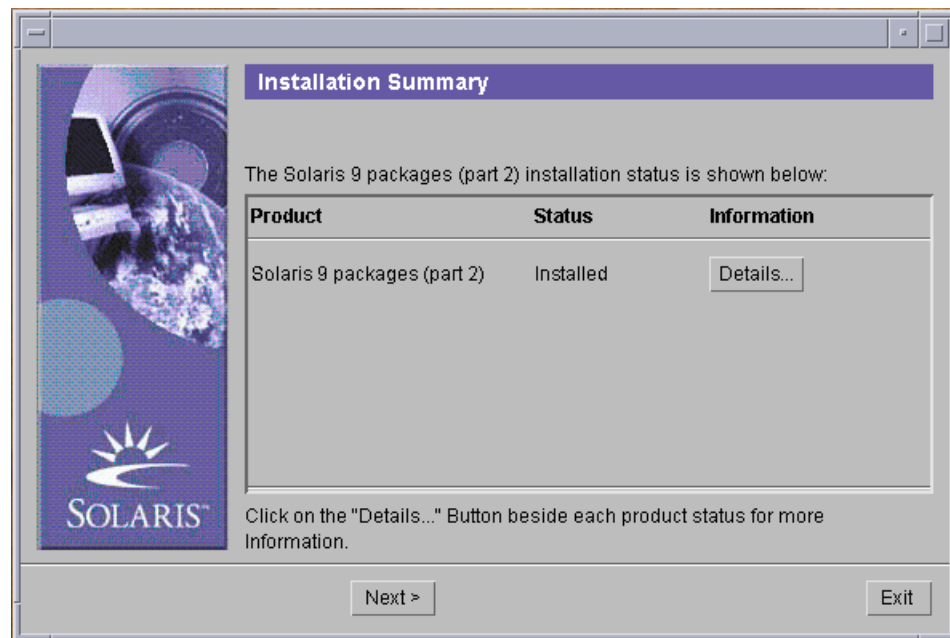


**Figure 5-51** Installation Summary Window

50. Click Details to display the log file of the installation. The log file contains information about the packages installed.
51. Click Next when you are finished reviewing the log file.

Figure 5-52 shows the next window that appears.

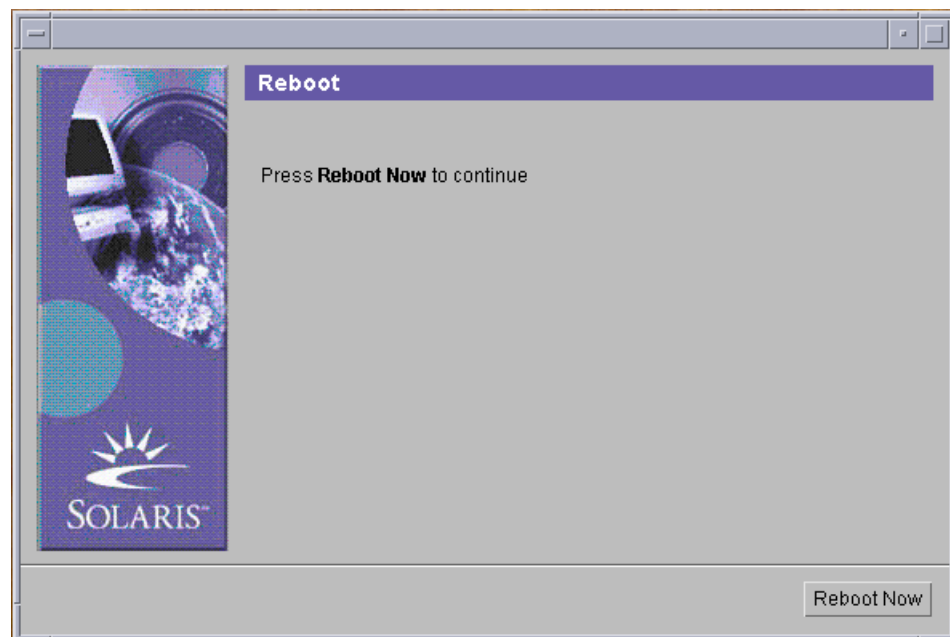


**Figure 5-52** Reboot Window

52. Click Reboot Now to reboot the system.
53. After the system completes the reboot process, log in and verify that the system is operational. You can review additional log file information after the system has rebooted by looking at the `/var/sadm/install_data/install_log` file.

You have now completed the installation demonstration.

# Performing Solaris 9 OE Package Administration

---

## Objectives

Upon completion of this module, you should be able to:

- Describe the fundamentals of package administration
- Administer packages using the command-line interface

The following course map shows how this module fits into the current instructional goal.

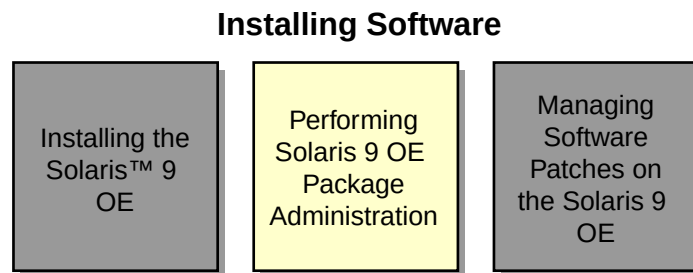


**Figure 6-1** Course Map

# Introducing the Fundamentals of Package Administration

Software package administration adds software to systems and removes software from systems. Sun and its third-party vendors deliver software products to users in software packages.

## Software Packages

The term package refers to the method of distributing software products and installing them in systems. In its simplest form, a package is a collection of files and directories.



---

**Note** – The Solaris OE software installation process installs all the required software packages automatically, based on the software group configuration choice.

---

Software packages contain:

- Files that describe the package and the amount of disk space required for installation
- Compressed software files to be installed on the system
- Optional scripts that run when the package is added or removed

## The /var/sadm/install/contents File

The /var/sadm/install/contents file is a complete record of all the software packages installed on the local system disk. It references every file and directory belonging to every software package and shows the configuration of each product installed. To list the contents of the /var/sadm/install/contents file, perform the command:

```
# more /var/sadm/install/contents
(output edited for brevity)
/bin=./usr/bin s none SUNWcsr
/dev d none 0755 root sys SUNWcsr SUNWcsd
/dev/allkmem=./devices/pseudo/mm@0:allkmem s none SUNWcsd
/dev/arp=./devices/pseudo/arp@0:arp s none SUNWcsd
/etc/ftpd/ftpusers e ftpusers 0644 root sys 185 15198 1008137961 SUNWftpr
/etc/passwd e passwd 0644 root sys 467 38912 1008137367 SUNWcsr
```



The `pkgadd` command updates the `/var/sadm/install/contents` file each time new packages are installed.

The `pkgrm` command uses the `/var/sadm/install/contents` file to determine where the files for a software package are located on the system. When a package is removed from the system, the `pkgrm` command updates the `/var/sadm/install/contents` file.

To determine if a particular file was installed on the system disk and to find the directory in which it is located, use the `grep` command to query the `/var/sadm/install/contents` file. For example, to verify that the `showrev` command is installed on the system disk, perform the command:

```
# grep showrev /var/sadm/install/contents  
/usr/bin/showrev f none 0755 root sys 29040 1417 993448469 SUNWadmc  
/usr/share/man/sman1m/showrev.1m f none 0444 root bin 6416 64169  
993108127 SUNWman
```

## Administering Packages From the Command Line

From the command line, you can add, remove, check the state of, and display information about packages. The command-line tools for viewing software, adding software, and removing software from a workstation after the Solaris OE software is installed on a system include:

|                      |                                          |
|----------------------|------------------------------------------|
| <code>pkgadd</code>  | Installs software packages to the system |
| <code>pkgrm</code>   | Removes a package from the system        |
| <code>pkginfo</code> | Displays software package information    |
| <code>pkgchk</code>  | Checks package installation state        |



---

**Note** – Students need to insert the Solaris 9 Software 1 of 2 CD-ROM to demonstrate the steps described in this module.

---

### Displaying Information About Installed Software Packages

Use the `pkginfo` command to display information about the software packages installed on the local system's disk. The `/var/sadm/pkg` directory maintains a record of all installed packages.

For example, to display information about software packages installed on the local system's disk, perform the command:

```
# pkginfo | more
<some output omitted>
application NSCPcom      Netscape Communicator
system      SUNWaccr      System Accounting, (Root)
system      SUNWaccu      System Accounting, (Usr)
system      SUNWadmap     System administration applications
system      SUNWadmc      System administration core libraries
system      SUNWaudd      Audio Drivers)
ALE         SUNWciu8      Simplified Chinese iconv modules for UTF-8
system      SUNWcsd       Core Solaris Devices
CTL         SUNWctplx     Portable layout services for CTL (64-bit)
system      SUNWdoc       Documentation Tools
application SUNWdej2p     Java Plug-in
```

The column on the left displays the package category, such as application, system, Complex Text Layout (CTL), or Alternate Language Environment (ALE). A CTL language is any language which stores text differently than it is displayed. An ALE is an alternate language, different from the basic Solaris OE languages.

The center column displays the software package name. If it begins with **SUNW**, it is a Sun Microsystems product. Otherwise, it represents a third-party package.

The column on the right displays a brief description of the software product.

## Displaying Information for All Packages

To display all the available information about the software packages, use the **pkginfo** command with the **-l** option.

For example, to view additional information about each software package installed on the local systems hard drive, perform the command:

```
# pkginfo -l | more
(output omitted)
```

### Displaying Information for a Specific Package

To display the information for a specific software package, specify its name on the command line.

For example, to view the information for the `SUNWman` software package, perform the command:

```
# pkginfo -l SUNWman
```

```
PKGINST:  SUNWman
NAME:      On-Line Manual Pages
CATEGORY:  system
ARCH:      sparc
VERSION:   42.0, REV=35
BASEDIR:   /usr
VENDOR:    Sun Microsystems, Inc.
DESC:      System Reference Manual Pages
PSTAMP:    tinkertoym21003318
INSTDATE:  Sep 27 2001 10:43
HOTLINE:   Please contact your local service provider
STATUS:    completely installed
FILES:     7033 installed pathnames
           3 shared pathnames
           84 directories
           81450 blocks used (approx)
```

The last line identifies the size of the package. The number of blocks used defines how much space is needed on the disk to install the package.

---

**Note** – A block is a 512-byte disk block.

---



To determine how many packages are currently installed on disk, perform the command:

```
# pkginfo | wc -l
657
```

### Displaying Information for Software Packages

To view information about packages that are located on Solaris 9 Software 1 of 2 CD-ROM, perform the command:

```
pkginfo -d /cdrom/cdrom0/s0/Solaris_9/Product |more
```

Software groups located on Solaris 9 Software 1 of 2 CD-ROM are Core and End User.

To view information about packages that are located on Solaris 9 Software 2 of 2 CD-ROM, perform the command:

```
pkginfo -d /cdrom/cdrom0/Solaris_9/Product |more
```

The software groups located on Solaris 9 Software 2 of 2 CD-ROM are the Developer, Entire Distribution, and Entire Distribution Plus OEM Support software groups.

## Adding a Software Package

When you add a software package, the `pkgadd` command copies the files from the installation media to the local system's disk and executes scripts to uncompress files. By default, the `pkgadd` command requires confirmation during the package add process.

For example, to transfer the `SUNWns6m` software package from a CD-ROM and install it on the system, perform the commands:

```
# cd /cdrom/cdrom0/Solaris_9/ExtraValue/EarlyAccess/Netscape_6/Packages
# pkgadd -d . SUNWns6m
Processing package instance <SUNWns6m> from
<cdrom/sol_9_sparc_2/Solaris_9/ExtraValue/EarlyAccess/Netscape_6/Packages
>
```

```
Netscape 6 for Solaris - Messenger
(sparc) 6.2,REV=20.2002.03.06
Copyright 2002 Sun Microsystems, Inc. All rights reserved.
Use is subject to license terms.
Using </usr> as the package base directory.
## Processing package information.
## Processing system information.
   2 package pathnames are already properly installed.
## Verifying package dependencies.
## Verifying disk space requirements.
## Checking for conflicts with packages already installed.
## Checking for setuid/setgid programs.
```

This package contains scripts which will be executed with super-user permission during the process of installing this package.

Do you want to continue with the installation of <SUNWns6m> [y,n,?] **y**

Installing Netscape 6 for Solaris - Messenger as <SUNWns6m>

## Installing part 1 of 1.  
15038 blocks

Installation of <SUNWns6m> was successful.



---

**Note** – Certain unbundled and third-party packages are no longer entirely compatible with the latest version of the `pkgadd` command. These packages require system administrator interaction throughout the installation and not just at the very beginning. To install these older packages set the following environment variable:  
`NONABI_SCRIPTS=TRUE`.

---

## Checking a Package Installation

The `pkgchk` command checks to determine if a package has been completely installed on the system. The `pkgchk` command also checks the path name, the file size and checksum, and the file attributes of a package. If the `pkgchk` command does not display a message, it indicates the package was installed successfully and that no changes have been made to any files or directories in the package.

The following example checks the contents and attributes of the `SUNWcarx` software package currently installed on the system.

```
# pkgchk SUNWcarx  
#
```

To list the files contained in a software package, use the `-v` option.

For example, to list the files in the `SUNWcarx` software package, perform the command:

```
# pkgchk -v SUNWcarx  
(some output omitted)  
/kernel  
/kernel/drv  
/kernel/drv/sparcv9  
/kernel/drv/sparcv9/arp  
/var
```

```
/var/ld  
/var/ld/64  
/var/ld/sparcv9
```

To determine if the contents and attributes of a file have changed since it was installed with its software package, use the `-p` option.

For example, to check the `/etc/shadow` file, perform the command:

```
# pkgchk -p /etc/shadow  
ERROR: /etc/shadow  
  modtime <06/19/01 03:55:23 PM> expected <11/07/01 02:31:51 PM> actual  
  file size <233> expected <247> actual  
  file cksum <15950> expected <17155> actual
```

The differences in `modtime`, `file size`, and `checksum` indicate that the original `/etc/shadow` file has changed in size since the initial Solaris OE software installation.

The `-l` option with the `pkgchk` command lists information about selected files that make up a package.

For example, to list information about the `/usr/bin/showrev` file, perform the command:

```
# pkgchk -l -p /usr/bin/showrev  
Pathname: /usr/bin/showrev  
Type: regular file  
Expected mode: 0755  
Expected owner: root  
Expected group: sys  
Expected file size (bytes): 29040  
Expected sum(1) of contents: 1417  
Expected last modification: Jun 24 11:54:29 PM 2001  
Referenced by the following packages:  
    SUNWadmc  
Current status: installed
```

The full path must be typed for the `pkgchk` command to return information about the file.

For example, the `pkgchk` command does not return any information if the `/usr/bin/` path is removed from the previous example.

```
# pkgchk -l -p showrev  
#
```

## Removing a Software Package

The `pkgrm` command removes a software package from the system and deletes all of the files associated with that package, unless other packages share those files.

By default, the `pkgrm` command requires confirmation to continue removing a package and issues a message to warn about possible package dependencies. If package dependencies do exist, the command again requires confirmation to continue with the package removal process.

The following command removes the `SUNWapchr` software package from the system.

```
# pkgrm SUNWapchr
```

```
The following package is currently installed:
```

```
SUNWapchr      Apache Web Server (root)
                (sparc) 11.9.0, REV=2002.01.18.00.45
```

```
Do you want to remove this package? [y,n,?,q] y
```

```
## Removing installed package instance <SUNWapchr>
```

```
## Verifying package dependencies.
```

```
WARNING:
```

```
    The <SUNWapchu> package depends on the package
    currently being removed.
```

```
WARNING:
```

```
    The <SUNWapchd> package depends on the package
    currently being removed.
```

```
Dependency checking failed.
```

```
Do you want to continue with the removal of this package [y,n,?,q] y
```

```
## Processing package information.
```

```
## Removing pathnames in class <initd>
```

```
/etc/rcS.d/K16apache
/etc/rc3.d/S50apache
/etc/rc2.d/K16apache
/etc/rc1.d/K16apache
/etc/rc0.d/K16apache
/etc/init.d/apache
```

```
(output omitted for brevity)
```

```
## Removing pathnames in class <preserve>
```



```
/var <shared pathname not removed>
/etc/rcS.d <shared pathname not removed>
/etc/rc3.d <shared pathname not removed>
/etc/rc2.d <shared pathname not removed>
/etc/rc1.d <shared pathname not removed>
/etc/rc0.d <shared pathname not removed>
/etc/init.d <shared pathname not removed>
/etc/apache/tomcat/server.xml-example
/etc/apache/tomcat
/etc/apache/httpd.conf-example
/etc/apache/README.Solaris
/etc/apache
/etc <shared pathname not removed>
## Updating system information.
```

Removal of <SUNWapchr> was successful.



---

**Note** – A file shared by two or more packages displays the message *filename* <shared pathname not removed>. The message is removed only when the file is no longer shared.

---

## Adding Packages by Using a Spool Directory

For convenience, copy frequently installed software packages from the Solaris 9 Software CD-ROM to a spool directory on the system.

The default installation directory for packages that have been spooled, but not installed, is `/var/spool/pkg`. The `pkgadd` command, by default, looks in the `/var/spool/pkg` directory for any packages specified on the command line.

Copying packages from the CD-ROM into a spool directory is not the same as installing the packages on disk.

To copy a package into the `/var/spool/pkg` directory, perform the command:

```
# pkgadd -d /cdrom/cdrom0/s0/Solaris_9/Product -s spool SUNWensqr.u
Transferring <SUNWensqr.u> package instance
```

The `-s` option with the keyword `spool` copies the package into the `/var/spool/pkg` directory by default.

To verify that the package exists in the `spool` directory, perform the command:

```
# ls -al /var/spool/pkg
total 6
drwxrwxrwt  3 root      bin           512 Nov  7 13:53 .
drwxr-xr-x 10 root      bin           512 Oct 25 09:01 ..
drwxr-xr-x  5 root      other          512 Nov  7 13:53 SUNWensqr.u
```

To remove software packages from a spool directory, use the `pkgrm` command with the `-s` option.

```
# pkgrm -s spool SUNWensqr.u
The following package is currently spooled:
SUNWensqr.u  Ensoniq ES1370/1371/1373 Audio Device Driver (Root), (32-bit)
              (sparc.sun4u) 6.1, REV=2001.05.04.09.44
```

Do you want to remove this package? **y**

Removing spooled package instance <SUNWensqr.u>

If alternative spooling directories exist, specify which directory to use by adding a directory path to the `-s` option.

For example, to select the `/export/pkg` directory, perform the commands:

```
# pkgadd -d /cdrom/cdrom0/s0/Solaris_9/Product -s /export/pkg SUNWensqr.u

# pkgrm -s /export/pkg SUNWensqr.u
```

## Reviewing Package Administration

This section details the package administration tasks.

Table 6-1 summarizes the commands used for package administration.

**Table 6-1** Package Administration Commands

| Command Name | Description                                                               |
|--------------|---------------------------------------------------------------------------|
| pkginfo      | Lists packages installed on the system or available on distribution media |
| pkgadd       | Installs packages                                                         |
| pkgrm        | Removes packages                                                          |
| pkgchk       | Verifies the attributes of the path names that belong to packages         |

Table 6-2 summarizes the files and directories used in package administration.

**Table 6-2** Package Administration Files and Directories

| File or Directory                    | Description                                                           |
|--------------------------------------|-----------------------------------------------------------------------|
| /var/sadm/install/contents           | A software package map of the entire system                           |
| /opt/pkgname                         | The preferred location for the installation of unbundled packages     |
| /opt/pkgname/bin or /opt/bin         | The preferred location for the executable files of unbundled packages |
| /var/opt/pkgname or /etc/opt/pkgname | The preferred location for log files of unbundled packages            |

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Manipulating Software Packages (Level 1)

In this exercise, you use package-related commands to remove, install, and spool packages.

### Preparation

Locate the Solaris 9 Software CD-ROMs. Refer to the lecture notes as necessary to perform the tasks listed.

### Tasks

Complete the following tasks:

- Find the names of packages installed on your system that relate to manuals. List and record the status of, the install date of, the number of files used by, and the number of blocks used by the `SUNWman` package. Obtain the same information from the spooled `SUNWman` package on the correct Solaris 9 OE Software CD-ROM. Remove and reinstall the `SUNWman` package.  
(Steps 1–6 in the Level 2 lab)
- Remove the `SUNWdoc` package from the system. Attempt to access the online man pages. Spool the `SUNWdoc` package from the correct Solaris 9 OE software CD-ROM into the default spool area. Verify the presence of this package in the spool area. Add the `SUNWdoc` package to the system. Remove the `SUNWdoc` package from the spool area.  
(Steps 7–15 in the Level 2 lab)

## Exercise: Manipulating Software Packages (Level 2)

In this exercise, you use package-related commands to remove, install, and spool packages.

### Preparation

Locate the Solaris 9 Software CD-ROMs. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Find the names of packages installed on your system that relate to manuals. List and record the status of, the install date of, the number of files used by, and the number of blocks used by the SUNWman package. Obtain the same information from the spooled SUNWman package on the correct Solaris 9 OE Software CD-ROM. Remove and reinstall the SUNWman package.
- Remove the SUNWdoc package from the system. Attempt to access the online man pages. Spool the SUNWdoc package from the correct Solaris 9 OE software CD-ROM into the default spool area. Verify the presence of this package in the spool area. Add the SUNWdoc package to the system. Remove the SUNWdoc package from the spool area.

### Tasks

Complete the following steps:

1. Insert the Solaris 9 Software 2 of 2 CD-ROM SPARC Platform Edition into the drive.
2. Use the `pkginfo` command to search for packages currently on your system that are related to manuals.  
Which packages were listed?
3. Display a long-format listing of the information for the SUNWman package installed on your system. What is listed for the status of, the install date of, the number of files used by, and the number of blocks used by this package?

4. Display a long-format listing of the information for the SUNWman package on the Solaris 9 OE Software 2 of 2 CD-ROM. Obtain the same information as in the previous step.



---

**Note** – Steps 5 and 6 take several minutes to perform.

---

5. Remove the SUNWman package from your system, and verify that it has been removed by trying to access the manual pages.
6. Reinstall the SUNWman package from the Solaris 9 OE Software 2 of 2 CD-ROM. Respond y to questions asked by the pkgadd command. Verify that the manual pages work.
7. Remove the SUNWdoc package from your system.
8. Are there any package dependencies related to removing this package?
9. Answer yes to questions from the pkgrm command.
10. Eject the Solaris 9 Software 2 of 2 CD-ROM, and insert the Solaris 9 Software 1 of 2 CD-ROM. Use the pkgadd command to spool the SUNWdoc package into the default spool area.
11. Use the pkginfo command with the appropriate options to verify the presence of the SUNWdoc package in the default spool area.
12. Install the SUNWdoc package. Observe the messages, and verify that the package is installed from the /var/spool/pkg directory.
13. Remove the SUNWdoc package from the default spool area.
14. Verify that the SUNWdoc package no longer exists in the spool area and that it is installed on your system.
15. Eject the Solaris 9 Software 1 of 2 CD-ROM.

## Exercise: Manipulating Software Packages (Level 3)

In this exercise, you use package-related commands to remove, install, and spool packages.

### Preparation

Locate the Solaris 9 Software CD-ROMs. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Find the names of packages installed on your system that relate to manuals. List and record the status of, the install date of, the number of files used by, and the number of blocks used by the SUNWman package. Obtain the same information from the spooled SUNWman package on the correct Solaris 9 OE Software CD-ROM. Remove and reinstall the SUNWman package.
- Remove the SUNWdoc package from the system. Attempt to access the online man pages. Spool the SUNWdoc package from the correct Solaris 9 OE software CD-ROM into the default spool area. Verify the presence of this package in the spool area. Add the SUNWdoc package to the system. Remove the SUNWdoc package from the spool area.

### Tasks and Solutions

Complete the following steps:

1. Insert the Solaris 9 Software 2 of 2 CD-ROM SPARC Platform Edition into the drive.
2. Use the `pkginfo` command to search for packages currently on your system that are related to manuals.

```
# pkginfo | grep anual
```

Which packages were listed?

SUNWman, SUNWmfman, SUNWopl5m, SUNWpl5m, and SUNWtltkm



*These packages contain the online manual pages, CDE motif manuals, Perl Reference manual pages, Perl 5 online manual pages, and ToolTalk™ software manual pages, respectively.*

3. Display a long-format listing of the information for the SUNWman package installed on your system.

```
# pkginfo -l SUNWman
```

What is listed for the status of, the install date of, the number of files used by, and the number of blocks used by this package?

```
Status:           Completely installed
Install date:      Should match the date and time when you installed
                  Solaris OE on your system
Number of files:   xxxx installed pathnames, x shared directories,
                  xx directories
Number of
blocks:           xxxxx
```

4. Display a long-format listing of the information for the SUNWman package on the Solaris 9 OE Software 2 of 2 CD-ROM. Obtain the same information as in the previous step.

```
# pkginfo -d /cdrom/cdrom0/Solaris_9/Product -l SUNWman
```

```
Status:           Spooled
Install date:      No install date indicated
Number of files:   xxxx spooled pathnames, xx directories, x package
                  information files
Number of
blocks:           xxxxx
```

5. Remove the SUNWman package from your system, and verify that it has been removed by trying to access the manual pages.

```
# pkgrm SUNWman
```

```
# pkginfo SUNWman
```

```
ERROR: information for "SUNWman" was not found
```

```
# man ls
```

```
No manual entry for ls.
```

6. Reinstall the SUNWman package from the Solaris 9 OE Software 2 of 2 CD-ROM. Respond y to questions asked by the pkgadd command. Verify that the manual pages work.

```
# pkgadd -d /cdrom/cdrom0/Solaris_9/Product SUNWman
# man ls
```

*The manual page for ls appears.*

7. Remove the SUNWdoc package from your system.

```
# pkgrm SUNWdoc
```

8. Are there any package dependencies related to removing this package?

*Yes there are. They are six other packages related to the SUNWdoc package.*

9. Answer yes to questions from the pkgrm command.
10. Eject the Solaris 9 Software 2 of 2 CD-ROM, and insert the Solaris 9 Software 1 of 2 CD-ROM. Use the pkgadd command to spool the SUNWdoc package into the default spool area.

```
# pkgadd -d /cdrom/cdrom0/s0/Solaris_9/Product -s spool SUNWdoc
```

11. Use the pkginfo command with the appropriate options to verify the presence of the SUNWdoc package in the default spool area.

```
# pkginfo -d spool SUNWdoc
```

```
system SUNWdoc
```

```
# pkginfo -d /var/spool/pkg -l SUNWdoc
```

```
PKGINST: SUNWdoc
```

```
(further output omitted)
```

12. Install the SUNWdoc package. Observe the messages, and verify that the package is installed from the /var/spool/pkg directory.

```
# pkgadd SUNWdoc
```

```
Processing package instance <SUNWdoc> from
</var/spool/pkg>
(further output omitted)
```

13. Remove the SUNWdoc package from the default spool area.

```
# pkgrm -s spool SUNWdoc
```

14. Verify that the SUNWdoc package no longer exists in the spool area and that it is installed on your system.

```
# pkginfo -d spool SUNWdoc
```

```
ERROR: information for "SUNWdoc" was not found
```

```
# pkginfo -l SUNWdoc
```

```
PKGINST: SUNWdoc
```

```
(further output omitted)
```

15. Eject the Solaris 9 OE Software 1 of 2 CD-ROM.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications



# Managing Software Patches on the Solaris 9 OE

---

## Objectives

Upon completion of this module, you should be able to:

- Describe the fundamentals of patch administration
- Install and remove patches

The following course map shows how this module fits into the current instructional goal.

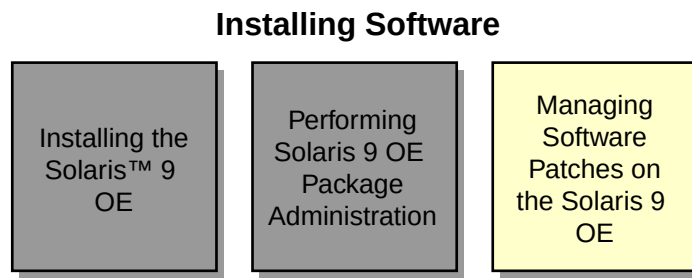


**Figure 7-1** Course Map

## Preparing for Patch Administration

The administration of patches involves installing or removing Solaris OE patches from a running Solaris OE.

### Introducing Solaris OE Patches

A patch contains a collection of files and directories. This collection replaces existing files and directories that prevent proper execution of the software. Some patches contain product enhancements. The Solaris OE patch types include:

- Standard patches – Patches that fix specific problems with the Solaris OE and other Sun hardware and software products.
- Recommended patches – Solaris OE patches that fix problems that might occur on a large percentage of systems.
- Y2K patches – Patches that ensure compliance of Sun products with the year 2000.
- Patch clusters – A group of standard, recommended, security, or Y2K patches that have been bundled into a single archive for easy downloading and installation.
- Maintenance update – A set of patches that have been tested together and packaged for one-step installation. Available to service contract customers, maintenance updates are designed to update the Solaris OE to a known, tested patch-level. The installation procedure takes much less time than installing the same patches individually.

A patch is distributed as a directory that is identified by a unique number. The number assigned to a patch includes the patch base code first, a hyphen, and a number that represents the patch revision number. For example, a patch directory named `105050-01`, indicates that `105050` is the base code and `01` is the revision number.

The Solaris 9 OE patches are in `zip` format, for example, `105050-01.zip`

## Accessing Patch Documents

Prior to installing patches on your system, you should review the patch documents available through the World Wide Web, patch update CD-ROMs, or anonymous FTP.

To access patch documents through the World Wide Web, go to:

<http://sunsolve.sun.com>

Click Worldwide for a list of alternative sites by geographic areas.

Anonymous FTP access to patch documents is available from [sunsolve.sun.com](http://sunsolve.sun.com). Use your complete email address as a password. After the connection is complete, the publicly available patch documents are located in the `/pub/patches` directory.

Table 7-1 shows important summary documents that list all recommended patches for the Solaris OE.

**Table 7-1** Patch Documents and Files

| Patch Document                    | Contents                                                                                                                                                                                                   |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>Solaris9.PatchReport</code> | A summary of all patches for the Solaris 9 OE release                                                                                                                                                      |
| <code>9_Recommended.README</code> | Instructions for how to install the recommended patch cluster for the Solaris 9 OE, as well as any important notes or warnings, special installation instructions, and usually a note to reboot the system |

When you are reviewing patch documentation, start with the Patch Report document first. This report is divided into categories that include information about all patches for a Solaris OE release.



**Note** – Not all patches available from Sun Microsystems must be installed. Only install the recommended patches, security patches, and those required to fix problems specific to your site.

## Checking Patch Levels

Before installing operating environment patches, you should know about patches that have been previously installed on a system.

The `showrev` command and the `patchadd` command provide useful information about currently installed patches.

```
# showrev -p
Patch: 106793-01 Obsoletes: Requires: Incompatibles: Packages: SUNWhea
. . .
# patchadd -p
Patch: 106793-01 Obsoletes: Requires: Incompatibles: Packages: SUNWhea
. . .
```



---

**Note** – Command output is the same for the `patchadd -p` and `showrev -p` commands; however, the `patchadd` command takes longer to display patch information. The `showrev` command is a binary, and the `patchadd` command is a script.

---

Historical information about all patches that are currently installed on a system and that can be uninstalled using the `patchrm` command is stored in the `/var/sadm/patch` directory.

The following command lists the contents of the `/var/sadm/patch` directory.

```
# ls /var/sadm/patch
107558-05  107594-04  107630-01  107663-01  107683-01  107696-01
107817-01  107582-01  107612-06  107640-03
```



---

**Caution** – Deleting files from the `/var/sadm` directory to make more space is a Solution Center call generator. The only way to correct the problems that occur is to restore the deleted files from backup tapes or to reload the software.

---



---

**Note** – It is important to ensure that sufficient space has been allocated for the `/var` file system. Be sure that the `/var` file system is at least 200 Mbytes in size to start with. There must be sufficient space for the `/var/sadm` directory to grow as new software packages and patches are installed on the system.

---



## Obtaining Patches

Sun customers who have a maintenance contract have access to the SunSolve<sup>SM</sup> program's database of patches and patch information, technical white papers, the Symptom and Resolution database, and more. These are available using the World Wide Web or anonymous FTP.

A SunService<sup>SM</sup> program customer can request to receive the patch update CD-ROMs, which are released quarterly.

Sun customers without maintenance contracts have access to a subset of the patches available through the SunSolve program. These patches are available at no charge and include important security and bug fix patches.

To access patches through the World Wide Web, use the following Universal Resource Locators (URLs):

<http://sunsolve.sun.com> – United States  
<http://sunsolve.sun.com.au> – Australia  
<http://sunsolve.sun.fr> – France  
<http://sunsolve.sun.de> – Germany  
<http://sunsolve.sun.co.jp> – Japan  
<http://sunsolve.sun.se> – Sweden  
<http://sunsolve.sun.ch> – Switzerland  
<http://sunsolve.sun.co.uk> – United Kingdom

The comprehensive set of patches and patch information is available to contract customers through the button labeled Login. The customer's assigned SunService program password is required to access this database.

To access patches using FTP, use the `ftp` command to connect to:

`sunsolve.sun.com`

The `ftp` utility has many commands; however, only a few are necessary for moving files from system to system. You can locate and copy patches to the local system with a few basic FTP commands.

The following example shows the procedure for changing to the `/var/tmp` directory on the local system, connecting to the remote FTP site, locating a patch and its `README` file in the `/pub/patches` directory, and transferring both files to the local system's directory.



---

**Note** – The default mode for an `ftp` connection is binary mode in Solaris 9 OE. The default mode for an `ftp` connection in Solaris 8 or earlier versions is American Standard Code for Information Interchange (ASCII) mode. You use the `bin` command to set the FTP transfer mode to binary mode to transfer binary, image, or a non-text files in these earlier versions of the OE.

---

```
# cd /var/tmp
# ftp sunsolve.sun.com
Connected to sunsolve.
220-
220-Welcome to the SunSolve Online FTP server.
220-
220-Public users may log in as anonymous.
220-
220-Contract customers should use the following 2-tier login procedure:
220-
220-At the 1st login prompt: sunsolve
220-          passwd: sunmicro
220-
220-At the 2nd login prompt: <sunsolve login name>/<sunsolve passwd>
220-example:  myssID/mypasswd
220-
220-Public users may log in as anonymous; contract customers
220-should use the standard sunsolve login and password,
220-followed by their SunSolve account/password when prompted.
220-
220 sunsolve.Sun.COM FTP server (Version wu-2.6.0(3) Wed Jan 5 15:02:27
MST 2000) ready.
Name (sunsolve:usera): anonymous
331 Guest login ok, send your complete e-mail address as password.
Password:yourpassword
230 Guest login ok, access restrictions apply.
ftp> cd /pub/patches
ftp> get Solaris9.PatchReport
200 PORT command successful.
150 Opening ASCII mode data connection for Solaris9.PatchReport (8187
bytes).
226 Transfer complete.
local: Solaris9.PatchReport remote: Solaris9.PatchReport
```

```
8432 bytes received in 4.9 seconds (1.7 Kbytes/s)
ftp> mget 112605*
mget 112605-01.zip? y
200 PORT command successful.
150 Opening ASCII mode data connection for 112605-01.zip (95744 bytes).
226 Transfer complete.
local: 112605-01.zip remote: 112605-01.zip
96052 bytes received in 1 seconds (91 Kbytes/s)
mget 112605.readme? y
200 PORT command successful.
150 Opening ASCII mode data connection for 112605.readme (2198 bytes).
226 Transfer complete.
local: 112605.readme remote: 112605.readme
2274 bytes received in 0.039 seconds (57 Kbytes/s)
ftp> bye
```



---

**Note** – To disable interactive prompting during multiple (mget) file transfers, you can begin a session using `ftp -i sitename` or use the `prompt` command at the `ftp>` prompt.

---

## Preparing Patches for Installation

When patches are downloaded to the local system, you must place the patches in a temporary directory to prepare them for installation. The directory commonly used is the `/var/tmp` directory.

One of the common reasons for patch installation failure is directory permission or ownership problems. The `/var/tmp` directory is open to all and eliminates any of these types of problems.

The Solaris 7, Solaris 8, and Solaris 9 OE patches are in `zip` format, for example, `105050-01.zip`.

Use the `unzip` command to unpack the patch files.

```
# /usr/bin/unzip 105050-01.zip
```

Earlier versions of the Solaris OE used compressed tar files in a `tar.Z` format, for example, `101010-01.tar.Z`

Use the `zcat` command to uncompress the patch files and the `tar` command to create the patch directories.

```
# /usr/bin/zcat 105050-01.tar.Z | tar xvf -
```

### Patch Contents

Figure 7-2 shows the contents of a patch directory after it is extracted from the zip file.

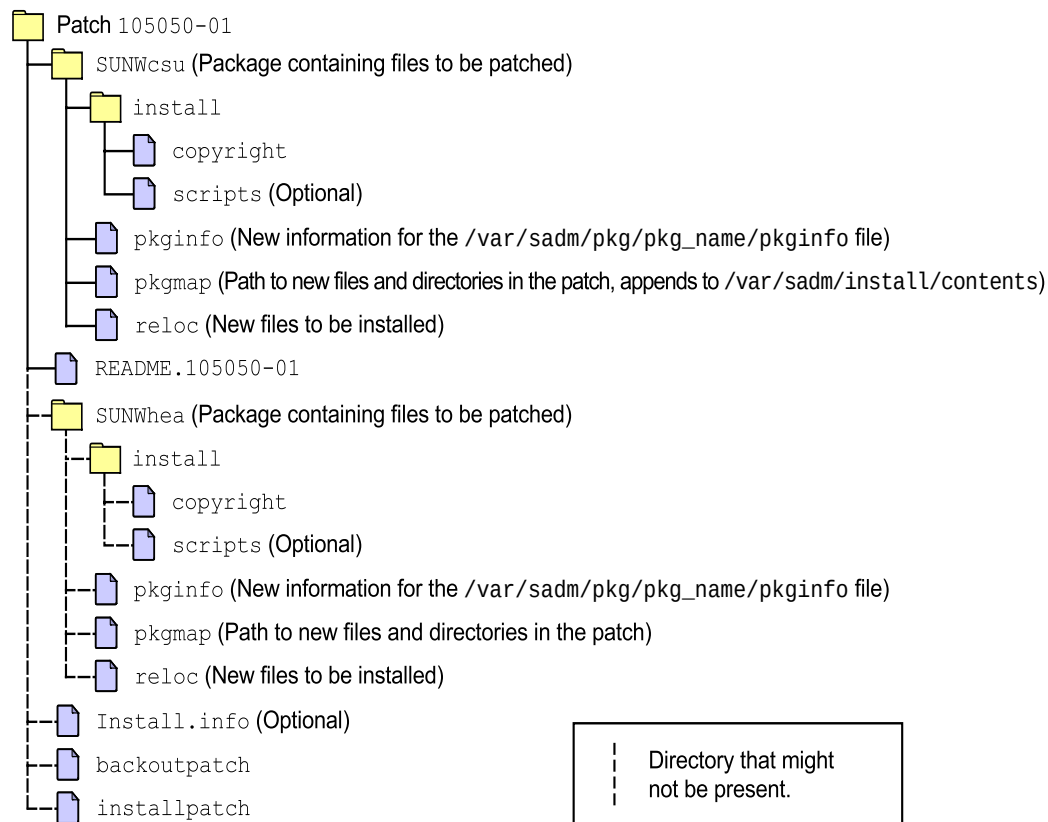


**Figure 7-2** An Extracted Patch Directory

## Installing and Removing Patches

The two most common commands for managing patches are:

- **patchadd** – Installs uncompressed patches to the Solaris OE
- **patchrm** – Removes patches installed on the Solaris OE

Additionally, you install cluster patches by using the **install\_cluster** command. You can also manage patches through the Solaris™ Management Console.

### Installing a Patch

When a patch is installed, the **patchadd** command calls the **pkgadd** command to install the patch packages.

The following example shows the procedure for patch installation. This example assumes that the patch to be installed exists in the **/var/tmp** directory and has been unzipped or uncompressed for installation.

```
# cd /var/tmp
# patchadd 105050-01
Checking installed patches...
Verifying sufficient filesystem capacity (dry run method)
Installing patch packages...
Patch number 105050-01 has been successfully installed.
See /var/sadm/patch/105050-01/log for details.
Patch packages installed:
  SUNWhea
```

Figure 7-3 shows those components of the `/var/sadm` directory that are updated during the installation of patch 105050-01.

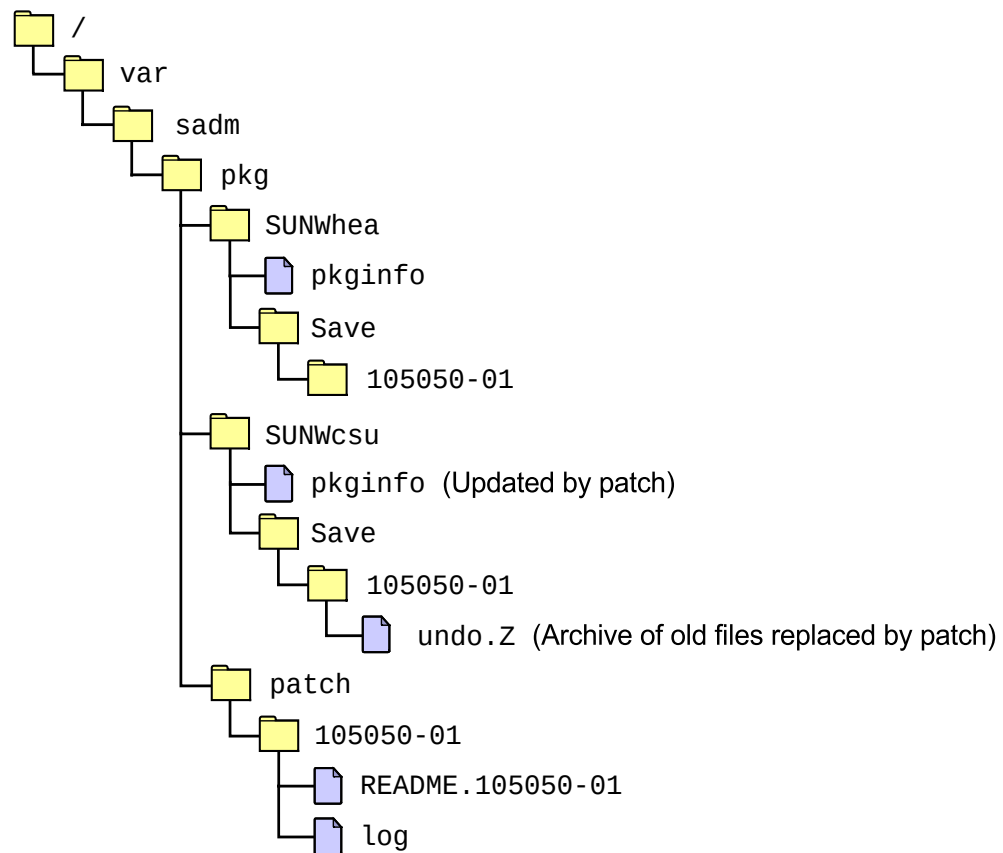


**Figure 7-3** Updated `/var/sadm` Directories

Error codes can be useful for troubleshooting problems encountered during installation.

Some of the error codes found in the `/usr/sbin/patchadd` command are shown in Table 7-2.

**Table 7-2** Some `/usr/sbin/patchadd` Command Error Codes

| Number | <b>patchadd</b> Error Codes                                |
|--------|------------------------------------------------------------|
| 0      | No error.                                                  |
| 1      | Usage error.                                               |
| 2      | An attempt to apply a patch that has already been applied. |

**Table 7-2** Some /usr/sbin/patchadd Command Error Codes  
(Continued)

| Number | patchadd Error Codes                                                                            |
|--------|-------------------------------------------------------------------------------------------------|
| 3      | The effective user ID (EUID) is not root .                                                      |
| 4      | An attempt to save original files failed.                                                       |
| 5      | The pkgadd command failed.                                                                      |
| 6      | The patch is obsolete.                                                                          |
| 7      | An invalid package directory.                                                                   |
| 8      | An attempt to patch a package that is not installed.                                            |
| 9      | Cannot access /usr/sbin/pkgadd (client problem).                                                |
| 10     | Package validation errors.                                                                      |
| 11     | An error occurred while adding a patch to the root template.                                    |
| 12     | The patch script terminated due to a signal.                                                    |
| 13     | A symbolic link was included in the patch.                                                      |
| 14     | Not used.                                                                                       |
| 15     | The prepatch script had a return code other than 0.                                             |
| 16     | The postpatch script had a return code other than 0.                                            |
| 17     | A mismatch of the -d option occurred between a previous patch installation and the current one. |
| 18     | There is not enough space in the file systems that are targets of the patch.                    |
| 19     | The \$SOFTINFO/INST_RELEASE file was not found.                                                 |
| 20     | A direct instance patch was required but was not found.                                         |
| 21     | The required patches have not been installed on the manager.                                    |
| 22     | A progressive instance patch was required but was not found.                                    |
| 23     | A restricted patch is already applied to the package.                                           |
| 24     | An incompatible patch was applied.                                                              |
| 25     | A required patch was not applied.                                                               |

**Table 7-2** Some /usr/sbin/patchadd Command Error Codes  
(Continued)

| Number | patchadd Error Codes                                                      |
|--------|---------------------------------------------------------------------------|
| 26     | The user-specified backout data cannot be found.                          |
| 27     | The relative directory supplied cannot be found.                          |
| 28     | A pkginfo file is corrupt or missing.                                     |
| 29     | Bad patch ID format.                                                      |
| 30     | Dry run failures occurred.                                                |
| 31     | The path given for the -C option was invalid.                             |
| 32     | You must be running the Solaris 2.6 OE to the Solaris 9 OE.               |
| 33     | The patch file was formatted incorrectly or the patch file was not found. |
| 34     | An incorrect patch spool directory was given.                             |
| 35     | A later revision was already installed.                                   |
| 36     | You cannot create a safe temporary directory.                             |
| 37     | An illegal backout directory was specified.                               |

## Removing a Patch

When you remove a patch, the `patchrm` command restores all files that were modified or replaced by that patch, unless:

- The patch was installed with the `patchadd -d` option (which instructs the `patchadd` command not to save copies of files being updated or replaced)
- The patch is required by another patch
- The patch has been obsoleted by a later patch

The `patchrm` command calls the `pkgadd` utility to restore packages that were saved during the initial patch installation.



The following example shows how to remove a patch by using the `patchrm` command.

```
# patchrm 105050-01
Checking installed packages and patches...
Backing out patch 105050-01...
Patch 105050-01 has been backed out.
#
```

## Installing Patch Clusters

The patch cluster provides a selected set of patches for a designated Solaris OE level and is conveniently wrapped for one-step installation. Patch clusters are usually a set of recommended, security, or Y2K patches.

You should not install cluster patches on systems with limited disk space. Sun does not recommend installing cluster patches on systems with less than 10 Mbytes of available space in the `/`(root), `/usr`, `/var`, or `/opt` partitions.

By default, the cluster installation procedure saves the base objects being patched. Prior to installing the patches, the cluster installation script first determines if enough system disk space is available in the `/var/sadm/pkg` directory to save the base packages and terminates if not enough space is available.

You can override the save feature by using the `-nosave` option when you are executing the cluster installation script. If you use the `-nosave` option, you will not be able to back out individual patches if the need arises.

You can remove individual patches that were installed by the patch cluster by using the `patchrm` command. The `README` file is located in the specific patch directory under the `/var/sadm/patch` directory after the patch has been installed.

To install a patch cluster, perform the following steps:

1. Be sure the patch cluster has been unzipped or uncompressed and extracted if the cluster was received as a `tar.Z` file.
2. Decide on which method to use to install the cluster—the recommended default `save` option or the `-nosave` option.
3. Change to the directory that contains the patch cluster. Then run the `install_cluster` script.

```
# cd patch_cluster_directory  
# ./install_cluster
```

The installation appears as follows:

```
# ./install_cluster
```

```
Patch cluster install script for <cluster name>
```

```
Determining if sufficient save space exists...  
Sufficient save space exists, continuing...  
Installing patches located in <patch cluster directory>  
Installing <patch-id>  
Installing <patch-id>  
.  
.  
.  
Installing <patch-id>
```

```
For more installation messages refer to the installation logfile:  
/var/sadm/install_data/<cluster name>_log
```

```
Use '/usr/bin/showrev -p' to verify installed patch-ids.  
Refer to individual patch README files for more patch detail.  
Rebooting the system is usually necessary after installation.
```

```
#
```

4. Read each individual patch README file to determine if any additional steps are required to fully install any individual patch.
5. Check the log file if more detail is needed.
6. Reboot the system for all patches to take effect.

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Maintaining Patches (Level 1)

In this exercise, you transfer a patch from a classroom server, apply the patch, and then remove it.

### Preparation

Your instructor should provide directions for accessing a patch on a server that is available to systems in the classroom. Refer to the lecture notes as necessary to perform the tasks listed.

### Tasks

Complete the following tasks:

- Create a directory to hold patches. Use the `ftp` command to transfer a patch from a classroom server into the directory you create. Unzip the patch. Verify that no patch has been applied to your system. Verify that the `/var/sadm/patch` directory is empty.
- Read the `README` file associated with the patch to verify which Solaris OE release is appropriate for the patch. Add the patch, and verify that it is installed in the `/var/sadm/patch` directory. View the log file for this patch.
- Remove the patch you just installed, and verify that it is no longer applied to the system.

## Exercise: Maintaining Patches (Level 2)

In this exercise, you transfer a patch from a classroom server, apply the patch, and then remove it.

### Preparation

Your instructor should provide directions for accessing a patch on a server that is available to systems in the classroom. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Create a directory to hold patches. Use the `ftp` command to transfer a patch from a classroom server into the directory you create. Unzip the patch. Verify that no patch has been applied to your system. Verify that the `/var/sadm/patch` directory is empty.
- Read the `README` file associated with the patch to verify which Solaris OE release is appropriate for the patch. Add the patch, and verify that it is installed in the `/var/sadm/patch` directory. View the log file for this patch.
- Remove the patch you just installed, and verify that it is no longer applied to the system.

## Tasks

Complete the following steps:

1. Create a directory to hold patches. Use the binary transfer mode of the `ftp` command to transfer a patch from a classroom server into the directory you created. Your instructor should provide information about where to find a patch on the server. Close your `ftp` connection when you are finished.



---

**Note** – The default mode for an `ftp` connection is binary mode in Solaris 9 OE. The default mode for an `ftp` connection in Solaris 8 or earlier versions is ASCII mode. You use the `bin` command to set the FTP transfer mode to binary mode to transfer binary, image, or a non-text files in these earlier versions of the OE.

---

2. Use the `unzip` command to extract the patch from the zip archive.
3. Use the `patchadd` command to determine if any patches are currently installed on your system.

The `patchadd` command creates the `/var/sadm/patch` directory the first time it runs.

4. Verify that the `/var/sadm/patch` directory is empty.
5. Read the `README` file that is associated with the patch you unzipped. Verify the Solaris OE release for which the patch is required.

Solaris OE release:

6. Add the patch.
7. Verify that the patch is installed. What are the packages that the patch affects?
8. Examine the patch installation log.
9. Remove the patch you just installed. Verify that the patch is no longer installed.

## Exercise: Maintaining Patches (Level 3)

In this exercise, you transfer a patch from a classroom server, apply the patch, and then remove it.

### Preparation

Your instructor should provide directions for accessing a patch on a server that is available to systems in the classroom. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Create a directory to hold patches. Use the `ftp` command to transfer a patch from a classroom server into the directory you create. Unzip the patch. Verify that no patch has been applied to your system. Verify that the `/var/sadm/patch` directory is empty.
- Read the `README` file associated with the patch to verify which Solaris OE release is appropriate for the patch. Add the patch, and verify that it is installed in the `/var/sadm/patch` directory. View the log file for this patch.
- Remove the patch you just installed, and verify that it is no longer applied to the system.

## Tasks and Solutions

Complete the following steps:



---

**Note** – The default mode for an `ftp` connection is binary mode in Solaris 9 OE. The default mode for an `ftp` connection in Solaris 8 or earlier versions is ASCII mode. You use the `bin` command to set the FTP transfer mode to binary mode to transfer binary, image, or a non-text files in these earlier versions of the OE.

---

1. Create a directory to hold patches. Use the binary transfer mode of the `ftp` command to transfer a patch from a classroom server into the directory you created. Your instructor should provide information about where to find a patch on the server. Close your `ftp` connection when you are finished. For example:

```
# cd /var/tmp
# ftp servername
(connection and login messages)
ftp> cd /export/patches
ftp> get 100000-01.zip
200 PORT command successful.
150 Opening ASCII mode data connection for 100000-01.zip(49236 bytes).
226 Transfer complete.
local: 100000-01.zip remote: 100000-01.zip
49236 bytes received in 0.045 seconds (1072.57 Kbytes/s)
ftp> bye
221 Goodbye.
#
```

2. Use the `unzip` command to extract the patch from the zip archive, for example:

```
# unzip 100000-01.zip
```

3. Use the `patchadd` command to determine if any patches are currently installed on your system.

```
# patchadd -p
```

*The `patchadd` command should display a message.*

The `patchadd` command creates the `/var/sadm/patch` directory the first time it runs.

4. Verify that the `/var/sadm/patch` directory is empty.

```
# ls /var/sadm/patch
```



5. Read the README file that is associated with the patch you unzipped. Verify the Solaris OE release for which the patch is required.

```
# more 100000-01/README*
```

Solaris OE release: *Solaris OE release 9*

6. Add the patch.

```
# patchadd 100000-01
```

7. Verify that the patch is installed. What are the packages that the patch affects?

```
# patchadd -p
```

*The packages affected by patches depend on the particular patches themselves.*

8. Examine the patch installation log file.

```
# cd /var/sadm/patch/100000-01
```

```
# more log
```

9. Remove the patch you just installed. Verify that the patch is no longer installed.

```
# cd
```

```
# patchrm 100000-01
```

```
# patchadd -p
```

*The patchadd command should display a message.*

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

# Executing Boot PROM Commands

---

## Objectives

Upon completion of this module, you should be able to:

- Identify boot programmable read-only memory (PROM) fundamentals
- Use basic boot PROM commands
- Identify the system's boot device
- Create and remove custom device aliases
- View and change nonvolatile random access memory (NVRAM) parameters from the shell
- Interrupt an unresponsive system

The following course map shows how this module fits into the current instructional goal.

### Performing System Boot Procedures

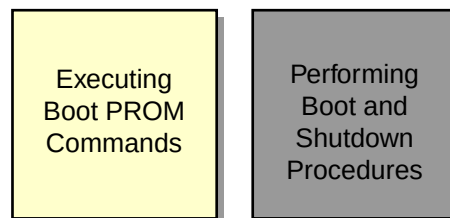


**Figure 8-1** Course Map

## Introducing Boot PROM Fundamentals

All Sun systems have resident boot PROM firmware that provides basic hardware testing and initialization prior to booting. The boot PROM also enables you to boot from a wide range of devices. In addition, there is a user interface that provides several important functions.

The Sun boot PROM has access to a standard set of generic device drivers. The system needs these drivers to access and control the buses and the boot device to boot the system properly.

All versions of the OpenBoot™ architecture allow a third-party board to identify itself and load its own plug-in device driver. Each device identifies its type and furnishes its plug-in device driver when requested by the OpenBoot PROM during the system hardware configuration phase of the boot process.

Figure 8-2 shows the identification process.

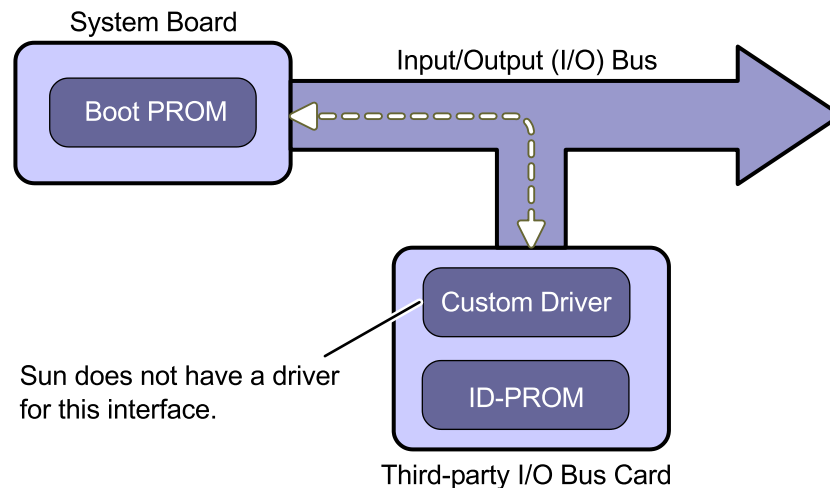


**Figure 8-2** Third-Party Device Identification Process

## Goal of the OpenBoot™ Architecture Standard

The overall goal of the Institute of Electrical and Electronics Engineers (IEEE) standard for the OpenBoot architecture is to provide the capabilities to:

- Test and initialize system hardware
- Determine the system's hardware configuration

- Boot the operating environment
- Provide an interactive interface for configuration, testing, and debugging
- Enable the use of third-party devices

## Boot PROM

Each Sun system has a boot PROM chip. This 1-Mbyte chip is typically located on the same board as the central processing unit (CPU). Boot PROM chips are usually found in a pluggable socket on older systems. As of the 3.x PROM, they are permanently soldered to the main system board.

The Ultra™ workstations use a reprogrammable boot PROM called a flash PROM (FPROM). The FPROM allows you to load new boot program data into the PROM by using software, instead of having to replace the chip. A CD-ROM distributes these updates.

Desktop systems have a write-protect jumper that must be moved before you can write to the PROM. You have to move the jumper because the default position is write-protect. Refer to the *Flash Programming Manual for Ultra Desktop Systems*, part number 802-3233-17, for the jumper location on your system.



---

**Caution** – Many systems have the jumper under an installed frame buffer or other removable card. Be careful when removing or replacing this card.

---

The main functions of the boot PROM are to test the system hardware and to boot the operating environment. The boot PROM firmware is referred to as the *monitor* program.

The boot PROM firmware controls the operation of the system before the operating environment has been booted and the kernel is available. The boot PROM also provides the user with a user interface and firmware utility commands, known as the FORTH command set. Commands include the boot commands, diagnostics commands, and commands to modify the default configuration.



---

**Note** – The boot PROM does not understand the Solaris™ Operating Environment (Solaris OE) file systems or files. It handles mainly hardware devices.

---

Currently, there are five generations of Sun boot PROMs. Each generation has its own base revision number, as described in the following list:

- 1.x      The first boot PROM used on SPARC<sup>®</sup> systems.
- 2.x      The first OpenBoot PROM.
- 3.x      The OpenBoot PROM with a flash update feature. You can update the 3.x firmware without having to replace the boot PROM chip. This generation was introduced with the Sun UltraSPARC<sup>®</sup> product line.
- 4.x      The OpenBoot PROM that supports the 64-bit UltraSPARC III processor.
- 5.x      Available on the Sun Enterprise<sup>™</sup> 3500, 4500, 5500, and 6500 servers.

To determine which revision of OpenBoot PROM is running on the system, perform the command:

```
# /usr/platform/'uname -m'/sbin/prtdiag -v
```

## NVRAM

Another important hardware element in each Sun system is the NVRAM chip. This removable chip is often located on the main system board.

The NVRAM module contains the electronically erasable programmable read-only memory (EEPROM). The EEPROM stores user-configurable parameters that have been changed or customized from the boot PROM's default parameters settings. This behavior gives you a certain level of flexibility in configuring the system to behave in a particular manner for a specific set of circumstances. A single lithium battery within the NVRAM module provides battery backup for the NVRAM and the clock.

The NVRAM contains editable and noneditable areas. The noneditable area includes the following:

- The Ethernet address, such as 8:0:20:5d:6f:9e
- The system host ID value, such as 805d6f9e

The editable area includes the following:

- The time-of-day (TOD) clock value
- The configuration data describing system operating parameters
- A diagnostic mode switch that enables or disables power-on self-test (POST)
- The device name and the path to the default boot device
- A location for customized programming that is used during the boot process



**Note** – Remember to retain the NVRAM chip, because it contains the host ID. Many licensed software packages are based on the system host ID. The NVRAM chip has a yellow sticker with a bar code on it. If the chip fails, Sun can replace the chip if given the numbers below this bar code. The replacement chip has the same host ID and Ethernet address. It can be plugged into the same location on the motherboard as the chip it is replacing.

Figure 8-3 shows the basic elements of the Boot PROM and NVRAM.

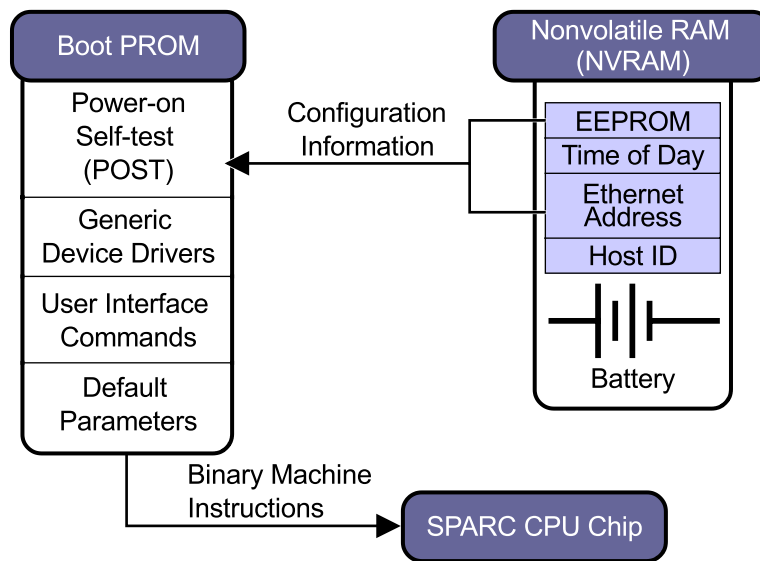


**Figure 8-3** Basic Elements of the Boot PROM and NVRAM

## POST

When a system's power is turned on, a low-level POST is initiated. This low-level POST code is stored in the boot PROM and is designed to test the most basic functions of the system hardware.

At the successful completion of the low-level POST phase, the boot PROM firmware takes control and performs the following initialization sequence:

- Probes the memory and then the CPU
- Probes bus devices, interprets their drivers, and builds a device tree
- Installs the console

After the boot PROM initializes the system, the banner displays on the console. The system checks parameters stored in the boot PROM and NVRAM to determine if and how to boot the operating environment.

### Controlling the POST Phase

One of the first tests that POST runs is to check to determine if a keyboard is connected to the system and if a Stop-key option is present.

---

**Note** – You can control the POST phase through the Sun keyboard only.

---



The Stop key is located on the left side of the keyboard. To enable various diagnostic modes, hold down the Stop key simultaneously with another key. The Stop-key sequences have an effect on the OpenBoot PROM and define how POST runs when a system's power is turned on. The following is a list of the Stop-key sequences:

- Stop-D key sequence – Hold down the Stop and D keys simultaneously while system power is turned on, and the firmware automatically switches to diagnostic mode. This mode runs more extensive POST diagnostics on the system hardware. The OpenBoot PROM variable `diag-switch?` is set to `true`.

See Figure 8-4 on page 8-7 to show the effect of the variable `diag-switch?`.



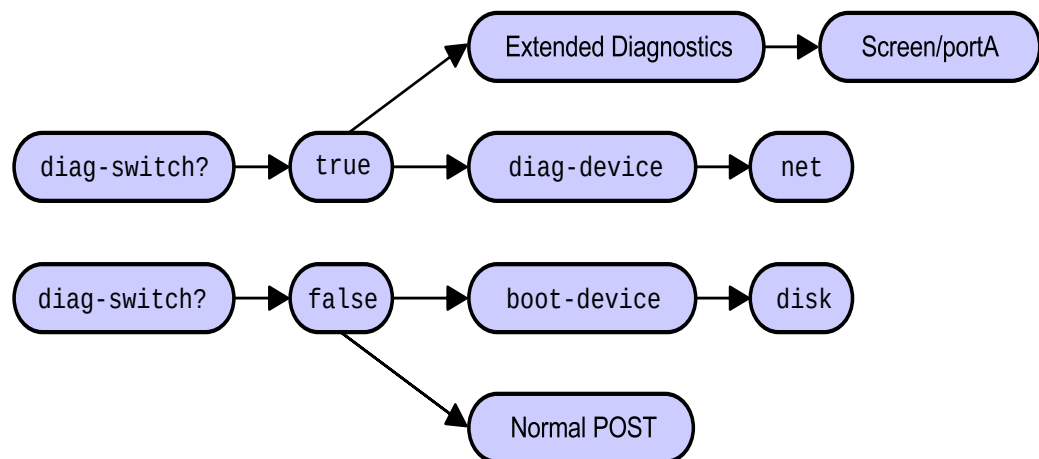


**Figure 8-4** Post Diagnostics



**Note** – The Stop-D key sequence is not available on a serial port terminal.

- Stop-N key sequence – Hold down the Stop and N keys simultaneously while the system power is turned on to set the NVRAM parameters to the default values. When you see the light emitting diodes (LEDs) on the keyboard begin to flash, you can release the keys, and the system should continue to boot.

Incorrect NVRAM settings can cause system boot failure. For example, during a flash PROM download, if a power failure occurs, some of the contents of the NVRAM can become unusable.

If the system does not boot and you suspect that the NVRAM parameters are set incorrectly, the parameters can easily be changed to the default values.
- Stop-A key sequence – Hold down the Stop and A keys simultaneously to interrupt any program that is running at the time these keys are pressed and to put the system into the command entry mode for the OpenBoot PROM. The system presents an ok prompt for the user, which signifies it is ready to accept OpenBoot PROM commands.



**Caution** – The Stop-A key sequence, as a method for getting to the ok prompt, is not recommended unless there is absolutely no alternative. The Stop-A key sequence can cause Solaris OE file system corruption which can be difficult to repair.

## Disabling the Abort Sequence

As a system administrator, you might want to disable the abort key sequence on a system to prevent possible corruption of a file system or to provide tighter security.

To disable the abort key sequence, edit the `/etc/default/kbd` file. Inside the file, the statement `KEYBOARD_ABORT=disable` is commented out. Remove the comment from in front of the value, save the file, and execute the command `kbd -i`. When you have completed these steps, the system allows Stop-A key sequence only during the boot process.

You can also configure the system to change the keyboard abort sequence to an alternate keystroke. Review the man page for the `kbd` command for more information.

## Displaying POST to the Serial Port

As the system administrator, you can attach a terminal to the serial port of a system to capture a far greater amount of information from the POST output.

When the power is turned on POST looks for a keyboard. If there is no keyboard present, POST diverts system output to serial port A.

POST runs more extensive tests when the system is in diagnostic mode with the PROM parameter `diag-switch?` set to true.

Be sure to attach the correct type of null modem cable for your system type to serial port A.

Some systems require a special adapter cable. Connect the other end of the cable to the modem port of the American Standard Code for Information Interchange (ASCII) terminal, as shown in Figure 8-5.

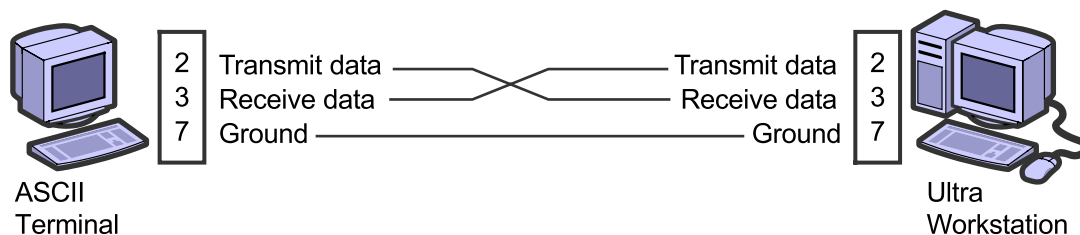


**Figure 8-5** Serial Port Connection to a Sun Workstation

The following example is the POST output from a Sun Blade™ 1000 workstation:

#### Partial Post Output Listing

```
@(#) 4.0 Version 29 created 2000/07/12 16:46
Clearing TLBs Done
Reset: 0000.0000.0000.0010 SPOR
Loading Configuration
Membase: 0000.0000.0000.0000
MemSize: 0000.0000.2000.0000
Init CPU arrays Done
Init E$ tags Done
Setup TLB Done
MMUs ON
Block Scrubbing Done
Copy Done
PC = 0000.07ff.f000.3138
Decompressing Done
Size = 0000.0000.0006.e3b0
ttya initialized
Start Reason: Soft Reset
System Reset: (SPOR)
Probing gptwo at 0,0 SUNW,UltraSPARC-III (750 MHz @ 5:1, 8 MB)
    memory-controller
Probing gptwo at 1,0 Nothing there
Probing gptwo at 8,0 pci pci upa ppm
Loading Support Packages: kbd-translator
Loading onboard drivers: ebus flashprom bbc ppm i2c dimm-fru dimm-fru
    dimm-fru dimm-fru dimm-fru dimm-fru dimm-fru dimm-fru nvram idprom
    i2c cpu-fru temperature fan-control card-reader motherboard-fru
Memory Configuration:
Segment @ Base:      0 Size:  512 MB (2-Way)
Probing /upa@8,480000 Device 0,0 Nothing there
Probing /upa@8,480000 Device 1,0 Nothing there
Probing /pci@8,600000 Device 4  SUNW,qlc fp disk
Probing /pci@8,600000 Device 1  Nothing there
Probing /pci@8,700000 Device 5  network firewire usb
dev-descrip
next-add
node made
Probing /pci@8,700000 Device 6  scsi disk tape scsi disk tape
Probing /pci@8,700000 Device 1  Nothing there
Probing /pci@8,700000 Device 2  Nothing there

(UltraSPARC-III) , Keyboard Present
OpenBoot 4.0, 512 MB memory installed, Serial #12134217.
Ethernet address 8:0:20:b9:27:49, Host ID: 80b92749.
```

## Using Basic Boot PROM Commands

The boot PROM monitor provides a user interface for invoking OpenBoot commands.



---

**Note** – The ok prompt indicates that the Solaris OE is currently not running.

---

Table 8-1 shows some of the commands typically entered at the ok prompt.

**Table 8-1** Typical Commands Used at the ok Prompt

| Command             | Description                                                                       |
|---------------------|-----------------------------------------------------------------------------------|
| banner              | Displays the power-on banner                                                      |
| boot                | Boots the system                                                                  |
| help                | Lists the main help categories                                                    |
| words               | Displays the FORTH words in the dictionary                                        |
| sifting <i>text</i> | Displays the FORTH commands containing <i>text</i>                                |
| printenv            | Displays all parameters' current and default values                               |
| setenv              | Sets the specified NVRAM parameter to some value                                  |
| reset-all           | Resets the entire system; similar to a power cycle                                |
| set-defaults        | Resets all parameter values to the factory defaults                               |
| probe-ide           | Identifies devices on the internal integrated device electronics (IDE) bus        |
| probe-scsi          | Identifies the devices on the internal Small Computer System Interface (SCSI) bus |
| probe-scsi-all      | Identifies the devices on all SCSI buses                                          |
| probe-fcal-all      | Identifies devices on all Fibre Channel loops                                     |
| .version            | Displays the version and the date of the boot PROM                                |

**Table 8-1** Typical Commands Used at the ok Prompt (Continued)

|                             |                                                                              |
|-----------------------------|------------------------------------------------------------------------------|
| <code>probe-pci</code>      | Probes all devices on a specific peripheral component interconnect (PCI) bus |
| <code>probe-pci-slot</code> | Probes a specific PCI slot on a specific PCI bus                             |
| <code>test</code>           | Runs self-tests on specified devices                                         |
| <code>.enet-addr</code>     | Displays the Ethernet address                                                |
| <code>.idprom</code>        | Displays the ID PROM contents                                                |
| <code>.speed</code>         | Displays the speed of the processor and of the buses attached to the system  |
| <code>.registers</code>     | Displays the contents of the registers                                       |

## Identifying the System Boot PROM Version

The `banner` command lists useful information about the system, such as the model name, the boot PROM version number (for example, 1.x, 2.x, 3.x, 4.x, or 5.x), the amount of memory, the Ethernet address, and the host ID.

The following example shows output from the `banner` command.

**ok banner**

```
Sun Ultra 5/10 UPA/PCI (UltraSPARC-IIi 360MHz), Keyboard Present
OpenBoot 3.31, 128 MB (50 ns) memory installed, Serial #11888271.
Ethernet address 8:0:20:b5:66:8f, Host ID: 80b5668f.
```

## Booting the System

Use the `boot` command to boot the Solaris OE from the `ok` prompt. This command has several options available for booting the system in different situations.

The format for the `boot` command is:

```
ok boot device_name - options
```

Enter the `boot` command at the `ok` prompt to boot the system to multiuser mode automatically.

**ok boot**

The following list describes the options for the **boot** command:

- **-s** – Boots the system to a single-user mode and asks the user for the root password.

ok **boot -s**

ok **boot cdrom -s**

- **-a** – Boots the system interactively. Use this option if an alternative file needs to be executed during boot. The boot program asks for the following information.

ok **boot -a**

Enter filename [kernel/sparcv9/unix]:

Enter default directory for modules [/platform/SUNW,Ultra-5\_10/kernel  
/platform/sun4u/kernel /kernel /usr/kernel]:

Name of system file [etc/system]:

root file system type [ufs]:

Enter physical name of root device:

- **-r** – Performs a reconfiguration boot. Use this option to find a newly attached device and to create new device entries in the **/devices** and **/dev** directories. It also updates the **/etc/path\_to\_inst** file.

ok **boot -r**

- **-v** – Boots the system while displaying more detailed device information to the console. Use this option to troubleshoot problems during the boot process. You can use this option with other options.

ok **boot -v**

ok **boot -rv**

ok **boot -sv**

## Accessing More Detailed Information

You use the `help` command to obtain help on the main categories in the OpenBoot firmware.

The following is an example of the `help` output from an Ultra 5 workstation that is running OpenBoot PROM version 3.31:

```
ok help
Enter 'help command-name' or 'help category-name' for more help
(Use ONLY the first word of a category description)
Examples:  help system -or- help nvramrc
Categories:
boot (Load and execute a program)
nvramrc (Store user defined commands)
system configuration variables (NVRAM variables)
command line editing
editor (nvramrc editor)
resume execution
devalias (Device aliases)
diag (Diagnostics commands)
ioredirect (I/O redirection commands)
misc (Miscellaneous commands)
ok
```

The `help` command listing provides a number of other keywords that you can use to view further details.

For example, to view specific information for one of the main categories listed in the preceding example, perform one of the following commands:

```
ok help boot
```

```
ok help nvramrc
```

```
ok help diag
```

```
ok help misc
```

## Listing NVRAM Parameters

You use the `printenv` command to list all the NVRAM parameters. If the parameter can be modified, the `printenv` command displays its default setting and current setting.

The following example shows output from the `printenv` command.

```
ok printenv
Variable Name      Value                      Default Value

tpe-link-test?    true                      true
scsi-initiator-id  7                        7
keyboard-click?   false                    false
keymap
ttyb-rts-dtr-off  false                    false
ttyb-ignore-cd    true                     true
ttya-rts-dtr-off  false                    false
ttya-ignore-cd    true                     true
ttyb-mode          9600,8,n,1,-            9600,8,n,1,-
ttya-mode          9600,8,n,1,-            9600,8,n,1,-
pcia-probe-list   1,2,3,4                 1,2,3,4
pcib-probe-list   1,2,3                   1,2,3
mfg-mode          off                      off
diag-level        max                      max
#power-cycles     273
output-device     screen                   screen
input-device      keyboard                 keyboard
boot-command      boot                     boot
auto-boot?        true                     true
diag-device       net                      net
boot-device       disk net                 disk net
local-mac-address? false                    false
screen-#columns   80                       80
screen-#rows      34                       34
use-nvramrc?      false                    false
nvramrc           devalias pgx24 /pci1f,0 ...
security-mode      none
security-password
security-#badlogins 0
diag-switch?      false                    false
ok
```

You can also use the `printenv` command to display a single parameter and its values.



For example, to display only the boot-device parameter, perform the command:

```
ok printenv boot-device  
boot-device = disk net
```

The possible values of the boot-device parameter include disk, net, and cdrom.



---

**Note** – Some OpenBoot PROM parameters, such as `auto-boot?`, end in a question mark. If an OpenBoot PROM parameter ends in a question mark, the parameter value is typically either `true` or `false`.

---

## Changing NVRAM Parameters

You use the `setenv` command to change the current values assigned to NVRAM parameters.

If the `auto-boot?` parameter is set to `true`, the system boots automatically. If it is set to `false`, the system stops at the `ok` prompt.

The following example changes the `auto-boot?` parameter from its default setting of `true` to the value of `false`.

```
ok printenv auto-boot?  
auto-boot? = true  
ok  
ok setenv auto-boot? false  
auto-boot? = false
```

The `reset-all` command halts the system, clears all buffers and registers, and performs a software simulated power-off/power-on of the system.

```
ok reset-all  
Resetting ...
```



---

**Note** – The `reset-all` command clears system registers, which is required on a system with a PROM 3.x or higher before you can use the `probe` command or perform other tests.

---

## Restoring Default NVRAM Parameters

You use the `set-defaults` command to reset all NVRAM parameters to their default values. It affects only parameters that have assigned default values.

**ok set-defaults**

Setting NVRAM parameters to default values.

ok

To reset a specific parameter to its default value, use the `set-default` command followed by the parameter name.

**ok set-default *parameter-name***

For example, to reset the `diag-level` parameter, perform the command:

**ok set-default diag-level**

To restore the default NVRAM parameters when you are starting the system, hold down the Stop-N key sequence while the system power is turned on.

When the LEDs on the keyboard begin to flash, release the keys, and the system continues to boot.

## Displaying Devices Connected to the Bus

To identify the peripheral devices currently connected to the system, such as disks, tape drives, or CD-ROMs, use the `probe` command.

To identify the various `probe` commands that are available with your system, use the `sifting` command. The `sifting` command is useful for finding OpenBoot PROM commands when you do not know the exact command syntax.

For example, to find the `probe` commands available, perform the command:

**ok sifting probe**

```
(f006c954) probe-all      (f006c5a0) probe-all      (f006c378) probe-ide
(f006c1e8) probe-pci-slot  (f006bc8c) probe-scsi
(f006bd78) probe-scsi-all (f0060fe8) probe-pci
(output truncated)
```

The most common **probe** commands are the **probe-scsi** command, the **probe-scsi-all** command, and the **probe-ide** command.

Systems that contain the Fibre Channel-Arbitrated Loop (FC-AL) Gigabit Interface Converters (GBICs) use the **probe-fcal-all** command.



**Caution** – The following warning message might be displayed if you invoke the **probe** commands on Sun systems that contain a boot PROM that is version 3.x and above.

This command may hang the system if a Stop-A or halt command has been executed. Please type **reset-all** to reset the system before executing this command.

Do you wish to continue? (y/n) **n**

To avoid having your system hang, perform the commands:

ok **setenv auto-boot? false**

ok **reset-all**

One method you can use to tell if the system might hang during a **probe** command is to use the **.registers** command.

ok **.registers**

|    | Normal | Alternate | MMU | Vector |   |
|----|--------|-----------|-----|--------|---|
| 0: | 0      |           | 0   | 0      | 0 |
| 1: | 0      |           | 0   | 0      | 0 |
| 2: | 0      |           | 0   | 0      | 0 |
| 3: | 0      |           | 0   | 0      | 0 |
| 4: | 0      |           | 0   | 0      | 0 |

(output edited for brevity)

|      |   |      |   |          |          |
|------|---|------|---|----------|----------|
| %PC  | 0 | %nPC | 0 |          |          |
| %TBA | 0 | %CCR | 0 | XCC:nzvc | ICC:nzvc |

The preceding output shows that the registers are all empty, with values of 0 (zero). Should the registers hold values other than 0, the **probe** command would most likely hang the system.

## The probe-scsi Command

The `probe-scsi` command identifies the peripheral devices attached to the on-board SCSI controller. The `probe-scsi` command identifies such peripheral devices as disks, tape drives, or CD-ROMs by their target addresses.

ok **probe-scsi**

Target 1

Unit 0 Disk FUJITSU MAB3045S SUN4.2G17059825M62990

Target 3

Unit 0 Disk IBM DDRS34560SUN4.2GS98E99255C5917

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1997. All rights reserved.

Target 6

Unit 0 Removable Read Only device SONY CDR0M

## The probe-scsi-all Command

The `probe-scsi-all` command identifies the peripheral devices that are attached to the on-board SCSI controller and all peripheral devices attached to separate SBus or PCI SCSI controllers.

ok **probe-scsi-all**

/pci@1f,0/pci@1/pci@1/SUNW,isp200@4

Target 3

Unit 0 Disk FUJITSU MAB3045S SUN4.2G1907

Target 4

Unit 0 Removable Tape EXABYTE EXB-8505SMBANSH20090

## The probe-ide Command

The `probe-ide` command identifies disks and CD-ROMs that are attached to the on-board IDE controller. This command displays the device number of the internal device.

ok **probe-ide**

```
Device 0      ( Primary Master )
              ATA Model : ST 38420A (DISK)

Device 1      ( Primary Slave )
              Not Present

Device 2      ( Secondary Master )
              Removable ATAPI Model : CRD-8322B (CD-ROM)

Device 3      ( Secondary Slave )
              Not Present
```

## The probe-fcal-all Command

The `probe-fcal-all` OpenBoot PROM command identifies peripheral devices on systems containing the FC-AL GBICs. The Sun Enterprise 3500 server is an example of one of these systems.

ok **probe-fcal-all**

The `probe-fcal-all` command is not used on the Sun Blade 1000 workstation. To identify FC-AL drives on board or attached externally to the Sun Blade 1000 workstation, use the `probe-scsi-all` command.

ok **probe-scsi-all**

```
/pci@8,600000/SUNW,qlc@4
LiD HA  --- Port WWN ---      ---- Disk description ----
10 10  2100002037651b0e SEAGATE ST318304FSUN18G 022D0017L007G2
12 12  2100002037651c12 SEAGATE ST318304FSUN18G 022D0017L007VJ
 1  1  2100002037653317 SEAGATE ST318304FSUN18G 032D0020L009TT
13 13  2100002037651f72 SEAGATE ST318304FSUN18G 022D0017L007JZ
11 11  2100002037651f76 SEAGATE ST318304FSUN18G 022D0017L007AL
14 14  2100002037651bf5 SEAGATE ST318304FSUN18G 022D0017L007XS
```

## Identifying the System's Boot Device

Sun hardware uses the concept of a device tree to organize devices that are attached to the system.

Figure 8-6 shows the organizational structure of a device tree for an Ultra 5 or an Ultra 10 workstation.

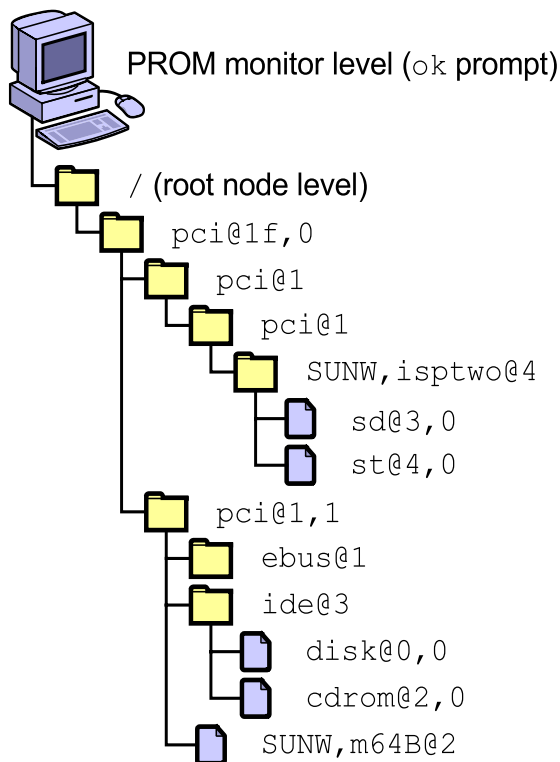


**Figure 8-6** A Partial Device Tree for an Ultra 5 or Ultra 10 Workstation

**Note** – In Figure 8-6, some license has been taken in naming these directories to simplify the illustration.

The OpenBoot firmware builds the device tree from information gathered at the POST. The device tree is loaded into memory and is used by the kernel during the boot process to identify all configured devices.

The top of the device tree is the root device node. Following the root device node is a bus nexus node. Connected to a bus nexus node is a leaf node, typically a controller for an attached device.

In Figure 8-6, the `disk@0,0` device is the IDE device for the hard disk drive, and the `cdrom@2,0` device is the IDE device for the CD-ROM drive. Both are attached to the IDE controller `ide@3`. Similarly, the `sd@3,0` device is the SCSI disk device and the `st@4,0` device is the SCSI tape device. Both are attached to the PCI-based SCSI controller `SUNW,isptwo@4`.

The paths built in the device tree by the OpenBoot firmware vary depending on the type of system and its device configuration.

Figure 8-7 shows a sample disk device path on an Ultra workstation with a PCI bus.

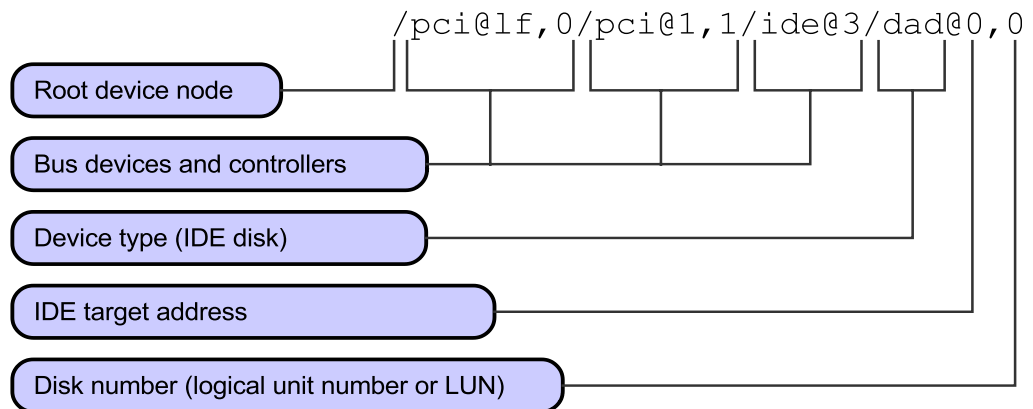


**Figure 8-7** Disk Device Path – Ultra Workstation With a PCI IDE Bus

Figure 8-8 shows a sample disk device path on an Ultra workstation with a PCI-SCSI bus.

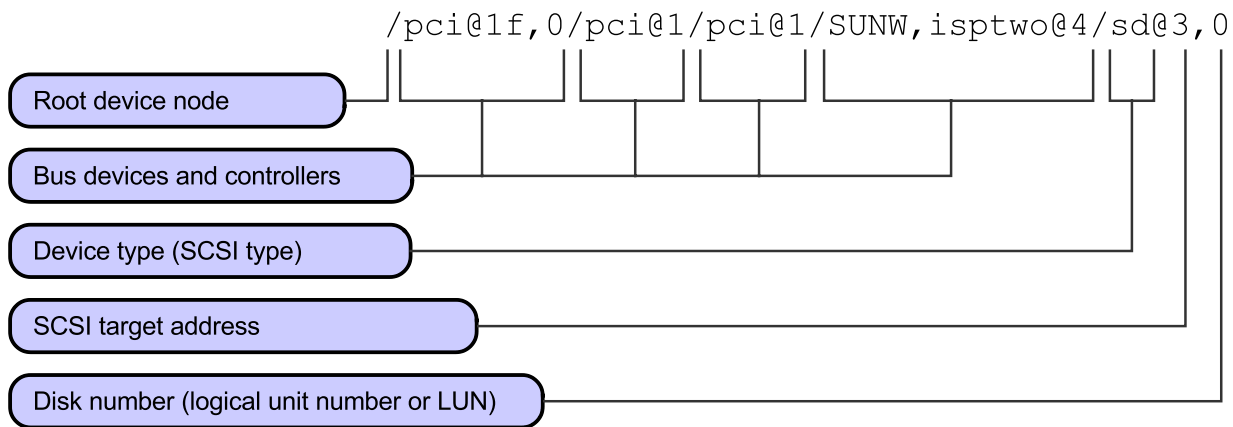


**Figure 8-8** Disk Device Path – Ultra Workstation With a PCI-SCSI Bus

## The show-devs Command

You use the `show-devs` command to view the entire device tree.

The following example shows output from the `show-devs` command.

```
ok show-devs
/SUNW,UltraSPARC-IIi@0,0
/pci@1f,0
/virtual-memory
/memory@0,10000000
/pci@1f,0/pci@1
/pci@1f,0/pci@1,1
/pci@1f,0/pci@1,1/ide@3
/pci@1f,0/pci@1,1/SUNW,m64B@2
/pci@1f,0/pci@1,1/network@1,1
/pci@1f,0/pci@1,1/ebus@1
/pci@1f,0/pci@1,1/ide@3/cdrom
/pci@1f,0/pci@1,1/ide@3/disk
/pci@1f,0/pci@1,1/ebus@1/SUNW,CS4231@14,200000
/pci@1f,0/pci@1,1/ebus@1/flashprom@10,0
/pci@1f,0/pci@1,1/ebus@1/eprom@14,0
/pci@1f,0/pci@1/pci@1
/pci@1f,0/pci@1/pci@1/SUNW,isptwo@4
(output truncated)
ok
```





**Note** – In addition to the `show-devs` command, use the following additional OpenBoot PROM commands to view specific device information: `show-ttys`, `show-displays`, `show-nets`, `show-disks`, and `show-tapes`.

## The `devalias` Command

To identify the current boot device alias for the system, use the `devalias` command.

The following example shows output from the `devalias` command.

```
ok devalias
screen          /pci@1f,0/pci@1,1/SUNW,m64B@2
net             /pci@1f,0/pci@1,1/network@1,1
cdrom           /pci@1f,0/pci@1,1/ide@3/cdrom@2,0:f
disk            /pci@1f,0/pci@1,1/ide@3/disk@0,0
disk3          /pci@1f,0/pci@1,1/ide@3/disk@3,0
disk2          /pci@1f,0/pci@1,1/ide@3/disk@2,0
disk1          /pci@1f,0/pci@1,1/ide@3/disk@1,0
disk0          /pci@1f,0/pci@1,1/ide@3/disk@0,0
ide            /pci@1f,0/pci@1,1/ide@3
floppy         /pci@1f,0/pci@1,1/ebus@1/fdthree
ttyb           /pci@1f,0/pci@1,1/ebus@1/se:b
ttya           /pci@1f,0/pci@1,1/ebus@1/se:a
keyboard!      /pci@1f,0/pci@1,1/ebus@1/su@14,3083f8:forcemode
keyboard       /pci@1f,0/pci@1,1/ebus@1/su@14,3083f8
mouse         /pci@1f,0/pci@1,1/ebus@1/su@14,3062f8
name          aliases
```

The left side of the command output lists the device alias names, and the right side of the output lists the physical address of each device.

Device aliases are hard-coded into the OpenBoot PROM firmware, and they are easier to remember and use than the physical device addresses. The `disk` device alias identifies the default boot device for the system.

The `boot-device` parameter sets the system's boot device in the NVRAM. By default, the `boot-device` parameter is set to `disk net`. You can view the system's boot device through commands from the `ok` prompt.

To boot the system from the default device, perform the `boot` command:

`ok boot`

## Creating and Removing Custom Device Aliases

A portion of the NVRAM called NVRAMRC contains registers to hold custom parameters and is also reserved for storing new device alias names. External devices do not, by default, have built-in device aliases associated with them.

The NVRAMRC is affected by the commands `nvalias` and `nvunalias`, as well as the parameter `use-nvramrc?`.

### The `nvalias` Command

You use the `nvalias` command to create a new device alias name to access a newly attached external device. The command format is:

```
nvalias aliasname device_path
```

The effect of the `nvalias` command is to store the following command line in the NVRAMRC:

```
dealias aliasname device_path
```

The following example shows how to add a new boot device alias, called `mydisk`, and boot the system from this new boot device alias.



---

**Note** – A shortcut provided with the `show-disks` command enables you to select a device and use the Control-Y keys to copy the device path onto the command line.

---

The example uses the `show-disks` command to select the device path for the disk being used. It then uses the `nvalias` command to create a new device alias called `mydisk`.

```
ok show-disks
a) /pci@1f,0/pci@1/scsi@1,1/disk
b) /pci@1f,0/pci@1/scsi@1/disk
c) /pci@1f,0/pci@1,1/ide@3/cdrom
d) /pci@1f,0/pci@1,1/ide@3/disk
e) /pci@1f,0/pci@1,1/ebus@1/fdthree@14,3023f0
q) NO SELECTION
Enter Selection, q to quit: d
/pci@1f,0/pci@1,1/ide@3/disk has been selected.
Type ^Y (Control-Y) to insert it in the command line.
e.g. ok nvalias mydev ^Y
      for creating devalias mydev for
/pci@1f,0/pci@1,1/ide@3/disk
ok nvalias mydisk ^y
```

To paste the device path for the selected disk, press Control-Y on the command line.

```
ok nvalias mydisk /pci@1f,0/pci@1,1/ide@3/disk@0,0
```



---

**Note** – When the device path has been pasted on the command line (by the Control-Y keys), the target number and logical unit number (LUN) must be added for the disk device, for example, `sd@0,0` or `disk@0,0`.

---

Set the `boot-device` parameter to the new value, in this case `mydisk`, and boot the system.

```
ok setenv boot-device mydisk
boot-device =          mydisk
ok boot
```

## The nvunalias Command

You use the `nvunalias` command to remove an alias name.

To remove a custom device alias name, use the following command format:

```
ok nvunalias aliasname
```



---

**Note** – The `nvunalias` command is the single exception to the rule that changes to NVRAM occur immediately and do not require a `reset-all` command.

---

In the example, you would use the `nvunalias` command to delete the alias name `mydisk` from NVRAMRC and use the `setenv` command to set the `boot-device` parameter to `disk`.

```
ok nvunalias mydisk
ok setenv boot-device disk
boot-device =          disk
ok reset-all
Resetting ...
```

## Viewing and Changing NVRAM Parameters From the Shell

Use the `/usr/sbin/eeprom` command to view and to change the NVRAM parameters while the Solaris OE is running.

### Using the `eeprom` Command

Be aware of the following guidelines when using the `eeprom` command:

- Only the `root` user can change the value of a parameter.
- You must enclose parameters with a trailing question mark in single quotation marks (single quotes) when the command is executed in the C shell.
- All changes are permanent. You cannot run a `reset` command to undo the parameter changes.

The following examples use the `eeprom` command to view and change NVRAM parameters.

- To list all of the parameters with their current values, perform the command:

```
# eeprom
```

- To list a single parameter and its value, in this case, the `boot-device` parameter, perform the command:

```
# eeprom boot-device
```

```
boot-device=disk
```

```
#
```

- To change the value of the default boot device to `disk2`, perform the command:

```
# eeprom boot-device=disk2
```

```
#
```

- To change the value of the `auto-boot?` parameter, perform the command:

```
# eeprom auto-boot?=true
```

```
#
```

## Interrupting an Unresponsive System

When a system freezes or stops responding to the keyboard, you might have to interrupt it. When you interrupt the system, all active processes stop immediately, and the processor services the OpenBoot PROM exclusively. It does not allow you to flush memory or to synchronize file systems.

## Aborting an Unresponsive System

To abort or interrupt an unresponsive system:

1. Attempt a remote login on the unresponsive system to locate and kill the offending process.
2. Attempt to reboot the unresponsive system gracefully.
3. Hold down the Stop-A key sequence on the keyboard of the unresponsive system. The system is placed at the ok prompt.



---

**Note** – If an ASCII terminal is being used as the system console, use the Break sequence keys.

---

4. Manually synchronize the file systems by using the OpenBoot PROM `sync` command.

ok **sync**

This command causes the syncing of file systems, a crash dump of memory, and then a reboot of the system.

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.



## Exercise: Using the OpenBoot PROM Commands (Level 1)

In this exercise, you use the OpenBoot PROM and Solaris OE commands to perform the tasks described in this module.

### Preparation

Refer to the lecture notes as necessary to perform the following tasks and answer the questions listed.

### Tasks

Complete the following tasks:

- Shut down the system to run level 0, and gather information about your system. Find out the following:
  - OpenBoot PROM revision
  - Megabytes of installed memory
  - System type
  - NVRAM serial number
  - Ethernet address
  - Host ID
- Set the `auto-boot?` parameter to `false`.  
(Steps 1–11 in the Level 2 lab)
- Create a new device alias called `mydisk` that uses the same device as the `disk` device alias. Verify the contents of the `nvrामrc` file, and verify how to set the `use-nvrामrc?` parameter.  
(Steps 12–17 in the Level 2 lab)

- Boot the system using the new alias. As the `root` user, use the `eeeprom` command to list all parameters. Set the `boot-device` parameter to the `mydisk` device alias.  
(Steps 18–22 in the Level 2 lab)
- Shut down the system to run level 0, and verify the change you made by using the `printenv` command. Remove the `mydisk` device alias. Reset the `boot-device` parameter to its default value, and boot the system.  
(Steps 23–31 in the Level 2 lab)

## Exercise: Using the OpenBoot PROM Commands (Level 2)

In this exercise, you use the OpenBoot PROM and Solaris OE commands to perform the tasks described in this module.

### Preparation

Refer to the lecture notes as necessary to perform the following tasks and answer the questions listed.

### Task Summary

In this exercise, you accomplish the following:

- Shut down the system to run level 0, and use the following commands to set parameters and gather basic information about your system.  
banner  
set-defaults  
help  
help file  
printenv  
setenv  
reset-all  
probe-scsi  
probe-scsi-all  
probe-ide
- Set the auto-boot? parameter to false.
- Create a new device alias called mydisk that uses the same device as the disk device alias. Verify the contents of the nvramrc file, and verify how to set the use-nvramrc? parameter.
- Boot the system using the new alias. As the root user, use the eeprom command to list all parameters. Set the boot-device parameter to the mydisk device alias.
- Shut down the system to run level 0, and verify the change you made by using the printenv command. Remove the mydisk device alias. Reset the boot-device parameter to its default value, and boot the system.

## Tasks

Complete the following steps:

1. If the Solaris OE is currently running, log in as the `root` user, and halt your system.
2. When the `ok` prompt appears, set the OpenBoot PROM parameters to their default values.
3. Use the `help` command to display the list of help topics.
4. Use the `help` command to display information about the `boot` command.

What does the `help` command list for `boot`?

5. Use the `banner` command to obtain the following information:

OpenBoot PROM revision:

Megabytes of installed memory:

System type:

NVRAM serial number:

Ethernet address:

Host ID:

6. Use the `printenv` command to display the list of OpenBoot PROM parameters. Record the current values for the following parameters:  
`output-device`  
`input-device`  
`auto-boot?`  
`boot-device`
7. Prevent the system from booting automatically after you use the `reset-all` command by setting the `auto-boot?` parameter to `false`.
8. Use the `reset-all` command to verify that the new `auto-boot?` value is in effect. The system should remain at the `ok` prompt after the `reset-all` command completes.
9. Use the `probe-scsi`, `probe-scsi-all`, and `probe-ide` commands to display the list of disk devices attached to your system. Not all of these commands are present on all systems.
10. What are the main differences that you see in the information that these commands display?

11. List the target number and device type (disk, tape, or CD-ROM) of all the devices shown by the `probe-scsi`, `probe-scsi-all`, and `probe-ide` commands.
12. Verify that your default boot-device is set to `disk net`.
13. Use the `devalias` command to display the full device path for the `disk` alias.

Record the path name reported:

14. Use the `show-disks` command to select the device path that relates to the disk recorded in Step 13, and use the `nvalias` command to create a new device alias called `mydisk`. Set the `mydisk` alias to the path and disk name you recorded in Step 13.

Remember to use the Control-Y key sequence to paste the disk path into your `nvalias` command. You must manually complete the path to specify the disk you want to use.

15. Verify that the new alias is correctly set.
16. Use the `printenv` command to display the contents of the `nvrarc` file.

What command does the `nvrarc` file contain that creates the `mydisk` alias?

17. Use the `printenv` command to display the setting of the `use-nvrarc?` parameter.

What is the current setting of the `use-nvrarc?` parameter?

18. Boot your system using the `mydisk` alias.
19. Log in as the `root` user on your system. Open a new terminal window.
20. Use the `eeeprom` command to list all NVRAM parameters.
21. Use the `eeeprom` command to list the setting of the `boot-device` parameter.
22. Use the `eeeprom` command to set the `boot-device` parameter to the alias `mydisk`.
23. Bring your system to run level 0.
24. Verify that the `eeeprom` command set the `boot-device` parameter to the alias `mydisk`.
25. Set the `boot-device` parameter to its default value, and verify the setting.
26. Use the `nvunalias` command to remove the alias `mydisk`.

27. Verify that the `mydisk` alias is no longer in the `nvrामrc` file.
28. Use the `devalias` command to see if the `mydisk` alias has been removed from the list of device aliases.  
Has it?
29. Run the `reset -all` command, and then check again if the `mydisk` alias has been removed from the list of device aliases.  
(If your system reboots, interrupt the reboot with a Stop-A key sequence.)  
Has it?
30. Set the OpenBoot PROM parameters back to their default values, and boot the system from the default device.
31. Log in as the `root` user.

## Exercise: Using the OpenBoot PROM Commands (Level 3)

In this exercise, you use the OpenBoot PROM and Solaris OE commands to perform the tasks described in this module.

### Preparation

Refer to the lecture notes as necessary to perform the following tasks and answer the questions listed.

### Task Summary

In this exercise, you accomplish the following:

- Shut down the system to run level 0, and use the following commands to set parameters and gather basic information about your system.  
banner  
set-defaults  
help  
help file  
printenv  
setenv  
reset-all  
probe-scsi  
probe-scsi-all  
probe-ide
- Set the auto-boot? parameter to false.
- Create a new device alias called mydisk that uses the same device as the disk device alias. Verify the contents of the nvramrc file, and verify how to set the use-nvramrc? parameter.
- Boot the system using the new alias. As the root user, use the eeprom command to list all parameters. Set the boot-device parameter to the mydisk device alias.
- Shut down the system to run level 0, and verify the change you made by using the printenv command. Remove the mydisk device alias. Reset the boot-device parameter to its default value, and boot the system.

## Tasks and Solutions

Complete the following steps:

1. If the Solaris OE is currently running, log in as the `root` user, and halt your system.

`# init 0`

2. When the `ok` prompt appears, set the OpenBoot PROM parameters to their default values.

`ok set-defaults`

3. Use the `help` command to display the list of help topics.

`ok help`

4. Use the `help` command to display information about the `boot` command.

`ok help boot`

What does the `help` command list for `boot`?

`boot` – *Default boot (values specified in NVRAM variables).*

`boot <network-device>:[dhcp,][server-ip], [boot-filename], [client-ip], [router-ip], [boot-retries], [tftp-retries], [subnet-mask], [boot-arguments].`

5. Use the `banner` command to obtain the following information:

OpenBoot PROM revision:

Megabytes of installed memory:

System type:

NVRAM serial number:

Ethernet address:

Host ID:

*Each system presents its own unique information.*

6. Use the `printenv` command to display the list of OpenBoot PROM parameters. Record the current values for the following parameters:

`ok printenv`

|                            |                         |
|----------------------------|-------------------------|
| <code>output-device</code> | – <code>screen</code>   |
| <code>input-device</code>  | – <code>keyboard</code> |
| <code>auto-boot?</code>    | – <code>true</code>     |
| <code>boot-device</code>   | – <code>disk net</code> |



7. Prevent the system from booting automatically after using the `reset-all` command by setting the `auto-boot?` parameter to `false`.

ok **setenv auto-boot? false**

8. Use the `reset-all` command to verify that the new `auto-boot?` value is in effect. The system should remain at the `ok` prompt after the `reset-all` command completes.

ok **reset-all**

9. Use the `probe-scsi`, `probe-scsi-all`, and `probe-ide` commands to display the list of disk devices attached to your system. Not all of these commands are present on all systems.

ok **probe-scsi**

ok **probe-scsi-all**

ok **probe-ide**

10. What are the main differences that you see in the information that these commands display?

*The `probe-scsi-all` command lists all devices on all SCSI chains and their full device paths. The `probe-scsi` command only lists devices on the first SCSI chain and does not list the full device paths. The `probe-ide` command reports the list of IDE devices attached to the system.*

11. List the target number and device type (disk, tape, or CD-ROM) of all the devices shown by the `probe-scsi`, `probe-scsi-all`, and `probe-ide` commands.

*Each system presents its own unique information.*

12. Verify that your default boot-device is set to `disk` or `net`.

ok **printenv boot-device**

13. Use the `devalias` command to display the full device path for the `disk` alias.

ok **devalias disk**

Record the path name reported:

*This differs from system to system. On an Ultra 5 workstation, the alias is defined as follows:*

`/pci@1f,0/pci@1,1/ide@3/disk@0,0`

14. Use the `show-disks` command to select the device path that relates to the disk recorded in Step 13, and use the `nvalias` command to create a new device alias called `mydisk`. Set the `mydisk` alias to the path and disk name you recorded in Step 13.

Remember to use the Control-Y key sequence to paste the disk path into your `nvalias` command. You must manually complete the path to specify the disk you want to use.

ok **show-disks**

(select one of the disks from the list)

ok **nvalias mydisk *pathname@#,#***

15. Verify that the new alias is correctly set.

ok **devalias mydisk**

16. Use the `printenv` command to display the contents of the `nvrarc` file.

ok **printenv nvrarc**

What command does the `nvrarc` file contain that creates the `mydisk` alias?

*Systems differ according to the disk devices they use. An Ultra 5 workstation would report the following:*

```
devalias mydisk /pci@1f,0/pci@1,1/ide@3/disk@0,0
```

17. Use the `printenv` command to display the setting of the `use-nvrarc?` parameter.

ok **printenv use-nvrarc?**

What is the current setting of the `use-nvrarc?` parameter?

true

18. Boot your system using the `mydisk` alias.

ok **boot mydisk**

19. Log in as the `root` user on your system. Open a new terminal window.

20. Use the `eeeprom` command to list all NVRAM parameters.

# **eeeprom**

21. Use the `eeeprom` command to list the setting of the `boot-device` parameter.

# **eeeprom boot-device**

22. Use the `eeeprom` command to set the `boot-device` parameter to the alias `mydisk`.

# **eeeprom boot-device=mydisk**

23. Bring your system to run level 0.

# **init 0**

24. Verify that the `eeeprom` command set the `boot-device` parameter to the alias `mydisk`.

ok **printenv boot-device**

25. Set the `boot-device` parameter to its default value, and verify the setting.

ok **set-default boot-device**

ok **printenv boot-device**

26. Use the `nvunalias` command to remove the alias `mydisk`.

ok **nvunalias mydisk**

27. Verify that the `mydisk` alias is no longer in the `nvrnrc` file.

ok **printenv nvrnrc**

28. Use the `devalias` command to see if the `mydisk` alias has been removed from the list of device aliases.

ok **devalias mydisk**

Has it?

*No*

29. Run the `reset-all` command, and then check again if the `mydisk` alias has been removed from the list of device aliases.

ok **reset-all**

(If your system reboots, interrupt the reboot with a Stop-A key sequence.)

ok **devalias mydisk**

Has it?

*Yes*

30. Set the OpenBoot PROM parameters back to their default values, and boot the system from the default device.

ok **set-defaults**

ok **reset-all**

31. Log in as the `root` user.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

# Performing Boot and Shutdown Procedures

---

## Objectives

Upon completion of this module, you should be able to:

- Identify run level fundamentals
- Identify the phases of the boot process
- Control boot processes
- Perform system shutdown procedures

The following course map shows how this module fits into the current instructional goal.

### Performing System Boot Procedures

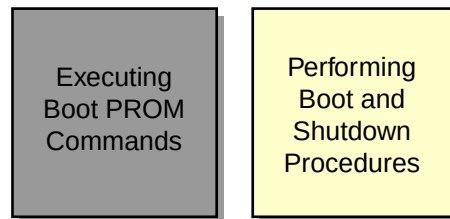


**Figure 9-1** Course Map

## Identifying Run Level Fundamentals

A run level is a system state, represented by a digit or letter, that defines what services and resources are currently available to users. The system is always running in a single run level.

### Solaris OE Run Levels

Table 9-1 shows the eight run levels found in the Solaris OE.

**Table 9-1** Solaris OE Run Levels

| Run Level | Function                                                                                                                                                                                                                    |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0         | System is running the PROM monitor.                                                                                                                                                                                         |
| s or S    | Solaris OE single-user mode with critical file systems mounted and accessible.                                                                                                                                              |
| 1         | The system is running in a single-user administrative state with access to all available file systems.                                                                                                                      |
| 2         | The system is supporting multiuser operations. Multiple users can access the system. All system daemons are running except for the Network File System (NFS) server and some other network resource server related daemons. |
| 3         | The system is supporting multiuser operations and has NFS resource sharing and other network resource servers available. Specified as the default run level in the <code>/etc/inittab</code> file.                          |
| 4         | This level is currently not implemented.                                                                                                                                                                                    |
| 5         | A transitional run level in which the Solaris OE is shut down and the system is powered off.                                                                                                                                |
| 6         | A transitional run level in which the Solaris OE is shut down and the system reboots to the default run level.                                                                                                              |

## Determining a System's Current Run Level

To determine the current run level of a system, use the `who -r` command.

Figure 9-2 shows output from the command.

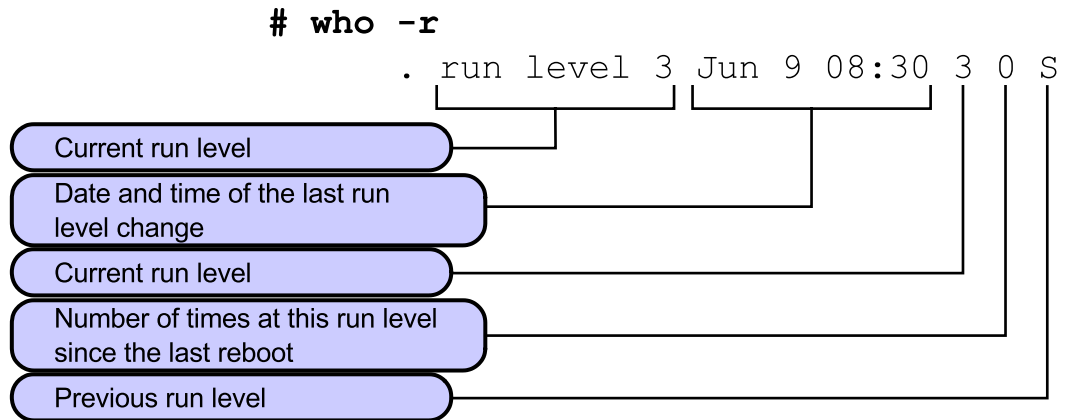


**Figure 9-2** The System's Current Run Level

## Changing Run Levels

Run levels are sometimes referred to as `init` states because the `init` process transitions between run levels. You can use the `init` command to manually initiate run-level transitions. You can also change run levels with the `shutdown`, `halt`, `reboot`, and `poweroff` commands.

## Identifying the Phases of the Boot Process

In general, when a system is powered on, the PROM monitor runs a POST procedure that checks the hardware and memory on the system. If no errors are found, and the `auto-boot?` parameter is set to true, the system begins the automatic boot process.

The entire boot process is described by four distinct phases:

- The boot PROM phase
- The boot programs phase
- The kernel initialization phase
- The init phase

Figure 9-3 shows the phases of the boot process.

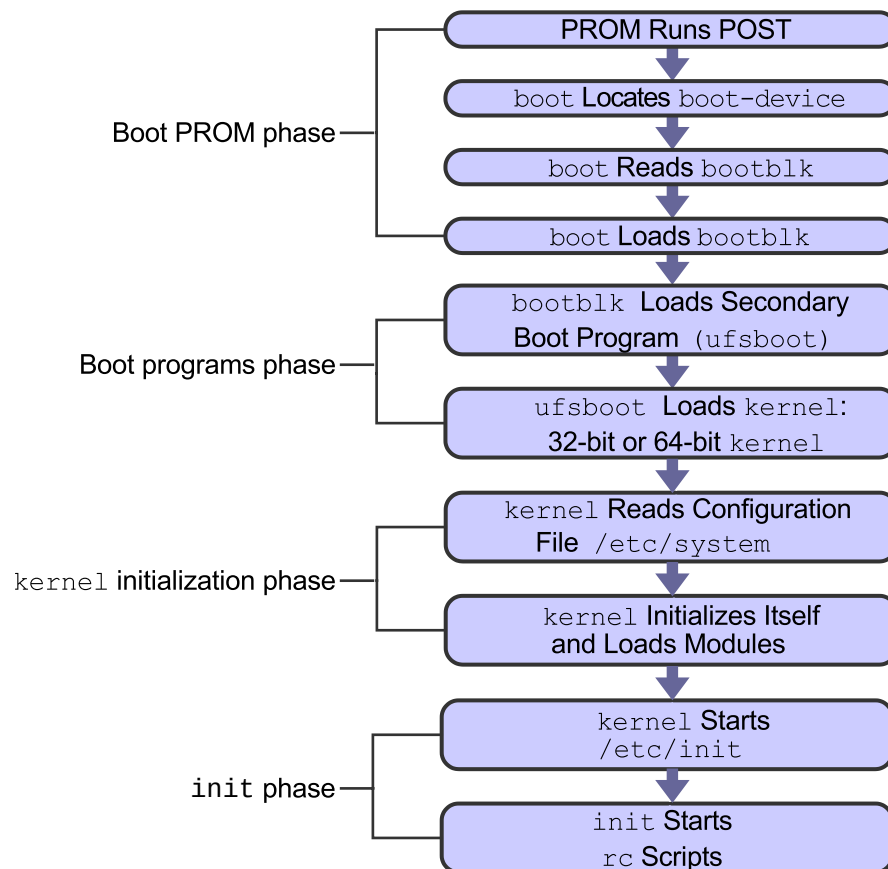


**Figure 9-3** Phases of the Boot Process



## Boot PROM Phase

The boot PROM performs the following steps during the first part of the boot sequence:

- The PROM runs the POST.  
The boot PROM firmware runs the POST to verify the system's hardware and memory. It then begins its boot sequence upon successful completion of the self-test diagnostics.
- The PROM displays the system identification banner.  
The model type, processor type and speed, keyboard status, PROM revision number, amount of installed random access memory (RAM), NVRAM serial number, Ethernet address, and host ID are displayed.
- The boot PROM determines the boot device by reading the PROM parameter `boot-device`.
- The boot PROM reads the disk label located at Sector 0 on the default boot device.
- The boot PROM finds the `boot` program from the default boot device programmed into the PROM.  
The boot PROM program reads a system's primary boot program called `bootblk` (located at Sectors 1 through 15) that contains a UNIX file system (`ufs`) file system reader. (The `bootblk` program is placed on the disk by the `installboot` program during system installation.)  
The `boot` command loads the `bootblk` program from its location on the boot device into memory.

## Boot Programs Phase

The following describes the boot programs phase:

- The `bootblk` program loads the secondary boot program, `ufsboot`, from the boot device into memory.  
The path to `ufsboot` is recorded in the `bootblk` program, which is installed by the Solaris OE utility `installboot`.
- The `ufsboot` program locates and loads the appropriate two-part kernel.

The core of the kernel is two pieces of static code called `genunix` and `unix`, where `genunix` is the platform-independent generic kernel file and `unix` is the platform-specific kernel file.

When `ufsboot` loads these two files into memory, they are combined to form the running kernel.

On a system running in 32-bit mode, the two-part kernel is located in the directory `/platform/'uname -m'/kernel`.

On a system running in 64-bit mode, the two-part kernel is located in the directory `/platform/'uname -m'/kernel/sparcv9`.



---

**Note** – To determine the platform name (for example, the system hardware class), type the `uname -m` command. For example, when you type this command on an Ultra 10 workstation, the console displays `sun4u`.

---

## The kernel Initialization Phase

The following describes the kernel initialization phase:

- The kernel reads its configuration file, called `/etc/system`.
- The kernel initializes itself and begins loading modules.

The kernel uses the `ufsboot` command to load the files. When it has loaded enough modules to mount the root file system, it unmaps the `ufsboot` program and continues.

- The kernel starts the `/etc/init` process.



---

**Note** – The `/etc/init` and `/sbin/init` processes are linked together.

---

The SunOS™ kernel is a small static core, consisting of `genunix` and `unix` and many dynamically loadable kernel modules.

Modules can consist of device drivers, binary files to support file systems, and streams, as well as other module types used for specific tasks within the system.

The modules that make up the kernel typically reside in the directories `/kernel` and `/usr/kernel`. Platform-dependent modules reside in the `/platform/'uname -m'/kernel` and `/platform/'uname -i'/kernel` directories.

Each subdirectory located under these directories (see Figure 9-4) is a collection of similar modules.

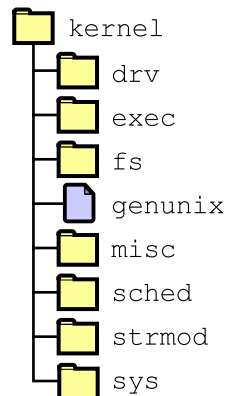


**Figure 9-4** Module Subdirectories in the /kernel Directory

The following describes the types of module subdirectories contained in the /kernel, /usr/kernel, /platform/'uname -m'/kernel, or /platform/'uname -i'/kernel directories:

- drv – Device drivers
- exec – Executable file formats
- fs – File system types, for example, ufs, nfs, and proc
- misc – Miscellaneous modules (virtual swap)
- sched – Scheduling classes (process execution scheduling)
- strmod – Streams modules (generalized connection between users and device drivers)
- sys – System calls (defined interfaces for applications to use)

The /kernel/drv directory contains all of the device drivers that are used for system boot. The /usr/kernel/drv directory is used for all other device drivers.

Modules are loaded automatically as needed either at boot time or on demand, if requested by an application. When a module is no longer in use, it might be unloaded on the basis that the memory it uses is needed for another task.

After the boot process is complete, device drivers are loaded when devices, such as tape devices, are accessed. This process is called autoconfiguration because some kernel driver modules are loaded automatically when needed.

Upon initial or reconfiguration boot, the system does a self-test and checks for all devices that are attached.

The advantage of this dynamic kernel arrangement is that the overall size of the kernel is smaller, which makes more efficient use of memory and allows for simpler modification and tuning. Figure 9-5 shows this arrangement.

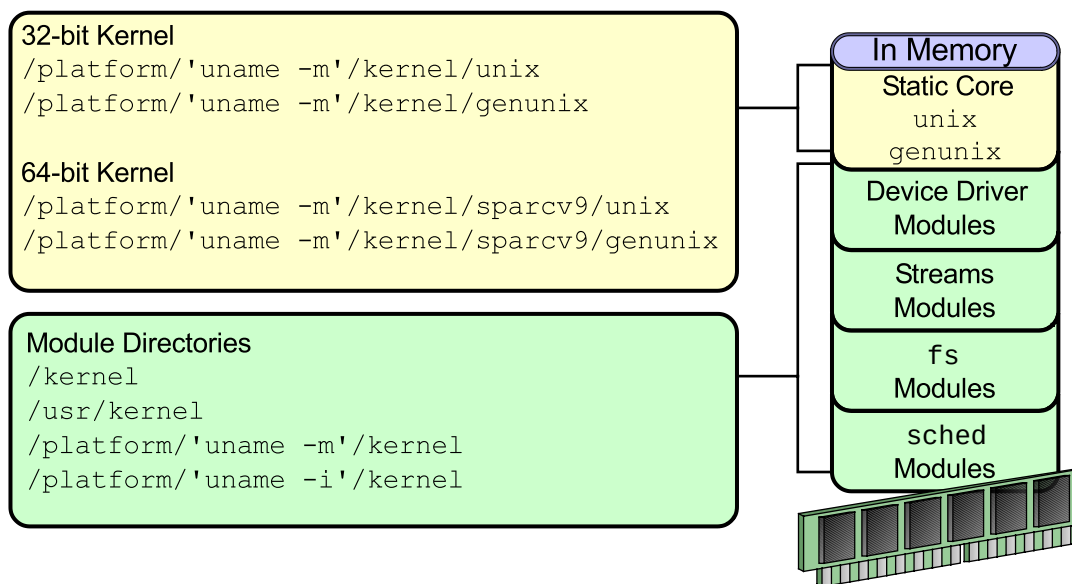


**Figure 9-5** The kernel and Modules Loaded In Memory

**Note** – The sparcv9 CPU is the type of CPU that supports 64-bit processing.

## The /etc/system File and kernel Configuration

**Caution** – The Solaris OE builds the kernel based upon the size of the system (memory, CPUs, and so on). In almost all cases, the performance of the default kernel that is built is quite adequate to handle most day to day activities on the system. Any modifications should be made with extreme caution.

The /etc/system file is the control file for modifying which modules and parameters are to be loaded by the kernel at boot time. By default, all lines in this file are commented out.

Modifying the kernel's behavior (or configuration) requires editing the `/etc/system` file. Altering this file allows you to modify the kernel's treatment of loadable modules as well as to modify kernel parameters for some performance tuning.

The `ufsboot` program contains a list of default loadable kernel modules that are loaded at boot time. However, you can override this list by modifying the `/etc/system` file to control which modules, as well as which parameters, are loaded.

All changes to this file take effect after a reboot.

The `/etc/system` file can explicitly control:

- The search path for default kernel modules to be loaded at boot time
- The root file system type and device
- The modules that are excluded from loading automatically at boot time
- The modules to be forcibly loaded at boot time, rather than at first access
- The new values to override the default kernel parameter values



---

**Note** – Command lines must be 80 characters or less in length, and comment lines must begin with an asterisk (\*) and end with a newline character.

---

The `/etc/system` file is divided into five distinct sections:

- `moddir:`  
Sets the search path for default loadable kernel modules. You can list together multiple directories to search, delimited either by blank spaces or colons. If the module is not found in the first directory, the second directory is searched, and so on.

- **root device and root file system configuration:**  
Sets the root file system type to the listed value. The default is `rootfs:ufs`.  
Sets the root device. The default is the physical path name of the device on which the boot program resides. The physical path name is platform dependent and configuration dependent. The following is an example path:  
`rootdev:/sbus@1,f8000000/esp@0,800000/sd@3,0:a`
- **exclude:**  
Does not allow the loadable kernel modules to be loaded during kernel initialization, for example:  
`exclude: sys/shmsys`
- **forceload:**  
Forces the kernel modules to be loaded during kernel initialization, for example:  
`forceload: drv/vx`  
The default action is to load a kernel module automatically when its services are first accessed during runtime by a user or an application.
- **set:**  
Changes kernel parameters to modify the operation of the system, for example:  
`set maxusers=40`

## Editing the /etc/system File

Before you edit the `/etc/system` file, you should make a backup copy. If you enter incorrect values in this file, the system might not be able to boot.

The following example shows how to copy the original `/etc/system` file to a backup file and then edit the `/etc/system` file.

```
# cp /etc/system /etc/system.orig  
# vi /etc/system
```

If a boot process fails because of an unusable `/etc/system` file, issue the interactive boot command: `boot -a`. When you are requested to enter the name of the `system` file, type in the name of your backup `system` file, or, alternatively, enter `/dev/null` for a null configuration file.

## The init Phase

The final phase of the boot process is the `init` phase. During this phase, the `init` daemon starts the run control (`rc`) scripts that start other processes. The `init` daemon is a general process spawner. Its primary role is to create processes from information stored in the file `/etc/inittab`.

The `init` daemon executes system startup (`rc`) scripts that, in turn, execute a series of other scripts.

After the `init` phase completes successfully, the default behavior is to display the system command-line login prompt or the GUI login window.

### The /etc/inittab File

When you boot a system or change run levels with the `init` or `shutdown` command, the `init` daemon stops process, starts processes, or does both by reading information from the `/etc/inittab` file.

The `inittab` file defines three important items for the `init` process:

- The system's default run level
- What actions to take when the system enters a new run level
- What processes to start, monitor, or restart if terminated

Each line entry in the `/etc/inittab` file contains the following four fields:

*id:rstate:action:process*

Figure 9-6 shows an `inittab` entry.

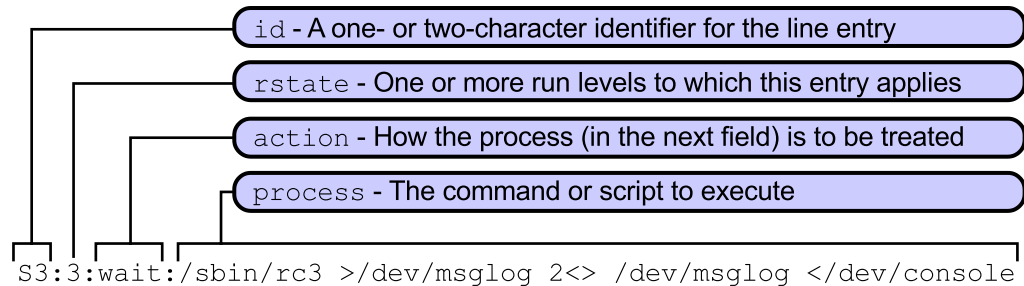


**Figure 9-6** An `/etc/inittab` File Entry



**Note** – Message output from `rc` scripts is directed to the `/dev/msglog` file. Prior to the Solaris 8 OE, all of these messages were written to the `/dev/console` file. The `/dev/msglog` file is used for message output collection from system startup or background applications.

Table 9-2 shows an explanation for each keyword.

**Table 9-2** The action Field Keywords

| Keyword                  | Explanation                                                                                                                                                                                                                                                 |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>initdefault</code> | Identifies the default run level. Read when the <code>init</code> process is initially invoked. Used by the <code>init</code> process to determine which run level to enter initially. The default is run level 3.                                          |
| <code>sysinit</code>     | Executes the process before the <code>init</code> process tries to access the console (for example, the console login prompt). The <code>init</code> process waits for completion of the process before it continues to read the <code>inittab</code> file. |
| <code>wait</code>        | Starts a process and waits for it to complete before moving to the next entry that contains the same run level.                                                                                                                                             |



**Table 9-2** The action Field Keywords (Continued)

| Keyword   | Explanation                                                                                                                                                                                                                                                                                                                      |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| respawn   | If the process dies, the <code>init</code> process restarts it. If the process does not exist, the <code>init</code> process starts it and continues reading the <code>inittab</code> file. If the process does exist, no action is required, and the <code>init</code> process continues reading the <code>inittab</code> file. |
| powerfail | Executes the process only if the <code>init</code> process receives a power fail signal.                                                                                                                                                                                                                                         |



**Caution** – If the `rstate` field is empty and the `initdefault` line is used, the `rstate` field is interpreted as `0123456`, and the `init` process enters run level 6 as the default. This causes the system to reboot continuously.



**Note** – Information about additional action keywords is available in the `inittab` man page.

The following is an example of a default `/etc/inittab` file.

```
ap::sysinit:/sbin/autopush -f /etc/iu.ap
ap::sysinit:/sbin/soconfig -f /etc/sock2path
fs::sysinit:/sbin/rcS sysinit >/dev/msglog 2< >/dev/msglog </dev/console
is:3:initdefault:
p3:s1234:powerfail:/usr/sbin/shutdown -y -i5 -g0 >/dev/msglog
2< >/dev/msglog
sS:s:wait:/sbin/rcS >/dev/msglog 2< >/dev/msglog </dev/console
s0:0:wait:/sbin/rc0 >/dev/msglog 2< >/dev/msglog </dev/console
s1:1:respawn:/sbin/rc1 >/dev/msglog 2< >/dev/msglog </dev/console
s2:23:wait:/sbin/rc2 >/dev/msglog 2< >/dev/msglog </dev/console
s3:3:wait:/sbin/rc3 >/dev/msglog 2< >/dev/msglog </dev/console
s5:5:wait:/sbin/rc5 >/dev/msglog 2< >/dev/msglog </dev/console
s6:6:wait:/sbin/rc6 >/dev/msglog 2< >/dev/msglog </dev/console
fw:0:wait:/sbin/uadmin 2 0 >/dev/msglog 2< >/dev/msglog </dev/console
of:5:wait:/sbin/uadmin 2 6 >/dev/msglog 2< >/dev/msglog </dev/console
rb:6:wait:/sbin/uadmin 2 1 >/dev/msglog 2< >/dev/msglog </dev/console
sc:234:respawn:/usr/lib/saf/sac -t 300
co:234:respawn:/usr/lib/saf/ttymon -g -h -p "'uname -n' console login: "
-T sun -d /dev/console -l console -m ldterm,ttcompat
```

The following describes each of the lines in the `inittab` file in order:

1. Initializes the streams modules
2. Configures the socket transport providers
3. Initializes the file systems
4. Defines the default run level
5. Describes a power fail shutdown
6. Defines single-user mode
7. Defines run level 0
8. Defines run level 1
9. Defines run level 2
10. Defines run level 3
11. Defines run level 5
12. Defines run level 6
13. Defines the transition to firmware
14. Defines the transition to power off
15. Defines the transition to reboot
16. Initializes the service access controller
17. Initializes the `ttymon` port monitor, which places a command-line login prompt to the console

## The init Process

Figure 9-7 shows the process of bringing a system to the default run level 3.

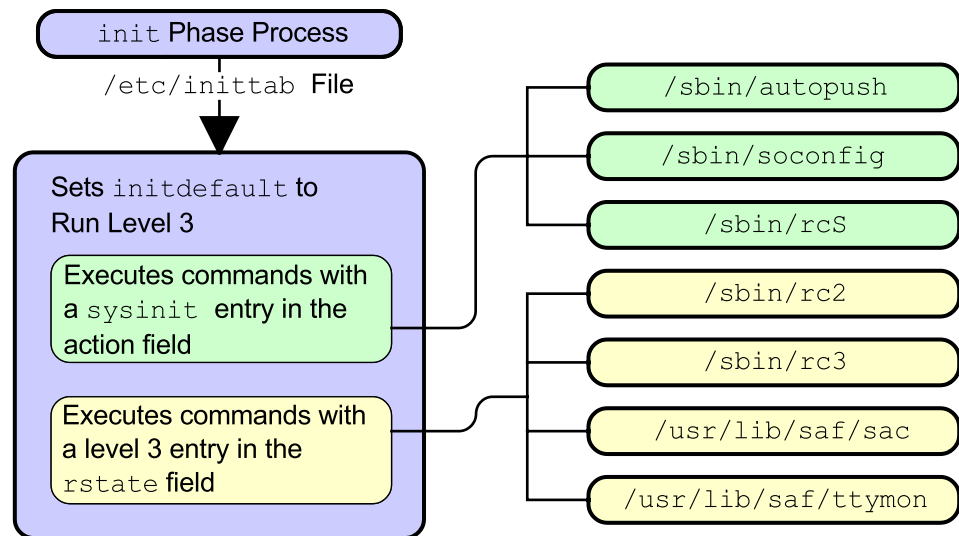


**Figure 9-7** The init Process

The `init` process reads the `/etc/inittab` file to do the following:

1. Identify the `initdefault` entry, which defines the default run level, 3.
2. Execute any process entries that have `sysinit` in the `action` field so that any special initialization can take place before users log in. This includes the execution of `/sbin/rcS`, which mounts and checks the `/` (root), `/usr`, `/var`, and `/var/adm` file systems.
3. Execute any process entries that have 3 in the `rstate` field and an appropriate keyword in the `action` field, which match the default run level, 3.

The commands executed at this run level include:

- `/usr/sbin/shutdown` – The `init` process runs the shutdown command only if the system has received a power fail signal.
- `/sbin/rc2` – Starts the system daemons, bringing the system up into run level 2 (multiuser mode).
- `/sbin/rc3` – Starts NFS and other network resource servers for run level 3.

- `/usr/lib/saf/sac` – Starts the port monitors for devices, such as ASCII terminals and modems.
- `/usr/lib/saf/ttymon` – Starts the `ttymon` process that monitors the console for login requests. The default `terminal_type` on all systems as listed in the `/etc/inittab` file is `sun`.

## Controlling Boot Processes

The Solaris OE provides a series of run control (rc) scripts to stop and start processes typically associated with run levels.

### The /sbin Directory

Each run level has an associated rc script located in the /sbin directory. Figure 9-8 shows the rc scripts associated with each run level in the /sbin directory and their inode numbers.

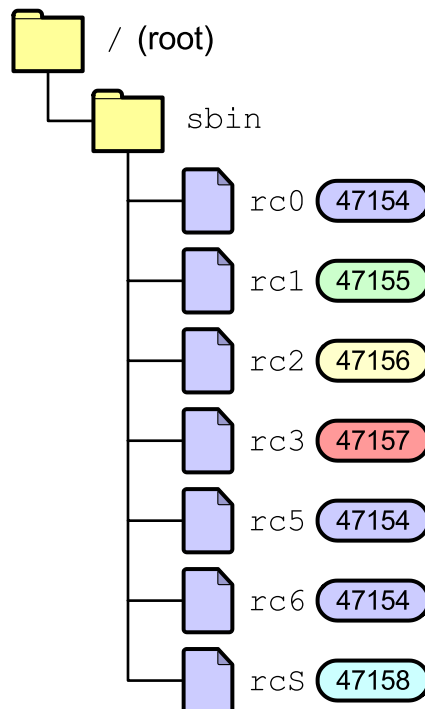


**Figure 9-8** The /sbin Directory With Inode Numbers

The rc scripts are executed by the `init` process to set up variables, test conditions, and make calls to other scripts that start and stop processes for that run level.

The rc scripts `rc0`, `rc5`, and `rc6` are hard-linked to each other. Notice each script is assigned the same inode number.

The following is an example of the hard links:

```
# cd /sbin
# ls -i rc*
47154 rc0          47156 rc2          47154 rc5          47158 rcS
47155 rc1          47157 rc3          47154 rc6
```

The Solaris OE provides the same series of rc scripts in the /etc directory for backward compatibility. These scripts are symbolic link files to the rc scripts in the /sbin directory.

The following example shows this connection:

```
# cd /etc
# ls -l rc?
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rc0 -> ../sbin/rc0
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rc1 -> ../sbin/rc1
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rc2 -> ../sbin/rc2
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rc3 -> ../sbin/rc3
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rc5 -> ../sbin/rc5
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rc6 -> ../sbin/rc6
lrwxrwxrwx 1 root root 11 Feb 22 14:19 rcS -> ../sbin/rcS
```

Table 9-3 summarizes the tasks performed by each of the /sbin rc scripts.

**Table 9-3** Run Control Scripts and Their Functions

| rc Script | Function                                                                                                                                                                                                                                                                                                                                                |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| /sbin/rc0 | <p>Runs the /etc/rc0.d/K* scripts and then the /etc/rc0.d/S* scripts to perform the following tasks:</p> <ul style="list-style-type: none"> <li>• Stops system services and daemons</li> <li>• Terminates all running processes</li> <li>• Unmounts all file systems</li> </ul> <p>Start scripts should only perform fast system cleanup functions.</p> |
| /sbin/rc1 | <p>Runs the /etc/rc1.d/S* scripts to perform the following tasks:</p> <ul style="list-style-type: none"> <li>• Stops system services and daemons</li> <li>• Terminates all running user processes</li> <li>• Unmounts all remote file systems</li> <li>• Mounts all local file systems if the previous run level was S</li> </ul>                       |

**Table 9-3** Run Control Scripts and Their Functions (Continued)

| <b>rc Script</b>                                 | <b>Function</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>/sbin/rc2</code>                           | Runs the <code>/etc/rc2.d/S*</code> scripts to perform the following tasks: <ul style="list-style-type: none"> <li>• Mounts all local file systems if the previous run level was S</li> <li>• Removes any files and subdirectories in the <code>/tmp</code> directory</li> <li>• Configures system accounting</li> <li>• Configures the default router</li> <li>• Starts most of the system daemons</li> </ul>                                                                                                                                                                                                                                        |
| <code>/sbin/rc3</code>                           | Runs the <code>/etc/rc3.d/K*</code> scripts and then the <code>/etc/rc3.d/S*</code> scripts to perform the following tasks: <ul style="list-style-type: none"> <li>• Cleans up the <code>/etc/dfs/sharetab</code> file</li> <li>• Shares all resources listed in the <code>/etc/dfs/dfstab</code> file</li> <li>• Starts the <code>nfsd</code> and <code>mountd</code> commands</li> </ul>                                                                                                                                                                                                                                                            |
| <code>/sbin/rc5</code><br><code>/sbin/rc6</code> | Runs the <code>/etc/rc0.d/K*</code> scripts and then the <code>/etc/rc0.d/S*</code> scripts to perform the following tasks: <ul style="list-style-type: none"> <li>• Stops system services and daemons</li> <li>• Terminates all running processes</li> <li>• Unmounts all file systems</li> <li>• Starts scripts that should only perform fast system cleanup functions</li> </ul>                                                                                                                                                                                                                                                                   |
| <code>/sbin/rcS</code>                           | Runs the <code>/etc/rcS.d</code> scripts to bring up the system to run level S: <ul style="list-style-type: none"> <li>• Establishes a minimal network</li> <li>• Mounts the <code>/usr</code>, <code>/var</code>, and <code>/var/adm</code> directories if they are separate file systems.</li> <li>• Sets the system name</li> <li>• Checks the <code>/</code> (root) and <code>/usr</code> file systems</li> <li>• Mounts pseudo file systems (<code>/proc</code> and <code>/dev/fd</code>)</li> <li>• Rebuilds the device entries for reconfiguration boots</li> <li>• Mounts other file systems that are required in single-user mode</li> </ul> |

## The /etc/rc#.d Directories

The /etc/rc#.d directories contain additional scripts that start and stop system processes for that run level.

Figure 9-9 shows an example of /etc/rc#.d directories.

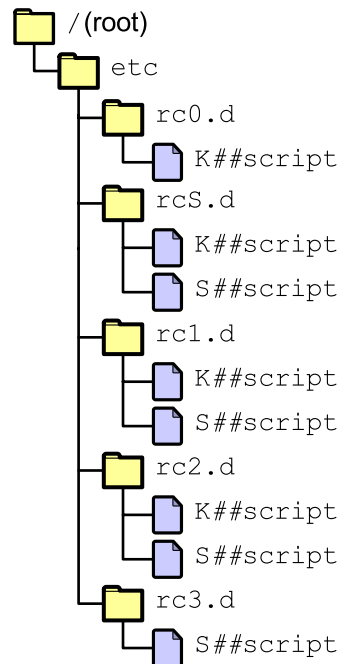


**Figure 9-9** The /etc/rc#.d Directories

For example, /etc/rc2.d contains scripts to start and stop processes for run level 2. The following output shows a partial list of these scripts.

```
# ls -l /etc/rc2.d
(some output omitted)
-rwxr--r--  6 root    sys      344 Jun 19 16:56 K06mipagent
-rwxr--r--  6 root    sys      404 Jun 19 17:27 K07snmpdx
-rwxr--r--  6 root    sys     2723 Jun 19 17:00 K28nfs.server
-rwxr--r--  2 root    sys     1597 Jun 19 17:00 S20syssetup
-rwxr--r--  2 root    sys      989 Jun 19 17:12 S21perf
-rwxr-xr-x  2 root    other   1995 Jun 25 00:09 S30sysid.net
```



## Start Run Control Scripts

The `/etc/rc#.d` start scripts are always run in the sort order shown by the `ls` command. The files that begin with `S` are run to start a system process. These scripts are called by the appropriate `/sbin/rc#` and this script passes the argument “start” to them if their names do not end in `.sh`. There are no arguments passed to `.sh` scripts. These files have names in the form of:

*S##name-of-script*

For example, the script that starts the line printer (LP) processes is named `S80lp`.

## Stop Run Control Scripts

The `/etc/rc#.d` stop scripts (also referred to as the kill scripts) are always run in the sort order shown by the `ls` command. The files that begin with `K` are run to stop or kill a system process. These scripts are called by the appropriate `/sbin/rc#`, and this script passes the argument “stop” to them if their names do not end in `.sh`.

These files have names in the form of:

*K##name-of-script*

For example, the script that stops the NFS server processes is called `K28nfs.server`.



---

**Note** – File names that begin with a lowercase `k` or `s` are ignored by the `init` process, and they are not executed. To disable a script, rename it with the appropriate lowercase letter.

---

## The /etc/init.d Directory

Run control scripts are located in the /etc/init.d directory.

The files shown in Figure 9-10 are hard-linked to corresponding run control scripts in the /etc/rc#.d directories.

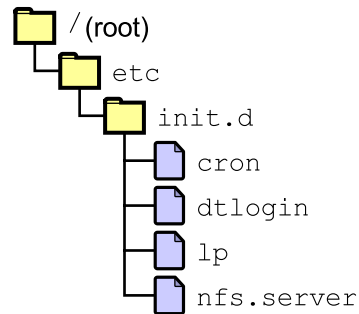


**Figure 9-10** The /etc/init.d Directory

The run control script /etc/init.d/cron is hard linked to the corresponding run control script /etc/rc2.d/S75cron, as shown by the `ls` commands:

```
# cd /etc/init.d
# ls -i cron
176404 cron
# cd /etc/rc2.d
# ls -i S75cron
176404 S75cron
```

The benefit of having individual scripts for each run level is that you can run scripts in the /etc/init.d directory individually as the root user.

You can stop a process or start a process without changing the system's run level.

For example, to stop and restart the LP print services, run the following scripts with a `stop` or `start` argument:

```
# /etc/init.d/lp stop
# /etc/init.d/lp start
```

## Creating New Run Control Scripts

You can create new scripts to start and stop additional processes or services to customize a system.

For example, to eliminate the requirement for a manual start of a database server, you could create a script to start the database server automatically after the appropriate network services have started.

You could then create another script to terminate this service and shut down the database server before the network services are stopped.

To add run control scripts to start and stop a service, create the script in the `/etc/init.d` directory and create links in the appropriate `/etc/rc#.d` directory for the run level in which the service is to be started and stopped.

Refer to the `README` file in each `/etc/rc#.d` directory for more information on run control scripts.

The following procedure describes how to add a run control script:

1. Create the script in the `/etc/init.d` directory.

```
# vi /etc/init.d/filename
# chmod 0744 /etc/init.d/filename
# chgrp sys /etc/init.d/filename
```

2. Create links to the appropriate `/etc/init.d` directory.

```
# cd /etc/init.d
# ln filename /etc/rc#.d/S##filename
# ln filename /etc/rc#.d/K##filename
```

3. Use the `ls` command to verify that the script has links in the appropriate directories.

```
# ls -li /etc/init.d/filename
# ls -li /etc/rc#.d/S##filename
# ls -li /etc/rc#.d/K##filename
```

4. Test the *filename* by performing the following commands:

```
# /etc/init.d/filename start
```

Figure 9-11 shows the run-level transitions that occur during the process of a system bootup or shutdown.

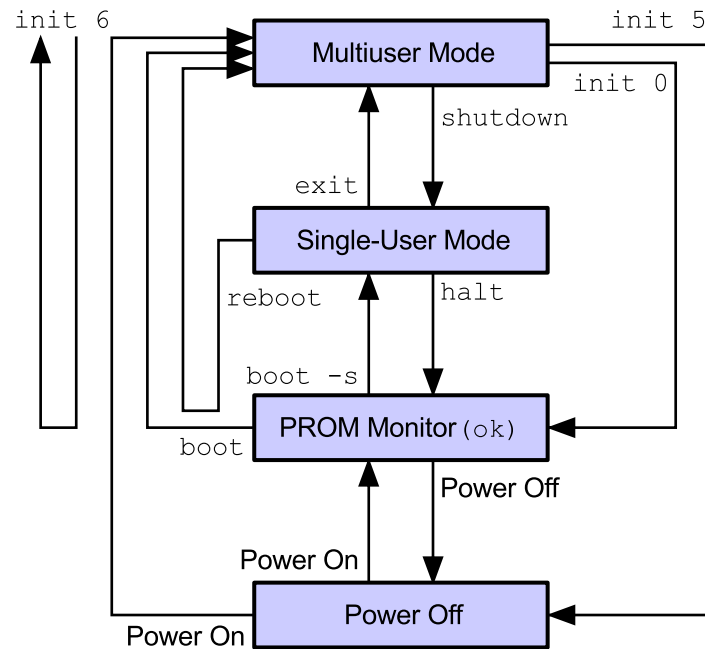


**Figure 9-11** Run-Level Transitions



**Note** – The `halt` and `reboot` commands shown in Figure 9-11 do not process the `inittab` file as the `init` and `shutdown` commands do. The `init` and `shutdown` commands are the preferred methods for transitioning between run states.

## Performing System Shutdown Procedures

You can shut down the Solaris OE to perform administration tasks or maintenance activities if you are anticipating a power outage or if you need to move the system to a new location.

The Solaris OE requires a clean and orderly shutdown, which stops processes, writes data in memory to disks, and unmounts file systems.

Of course, the type of work you need to do while the system is shut down determines how the system is shut down and which command you use.

The following describes the different types of system shutdowns.

- Shut down the system to single-user mode
- Shut down the system to stop the Solaris OE, and display the ok prompt
- Shut down the system and turn off power
- Shut down the system and automatically reboot to multiuser mode

The commands available to the root user for doing these types of system shutdown procedures include:

- /sbin/init (using run levels S, 0, 1, 2, 5, or 6)
- /usr/sbin/shutdown (using run levels S, 0, 1, 5, or 6)
- /usr/sbin/halt
- /usr/sbin/poweroff
- /usr/sbin/reboot

## The /usr/sbin/init Command

You use the `init` command to shut down, power off, or reboot a system in a clean and orderly manner. It executes the `rc0` kill scripts. However, this command does not warn logged-in users that the system is being shut down, and there is no grace period.

To shut down the system to single-user mode, use either run level S or 1.

# **init S**

To shut down the system to stop the Solaris OE and display the `ok` prompt, perform the command:

# **init 0**

To shut down the system and turn its power off, perform the command:

# **init 5**

To shut down the system and then reboot to multiuser mode, perform the command:

# **init 6**

## The /usr/sbin/shutdown Command

The `shutdown` command is a script that invokes the `init` daemon to shut down, power off, or reboot the system. It executes the `rc0` kill scripts to shut down processes and applications gracefully. But unlike the `init` command, the `shutdown` command does the following:

- Notifies all logged-in users that the system is being shut down
- Delays the shutdown for 60 seconds by default
- Enables you to include an optional descriptive message to inform your users of what will transpire

The command format for the `shutdown` command is:

```
shutdown -y -g grace-period -i init-state  
optional message
```

The `-y` option pre-answers the final shutdown confirmation question so that the command runs without your intervention.

The `-g grace-period` allows you to change the number of seconds from the 60-second default.

The `-i init-state` specifies the run-level that the `init` process is to attain. By default, system state S is used.



---

**Note** – If the shutdown command displays the error message: “shutdown: ‘i’ - unknown flag,” it indicates that the shell has located and executed the `/usr/ucb/shutdown` command. Reissue the command using its full path (for example, `/usr/sbin/shutdown`), or set the `PATH` variable to ensure `/usr/sbin` comes before `/usr/ucb`.

---

To shut down the system to single-user mode, enter the `shutdown` command without options.

```
# shutdown
```

To shut down the system to stop the Solaris OE, and display the `ok` prompt, perform the command:

```
# shutdown -i0
```

To shut down the system and turn off its power automatically, perform the command:

```
# shutdown -i5
```

To shut down the system and then reboot to multiuser mode, perform the command:

```
# shutdown -i6
```

The `-i` option can be used with other command options. For example, to shut down the system and then reboot to multiuser mode, answer yes to the questions presented, provide a grace period of two minutes, and provide a message to the users, perform the command:

```
# shutdown -y -g120 -i6 "The system is being rebooted"
```

## The /usr/sbin/halt Command

The `halt` command performs an immediate system shutdown. It does not execute the `rc0` kill scripts. It does not notify logged-in users, and there is no grace period.

To shut down the system, stop the Solaris OE, and display the `ok` prompt, perform the command:

```
# halt
```

## The /usr/sbin/poweroff Command

The `poweroff` command performs an immediate shutdown. It does not execute the `rc0` kill scripts. It does not notify logged-in users, and there is no grace period.

To shut down the system and turn off its power, perform the command:

```
# poweroff
```

## The /usr/sbin/reboot Command

The `reboot` command performs an immediate shutdown and reinitialization, bringing the system to run level 3 by default. The `reboot` command differs from the `init 6` command because it does not execute the `rc0` kill scripts.

To shut down the system and then reboot to multiuser mode, perform the `reboot` command without options:

```
# reboot
```



## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Controlling the Boot Process (Level 1)

In this exercise, you create a new startup script, make changes in the `/etc/system` file, and observe their effects.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed.

Your instructor should provide you with instructions on how to obtain a script called “`banner`” that will be used during this exercise.

### Tasks

Complete the following tasks:

- In the `/etc/rc2.d` directory, create a hard link to the `/etc/init.d/banner` file, called `S22banner`. In the `/etc/rcS.d` directory, create a hard link to the `/etc/init.d/banner` file called `K99banner`.  
(Steps 1–5 in the Level 2 lab)
- Reboot the system, and verify that `S22banner` runs. Shut down the system to run level S, and verify that `K99banner` runs. Change back to run level 3. Make a backup copy of the `/etc/system` file. Check if any instances of the `st` driver are loaded. Modify the `/etc/system` file to force-load the `st` driver. Reboot the system, and verify that `st` driver instances are loaded.  
(Steps 6–10 in the Level 2 lab)
- Edit the `/etc/system` file to exclude the boot disk driver for your system (either `dad` or `sd`). Shut down the system to run level 0, and attempt to boot it. Make note of what happens. Interactively boot your system, and return it to an operational state.  
(Steps 11–14 in the Level 2 lab)

## Exercise: Controlling the Boot Process (Level 2)

In this exercise, you create a new startup script, make changes in the `/etc/system` file, and observe their effects.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed.

Your instructor should provide you with instructions on how to obtain a script called `banner` that will be used during this exercise.

### Task Summary

In this exercise, you accomplish the following:

- In the `/etc/rc2.d` directory, create a hard link to the `/etc/init.d/banner` file, called `S22banner`. In the `/etc/rcS.d` directory, create a hard link to the `/etc/init.d/banner` file called `K99banner`.
- Reboot the system, and verify that `S22banner` runs. Shut down the system to run level `S`, and verify that `K99banner` runs. Change back to run level `3`. Make a backup copy of the `/etc/system` file. Check if any instances of the `st` driver are loaded. Modify the `/etc/system` file to force-load the `st` driver. Reboot the system, and verify that `st` driver instances are loaded.
- Edit the `/etc/system` file to exclude the boot disk driver for your system (either `dad` or `sd`). Shut down the system to run level `0`, and attempt to boot it. Make note of what happens. Boot the system using the `-a` option of the `boot` command. Use your backup of the `/etc/system` file as required. Replace the `/etc/system` file with your backup when finished, and reboot the system.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change the directory to `/etc/init.d`. Make sure that the `banner` script your instructor provided you is present and executable.
2. Verify that the script runs with both the `start` and `stop` arguments.
3. Change the directory to `/etc/rc2.d`. Create a hard link called `S22banner` that points to the same data as the `/etc/init.d/banner` file.
4. Change the directory to the `/etc/rcS.d` directory. Create a hard link called `K99banner` that points to the same data as the `/etc/init.d/banner` file.
5. Reboot the system, and watch for the output of the script you just installed.

Does the startup message from `S22banner` appear?

6. Log in as the `root` user, and open a terminal window. Use the `init` command to change to run level `S`.

Does the shutdown message from `K99banner` appear?

7. Type the password for the `root` user to log in at the command line. Change to run level `3`.
8. Log in as the `root` user, and open a terminal window. Change the directory to `/etc`.
9. Make a backup copy of the `/etc/system` file, and name the backup file `system.orig`.
10. If your system uses a SCSI tape device, perform the following:
  - a. Log in as the `root` user, and open a terminal window. Use the `prtconf` command to list instances of the `st` driver currently loaded.

How many instances are reported?
  - b. Edit the `/etc/system` file so that it includes the following line:  
`forceload: drv/st`

Then reboot the system.
  - c. Log in as `root`, and open a terminal window. Again list instances of the `st` driver currently loaded.

How many instances are reported?

11. Edit the `/etc/system` file so that it excludes the main disk driver for your system.

On systems using SCSI disks, add the following:

`exclude: drv/sd`

On systems using IDE disks, add the following:

`exclude: drv/dad`

12. Shut down the system to run level 0, and then attempt to boot it again.

What happened?

13. Use the `boot -a` command to boot the system, and supply the name of your backup file called `etc/system.orig` (note there is *not* a leading slash to the `etc`). Press the Return key to accept the default values for all other boot parameters. For example:

ok **boot -a**

Enter filename [kernel/sparcv9/unix]: **<Return>**

Enter default directory for modules [/platform...]: **<Return>**

Name of system file [etc/system]: **etc/system.orig**

root filesystem type [ufs]: **<Return>**

Enter physical name of root device [/...]: **<Return>**

14. Log in as the `root` user, and open a terminal window. Copy the `/etc/system.orig` file to the `/etc/system` file. Reboot the system.

## Exercise: Controlling the Boot Process (Level 3)

In this exercise, you create a new startup script, make changes in the `/etc/system` file, and observe their effects.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed.

Your instructor should provide you with instructions on how to obtain a script called `banner` that will be used during this exercise.

### Task Summary

In this exercise, you accomplish the following:

- In the `/etc/rc2.d` directory, create a hard link to the `/etc/init.d/banner` file, called `S22banner`. In the `/etc/rcS.d` directory, create a hard link to the `/etc/init.d/banner` file called `K99banner`.
- Reboot the system, and verify that `S22banner` runs. Shut down the system to run level `S`, and verify that `K99banner` runs. Change back to run level `3`. Make a backup copy of the `/etc/system` file. Check if any instances of the `st` driver are loaded. Modify the `/etc/system` file to force-load the `st` driver. Reboot the system, and verify that `st` driver instances are loaded.
- Edit the `/etc/system` file to exclude the boot disk driver for your system (either `dad` or `sd`). Shut down the system to run level `0`, and attempt to boot it. Make note of what happens. Boot the system using the `-a` option of the `boot` command. Use your backup of the `/etc/system` file as required. Replace the `/etc/system` file with your backup when finished, and reboot the system.

## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change the directory to `/etc/init.d`. Make sure that the `banner` script your instructor provided you is present and executable.

```
# cd /etc/init.d
# ls -l banner
```

2. Make the `banner` script executable, and verify that it runs with both the `start` and `stop` arguments.

```
# ./banner start
# ./banner stop
```

3. Change the directory to the `/etc/rc2.d` directory. Create a hard link called `S22banner` that points to the same data as the `/etc/init.d/banner` file.

```
# cd /etc/rc2.d
# ln /etc/init.d/banner S22banner
```

4. Change the directory to the `/etc/rcS.d` directory. Create a hard link called `K99banner` that points to the same data as the `/etc/init.d/banner` file.

```
# cd /etc/rcS.d
# ln /etc/init.d/banner K99banner
```

5. Reboot the system, and watch for the output of the script you just installed.

```
# init 6
```

Does the startup message from `S22banner` appear?

Yes.

6. Log in as the `root` user, and open a terminal window. Use the `init` command to change to run level `S`.

```
# init S
```

Does the shutdown message from `K99banner` appear?

Yes.

7. Type the password for the `root` user to log in at the command line. Change to run level `3`.

```
# init 3
```

8. Log in as the `root` user, and open a terminal window. Change the directory to `/etc`.

**# cd /etc**

9. Make a backup copy of the `/etc/system` file, and name the backup file `system.orig`.

**# cp system system.orig**

10. If your system uses a SCSI tape device, perform the following:

- a. Log in as the `root` user, and open a terminal window. Use the `prtconf` command to list instances of the `st` driver currently loaded.

**# prtconf | grep "st, instance"**

How many instances are reported?

*None*

- b. Edit the `/etc/system` file so that it includes the following line:

`forceload: drv/st`

Then reboot the system.

**# init 6**

- c. Log in as `root`, and open a terminal window. Again list instances of the `st` driver currently loaded.

**# prtconf | grep "st, instance"**

How many instances are reported?

*The number varies depending on how many SCSI controllers are present. You should see Instances 0 through 6 for a system with one controller.*

11. Edit the `/etc/system` file so that it excludes the main disk driver for your system.

On systems using SCSI disks, add the following:

`exclude: drv/sd`

On systems using IDE disks, add the following:

`exclude: drv/dad`



12. Shut down the system to run level 0, and then attempt to boot it again.

```
# shutdown -y -i0 -g0
(shutdown messages)
ok boot
```

What happened?

*The system is unable to boot. Excluding this driver prevents you from using the boot disk so long as you use the same /etc/system file. You must boot using the -a option to be able to supply an alternative file for the /etc/system file.*

13. Use the **boot -a** command to boot the system, and supply the name of your backup file called **etc/system.orig** (Note there is *not* a leading slash to the **etc**). Press Return to accept the default values for all other boot parameters. For example:

```
ok boot -a
Enter filename [kernel/sparcv9/unix]: <Return>
Enter default directory for modules [/platform...]: <Return>
Name of system file [etc/system]: etc/system.orig
root filesystem type [ufs]: <Return>
Enter physical name of root device [/...]: <Return>
```

14. Log in as the **root** user, and open a terminal window. Copy the /etc/system.orig file to the /etc/system file. Reboot the system.

```
# cd /etc
# cp system.orig system
# init 6
```

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications

# Performing User Administration

---

## Objectives

Upon completion of this module, you should be able to:

- Describe user administration fundamentals
- Manage user accounts
- Manage initialization files

The following course map shows how this module fits into the current instructional goal.

### Performing User and Security Administration

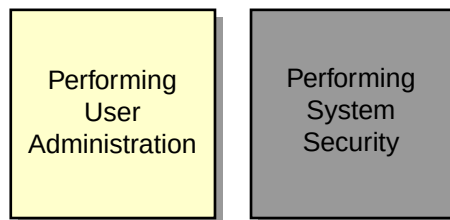


**Figure 10-1** Course Map

## Introducing User Administration

An important system administration task is setting up user accounts for each user who requires system access. Each user needs a unique account name, a user identification (UID) number, a home directory, and a login shell. You also have to determine which groups a user may access.

### Main Components of a User Account

The following is a list of the main components of a user account:

- User name – A unique name that a user enters to log in to a system. The user name is also called the login name.
- Password – A combination of six to eight letters, numbers, or special characters that a user enters with the login name to gain access to a system.
- UID number – A user account's unique numerical identification within the system.
- Group identification (GID) number – A unique numerical identification of the group to which the user belongs.



---

**Note** – You can add a user to predefined groups listed in the `/etc/group` file.

---

- Comment – Information that identifies the user. A comment generally contains the full name of the user and optional information, such as a phone number or a location.
- User's home directory – A directory into which the user is placed after login. The directory is provided to the user to store and create files.
- User's login shell – The user's work environment is set up by the initialization files that are defined by the user's login shell.
- Password aging – An optional feature to require users to change their passwords on a regular basis.

## System Files That Store User Account Information

The Solaris™ Operating Environment (Solaris OE) stores user account and group entry information in the following system files:

- /etc/passwd
- /etc/shadow
- /etc/group

Authorized system users have login account entries in the /etc/passwd file.

The /etc/shadow file is a separate file that contains the encrypted passwords. To further control user passwords, you can enforce password aging. This information is also maintained in the /etc/shadow file.

The /etc/group file defines the default system group entries. You use this file to create new group entries or modify existing group entries on the system.

### The /etc/passwd File

Due to the critical nature of the /etc/passwd file, you should refrain from editing this file directly. Instead, you should use the Solaris™ Management Console or command-line tools to maintain the file.

The following is an example of an /etc/passwd file that contains the default system account entries.

```
root:x:0:1:Super-User:/:/sbin/sh
daemon:x:1:1:/:
bin:x:2:2:/:usr/bin:
sys:x:3:3:/:
adm:x:4:4:Admin:/var/adm:
lp:x:71:8:Line Printer Admin:/usr/spool/lp:
uucp:x:5:5:uucp Admin:/usr/lib/uucp:
nuucp:x:9:9:uucp Admin:/var/spool/uucppublic:/usr/lib/uucp/uucico
smmsp:x:25:25:SendMail Message Submission Program:/:
listen:x:37:4:Network Admin:/usr/net/nls:
nobody:x:60001:60001:Nobody:/:
noaccess:x:60002:60002:No Access User:/:
nobody4:x:65534:65534:SunOS 4.x Nobody:/:
```

Each entry in the `/etc/passwd` file contains seven fields. A colon separates each field. The following is the format for an entry:

*loginID:x:UID:GID:comment:home\_directory:login\_shell*

10-1 defines the requirements for each of the seven fields.

**Table 10-1** Fields in the `/etc/passwd` File

| Field          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>loginID</i> | <p>Represents the user's login name. It should be unique to each user. The field should contain a string of no more than eight letters (A–Z, a–z) and numbers (0–9). The first character should be a letter, and at least one character should be lowercase.</p> <hr/> <p><b>Note</b> – Even though some programs allow a maximum of 32 characters, as well as user names that contain periods (.), underscores (_), and hyphens (-), this practice is not recommended and might cause problems with other programs.</p>                                                                                                                                                                                           |
| <i>x</i>       | <p>Represents a placeholder for the user's encrypted password, which is kept in the <code>/etc/shadow</code> file.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>UID</i>     | <p>Contains the UID number used by the system to identify the user. UID numbers for users range from 100 to 60000. Values 0 through 99 are reserved for system accounts. UID number 60001 is reserved for the <code>nobody</code> account. UID number 60002 is reserved for the <code>noaccess</code> account. While duplicate UID numbers are allowed, they should be avoided unless absolutely required by a program.</p> <hr/> <p><b>Note</b> – The maximum value for a UID is 2147483647. However, the UIDs over 60000 do not have full utility and are incompatible with some Solaris OE features. Avoid using UIDs over 60000 so as to be compatible with earlier versions of the operating environment.</p> |

**Table 10-1** Fields in the /etc/passwd File (Continued)

| Field                 | Description                                                                                                                                                                                |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>GID</i>            | Contains the GID number used by the system to identify the user's primary group. GID numbers for users range from 100 to 60000. (Those between 0 and 99 are reserved for system accounts.) |
| <i>comment</i>        | Typically contains the user's full name.                                                                                                                                                   |
| <i>home_directory</i> | Contains the full path name to the user's home directory.                                                                                                                                  |
| <i>login_shell</i>    | Defines the user's login shell. There are six possible login shells in the Solaris OE: the Bourne shell, the Korn shell, the C shell, the Z shell, the BASH shell, and the TC shell.       |

10-2 shows the default system account data for entries in the /etc/passwd file.

**Table 10-2** Default System Account Entries

| User Name | User ID | Description                                                                                                                                        |
|-----------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| root      | 0       | The root account that has access to the entire system. It has almost no restrictions and overrides all other logins, protections, and permissions. |
| daemon    | 1       | The system daemon account that is associated with routine system tasks.                                                                            |
| bin       | 2       | The administrative daemon account that is associated with running system binary files.                                                             |
| sys       | 3       | The administrative daemon account that is associated with system logging or updating files in temporary directories.                               |
| adm       | 4       | The administrative daemon account that is associated with system logging.                                                                          |
| lp        | 71      | The line printer (lp) daemon account.                                                                                                              |
| uucp      | 5       | The daemon account associated with UNIX®-to-UNIX Copy Protocol (UUCP) functions.                                                                   |
| nuucp     | 6       | The account that is used by remote systems to log in to the host and start file transfers.                                                         |

**Table 10-2** Default System Account Entries (Continued)

| User Name | User ID | Description                                                                                                                                                                                                                           |
|-----------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| smmsp     | 25      | The sendmail message submission daemon account.                                                                                                                                                                                       |
| listen    | 37      | The network listener daemon account.                                                                                                                                                                                                  |
| nobody    | 60001   | The anonymous user account that is assigned by a Network File System (NFS) server when an unauthorized root user makes a request. The nobody user account is assigned to software processes that do not need any special permissions. |
| noaccess  | 60002   | The account assigned to a user or a process that needs access to a system through some application instead of through a system login procedure.                                                                                       |
| nobody4   | 65534   | The anonymous user account that is the SunOS™ 4.0 or 4.1 software version of the nobody account. <sup>a</sup>                                                                                                                         |

a. The nobody account secures NFS resources. When a user is logged in as root on an NFS client and attempts to access a remote file resource, the UID number changes from 0 to the UID of nobody (60001).

## The /etc/shadow File

Due to the critical nature of the /etc/shadow file, you should refrain from editing it directly. Instead, maintain the fields of the file by using the Solaris Management Console or command-line tools. Only the root user can read the /etc/shadow file.

The following is an example /etc/shadow file that contains initial system account entries.

```
root:5RiJS.yvdGBkU:6445::::::
daemon:NP:6445::::::
bin:NP:6445::::::
sys:NP:6445::::::
adm:NP:6445::::::
lp:NP:6445::::::
uucp:NP:6445::::::
nuucp:NP:6445::::::
smmsp:NP:6445::::::
listen:*LK*::::::
nobody:NP:6445::::::
noaccess:NP:6445::::::
nobody4:NP:6445::::::
```



Each entry in the `/etc/shadow` file contains nine fields. A colon separates each field. The ninth field is reserved for future use and is not currently used.

Following is the format of an entry:

*loginID:password:lastchg:min:max:warn:inactive:expire:*

10-3 defines the requirements for each of the eight fields.

**Table 10-3** Fields in the `/etc/shadow` File

| Field           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>loginID</i>  | The user's login name.                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <i>password</i> | A 13-character encrypted password. The string <code>*LK*</code> indicates a locked account, and the string <code>NP</code> indicates no valid password. Passwords must be constructed to meet the following requirements:<br><br>Each password must be at least six characters and contain at least two alphabetic characters and at least one numeric or special character. It cannot be the same as the login ID or the reverse of the login ID. |
| <i>lastchg</i>  | The number of days between January 1, 1970, and the last password modification date.                                                                                                                                                                                                                                                                                                                                                               |
| <i>min</i>      | The minimum number of days required between password changes.                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>max</i>      | The maximum number of days the password is valid before the user is prompted to enter a new password at login.                                                                                                                                                                                                                                                                                                                                     |
| <i>warn</i>     | The number of days the user is warned before the password expires.                                                                                                                                                                                                                                                                                                                                                                                 |
| <i>inactive</i> | The number of inactive days allowed for the user before the user's account is locked.                                                                                                                                                                                                                                                                                                                                                              |
| <i>expire</i>   | The date (given as number of days since January 1, 1970) when the user account expires. After the date is exceeded, the user can no longer log in.                                                                                                                                                                                                                                                                                                 |

### The /etc/group File

Each user belongs to a group that is referred to as the user's primary group. The GID number, located in the user's account entry within the /etc/passwd file, specifies the user's primary group.

Each user can also belong to up to 15 additional groups, known as secondary groups. In the /etc/group file, you can add users to group entries, thus establishing the user's secondary group affiliations.

The following is an example of the default entries in an /etc/group file:

```
root::0:root
other::1:
bin::2:root,bin,daemon
sys::3:root,bin,sys,adm
adm::4:root,adm,daemon
uucp::5:root,uucp
mail::6:root
tty::7:root,adm
lp::8:root,lp,adm
nuucp::9:root,nuucp
staff::10:
daemon::12:root,daemon
sysadmin::14:
smmsp::25:smmsp
nobody::60001:
noaccess::60002:
nogroup::65534:
```

Each line entry in the /etc/group file contains four fields. A colon character separates each field. The following is the format for an entry:

*groupname:group-password:GID:username-list*

10-4 defines the requirements for each of the four fields.

**Table 10-4** Fields in the `/etc/group` File

| Field                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>groupname</i>      | Contains the name assigned to the group. Group names contain up to a maximum of eight characters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>group-password</i> | <p>Usually contains an empty field or an asterisk. This is a relic of earlier versions of UNIX. A group-password is a security hole because it might allow an unauthorized user who is not a member of the group but who knows the group password, to enter the group.</p> <hr/> <p><b>Note</b> – The <code>newgrp</code> command changes a user's primary group association within the shell environment from which it is executed. If this new, active group has a password and the user is not a listed member in that group, the user must enter the password before the <code>newgrp</code> command can continue.</p> <hr/> |
| <i>GID</i>            | Contains the group's GID number. It is unique on the local system and should be unique across the organization. Numbers 0 to 99, 60001, 60002 and 65534 are reserved for system group entries. User-defined groups range from 100 to 60000.                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>username-list</i>  | <p>Contains a comma-separated list of user names that represent the user's secondary group memberships. By default, each user can belong to a maximum of 15 secondary groups.</p> <hr/> <p><b>Note</b> – The maximum number of groups is set by the <code>kernel</code> parameter called <code>ngroups_max</code>. You can set this parameter in the <code>/etc/system</code> file to allow for a maximum of 32 groups. Not all applications will be able to reference group memberships greater than 16. NFS is a notable example.</p> <hr/>                                                                                    |

## The /etc/default/passwd File

Set values for the following parameters in the /etc/default/passwd file to control properties for all users' passwords on the system:

- **MAXWEEKS** – Sets the maximum time period (in weeks) that the password is valid.
- **MINWEEKS** – Sets the minimum time period before the password can be changed.
- **PASSLENGTH** – Sets the minimum number of characters for a password. Valid entries are 6, 7, and 8.
- **WARNWEEKS** – Sets the time period prior to a password's expiration to warn the user that the password will expire.



---

**Note** – The **WARNWEEKS** value does not exist by default in the /etc/default/passwd file, but it can be added.

---

The password aging parameters **MAXWEEKS**, **MINWEEKS**, and **WARNWEEKS** are default values. If set in the /etc/shadow file, the parameters in that file override those in the /etc/default/passwd file for individual users.

# Managing User Accounts

Each of the following sections present two sets of command-line tools for managing user accounts: the command-line tools used in the Solaris OE versions prior to the Solaris 9 OE, and the new set of command-line tools developed for the Solaris 9 OE.

## Introducing Command-Line Tools

The Solaris 7 OE and the Solaris 8 OE provide you with command-line tools, defined as follows:

- `useradd` – Adds a new user account on the local system
- `usermod` – Modifies a user's account on the local system
- `userdel` – Deletes a user's account from the local system
- `groupadd` – Adds a new group entry to the system
- `groupmod` – Modifies a group entry on the system
- `groupdel` – Deletes a group entry from the system

In addition to these command-line tools, the Solaris 9 OE has a new set of command-line tools that accomplish the same tasks. They are the `smuser` and `smgroup` commands.

The `smuser` command enables you to manage one or more users on the system with the following set of subcommands:

- `add` – Adds a new user account
- `modify` – Modifies a user's account
- `delete` – Deletes a user's account
- `list` – Lists one or more user entries



---

**Note** – The `smuser` and `smgroup` commands are the command-line interface equivalent to the Solaris Management Console range of operation, and allow you to perform Solaris Management Console actions in scripts. Therefore, the `smuser` and `smgroup` commands have numerous subcommands and options designed to function across domains and multiple systems. This module describes only the basic commands.

---

The `smgroup` command enables you to manage one or more groups on the system with the following set of subcommands:

- `add` – Adds a new group entry
- `modify` – Modifies a group entry
- `delete` – Deletes a group entry
- `list` – Lists one or more group entries

Any subcommand to add, modify, list, or delete users with the `smuser` and `smgroup` commands requires authentication with the Solaris Management Console server and requires the initialization of the Solaris Management Console. For example, the following is the command format for the `smuser` command:

```
/usr/sadm/bin/smuser subcommand [auth_args] -- [subcommand_args]
```

The authorization arguments are all optional. However, if you do not specify the authorization argument, the system might prompt you for additional information, such as a password for authentication purposes.

The `--` option separates the subcommand-specific options from the authorization arguments. The `--` option must be entered even if an authorization argument is not specified because it must precede the subcommand arguments.

The subcommand arguments are quite numerous. For a complete listing of the subcommands, refer to the `smuser` man page. It is important to note that descriptions and other arguments that contain white space must be enclosed in double quotation marks.

## Creating a User Account

Use the `useradd` or `smuser add` command to add new user accounts to the local system. These commands add an entry for a new user into the `/etc/passwd` and `/etc/shadow` files.

These commands also automatically copy all the initialization files from the `/etc/skel` directory to the user's new home directory.

### The `useradd` Command Format and Options

The following is the command format for the `useradd` command:

```
useradd [ -u uid ][ -g gid ][ -G gid [,gid,.. ]]  
[ -d dir ][ -m ][ -s shell ][ -c comment ] loginname
```

10-5 shows the options for the `useradd` command.

**Table 10-5** Options for the `useradd` Command

| Option                         | Definition                                                                 |
|--------------------------------|----------------------------------------------------------------------------|
| <code>-u <i>uid</i></code>     | Sets the UID number for the new user                                       |
| <code>-g <i>gid</i></code>     | Defines the new user's primary group                                       |
| <code>-G <i>gid</i></code>     | Defines the new user's secondary group memberships                         |
| <code>-d <i>dir</i></code>     | Defines the full path name for the user's home directory                   |
| <code>-m</code>                | Creates the user's home directory if it does not already exist             |
| <code>-s <i>shell</i></code>   | Defines the full path name for the shell program of the user's login shell |
| <code>-c <i>comment</i></code> | Specifies any comment, such as the user's full name and location           |
| <i>loginname</i>               | Defines the user's login name for the user account                         |
| <code>-D</code>                | Displays the defaults that are applied to the <code>useradd</code> command |

The following example uses the `useradd` command to create an account for a user named `newuser1`. It assigns `100` as the UID number, adds the user to the group `other`, creates a home directory in the `/export/home` directory, and sets `/bin/ksh` as the login shell for the user account.

```
# useradd -u 100 -g other -d /export/home/newuser1 -m -s /bin/ksh \  
-c "Regular User Account" newuser1  
64 blocks  
#
```

User accounts are locked by default when added with the `useradd` command.

By convention, a user's login name is also the user's home directory name.

You use the `passwd` command to create a password for the new account.

```
# passwd newuser1  
New Password: 123pass  
Re-enter new Password: 123pass  
passwd: password successfully changed for newuser1
```

### The `smuser add` Command Format and Options

The following is the command format for the `smuser add` command:

```
smuser add [auth_args] -- [subcommand_args]
```

10-6 shows some of the most common subcommand arguments for the `smuser add` command.

**Table 10-6** Subcommand Arguments for the `smuser add` Command

| Subcommand Argument       | Definition                                                                                            |
|---------------------------|-------------------------------------------------------------------------------------------------------|
| <code>-c comment</code>   | A short description of the login, typically the user's name. This string can be up to 256 characters. |
| <code>-d directory</code> | Specifies the home directory of the new user and is limited to 1024 characters.                       |
| <code>-g group</code>     | Specifies the new user's primary group membership.                                                    |



**Table 10-6** Subcommand Arguments for the `smuser add` Command  
(Continued)

|                       |                                                                                                                                                          |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-G group</code> | Specifies the user's secondary group membership.                                                                                                         |
| <code>-n login</code> | Specifies the user's login name.                                                                                                                         |
| <code>-s shell</code> | Specifies the full path name of the user's login shell.                                                                                                  |
| <code>-u uid</code>   | Specifies the user ID of the user you want to add. If you do not specify this option, the system assigns the next available unique UID greater than 100. |

The following example uses the `smuser add` command to create an account for a user named `newuser2`. It designates the login name as `newuser2`, assigns the UID number 500, adds the user to the group `other`, creates a home directory in the `/export/home` directory, and sets `/bin/ksh` as the login shell for the user account.



**Note** – The `-x autohome=N` option to the `smuser` command adds the user without automounting the user's home directory. See the man page for `automount` for more information.

```
# /usr/sadm/bin/smuser add -- -n newuser2 -u 500 -g other -d \
/export/home/newuser2 -c "Regular User Account 2" -s /bin/ksh \
-x autohome=N
```

Authenticating as user: root

```
Type /? for help, pressing <enter> accepts the default denoted by [ ]
Please enter a string value for: password :: EnterPassword
Loading Tool: com.sun.admin.usermgr.cli.user.UserMgrCli from sys41
Login to sys41 as user root was successful.
Download of com.sun.admin.usermgr.cli.user.UserMgrCli from sys41 was
successful.
```

Users are added without a password by default with the `smuser` command. Use the `passwd` command to create one.

```
# passwd newuser2
New Password: 123pass
Re-enter new Password: 123pass
passwd: password successfully changed for newuser2
```

## Modifying a User Account

Use the `usermod` or `smuser modify` command to modify a user's login account on the system.

### The `usermod` Command Format and Options

The following is the command format for the `usermod` command:

```
usermod [ -u uid [ -o ] ] [ -g gid ] [ -G gid [ , gid . . . ] ]  
[ -d dir ] [ -m ] [ -s shell ] [ -c comment ]  
[ -l newlogname ] loginname
```

In general, the options for the `usermod` command function the same as those for the `useradd` command.

10-7 shows the key options to the `usermod` command.

**Table 10-7** Key Options for the `usermod` Command

| Option                            | Definition                                                                                                                                                                               |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-o</code>                   | Allows a UID to be duplicated.                                                                                                                                                           |
| <code>-m</code>                   | Moves the user's home directory to the new location specified with the <code>-d</code> option.                                                                                           |
| <code>-l <i>newlogname</i></code> | Changes a user's login name for the specified user account.                                                                                                                              |
| <code>-f <i>inactive</i></code>   | Sets the number of inactive days that are allowed on a user account. If the account is not logged in to for the specified number of days, it is locked.                                  |
| <code>-e <i>expire</i></code>     | Sets an expiration date on the user account. Specifies the date ( <i>mm/dd/yy</i> ) on which a user can no longer log in and access the account. After that date, the account is locked. |
| <i>loginname</i>                  | Identifies the user's login name for the current user account.                                                                                                                           |

The following example changes the login name and home directory for `newuser1` to `usera`.

```
# usermod -m -d /export/home/usera -l usera newuser1
```

## The smuser modify Command Format and Options

The following is the command format for the `smuser modify` command:

```
smuser modify [auth_args] -- [subcommand_args]
```

In general, the options for the `smuser modify` command function the same as for the `smuser add` command. Refer to the `smuser(1M)` man page for additional options.

10-8 shows the options for the `smuser modify` command.

**Table 10-8** Options for the `smuser modify` Command

| Option                | Definition                          |
|-----------------------|-------------------------------------|
| <code>-n login</code> | Specifies the user's login name     |
| <code>-N login</code> | Specifies the user's new login name |

The following example changes the login name and home directory for `newuser2` to `userb`.

```
# /usr/sadm/bin/smuser modify -- -n newuser2 -N userb \
-d /export/home/userb
Authenticating as user: root
```

```
Type /? for help, pressing <enter> accepts the default denoted by [ ]
Please enter a string value for: password :: EnterPassword
Loading Tool: com.sun.admin.usermgr.cli.user.UserMgrCli from sys41
Login to sys41 as user root was successful.
Download of com.sun.admin.usermgr.cli.user.UserMgrCli from sys41 was
successful.
```

## Deleting a User Account

Use the `userdel` command or `smuser delete` command to delete a user's login account from the system.

The following is the command format for the `userdel` command:

```
userdel -r login
```

The `userdel` command also removes the user's home directory and all of its contents if you request it to do so. Use the `-r` option to remove the user's home directory from the local file system. This directory must exist.

The following example removes the login account for a user named `usera`.

```
# userdel usera
```

To request that both the user's account and home directory be removed from the system at the same time, perform the command:

```
# userdel -r usera
```

### The `smuser delete` Command Format and Options

The following is the command format for the `smuser delete` command:

```
smuser delete [auth_args] -- [subcommand_args]
```

The following example removes the `userb` account from the system:

```
# /usr/sadm/bin/smuser delete -- -n userb
```

```
Authenticating as user: root
```

```
Type /? for help, pressing <enter> accepts the default denoted by [ ]
```

```
Please enter a string value for: password :: EnterPassword
```

```
Loading Tool: com.sun.admin.usermgr.cli.user.UserMgrCli from sys41
```

```
Login to sys41 as user root was successful.
```

```
Download of com.sun.admin.usermgr.cli.user.UserMgrCli from sys41 was  
successful.
```



---

**Note** – Unlike the `userdel` command, the `smuser delete` command has no `-r` equivalent option for deleting the home directory. The user's home directory must be deleted manually.

---

## Creating a Group Entry

As the `root` user, you create new group entries on the local system by using the `groupadd` or `smgroup add` command. These commands add an entry for the new group into the `/etc/group` file.

Like the `smuser` command, the `smgroup add` command uses the same subcommands and authentication arguments derived from the Solaris Management Console.

### The groupadd Command Format and Options

The following is the command format for the `groupadd` command:

```
groupadd [ -g gid [ -o ] ] groupname
```

10-9 shows the options for the `groupadd` command.

**Table 10-9** Options for the `groupadd` Command

| Option                     | Description                              |
|----------------------------|------------------------------------------|
| <code>-g <i>gid</i></code> | Assigns the GID number for the new group |
| <code>-o</code>            | Allows the GID number to be duplicated   |

The following example uses the `groupadd` command to create the new group `class` on the local system:

```
# groupadd -g 301 class
```

### The smgroup add Command Format and Options

The following is the command format for the `smgroup add` command:

```
/usr/sadm/bin/smgroup subcommand [auth_args] -- [subcommand_args]
```

10-10 shows the options for the `smgroup add` command.

**Table 10-10** Options for the `smgroup add` Command

| Option                              | Description                                   |
|-------------------------------------|-----------------------------------------------|
| <code>-g <i>gid</i></code>          | Specifies the GID number for the new group    |
| <code>-m <i>group_member</i></code> | Specifies the new members to add to the group |
| <code>-n <i>group_name</i></code>   | Specifies the name of the new group           |

The following example uses the `smgroup add` command to create a new group called `workgroup` with a GID of 123, and to add `usera` to the group:

```
# /usr/sadm/bin/smgroup add -- -n workgroup -g 123 -m usera
Authenticating as user: root
```

```
Type /? for help, pressing <enter> accepts the default denoted by [ ]
Please enter a string value for: password :: EnterPassword
Loading Tool: com.sun.admin.usermgr.cli.group.UserMgrGroupCli from sys41
Login to sys41 as user root was successful.
Download of com.sun.admin.usermgr.cli.group.UserMgrGroupCli from sys41
was successful.
```

## Modifying a Group Entry

You can use the following commands to modify a group entry:

- The `groupmod` command
- The `smgroup modify` command

### The `groupmod` Command Format and Options

The following is the command format for the `groupmod` command:

```
groupmod [ -g gid [ -o ] ] [ -n name ] groupname
```

10-11 defines the options for the `groupmod` command:.

**Table 10-11** Options for the `groupmod` Command

| Options              | Description                                |
|----------------------|--------------------------------------------|
| <code>-g gid</code>  | Specifies the new GID number for the group |
| <code>-o</code>      | Allows the GID number to be duplicated     |
| <code>-n name</code> | Specifies the new name for the group       |

The following example changes the `class` account group GID number to 400:

```
# groupmod -g 400 class
```

### The `smgroup modify` Command Format and Options

The following is the command format for the `smgroup modify` command:

```
/usr/sadm/bin/smgroup subcommand [auth_args] -- [subcommand_args]
```

10-12 shows the options for the `smgroup modify` command.

**Table 10-12** Options for the `smgroup modify` Command

| Option                     | Description                                        |
|----------------------------|----------------------------------------------------|
| <code>-n name</code>       | Specifies the name of the group you want to modify |
| <code>-m new_member</code> | Specifies the new members to add to the group      |
| <code>-N new_group</code>  | Specifies the new group name                       |

The following example changes the group `workgroup` to `schoolgroup`:

```
# /usr/sadm/bin/smgroup modify -- -n workgroup -N schoolgroup
Authenticating as user: root
```

```
Type /? for help, pressing <enter> accepts the default denoted by [ ]
Please enter a string value for: password :: EnterPassword
Loading Tool: com.sun.admin.usermgr.cli.group.UserMgrGroupCli from sys41
Login to sys41 as user root was successful.
Download of com.sun.admin.usermgr.cli.group.UserMgrGroupCli from sys41
was successful.
```

## Deleting a Group Entry

Use the `groupdel` or `smgroup delete` commands to delete a group entry from the `/etc/group` file on the system.

### The `groupdel` Command Format

The following is the command format for the `groupdel` command:

```
groupdel groupname
```

The following example removes the group entry `class` from the local system:

```
# groupdel class
```

### The `smgroup delete` Command Format and Options

The following is the command format for the `smgroup delete` command:

```
/usr/sadm/bin/smgroup subcommand [auth_args] -- [subcommand_args]
```

You can use the `-n group_name` option with the `smgroup delete` command to specify the name of the group you want to delete.

The following example deletes the group entry `schoolgroup` from the local system:

```
# /usr/sadm/bin/smgroup delete -- -n schoolgroup
Loading Tool: com.sun.admin.usermgr.cli.group.UserMgrGroupCli from sys41
Login to sys41 as user root was successful.
Download of com.sun.admin.usermgr.cli.group.UserMgrGroupCli from sys41
was successful.
```

## Using the Solaris Management Console Users Tool

The Solaris Management Console Users Tool is a graphical user interface (GUI) that provides access to Solaris OE system administration tools. You can use it for adding, removing, and modifying user and group entries. The following sections contain a demonstration.



Start the Solaris Management Console by typing **smc** on the command line or by clicking the SMC icon under the Tools submenu. After the “Welcome to Solaris Management Console” message appears, click This Computer to open the Solaris Management Console window. See Figure 10-2.

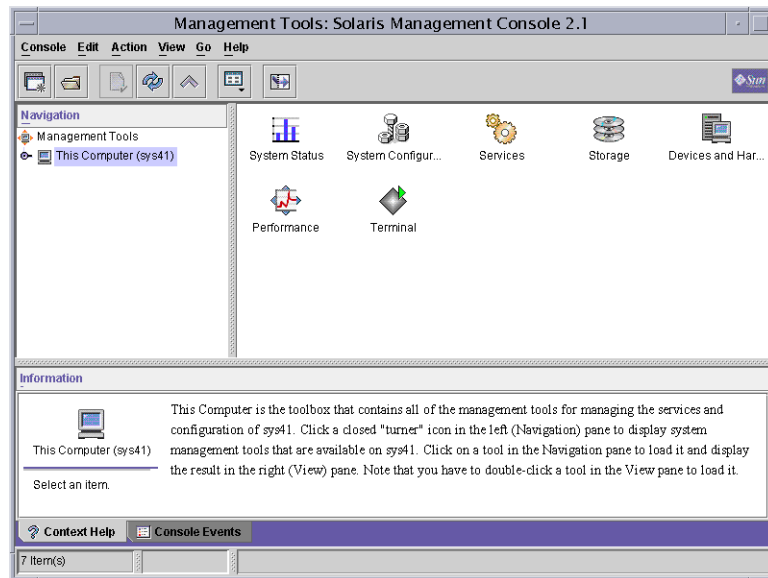


**Figure 10-2** Solaris Management Console Window

## Adding a User Account

The default method of adding a user account through Solaris Management Console is to add the user account with the user’s home directory automounted. The following steps demonstrate how to build a user template that adds the user account with the user’s directory under the /export/home directory.

To add a user account, perform the following steps:

1. Click This Computer in the Navigation pane to display the system management tools.
2. Click System Configuration to display the tool for setting up a new user account.
3. Click Users and enter the user name and password to be used for authentication if prompted to do so by Solaris Management Console.
4. Double-click User Templates to access the tool to create and manage user templates.
5. From the Menu Bar, select Add User Template from the Action list.

Figure 10-3 shows the Add User Template window.

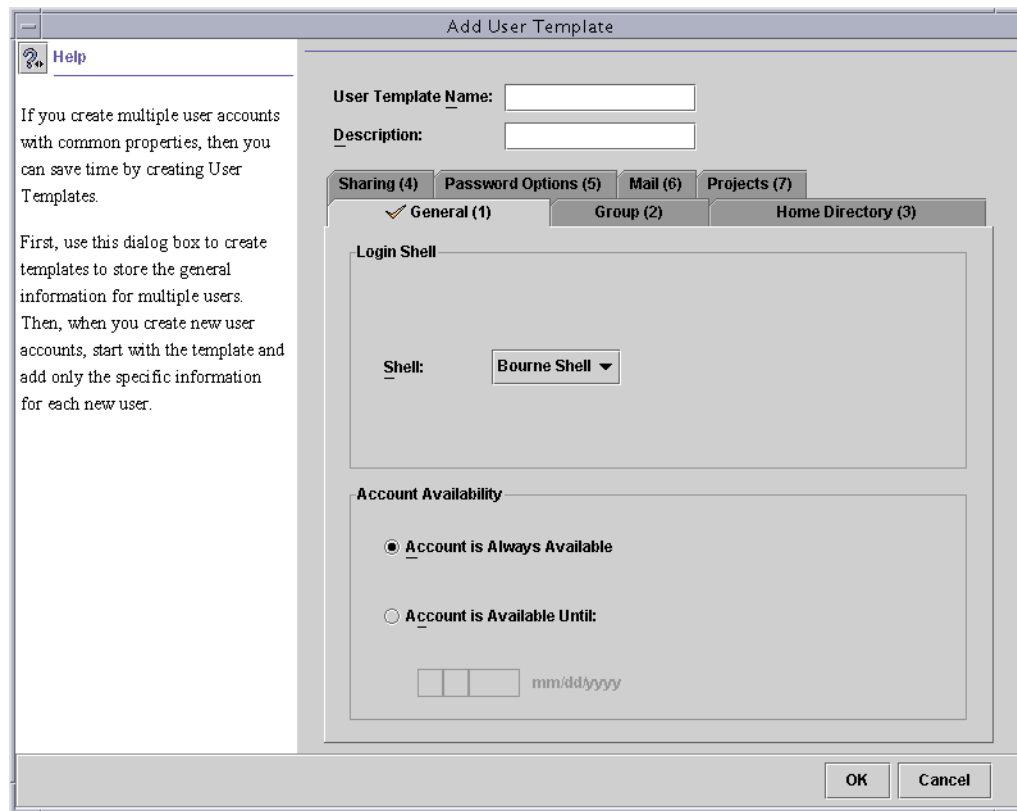


**Figure 10-3** Add User Template Window

6. Type the name SA239user in the User Template Name field. You can provide an optional description if you wish.
7. Click the Home Directory tab. Type your system name in the Home Directory Server field. Uncheck the check box labeled Automatically Mount Home Directory.

8. Click OK, and the Solaris Management Console (User Templates) window (Figure 10-4) reappears with the SA239user template in the View pane.

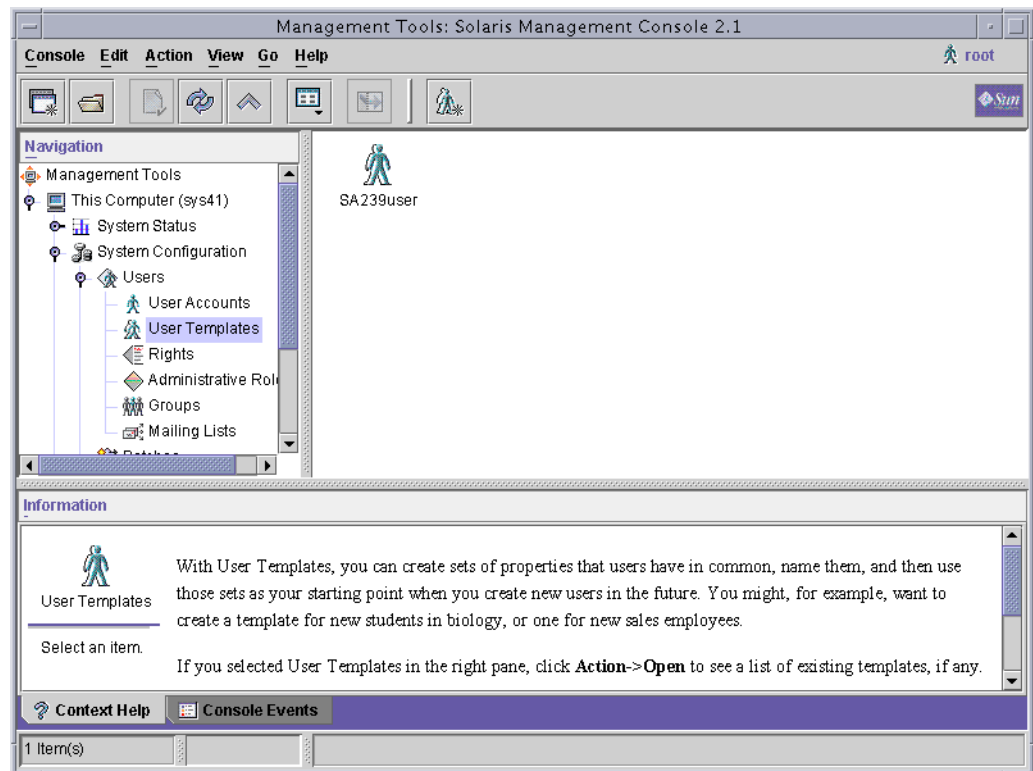


**Figure 10-4** Management Tools: Solaris Management Console Window – User Templates

- Click User Accounts from the Navigation pane, and a list of user accounts on the system appears in the View pane. See Figure 10-5.

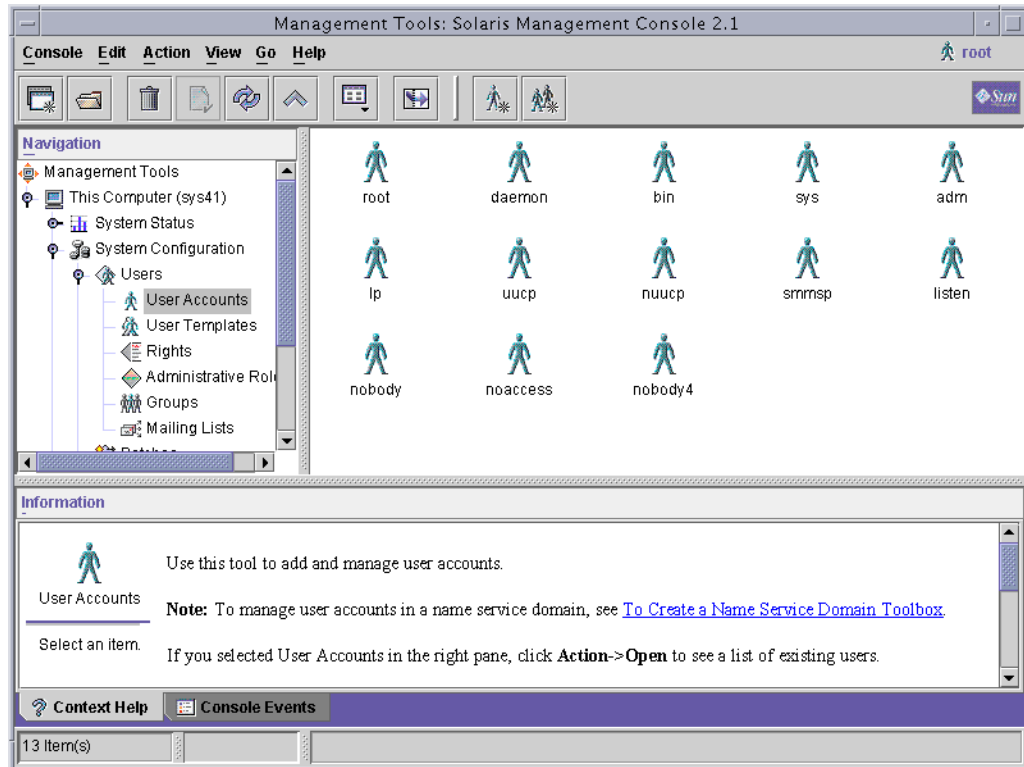


**Figure 10-5** Management Tools: Solaris Management Console Window – User Accounts

10. From the Menu Bar, select Action. Then select Add User, and then select From Template. The Add User From Template window appears. See Figure 10-6.

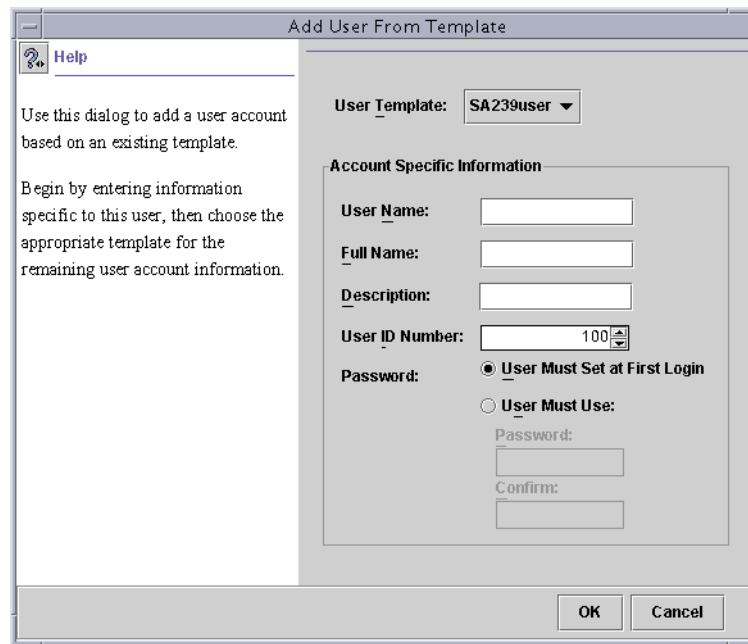


**Figure 10-6** Add User From Template Window

Because you only have one template created, it is the default template available from the User Template pull-down list.

11. In the field beside User Name, enter the login ID of the user you wish to create. A full name and description are optional.
12. Click the button User Must Use and fill in the password and confirmation fields with the password 123pass.
13. Click OK and the Solaris Management Console (User Accounts) window reappears with the user account you just created in the View pane.

14. Double-click the user account you just created. The User Properties window appears (Figure 10-7). You can view and modify the properties of that user account.

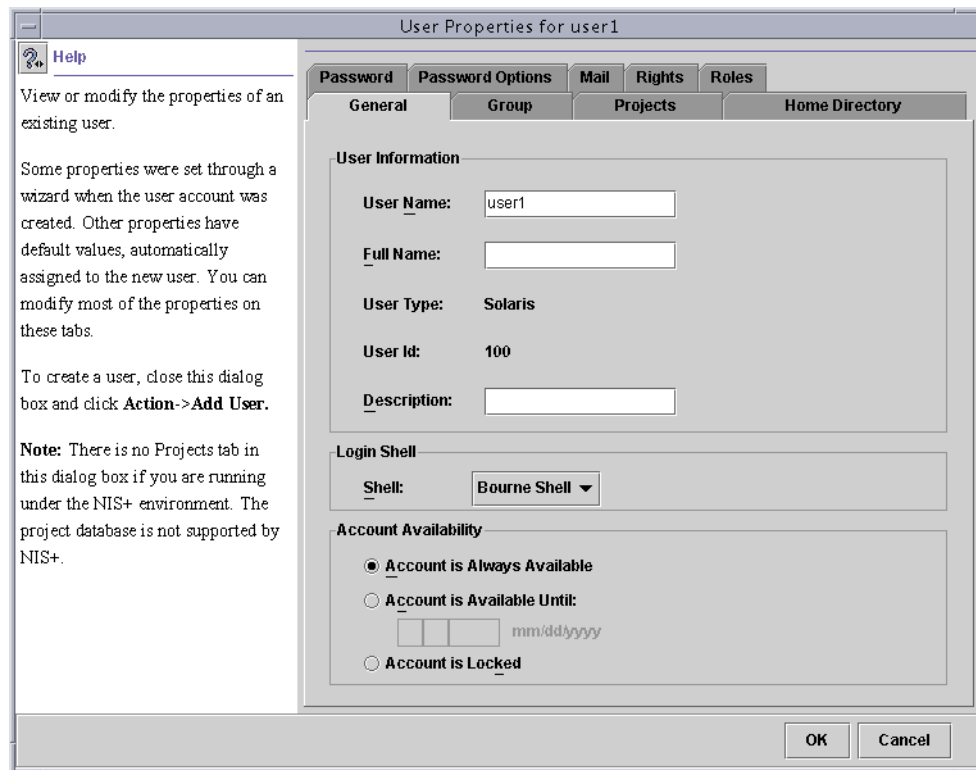


**Figure 10-7** User Properties Window

15. Click the Group tab.

The screen changes to reveal a list of groups. Figure 10-8 shows the information under the Group tab, including the primary group to which the user belongs and a list of available groups.

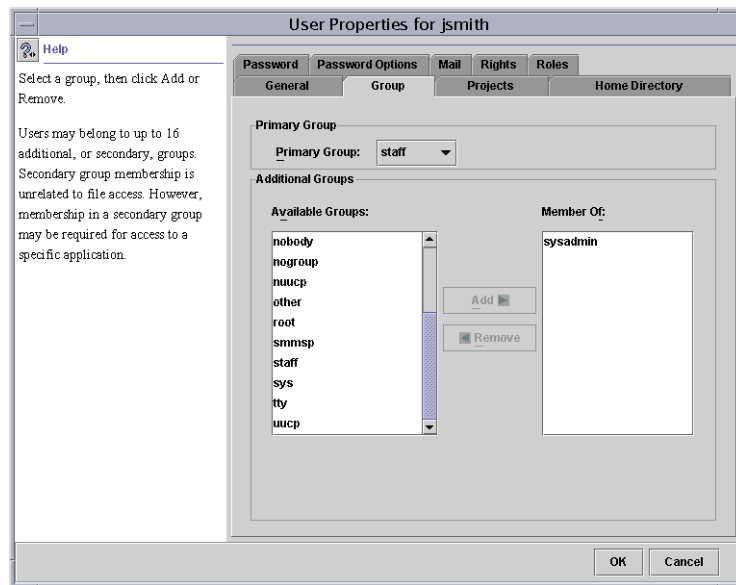


**Figure 10-8** User Properties Window – Adding Groups

16. You can click a group listed under Available Groups, and then click Add, and the group moves into the Member Of column.
17. Add the groups to which you want the user to belong, and then click OK.

## Deleting a User Account

Figure 10-9 shows the initial steps you take to remove a user account from the system.

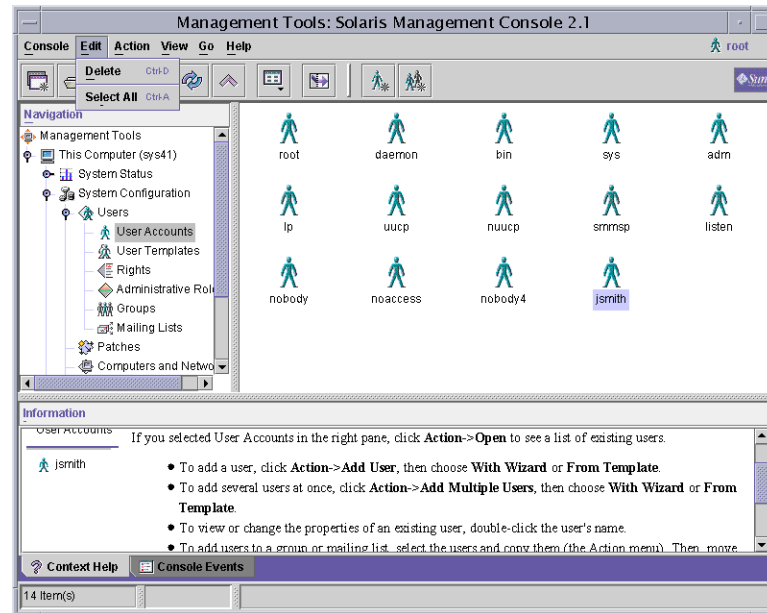


**Figure 10-9** Management Tools: Solaris Management Console Window – Deleting a User Account Window

1. Highlight the user account in the User Accounts window.
2. From the Menu Bar, click Edit. Select Delete from the Edit menu.

Figure 10-10 shows the warning window that appears asking you to verify that you want to delete the user account.



**Figure 10-10** Warning: Delete User

This window also contains options to remove the user's home directory and to remove the user's mailbox.

3. Check the appropriate boxes, and then click Delete. The user account is deleted.



## Troubleshooting Login Issues

Some of the most common problems you might encounter as a system administrator are user login problems. There are two categories of login problems: login problems when the user logs in at the command line and login problems when the user logs in from the Common Desktop Environment (CDE).

The CDE uses more configuration files, so there are more potential problems associated with logging in from the CDE. When you troubleshoot a login problem, first determine whether you can log in from the command line. Attempt to log in from another system by using either the `telnet` command or the `rlogin` command, or click Options from the CDE login panel and select Command Line Login. If you can log in successfully at the command line, then the problem is with the CDE configuration files. If you cannot log in at the command line, then the problem is more serious and involves key configuration files.

### Login Problems at the Command Line

10-13 presents an overview of common login problems that occur when the user logs in at the command line.

**Table 10-13** Login Problems at the Command Line

| Login Problem     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Login incorrect   | This message occurs when there are problems with the login information. The most common cause of an incorrect login message is a mistyped password. Make sure the that correct password is being used, and then attempt to enter it again. Remember that passwords are case-sensitive, so you cannot interchange uppercase letters and lowercase letters. In the same way, the letter "o" is not interchangeable with the numeral "0" nor is the letter "l" interchangeable with the numeral "1." |
| Permission denied | This message occurs when there are login, password, or NIS+ security problems. Most often, an administrator has locked the user's password or the user's account has been terminated.                                                                                                                                                                                                                                                                                                             |

**Table 10-13** Login Problems at the Command Line (Continued)

|                                                                       |                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Password will not work at lockscreen                                  | A common error is to have the Caps Lock key on, which causes all letters to be uppercase. This does not work if the password contains lowercase letters.                                                                                                                                                                                                          |
| No shell                                                              | This message occurs when the user's shell does not exist, is typed incorrectly, or is wrong in the <code>/etc/passwd</code> file.                                                                                                                                                                                                                                 |
| No directory!<br>Logging in with home=/<br>                           | This message occurs when the user cannot access the home directory for one of the following reasons: An entry in the <code>/etc/passwd</code> file is incorrect, or the home directory has been removed or is missing, or the home directory exists on a mount point that is currently unavailable.                                                               |
| Choose a new password<br>(followed by the<br>New password:<br>prompt) | This message occurs the first time a user logs in and chooses an initial password to access the account.                                                                                                                                                                                                                                                          |
| Couldn't fork a process!                                              | This message occurs then the server could not fork a child process during login. The most common cause of this message is that the system has reached its maximum number of processes. You can either kill some unneeded processes (if you are already logged into that system as <code>root</code> ) or increase the number of processes your system can handle. |

## Login Problems in the CDE

Problems associated with logging into the CDE range from a user being unable to login (and returning to the CDE login screen), to the custom environment not loading properly. In general, the system does not return error messages to the user from the CDE. The following is a list of files and directories that provide troubleshooting information about the CDE:

- `/usr/dt/bin/Xsession`

This file is the configuration script for the login manager. This file should not be edited. The first user-specific file that the `Xsession` script calls is the `$HOME/.dtprofile` file.

- **`$HOME/.dtprofile`**

By default, the file does not contain much content, except for examples. It contains a few `echo` statements for session logging purposes, and the `DTSOURCEPROFILE` variable is set. But it also contains information about how it might be edited. The user can edit this file to add user-specific environment variables.

- **`DTSOURCEPROFILE=true`**

This line allows the user's `$HOME/.login` file (for `cs`h users) or the `$HOME/.profile` (for other shell users) to be sourced as part of the startup process.

Sometimes a `.login` or `.profile` file contains problem commands that cause the shell to crash. If the `.dtprofile` file is set to source a `.login` or `.profile` file that has problem commands, desktop startup might fail.

Consequently, no desktop appears. Instead, the system redisplay the Solaris OE CDE login screen. Startup errors from the `.login` or `.profile` file are usually noted in the `$HOME/.dt/startlog` file. Use a Failsafe login Session or a command-line login to debug problem commands in the `.login` or `.profile` files.

- **`$HOME/.dt/sessions`**

This directory structure contains files and directories that configure the display of the user's custom desktop and determine the applications that start when the user logs in. Look for recent changes to files and for changes to the directory structure. For example, examine the `home` directory and the `home.old` directory or a `current` directory and the `current.old` directory. Compare the changes. The changes could provide information on a new application or on changes in the saved desktop that cause the user's login to fail.

- **`$HOME/.dt`**

Upon removing the entire `.dt` directory structure, log out, and log back in again for the system to rebuild a default `.dt` file structure. This action allows the user to get back into the system if the problem with the CDE files cannot be resolved.

10-14 shows the locations of and information found in error logs for the CDE.

**Table 10-14** CDE Error Log Locations

| Location                                                             | Error Log                                                                                                                                 |
|----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| /var/dt/Xerrors                                                      | The Solaris OE CDE login window system errors that occur prior to user login                                                              |
| <i>\$HOME</i> /.dt/startlog                                          | The Solaris OE CDE errors that occur during the startup of the Xsession script, while processing the .dtprofile, .login, or .profile file |
| <i>\$HOME</i> /.dt/errorlog.old<br><i>\$HOME</i> /.dt/errorlog.older | The Solaris OE CDE errors that occur after the Xsession script startup                                                                    |
| <i>\$HOME</i> /.dt/sessionlogs                                       | Directory of session logs for Session Manager and Window Manager errors                                                                   |

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Adding User Accounts and Group Entries (Level 1)

In this exercise, you use the Solaris Management Console, as well as the `smuser`, `smgroup`, `usermod`, `userdel`, `groupadd`, and `groupdel` commands, to create, modify, and delete multiple user accounts and group entries.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed. Refer to 10-15 and 10-16 as needed.

**Table 10-15** Group Specifications

| Group Name | GID Number |
|------------|------------|
| class1     | 101        |
| class2     | 102        |

**Table 10-16** User Specifications

| User Name | Password                                    | Shell  | UID  | Primary Group | Secondary Group |
|-----------|---------------------------------------------|--------|------|---------------|-----------------|
| user3     | 123pass                                     | Korn   | 1003 | 10            | class1          |
| user4     | 123pass                                     | C      | 1004 | 10            | class1          |
| user5     | 123pass                                     | Bourne | 1005 | 10            |                 |
| locked1   | Select Account is Locked                    | Bourne | 2001 | 10            |                 |
| cleared1  | Select User must set password at next login | Bourne | 2002 | 10            |                 |

## Tasks

Complete the following tasks:

- Disable the Solaris OE registration window.  
(Steps 1–5 of Task 1 in the Level 2 lab)
- Working from 10-15 and Table 10-16 on page 10-36, create two new groups and two new users by using the `groupadd`, `smgroup`, `useradd`, and `smuser` commands.  
(Steps 1–2 of Tasks 2 and 3 in the Level 2 lab)
- Launch the Solaris Management Console, and create a user template to add users that do not use automounted home directories.  
(Step 3 of Task 3 in the Level 2 lab)
- Using the Solaris Management Console, add the new users `user5`, `locked1`, and `cleared1` with characteristics from Table 10-16 on page 10-36.  
(Steps 4–5 of Task 3 in the Level 2 lab)
- Verify that the shells you specify are set in the `/etc/passwd` file. Determine if the password strings for users with the same password are also the same in the `/etc/shadow` file. Check the password strings for the users `locked1` and `cleared1`. Verify that the users `user3` and `user4` are secondary members of the `class1` group.  
(Steps 1–4 of Task 4 in the Level 2 lab)
- Determine what happens when you try to log in as the user `locked1`. Verify that you can log in as the user `cleared1`. Record the password requirements indicated.  
(Steps 5–6 of Task 4 in the Level 2 lab)
- Establish password aging for the user `user5`. Determine what happens when you attempt to log in as that user. Log in as `user5` and attempt to change the password from the command line. Log in as the `root` user when you are finished.  
(Steps 1–4 of Task 5 in the Level 2 lab)

- Use the `groupadd` command to add a group called `class3`. Use the `usermod` command to change the UID number, home directory, and user name for the user `locked1`. Verify that the changes exist in the `/etc/passwd` file.

(Steps 1–2 of Task 5 in the Level 2 lab)

- Use the `smuser` command to change the login shell of `user5` to `ksh`. Use the `userdel` command to delete the user `user3`. Verify that the home directory has been deleted. Use the `smgroup` command to rename the group `class1` to `group1`. Use the `groupdel` command to remove the group `class2`. Verify the changes to the `/etc/group` file.

(Steps 3–7 of Task 5 in the Level 2 lab)



## Exercise: Adding User Accounts and Group Entries (Level 2)

In this exercise, you use the Solaris Management Console, as well as the `smuser`, `smgroup`, `usermod`, `userdel`, `groupadd`, and `groupdel` commands, to create, modify, and delete multiple user accounts and group entries.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed. Refer to 10-15 and Table 10-16 on page 10-36 as needed.

### Task Summary

In this exercise, you accomplish the following:

- Disable the Solaris OE registration window.
- Working from 10-15 and Table 10-16 on page 10-36, create two new groups and two new users by using the commands `groupadd`, `smgroup`, `useradd`, and `smuser`.
- Launch the Solaris Management Console, and create a user template to add users that do not use automounted home directories.
- Using the Solaris Management Console, add the new users `user5`, `locked1` and `cleared1` with characteristics from Table 10-16 on page 10-36.
- Verify that the shells you specify are set in the `/etc/passwd` file. Determine if the password strings for users with the same password are also the same in the `/etc/shadow` file. Check the password strings for the users `locked1` and `cleared1`. Verify that the users `user3` and `user4` are secondary members of the `class1` group.
- Determine what happens when you try to log in as the user `locked1`. Verify that you can log in as the user `cleared1`. Record the password requirements indicated.
- Establish password aging for `user5`. Determine what happens when you attempt to log in as that user. Log in as `user5` and attempt to change the password from the command line. Log in as the `root` user when you are finished.

- Use the `groupadd` command to add a group called `class3`. Use the `usermod` command to change the UID number, home directory, and user name for the user `locked1`. Verify that the changes exist in the `/etc/passwd` file.
- Use the `smuser` command to change the login shell of `user5` to `ksh`. Use the `userdel` command to delete the user `user3`. Verify that the user's home directory has been deleted. Use the `smgroup` command to rename the group `class1` to `group1`. Use the `groupdel` command to remove the group `class2`. Verify the changes to the `/etc/group` file.

## Tasks

Complete the following tasks.

### Task 1 – Disabling the Solaris OE Registration Window

Complete the following steps:

1. Disable the Solaris OE Registration window so that it does not appear whenever a new user logs in from the CDE.
2. Log in as the `root` user (or use the `su` command to change to the `root` user).
3. Change to the `/etc/default` directory.
4. In the `default` directory, create the `solregis` file.

**#vi solregis**

5. In the `solregis` file, type the keyword `DISABLE=1` (note that the character "1" is the number one).
6. Save this file, and exit the editor.

### Task 2 – Adding Group Entries

Complete the following steps:

---

**Note** – Refer to Table 10-15 on page 10-36 for details while adding groups.

---

1. As the `root` user, open a terminal window.
2. Add the two groups `class1` and `class2` with the `groupadd` and `smgroup` commands, respectively.



### Task 3 – Adding User Accounts

Complete the following steps:



---

**Note** – Refer to Table 10-16 on page 10-36 for details while adding users with the various tools.

---

1. Add a user named `user3` by using the `useradd` command.
2. Add a user named `user4` by using the `smuser` command.
3. Launch the Solaris Management Console by typing **smc** on the command line. After the Solaris Management Console appears, create a user template to add user accounts that do not use automounted home directories by performing the following:
  - a. Select This Computer, and then select System Configuration. Then select Users, and then select User Templates to open the User Templates tool.
  - b. From the Menu Bar, select Action. Then select Add User Template.
  - c. The Add User Template window appears, containing blank fields for a template name and description. Enter the name `239user` in the User Template Name field, and `SA239` for the Description field.
  - d. Click the Home Directory Tab and uncheck the Automatically Mount Home Directory checkbox. Enter the name of your system in the Home Directory Server field.
  - e. Click OK to create your template.
4. Click User Accounts, and add the `user5` account by selecting Action, then selecting Add User, and then selecting From Template on the menu bar.

The Add User From Template window appears. Enter `user5` in the User Name field, and select `1005` as the User ID Number. For the password, click User Must Use, and enter `123pass` in both password fields. Click OK.

5. From the Solaris Management Console, add additional users `locked1` and `cleared1` by using the `239user` template. While adding the `cleared1` user, select the password option `User Must Set Password At Next Login`. After adding both users, double-click the `locked1` user and select the tab `General`. Under the `Account Availability` section, select the button `Account is Locked`. Also select the shell as listed in Table 10-16 on page 10-36.

## Task 4 – Examining Configuration Files

Complete the following steps:

1. Examine the contents of the `/etc/passwd` file. What are the full path names of the shells used by `user3`, `user4`, and `user5`?
2. Examine the contents of the `/etc/shadow` file. What text is found in the password field for the users `locked1` and `cleared1`?
3. You used the same password for `user3` through `user5`. Are the password strings the same in the `/etc/shadow` file?
4. Examine the contents of the `/etc/group` file. Verify that `user3` and `user4` are both listed as secondary members of the `class1` group. Are they?
5. Log out of the CDE, and attempt to log in as `locked1`. Are you able to log in?
6. Attempt to log in as `cleared1`. What happens? Attempt to use the password `abcdefg`. What are the system requirements for the password?

Use the password `abc123`. Log in as `cleared1` after you establish a password to verify that the login works. Log out, and log in as the `root` user.

## Task 5 – Establishing Password Aging

Complete the following steps:

1. Start the Solaris Management Console, and go back into the User Accounts Tool. Select `user5` from the list of users. Change the password options information for `user5` so that it matches the following information. Click OK when you are finished, and exit the Solaris Management Console.

User Must Keep For: 1 (one day)

Before Change Alert User: 1 (one day)

User Must Change Within: 2 (two days)

Expires If Not Used For: 1 (one day)

2. Log out of your `root` login session. Attempt to log in as `user5`. What happens? Supply a new password if necessary.
3. Complete the login as `user5`. Open a terminal window, and attempt to change the password you just set. What happens?
4. Log out, and log in again as the `root` user.

## Task 6 – Modifying User Accounts and Group Entries

Complete the following steps:

1. Use the `groupadd` command to create a new group entry called `class3` that uses GID number 103.
2. Use the `usermod` command to change the login name of `locked1` to `user6`, the UID to 3001, and the home directory of `locked1` to `user6`. Verify that the changes you request are recorded in the `/etc/passwd` file and the directory that was moved.
3. Use the `smuser modify` command to change the login shell of `user5` to `/bin/ksh`. Verify that the changes you request are recorded in the `/etc/passwd` file.
4. Use the `userdel` command to delete the user account `cleared1` and the related home directory. Verify that the `/export/home/cleared1` directory no longer exists.
5. Use the `smgroup` command to change the group name of `class1` to `group1`.
6. Use the `groupdel` command to remove the group entry `class2`.
7. Verify that the commands used to modify group entries have correctly modified the `/etc/group` file.

## Exercise: Adding User Accounts and Group Entries (Level 3)

In this exercise, you use the Solaris Management Console, as well as the `smuser`, `smgroup`, `usermod`, `userdel`, `groupadd`, `groupmod`, and `groupdel` commands, to create, modify, and delete multiple user accounts and group entries.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed. Refer to 10-15 and Table 10-16 on page Lab -36 as needed.

### Task Summary

In this exercise, you accomplish the following:

- Disable the Solaris OE registration window.
- Working from 10-15 and Table 10-16 on page 10-36, create two new groups and two new user accounts using the commands `groupadd`, `smgroup`, `useradd`, and `smuser`.
- Launch the Solaris Management Console and create a user template to add users that do not use automounted home directories.
- Using the Solaris Management Console, add the new user accounts `user5`, `locked1`, and `cleared1` with characteristics from Table 10-16 on page 10-36.
- Verify that the shells you specify are set in the `/etc/passwd` file. Determine if the password strings for users with the same password are also the same in the `/etc/shadow` file. Check the password strings for the users `locked1` and `cleared1`. Verify that the users `user3` and `user4` are secondary members of the `class1` group.
- Determine what happens when you try to log in as the user `locked1`. Verify that you can log in as the user `cleared1`. Record the password requirements indicated.
- Establish password aging for the user `user5`. Determine what happens when you attempt to log in as that user. Log in as `user5` and attempt to change the password from the command line. Log in as `root` when you are finished.

- Use the `groupadd` command to add a group called `class3`. Use the `usermod` command to change the UID number, home directory, and user name for the user `locked1`. Verify that the changes exist in the `/etc/passwd` file.
- Use the `smuser` command to change the login shell of `user5` to `ksh`. Use the `userdel` command to delete the `user3` account. Verify that the user's home directory has been deleted. Use the `smgroup` command to rename the group `class1` to `group1`. Use the `groupdel` command to remove the group `class2`. Verify the changes to the `/etc/group` file.

## Tasks and Solutions

Complete the following tasks.

### Task 1 – Disabling the Solaris OE Registration Window

Complete the following steps:

1. Disable the Solaris OE Registration window so that it does not appear whenever a new user logs in from the CDE.
  2. Log in as the `root` user (or use the `su` command to change the `root` user).
  3. Change to the `/etc/default` directory.
  4. In the `default` directory, create the file `solregis`.
- #vi solregis**
5. In the `solregis` file, type the keyword `DISABLE=1` (note that the character "1" is the number one).
  6. Save this file, and exit the editor.

### Task 2 – Adding Group Entries

Complete the following steps:

---

**Note** – Refer to Table 10-15 on page 10-36 for details while adding groups.

---

1. As the `root` user, open a terminal window.
2. Add the two groups `class1` and `class2`, with `groupadd` and `smgroup` commands, respectively.



```
# groupadd -g 101 class1
# /usr/sadm/bin/smggroup add -- -n class2 -g 102
```

### Task 3 – Adding User Accounts

Complete the following steps:



---

**Note** – Refer to Table 10-16 on page 10-36 for details while adding users with the various tools.

---

1. Add a user named user3 by using the useradd command.

```
# useradd -u 1003 -g 10 -G class1 -d /export/home/user3 \
-m -s /bin/ksh user3
# passwd user3
New Password: 123pass
Re-enter new Password: 123pass
passwd: password successfully changed for user3
```

2. Add a user named user4 by using the smuser command.

```
# /usr/sadm/bin/smuser add -- -n user4 -u 1004 -g 10 -G class1 \
-d /export/home/user4 -s /bin/csh -x autohome=N
# passwd user4
New Password: 123pass
Re-enter new Password: 123pass
passwd: password successfully changed for user4
```

3. Launch the Solaris Management Console by typing **smc&** on the command line. After the Solaris Management Console appears, create a user template to add user accounts that do not use automounted home directories by performing the following:
  - a. Select This Computer, and then select System Configuration. Then select Users, and then select User Templates to open the User Templates tool.
  - b. From the Menu Bar, select Action, and then select Add User Template.
  - c. The Add User Template window appears, containing blank fields for a template name and description. Enter the name 239user in the User Template Name field, and SA239 for the Description field.



- d. Click the Home Directory Tab and uncheck the Automatically Mount Home Directory checkbox. Enter the name of your system in the Home Directory Server field.
  - e. Click OK to create your template.
4. Click User Accounts, and add the `user5` account by selecting Action, then selecting Add User, and then selecting From Template on the menu bar.

The Add User From Template window appears. Enter `user5` in the User Name field and select `1005` as the UID Number. For password, click the button called User Must Use, and enter `123pass` in both password fields. Click OK.

5. From the Solaris Management Console, add the users `locked1` and `cleared1` by using the `239user` template. While adding the `cleared1` user, select the password option User Must Set Password At Next Login. After adding both users, double-click the `locked1` user and select the tab General. Under the Account Availability section, select Account is Locked. Also select the shell as listed in Table 10-16 on page 10-36.

## Task 4 – Examining Configuration Files

Complete the following steps:

1. Examine the contents of the `/etc/passwd` file. What are the full path names of the shells used by `user3`, `user4`, and `user5`?

|                    |                       |
|--------------------|-----------------------|
| <code>user3</code> | <code>/bin/ksh</code> |
| <code>user4</code> | <code>/bin/csh</code> |
| <code>user5</code> | <code>/bin/sh</code>  |

2. Examine the contents of the `/etc/shadow` file. What text is found in the password field for the users `locked1` and `cleared1`?

|                       |                   |
|-----------------------|-------------------|
| <code>locked1</code>  | <code>*LK*</code> |
| <code>cleared1</code> | <code>none</code> |

3. You used the same password for `user3` through `user5`. Are the password strings the same in the `/etc/shadow` file?

*No.*

4. Examine the contents of the `/etc/group` file. Verify that `user3` and `user4` are both listed as secondary members of the `class1` group. Are they?

*The names `user3` and `user4` should be listed in the last field for the `class1` group.*

5. Log out of the CDE, and attempt to log in as `locked1`. Are you able to log in?

*No, you get a message that says `login incorrect`, no matter what you use as a password.*

6. Attempt to log in as `cleared1`. What happens? Attempt to use the password `abcdefg`. What are the system requirements for the password? You must not press Return when you are asked for an initial password.

*You must choose an initial password for this user and then log in again. The first six characters must contain at least two alphabetic characters and at least one numeric or special character.*

Use the password `abc123`. Log in as `cleared1` after you establish a password to verify that the login works. Log out, and log in as the `root` user.

### Task 5 – Establishing Password Aging

Complete the following steps:

1. Start the Solaris Management Console, and go back into the User Accounts tool. Select `user5` from the list of users. Change the password options information for `user5` so that it matches the following information. Click OK when you are finished, and exit the Solaris Management Console.

|                           |              |
|---------------------------|--------------|
| User Must Keep For:       | 1 (one day)  |
| Before Change Alert User: | 1 (one day)  |
| User Must Change Within:  | 2 (two days) |
| Expires If Not Used For:  | 1 (one day)  |

2. Log out of your `root` login session. Attempt to log in as `user5`. What happens? Supply a new password if necessary.

*You must supply a new password before you can log in.*

3. Complete the login as user5. Open a terminal window, and attempt to change the password you just set. What happens?

*When you log in, a warning indicates that your password expires in two days.*

*When you try to change your password, the following error message appears:*

```
passwd: Sorry: less than 1 days since the last change.  
Permission denied
```

4. Log out, and log in again as the root user.

## Tasks 6 – Modifying User Accounts and Group Entries

Complete the following steps:

1. Use the groupadd command to create a new group entry called class3 that uses GID number 103.

```
# groupadd -g 103 class3
```

2. Use the usermod command to change the login name of locked1 to user6, the UID to 3001, and the home directory of locked1 to user6. Verify that the changes you request are recorded in the /etc/passwd file and that the directory was moved.

```
# usermod -u 3001 -d /export/home/user6 -m -l user6 locked1
```

*The /etc/passwd file should reflect the new UID number and user name. The directory under /export/home should be renamed.*

3. Use the smuser modify command to change the login shell of user5 to /bin/ksh. Verify that the changes you request are recorded in the /etc/passwd file.

```
# /usr/sadm/bin/smuser modify -- -n user5 -s /bin/ksh
```

*The /etc/passwd file should show that the shell is /bin/ksh.*

4. Use the userdel command to delete the user account cleared1 and the related home directory. Verify that the /export/home/cleared1 directory no longer exists.

```
# userdel -r cleared1
```

*The /export/home/cleared1 directory should no longer exist.*

5. Use the `smgroup` command to change the group name of `class1` to `group1`.

```
# /usr/sadm/bin/smgroup modify -- -n class1 -N group1
```

6. Use the `groupdel` command to remove the group entry `class2`.

```
# groupdel class2
```

7. Verify that the commands used to modify group entries have correctly modified the `/etc/group` file.

*The group `group1` should exist. The groups `class1` and `class2` should not exist.*

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

## Managing Initialization Files

The environment maintained by the shell includes variables that are defined by the `login` program, the system initialization files, and the user initialization files.

When users log in to the system, their login shells look for and execute two different types of initialization files. The first type controls the system-wide environment. The second type controls the user's environment. The six shells available in the Solaris 9 OE provide basic features and a set of variables which the `root` user or a regular user can set in the initialization files to customize the shell environment.

The shells support two types of variables:

- Environment variables – Variables that provide information about the user's environment to every shell program that is started.
- Local variables – Variables that affect only the current shell. Any subshell started would not have knowledge of these variables.

## Introducing System-Wide Initialization Files

As the system administrator, you maintain the system-wide initialization files. These files provide an environment for the entire community of users who log in to the system. The Solaris OE provides the system initialization files. They reside in the `/etc` directory.

The `/etc/profile` file and the `/etc/.login` file are the two main system initialization files.

The Bourne, Korn, and BASH login shells look for and execute the system initialization file `/etc/profile` during login.

The C login shell looks for and executes the system initialization file `/etc/.login` during the login process.

There are no default global initialization files for the Z or TC shells.



**Note** – The default files `/etc/profile` and `/etc/.login` check disk usage quotas, print the message of the day from the `/etc/motd` file, and check for mail. None of the messages are printed to the screen if the `.hushlogin` file exists in the user's home directory.

## Introducing User Initialization Files

As the system administrator, you set up the user initialization files that are placed in each user account's home directory when the user is created.

The primary purpose of the user initialization files is to define the characteristics of a user's work environment, such as the command-line prompt, the environment variables, and the windowing environment.

Only the owners of the files or the `root` user can change or customize the content of these files.

10-17 shows the initialization files necessary for each primary shell available in the Solaris 9 OE.

**Table 10-17** Initialization Files for the Primary Shells

| Shells | System-Wide Initialization Files | Primary User Initialization Files Read at Login            | User Initialization Files Read When a New Shell Is Started | Shell Path Name       |
|--------|----------------------------------|------------------------------------------------------------|------------------------------------------------------------|-----------------------|
| Bourne | <code>/etc/profile</code>        | <code>\$HOME/.profile</code>                               |                                                            | <code>/bin/sh</code>  |
| Korn   | <code>/etc/profile</code>        | <code>\$HOME/.profile</code><br><code>\$HOME/.kshrc</code> | <code>\$HOME/.kshrc</code>                                 | <code>/bin/ksh</code> |
| C      | <code>/etc/.login</code>         | <code>\$HOME/.login</code><br><code>\$HOME/.cshrc</code>   | <code>\$HOME/.cshrc</code>                                 | <code>/bin/csh</code> |

For additional information about the Z, BASH, and TC shells available in the Solaris 9 OE, refer to the online manual pages.



**Note** – By default, the `root` user's login shell is the Bourne shell, and the shell entry in the `/etc/passwd` file appears as `/sbin/sh`.

When a user logs in to the system, the system invokes the user's login shell program. The shell program looks for its initialization files in a specific order, executes the commands contained in each file, and displays the shell prompt on the user's screen.

## Customizing the User's Work Environment

The Solaris OE provides a set of initialization file templates. The `/etc/skel` directory contains the initialization file templates. 10-18 shows the default initialization file templates and the user initialization files for the Bourne, Korn, and C shells.

**Table 10-18** Default User Initialization Files

| Shell  | Initialization File Templates                                            | User Initialization Files                                |
|--------|--------------------------------------------------------------------------|----------------------------------------------------------|
| Bourne | <code>/etc/skel/local.profile</code>                                     | <code>\$HOME/.profile</code>                             |
| Korn   | <code>/etc/skel/local.profile</code>                                     | <code>\$HOME/.profile</code>                             |
| C      | <code>/etc/skel/local.cshrc</code><br><code>/etc/skel/local.login</code> | <code>\$HOME/.cshrc</code><br><code>\$HOME/.login</code> |



---

**Note** – The `useradd` command copies files from the `/etc/skel` directory to the `$HOME` directory. The `smuser` command copies files from the `/etc/skel` directory to the `$HOME` directory and renames them to the appropriate file names.

---

The `root` user can customize these templates to create a standard set of user initialization files. A standard set of user initialization files provides a common work environment for each user. When the `root` user creates new user accounts, some or all of these initialization files are automatically copied to each new user's home directory.

Users can then edit their initialization files to further customize their environments for each shell.



10-19 shows some of the variables available for customizing a user's shell environment.

**Table 10-19** Login Variables

| Variable Name | Set By             | Description                                                                                |
|---------------|--------------------|--------------------------------------------------------------------------------------------|
| LOGNAME       | Login              | Defines the user's login name.                                                             |
| HOME          | Login              | Sets the path to the user's home directory. It is the default argument for the cd command. |
| SHELL         | Login              | Sets the path to the default shell.                                                        |
| PATH          | Login              | Sets the default path that the shell searches to find commands.                            |
| MAIL          | Login              | Sets the path to the user's mailbox.                                                       |
| TERM          | Login              | Defines the terminal.                                                                      |
| LPDEST        | Not set by default | Sets the user's default printer.                                                           |
| PWD           | Shell              | Defines the current working directory.                                                     |
| PS1           | Shell              | Defines the shell prompt for the Bourne or Korn shell.                                     |
| prompt        | Shell              | Defines the shell prompt for the C shell.                                                  |



**Note** – For complete information on all variables used by the default shells, see the following man pages: sh(1), ksh(1), csh(1), zsh(1), bash(1), and tcsh(1).

A user can change the values of the predefined variables and specify additional variables.

10-20 shows how to set environment variables in the user initialization files of the Bourne, Korn and C shells.

**Table 10-20** Setting Environment Variables

| Shell          | User's Initialization File                                                                                     |
|----------------|----------------------------------------------------------------------------------------------------------------|
| Bourne or Korn | <i>VARIABLE=value</i> ; export <i>VARIABLE</i><br>For example:<br><i>PS1="\$HOSTNAME "</i> ; export <i>PS1</i> |
| C              | <i>setenv variable value</i><br>For example:<br><i>setenv LPDEST laserprinter</i>                              |

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Modifying Initialization Files (Level 1)

In this exercise, complete the following tasks:

- Modify initialization file templates in the `/etc/skel` directory
- Create user accounts that use the initialization files

### Preparation

This exercise requires the skills practiced in the previous exercise. The user accounts that you create in this exercise are required in later sections of the course. Refer to the lecture notes as necessary to perform the tasks listed.

### Tasks

Complete the following tasks:

- Modify the template for Bourne shell users. Set the `EDITOR` to `vi`, `LPDEST` to `printer1`, `EXINIT` to set `showmode` `autoindent` and `number`, and `ENV` to source the `.kshrc` file.  
(Steps 1–3 in the Level 2 lab)
- Use the Solaris Management Console to create a new user account called `user9` that uses the Korn shell. Log in as the new user, and verify that all the variables you set in `local.profile` are set correctly in the user's environment.  
(Steps 4–6 in the Level 2 lab)
- Create a `.kshrc` file for the new user account that includes two aliases and sets the primary prompt to echo the current working directory. Log out, and log in again as the same user to verify that the `.kshrc` file works. Log out, and log in again as the `root` user.  
(Steps 7–9 in the Level 2 lab)
- Use the `useradd` command to create a new user account called `user10` that uses the Korn shell. Log in as this user, and record the list of initialization files in the home directory. Copy the appropriate file to the `.profile` file. Test the login to verify that the list of variables is set the same as those of the first user you created. Log out, and log in as the `root` user when you are finished.  
(Steps 9–13 in the Level 2 lab)

## Exercise: Modifying Initialization Files (Level 2)

In this exercise, complete the following tasks:

- Modify initialization file templates in the `/etc/skel` directory
- Create user accounts that use the initialization files

### Preparation

This exercise requires the skills practiced in the previous exercise. The user accounts that you create in this exercise are required in later sections of the course. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Modify the template for Bourne shell users. Set the `EDITOR` to `vi`, `LPDEST` to `printer1`, `EXINIT` to set `showmode` `autoindent` and `number`, and `ENV` to source the `.kshrc` file.
- Use the Solaris Management Console to create a new user account called `user9` that uses the Korn shell. Log in as the new user, and verify that all the variables you set in `local.profile` are set correctly in the user's environment.
- Create a `.kshrc` file for the new user account that includes two aliases and sets the primary prompt to echo the current working directory. Log out, and log in again as the same user to verify that the `.kshrc` file works. Log out, and log in again as the `root` user.
- Use the `useradd` command to create a new user account called `user10` that uses the Korn shell. Log in as this user, and record the list of initialization files in the home directory. Copy the appropriate file to the `.profile` file. Test the login to verify that the list of variables is set the same as those of the first user you created. Log out, and log in as the `root` user when you are finished.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window.
2. Change to the `/etc/skel` directory.
3. Use the `vi` editor to edit the `local.profile` file, and make the following changes:
  - a. Edit the line that declares the `PATH` variable so that it reads as follows. Enter this text as one line (no spaces).

```
PATH=/usr/sbin:/sbin:/usr/sadm/bin:/usr/dt/bin:/usr/openwin/bin:/usr/bin:/usr/ucb:.
```

- b. Add the following lines below the `PATH` variable you just edited:

```
EDITOR=vi  
LPDEST=printer1  
EXINIT='set showmode autoindent number'  
ENV=$HOME/.kshrc
```

- c. Change the line that reads:

```
export PATH
```

so that it reads:

```
export PATH EDITOR LPDEST EXINIT ENV
```

4. Use the Solaris Management Console to create a new user account with the following characteristics. Exit the Solaris Management Console when you are finished.

|                |         |
|----------------|---------|
| User Name:     | user9   |
| User ID:       | 1009    |
| Primary Group: | staff   |
| Login Shell:   | Korn    |
| Password:      | 123pass |

5. Log out, and log in again as `user9`. Select the CDE. Open a terminal window.
6. Verify that the `PATH`, `LPDEST`, `EDITOR`, `EXINIT`, and `ENV` variables are set according to the changes you made in the `/etc/skel/local.profile` file.

Do they match?

7. Create a file called `.kshrc` in user9's home directory.

Insert the following lines. A space follows the `$PWD$` in the last line.

```
set -o noclobber
set -o ignoreeof
alias h=history
alias c=clear
PS1='$PWD$ '
```

8. Log out, and then log in again as user9. Open a terminal window, and verify that your new variables work.

Do they work?

9. Log out, and log in again as the root user. Use the `useradd` command to create a new user account called `user10` with the following characteristics:

|                 |                     |
|-----------------|---------------------|
| User Name:      | user10              |
| User ID:        | 1010                |
| Primary Group:  | 10                  |
| Login Shell:    | Korn                |
| Home Directory: | /export/home/user10 |
| Comment:        | SA-239 Student      |
| Password:       | cangetin            |

10. Log out, and log in again as user10. Select the CDE. Open a terminal window. What shell initialization files exist in your home directory? Which of these are the same as `/etc/skel/local.profile`?
11. Copy the `local.profile` file to the `.profile` file.
12. Log out, and log in again as user10. Verify that the variables set for the user9 login are also set for this login.  
Do they match?
13. Log out, and log in again as the root user.

## Exercise: Modifying Initialization Files (Level 3)

In this exercise, complete the following tasks:

- Modify initialization file templates in the `/etc/skel` directory
- Create user accounts that use the initialization files

### Preparation

This exercise requires the skills practiced in the previous exercise. The user accounts that you create in this exercise are required in later sections of the course. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Edit the `/etc/skel/local.profile` file so that it sets the `PATH` variable to a specific list of directories. Set the `EDITOR`, `LPDEST`, `EXINIT`, and `ENV` variables to appropriate values.
- Use the Solaris Management Console to create a new user account called `user9` that uses the Korn shell. Log in as the new user, and verify that all the variables you set in `local.profile` are set correctly in the user's environment.
- Create a `.kshrc` file for the new user account that includes two aliases and sets the primary prompt to echo the current working directory. Log out, and log in again as the same user to verify that the `.kshrc` file works. Log out, and log in again as the `root` user.
- Use the `useradd` command to create a new user account called `user10` that uses the Korn shell. Log in as this user, and record the list of initialization files in the home directory. Copy the appropriate file to the `.profile` file. Test the login to verify that the list of variables is set the same as those of the first user you created. Log out, and log in as the `root` user when you are finished.



## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window.
2. Change to the `/etc/skel` directory.

```
# cd /etc/skel
```

3. Use the `vi` editor to edit the `local.profile` file, and make the following changes:

```
# vi local.profile
```

- a. Edit the line that declares the `PATH` variable so that it reads as follows. Enter this text as one line (no spaces).

```
PATH=/usr/sbin:/sbin:/usr/sadm/bin:/usr/dt/bin:/usr/openwin/bin:/usr/bin:/usr/ucb:.
```

- b. Add the following lines below the `PATH` variable you just edited:

```
EDITOR=vi
LPDEST=printer1
EXINIT='set showmode autoindent number'
ENV=$HOME/.kshrc
```

- c. Change the line that reads:

```
export PATH
```

so that it reads:

```
export PATH EDITOR LPDEST EXINIT ENV
```

4. Use the Solaris Management Console to create a new user with the following characteristics. Exit the Solaris Management Console when you are finished.

|                |         |
|----------------|---------|
| User Name:     | user9   |
| User ID:       | 1009    |
| Primary Group: | staff   |
| Login Shell:   | Korn    |
| Password:      | 123pass |

5. Log out, and log in again as `user9`. Select the CDE. Open a terminal window.

6. Verify that the PATH, LPDEST, EDITOR, EXINIT, and ENV variables are set according to the changes you made in the /etc/skel/local.profile file.

```
$ echo $PATH
$ echo $LPDEST
$ echo $EDITOR
$ echo $EXINIT
$ echo $ENV
```

Do they match?

*These variables should match the settings made in the local.profile file.*

7. Create a file called .kshrc in user9's home directory.

```
$ cd
$ vi .kshrc
```

Insert the following lines. A space follows the \$PWD\$ in the last line.

```
set -o noclobber
set -o ignoreeof
alias h=history
alias c=clear
PS1='$PWD$ '
```

8. Log out, and then log in again as user9. Open a terminal window, and verify that your new variables work.

```
$ cd /tmp
$ cd
$ c
$ h
```

Do they work?

*These variables should function according to the values set in .kshrc. The prompt should reflect your current directory, and the aliases should clear the screen and present a history list.*

9. Log out, and log in again as the `root` user. Use the `useradd` command to create a new user account called `user10` with the following characteristics:

|                 |                                  |
|-----------------|----------------------------------|
| User Name:      | <code>user10</code>              |
| User ID:        | <code>1010</code>                |
| Primary Group:  | <code>10</code>                  |
| Login Shell:    | <code>Korn</code>                |
| Home Directory: | <code>/export/home/user10</code> |
| Comment:        | <code>SA-239 Student</code>      |
| Password:       | <code>cangetin</code>            |

```
# useradd -u 1010 -g 10 -d /export/home/user10 -m -s /bin/ksh -c "SA-239
Student" user10
64 blocks
# passwd user10
New password: cangetin
Re-enter new password: cangetin
```

10. Log out, and log in again as `user10`. Select the CDE. Open a terminal window. What shell initialization files exist in your home directory?

```
$ ls -la
.profile, local.profile, local.login, local.cshrc
```

Which of these are the same as the `/etc/skel/local.profile` file?  
*The local.profile file.*

11. Copy the `local.profile` file to the `.profile` file.

```
$ cp local.profile .profile
```

12. Log out, and log in again as `user10`. Verify that the variables set for the `user9` login are also set for this login.

```
$ echo $PATH
$ echo $LPDEST
$ echo $EDITOR
$ echo $EXINIT
$ echo $ENV
```

Do they match?

*These variables should match the settings made in the local.profile file.*

13. Log out, and log in again as the `root` user.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

# Performing System Security

---

## Objectives

Upon completion of this module, you should be able to:

- Monitor system access
- Switch users on a system
- Control system access
- Restrict access to data in files

The following course map shows how this module fits into the current instructional goal.

### Performing User and Security Administration

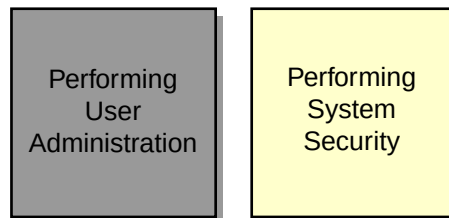


**Figure 11-1** Course Map

## Monitoring System Access

All systems should be monitored routinely for unauthorized user access. You can determine who is or who has been logged into the system by executing commands and examining log files.

### Displaying Users on the Local System

The `who` command displays a list of users currently logged in to the local system. It displays each user's login name, the login device (TTY port), the login date and time. The command reads the binary file `/var/adm/utmpx` to obtain this information and information about where the users logged in from.

If a user is logged in remotely, the `who` command displays the remote host name, or Internet Protocol (IP) address in the last column of the output.

```
# who
user2 pts/2 Feb 7 13:53 (sys43)
root pts/5 Feb 6 09:22 (129.147.4.13)
root pts/3 Feb 7 14:27 (sys41)
root console Feb 5 11:05 (:0)
#
```

The second field displayed by the `who` command defines the user's login device, which is one of the following:

- `console` – The device used to display system boot and error messages
- `pts` – The pseudo device that represents a login or window session without a physical device
- `term` – The device physically connected to a serial port, such as a terminal or a modem

---

**Note** – The `who` command has many options, one of which is the `-m` option. The `who -m` command outputs information about only the current terminal window.

---



## Displaying Users on Remote Systems

The `rusers` command produces output similar to that of the `who` command, but it displays a list of the users logged in on local and remote hosts. The list displays the user's name and the host's name in the order in which the responses are received from the hosts.

A remote host responds only to the `rusers` command if its `rpc.rusersd` daemon is enabled. The `rpc.rusersd` daemon is the network server daemon that returns the list of users on the remote hosts.



---

**Note** – The full path to this network server daemon is `/usr/lib/netsvc/rusers/rpc.rusersd`.

---

The following is the command format for the `rusers` command:

`rusers -options hostname`

The `rusers -l` command displays a long list of the login names of users who are logged in on local and remote systems. The output displays the name of the system into which a user is logged, the login device (TTY port), the login date and time, the idle time, and the login host name. If the user is not idle, no time is displayed in the idle time field. The term idle means that the user is not actively doing anything at the time on the terminal, which would denote the user is probably at screen lock or away from the terminal.

The following is an example of the `rusers` command:

```
# rusers -l
Sending broadcast for rusersd protocol version 3...
root      instructor:console    Feb  5 11:05    50:15 (:0)
root      instructor:pts/5    Feb  6 09:22    27:38 (129.147.4.13)
root      instructor:pts/6    Feb  4 13:36     5:08 (129.147.48.219)
root      instructor:pts/7    Feb  4 13:36    25:50 (129.147.48.219)
root      instructor:pts/2    Feb  6 09:23    27:10 (129.147.4.13)
root      instructor:pts/10   Feb  7 07:35     45 (lightbandit)
root      instructor:pts/12   Feb  7 09:38     44 (lightbandit)
root      instructor:pts/11   Feb  7 14:16    (129.147.4.20)
user2     sys44:pts/2              Feb  7 13:53     45 (instructor)
root      sys11ext:console    Feb  6 13:17    23:52
user2     sys41:pts/1          Feb  7 13:48     44 (instructor)
root      sys41:pts/3          Feb  7 14:32    (instructor)
Sending broadcast for rusersd protocol version 2...
```

## Displaying User Information

To display detailed information about user activity that is either local or remote, use the `finger` command.

The `finger` command displays:

- The user's login name
- The home directory path
- The login time
- The login device name
- The data contained in the comment field of the `/etc/passwd` file (usually the user's full name)
- The login shell
- The name of the host, if the user is logged in remotely, and any idle time

The following is the command format for the `finger` command:

```
finger [-bfhiImpqsw] [username...]
finger [-l] [ username@hostname1 [ @hostname ]]
```

The `-m` option matches arguments only on *username* (not the first or last name that might appear in the comment field of `/etc/passwd`).



To display information for `usera`, perform the command:

```
# finger -m usera
Login name: usera           In real life: Alpha User located in Office #4
Directory: /home/usera     Shell: /bin/sh
On since Dec 17 10:32:53 on console from :0
1 minute 47 seconds Idle Time
No unread mail
No Plan.
```

If users create the standard ASCII files `.plan` or `.project` in their home directories, the content of those files is shown as part of the output of the `finger` command.

These files are traditionally used to outline a user's current plans or projects and must be created with file access permissions set to 644 (`rw-r--r--`).



---

**Note** – You get a response from the `finger` command only if the `in.fingerd` daemon is enabled.

---

## Displaying a Record of Login Activity

Use the `last` command to display a record of all logins and logouts with the most recent activity at the top of the output. The `last` command reads the binary file `/var/adm/wtmpx`, which records all logins, logouts, and reboots.

Each entry includes the user name, the login device, the host that the user is logged in from, the date and time that the user logged in, the time of logout, and the total login time in hours and minutes, including entries for system reboot times.

The output of the `last` command can be extremely long. Therefore, you might want to use it with the `-n` number option to specify the number of lines to display.

The following is an example of the `last` command:

```
# last
user9  console      :0                Mon Dec 17 10:38  still logged in
root   pts/4          129.147.4.12     Mon Dec 17 10:33  still logged in
usera  console      :0                Mon Dec 17 10:32 - 10:38  (00:05)
reboot system boot                Fri Dec 14 09:58
(output truncated)
```

You can use the `last` command also to display information about an individual user if you supply the user's login name as an argument.

```
# last user9
user9  console      :0                Mon Dec 17 10:38  still logged in
user9  console      :0                Fri Dec 14 10:18 - 10:25  (00:07)
(output truncated)
```

To view the last five system reboot times only, perform the command:

```
# last -n 5 reboot
reboot system boot                Wed Feb 20 13:20
reboot system boot                Wed Feb 20 13:18
reboot system boot                Fri Feb  1 12:46
reboot system boot                Thu Jan 17 09:02
reboot system boot                Thu Jan 17 08:55
```

## Recording Failed Login Attempts

When a user logs in to a system either locally or remotely, the `login` program consults the `/etc/passwd` and the `/etc/shadow` files to authenticate the user. It verifies the user name and password entered.

If the user provides a login name that is in the `/etc/passwd` file and the correct password for that login name, the `login` program grants access to the system.

If the login name is not in the `/etc/passwd` file or the password is not correct for the login name, the `login` program denies access to the system.

You can log failed command-line login attempts in the `/var/adm/loginlog` file. This is a useful tool if you want to determine if attempts are being made to break into a system.

By default, the `loginlog` file does not exist. To enable logging, you should create this file with read and write permissions for the `root` user only, and it should belong to the `SYS` group.

```
# touch /var/adm/loginlog
# chown root:sys /var/adm/loginlog
# chmod 600 /var/adm/loginlog
```

All failed command-line login activity is written to this file automatically after five consecutive failed attempts.

The `loginlog` file contains one entry for each of the failed attempts. Each entry contains the user's login name, login device (TTY port), and time of the failed attempt.

If there are fewer than five consecutive failed attempts, no activity is logged to this file.

## Switching Users on a System

As the system administrator, you should log in to a system as a regular user, and then switch to the `root` account only to perform administrative tasks.

You should avoid logging in directly as the `root` user. This precaution helps protect the system from unauthorized access, because it reduces the likelihood that the system will be left unattended with the `root` user logged in. Also, critical mistakes are less likely to occur if you perform routine work as a regular system user.

## Introducing the `su` Command

Use the `su` command to switch to the superuser or another user without logging out and back in as that user.

The following is the command format for the `su` command:

```
su - username
```

If no user name is given, then the `su` command attempts to switch to the `root` user.

To use the `su` command, supply the appropriate password unless you are already the `root` user. The `root` user can run the `su` command without passwords.

If the password is correct, the `su` command creates a new shell process, as specified in the shell field of that user account's `/etc/passwd` file entry.

The `su -` (dash) option specifies a complete login by reading all of the user's shell initialization files. The `-` (dash) option changes your work environment to what would be expected if you had logged in directly as that specified user. It also changes the user's home directory.

Table 11-1 shows the effect of the `su` command on real user IDs (UIDs), not effective user IDs (EUIDs). The table assumes that `user1` has a UID of 100 and a group ID (GID) of 10 and switches to `user2` with a UID of 200 and a GID of 20.

**Table 11-1** The `su` Command and Real UIDs and EUIDs

| IDs  | ID Value | Variation | The Command That Shows the Variation |
|------|----------|-----------|--------------------------------------|
| UID  | 100      | 100       | <code>who am i</code>                |
| EUID | 100      | 200       | <code>whoami</code>                  |
| GID  | 10       | 10        |                                      |
| EGID | 10       | 20        |                                      |

## Displaying the Effective User ID

When you run the `su` command, the user ID and the user group ID (GID) change to that of the user to which you have switched, becoming the EUID and effective group ID (EGID), respectively.

Access to files and directories is determined by the value of the EUID and EGID for the effective user, rather than by the UID and GID numbers of the original user who logged in to the system.

### Using the `whoami` Command

The `whoami` command displays the login name of the EUID.

---

**Note** – The `whoami` command resides in the `/usr/ucb` directory.

---



For example, `user1` is logged into the system under that login name. This user then runs the `su` command to become the `root` user and enters the `root` password. The `whoami` command displays the user's EUID.

```
$ whoami
user1
$ pwd
/export/home/user1
$ su
password: EnterPassword
# whoami
root
# pwd
/export/home/user1
```

## Displaying the Real User ID

To determine the login name of the original user use the `who` command with the `am i` option.

### Using the `who am i` Command

To use the `who am i` command, at the shell prompt, type the `su` command and the login name of the user account to which you want to switch, and press Return. Type the password for the user account, and press Return.

For example, while logged in as `user1`, use the `su` command to switch to `user2`:

```
$ su user2
password: EnterPassword
$ who am i
user1      pts/2          Dec 17 12:18    (129.147.4.12)
```

An alternative to the `who am i` command is the `who -m` command.

## Switching to Another Regular User

To switch to another user and have that user's environment, use the `su` command as follows:

1. At the shell prompt, display your login name and path.

```
$ who am i
user1      pts/4          Feb  8 08:38    (sys41)
$ pwd
/export/home/user1
```

2. Enter the `su` command with the dash (-) option and the login name of the user to which you want to switch. Then, enter the password for the user.

```
$ su - user2
Password: EnterPassword
```

3. To determine the login name of the effective user, perform the `whoami` command, and press Return.

```
$ whoami
user2
```

4. To determine the current working directory, perform the `pwd` command. The location is the effective user's home directory.

```
$ pwd
/export/home/user2
```

5. To display the login name of the original user, perform the `who am i` command.

```
$ who am i
user1      pts/4          Feb  8 08:38    (sys41)
```

6. To return to the original user status and home directory, perform the `exit` command.

```
$ exit
$ pwd
/export/home/user1
```

## Becoming the root User

In the default system configuration, direct `root` logins are restricted to the console. This means that you cannot remotely log in to a system as `root`. To remotely log in to a host as the `root` user, you must log in as a regular user and then run the `su` command to become the `root` user.

To become the `root` user, use the `su` command as follows:

1. Log in from the login window as a regular user, such as `user1`.
2. At the shell prompt in a terminal window, perform the `su` command.  
Enter the `root` password.

```
$ su -
```

```
Password: EnterPassword
```

3. To display the original login, perform the `who am i` command.

```
# who am i
```

```
user1 pts/4 Feb 8 08:48 (sys41)
```

4. To determine the login name of the user to which you have switched, perform the `whoami` command.

```
# whoami
```

```
root
```

5. To determine the current working directory, perform the `pwd` command.

```
# pwd
```

```
/
```

6. To exit the `root` session and return to the original user, perform the `exit` command.

```
# exit
```

```
$ pwd
```

```
/export/home/user1
```

```
$
```



## Monitoring su Attempts

For security reasons, you must monitor who has been using the `su` command, especially those users who are trying to gain `root` access on the system. You can initiate the monitoring by setting two variables in the `/etc/default/su` file.



---

**Note** – There are many variables in the `/etc/default/su` file. This course presents only a small subset of the variables.

---

### Contents of the `/etc/default/su` File

To display the contents of the `/etc/default/su` file, perform the command:

```
# cat /etc/default/su
#ident "@(#)su.dfl      1.6      93/08/14 SMI"    /* SVr4.0 1.2 */

# SLOG determines the location of the file used to log all su attempts
SLOG=/var/adm/sulog

# CONSOLE determines whether attempts to su to root should be logged
# to the named device
#CONSOLE=/dev/console
(output edited for brevity)
SYSLOG=YES
```

In the preceding example, unsuccessful attempts to use the `su` command to access the `root` account are logged to the `/var/adm/messages` file. The following is an example entry from that file:

```
Dec 17 12:35:47 sys41 su: [ID 810491 auth.crit] 'su root' failed for
usera on /dev/pts/2
```

### The CONSOLE Variable in the /etc/default/su File

By default, the system ignores the CONSOLE variable in the /etc/default/su file because of the preceding comment (#) symbol. All attempts to use the su command are logged to the console, regardless of success or failure. Here is an example of output to the console:

```
Feb 2 09:50:09 host1 su: 'su root' failed for user1 on /dev/pts/4
Feb 2 09:50:33 host1 su: 'su user3' succeeded for user1 on /dev/pts/4
```

When the comment symbol is removed, the value of the CONSOLE variable is defined for the /dev/console file. Subsequently, an additional line of output for each successful attempt to use the su command to access the root account is logged to the console. Here is an example of logged su command activity:

```
Feb 2 11:20:07 host1 su: 'su root' succeeded for user1 on /dev/pts/4
SU 02/02 11:20 + pts/4 user1-root
```

### The SULOG Variable in the /etc/default/su File

The SULOG variable in the /etc/default/su file specifies the name of the file in which all attempts to use the su command to switch to another user are logged. If the variable is undefined, the su command logging is turned off.

The /var/adm/sulog file is a record of all attempts by users on the system to execute the su command. Each time the su command is executed, an entry is added to the sulog file.

The entries in this file include the date and time the command was issued, whether it was successful (shown by the plus (+) symbol for success or the hyphen (-) symbol for failure), the device from which the command was issued, and, finally, the login and the effective identity.

The following is an example of entries from the /var/adm/sulog file:

```
# more /var/adm/sulog
SU 10/20 14:50 + console root-sys
SU 10/20 16:55 + pts/2 user3-root
SU 11/05 11:21 - pts/3 user1-root
```

## Controlling System Access

The more access that is available over the network, the more beneficial it is for remote system users. However, unrestricted access and sharing of data and resources can create security problems.

A local host's remote security measures are generally based on an ability to validate, limit, or block operations from remote system users.

### The /etc/default/login File



---

**Note** – There are many variables in the /etc/default/login file. This course, presents only a small subset of the variables.

---

The /etc/default/login file establishes default parameters for users when they log in to the system. The /etc/default/login file gives you the ability to protect the `root` account on a system. You can restrict `root` access to a specific device or to a console, or disallow `root` access altogether.

To display the contents of the /etc/default/login file, perform the command:

```
# cat /etc/default/login
(output edited for brevity)
# If CONSOLE is set, root can only login on that device.
# Comment this line out to allow remote login by root.
#
CONSOLE=/dev/console

# PASSREQ determines if login requires a password.
#
PASSREQ=YES
```

### The CONSOLE Variable in the /etc/default/login File

You can set the CONSOLE variable in the /etc/default/login file to specify one of three possible conditions that restrict access to the root account:

- If the variable is defined as `CONSOLE=/dev/console`, the root user can log in only at the system console. Any attempt to log in as root from any other device generates the error message:

```
# rlogin host1
```

```
Not on system console
```

```
Connection closed.
```

- If the variable is not defined, such as `#CONSOLE=/dev/console`, the root user can log in to the system from any device across the network, through a modem, or using an attached terminal.
- If the variable does not have a value assigned to it (for example `CONSOLE=` ) then the root user cannot log in from anywhere, not even the console. The only way to become the root user on the system is to log in as a regular user and then become root by using the su command.



---

**Note** – You can confine root logins to a particular port with the CONSOLE variable. For example, `CONSOLE=/dev/term/a` permits the root user to log in to the system only from a terminal that is connected to Serial Port A.

---

### The PASSREQ Variable in the /etc/default/login File

When the PASSREQ variable in the /etc/default/login file is set to the default value of YES, then all users who had not been assigned passwords when their accounts were created are required to enter a new password as they log in for the first time. If this variable is set to NO, then null passwords are permitted. This variable does not apply to the root user.

## File Transfer Protocol (FTP) Access

The Solaris OE provides an American Standard Code for Information Interchange (ASCII) file named `/etc/ftpd/ftpusers`. The `/etc/ftpd/ftpusers` file lists the names of users who are prohibited from connecting to the system through the FTP protocol.

Each line entry in this file contains a login name for a restricted user, for example:

*username*

The FTP server daemon `in.ftpd` reads the `/etc/ftpd/ftpusers` file when an FTP session is invoked. If the login name of the user matches one of the listed entries, it rejects the login session and sends the Login failed error message.

By default, the `/etc/ftpd/ftpusers` file lists these system account entries:

```
root
daemon
bin
sys
adm
lp
uucp
nuucp
smmsp
listen
nobody
noaccess
nobody4
```

As with any login name that you can add, these entries must match the user account names located in the `/etc/passwd` file.

The `root` entry is included in the `ftpusers` file as a security measure. The default security policy is to disallow remote logins for the `root` user. The policy is also followed for the default value set as the `CONSOLE` entry in the `/etc/default/login` file.

## The `/etc/hosts.equiv` and `$HOME/.rhosts` Files

Typically, when a remote user requests login access to a local host, the first file read by the local host is its `/etc/passwd` file. An entry for that particular user in this file enables that user to log in to the local host from a remote system. If a password is associated with that account, then the remote user is required to supply this password at log in to gain system access.

If there is no entry in the local host's `/etc/passwd` file for the remote user, access is denied.

The `/etc/hosts.equiv` and `$HOME/.rhosts` files bypass this standard password-based authentication to determine if a remote user is allowed to access the local host, with the identity of a local user.

These files provide a remote authentication procedure to make that determination.

This procedure first checks the `/etc/hosts.equiv` file and then checks the `$HOME/.rhosts` file in the home directory of the local user who is requesting access. The information contained in these two files (if they exist) determines if remote access is granted or denied.

The information in the `/etc/hosts.equiv` file applies to the entire system, while individual users can maintain their own `$HOME/.rhosts` files in their home directories.

Figure 11-2 shows the flow of remote access authentication.

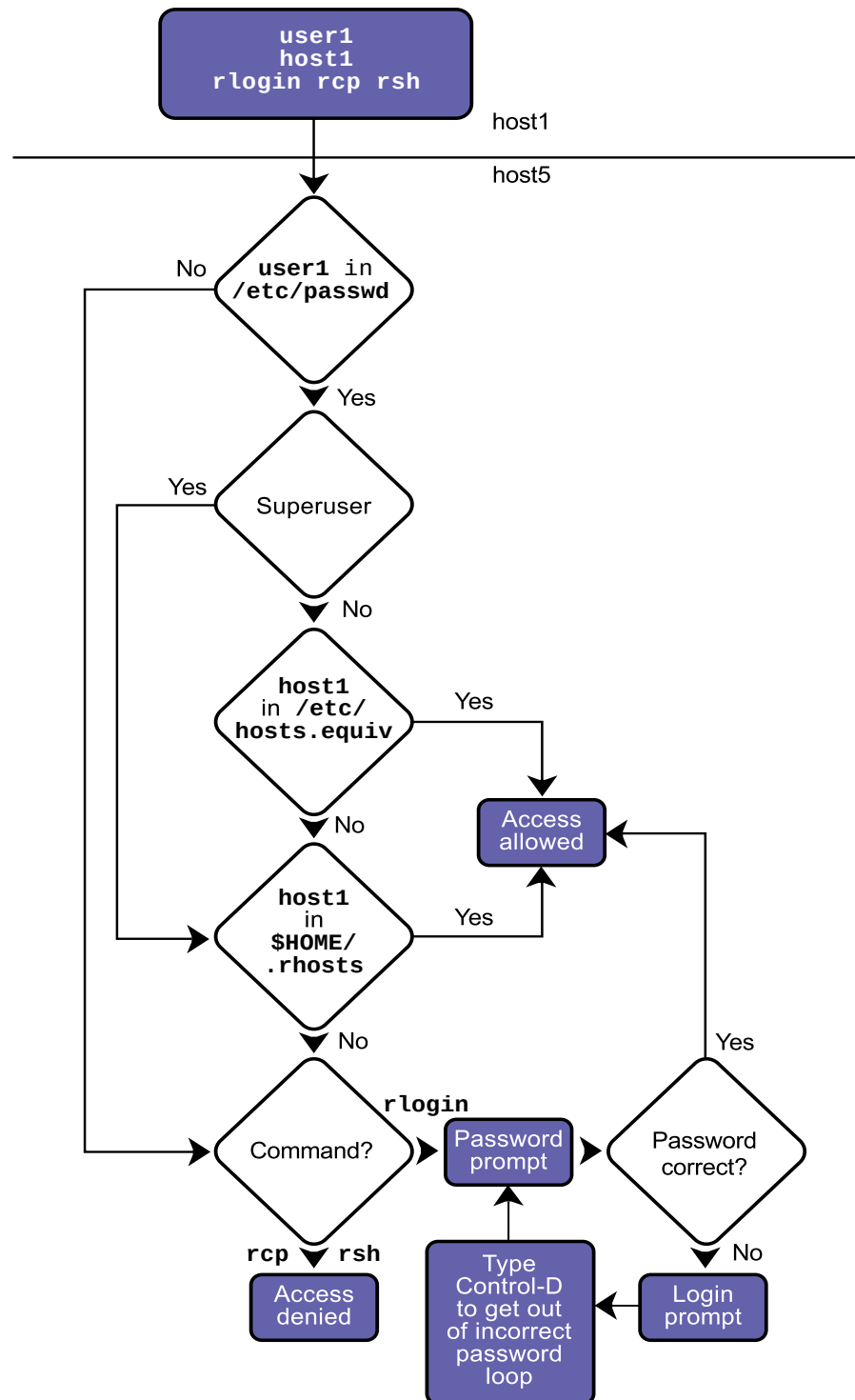


**Figure 11-2** Remote Access Authentication

### Entries in the `/etc/hosts.equiv` and `$HOME/.rhosts` Files

While the `/etc/hosts.equiv` and `$HOME/.rhosts` files have the same format, the same entries in each file have different effects.

Both files are formatted as a list of one-line entries, which can contain the following types of entries:

```
hostname
hostname username
+
```

The host names in the `/etc/hosts.equiv` and `$HOME/.rhosts` files must be the official name of the host, not one of its alias names.



---

**Note** – When logging in to a number of different systems, you can run the `uname -n` command to determine on which system you are currently logged in.

---

### The `/etc/hosts.equiv` File Rules

For regular users, the `/etc/hosts.equiv` file identifies remote hosts and remote users who are considered to be *trusted*.



---

**Note** – The `/etc/hosts.equiv` file is not checked at all if the remote user requesting local access is the `root` user.

---

If the local host's `/etc/hosts.equiv` file contains the host name of a remote host, then all regular users of that remote host are trusted and do not need to supply a password to log in to the local host. This is provided so that each remote user is known to the local host by having an entry in the local `/etc/passwd` file; otherwise, access is denied.

This functionality is particularly useful for sites where regular users commonly have accounts on many different systems, eliminating the security risk of sending ASCII passwords over the network.

The `/etc/hosts.equiv` file does not exist by default. It must be created if trusted remote user access is required on the local host.



## The \$HOME/.rhosts File Rules

While the `/etc/hosts.equiv` file applies system-wide access for non-root users, the `.rhosts` file applies to a specific user.

All users, including the `root` user, can create and maintain their own `.rhosts` files in their home directories.

For example, if you run an `rlogin` process from a remote host to gain `root` access to a local host, the `.rhosts` file is checked in the `root` home directory on the local host.

If the remote host name is listed in this file, it is a trusted host, and, in this case, `root` access is granted on the local host. The `CONSOLE` variable in the `/etc/default/login` file must be commented out for remote `root` logins.

The `$HOME/.rhosts` file does not exist by default. You must create it in the user's home directory.

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: User Access (Level 1)

In this exercise, you complete the following tasks:

- Log failed login attempts
- Use the commands `finger`, `last`, `rusers`, `su`, and `whoami`
- Examine the `su` log file
- Change the `/etc/default/login` file to allow `root` logins from any terminal
- Change the `/etc/ftpd/ftpusers` file to allow FTP access as the `root` user
- Create a `/.rhosts` file to allow `root` access from another system

## Preparation

This lab requires two systems. Each system lists the other in its `/etc/inet/hosts` file. The lab also requires two specific users, `user9` and `user3`, on both systems. Both users should use the password `123pass`. Refer to the lecture notes as necessary to perform the steps listed.

## Tasks

Complete the following tasks:

- Create a log file to record failed login attempts. Use the command-line login to make five failed login attempts. List the contents of the log file. Use commands to display information for `user9` on both your system and your partner's system.  
(Steps 1–7 in the Level 2 lab)
- Identify when the first `root` login session on your system occurred and how long the session lasted. Identify when your system last booted. List the users logged in on all systems on your network and on just your partner's system.  
(Steps 8–11 in the Level 2 lab)

- Change your user identity from the `root` user to `user9`, both with and without the `-` (dash) option. Record the differences. List effective and real user identity during your `su` sessions. Locate the `su` log and identify which user initiated your `su` attempts.  
(Steps 12–18 in the Level 2 lab)
- As the `root` user, attempt to log into your partner's system. Record error messages. Change the `CONSOLE` variable on your partner's system to allow `root` logins from any terminal. Attempt to access your partner's system again.  
(Steps 19–21 in the Level 2 lab)
- As the `root` user, attempt to use the `ftp` command to access your partner's system. Change the `ftp` permissions file to allow `root` access to your partner's system.  
(Step 22 in the Level 2 lab)
- As the `root` user, attempt to use the `rlogin` command to access your partner's system. Ask your partner to create a `/.rhosts` file that lists your system name. Attempt to use the `rlogin` command to access your partner's system again.  
(Step 23 in the Level 2 lab)

## Exercise: User Access (Level 2)

In this exercise, you complete the following tasks:

- Log failed login attempts
- Use the commands `finger`, `last`, `rusers`, `su`, and `whoami`
- Examine the `su` log file
- Change the `/etc/default/login` file to allow `root` logins from any terminal
- Change the `/etc/ftpd/ftpusers` file to allow FTP access as the `root` user
- Create a `/.rhosts` file to allow `root` access from another system

### Preparation

This lab requires two systems. Each system lists the other in its `/etc/inet/hosts` files. It also requires two specific users, `user9` and `user3`, on both systems. Both users should use the password `123pass`. Refer to the lecture notes as necessary to perform the steps listed.

### Task Summary

In this exercise, you accomplish the following:

- Create the file `/var/adm/loginlog`. Use the command-line login to make five failed login attempts. List the contents of the `/var/adm/loginlog` file. Use the `finger` command to display information for `user9` on both your system and your partner's system.
- Use the `last` command to identify when the first `root` login session on your system occurred and how long the session lasted. Use the `last` command to learn when your system last booted. Use the `rusers` command to list the users logged in on all systems on your network and on just your partner's system.

- Use the `su` command to change your user identity from the `root` user to `user9`, both with and without the `-` (dash) option. Record the differences. Use the `whoami` and `who am i` commands to list your effective and real user identity during your `su` sessions. Locate the `su` log declared in the `/etc/default/su` file, and identify which user initiated your `su` attempts.
- As the `root` user, attempt a session to your partner's system by using the `telnet` command. Record error messages. Change the `CONSOLE` variable on your partner's system to allow `root` logins from any terminal. Attempt the `telnet` session again.
- As the `root` user, attempt to use the `ftp` command to access your partner's system. Change the `/etc/ftpd/ftpusers` file to allow `root` access to your partner's system.
- As the `root` user, attempt to use the `rlogin` command to access your partner's system. Ask your partner to create a `/.rhosts` file that lists your system name. Attempt to use the `rlogin` command to access your partner's system again.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change the directory to `/var/adm`.
2. Use the `touch` command to create a file called `loginlog`. (Ensure permissions are set to read and write for the `root` user only.) If necessary, set the group ownership to `sys`.
3. Log out. From the CDE Options menu, select the Command Line Login option. When the CDE login screen clears, press Return to obtain the command-line login prompt.
4. Enter `root` after the login prompt, but supply an incorrect password. Do this five times. After the fifth attempt, the CDE login screen appears again. Log in as `root`, and open a terminal window.
5. Examine the `/var/adm/loginlog` file. What does it contain?
6. Use the `finger` command to display information for the user called `user9`. What is the difference in the output between the `finger -m` command and the `finger` command with no option?

7. Use the `finger` command to display information for the same user on your partner's system. (You will need to reference your partner's system on the command line.) Try this with and without the `-m` option. Does the `-m` option change the output that the `finger` command displays?
8. Use the `last` command to display login and system reboot activity. When did the first `root` login occur, and how long did that session last?
9. Use the `last` command to display only system boot activity. When did the system last reboot?
10. Use the `rusers` command to list information about the users on all systems on your network segment.
11. Use the `rusers` command to list information for users on your partner's system. When, and on what terminal, did the first user listed log in?
12. Switch your user identity to that of `user9`. Do not use the `-` (dash) option.
13. Display some of the variables that define your environment.
14. Exit the `su` session and try to switch your user identity again, this time using the `-` (dash) option.  
  
Are the values reported now correct for the user `root` or for `user9`?
15. Use the `whoami` and `who am i` commands to list your effective and real user identity.  
  
What do these commands report?
16. Use the `su` command to change your user identity from `user9` to `user3`, and use the `whoami` and `who am i` commands again.  
  
What do these commands report?  
  
Exit both `su` sessions when you are finished.
17. Change the directory to `/etc/default`. Examine the `/etc/default/su` file, and record the value of the `SULOG` variable.
18. Display the file named by the `SULOG` variable, and identify the entry that relates to your last `su` command. Is `user9` or the `root` user identified as the user who became `user3`?
19. As the user `root`, attempt to log in to your partner's system by using the `telnet` command. Was your attempt successful? What message appears?

20. On your partner's system, edit the `/etc/default/login` file, and change the line that reads:

`CONSOLE=/dev/console`

so that it reads:

`#CONSOLE=/dev/console`

21. As the `root` user, again attempt to log in to your partner's system by using the `telnet` command. If your login attempt is successful, exit the `telnet` session. If not, check the change you made in Step 20, and try again.
22. As the `root` user, attempt to use the `ftp` command to access your partner's system. Were you successful? Ask your partner to edit the `/etc/ftpd/ftpusers` file and comment out the `root` entry. Attempt to use the `ftp` command to access your partner's system again. List some files in the `/tmp` directory from the `ftp>` prompt.
23. As the `root` user, attempt to use the `rlogin` command to access your partner's system. Were you successful? Ask your partner to create a `/.rhosts` file and enter the name of your system on a line by itself. Attempt to use the `rlogin` command to access your partner's system again.



## Exercise: User Access (Level 3)

In this exercise, you complete the following tasks:

- Log failed login attempts
- Use the commands `finger`, `last`, `rusers`, `su`, and `whoami`
- Examine the `su` log file
- Change the `/etc/default/login` file to allow `root` logins from any terminal
- Change the `/etc/ftpd/ftpusers` file to allow FTP access as the `root` user
- Create a `/.rhosts` file to allow `root` access from another system

### Preparation

This lab requires two systems that list each other in their `/etc/inet/hosts` files. It also requires two specific users, `user9` and `user3`, on both systems. Both users should use the password `123pass`. Refer to the lecture notes as necessary to perform the steps listed.

### Task Summary

In this exercise, you accomplish the following:

- Create the file `/var/adm/loginlog`. Use the command-line login to make five failed login attempts. List the contents of the `/var/adm/loginlog` file. Use the `finger` command to display information for `user9` on both your system and your partner's system.
- Use the `last` command to identify when the first `root` login session on your system occurred and how long the session lasted. Use the `last` command to learn when your system last booted. Use the `rusers` command to list the users logged in on all systems on your network and on just your partner's system.

- Use the `su` command to change your user identity from the `root` user to `user9`, both with and without the `-` (dash) option. Record the differences. Use the `whoami` and `who am i` commands to list your effective and real user identity during your `su` sessions. Locate the `su` log declared in the `/etc/default/su` file, and identify which user initiated your `su` attempts.
- As the `root` user, attempt a session to your partner's system by using the `telnet` command. Record error messages. Change the `CONSOLE` variable on your partner's system to allow `root` logins from any terminal. Attempt the `telnet` session again.
- As the `root` user, attempt to use the `ftp` command to access your partner's system. Change the `/etc/ftpd/ftpusers` file to allow `root` access to your partner's system.
- As the `root` user, attempt to use the `rlogin` command to access your partner's system. Ask your partner to create a `/.rhosts` file that lists your system name. Attempt to use the `rlogin` command to access your partner's system again.

## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change the directory to `/var/adm`.

```
# cd /var/adm
```

2. Use the `touch` command to create a file called `loginlog`. (Ensure permissions are set to read and write for the `root` user only.) If necessary, set the group ownership to `sys`.

```
# touch loginlog
```

```
# chmod 600 loginlog
```

```
# chgrp sys loginlog
```

3. Log out. From the CDE Options menu, select the Command Line Login option. When the CDE login screen clears, press Return to obtain the command-line login prompt.
4. Enter `root` after the login prompt, but supply an incorrect password. Do this five times. After the fifth attempt, the CDE login screen appears again. Log in as `root`, and open a terminal window.
5. Examine the `/var/adm/loginlog` file. What does it contain?

*This file should contain a list of failed login attempts which appear similar to the following:*

```
login:/dev/pts/2:Tue Dec 18 13:29:22 2001
```

6. Use the `finger` command to display information for the user called `user9`. What is the difference in output between the `finger -m` command and the `finger` command with no option?

```
# finger user9
# finger -m user9
```

*The `finger` command with no option lists all user accounts that have the string `user` in their names and comment fields. The `finger -m` command lists only the entry for the user named `user9`.*

7. Use the `finger` command to display information for the same user on your partner's system. (You will need to reference your partner's system on the command line.) Try this with and without the `-m` option. Does the `-m` option change the output that the `finger` command displays?

```
# finger user9@hostname
# finger -m user9@hostname
```

*No.*

8. Use the `last` command to display login and system reboot activity. When did the first root login occur, and how long did that session last?

```
# last
```

*This information depends on the activity on your particular system.*

9. Use the `last` command to display only system boot activity. When did the system last reboot?

```
# last reboot
```

*This information depends on the activity on your particular system.*

10. Use the `rusers` command to list information about the users on all systems on your network segment.

```
# rusers -l
```

11. Use the `rusers` command to list information about the users on your partner's system. When, and on what terminal, did the first user listed log in?

```
# rusers -l hostname
```

*This information depends on the activity on your particular system.*

12. Switch your user identity to that of user9. Do not use the - (dash) option.

```
# su user9
$
```

13. Display some of the variables that define your environment.

```
$ echo $LOGNAME
$ echo $HOME
```

Are the values reported correct for the user root or for user9?

root

14. Exit the su session and try to switch your user identity again, this time using the - (dash) option.

```
$ exit
# su - user9
$ echo $LOGNAME
$ echo $HOME
```

Are the values reported now correct for the user root or for user9?

user9

15. Use the `whoami` and `who am i` commands to list your effective and real user identity.

```
$ /usr/ucb/whoami
$ who am i
```

What do these commands report?

*The /usr/ucb/whoami command displays the login name matching your effective UID, user9. The who am i command displays the login name matching your real UID, root.*

16. Use the `su` command to change your user identity from user9 to user3, and use the `whoami` and `who am i` commands again.

```
$ su user3
Password: 123pass
$
```

What do these commands report?

```
$ /usr/ucb/whoami
```

user3

```
$ who am i
```

root

Exit both su sessions when you are finished.

```
$ exit
$ exit
#
```

17. Change the directory to /etc/default. Examine the /etc/default/su file, and record the value of the SULOG variable.

```
# cd /etc/default
# more su
```

/var/adm/sulog

18. Display the file named by the SULOG variable, and identify the entry that relates to your last su command. Is user9 or the root user identified as the user who became user3?

```
# cat /var/adm/sulog
```

root

19. As the root user, attempt to log in to your partner's system by using the telnet command. Was your attempt successful? What message appears?

```
# telnet hostname
(telnet connection messages)
```

SunOS 5.9

```
login: root
Password: cangetin
```

*The login attempt should not succeed. It fails and the system sends the messages:*

```
Not on system console
Connection closed by foreign host.
```

20. On your partner's system, edit the /etc/default/login file, and change the line that reads:

```
CONSOLE=/dev/console
```

so that it reads:

```
#CONSOLE=/dev/console
```

21. As the `root` user, again attempt to log in to your partner's system by using the `telnet` command. If your login attempt is successful, exit the `telnet` session. If not, check the change you made in Step 20, and try again.

```
# telnet host
```

```
(telnet connection messages)
```

```
SunOS 5.9
```

```
login: root
```

```
Password: cangetin
```

```
Last login: Fri Feb  8 08:38:17 from sys41
```

```
Sun Microsystems Inc.  SunOS 5.9          s81_54  May 2002
```

```
# exit
```

```
Connection closed by foreign host.
```

```
#
```

22. As the `root` user, attempt to use the `ftp` command to access your partner's system. Were you successful?

*No, you should receive the message: Login incorrect. Login failed.*

Ask your partner to edit the `/etc/ftpd/ftpusers` file and comment out the `root` entry. Attempt to use the `ftp` command to access your partner's system again. List some files in the `/tmp` directory from the `ftp>` prompt.

*You should see files such as:*

```
dtddbcache_:0
```

```
sdtvolcheck402
```

```
speckeyd.lock
```

23. As the `root` user, attempt to use the `rlogin` command to access your partner's system. Were you successful?

*You should not be able to use the `rlogin` command to directly access your partner's system. You should be prompted for a password.*

Ask your partner to create a `/.rhosts` file and enter the name of your system on a line by itself. Attempt to use the `rlogin` command to access your partner's system again.

*You should be able to use the `rlogin` command to log directly in to your partner's system now.*

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

## Restricting Access to Data in Files

After you have established login restrictions, the next task is to control access to the data on the systems. Of course, some users need to be allowed to read various files; other users need permission to change and delete files, and there are some files that no regular user should be able to access.

Users who need to share files should be in the same group in the `/etc/group` file.



---

**Note** – In general, you use file access permissions to determine which users or groups have permission to read, modify, or delete files.

---

### Determining a User's Group Membership

The `groups` command displays group memberships for the user.

The command format for the `groups` command is:

```
groups [username]
```

For example, to see which groups you are a member of, perform the command:

```
# groups
other root bin sys adm uucp mail tty lp nuucp daemon
```

To list the groups to which a specific user is a member, use the `groups` command with the user's name, such as `user5`, as an argument.

```
# groups user5
staff class sysadmin
```



## Identifying a User Account

You use the `id` command to further identify users by listing their UID number, user name, GID number, and group name. This information is useful when you are troubleshooting file access problems for users.

The `id` command also returns the EUID number and name, and the EGID number and login name. For example, if you logged in as `user1` and then used the `su` command to become `user4`, the `id` command reports the information for the `user4` account.

The command format for the `id` command is:

```
id options username
```

To view your effective user account, perform the command:

```
$ id
uid=101(user1) gid=300(class)
```

To view account information for a specific user, use a user login name with the `id` command:

```
$ id user1
uid=101(user1) gid=300(class)
```

To view information about the secondary groups of a user, use the `-a` option and a user login name, such as `user1`:

```
$ id -a user1
uid=101(user1) gid=300(class) groups=14(sysadmin)
```

## Changing File and Directory Ownership

You might need to use the `chown` command to change the original owner of a file or directory to another user account on the system. By default, only the `root` user can change the ownership of a file or directory.



---

**Note** – Regular users can be given permission to use the `chown` command to change the ownership of files and directories owned by them. Edit the `/etc/system` file, and add the parameter: `set rstchown=0` (zero). You need to reboot the system for the changes to take effect.

---

The command format for the `chown` command is:

```
chown option(s) user_name filename(s)
```

or

```
chown option(s) UID filename(s)
```



---

**Note** – The user must exist in the `/etc/passwd` file.

---

In this example, a user named `user1` created a file called `file7`.

```
# cd /export/home/user1
# ls -l file7
-rw-r--r--  1 user1      staff           672 Jun 1 15:11  file7
#
```

You can use the `chown` command to give ownership of this file to a new user named `user2`. You use the `ls` command to verify the new ownership.

```
# chown user2 file7
# ls -l file7
-rw-r--r--  1 user2      staff           672 Jun 1 15:12  file7
#
```

After this sequence of commands, the file is owned by `user2`. This file is still in the `home` directory of `user1`. The two users need to determine if the file should be moved to a new directory location.

The ownerships of subdirectories can be changed in the same manner as files, as shown in the following examples:

In this example, `user1` owns a directory called `dir4`.

```
$ ls -lR dir4
dir4:
total 0
-rw-r--r--  1 user1      staff           0 Mar 19 16:06 file1
-rw-r--r--  1 user1      staff           0 Mar 19 16:06 file2
-rw-r--r--  1 user1      staff           0 Mar 19 16:06 file3
$
```

You would use the `chown` command with the `-R` option to give ownership of this directory and all of its contents (files and subdirectories) to `user2`.

```
$ chown -R user2 dir4
$ ls -lR dir4
dir4:
total 0
-rw-r--r--  1 user2  staff      0 Mar 19 16:06 file1
-rw-r--r--  1 user2  staff      0 Mar 19 16:06 file2
-rw-r--r--  1 user2  staff      0 Mar 19 16:06 file3
$
```

The `-R` option makes the `chown` command recursive. It descends through the directory and any subdirectories, setting the ownership UID number as it moves through the directory hierarchy.

The `chown` command can also change both the individual and group ownership of a file or subdirectory simultaneously.

```
$ chown user3:class file2
```

Additionally, you can use the `-R` option to descend a directory hierarchy recursively, changing individual and group ownership of the directory and its contents simultaneously. The following example demonstrates this kind of change to the `dir1` directory.

```
$ chown -R user3:class dir1
$ ls -lR dir1
dir1:
total 0
-rw-r--r--  1 user3  class      0 Mar 19 16:18 file1
-rw-r--r--  1 user3  class      0 Mar 19 16:18 file2
```

## Changing File and Directory Group Membership

The `chgrp` command can be used by the `root` user or the file's owner to change the group ownership of files and directories to another group on the system. However, the file owner must also belong to the new group.



**Note** – Regular users can be given permission to use the `chgrp` command to change a file's or directory's group ownership to groups of which the user is not a member. Edit the `/etc/system` file, and add a parameter: `set rstchown=0` (zero). You must reboot the system for the changes to take effect.

The command format for the `chgrp` command is:

```
chgrp groupname filename(s)
```

or

```
chgrp GID filename(s)
```



---

**Note** – The *groupname* must exist in the `/etc/group` file.

---

For example, the `file4` file currently is a member of a group named `staff`.

```
# ls -l file4
-rw-rw-r-- 1 user1  staff          874 Jun 1 15:08  file4
#
```

You would use the `chgrp` command to give this file to a new group named `class` and use the `ls` command to verify the new group ownership.

```
# chgrp class file4
# ls -l file4
-rw-rw-r-- 1 user1  class          874 Jun 1 15:09  file4
#
```

When you are finished, all users who are members of the group called `class` have read and write access to this file.

## Using File Permissions

Three types of special permissions are available for executable files and directories. These are:

- The `setuid` permission
- The `setgid` permission
- The Sticky Bit permission

## The setuid Permission on Executable Files

When the set-user identification (`setuid`) permission is set on an executable file, a user or process that runs this executable file is granted access based on the owner of the file (usually the `root` user), instead of on who started the executable.

This setting allows a user to access files and directories that are typically accessible only by the owner of the executable. Note that many executable programs must be run by the `root` user, or by `sys` or `bin` to work properly.

Use the `ls` command to check the `setuid` permission.

```
# ls -l /usr/bin/su
-r-sr-xr-x  1 root      sys          22292 Jan 15 17:49 /usr/bin/su
```

The `setuid` permission displays as an “s” in the owner’s execute field.



---

**Note** – If a capital “S” appears in the owner’s execute field, it indicates that the `setuid` bit is on, and the execute bit “x” for the owner of the file is off or denied.

---

The `root` user and the owner can set the `setuid` permissions on an executable file by using the `chmod` command and the octal value `4###`.

For example:

```
# chmod 4555 executable_file
```

Except for those `setuid` executable files that exist by default in the Solaris OE, you should disallow the use of `setuid` programs or at least restrict their use.

To search for files with `setuid` permissions and to display their full path names, perform the command:

```
# find / -perm -4000
```

### The setgid Permission on Executable Files

The set-group identification (setgid) permission is similar to the setuid permission, except that when the process runs, it runs as if it were a member of the same group in which the file is a member. Also, access is granted based on the permissions assigned to that group.

For example, the `write` program has a setgid permission that allows users to send messages to other users' terminals.

Use the `ls` command to check the setgid permission.

```
# ls -l /usr/bin/write
-r-xr-sr-x  1 root      tty          11484 Jan 15 17:55 /usr/bin/write
```

The setgid permission displays as an "s" in the group's execute field.



---

**Note** – If a lowercase letter "l" appears in the group's execute field, it indicates that the setgid bit is on, and the execute bit for the group is off or denied. This indicates that mandatory file and record locking occurs during file access for those programs that are written to request locking.

---

The root user and the owner can set setgid permissions on an executable file by using the `chmod` command and the octal value 2###. Here is the command-line format:

```
# chmod 2555 executable_file
```

### The setgid Permission on Directories

The setgid permission is a useful feature for creating shared directories.

When a setgid permission is applied to a directory, files created in the directory belong to the group of which the directory is a member.

For example, if a user has write permission in the directory and creates a file there, that file is a member of the same group as the directory and not the user's group.

To create a shared directory, you must set the `setgid` bit using symbolic mode. Here is the format for that mode:

```
# chmod g+s shared_directory
```

To search for files with `setgid` permissions and display their full path names, perform the command:

```
# find / -perm -2000
```

## The Sticky Bit Permission on Public Directories

The Sticky Bit is a special permission that protects the files within a publicly writable directory.

If the directory permissions have the Sticky Bit set, a file can be deleted only by the owner of the file, the owner of the directory, or by the `root` user. This prevents a user from deleting other users' files from publicly writable directories.

Use the `ls` command to determine if a directory has the Sticky Bit permission set.

```
# ls -ld /tmp  
drwxrwxrwt 6 root sys 719 May 31 03:30 /tmp
```

The Sticky Bit displays as the letter "t" in the execute field for other.



---

**Note** – If a capital "T" appears in the execute field for other, it indicates that the Sticky Bit is on; however, the execute bit is off or denied.

---

The `root` user and the owner can set the Sticky Bit permission on directories by using the `chmod` command and the octal value `1###`. Here is the command-line format:

```
# chmod 1777 public_directory
```

To search for directories that have Sticky Bit permissions and display their full path names, execute the following command:

```
# find / -type d -perm -1000
```



---

**Note** – For more detailed information on the Sticky Bit, execute the `man sticky` command.

---



## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Restricting Access to Data on Systems (Level 1)

In this exercise, you complete the following tasks:

- Practice using commands related to user identity and file ownership
- Assign a user to the `sysadmin` group
- Assign special file permissions to files

### Preparation

Refer to lecture notes as necessary to perform the steps listed.

### Tasks

Complete the following tasks:

- Using the commands presented in the lecture, identify the groups of which `root` is a member. Compare the output from these commands. Add a user account called `user11` with the `useradd` command. Verify the list of groups of which `user11` is a member. Use the Solaris Management Console to create a new user account called `user12`. Add `user11` to the `sysadmin` group.

(Steps 1–7 in the Level 2 lab)

- Log in as `user11` and create a new file called `file1`. Attempt to change its user ownership. Record error messages. Change the group ownership of `file1` to `sysadmin`. Switch the user identity to the `root` user, and change ownership of `file1` to `user12`.

(Steps 8–11 in the Level 2 lab)

- As `user11`, create a new file called `file2`. Set `setuid` and `setgid` permissions on `file2`. Remove all execute permissions from `file2`. Record the permissions listed as you change them.

(Steps 12–15 in the Level 2 lab)

- Record the permissions associated with the `/tmp` directory. As `user11`, create a new file called `test1` in the `/tmp` directory. As `user12`, attempt to remove this file. Record the result. As `user11`, create a new directory called `dir1` in `/export/home/user11`. Set permissions for the `dir1` directory to `777`. Create a file called `test2` in the `dir1` directory. As `user12` attempt to remove this file. Record the result. Log in again as the `root` user.

(Steps 16–21 in the Level 2 lab)

## Exercise: Restricting Access to Data on Systems (Level 2)

In this exercise, you complete the following tasks:

- Practice using commands related to user identity and file ownership
- Assign a user to the `sysadmin` group
- Assign special file permissions to files

### Preparation

Refer to lecture notes as necessary to perform the steps listed.

### Task Summary

In this exercise, you accomplish the following:

- Using the commands `groups`, `id`, and `id -a`, identify the groups of which the `root` user is a member. Compare the output from these commands. Add a user account called `user11` with the `useradd` command. Verify the list of groups of which `user11` is a member. Use the Solaris Management Console to create a new user account called `user12`. Add `user11` to the `sysadmin` group.
- Log in as `user11` and create a new file called `file1`. Attempt to change its user ownership. Record error messages. Change the group ownership of `file1` to `sysadmin`. Switch your user identity to the `root` user, and change ownership of `file1` to `user12`.
- As `user11`, create a new file called `file2`. Use the `chmod` command to set `setuid` and `setgid` permissions on `file2`. Use the `chmod` command to remove all execute permissions from `file2`. Record the permissions listed as you change them.
- Record the permissions associated with the `/tmp` directory. As `user11`, create a new file called `test1` in the `/tmp` directory. As `user12`, attempt to remove this file. Record the result. As `user11`, create a new directory called `dir1` in `/export/home/user11`. Set permissions for the `dir1` directory to `777`. Create a file called `test2` in the `dir1` directory. As `user12` attempt to remove this file. Record the result. Log in again as the `root` user.

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Use the `groups` command to display the groups of which `root` is a member. Record the list that the `groups` command displays.
2. Use the `id` command both without and then with the `-a` option.  
Does the `id` command report the primary or a secondary group for the `root` user?  
Compare the `id -a` command output with that from the `groups` command in Step 1. What additional information does the `id -a` command provide?
3. Use the `useradd` command to create a new user account called `user11` with the following characteristics:

|                 |                                  |
|-----------------|----------------------------------|
| User Name:      | <code>user11</code>              |
| User ID:        | <code>1011</code>                |
| Primary Group:  | <code>10</code>                  |
| Login Shell:    | <code>Korn</code>                |
| Home Directory: | <code>/export/home/user11</code> |
| Comment:        | <code>SA239 User</code>          |
| Password:       | <code>123pass</code>             |

4. List the groups of which `user11` is a member.
5. Open a terminal window, and launch the Solaris Management Console.

6. Open the User Accounts tool. Select Add User from the Action menu. Then select From Template. Create a user account from the following information. Exit the Solaris Management Console when you are finished.

User Name:           user12  
User ID:             1012  
Password:            123pass  
Primary Group:       staff  
Home Directory;     /export/home/user12

7. From a terminal window, use the `usermod` command to add `user11` to group 14. Verify that the change took place. Log out.
8. Log in as `user11`. Open a terminal window, and use the `touch` command to create a file called `file1`. Verify that `user11` and the group `staff` own `file1`.
9. Attempt to change the owner of `file1` from `user11` to `user12`. What error message displays?
10. Attempt to change the group ownership of `file1` from `staff` to `sysadmin`. Verify the change. Did it work?
11. Switch your user identity to the `root` user, and change the directory to `/export/home/user11`. Change the owner of `file1` from `user11` to `user12`. Verify the change. Did it work? Exit your `su` session when you are finished.
12. In the home directory for `user11`, use the `touch` command to create a file called `file2`. Display and record the permissions associated with `file2`.
13. Use the `chmod` command to add `setuid` and execute permissions to `file2`. Display and record the permissions associated with `file2`. What changed?
14. Use the `chmod` command to add `setuid` and `setgid` permissions to `file2`. Display and record the permissions associated with `file2`. What changed?
15. Use the `chmod` command with octal arguments to remove all execute permissions from `file2`. Display and record the permissions associated with `file2`. What changed?

16. Change the directory to / (root), and list the permissions associated with the /tmp directory. Is the Sticky Bit set on /tmp? Do all users have write permission in the /tmp directory?
17. Change the directory to /tmp. Create a file called test1 in the /tmp directory. Verify that user11 and the group staff own test1 and that 644 (rw-r--r--) permissions apply. Do they?
18. Switch your user identity to user12. In the /tmp directory, attempt to remove the test1 file. What messages appear? Exit your su session when you are finished.
19. In the home directory for user11, create a directory called dir1. Change permissions for the dir1 directory to 777. Create a file called test2 below the dir1 directory.
20. Switch your user identity to user12. Attempt to remove the file test2 from the dir1 directory. Verify that the test2 file no longer exists. Exit your su session when you are finished.
21. Log out, and log in again as the root user.

## Exercise: Restricting Access to Data on Systems (Level 3)

In this exercise, you complete the following tasks:

- Practice using commands related to user identity and file ownership
- Assign a user to the `sysadmin` group
- Assign special file permissions to files

### Preparation

Refer to lecture notes as necessary to perform the steps listed.

### Task Summary

In this exercise, you accomplish the following:

- Using the commands `groups`, `id`, and `id -a`, identify the groups of which the `root` user is a member. Compare the output from these commands. Add a user account called `user11` by using the `useradd` command. Verify the list of groups of which `user11` is a member. Use the Solaris Management Console to create a new user account called `user12`. Add `user11` to the `sysadmin` group.
- Log in as `user11` and create a new file called `file1`. Attempt to change its user ownership. Record error messages. Change the group ownership of `file1` to `sysadmin`. Switch your user identity to the `root` user, and change ownership of `file1` to `user12`.
- As `user11`, create a new file called `file2`. Use the `chmod` command to set `setuid` and `setgid` permissions on `file2`. Use the `chmod` command to remove all execute permissions from `file2`. Record the permissions listed as you change them.
- Record the permissions associated with the `/tmp` directory. As `user11`, create a new file called `test1` in the `/tmp` directory. As `user12`, attempt to remove this file. Record the result. As `user11`, create a new directory called `dir1` in `/export/home/user11`. Set permissions for the `dir1` directory to `777`. Create a file called `test2` in the `dir1` directory. As `user12` attempt to remove this file. Record the result. Log in again as the `root` user.



## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Use the `groups` command to display the groups of which `root` is a member. Record the list that the `groups` command displays.

**# groups**

```
other root bin sys adm uucp mail tty lp nuucp
daemon
```

2. Use the `id` command both without and then with the `-a` option.

**# id**

Does the `id` command report the primary or a secondary group for the `root` user?

*The `id` command reports the primary group.*

**# id -a**

Compare the `id -a` command output with that from the `groups` command in Step 1. What additional information does the `id -a` command provide?

*The `id -a` command reports group ID numbers in addition to group names for all groups.*

3. Use the `useradd` command to create a new user called `user11` with the following characteristics:

```
User Name:      user11
User ID:        1011
Primary Group:  10
Login Shell:    Korn
Home Directory: /export/home/user11
Comment:       SA239 User
Password:      123pass
```

```
# useradd -u 1011 -g 10 -d /export/home/user11 \
-m -s /bin/ksh -c "SA239 User" user11
64 blocks
# passwd user11
New password: 123pass
```

Re-enter new password: **123pass**

passwd (SYSTEM): passwd successfully changed for user11

#

4. List the groups of which user11 is a member.

# **id -a user11**

staff

5. Open a terminal window, and run the Solaris Management Console.

# **smc &**

6. Open the User Accounts tool. Select Add User from the Action menu. Then select With Template. Create a user account from the following information. Exit the Solaris Management Console when you are finished.

|                 |                     |
|-----------------|---------------------|
| User Name:      | user12              |
| User ID:        | 1012                |
| Password:       | 123pass             |
| Primary Group:  | staff               |
| Home Directory; | /export/home/user12 |

7. From a terminal window, use the usermod command to add user11 to group 14. Verify that the change took place. Log out.

# **usermod -G 14 user11**

# **id -a user11**

8. Log in as user11. Open a terminal window, and use the touch command to create a file called file1. Verify that user11 and the group staff own file1.

\$ **touch file1**

\$ **ls -l file1**

9. Attempt to change the owner of file1 from user11 to user12. What error message appears?

\$ **chown user12 file1**

chown: file1: Not owner

10. Attempt to change the group ownership of file1 from staff to sysadmin. Verify the change. Did it work?

\$ **chgrp sysadmin file1**

\$ **ls -l file1**

Yes.

11. Switch your user identity to the root user, and change the directory to /export/home/user11. Change the owner of file1 from user11 to user12. Verify the change. Did it work? Exit your su session when you are finished.

```
$ su -  
Password: cangetin  
# pwd  
/  
# cd /export/home/user11  
# chown user12 file1  
# ls -l  
-rw-r--r--  1 user12 sysadmin 0 Apr 17  2002 file1  
# exit  
$
```

*Yes.*

12. In the home directory for user11, use the touch command to create a file called file2. Display and record the permissions associated with file2.

```
$ touch file2  
$ ls -l file2
```

*The permissions for file2 should read -rw-r--r.*

13. Use the chmod command to add setuid and execute permissions to file2. Display and record the permissions associated with file2. What changed?

```
$ chmod 4555 file2  
$ ls -l file2
```

*The permissions for file2 should read -r-sr-xr-x.*

14. Use the chmod command to add setuid and setgid permissions to file2. Display and record the permissions associated with file2. What changed?

```
$ chmod 6555 file2  
$ ls -l file2
```

*The permissions for file2 should read -r-sr-sr-x.*

15. Use the chmod command with octal arguments to remove all execute permissions from file2. Display and record the permissions associated with file2. What changed?

```
$ chmod 6444 file2  
$ ls -l file2
```

*The permissions for file2 should read -r-Sr-lr--.*

16. Change the directory to / (root), and list the permissions associated with the /tmp directory. Is the Sticky Bit set on the /tmp directory? Do all users have write permission in /tmp?

```
$ cd /
$ ls -ld tmp
```

*Yes to both.*

17. Change the directory to /tmp. Create a file called test1 in the /tmp directory. Verify that user11 and the group staff own test1 and that 644 (rw-r--r--) permissions apply. Do they?

```
$ cd tmp
$ touch test1
$ ls -l test1
```

*Yes.*

18. Switch your user identity to user12. In the /tmp directory, attempt to remove the test1 file. What messages appear? Exit your su session when you are finished.

```
$ su user12
Password: 123pass
$ rm test1
rm: test1: override protection 644 (yes/no)? y
rm: test1 not removed: Permission denied
$ exit
$
```

19. In the home directory for user11, create a directory called dir1. Change permissions for the dir1 directory to 777. Create a file called test2 below the dir1 directory.

```
$ cd
$ mkdir dir1
$ chmod 777 dir1
$ touch dir1/test2
```

20. Switch your user identity to user12. Attempt to remove the file test2 from the dir1 directory. Verify that the test2 file no longer exists. Exit your su session when you are finished.

```
$ su user12
Password: 123pass
$ rm dir1/test2
$ ls -l dir1
$ exit
$
```

21. Log out, and log in again as the root user.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications



# Configuring Printer Services

---

## Objectives

Upon completion of this module, you should be able to:

- Identifying network printing fundamentals
- Configure printer services
- Administer printer services
- Start and stop the line printer (LP) print service

The following course map shows how this module fits into the current instructional goal.

### Managing Network Printers and System Processes

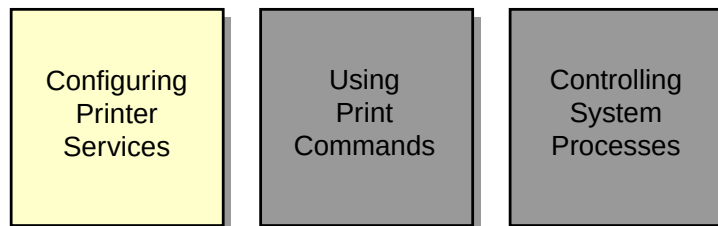


**Figure 12-1** Course Map

# Introducing Network Printing Fundamentals

The Solaris™ Operating Environment (Solaris OE) LP print service provides a complete printing environment that allows the sharing of printers across systems and a set of software utilities that enable users to print files while they continue to work on other tasks.

## Print Management Tools

The LP print service software contains the following components for the set up and administration of printers in the Solaris OE:

- Solaris OE Print Manager – A graphical user interface (GUI) that provides the ability to configure and manage printers.
- LP print service commands – A command-line interface that configures and manages printers. These commands also provide functionality not available in the other print management tools.

## Client-Server Model

The Solaris OE print service is implemented in a client-server model.

### Print Server

A print server is any system that is configured to manage a printer directly connected to it or that is attached to the network. The print server makes the printers available to other systems on the network and provides spooling for the client's print requests.

### Print Client

A print client is a system that sends print requests to a print server.



## Types of Printer Configurations

As a system administrator, you must configure printers so that users have access to one or more printers.

You should distribute printers over several print servers. If one print server becomes unavailable, print requests can be quickly and easily routed to other print servers on the network.

The Solaris OE supports local, network, and remote printer configurations.

### Local Printer

A local printer is physically connected to a system and is accessed from that system.

### Network Printer

A network printer is physically attached to the network and has its own host name and Internet Protocol (IP) address. A network printer provides print services to clients but is not directly connected to a print server.

### Remote Printer

A remote printer is one that users access over the network, that is, a printer that is either physically connected to a remote system or physically attached to the network.

Figure 12-2 shows the concept of local, network, and remote printers.

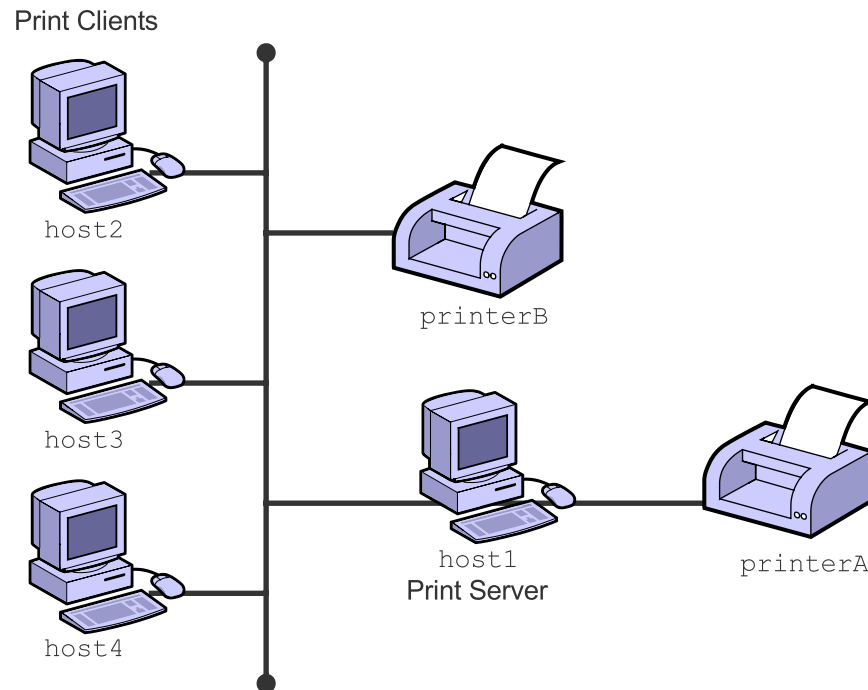


**Figure 12-2** Local, Network, and Remote Printers

The printer named `printerA`, connected to the system named `host1`, is a local printer for any user logged on to that system.

The printer named `printerB` is a network printer that is controlled by the print server, `host1`. This is a network printer for any users logged in on `host1`, `host2`, `host3`, or `host4`.

For users who are logged in to `host2`, `host3`, or `host4`, both `printerA` and `printerB` can be accessed as remote printers.

## Basic Functions of the Solaris OE LP Print Service

Basic functions of the Solaris OE LP print service include initialization, queuing, tracking, fault notification, and filtering.

### Initialization

The Solaris OE LP print service initializes a printer prior to sending it a print request. The initialization function ensures that the printer is in a known state.

### Queuing

The Solaris OE LP print service queues the print requests. The queuing function schedules the print requests that are waiting to be sent to the printer.

### Tracking

The Solaris OE LP print service tracks the status of every print request. The tracking function enables the `root` user to manage all of the requests and typical users to view or cancel their own requests. This function also logs any errors that have occurred during the printing process.

### Fault Notification

The Solaris OE LP print service provides fault notification if a problem occurs in the print service. The fault notification function prints an error message on the console or sends an email to the `root` user, depending on how the service has been configured.

### Filtering

The Solaris OE LP print service provides filtering capabilities that convert print jobs to the appropriate type of file for the destination printer.

## LP Print Service Directory Structure

The Solaris OE LP print service includes a directory structure, files, and logs. The following section describes some of the more important components of this structure.

See Figure 12-3 for an example of the LP print service directory.

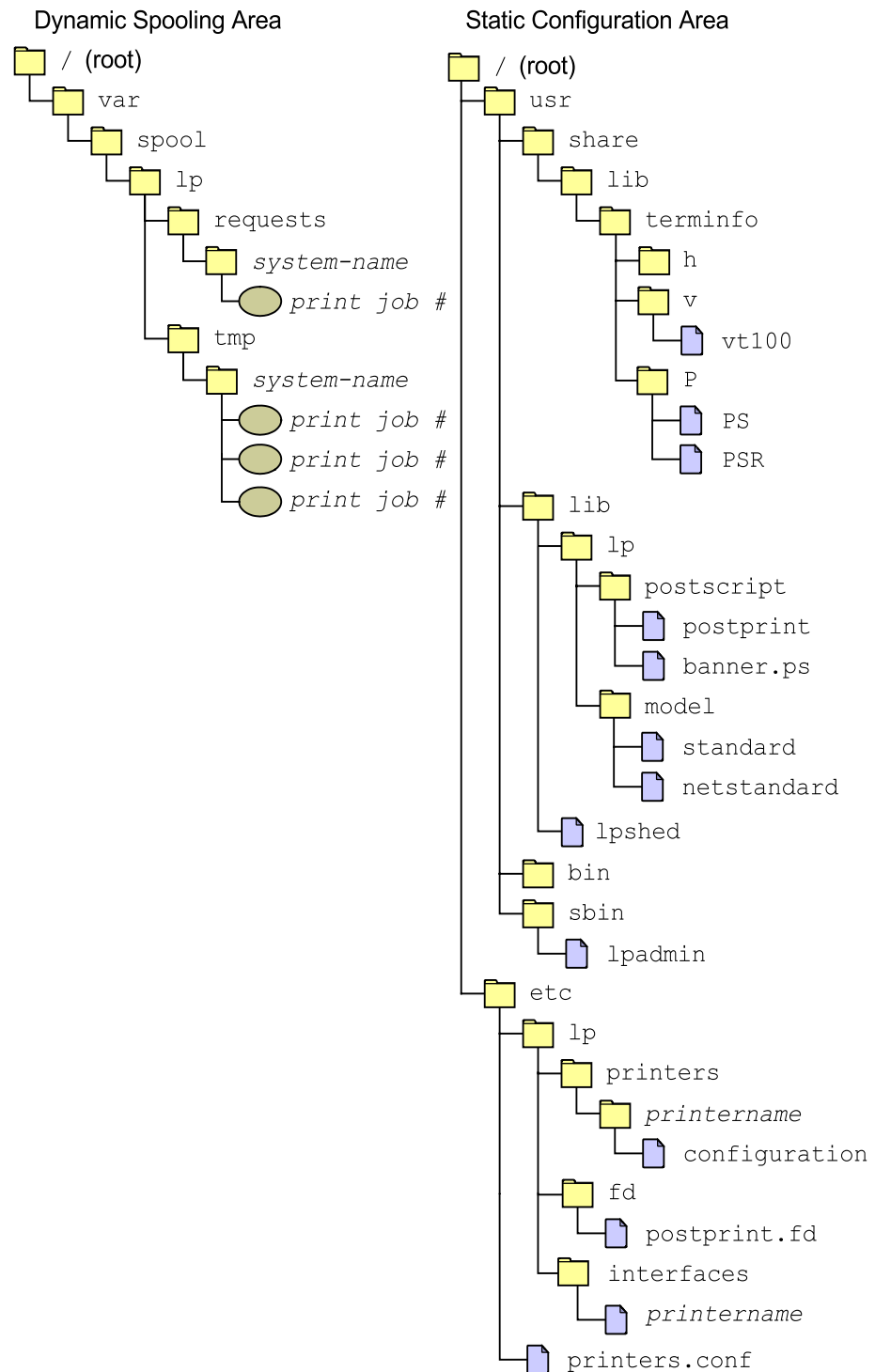


**Figure 12-3** LP Print Service Directory Structure

### The /usr/bin Directory

This directory contains the LP print service user commands, such as the `lp`, `lpstat`, and `cancel` commands.

### The /usr/sbin Directory

This directory contains the LP print service administrative commands, such as the `lpadmin`, `lpusers`, and `lpshut` commands.

### The /usr/share/lib/terminfo Directory

This directory contains the `terminfo` database directories, which describe the capabilities of printers and terminals.

### The /usr/lib/lp Directory

This directory contains the `lpsched` daemon, binary files that the LP print service uses, PostScript™ filters, and standard printer interface programs. Two important subdirectories in the `/usr/lib/lp` directory are the `model` and `postscript` directories.

### The /usr/lib/lp/model Directory

This directory contains two default printer interface programs or shell scripts, called the `standard` and the `netstandard` scripts.

The `standard` script supports local printers. For example, when a print request is queued for printing, the print service runs the printer's `standard` script to:

- Initialize the printer port, if necessary
- Initialize the actual printer, using the `terminfo` database to find the appropriate control sequences
- Print a banner page, if necessary
- Print the correct number of copies, as specified by the user's print request

The `netstandard` script specifically supports network printers. It collects the spooler and print database information needed to perform network printing and passes the information to a print output module. The `netpr` module opens the network connection to the printer and sends the data to the printer.



---

**Note** – The `netpr` module is located in the `/usr/lib/lp/bin` directory.

---

The `root` user can modify any printer's interface script. For example, to turn off the printing of a banner page, edit the `/etc/lp/interfaces/printer_name` file on the print server. Change the `nobanner` line from:

```
nobanner="no"
```

to

```
nobanner="yes"
```

## The `/usr/lib/lp/postscript` Directory

This directory contains all PostScript filter programs provided by the Solaris OE LP print service.



---

**Note** – Print filters are programs that the print server uses to convert the content type of a queued print request from one format to another format that is acceptable to the destination printer.

---

The PostScript print filters in this directory handle many situations in which the printer requires the content of files to be in PostScript format.

These filters have companion descriptor files in the `/etc/lp/fd` directory that tell the LP print service the characteristics and location of the filters.

## The `/etc/lp` Directory

This directory contains a hierarchy of LP server configuration directories and files.

You can view the contents of these configuration files. However, you should not edit these files directly. To make configuration changes, use the `lpadmin` command or `printmgr` GUI.

There are three subdirectories in the `/etc/lp` directory that are important to printer configuration. These are the `fd`, `interfaces`, and `printers` directories.

- The `/etc/lp/fd` directory contains a set of print filter descriptor files. These files describe the characteristics of the filter and point to the actual filter program.

---

**Note** – The `/etc/lp/filter.table` file contains a filter lookup table.

---



- The `/etc/lp/interfaces` directory contains each printer's interface script file. When a printer is configured, the print service places a copy of the appropriate default interface script from the `/usr/lib/lp/model` directory into the `/etc/lp/interfaces/printername` file. The *printername* variable is the file created that contains the newly configured printer's own interface script.
- The `/etc/lp/printers` directory contains a subdirectory for each printer served by the system. Each subdirectory contains configuration information and alert files for an individual printer.

For example, the configuration file for a printer named `printerB` can contain the following information:

```
# cat /etc/lp/printers/printerB/configuration
```

```
Banner: optional
```

```
Content types: postscript
```

```
Device: /dev/null
```

```
Interface: /usr/lib/lp/model/netstandard
```

```
Printer type: PS
```

```
Modules:
```

```
Options: dest=printerB,protocol=bsd
```

### The `/var/spool/lp` Directory

This directory contains a list of current requests that are in the print queue.

The `lp` daemon for each system keeps track of print requests in the following directories:

- `/var/spool/lp/tmp/system-name`
- `/var/spool/lp/requests/system-name`



With a local print request, the `/var/spool/lp/tmp/system-name` directory contains one file, and the `/var/spool/lp/requests/system-name` directory contains another file.

With a remote print request, the `/var/spool/lp/tmp/system-name` directory contains two files, and the `/var/spool/lp/requests/system-name` directory contains one file.

Only the root user or lp users can access the information in the `/var/spool/lp/requests/system-name` directory.

Only the user who submitted the print request, the root user, or the lp user can access the information in the `/var/spool/lp/tmp/system-name` directory.

These files remain in their directories only as long as the print request is in the queue. After completing the print request, the print service combines the information in the files and appends it to the `/var/lp/logs/requests` file.



---

**Note** – The `/var/spool/print` directory contains the client-side request staging area for the LP print service.

---

## The `/var/lp/logs` Directory

This directory contains an ongoing history of print requests. The log file `/var/lp/logs/requests` contains information about completed print requests that are no longer in the print queue.

## The `/usr/sbin/inetd` Internet Service Daemon

The Internet services daemon, `inetd`, is the server process for many network services. It is usually started up at system boot time. The daemon listens for service requests on the ports that are associated with each of the services listed in its configuration file, `/etc/inetd.conf`. When a request arrives, the `inetd` daemon executes the server program that is associated with the service. Print servers listen for print requests with the `inetd` daemon, and upon hearing a request, start up the `in.lpd` daemon.

### The `/usr/lib/print/in.lpd` Program

The `inetd` daemon starts the `in.lpd` program, sometimes referred to as the protocol adapter. The `in.lpd` program implements the network listening service for the print protocol. The print protocol provides a remote interface that enables systems to interact with a local spooling system. This protocol defines standard requests from the print client to the print server, such as requests to start queue processing, to transfer print jobs, to retrieve print status, and to cancel print jobs.

Upon the receipt of a connect request, the `in.lpd` program starts and services the connection. The `in.lpd` program closes the connection and exits after servicing the request.

### The `/usr/lib/lp/lpsched` Daemon

The LP print service has a scheduler daemon called `lpsched`. The scheduler daemon updates the LP system files with information about printer setup and configuration. It also manages requests issued to the system by the `lp` and `lpr` commands.

The `lpsched` daemon schedules all of the local print requests on a print server. It also tracks the status of printers and filters on the print server. When a printer finishes a request, the `lpsched` daemon schedules the next request, if there is one in the queue on the print server.

Each print server has by default only one `lpsched` daemon running. It is started by the control script `/etc/rc2.d/S80lp` when the system is booted (or enters run level 2). The parent `lpsched` daemon spawns a child `lpsched` processes to service print jobs.

## Solaris OE Printing Process

Users submit print requests from print clients by using the `lp` or `lpr` commands.

---

**Note** – The Solaris OE Print Service accepts both the System V Interface Definition (SVID) `/usr/bin/lp` command and the Berkeley Software Distribution (BSD) `/usr/ucb/lpr` command to submit print requests.

---



Users should use these commands to print text files. These commands do not print documents created in applications such as FrameMaker. Most third-party applications require you to print from a selection menu within the application.

The function of the `lp` and `lpr` commands is to queue print requests for printing on a destination printer.

### Locating the Destination Printer

The Solaris OE LP print service checks several resources to locate the destination printer for a print request.

Figure 12-4 shows the resources checked as it identifies the appropriate printer for a print request.

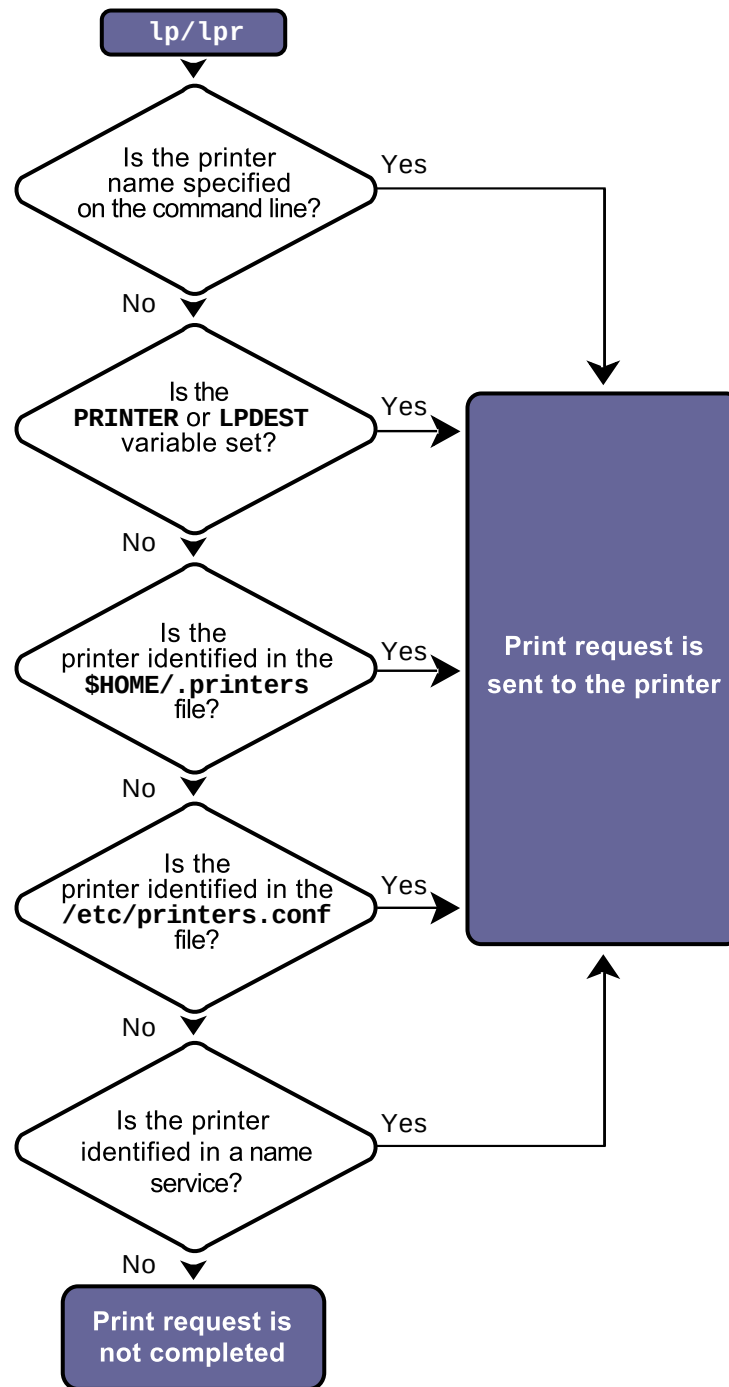


**Figure 12-4** Locating the Destination Printer

If the command line does not specify a named printer destination, the user's shell environment is checked.

You can set the LPDEST or PRINTER environment variables to a default printer name. The lp command checks LPDEST and then PRINTER. The lpr command reverses the order when searching for a printer.

If neither variable specifies a named printer destination, then the Solaris OE LP print service checks for the variable named `_default` in the following files:

- The `$HOME/.printers` file

Users can create their own `.printers` file in their home directory to set the default printer name. They should add the following line to the file:

```
_default printername
```

If the `$HOME/.printers` file does not exist or does not specify a printer name destination, then the Solaris OE LP print service checks the `/etc/printers.conf` file.

- The `/etc/printers.conf` file

Each entry in the `/etc/printers.conf` file describes a printer destination. For example, if `host1` is the print server's name and `printerA` is the printer's name, the entry in this file appears as follows:

```
_default:\
      :use=printerA:\
printerA:\
      :bsdaddr=host1,printerA,Solaris
      :description=printerA
```

If the `_default` variable is not set, then the `_default` variable in the name service database (for example, Network Information Service (NIS)) is checked.

- The `printers.conf.byname` file

The `printers.conf.byname` file is the NIS version of the `/etc/printers.conf` file. In this case, the `_default` variable entry in the name service map called `printers.conf.byname` defines the print server and printer name destination:

```
_default:bsdaddr=servername,printername:
```

If the destination printer name cannot be located in any of these configuration resources, the print request cannot be completed.



---

**Note** – The last three files described in the following paragraphs rely on the `printers:` entry in the NIS version of the `/etc/nsswitch.conf` file.

---

An example of the `/etc/nsswitch.conf` file syntax is:

```
printers: user files nis
```

where:

`user` = Checks `$HOME/.printers` file

`files` = Checks `/etc/printers.conf` file

`nis` = Checks `printers.conf.byname` file

### Introducing the Local Print Process

When a user submits a print request to a local printer, the `lp` or `lpr` command sends the request to the `lpsched` daemon. The `lpsched` daemon is also called the print scheduler.

Figure 12-5 shows the role of the `lp` daemon in the printing process.

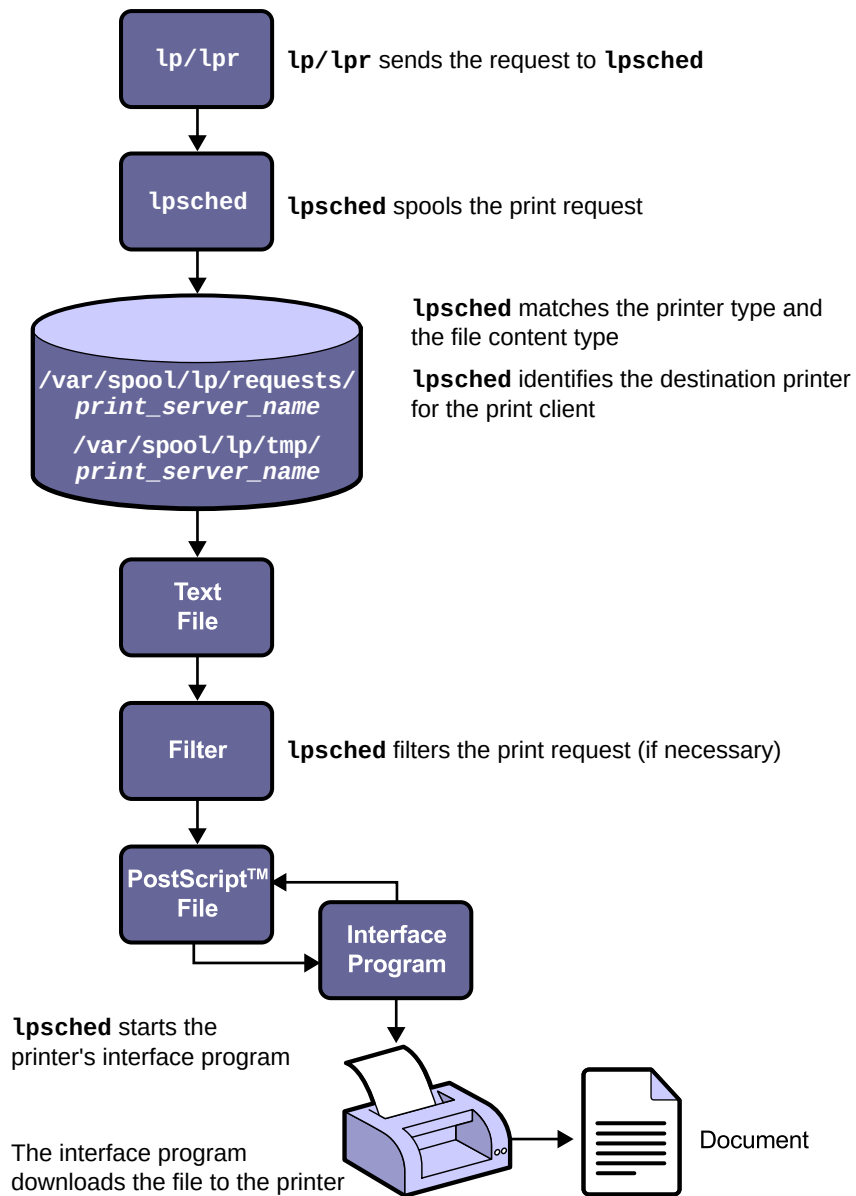


**Figure 12-5** Local Printing Process

The `lpsched` daemon matches the printer type and identifies the default printer for the system. It then filters the print job.

The `lpsched` daemon keeps track of print requests in the following directories:

- `/var/spool/lp/requests/system_name`
- `/var/spool/lp/tmp/system_name`

If the printer is free, the `lpsched` daemon starts the printer's interface program. The interface program performs the following functions:

- Initializes the printer port
- Initializes the printer
- Prints the banner page
- Prints the correct number of file copies
- Sends any fault notifications



## The Remote Print Process

When a user submits a print request to a remote printer, the `lp` or `lpr` command sends the print request directly to the print server.

The print server processes the print request and sends the print request to the destination printer to be printed.

Figure 12-6 shows a remote print request submitted from a print client to a print server in the Solaris OE.

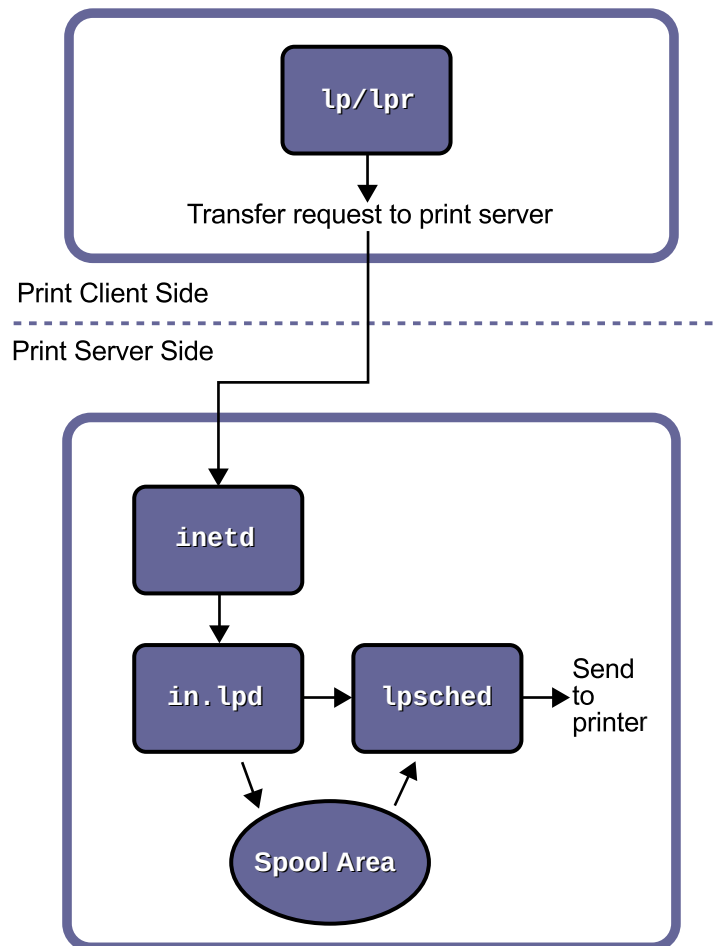


**Figure 12-6** Solaris OE Remote Printing

The client's print command communicates directly with the print service on the server to transfer a print request to the printer.

The print server listens for print requests with the Internet services daemon `inetd`. When the `inetd` daemon hears a request for a print service on the network, it starts the `in.lpd` program. The `in.lpd` program is also called the print protocol adapter. The `in.lpd` program starts on demand and exits when the network request finishes.

The print protocol adapter translates the print request, communicates it to the print spooler, and returns the results to the print requester.

The print protocol adapter contacts the `lpsched` daemon to start the printer's interface program and to transfer the print request to the destination printer.

## Configuring Printer Services

Configuring printer services in the Solaris OE involves a number of key tasks. Table 12-1 shows these tasks.

**Table 12-1** Main Tasks for Configuring Printer Services

| Tasks                       | Description                                                                                                        |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------|
| Setting up the printer      | Physically connecting the printer to a system or the network                                                       |
| Setting up the print server | Configuring the system that is to manage and provide access to the printer                                         |
| Setting up the print client | Configuring the system to access a remote printer                                                                  |
| Verifying printer access    | Checking that the print server recognizes all print clients and that each print client recognizes the print server |



**Note** – When a network of systems is not running a name service, such as NIS, enter each print server's host name and IP address in the `/etc/inet/hosts` file on the print client when you are setting up the printer services.

## Identifying Print Server Requirements

Any system on the network can be a print server if it has the resources to manage the printing load, such as spooling space and memory.

### Spooling Space

The spooling space is the amount of disk space that is used to store and process print requests. Spooling space is the most important factor to consider when designating systems as print servers. The recommended starting size for spooling space is from 25 to 500 Mbytes, depending on the type and the size of files being printed and the number of users.



---

**Note** – The term `spool` is an acronym for system peripheral operation offline.

---

### Memory

The Solaris OE requires 64 Mbytes of memory to run on a system. Print servers do not require additional memory. However, an extra 32 Mbytes of memory can improve performance when the server is filtering print requests.

## Using the Solaris OE Print Manager

The Solaris OE Print Manager enables you to set up and manage printers.

The Solaris OE Print Manager is the preferred method for managing printers. When used with a name service such as NIS, it centralizes printer information and simplifies printer administration.



---

**Note** – The Solaris OE Print Manager recognizes existing printer information on print servers, print clients, and in the name service databases.

---

The following steps demonstrate how to configure a network printer with the Solaris Print Manager. As the `root` user, start the Solaris OE Print Manager with the following command:

```
# /usr/sadm/admin/bin/printmgr &
```

You can also start the Solaris OE Print Manager by selecting the Printer Administrator from the Tools option on the Common Desktop Environment (CDE) Workspace menu and entering the host name of the workstation to continue.

Either method displays the Solaris OE Print Manager main window, with Figure 12-7 overlaid on top of it.

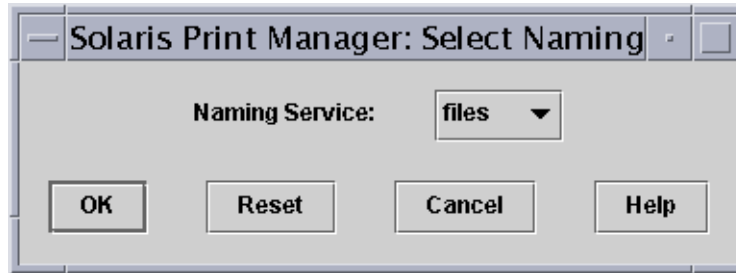


**Figure 12-7** Select Naming Service Window

1. Click OK to select the default, files.

Figure 12-8 remains on the screen.

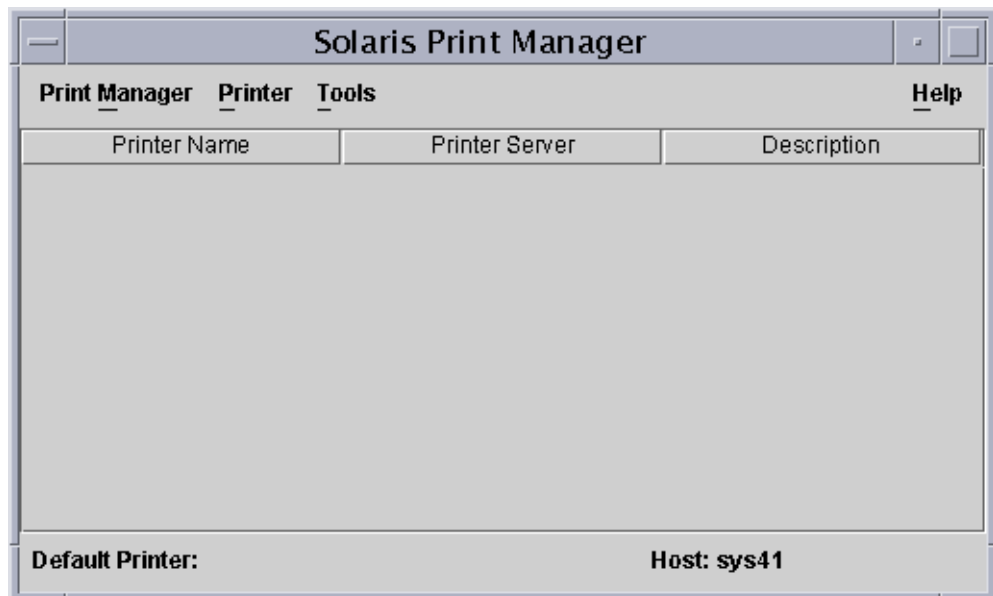


**Figure 12-8** Solaris OE Print Manager Window

2. Click the Printer menu in this window. Figure 12-9 shows possible menu selections on the Printer menu.

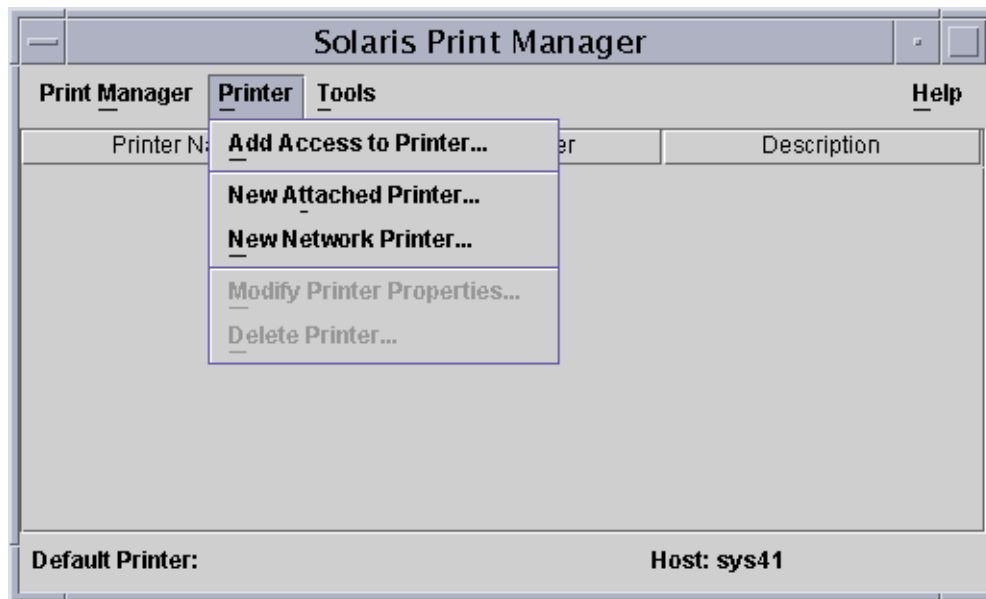


**Figure 12-9** Solaris OE Print Manager Printer Menu



**Note** – By clicking Print Manager and selecting Show Command Line Console, you can see the command-line equivalents to each of the actions taken to configure printers. You can then save these steps as commands to perform similar actions in the future or build your own scripts for configuring printers.

Menu selections include:

- **Add Access to Printer** – Selected from a print client to set up access to printers that are controlled by a print server. The host name and IP address of the print server must be in the print client's `/etc/inet/hosts` file or in a name service database (for example, NIS).
- **New Attached Printer** – Selected from a print server to configure a printer that is physically connected to it. The print server provides the queuing capabilities, filtering, and printing administration.
- **New Network Printer** – Selected from a print server to configure a printer that is directly attached to the network. The print server provides the queuing capabilities, filtering, and printing administration. The network printer's name and its IP address must be entered either in the print server's `/etc/inet/hosts` file or in a name service database.

## Configuring a New Network Printer

Table 12-2 shows the information you would use to configure the new network printer.

**Table 12-2** Information Fields for Configuring a New Network Printer

| Required Field     | Description                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Printer Name       | A unique name for the network printer. The name can contain a maximum of 14 alphanumeric characters, including dashes and underscores. This is the name entered on the command line with a print command.                                                                                                                                                                                      |
| Printer Server     | Defaults to the name of the system on which you are currently running the Solaris OE Print Manager. This system is the print server for this network printer.                                                                                                                                                                                                                                  |
| Description        | This field is optional. A printer's description commonly contains information to help users identify the printer (for example, physical location or printer type).                                                                                                                                                                                                                             |
| Printer Type       | The generic name for the type of printer (for example, PostScript, HP Printer, Diablo). The LP print service identifies each printer by its printer type. Printer type data is held in the directory <code>/usr/share/lib/terminfo</code> . The Other option, located at the end of the list, allows for the selection of any other printer type listed in the <code>terminfo</code> database. |
| File Contents      | Specifies the data format of files that can be printed without any special filtering by the LP print service software.                                                                                                                                                                                                                                                                         |
| Fault Notification | The list of choices for how the superuser is notified of printer errors. These include: Write to Superuser, Mail to Superuser, or None.                                                                                                                                                                                                                                                        |

**Table 12-2** Information Fields for Configuring a New Network Printer  
(Continued)

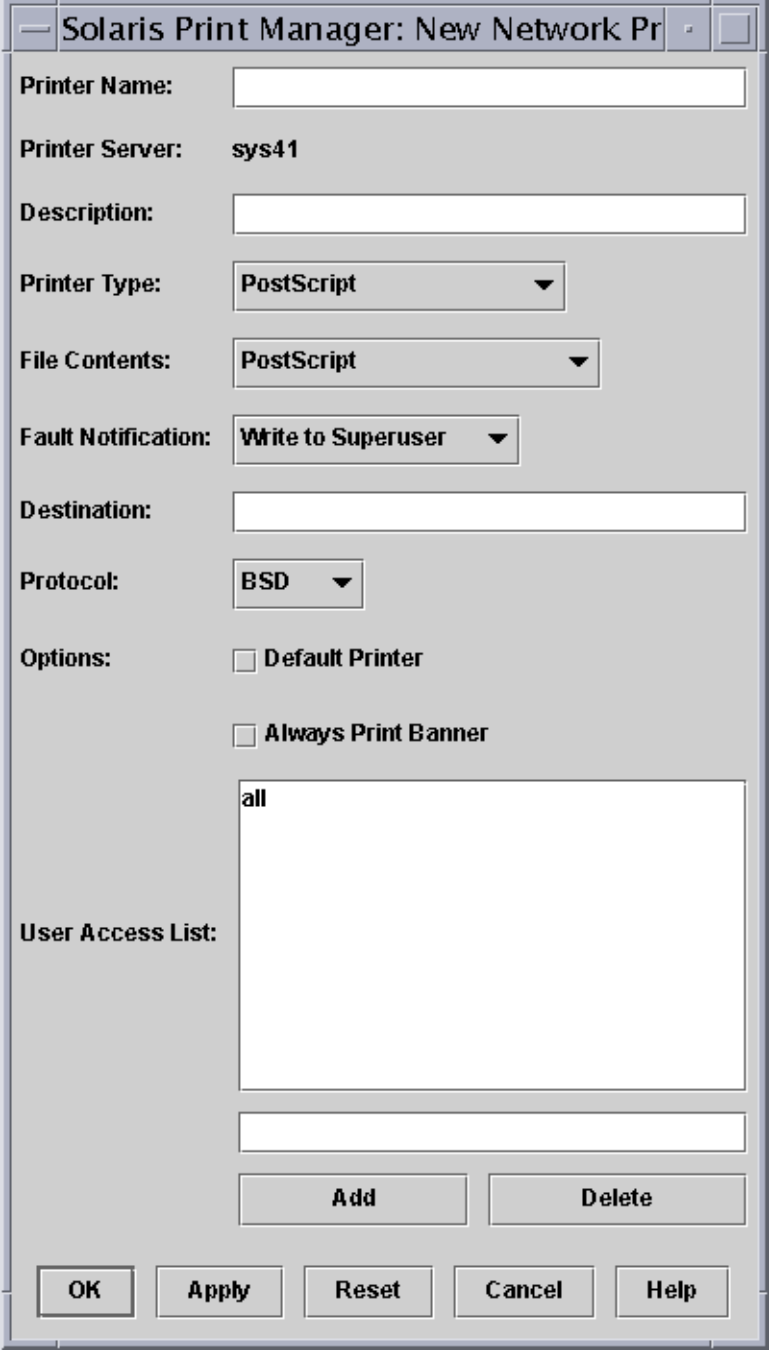
| Required Field   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Destination      | The network printer's unique access name. The Destination access name can be either the name of the printer or its IP address as defined in the <code>/etc/inet/hosts</code> file or in a name service database. The Destination access name is used only by the print subsystem when it is making the network connection to the physical printer or the printer-host device. It becomes part of the printer configuration database and is associated with the network printer's IP address. |
| Protocol         | The Internet protocol that is used to communicate with the printer for file transfer. The choices are Berkeley BSD Printer Protocol and raw Transmission Control Protocol (TCP). In general, the TCP protocol is more generic across printers. The printer vendor documentation supplies the information about the protocol to select.                                                                                                                                                       |
| Options          | Identifies two options, the Default Printer option and the Always Print Banner option, which, by default, are disabled. To enable an option, click in the appropriate box (a check mark appears).                                                                                                                                                                                                                                                                                            |
| User Access List | Specifies print clients that can print to this printer. By default, the word <i>all</i> allows every print client access to this printer.                                                                                                                                                                                                                                                                                                                                                    |



From the print server, use the following procedure to set up the configuration information to provide access to a new network printer.

3. From the Printer menu, select the New Network Printer option.

Figure 12-10 shows the window that appears.



The image shows a window titled "Solaris Print Manager: New Network Printer". The window contains several fields and controls for configuring a new network printer. The fields are: "Printer Name:" (text input), "Printer Server:" (text input with "sys41" entered), "Description:" (text input), "Printer Type:" (dropdown menu with "PostScript" selected), "File Contents:" (dropdown menu with "PostScript" selected), "Fault Notification:" (dropdown menu with "Write to Superuser" selected), "Destination:" (text input), "Protocol:" (dropdown menu with "BSD" selected), "Options:" (checkboxes for "Default Printer" and "Always Print Banner", both unchecked), and "User Access List:" (a list box containing "all"). Below the list box are "Add" and "Delete" buttons. At the bottom of the window are "OK", "Apply", "Reset", "Cancel", and "Help" buttons.

**Figure 12-10** Solaris Print Manager: New Network Printer Window

4. In the Printer Name field, enter the new printer name, for example, `printerA`.
5. Click the Description field, and enter a printer description of your choice.
6. For the purposes of this demonstration, accept the default Printer Type: PostScript.

The LP print service uses information in the `terminfo` database to initialize the printer, as well as to communicate the sequence of codes to the printer.

To view the contents of the `terminfo` directory, type the following command:

```
# ls /usr/share/lib/terminfo
```

```
1 2 3 4 5 6 7 8 9 A a B b c d e f G g H h i j k l
M m n o P p q r S s t u v w x y z
```

The `terminfo` directory contains many different subdirectories that are named with a letter or digit. Use the same initial letter or digit that the manufacturer assigned to the printer's generic name. The `terminfo` database includes information about terminals and modems too.

For example, the printer type for a particular Epson printer would be located in the subdirectory `/usr/share/lib/terminfo/e`.

```
# ls /usr/share/lib/terminfo/e
```

|              |             |                |          |           |
|--------------|-------------|----------------|----------|-----------|
| emots        | ep2500+high | ep48           | ergo4000 | exidy2500 |
| env230       | ep2500+low  | epson2500      | esprit   |           |
| envision230  | ep40        | epson2500-80   | ethernet |           |
| ep2500+basic | ep4000      | epson2500-hi   | ex3000   |           |
| ep2500+color | ep4080      | epson2500-hi80 | exidy    |           |

7. Accept the default File Contents: PostScript.

Every printer has configuration information pertaining to the content type of files that it can accept for its printer type. The LP print service depends on this configuration information to match the content type of each print request to the printer type, which ensures that the file is printed correctly.

By selecting a file content type, as shown in Table 12-3, you can specify the data format of the file that can be printed without any special filtering by the print software.

**Table 12-3** Descriptions of File Content Types

| File Content Type         | Description                                                                                           |
|---------------------------|-------------------------------------------------------------------------------------------------------|
| ASCII                     | ASCII files do not require filtering.                                                                 |
| PostScript                | PostScript files do not require filtering. PostScript is the default.                                 |
| Both PostScript and ASCII | PostScript and ASCII files do not require filtering.                                                  |
| None                      | All files require filtering, except those matching the printer's type.                                |
| Any                       | No filtering required. If printer cannot handle the file content type, the file is not to be printed. |

8. Click Fault Notification, and select the Mail to Superuser option.
9. Click the Destination field, and type a Destination access name.

If the network printer is not recognized by its name or IP address in the hosts table, you might need to use the vendor-supplied access name for the network printer, which is *sometimes* qualified by a designated port number. These are both explicitly defined in the printer vendor's documentation.

Table 12-4 shows the format for a Destination entry.

**Table 12-4** Destination Entry Format

| Destination                             | Protocol |
|-----------------------------------------|----------|
| <i>printer_name</i>                     | BSD      |
| <i>system_name:printer</i>              | BSD      |
| <i>IP_ADDR</i>                          | BSD      |
| <i>IP_ADDR:port_number</i> <sup>1</sup> | TCP      |
| <i>printer_node_name:port_number</i>    | TCP      |

1. The port number is print server dependent. For example, LexMark uses Port 9100.
10. Leave the Internet protocol set to BSD.
11. Click in the Default Printer box to enable the Default Printer option.




---

**Note** – If enabled, the Default Printer option designates this printer as the default printer for print jobs from this system.

---

12. You can (optionally) click in the Always Print Banner box to enable the Always Print Banner option.
13. Accept the default, all, for the User Access List. This allows all users on all systems to use the printer.

To restrict user access to this printer, you can enter the values shown in Table 12-5 in the text field below the User Access List window.

**Table 12-5** User Access Values

| Value                        | Definition                                                                                         |
|------------------------------|----------------------------------------------------------------------------------------------------|
| <i>user-name</i>             | The specified user, for example <i>user1</i> , can access the printer from any system.             |
| <i>system-name!user-name</i> | The specified user from the named system can access the printer, for example, <i>host2!user4</i> . |
| <i>system-name!all</i>       | All users from the named system only can access the printer, for example, <i>host5!all</i> .       |
| <i>all!user-name</i>         | The specified user from all systems can access the printer, for example, <i>all!user1</i> .        |



**Note** – To delete an entry from the User Access List, select the entry, and click Delete.

14. To accept the new network printer's configuration information, click OK.

Figure 12-11 shows the Solaris OE Print Manager window, which is displaying the newly configured printer.

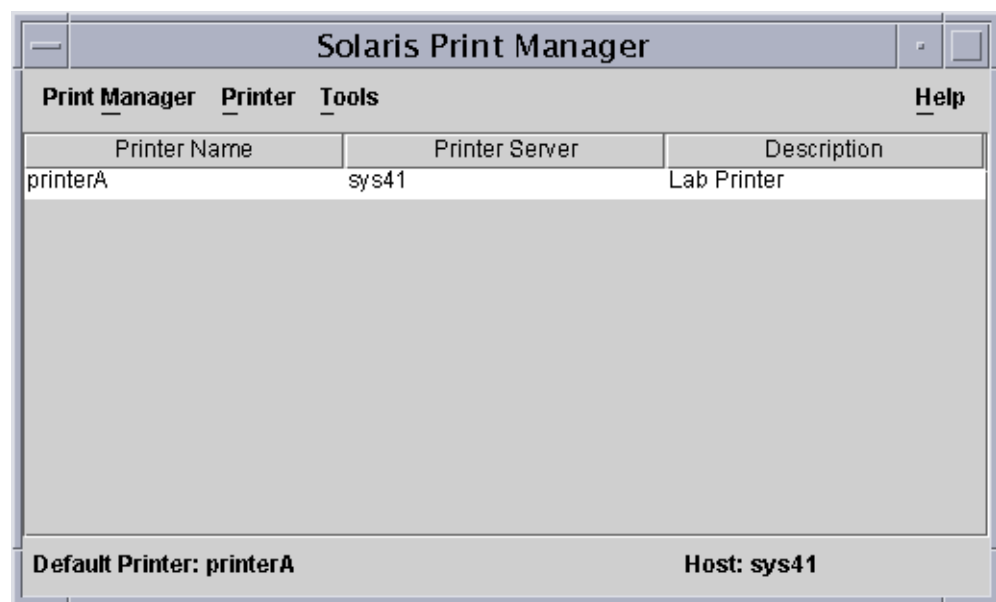


**Figure 12-11** Solaris OE Print Manager Window: Configured Printer

15. To close the Solaris OE Print Manager window, select the Exit option from the Print Manager menu.

# Administering Printer Services

You use the `lpadmin` command to configure the LP print services from the command line.

You could use this command to perform the following tasks:

- Defining printer devices and printer names
- Specifying interface programs (custom or standard) and printer options
- Defining printer types and file content types
- Creating printer classes
- Defining allow and deny user lists
- Specifying fault recovery
- Removing printers and printer classes

The `lpadmin` command is most commonly used by the `root` user for the purpose of:

- Creating printer classes
- Setting or changing a system's default printer destination
- Removing a printer's configuration from the LP print service

## Configuring Printer Classes

You can increase printer access by establishing printer classes. A printer class is a way of grouping individual printers so that they can be identified by a single name known as a class name.

After a printer class is created, you use it as the destination for users' print requests. The LP print service automatically sends each print request to the first available printer within the class that matches the content type expected by the printer. This useful feature can help you balance the load of print requests among several printers.

A printer class can include:

- Specific printer types (for example, all PostScript printers)
- Printers in a specific location (for example, Building 2)
- Printers in a specific work group or department (for example, Marketing, Engineering, Accounting).

You can create a printer class by using the `lpadmin` command only on the print server for which the printers are configured. Printer classes cannot be defined on print clients.

### Configuring Printer Priority Within a Class

When you create a printer class, the `root` user can control the printer access order by adding the printers to the class in a descending order. For example, by adding a high-speed printer to the printer class first, you can enable it to handle as many print requests as possible, before off-loading to the printer that was added to the class next, and so on.

### Creating a Printer Class

You create a printer class when the first printer is added to the printer class name. After creating a printer class, you can add other printers to it at any time.

The following example creates a printer class called `bldg2`:

```
# lpadmin -p printerB -c bldg2
```

The following example adds another printer (`printerD`) to this class:

```
# lpadmin -p printerD -c bldg2
```



After you have finished adding printers to the printer class, use the **accept** command to allow queueing of print requests to the new print queue (bldg2 in the example).




---

**Note** – The **accept** command is explained in Module 13, Using Print Commands.

---

```
# accept bldg2
destination "bldg2" now accepting requests
```

Use the **lpstat -t** command on the print server to check the status of the new printer class:

```
# lpstat -t
scheduler is running
system default destination: printerA
members of class bldg2:
    printerB
    printerD
device for printerB: /dev/null
device for PrinterD: /dev/null
bldg2 accepting requests since Fri Jan  4 10:37:44 MST 2002
printerB accepting requests since Fri Jan  4 10:37:44 MST 2002
printerD accepting requests since Fri Jan  4 10:37:44 MST 2002
```

To send a print request to a printer class, perform the following command:

```
# lp -d bldg2 myfile
request id is bldg2-0 (1 file)
```

## Setting the System's Default Printer

The **root** user can run the **lpadmin** command to set an individual printer or a printer class to be the system's default destination for all print requests.

```
# lpadmin -d printername
# lpadmin -d printer-classname
```

For example, to set a system's default destination printer, perform the command:

```
# lpadmin -d printerE
```

To verify that the system's default destination printer has been set, perform the command:

```
# lpstat -d
system default destination: printerE
```

To verify an individual user's default destination printer, perform the command:

```
$ lpstat -d
system default destination: users_printer
```

The print request issued is sent by default to printerE.

```
# lp myfile
request id is printerE-514 (1 file)
```

## Changing the System's Default Printer Class

To change a system's default destination printer to the class bldg2, perform the command:

```
# lpadmin -d bldg2
#
# lpstat -d
system default destination: bldg2
```



---

**Note** – You cannot activate or deactivate a printer class with the `enable` and `disable` commands. You can activate or deactivate only the individual printers within a printer class. But you can allow or disallow spooling a classes' jobs by using the commands `accept` and `reject`.

---

## Removing a Client's Printer Configuration

To remove a printer's configuration manually on the client side, perform the following:

1. Log in as the `root` user on the print client that has access to the printer to be removed from the LP print service.
2. Delete information about the printer from the print client by performing an `lpadmin` command.

```
# lpadmin -x printername
```

where `-x` deletes the specified printer.

For example, the following command deletes `printerD` from the system.

```
# lpadmin -x printerD
```

Information for the specified printer is deleted from the print client's `/etc/printers.conf` file.

Repeat Steps 1 and 2 for each print client that has access to the printer.

## Removing a Server's Printer Configuration

To remove a printer's configuration manually on the server side, perform the following:

1. Log in as the `root` user on the print server on which the printer is configured.
2. Stop queuing print requests on the printer.

```
# reject printerD
```

3. Stop the printer.

```
# disable printerD
```

4. Delete the printer from the print server.

```
# lpadmin -x printerD
```

This action deletes configuration information for the printer from the print server's `/etc/lp/printers` directory and `/etc/printers.conf` file.

## Starting and Stopping the LP Print Service

The LP print service is started by the `lpsched` daemon and is shut down by the `lpshut` command.

### Starting the LP Print Service

The `lpsched` daemon starts or restarts the LP print service. Printers that are restarted with a `lpsched` command from the command line, reprint, in their entirety, the print requests stopped by the `lpshut` command.

The following is an example of starting the `lpsched` daemon from the command line:

```
# /usr/lib/lpsched
Print services started
```

The `lp` print service script, located in the `/etc/init.d` directory, also can be used to start the `lpsched` daemon.

```
# /etc/init.d/lp start
Print services started
```

### Stopping the LP Print Service

The `lpshut` command stops the LP print service. Any printers that are currently printing when the command is invoked stop printing.

The following is an example of the `lpshut` command:

```
# /usr/lib/lpshut
Print services stopped.
```

The `lp` print service script, located in the `/etc/init.d` directory, also can be used to stop the `lpsched` daemon.

```
# /etc/init.d/lp stop
Print services stopped.
```

# Using Print Commands

---

## Objectives

Upon completion of this module, you should be able to:

- Specify a destination printer
- Use the LP print service

The following course map shows how this module fits into the current instructional goal.

### Managing Network Printers and System Processes

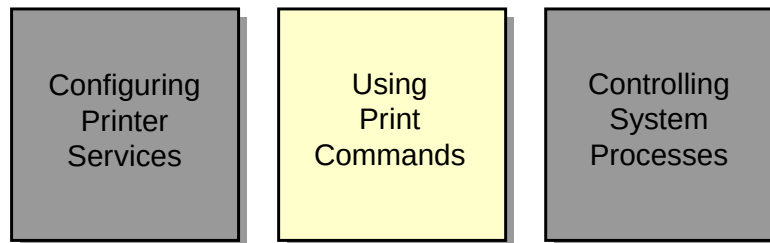


**Figure 13-1** Course Map

## Specifying a Destination Printer

In the Solaris OE, users submit print requests by using the `lp` command or the `lpr` command.



---

**Note** – The Solaris OE LP Print Service accepts both the SVID `/usr/bin/lp` command and the BSD `/usr/ucb/lpr` command to submit print requests.

---

### Using the `lp` Command

The `lp` command is located in the `/usr/bin` directory. The `lp` command submits a print job to the default printer or to another printer (by specifying the printer name). To use the command, perform one of the following commands:

```
$ /usr/bin/lp filename
$ /usr/bin/lp -d printername filename
```

### Using the `lpr` Command

The `lpr` command is located in the `/usr/ucb` directory. The `lpr` command functions in the same manner as the `lp` command—it submits a print job to the default printer or to another printer.

```
$ /usr/ucb/lpr filename
$ /usr/ucb/lpr -P printername filename
```

The preceding examples of the print commands demonstrate the atomic style. You can also use the Portable Open Systems Interface (POSIX) style to specify a destination printer.

To submit a print request that uses the POSIX style, include the print command and an option, followed by the printer server name, a colon, and the printer name as configured on the print server.

The full command-line entry is as follows:

```
$ /usr/bin/lp -d hostname:printername filename
$ /usr/ucb/lpr -P hostname:printername filename
```

## Using the LP Print Service

The LP print service is a set of software commands, utilities, and filters that allow users to print files and the `root` user to set up and manage the print operations.

Table 13-1 lists some of the more commonly used print service administration commands.




---

**Note** – You must be the `root` user to use these commands.

---

**Table 13-1** LP Print Service Administration Commands

| Command Name         | Description                                                         |
|----------------------|---------------------------------------------------------------------|
| <code>accept</code>  | Permits print requests to be queued for the specific printers       |
| <code>reject</code>  | Prevents print requests from being queued for the specific printers |
| <code>enable</code>  | Activates the specified printers                                    |
| <code>disable</code> | Deactivates the specified printers                                  |
| <code>lpmove</code>  | Moves print requests from one printer destination to another        |

## Accepting Print Jobs

As the `root` user, you use the `accept` command on the print server to permit print requests to be queued on the specified printers.

### Using the `accept` Command

You use the `accept` command to allow queuing of print requests for the named destinations. A destination specifies the name of a printer or printer class.

The format for the command is:

```
# /usr/sbin/accept destination(s)
```

In the following example, the `root` user has enabled the queuing of print requests on `printerD`.

```
# accept printerD  
destination "printerD" now accepting requests
```

## Rejecting Print Jobs

As the `root` user, you use the `reject` command on the print server to prevent print requests from queuing on the specified printers.

### Using the reject Command

You use the `reject` command to prevent print requests from queuing and stop users from submitting requests to the printer queues.

The format for the command is:

```
# /usr/sbin/reject -r "reason" destination(s)
```

The following example shows how to use the option `-r "reason"` to enter an explanation for the rejection of print requests for a printer. A user can see that text by issuing the `lpstat -a` or `lpstat -t` command.

```
# reject -r "Replacing Toner Cartridge" printerD  
destination "printerD" will no longer accept requests
```

## Enabling Printers

On the print server, as the `root` user, you can use the `enable` command to activate the specified printers.

### Using the enable Command

The `enable` command activates the printers, which enables the printing of requests submitted to the print queues.

The format for the command is:

```
# /usr/bin/enable destination(s)
```



The following example shows how to enable `printerD`.

```
# enable printerD
printer "printerD" now enabled
```

## Disabling Printers

On the print server, as the `root` user, you can use the `disable` command to deactivate the specified printers.

### Using the `disable` Command

The `disable` command deactivates printers, which disables them from printing print requests waiting in the print queues.

By default, any requests currently printing on the printer when the `disable` command is issued are reprinted in their entirety when the printer is enabled again.

The format for the command is:

```
# /usr/bin/disable -c | -W -r "reason" destination
```

Table 13-2 shows the options for the `disable` command.

**Table 13-2** Options for the `disable` Command

| Option | Definition                                                                              |
|--------|-----------------------------------------------------------------------------------------|
| -c     | Cancels the current job and disables the printer. The current job is not printed later. |
| -W     | Waits until the current job is finished before disabling the printer.                   |
| -r     | Assigns a reason for the disabling of the printer.                                      |

The following example shows how to use the `disable` command with options.

```
# disable -W -r "Printer down for maintenance" printerD
printer "printerD" now disabled
```

## Moving Print Jobs

You use the `lpmove` command to move one or all print requests from one printer destination to another printer destination.

### Using the `lpmove` Command

The format for the `lpmove` command is:

```
# /usr/sbin/lpmove source_destination target_destination
```

To move one or all print requests by using the `lpmove` command, complete the following steps.

1. Become the `root` user on the print server.
2. Use the `reject` command to prevent any further print requests from being sent to the print queue. This step notifies users that the printer is not accepting requests.

```
# reject -r "PrinterC is down for repairs" printerC
destination "printerC" will no longer accept requests
```

3. Use the `lpstat` command to display the print queue to see how many print requests are to be moved. This step is needed to identify print request identification numbers (IDs) only if selected print requests are going to be moved to another printer.

```
# lpstat -o
printerC-29    sys41!user1    61426    Jan 07 12:30
printerC-30    sys41!user1    9560     Jan 07 12:30
printerC-31    sys42!user2     845     Jan 07 12:30
printerC-32    sys42!user2     845     Jan 07 12:30
printerC-33    sys42!user2     845     Jan 07 12:30
```

4. Use the `lpstat` command to verify that the destination printer is accepting print requests.

```
# lpstat -a printerA
printer printerA accepting requests since Tue Jan 1
```

5. Move the print requests.

- a. For example, to move all print requests from printerC over to printerA, perform the following command:

```
# lpmove printerC printerA
move in progress ...
total of 5 requests moved from printerC to printerA
```

- b. For example, to move one or more individual print requests from printerC to printerA, perform the following command:

```
# lpmove printerC-32 printerC-33 printerA
total of 2 requests moved to printerA
```

6. When printerC, is available again, use the accept command to print jobs to queue to printerC.

```
# accept printerC
destination "printerC" now accepting requests
```

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Using the LP Print Service (Level 1)

In this exercise, you use the Solaris OE Print Manager to set up a print spooler that sends output to a local terminal window, add access to a remote printer, and use print management commands.

### Preparation

The host name and IP address of the system that controls the printer you want to access must exist in the `/etc/hosts` file. Refer to the lecture notes as necessary to perform the tasks listed.

### Tasks

Complete the following tasks:

- Open two terminal windows. Record the pseudoterminal device used by one of them. In the other window, run the Solaris OE Print Manager, and define a local Diablo printer that uses the first window's terminal as its output device. Test the new printer.  
(Steps 1–7 in the Level 2 lab)
- Use the Solaris OE Print Manager to gain access to a printer defined on another system. Test the remote printer.  
(Steps 9–13 in the Level 2 lab)
- Manipulate your Diablo printer to:
  - Disable printer output
  - Queue four files for printing
- List all print jobs
- Cancel two jobs by listing their request IDs
- Cancel the remaining jobs by using their associated user names
- Enable printing again
- Reject print requests and supply a reason
- View the reason
- Accept print requests on the default printer  
(Steps 14–24 in the Level 2 lab)

## Exercise: Using the LP Print Service (Level 2)

In this exercise, you use the Solaris OE Print Manager to set up a print spooler that sends output to a local terminal window, add access to a remote printer, and use print management commands.

### Preparation

The host name and IP address of the system that controls the printer you want to access must exist in the `/etc/hosts` file. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Open two terminal windows. Record the pseudoterminal device used by one of them. In the other window, run the Solaris OE Print Manager, and define a local Diablo printer that uses the first window's terminal as its output device. Test the new printer.
- Use the Solaris OE Print Manager to gain access to a printer defined on another system. Test the remote printer.
- Use the following commands to manipulate your Diablo printer:
  - `enable`
  - `disable`
  - `lp`
  - `lpstat`
  - `accept`
  - `reject`
  - `cancel`
- Manipulate your Diablo printer to:
  - Disable printer output
  - Queue four files for printing
- List all print jobs
- Cancel two jobs by listing their request IDs
- Cancel the remaining jobs by using their associated user names

- Enable printing again
- Reject print requests and supply a reason
- View the reason
- Accept print requests on the default printer

## Tasks

Complete the following steps:

1. Log in as the `root` user, and open two terminal windows. In one of the windows, use the `tty` command to identify the pseudoterminal device that it uses. Use this device name as the port for the new printer. For example, the device name in the following output is `/dev/pts/5`:

```
# tty
/dev/pts/5
```

Device name:

2. In the other terminal window, run the Solaris OE Print Manager.
3. In the Select Naming Service panel, verify that `files` is selected, and click OK. From the Print Manager menu, select the Show Command Line Console option. Position the Command Line Console in a convenient location.
4. From the Printer menu, select the New Attached Printer option.
5. Fill in the fields according to Table 13-3. To name your printer, use a name different from that of your system.

**Table 13-3** Configuration Fields

| Field              | Selection or Entry                                                                     |
|--------------------|----------------------------------------------------------------------------------------|
| Printer name       | Your choice.                                                                           |
| Description        | Your choice.                                                                           |
| Printer port       | Select the Other option. Enter the device name of the terminal window found in Step 1. |
| Printer type       | Diablo.                                                                                |
| File contents      | ASCII.                                                                                 |
| Fault notification | Write to superuser .                                                                   |

**Table 13-3** Configuration Fields (Continued)

| Field               | Selection or Entry       |
|---------------------|--------------------------|
| Default Printer     | (Select the box.)        |
| Always Print Banner | (Do not select the box.) |
| User Access List    | (No change.)             |

6. Click OK when you are finished. Notice the command-line entries that appear in the console window.
7. Test your printer configuration by printing the `/etc/hosts` file to the default printer. Observe the output on the other terminal window.

You should see the contents of the `/etc/hosts` file scroll through the other window.

8. From the Printer menu, select the Add Access to Printer option.
9. Fill in the fields according to Table 13-4.

**Table 13-4** Configuration Fields

| Field           | Selection or Entry                                                                                                                                       |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Printer name    | Enter the name of a printer on another system.                                                                                                           |
| Print server    | Enter the name of the system on which the preceding printer is defined. Ensure this system name and IP address are in your <code>/etc/hosts</code> file. |
| Description     | Your choice.                                                                                                                                             |
| Default printer | Do not select the box.                                                                                                                                   |



10. Click OK when you are finished.  
Notice the command-line entries that appear in the console window.
11. Test your new configuration by printing the `/etc/hosts` file to the remote printer. Observe the output on the other system.  
You should see the contents of the `/etc/hosts` file scroll through the other window.
12. In an available terminal window, use the `lpstat` command to display the current status information of the printers on your system.
13. Disable print output for your default printer.
14. Send the following four files to your default printer: `/etc/hosts`, `/etc/inittab`, `/etc/dfs/dfstab`, and `/etc/skel/local.profile`.
15. Check the print queue to find the request ID for each job.  
The four print jobs should be listed with sequential numbers.
16. Use the request IDs to cancel two of the requests. Verify the result.  
Use the following syntax to cancel the requests:

```
# cancel printername-# printername-#
```

Two of the print jobs should be gone.

17. Cancel the other two jobs by indicating the user who sent them.  
Verify the result.
18. Enable printing for your default printer. Use the following syntax:

```
# enable printername
```

19. Set your default printer to reject requests, and display a reason for doing so. For example:

```
# reject -r "Printer is down for maintenance" printername
```

20. Attempt to send a job to the default printer. Observe the messages displayed.

```
# lp /etc/hosts
```

Your message should say *printername*: Requests are not being accepted

21. Use the `lpstat` command to display the reason that the printer is not accepting requests. Use the following syntax:

**# `lpstat -a printername`**

Your message should say *printername: your reason from step 20*.

22. Set your default printer to again accept requests.

**# `accept printername`**

## Exercise: Using the LP Print Service (Level 3)

In this exercise, you use the Solaris OE Print Manager to set up a print spooler that sends output to a local terminal window, add access to a remote printer, and use print management commands.

### Preparation

The host name and IP address of the system that controls the printer you want to access must exist in the `/etc/hosts` file. Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Open two terminal windows. Record the pseudoterminal device used by one of them. In the other window, run the Solaris OE Print Manager, and define a local Diablo printer that uses the first window's terminal as its output device. Test the new printer.
- Use the Solaris OE Print Manager to gain access to a printer defined on another system. Test the remote printer.
- Use the following commands to manipulate your Diablo printer:
  - `enable`
  - `disable`
  - `lp`
  - `lpstat`
  - `accept`
  - `reject`
  - `cancel`
- Manipulate your Diablo printer to:
  - Disable printer output
  - Queue four files for printing
- List all print jobs
- Cancel two jobs by listing their request IDs
- Cancel the remaining jobs by using their associated user names

- Enable printing again
- Reject print requests and supply a reason
- View the reason
- Accept print requests

## Tasks and Solutions

Complete the following steps:

1. Log in as the **root** user and open two terminal windows. In one of the windows, use the **tty** command to identify the pseudoterminal device it uses. Use this device name as the port for the new printer. For example, the device name in the following output is **/dev/pts/5**:

```
# tty
/dev/pts/5
```

Device name: *Your device name will vary.*

2. In the other terminal window, run the Solaris OE Print Manager.

```
# /usr/sadm/admin/bin/printmgr &
```

3. In the Select Naming Service panel, verify that **files** is selected, and click OK. From the Print Manager menu, select the Show Command Line Console option. Position the Command Line Console in a convenient location.
4. From the Printer menu, select the New Attached Printer option.
5. Fill in the fields according to Table 13-3 on page 13-11. To name your printer, use a name different from that of your system.
6. Click OK when you are finished. Notice the command line entries that appear on the console window.
7. Test your printer configuration by printing the **/etc/hosts** file to the default printer. Observe the output on the other terminal window.

```
# lp /etc/hosts
```

You should see the contents of the **/etc/hosts** file scroll through the other window.

8. From the Printer menu, select the Add Access to Printer option.
9. Fill in the fields according to Table 13-4 on page 13-12.

10. Click OK when you are finished.

Notice the command line entries that appear in the console window.

11. Test your new configuration by printing the `/etc/hosts` file to the remote printer. Observe the output on the other system.

```
# lp -d printername /etc/hosts
```

You should see the contents of the `/etc/hosts` file scroll through the other window.

12. In an available terminal window, use the `lpstat` command to display the current status information of the printers on your system.

```
# lpstat -t
```

13. Disable print output for your default printer.

```
# disable printername
```

14. Send the following four files to your default printer: `/etc/hosts`, `/etc/inittab`, `/etc/dfs/dfstab`, and `/etc/skel/local.profile`.

```
# lp /etc/hosts
```

```
# lp /etc/inittab
```

```
# lp /etc/dfs/dfstab
```

```
# lp /etc/skel/local.profile
```

15. Check the print queue to find the request ID for each job.

```
# lpstat -o
```

The four print jobs should be listed with sequential numbers.

16. Use the request IDs to cancel two of the requests. Verify the result. Use the following syntax to cancel the requests:

```
# cancel printername-# printername-#
```

```
# lpstat -o
```

Two of the print jobs should be gone.

17. Cancel the other two jobs by indicating the user who sent them. Verify the result. For example:

```
# cancel -u root
```

```
# lpstat -o
```

18. Enable printing for your default printer.

```
# enable printername
```

19. Set your default printer to reject requests, and display a reason for doing so. For example:

```
# reject -r "Printer is down for maintenance" printername
```

20. Attempt to send a job to the default printer. Observe the messages displayed.

# **lp /etc/hosts**

Your message should say *printername*: Requests are not being accepted

21. Use the **lpstat** command to display the reason that the printer is not accepting requests. Use the following syntax:

# **lpstat -a *printername***

Your message should say *printername*: *your reason from step 20*.

22. Set your default printer to again accept requests.

# **accept *printername***

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications





# Controlling System Processes

---

## Objectives

Upon completion of this module, you should be able to:

- View system processes
- Clear frozen processes
- Schedule an automatic one-time execution of a command
- Schedule an automatic recurring execution of a command

The following course map shows how this module fits into the current instructional goal.

### Managing Network Printers and System Processes

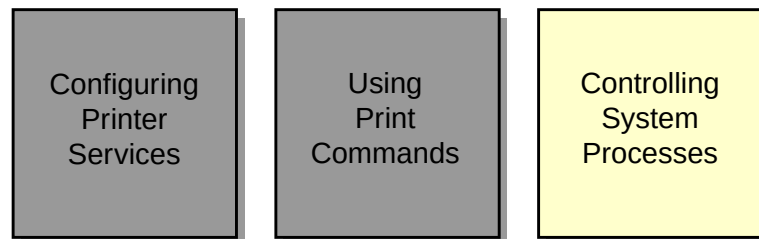


**Figure 14-1** Course Map

## Viewing System Processes

A process is any program that is running on the system. All processes are assigned a unique process identification (PID) number, which is used by the kernel to track and manage the process. The PID numbers are used by the root and regular users to identify and control their processes.

### Using the CDE Process Manager

The Solaris OE Common Desktop Environment (CDE) provides a Process Manager to monitor and control processes that are running on the local system.

To start the Process Manager, click the Find Process control on the Tools subpanel of the Front Panel. Figure 14-2 shows the Tools menu.

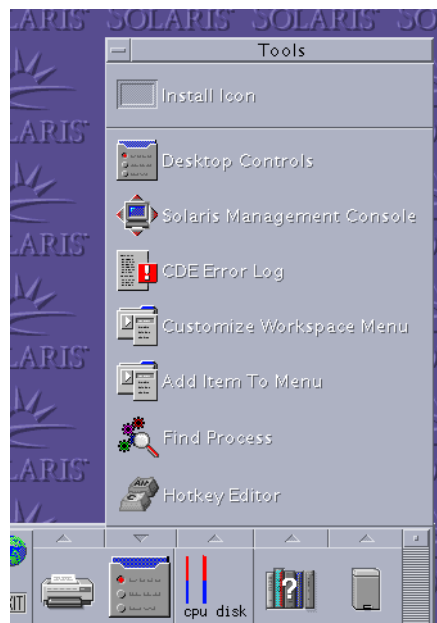
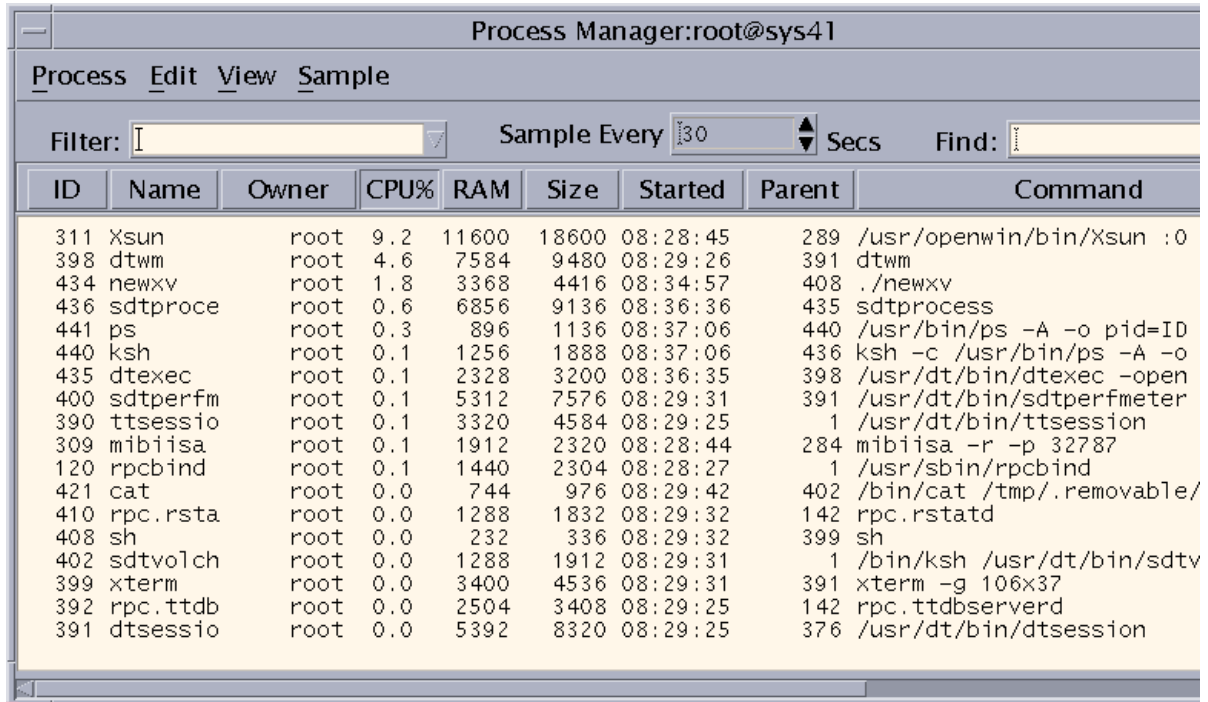


**Figure 14-2** Tools Menu

You can also start the CDE Process Manager from the command line by typing the following:

```
# /usr/dt/bin/sdtprocess &
```

Figure 14-3 shows the window that appears.



The screenshot shows the 'Process Manager: root@sys41' window. It has a menu bar with 'Process', 'Edit', 'View', and 'Sample'. Below the menu bar is a 'Filter:' text field, a 'Sample Every' dropdown set to '30' with a unit of 'Secs', and a 'Find:' text field. The main area is a table with the following columns: ID, Name, Owner, CPU%, RAM, Size, Started, Parent, and Command. The table lists various system processes such as Xsun, dtwm, newxv, sdtproce, ps, ksh, dtexec, sdtperfm, ttsessio, mibiisa, rpcbind, cat, rpc.rsta, sh, sdtvolch, xterm, rpc.ttdb, and dtsessio.

| ID  | Name     | Owner | CPU% | RAM   | Size  | Started  | Parent | Command                   |
|-----|----------|-------|------|-------|-------|----------|--------|---------------------------|
| 311 | Xsun     | root  | 9.2  | 11600 | 18600 | 08:28:45 | 289    | /usr/openwin/bin/Xsun :0  |
| 398 | dtwm     | root  | 4.6  | 7584  | 9480  | 08:29:26 | 391    | dtwm                      |
| 434 | newxv    | root  | 1.8  | 3368  | 4416  | 08:34:57 | 408    | ./newxv                   |
| 436 | sdtproce | root  | 0.6  | 6856  | 9136  | 08:36:36 | 435    | sdtprocess                |
| 441 | ps       | root  | 0.3  | 896   | 1136  | 08:37:06 | 440    | /usr/bin/ps -A -o pid=ID  |
| 440 | ksh      | root  | 0.1  | 1256  | 1888  | 08:37:06 | 436    | ksh -c /usr/bin/ps -A -o  |
| 435 | dtexec   | root  | 0.1  | 2328  | 3200  | 08:36:35 | 398    | /usr/dt/bin/dtexec -open  |
| 400 | sdtperfm | root  | 0.1  | 5312  | 7576  | 08:29:31 | 391    | /usr/dt/bin/sdtperfmer    |
| 390 | ttsessio | root  | 0.1  | 3320  | 4584  | 08:29:25 | 1      | /usr/dt/bin/ttsession     |
| 309 | mibiisa  | root  | 0.1  | 1912  | 2320  | 08:28:44 | 284    | mibiisa -r -p 32787       |
| 120 | rpcbind  | root  | 0.1  | 1440  | 2304  | 08:28:27 | 1      | /usr/sbin/rpcbind         |
| 421 | cat      | root  | 0.0  | 744   | 976   | 08:29:42 | 402    | /bin/cat /tmp/.removable/ |
| 410 | rpc.rsta | root  | 0.0  | 1288  | 1832  | 08:29:32 | 142    | rpc.rstatd                |
| 408 | sh       | root  | 0.0  | 232   | 336   | 08:29:32 | 399    | sh                        |
| 402 | sdtvolch | root  | 0.0  | 1288  | 1912  | 08:29:31 | 1      | /bin/ksh /usr/dt/bin/sdtv |
| 399 | xterm    | root  | 0.0  | 3400  | 4536  | 08:29:31 | 391    | xterm -g 106x37           |
| 392 | rpc.ttdb | root  | 0.0  | 2504  | 3408  | 08:29:25 | 142    | rpc.ttdbserverd           |
| 391 | dtsessio | root  | 0.0  | 5392  | 8320  | 08:29:25 | 376    | /usr/dt/bin/dtsession     |

**Figure 14-3** CDE Process Manager Window

The Process Manager can sort processes alphabetically (Name) or numerically (ID), depending on the column that is selected.

You can initiate a search by typing text into the Find field.

To terminate a process, highlight it and press Control-C, select the Kill option from the Process menu, or select the kill option from the options that are available when you press the right mouse button.

## Using the prstat Command

The `prstat` command examines and displays information about active processes on the system.

This command enables you to view information by specific processes, user identification (UID) numbers, central processing unit (CPU) IDs, or processor sets. By default, the `prstat` command displays information about all processes sorted by CPU usage. To use the `prstat` command, perform the command:

# **prstat**

To quit the `prstat` command, type **q**.

Table 14-1 shows the column headings and their meanings in a `prstat` report.

**Table 14-1** Column Headings for the `prstat` Report

| Default Column Heading | Description                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PID                    | The PID number of the process.                                                                                                                                                                                                                                                                                                                                                                                               |
| USERNAME               | The login name or UID of the owner of the process.                                                                                                                                                                                                                                                                                                                                                                           |
| SIZE                   | The total virtual memory size of the process.                                                                                                                                                                                                                                                                                                                                                                                |
| RSS                    | The resident set size of the process in kilobytes, megabytes, or gigabytes.                                                                                                                                                                                                                                                                                                                                                  |
| STATE                  | The state of the process: <ul style="list-style-type: none"><li>• <code>cpu</code> – The process is running on the CPU.</li><li>• <code>sleep</code> – The process is waiting for an event to complete.</li><li>• <code>run</code> – The process is in the run queue.</li><li>• <code>zombie</code> – The process terminated, and the parent is not waiting.</li><li>• <code>stop</code> – The process is stopped.</li></ul> |
| PRI                    | The priority of the process.                                                                                                                                                                                                                                                                                                                                                                                                 |
| NICE                   | The value used in priority computation.                                                                                                                                                                                                                                                                                                                                                                                      |
| TIME                   | The cumulative execution time for the process.                                                                                                                                                                                                                                                                                                                                                                               |

**Table 14-1** Column Headings for the `prstat` Report (Continued)

| Default Column Heading | Description                                                                        |
|------------------------|------------------------------------------------------------------------------------|
| CPU                    | The percentage of recent CPU time used by the process.                             |
| PROCESS/NLWP           | The name of the process/the number of lightweight processes (LWPs) in the process. |



**Note** – The `kernel` and many applications are now multithreaded. A thread is a logical sequence of program instructions written to accomplish a particular task. Each application thread is independently scheduled to run on an LWP, which functions as a virtual CPU. LWPs in turn, are attached to `kernel` threads, which are scheduled to run on actual CPUs.



**Note** – Use the `priocntl(1)` command to assign processes to a priority class and to manage process priorities. The `nice(1)` command is only supported for backward compatibility to previous Solaris OE releases. The `priocntl` command provides more flexibility in managing processes.

Table 14-2 shows the options for the `prstat` command.

**Table 14-2** Options for the `prstat` Command

| Option            | Description                                                                                                                                                                                                                    |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -a                | Displays separate reports about processes and users at the same time.                                                                                                                                                          |
| -c                | Continuously prints new reports below previous reports.                                                                                                                                                                        |
| -n <i>nproc</i>   | Restricts the number of output lines.                                                                                                                                                                                          |
| -p <i>pidlist</i> | Reports only on processes that have a PID in the given list.                                                                                                                                                                   |
| -s <i>key</i>     | Sorts output lines by <i>key</i> in descending order. The five possible keys include: <code>cpu</code> , <code>time</code> , <code>size</code> , <code>rss</code> , and <code>pri</code> . You can use only one key at a time. |
| -S <i>key</i>     | Sorts output lines by <i>key</i> in ascending order.                                                                                                                                                                           |
| -t                | Reports total usage summary for each user.                                                                                                                                                                                     |

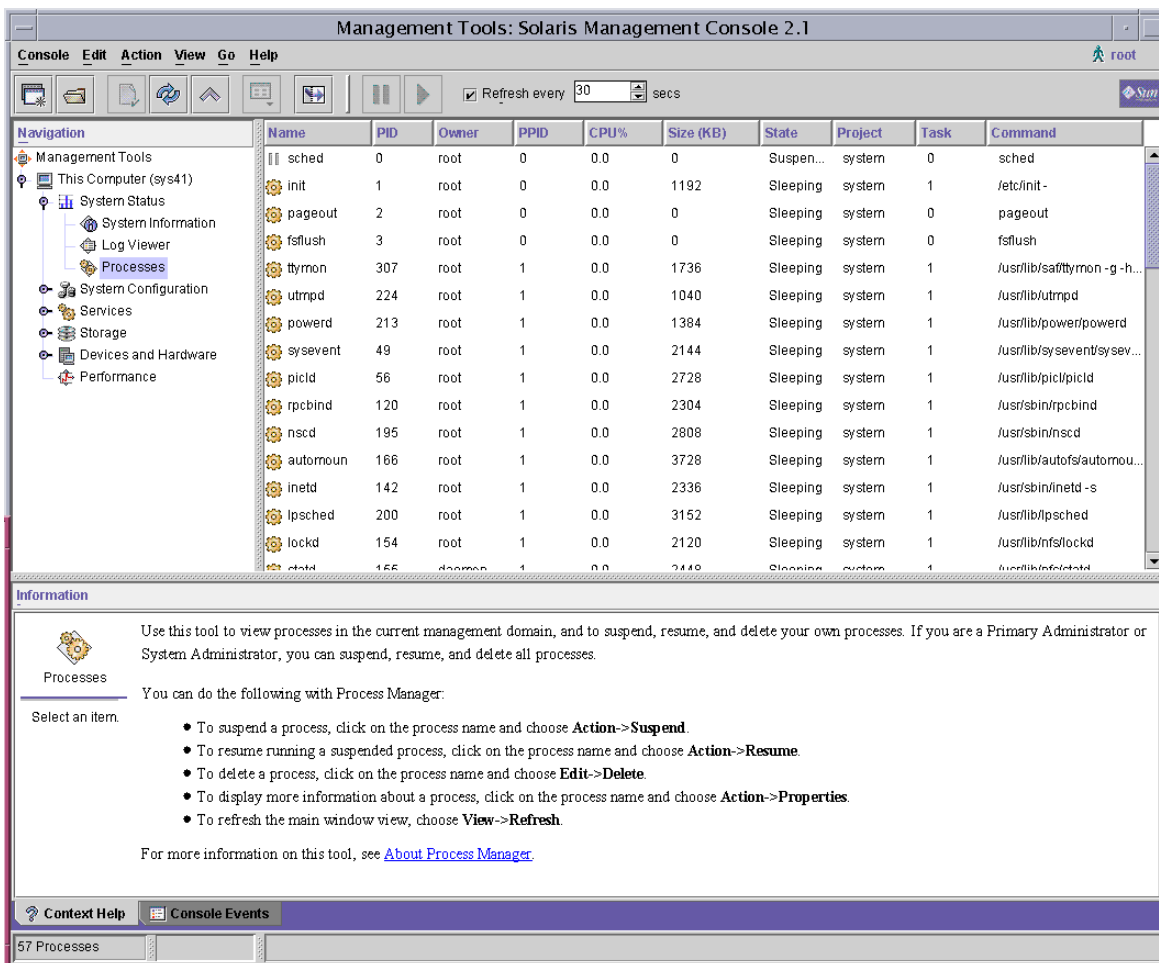
**Table 14-2** Options for the prstat Command (Continued)

| Option               | Description                                                                     |
|----------------------|---------------------------------------------------------------------------------|
| -u <i>euclidlist</i> | Reports only processes that have an effective user ID (EUID) in the given list. |
| -U <i>uidlist</i>    | Reports only processes that have a real UID in the given list.                  |

## Using the Solaris Management Console Process Tool

The Solaris Management Console provides a tool for monitoring and managing system processes. You open the Process Tool by clicking This Computer, and then clicking System Status. Then click Process.

Figure 14-4 shows the Solaris Management Console Process Tool.

**Figure 14-4** Solaris Management Console – Process Tool Window

From the Process Tool, you can do the following:

- Suspend a process. To do this, click the process name, and choose Suspend from the Action menu.
- Resume running a suspended process. To do this, click the process name, and choose Resume from the Action menu.
- Kill (delete) a process. To do this, click the process name, and choose Delete from the Edit menu.
- Display more information about a process. To do this, click the process name, and choose Properties from the Action menu.
- Refresh the main window view. To do this, choose Refresh from the View menu.

## Clearing Frozen Processes

You use the `kill` command or the `pkill` command to send a signal to one or more running processes. You would typically use these commands to terminate or clear an unwanted process.

### Using the `kill` and `pkill` Commands

You use the `kill` or `pkill` commands to terminate one or more processes.

The format for the `kill` command is:

```
kill -signal PID
```

The format for the `pkill` command is:

```
pkill -signal Process
```

Before you can terminate a process, you must know its name or PID. Use either the `ps` or `pgrep` command to locate the PID for the process.

The following examples use the `pgrep` command to locate the PID for the `mail` processes.

```
$ pgrep -l mail  
551 sendmail  
12047 dtmail  
$  
$ pkill dtmail
```

The following examples use the `ps` and `pkill` commands to locate and terminate the `dtmail` process.

```
# ps -e |grep mail  
314 ? 0:00 sendmail  
1197 ? 0:01 dtmail  
# kill 1197
```

To terminate more than one process at the same time, use the following syntax:

```
$ kill signal PID PID PID PID  
$ pkill signal process process
```



You use the `kill` command without a signal on the command line to send the default Signal 15 to the process. This signal usually causes the process to terminate.

Table 14-3 shows some signals and names.

**Table 14-3** Process Signal Numbers and Names

| Signal Number | Signal Name | Event     | Default Action |
|---------------|-------------|-----------|----------------|
| 1             | SIGHUP      | Hangup    | Exit           |
| 2             | SIGINT      | Interrupt | Exit           |
| 9             | SIGKILL     | Kill      | Exit           |
| 15            | SIGTERM     | Terminate | Exit           |

- 1, SIGHUP – A hangup signal to cause a telephone line or terminal connection to be dropped. For certain daemons, such as `inetd` and `in.named`, a hangup signal will cause the daemon to reread its configuration file.
- 2, SIGINT – An interrupt signal from your keyboard—usually from a Control-C key combination.
- 9, SIGKILL – A signal to kill a process. A process cannot ignore this signal.
- 15, SIGTERM – A signal to terminate a process in an orderly manner. Some processes ignore this signal.

A complete list of signals that the `kill` command can send can be found by executing the command `kill -l`, or by referring to the man page for `signal`:

```
# man -s3head signal
```

Some processes can be written to ignore Signal 15. Processes that do not respond to a Signal 15 can be terminated by force by using Signal 9 with the `kill` or `pkill` commands. You use the following syntax:

```
$ kill -9 PID
$ pkill -9 process
```



---

**Caution** – Use the `kill -9` or `killall -9` command as a last resort to terminate a process. Using `kill -9` on a process that controls a database application or a program that updates files can be disastrous. The process is terminated instantly with no opportunity to perform an orderly shutdown.

---

## Performing a Remote Login

When a workstation is not responding to your keyboard or mouse input, the CDE might be frozen. In such cases, you may be able to remotely access your workstation by using the `rlogin` command or by using the `telnet` command from another system.

### Killing the Process for a Frozen Login

After you are connected remotely to your system, you can invoke the `kill` command to terminate the corrupted session on your workstation.

In the following example, the `rlogin` command is used to log in to `sys42`, from which you can issue a `kill` command.

```
$ rlogin sys42
Password: EnterPassword
Last login: Mon Jan 14 10:11:56 from sys43
Sun Microsystems Inc. SunOS 5.9 Beta May 2002
$ kill -9 Xsun
or
$ killall -9 Xsun
```

## Scheduling an Automatic One-Time Execution of a Command

Use the `at` command to automatically execute a job only once at a specified time.

### Using the `at` Command

The format for the `at` command is:

```
at -m -q queueName time date
at -r job
at -l
```

Table 14-4 shows the options you can use to instruct the `cron` process on how to execute an `at` job.

**Table 14-4** Options for the `at` Command

| Option              | Description                                                                                                                       |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| -m                  | Sends mail to the user after the job has finished                                                                                 |
| -r <i>job</i>       | Removes a scheduled <code>at</code> job from the queue                                                                            |
| -q <i>queueName</i> | Specifies a specific queue                                                                                                        |
| <i>time</i>         | Specifies a time for the command to execute                                                                                       |
| -l                  | Reports all jobs scheduled for the invoking user                                                                                  |
| <i>date</i>         | Specifies an optional date for the command to execute, which is either a month name followed by a day number or a day of the week |

For example, to create an `at` job to run at 9:00 p.m. to locate and delete core files from user2's home directory, perform the command:

```
# at 9:00 pm
at>find /export/home/user2 -name core -exec rm {} \;
at><Control-D>
commands will be executed using /sbin/sh
job 1016078400.a at Wed Mar 13 21:00:00 2002
```

To display information about the execution times of jobs, perform the command:

```
# at -l 1016078400.a
```

To display the jobs queued to run at specified times by chronological order of execution, perform the command:

```
# atq
```

| Rank | Execution Date     | Owner | Job          | Queue | Job Name |
|------|--------------------|-------|--------------|-------|----------|
| 1st  | Mar 13, 2002 21:00 | root  | 1016078400.a | a     | stdin    |
| 2nd  | Mar 13, 2002 21:05 | root  | 1016078700.a | a     | stdin    |
| 3rd  | Mar 13, 2002 21:10 | root  | 1016079000.a | a     | stdin    |

To view all the `at` jobs currently scheduled in the queue, perform the command:

```
# ls -l /var/spool/cron/atjobs
```

|            |   |      |       |     |              |              |
|------------|---|------|-------|-----|--------------|--------------|
| -r-Sr--r-- | 1 | root | other | 921 | Mar 13 13:08 | 1016078400.a |
| -r-Sr--r-- | 1 | root | other | 913 | Mar 13 13:08 | 1016078700.a |
| -r-Sr--r-- | 1 | root | other | 885 | Mar 13 13:09 | 1016079000.a |

You can also use the `at` command to remove a job from the `at` queue.

For example, to remove job 1016078400.a from the `at` queue, perform the command:

```
# at -r 1016078400.a
# atq
```

| Rank | Execution Date     | Owner | Job          | Queue | Job Name |
|------|--------------------|-------|--------------|-------|----------|
| 1st  | Mar 13, 2002 21:05 | root  | 1016078700.a | a     | stdin    |
| 2nd  | Mar 13, 2002 21:10 | root  | 1016079000.a | a     | stdin    |

## Controlling Access to the at Command

As the root user, you control who has access to the at command with the `at.deny` and `at.allow` files.

### The `/etc/cron.d/at.deny` File

By default, the Solaris OE includes the `/etc/cron.d/at.deny` file. This file identifies users who are prohibited from using the at command. The file format is one user name per line. The file initially contains:

```
daemon
bin
smtp
nuucp
listen
nobody
noaccess
```

A user who is denied access to the at command receives the following message when attempting to use the command:

```
at: you are not authorized to use at. Sorry.
```

If only the `/etc/cron.d/at.deny` file exists but is empty, then all logged-in users can access the at command.

### The `/etc/cron.d/at.allow` File

The `/etc/cron.d/at.allow` file does not exist by default, so all users (except those listed in the `/etc/cron.d/at.deny` file) can create at jobs. By creating the `/etc/cron.d/at.allow` file, you create a list of only those users who are allowed to execute at commands.

The `/etc/cron.d/at.allow` file consists of user names, one per line.

The interaction between the `at.allow` and the `at.deny` files follows these rules:

- If the `at.allow` file exists, only the users listed in this file can execute `at` commands.
- If the `at.allow` file does not exist, all users, except for users listed in the `at.deny` file, can execute `at` commands.
- If neither file exists, only the `root` user can use the `at` command.

## Scheduling an Automatic Recurring Execution of a Command

You can use the `cron` facility to schedule regularly recurring commands. Users can submit a command to the `cron` facility by modifying their `crontab` file.

All `crontab` files are maintained in the `/var/spool/cron/crontabs` directory and are stored as the login name of the user that created the `cron` job.

The `cron` daemon is responsible for scheduling and running these jobs.



---

**Note** – The clock daemon, `cron`, starts at system boot and runs continuously in the background.

---

### Introducing the `crontab` File Format

A `crontab` file consists of lines of six fields each. The fields are separated by spaces or tabs. The first five fields provide the date and time the command is to be scheduled. The last field is the full path to the command.



---

**Note** – If the command field contains a percent (%) character, then all subsequent characters are passed to the command as standard input.

---

These first five fields are separated by spaces and indicate when the command will be executed. See Figure 14-5.

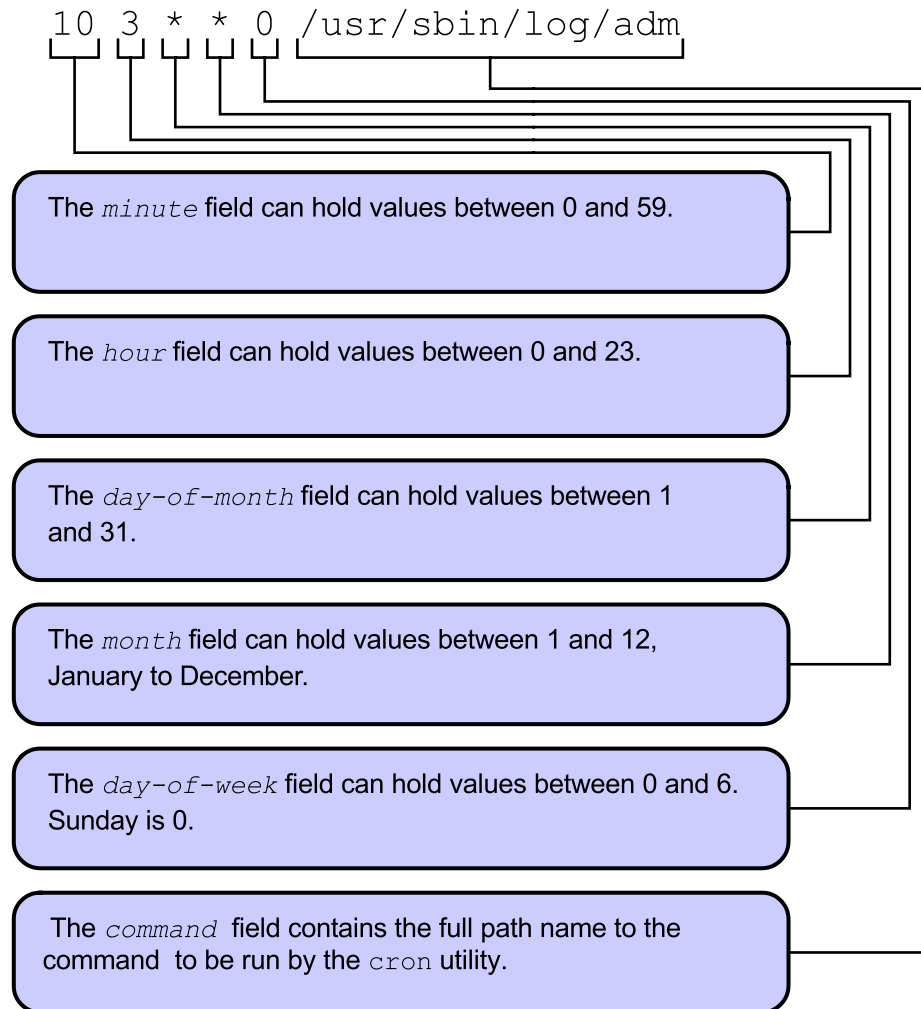


**Figure 14-5** First Five Fields in a crontab File



The first five fields follow the format rules shown in Table 14-5.

**Table 14-5** Rules for the crontab Fields

| Value        | Rule                                                                | Example                                                               |
|--------------|---------------------------------------------------------------------|-----------------------------------------------------------------------|
| <i>n</i>     | Matches if field value is <i>n</i>                                  | As shown in the preceding figure for hour or minute, a 3 or 10        |
| <i>n,p,q</i> | Matches if field value is <i>n</i> , <i>p</i> , or <i>q</i>         | Every 10 minutes would be represented by 0,10,20,30,40,50             |
| <i>n-p</i>   | Matches if field has values between <i>n</i> and <i>p</i> inclusive | The hours between 1:00 a.m. and 4:00 a.m. would be represented by 1-4 |
| *            | Matches all legal values                                            | As in the preceding example for the month, representing every month.  |

## Using the crontab Command

The `crontab` command enables the user to view, edit, or remove a crontab file.

### Viewing a crontab File

To view the contents of the root crontab file, run the `crontab -l` command as the root user.

```
# crontab -l
#ident "@(#)root      1.20    01/11/06 SMI"
#
# The root crontab should be used to perform accounting data collection.
#
# The rtc command is run to adjust the real time clock if and when
# daylight savings time changes.
#
10 3 * * * /usr/sbin/logadm
15 3 * * 0 /usr/lib/fs/nfs/nfsfind
1 2 * * * [ -x /usr/sbin/rtc ] && /usr/sbin/rtc -c > /dev/null 2>&1
30 3 * * * [ -x /usr/lib/gss/gsscred_clean ] &&
/usr/lib/gss/gsscred_clean
#10 3 * * * /usr/lib/krb5/kprop_script ____slave_kdcs____
```

This is the same command that users run to view the contents of their own crontab file.

As the `root` user, you can view the contents of any regular user's crontab file by performing the command:

```
# crontab -l username
```

### Editing a crontab File

To create or edit a crontab file, follow these steps:

1. Check that the `EDITOR` variable is set to the editor you want to use. This instructs the cron utility which editor to use to open the file.

```
# EDITOR=vi  
# export EDITOR
```

2. Run the following crontab command to open your crontab file, and add the appropriate entry.

```
# crontab -e  
30 17 * * 5 /usr/bin/banner "Time to go!" > /dev/console  
:wq
```



---

**Note** – If the users do not redirect the standard output and standard error of their commands in the crontab file, any generated output or errors are mailed electronically to the user.

---

### Removing a crontab File

The correct way to remove a crontab file is to invoke the command:

```
# crontab -r username
```

Typical users can remove only their own crontab file. The `root` user can delete any user's crontab file.



---

**Caution** – If you accidentally enter the `crontab` command on the command line without an option (`-l`, `-e`, `-r`), press the interrupt keys Control-C to exit. Do not press Control-D; this action overwrites the existing crontab file with an empty file.

---

## Controlling Access to the crontab Command

You can control access to the `crontab` command with two files in the `/etc/cron.d` directory—the `cron.deny` file and the `cron.allow` file.

These files permit only specified users to perform `crontab` tasks, such as creating, editing, displaying, or removing their own `crontab` files.

### The `/etc/cron.d/cron.deny` File

The Solaris OE provides a default `cron.deny` file. The file consists of a list of user names, one per line, of the users who are not allowed to use `cron`. The following is an example of the contents of a `cron.deny` file:

```
daemon
bin
smtp
nuucp
listen
nobody
noaccess
```

### The `/etc/cron.d/cron.allow` File

The `/etc/cron.d/cron.allow` file does not exist by default, so all users (except those listed in the `cron.deny` file) can access their `crontab` file. By creating a `cron.allow` file, you can list only those users who can access `crontab` commands.

The file consists of a list of user names, one per line.

The interaction between the `cron.allow` and the `cron.deny` files follows these rules:

- If the `cron.allow` file exists, only the users listed in this file can create, edit, display, or remove `crontab` files.
- If the `cron.allow` file does not exist, all users, except for users listed in the `cron.deny` file, can create, edit, display, or remove `crontab` files.
- If neither file exists, only the `root` user can run the `crontab` command.

## Using the Solaris™ Management Console Job Scheduler Tool

The Solaris™ Management Console contains a Scheduled Jobs tool to create and schedule jobs on your system. Users can manage jobs if the following conditions exist:

- Their user name appears in the `/etc/cron.d/cron.allow` file.
- Their user name does not appear in the `/etc/cron.d/cron.deny` file.
- The `/etc/cron.d/cron.allow` and `/etc/cron.d/cron.deny` files do not exist, and you are the root user.

To open the Job Scheduler from the Solaris Management Console, click This Computer and then click Service, and finally, click Scheduled Jobs.

See Figure 14-6 for an example of the Solaris Management Console Job Scheduler window.

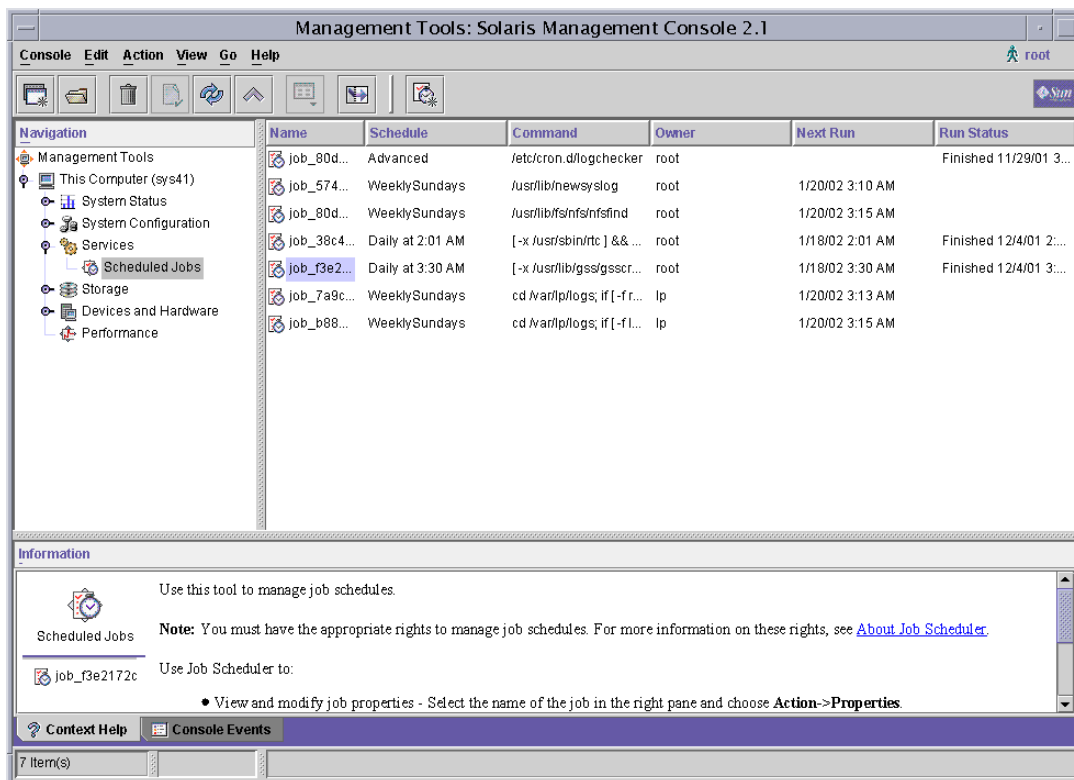


**Figure 14-6** Solaris Management Console – Job Scheduler Window

You can use the Job Scheduler to:

- View and modify job properties  
Select the name of the job in the view pane, and choose Properties from the Action menu.
- Delete a job  
Select the job name and choose Delete from the Edit menu. The root user can delete all jobs. Users can only view and delete their own jobs.
- Add a scheduled job  
Choose Add Scheduled Job on the Action menu.
- Enable and disable job logging, and set search paths  
Choose Scheduled Job Policies on the Action menu.

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Using Process Control (Level 1)

In this exercise, you use the Process Tool and the `prstat` command to monitor and kill processes. You create an `at` job and create an entry in a `crontab` file.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed.

### Tasks

Complete the following tasks:

- Start the Process Tool. Run the `prstat` command in a window. In a separate window, run the `find /` command. Make note of the CPU percentages for the `find` command, as displayed by the `prstat` command and the Process Tool. Open a third window, and identify the PID of the shell running in it. Use the Process Tool to show the ancestry of the shell process. Use the Process Tool to kill the shell process. Use the Process Tool to send the `TERM` signal to the `prstat` process. Exit the Process Tool when you are finished.

(Steps 1–6 in the Level 2 lab)

- Identify the device associated with your current terminal, and display the current time of day. Submit an `at` job that echoes `Test Complete` to your current window. Have the job run five minutes from the current time, and submit it to the queue called `x`. Display the `at` job in the queue.

(Steps 7–10 in the Level 2 lab)

- Set the `EDITOR` variable to `vi`. Use the `crontab` command to determine when the `logadm` process is scheduled to run. Use the `crontab` command to edit the `crontab` file for the `root` user. Add an entry that sends the message `It works!` to your current window five minutes from the current time.

(Steps 11–14 in the Level 2 lab)

## Exercise: Using Process Control (Level 2)

In this exercise, you use the Process Tool and the `prstat` command to monitor and kill processes. You create an `at` job and create an entry in a `crontab` file.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Start the Process Tool. Run the `prstat` command in a window. In a separate window, run the `find /` command. Make note of the CPU percentages for the `find` command, as displayed by the `prstat` command and the Process Tool. Open a third window, and identify the PID of the shell running in it. Use the Process Tool to show the ancestry of the shell process. Use the Process Tool to kill the shell process. Use the Process Tool to send the `TERM` signal to the `prstat` process. Exit the Process Tool when you are finished.
- Identify the device associated with your current terminal, and display the current time of day. Submit an `at` job that echoes `Test Complete` to your current window. Have the job run five minutes from the current time, and submit it to the queue called `x`. Display the `at` job in the queue.
- Set the `EDITOR` variable to `vi`. Use the `crontab` command to determine when the `logadm` process is scheduled to run. Use the `crontab` command to edit the `crontab` file for the `root` user. Add an entry that sends the message `It works!` to your current window five minutes from the current time.



## Tasks

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Start the Process Tool either by selecting the Find Process option from the Front Panel Tools menu in CDE or by invoking the appropriate command from the command line.  
  
In the Process Tool display, sort the listing according to CPU%, and change the sample time to five seconds.
2. Open a second terminal window, and run the `prstat` command.
3. Position the Process Tool and the window in which the `prstat` command is running so that you can observe both simultaneously. In an available window, run the `find` command to list all files on your system. Observe how the Process Tool and the `prstat` command display statistics for the `find` command.  
  
What is the maximum percentage of recent CPU time used by the `find` command as it executes?
4. Open a third terminal window, and run the `ps` command to determine the PID of the shell. Record the PID you find.
5. In the Process Tool, locate and select the shell process you identified in the previous step. Select the Show Ancestry option from the Process menu in the Process Tool. What is the name and PID of the first process listed?
6. Close the Show Ancestry window. Again, select the shell process you identified in Step 4. From the Process menu in the Process Tool, select the Kill option. What happens?

7. In the Process Tool, use the Find function to locate the `prstat` process. Select the Signal option from the Process menu. In the Signal fill-in field, enter the `TERM` signal, and click OK. What happens to the `prstat` process? Close the Process Tool when you are finished.
8. Identify the device associated with your current terminal by using the `tty` command, and display the current time of day.
9. Submit an `at` job that echoes `Test Complete` to your current window. Have the job run five minutes from the current time, and submit it to the queue called `x`.
10. Display the `at` job in the queue.
11. Open a new window and set and export the `EDITOR` environment variable to use the `vi` editor to edit `crontab` files.

If you are using the Bourne or Korn shell, perform the command:

```
# EDITOR=vi
# export EDITOR
```

If you are using the C shell, perform the command:

```
# setenv EDITOR vi
```

12. Use the `crontab` command to view the current `crontab` file for the `root` user.
13. When is the `logadm` process scheduled to run?
14. Use the `crontab` command to edit the `crontab` file for the `root` user. Add an entry that sends the message `It works!` to your current window five minutes from now. For example, if the current time is 10:25, make an entry in your `crontab` file for the 30th minute of the same hour.

Save the file, and quit the `vi` edit session. In about five minutes, you should see the result in your window.

## Exercise: Using Process Control (Level 3)

In this exercise, you use the Process Tool and the `prstat` command to monitor and kill processes. You create an `at` job and create an entry in a `crontab` file.

### Preparation

Refer to the lecture notes as necessary to perform the tasks listed.

### Task Summary

In this exercise, you accomplish the following:

- Start the Process Tool. Run the `prstat` command in a window. In a separate window, run the `find /` command. Make note of the CPU percentages for the `find` command, as displayed by the `prstat` command and the Process Tool. Open a third window, and identify the PID of the shell running in it. Use the Process Tool to show the ancestry of the shell process. Use the Process Tool to kill the shell process. Use the Process Tool to send the `TERM` signal to the `prstat` process. Exit the Process Tool when you are finished.
- Identify the device associated with your current terminal, and display the current time of day. Submit an `at` job that echoes `Test Complete` to your current window. Have the job run five minutes from the current time, and submit it to the queue called `x`. Display the `at` job in the queue.
- Set the `EDITOR` variable to `vi`. Use the `crontab` command to determine when the `logadm` process is scheduled to run. Use the `crontab` command to edit the `crontab` file for the `root` user. Add an entry that sends the message `It works!` to your current window five minutes from the current time.

## Tasks and Solutions

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Start the Process Tool either by selecting the Find Process option from the Front Panel Tools menu in CDE or by invoking the appropriate command from the command line.

# `/usr/dt/bin/sdtprocess &`

In the Process Tool display, sort the listing according to CPU%, and change the sample time to five seconds.

2. Open a second terminal window, and run the `prstat` command.

# `prstat`

3. Position the Process Tool and the window in which the `prstat` command is running so that you can observe both simultaneously. In an available window, run the `find` command to list all files on your system. Observe how the Process Tool and the `prstat` command display statistics for the `find` command.

# `find /`

What is the maximum percentage of recent CPU time used by the `find` command as it executes?

*This varies according to your system configuration. Some systems might display values in the 20-percent range.*

4. Open a third terminal window, and run the `ps` command to determine the PID of the shell. Record the PID you find.

# `ps`

*Your value appears here.*

5. In the Process Tool, locate and select the shell process you identified in the previous step. Select the Show Ancestry option from the Process menu in the Process Tool. What is the name and PID of the first process listed?

*The PID varies. On systems running the CDE, the first process listed should be `/usr/dt/bin/dtlogin`.*

6. Close the Show Ancestry window. Again, select the shell process you identified in Step 4. From the Process menu in the Process Tool, select the Kill option. What happens?

*The process stops, and the window no longer appears.*

7. In the Process Tool, use the Find function to locate the `prstat` process. Select the Signal option from the Process menu. In the Signal fill-in field, enter the `TERM` signal, and click OK. What happens to the `prstat` process? Close the Process Tool when you are finished.

*The `prstat` process terminates, and the prompt appears in the window in which it ran.*

8. Identify the device associated with your current terminal by using the `tty` command, and display the current time of day.

```
# tty
```

```
(something like /dev/pts/4 should appear)
```

```
# date
```

```
(current date/time appears)
```

9. Submit an `at` job that echoes `Test Complete` to your current window. Have the job run five minutes from the current time, and submit it to the queue called `x`.

```
# at -q x 13:30
```

```
at> echo "Test Complete" > /dev/pts/# (# is from the tty command)
```

```
at> <Control-D>
```

```
commands will be executed using /sbin/sh
```

```
job 958163400.x at Fri May 12 13:30:00 2000
```

```
#
```

10. Display the `at` job in the queue.

```
# atq
```

11. Open a new window and set and export the `EDITOR` environment variable to use the `vi` editor to edit `crontab` files.

If you are using the Bourne or Korn shell, perform the command:

```
# EDITOR=vi
```

```
# export EDITOR
```

If you are using the C shell, perform the command:

```
# setenv EDITOR vi
```

12. Use the `crontab` command to view the current `crontab` file for the `root` user.

```
# crontab -l
```

13. When is the `logadm` process scheduled to run?

*Ten minutes after 3:00 a.m. on all days*

14. Use the `crontab` command to edit the `crontab` file for the root user. Add an entry that sends the message `It works!` to your current window five minutes from now. For example, if the current time is 10:25, make an entry in your `crontab` file for the 30th minute of the same hour.

```
# tty
/dev/pts/#
# date
Thu May 11 10:25:14 PDT 2000
# crontab -e
```

*Add the following line, but substitute the correct time and terminal device:*

```
30 10 * * * /usr/bin/echo "It works!" > /dev/pts/#
```

Save the file, and quit the `vi` edit session. In about five minutes, you should see the result in your window.

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications





# Performing File System Backups

---

## Objectives

Upon completion of this module, you should be able to:

- Identify the fundamentals of backups
- Back up an unmounted file system

The following course map shows how this module fits into the current instructional goal.

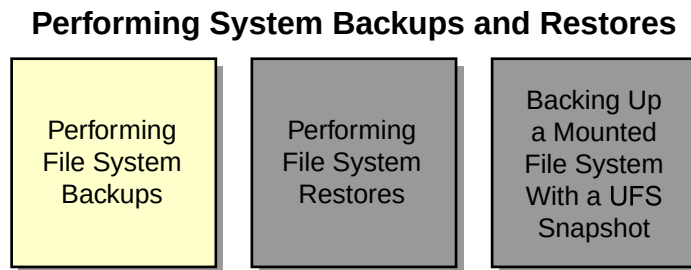


**Figure 15-1** Course Map

## Introducing the Fundamentals of Backups

A crucial function of system administration is to backup file systems. Backups safeguard against data loss, damage, or corruption. Backup tapes are often referred to as dump tapes.

### Importance of Routine File System Backups

To back up file systems, you copy file systems to removable media, such as a tape. You perform backups on a regular basis to prevent loss of data due to:

- Accidental deletion of files
- Hardware failures
- Problems with re-installations or system upgrades
- System crashes
- System break-ins by unauthorized users, compromising data integrity
- Natural disasters

## Tape Media Types

Table 15-1 shows typical tape media that you can use to store file systems during the backup process. Select media based on the availability of equipment and your preference.

**Table 15-1** Tape Media Types

| Media Type                                                   | Capacity                        |
|--------------------------------------------------------------|---------------------------------|
| 1/2-inch reel tape                                           | 140 Mbytes (6250 bits per inch) |
| 1/4-inch cartridge (QIC) <sup>1</sup><br>cartridge tape      | 8 Gbytes                        |
| 8-mm cartridge tape                                          | 40 Gbytes                       |
| 4-mm digital audio tape (DAT) <sup>2</sup><br>cartridge tape | 24 Gbytes                       |
| DLT <sup>3</sup> 1/2-inch cartridge tape                     | 70 Gbytes                       |
| LTO <sup>4</sup> cartridge tape                              | 100 Gbytes                      |

1. QIC stands for quarter-inch tape. 2. DAT stands for digital audio tape.  
3. DLT stands for digital linear tape. 4. LTO stands for linear tape open.

The capacities in the table are approximate. Tape capacity increases with new technology. Check the documentation that comes with the tape device to determine the capacity.

## Tape Drive Naming

All tape drives have logical device names that you use to reference the device on the command line. Figure 15-2 shows the format that all logical device names use.

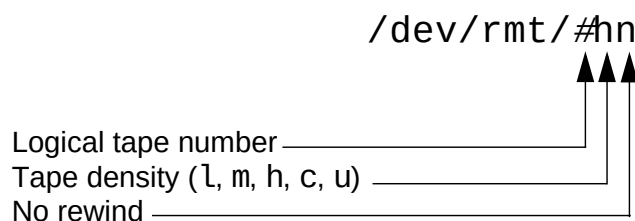


**Figure 15-2** Logical Device Name Format

The logical tape numbers in the tape drive names always start with 0. For example:

- The first instance of a tape drive:  
`/dev/rmt/0`
- The second instance of a tape drive:  
`/dev/rmt/1`
- The third instance of a tape drive:  
`/dev/rmt/2`

Two optional parameters further define the logical device name:

- Tape density – Five values can be given in the tape device name: l (low), m (medium), h (high), c (compressed), or u (ultra compressed).
- No rewind – The letter n at the end of a tape device name indicates that the tape should not be rewound when the current operation completes.

Tape densities depend on the tape drive. Check the manufacturer's documentation to determine the correct densities for the tape media.

Tape drives that support data compression contain internal hardware that performs the compression. Hardware compression uses more space than the software compression you can achieve from the Solaris™ Operating Environment (Solaris OE) `compress` command, but compression is much faster. If you back up a software-compressed file with hardware compression, the resultant file is larger in size.

## Tape Drive Control

You use the `mt` command (magnetic tape control) to send instructions to the tape drive. Not all tape drives support all `mt` commands.

The format for the `mt` command is:

```
mt -f tape-device-name command count
```

You use the `-f` option to specify the tape device name, typically a no-rewind device name.

## Using the `mt` Command

Table 15-2 lists some of the `mt` commands that you can use to control a magnetic tape drive.

**Table 15-2** Definitions of `mt` Commands

| Command                          | Definition                                                                                                  |
|----------------------------------|-------------------------------------------------------------------------------------------------------------|
| <code>mt status</code>           | Displays status information about the tape drive                                                            |
| <code>mt rewind</code>           | Rewinds the tape                                                                                            |
| <code>mt offline</code>          | Rewinds the tape and, if appropriate, takes the drive unit offline and if the hardware supports it, unloads |
| <code>mt fsf <i>count</i></code> | Moves the tape forward <i>count</i> records                                                                 |

The following command positions the tape at the beginning of the third tape record.

```
# mt -f /dev/rmt/0n fsf 2
```

## Strategies for Scheduled Backups

The most common method to schedule backups is to perform cumulative incremental backups daily. This schedule is recommended for most situations.

To set up a backup schedule, determine:

- The file systems to back up
- A backup device (for example, tape drive)
- The number of tapes to use for the backup
- The type of backup (for example, full or incremental)
- The procedures for marking and storing tapes
- The time it takes to perform a backup

### Determining File System Names to Back Up

Display the contents of the `/etc/vfstab` file. Then view the `mount point` column to find the name of the file system that you want to back up.

### Determining the Number of Tapes

You determine the number of tapes for a backup according to the size of the file system you are backing up.

To determine the size of the file system, use the `ufsdump` command with the `S` option. The following are the command formats:

```
# ufsdump 0S filesystem_name
<number reported>
```

or

```
# ufsdump 3S filesystem_name
<number reported>
```

The numeric option determines the appropriate dump level. The output is the estimated number of bytes that the system requires for a complete backup.

Divide the reported bytes by the capacity of the tape to determine how many tapes you need to backup the file system.

### Determining Back Up Frequency and Levels

You determine how often and at what level to backup each file system. The level of a backup refers to the amount of information that is backed up.

### Identifying Incremental and Full Back Ups

You can perform a full backup or an incremental backup of a file system. A full backup is a complete file system backup. An incremental backup copies only files in the file system that have been added or modified since a previous lower-level backup.

You use Dump Level 0 to perform a full backup. You use Dump Levels 1 through 9 to schedule incremental backups. The level numbers have no meaning other than their relationship to each other as a higher or lower number.

Figure 15-3 shows an example of a file system backup performed in incremental levels.

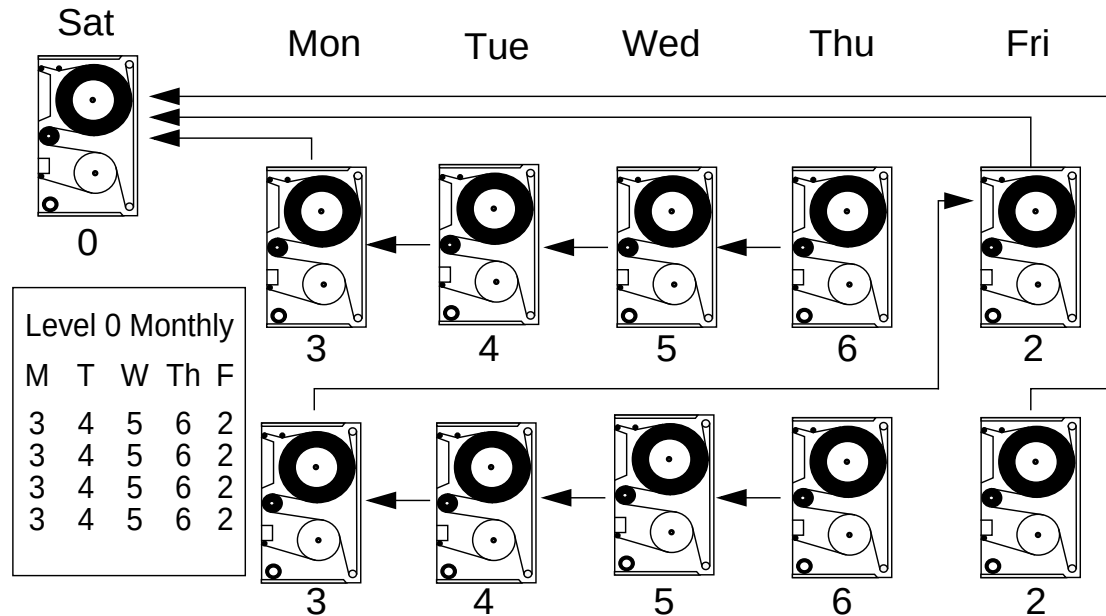


**Figure 15-3** Incremental Back Up Strategy

Table 15-3 defines the elements of the incremental backup strategy shown in Figure 15-3.

**Table 15-3** Incremental Back Up Level Definitions

| Level       | Example                                                                                                                                                       |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0<br>(Full) | Performed once each month.                                                                                                                                    |
| 3           | Performed every Monday. The backup copies new or modified files since the last lower-level backup (for example, 0).                                           |
| 4           | Performed every Tuesday. The backup copies new or modified files since the last lower-level backup (for example, 3).                                          |
| 5           | Performed every Wednesday. The backup copies new or modified files since the last lower-level backup (for example, 4).                                        |
| 6           | Performed every Thursday. The backup copies new or modified files since the last lower-level backup (for example, 5).                                         |
| 2           | Performed every Friday. The backup copies new or modified files since the last lower-level backup, which is the Level 0 backup at the beginning of the month. |



---

**Note** – Many system administrators use the `crontab` utility to start a script that runs the `ufsdump` command.

---



## The /etc/dumpdates File

The /etc/dumpdates file records backups if the -u option is used with the `ufsdump` command. Each line in the /etc/dumpdates file shows the file system that was backed up and the level of the last backup. It also shows the day, the date, and the time of the backup.

The following is an example /etc/dumpdates file:

```
# cat /etc/dumpdates
/dev/rdisk/c0t2d0s6 0 Fri Jan 4 19:12:27 2002
/dev/rdisk/c0t2d0s0 0 Fri Jan 4 20:44:02 2002
/dev/rdisk/c0t0d0s7 0 Tue Mar 12 09:58:26 2002
/dev/rdisk/c0t0d0s7 1 Tue Mar 12 16:25:28 2002
```

When an incremental backup is performed, the `ufsdump` command consults the /etc/dumpdates file. It looks for the date of the next lower-level backup. Then, the `ufsdump` command copies to the backup media all of the files that were modified or added since the date of that lower-level backup.

When the backup is complete, the /etc/dumpdates file records a new entry that describes this backup. The new entry replaces the entry for the previous backup at that level.

You can view the /etc/dumpdates file to determine if the system is completing backups. If a backup does not complete because of equipment failure, the /etc/dumpdates file does not record the backup.



---

**Note** – When you are restoring an entire file system, check the /etc/dumpdates file for a list of the most recent dates and levels of backups. Use this list to determine which tapes are needed to restore the entire file system. The tapes should be physically marked with the dump level and date of the backup.

---

## Backing Up an Unmounted File System

Check that the file system is inactive, or unmounted, before you back the system up. If the file system is active, the output of the backup can be inconsistent, and you could find it impossible to restore the files correctly.

### The ufsdump Command

The standard Solaris OE command for ufs file system backups is `/usr/sbin/ufsdump`.

The format for the `ufsdump` command is:

`ufsdump option(s) argument(s) filesystem_name`

You can use this command to back up a complete or a partial file system. Backups are often referred to as dumps.

## Options for the `ufsdump` Command

Table 15-4 defines several common options for the `ufsdump` command.

**Table 15-4** Options for the `ufsdump` Command

| Option          | Description                                                                                                                                                                                                                                                                                                                                            |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0–9             | Back up level. Level 0 is a full backup of the file system. Levels 1 through 9 are incremental backups of files that have changed since the last lower-level backup.                                                                                                                                                                                   |
| v               | Verify. After each tape is written, the system verifies the contents of the media against the source file system. If any discrepancies occur, the system prompts the operator to insert new media and repeat the process. Use this option only on an unmounted file system. Any activity in the file system causes the system to report discrepancies. |
| S               | Size estimate. This option allows you to estimate the amount of space that will be needed on the tape to perform the level of backup you want.                                                                                                                                                                                                         |
| l               | Autoload. You use this option with an autoloading (stackloader) tape drive.                                                                                                                                                                                                                                                                            |
| o               | Offline. When the backup is complete, the system takes the drive offline, rewinds the tape (if you use a tape), and, if possible, ejects the media.                                                                                                                                                                                                    |
| u               | Update. The system creates an entry in the <code>/etc/dumpdates</code> file with the device name for the file system disk slice, the backup level (0–9), and the date. If an entry already exists for a backup at the same level, the system replaces the entry.                                                                                       |
| n               | Notify. The system sends messages to the terminals of all logged-in users who are members of the <code>sys</code> group to indicate that the <code>ufsdump</code> command requires attention.                                                                                                                                                          |
| f <i>device</i> | Specify. The system specifies the device name of the file system backup. When you use the default tape device, <code>/dev/rmt/0</code> , you do not need the <code>-f</code> option. The system assumes the default.                                                                                                                                   |

## Tape Back Ups

You use the `ufsdump` command to create file system backups to tape. The dump level (0–9) specified in the `ufsdump` command determines which files to back up.

### Using the `ufsdump` Command

Perform the following steps to use the `ufsdump` command to start a tape backup:

1. Become the `root` user to change the system to single-user mode, and unmount the file systems.

```
# /usr/sbin/shutdown -y -g300 "System is being shutdown for backup"
```

```
Shutdown started.      Thu 24 Jan 2002 01:01:47 PM MST
```

```
Broadcast Message from root (pts/1) on host1 Thu Jan 24 01:01:52...
```

```
The system host1 will be shut down in 5 minutes
```

```
System is being shutdown for backup
```

2. Verify that the `/export/home` file system was unmounted with the shutdown command. If not, unmount it manually.
3. Check the integrity of the file system data with the `fsck` command.

```
# fsck /export/home
```

4. Perform a full (Level 0) backup of the `/export/home` file system.

```
# ufsdump 0uf /dev/rmt/0 /export/home
```

```
ufsdump 0uf /dev/rmt/0 /export/home
```

```
DUMP: Writing 32 Kilobyte records
```

```
DUMP: Date of this level 0 dump: Thu 24 Jan 2002 01:06:47 PM MST
```

```
DUMP: Date of last level 0 dump: the epoch
```

```
DUMP: Dumping /dev/rdisk/c0t0d0s7 (host1:/export/home) to /dev/rmt/0.
```

```
DUMP: Mapping (Pass I) [regular files]
```

```
DUMP: Mapping (Pass II) [directories]
```

```
DUMP: Estimated 1126 blocks (563KB).
```

```
DUMP: Dumping (Pass III) [directories]
```

```
DUMP: Dumping (Pass IV) [regular files]
```

```
DUMP: Tape rewinding
```

```
DUMP: 1086 blocks (543KB) on 1 volume at 1803 KB/sec
```

```
DUMP: DUMP IS DONE
```

```
DUMP: Level 0 dump on Thu 24 Jan 2002 01:06:47 PM MST
```

```
#
```

## Remote Backups to a Tape

You can use the `ufsdump` command to perform a backup on a remote tape device.

The format for the `ufsdump` command is:

```
ufsdump options remotehost:tapedevice filesystem
```

To perform remote backups across the network, the system with the tape drive must have an entry in its `/.rhosts` file for every system that uses the tape drive.

### Using the `ufsdump` Command

The following example shows how to perform a full (Level 0) backup of the `/export/home` file system on the `host1` system, to the remote tape device on the `host2` system.

```
# ufsdump 0uf host2:/dev/rmt/0 /export/home
DUMP: Writing 32 Kilobyte records
DUMP: Date of this level 0 dump: Thu 24 Jan 2002 01:13:55 PM MST
DUMP: Date of last level 0 dump: the epoch
DUMP: Dumping /dev/rdisk/c0t0d0s7 (host1:/export/home) to
host2:/dev/rmt/0.
DUMP: Mapping (Pass I) [regular files]
DUMP: Mapping (Pass II) [directories]
DUMP: Estimated 320 blocks (160KB).
DUMP: Dumping (Pass III) [directories]
DUMP: Dumping (Pass IV) [regular files]
DUMP: Tape rewinding
DUMP: 318 blocks (159KB) on 1 volume at 691 KB/sec
DUMP: DUMP IS DONE
DUMP: Level 0 dump on Thu 24 Jan 2002 01:13:55 PM MST
#
```

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Backing Up a File System (Level 1)

In this exercise, you back up an available file system on your system.

### Preparation

This exercise requires a system that is configured with a tape drive and a file system that is available to unmount. This exercise assumes that the `/export/home` file system exists on a separate partition from the `/` (root) file system and can be unmounted. Identify the slice on which the `/export/home` file system resides. Get a tape that is appropriate for your system from the instructor.

### Tasks

Complete the following tasks:

- Use the `mt` command to rewind the tape to the beginning.
- Use the `ufsdump` command to create a tape backup of the `/export/home` file system. Make sure that the `/etc/dumpdates` file is updated.  
(Steps 1–4 in the Level 2 lab)
- Add files and directories to the `/export/home` file system.  
(Steps 5–6 in the Level 2 lab)
- Use the `ufsdump` command to do an incremental backup of the `/export` file system.  
(Steps 7–9 in the Level 2 lab)
- Use the `mt` command to remove the tape from the tape drive.
- Review the `/etc/dumpdates` file.  
(Steps 10–12 in the Level 2 lab)

## Exercise: Backing Up a File System (Level 2)

In this exercise, you back up an available file system on your system.

### Preparation

This exercise requires a system that is configured with a tape drive and a file system that is available to unmount. This exercise assumes that the `/export/home` file system exists on a separate partition from the `/` (root) file system and can be unmounted. Identify the slice on which the `/export/home` file system resides. Get a tape that is appropriate for your system from the instructor.

### Task Summary

In this exercise, you accomplish the following:

- Use the `mt` command to rewind the tape to the beginning.
- Use the `ufsdump` command to create a tape backup of the `/export/home` file system.
- Add files and directories to the `/export/home` file system.
- Use the `ufsdump` command to do an incremental backup of the `/export` file system.
- Use the `mt` command to remove the tape from the tape drive.
- Review the `/etc/dumpdates` file.

### Tasks

Complete the following steps:

1. Unmount the `/export/home` file system. If your system reports that the `/export/home` file system is busy, use the `umount -f` command.
2. Insert a tape into your tape drive.
3. Use the `mt` command to rewind the tape to the beginning.
4. Use the `ufsdump` command to create a backup for the `/export/home` file system. Make sure that the `/etc/dumpdates` file is updated.
5. Mount the `/export/home` file system.



6. Copy the contents of the `/etc/uucp` directory to the `/export/home` directory.
7. Unmount the `/export/home` file system.
8. Move the tape to the next tape record.
9. Use the `ufsdump` command to create an incremental backup for the `/export/home` file system, using a non-rewinding device.
10. Rewind and eject the tape from the tape drive.
11. Set the tape aside for use with subsequent labs.
12. Review the contents of the `/etc/dumpdates` file.

## Exercise: Backing Up a File System (Level 3)

In this exercise, you back up an available file system on your system.

### Preparation

This exercise requires a system that is configured with a tape drive and file system that is available to unmount. This exercise assumes that the `/export/home` file system exists on a separate partition from the `/` (root) file system and can be unmounted. Identify the slice on which the `/export/home` file system resides. Get a tape that is appropriate for your system from the instructor.

### Task Summary

In this exercise, you accomplish the following:

- Use the `mt` command to rewind the tape to the beginning.
- Use the `ufsdump` command to create a tape backup of the `/export/home` file system.
- Add files and directories to the `/export/home` file system.
- Use the `ufsdump` command to do an incremental backup of the `/export` file system.
- Use the `mt` command to remove the tape from the tape drive.
- Review the `/etc/dumpdates` file.

### Tasks and Solutions

Complete the following steps:

1. Unmount the `/export/home` file system. If your system reports that the `/export/home` file system is busy, use the `umount -f` command.

```
# umount /export/home
```

2. Insert a tape into your tape drive.
3. Use the `mt` command to rewind the tape to the beginning.

```
# mt rewind
```

4. Use the `ufsdump` command to create a backup tape for the `/export/home` file system, where `c#t#d#s#` represents. If you cannot remember which device the `/export/home` file system was mounted on, view the contents of the `/etc/vfstab` file with the `more` command.

```
# ufsdump 0uf /dev/rmt/0 /dev/rdisk/c#t#d#s#
```

*You should see output similar to:*

```
ufsdump 0uf /dev/rmt/0 /dev/rdisk/c0d0t0s7
DUMP: Writing 32 Kilobyte records
DUMP: Date of this level 0 dump: Thu 24 Jan 2002 01:06:47 PM MST
DUMP: Date of last level 0 dump: the epoch
DUMP: Dumping /dev/rdisk/c0t0d0s7 (sys43:/export/home) to /dev/rmt/0.
DUMP: Mapping (Pass I) [regular files]
DUMP: Mapping (Pass II) [directories]
DUMP: Estimated 1126 blocks (563KB).
DUMP: Dumping (Pass III) [directories]
DUMP: Dumping (Pass IV) [regular files]
DUMP: Tape rewinding
DUMP: 1086 blocks (543KB) on 1 volume at 1803 KB/sec
DUMP: DUMP IS DONE
DUMP: Level 0 dump on Thu 24 Jan 2002 01:06:47 PM MST
```

5. Mount the `/export/home` file system.

```
# mount /export/home
```

6. Copy the contents of the `/etc/uucp` directory to the `/export/home` directory.

```
# cp -r /etc/uucp /export/home
```

7. Unmount the `/export/home` file system.

```
# umount /export/home
```

8. Move the tape to the next tape record.

```
# mt -f /dev/rmt/0n fsf 1
```

9. Use the `ufsdump` command to create an incremental backup for the `/export/home` file system, using a non-rewinding device.

```
# ufsdump 1uf /dev/rmt/0n /dev/rdisk/c0t0d0s7
```

*You should see output similar to:*

```
ufsdump 1uf /dev/rmt/0n /dev/rdisk/c0t0d0s7
DUMP: Writing 32 Kilobyte records
DUMP: Date of this level 0 dump: Thu 24 Jan 2002 01:13:55 PM MST
DUMP: Date of last level 0 dump: Thu 24 Jan 2002 01:06:47 PM MST
DUMP: Dumping /dev/rdisk/c0t0d0s7 (sys43:/export/home) to /dev/rmt/0.
DUMP: Mapping (Pass I) [regular files]
DUMP: Mapping (Pass II) [directories]
DUMP: Estimated 320 blocks (160KB).
DUMP: Dumping (Pass III) [directories]
DUMP: Dumping (Pass IV) [regular files]
DUMP: 318 blocks (159KB) on 1 volume at 691 KB/sec
DUMP: DUMP IS DONE
DUMP: Level 1 dump on Thu 24 Jan 2002 01:13:55 PM MST
```

10. Rewind and eject the tape from the tape drive.

```
# mt offline
```

11. Set the tape aside for use with subsequent labs.
12. Review the contents of the `/etc/dumpdates` file.

```
# more /etc/dumpdates
```

*You should see one line showing information for the Level 0 dump and another line for the Level 1 dump, for example:*

```
/dev/rdisk/c0t0d0s7      0 Thu Jan 24 13:20:49 2002
/dev/rdisk/c0t0d0s7      1 Thu Jan 24 13:22:06 2002
```

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercise.

- Experiences
- Interpretations
- Conclusions
- Applications



# Performing File System Restores

---

## Objectives

Upon completion of this module, you should be able to:

- Restore ufs file systems
- Explain disaster recovery fundamentals

The following course map shows how this module fits into the current instructional goal.

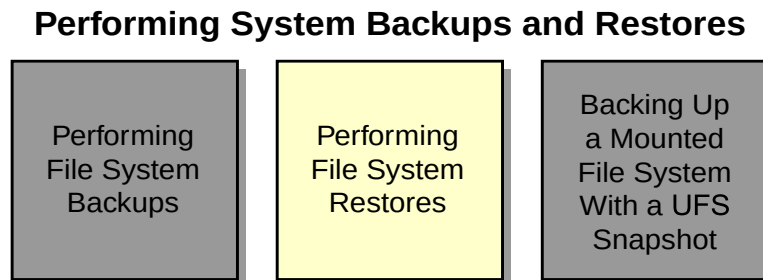


**Figure 16-1** Course Map

## Restoring a ufs File System

You restore a file system to rebuild a damaged file system, to reinstall or upgrade the Solaris OE software, or to reorganize file systems on existing or new disks.

### Restoring a Regular File System

When you are restoring data to a system, consider the following questions:

- Can the system boot on its own (regular file system restore)?
- Do you need to boot the system from CD-ROM (critical file system restore)?
- Do you need to boot the system from CD-ROM and repair the boot drive (special case recovery)?

To restore files or file systems, determine the following:

- The file system backup tapes that are needed
- The device name to which you will restore the file system
- The name of the temporary directory to which you will restore individual files
- The type of backup device to be used (local or remote)
- The backup device name (local or remote)

To restore a regular file system, such as the `/export/home` or `/opt` file system, back up to the disk, you use the `ufsrestore` command. The `ufsrestore` command copies files to the disk, relative to the current working directory, from backup tapes that were created by the `ufsdump` command.

You can use the `ufsrestore` command to reload an entire file system hierarchy from a Level 0 backup and related incremental backups. You can also restore one or more single files from any backup tape.

The format for the `ufsrestore` command is:

`ufsrestore option(s) argument(s) filesystem`



Table 16-1 describes some options that you can use with the `ufsrestore` command.

**Table 16-1** Options for the `ufsrestore` Command

| Option                     | Description                                                                                                |
|----------------------------|------------------------------------------------------------------------------------------------------------|
| <code>t</code>             | Lists the table of contents of the backup media.                                                           |
| <code>r</code>             | Restores the entire file system from the backup media.                                                     |
| <code>x file1 file2</code> | Restores only the files named on the command line.                                                         |
| <code>i</code>             | Invokes an interactive restore.                                                                            |
| <code>v</code>             | Specifies verbose mode. This mode displays the path names to the terminal screen as each file is restored. |
| <code>f device</code>      | Specifies the tape device name.                                                                            |

When you restore an entire file system from a backup tape, the system creates a `restoresymtable` file. The `ufsrestore` command uses the `restoresymtable` file for check-pointing or passing information between incremental restores. You can remove the `restoresymtable` file when the restore is complete.

## Using the `ufsrestore` Command to Restore the `/opt` File System

The following procedure demonstrates how to use the `ufsrestore` command to restore the `/opt` file system on the `c0t0d0s5` slice.

1. Create the new file system structure.

```
# newfs /dev/rdisk/c0t0d0s5
```

2. Mount the file system to the `/opt` directory, and change to that directory.

```
# mount /dev/dsk/c0t0d0s5 /opt
# cd /opt
```

3. Restore the `/opt` file system from the backup tape.

```
# ufsrestore rf /dev/rmt/0
```



**Note** – Always restore a file system by starting with the Level 0 backup tape, continuing with the next-lower-level tape, and continuing through the highest-level tape.

---

4. Remove the `restoresymtable` file.

```
# rm restoresymtable
```

5. Unmount the new file system.

```
# cd /
```

```
# umount /opt
```

6. Use the `fsck` command to check the restored file system.

```
# fsck /dev/rdisk/c0t0d0s5
```

7. Perform a full backup of the file system.

```
# ufsdump 0uf /dev/rmt/0 /dev/rdisk/c0t0d0s5
```



**Note** – Always back up the newly created file system because the `ufsrestore` command repositions the files and changes the inode allocation.

---

## Restoring the /usr File System

To restore the `/usr` file system, boot from the Solaris 9 Software 1 of 2 CD-ROM, and then use the `ufsrestore` command to restore files back to the `/usr` partition.



**Note** – If the `/` (root), `/usr`, or `/var` file systems are unusable because of some type of corruption or damage, the system will not boot.

---

## Using the ufsrestore Command to Restore the /usr File System

The following procedure demonstrates how to restore the /usr file system on Slice 6 of the boot disk.

1. Insert the Solaris 9 Software 1 of 2 CD-ROM, and boot from the CD-ROM with the single-user mode option.

```
ok boot cdrom -s
```

2. Create the new file system structure.

```
# newfs /dev/rdisk/c0t0d0s6
```

3. Mount the file system to the mount point /a, and change to that directory.

```
# mount /dev/dsk/c0t0d0s6 /a
```

```
# cd /a
```

4. Restore the /usr file system from the backup tape.

```
# ufsrestore rf /dev/rmt/0
```



---

**Note** – Remember to restore a file system by starting with the Level 0 backup tape, continuing with the next-lower-level tape, and continuing through the highest-level tape.

---

5. Remove the restoresymtable file.

```
# rm restoresymtable
```

6. Unmount the new file system.

```
# cd /
```

```
# umount /a
```

7. Use the fsck command to check the restored file system.

```
# fsck /dev/rdisk/c0t0d0s6
```

8. Perform a full backup of the file system.

```
# ufsdump 0uf /dev/rmt/0 /dev/rdisk/c0t0d0s6
```

9. Reboot the system.

```
# init 6
```

## Performing a Special Case Recovery of the /(root) File System

You perform a special case recovery to recover the / (root) file system if there is damage to the boot block.

To restore the / (root) file system, boot from the Solaris 9 Software 1 of 2 CD-ROM, and use the `ufsrestore` command.

The following procedure demonstrates how to restore the / (root) file system on Slice 0 of the boot disk.

1. Insert the Solaris 9 Software 1 of 2 CD-ROM, and boot the CD-ROM with the single-user mode option.

```
ok boot cdrom -s
```

2. Create the new file system structure.

```
# newfs /dev/rdisk/c0t0d0s0
```

3. Mount the file system to the mount point /a and change to that directory.

```
# mount /dev/dsk/c0t0d0s0 /a
```

```
# cd /a
```

4. Restore the / (root) file system from the backup tape.

```
# ufsrestore rf /dev/rmt/0
```



---

**Note** – Always restore a file system by starting with the Level 0 backup tape, and continuing with the next-lower-level tape, and continuing through the highest-level tape.

---

5. Remove the `restoresymtable` file.

```
# rm restoresymtable
```

6. Install the bootblk in Sectors 1 through 15 of the boot disk. To do this, change to the directory that contains the bootblk, and enter the installboot command.

```
# cd /usr/platform/`uname -m`/lib/fs/ufs
# installboot bootblk /dev/rdisk/c0t0d0s0
```

7. Unmount the new file system.

```
# cd /
# umount /a
```

8. Use the fsck command to check the restored file system.

```
# fsck /dev/rdisk/c0t0d0s0
```

9. Perform a full backup of the file system.

```
# ufsdump 0uf /dev/rmt/0 /dev/rdisk/c0t0d0s0
```

10. Reboot the system.

```
# init 6
```

## Invoking an Interactive Restore

The `ufsrestore i` command invokes an interactive interface. Through the interface, you can browse the directory hierarchy of the backup tape and select individual files to extract.

### Using the `ufsrestore i` Command

The following procedure demonstrates how to use the `ufsrestore i` command to extract individual files from a backup tape.

1. Become the `root` user, and change to the temporary directory which you want to receive the extracted files.

```
# cd /var/tmp
```

2. Perform the `ufsrestore i` command.

```
# ufsrestore ivf /dev/rmt/0
Verify volume and initialize maps
Media block size is 64
Dump   date: Fri Jan 25 08:38:53 2002
Dumped from: the epoch
Level 0 dump of /export/home on sys43:/dev/dsk/c0t0d0s7
Label: none
Extract directories from tape
Initialize symbol table.
```

3. Display the contents of the directory structure on the backup tape.

```
ufsrestore > ls
```

```
.:
 2 */          13 directory1  15 directory3  11 file2
 2 */          14 directory2  10 file1       12 file3
```

4. Change to the target directory on the backup tape.

```
ufsrestore > cd directory1
```

```
ufsrestore > ls
```

```
./directory1:
3904 ./          2 */          3905 file1      3906 file2      3907 file3
```

5. Add the files you want to restore to the extraction list.

```
ufsrestore > add file1 file2
```

```
Make node ./directory1
```

Files you want to restore are marked with an asterisk (\*) for extraction. If you extract a directory, all of the directory contents are marked for extraction.

In this example, two files are marked for extraction. The `ls` command displays an asterisk in front of the selected file names, `file1` and `file2`.

```
ufsrestore > ls
```

```
./directory1:
3904 */          2 */          3905 *file1     3906 *file2     3907 file3
```

6. To delete a file from the extraction list, use the `delete` command.

```
ufsrestore > delete file1
```

The `ls` command displays the `file1` file without an asterisk.

```
ufsrestore > ls
```

```
./directory1:
3904 */          2 */          3905 file1     3906 *file2     3907 file3
```

7. To view the files and directories marked for extraction, use the `marked` command.

```
ufsrestore > marked
```

```
./directory1:
3904 */          2 */          3906 *file2
```

8. To restore the selected files from the backup tape, perform the `extract` command:

```
ufsrestore > extract
```

```
Extract requested files
```

```
You have not read any volumes yet.
```

```
Unless you know which volume your file(s) are on you should start  
with the last volume and work towards the first.
```

```
Specify next volume #: 1
```



**Note** – The `ufsrestore` command has to find the selected files. If you used more than one tape for the backup, first insert the tape with the highest volume number and type the appropriate number at this point. Then repeat, working towards Volume #1 until all files have been restored.

---

```
extract file ./directory1/file2
Add links
Set directory mode, owner, and times.
set owner/mode for '.'? [yn] n
```



**Note** – Answering `y` sets ownership and permissions of the temporary directory to those of the directory structure on the tape.

---

9. To exit the interactive restore after the files are extracted, perform the command:

```
ufsrestore> quit
```

10. Move the restored files to their original or permanent directory location, and delete the files from the temporary directory.

```
# mv /var/tmp/directory1/file2 /export/home
# rm -r /var/tmp/directory1
```



**Note** – You can use the `help` command in an interactive restore to display a list of available commands.

---

## Performing an Incremental Restore

When performing incremental restores, start with the last volume and work towards the first. The system uses information in the `restoresymtable` file to restore incremental backups on top of the latest full backup.



**Note** – If you perform an incremental restore of data from backup tapes that were written from an active file system, the `ufsrestore` command might become disrupted.

---

The following procedure demonstrates how to restore the /export/home file system from incremental tapes.



---

**Note** – This procedure makes use of the interactive restore to assist in showing the concept of incremental restores. You would typically use a command, such as `ufsrestore rf`, for restoring entire file systems.

---

1. View the contents of the /etc/dumpdates file for information about the /export/home file system.

```
# more /etc/dumpdates |grep c0t0d0s7
/dev/rdisk/c0t0d0s7      0 Mon Jan 28 13:10:12 2002
/dev/rdisk/c0t0d0s7      1 Mon Jan 28 13:12:41 2002
```

2. Create the new file system structure for the /export/home file system.

```
# newfs /dev/rdisk/c0t0d0s7
```

3. Mount the file system and change to that directory.

```
# mount /dev/dsk/c0t0d0s7 /export/home
# cd /export/home
```

4. Insert the Level 0 backup tape.



## 5. Restore the /export/home file system from the backup tapes.

```
# ufsrestore rvf /dev/rmt/0
Verify volume and initialize maps
Media block size is 64
Dump   date: Wed Apr 03 09:55:34 2002
Dumped from: the epoch
Level 0 dump of /export/home on sys41:/dev/dsk/c0t0d0s7
Label: none
Begin level 0 restore
Initialize symbol table.
Extract directories from tape
Calculate extraction list.
Make node ./directory1
Make node ./directory2
Make node ./directory3
Extract new leaves.
Check pointing the restore
extract file ./file1
extract file ./file2
extract file ./file3
Add links
Set directory mode, owner, and times.
Check the symbol table.
Check pointing the restore
#
```

## 6. Load the next lower-level tape into the tape drive.

```
# ufsrestore rvf /dev/rmt/0
Verify volume and initialize maps
Media block size is 64
Dump   date: Wed Apr 03 09:57:30 2002
Dumped from: Wed Apr 03 09:55:34 2002
Level 1 dump of /export/home on sys41:/dev/dsk/c0t0d0s7
Label: none
Begin incremental restore
Initialize symbol table.
Extract directories from tape
Mark entries to be removed.
Calculate node updates.
Make node ./directory4
Make node ./directory5
Make node ./directory6
Find unreferenced names.
Remove old nodes (directories).
Extract new leaves.
Check pointing the restore
```

```
extract file ./file4
extract file ./file5
extract file ./file6
Add links
Set directory mode, owner, and times.
Check the symbol table.
Check pointing the restore
#
```

### Alternative Steps

The following steps are an alternative to the previous Steps 5 and 6.

5. Restore the /export/home file system from the backup tapes. (This example uses an interactive, verbose restore to provide more detailed information.)

```
# ufsrestore iv /dev/rmt/0
Verify volume and initialize maps
Media block size is 64
Dump   date: Mon Jan 28 13:10:12 2002
Dumped from: the epoch
Level 0 dump of /export/home on sys41:/dev/dsk/c0t0d0s7
Label: none
Extract directories from tape
Initialize symbol table.
ufsrestore > ls
.:
    2 *./                8 directory2          5 file2
    2 *../              9 directory3          6 file3
    7 directory1         4 file1               3 lost+found/
```

The system lists files from the last Level 0 backup.

```
ufsrestore > add *
Warning: ./lost+found: File exists
ufsrestore > extract
Extract requested files
You have not read any volumes yet.
Unless you know which volume your file(s) are on you should start
with the last volume and work towards the first.
Specify next volume #: 1
extract file ./file1
extract file ./file2
extract file ./file3
extract file ./directory1
extract file ./directory2
extract file ./directory3
```

Add links

Set directory mode, owner, and times.

set owner/mode for '.'? [yn] **n**

Directories already exist, set modes anyway? [yn] **n**

ufsrestore > **q**

#

6. The information in the /etc/dumpdates file shows an incremental backup that was taken after the Level 0 backup. Load the next tape and perform the incremental restore.

# **ufsrestore iv**

Verify volume and initialize maps

Media block size is 64

Dump date: Mon Jan 28 13:12:41 2002

Dumped from: Mon Jan 28 13:10:12 2002

Level 1 dump of /export/home on sys41:/dev/dsk/c0t0d0s7

Label: none

Extract directories from tape

Initialize symbol table.

ufsrestore > **ls**

..:

|      |               |               |          |
|------|---------------|---------------|----------|
| 2 */ | 13 directory4 | 15 directory6 | 11 file5 |
| 2 */ | 14 directory5 | 10 file4      | 12 file6 |

ufsrestore > **add \***

ufsrestore > **extract**

Extract requested files

You have not read any volumes yet.

Unless you know which volume your file(s) are on you should start with the last volume and work towards the first.

Specify next volume #: **1**

extract file ./file4

extract file ./file5

extract file ./file6

extract file ./directory4

extract file ./directory5

extract file ./directory6

Add links

Set directory mode, owner, and times.

set owner/mode for '.'? [yn] **n**

ufsrestore > **q**

#

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Recovering Backup Files and File Systems (Level 1)

In this exercise, you read the backup tape from the previous exercise. You back up the / (root) file system, restore a single file from tape, and destroy and restore the / (root) file system.

### Preparation

This exercise requires a system that is configured with a tape drive and a / (root) file system that is separate from the /usr and /var file systems. Identify the slice that holds the / (root) file system. From your instructor, get a tape appropriate for your system.

### Tasks

Complete the following:

- Read the contents of both `ufsdump` files on the backup tape written in the previous exercise.  
(Steps 1–3 in Task 1 of the Level 2 lab)
- Reboot the system to run level S. Use the `ufsdump` command to create a backup tape of the / (root) file system on your system. Verify that the tape contains valid data for this file system. Allow the system to continue to boot to run level 3.  
(Steps 1–5 in Task 2 of the Level 2 lab)
- Use the `ufsrestore i` command to restore the `/etc/inet/hosts` file from tape, and place it below the `/var/tmp` directory.  
(Steps 1–6 in Task 3 of the Level 2 lab)
- Remove the `/kernel`, `/platform`, and `/devices` directories recursively. Abort the operating system, and attempt to boot the system from disk. Record what happens. Boot the system from the Solaris 9 Software 1 of 2 CD-ROM to run level S. Create a new file system on the / (root) slice. Use the `ufsrestore` command to reload the / (root) file system. Install a new boot block. Reboot the system, and eject the CD-ROM.  
(Steps 1–11 in Task 4 of the Level 2 lab)

## Exercise: Recovering Backup Files and File Systems (Level 2)

In this exercise, you read the backup tape from the previous exercise. You back up the / (root) file system, restore a single file from tape, and destroy and restore the / (root) file system.

### Preparation

This exercise requires a system that is configured with a tape drive and a / (root) file system that is separate from the /usr and /var file systems. Identify the slice that holds the / (root) file system. From the instructor, get a tape appropriate for your system.

### Task Summary

In this exercise, you accomplish the following:

- Read the contents of both `ufsdump` files on the backup tape written in the previous exercise.
- Reboot the system to run level S. Use the `ufsdump` command to create a backup tape of the / (root) file system on your system. Verify that the tape contains valid data for this file system. Allow the system to continue to boot to run level 3.
- Use the `ufsrestore i` command to restore the `/etc/inet/hosts` file from tape, and place it below the `/var/tmp` directory.
- Remove the `/kernel`, `/platform`, and `/devices` directories recursively. Abort the operating system, and attempt to boot the system from disk. Record what happens. Boot the system from the Solaris 9 OE Software 1 of 2 CD-ROM to run level S. Create a new file system on the / (root) slice. Use the `ufsrestore` command to reload the / (root) file system. Install a new boot block. Reboot the system, and eject the CD-ROM.

## Tasks

Complete the following tasks.

### Task 1 – Read Your Previous Backup Tape

Complete the following steps:

1. Locate the backup tape written in the previous exercise, and load it into your tape drive.
2. Use the interactive restore command to view the contents of the first Level 0 backup tape. Verify that the files are from the `/export/home` directory that you backed up. Enter **q** to quit the interactive restore.
3. Using a non-rewind device, move the tape to the next record, and view the contents of the second, incremental backup. Verify that the files you see are from the incremental backup. (The `uucp` directory is the one you added after the Level 0 backup.)

### Task 2 – Create a Backup of the / (root) File System

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Shut down the system to run level 0. Then, boot the system to run level S. Supply the `root` password as required to enter run level S.
2. Verify that a tape is in your tape drive.
3. Use the `ufsdump` command to create a backup tape for the / (root) file system.
4. Verify that the / (root) file system is on the tape.
5. Allow the system to continue to boot to run level 3.

### Task 3 – Restore the /etc/inet/hosts File From a Tape

Complete the following steps:

1. Log in as the `root` user, and open a terminal window. Change to the `/var/tmp` directory.
2. Enter the `ufsrestore i` command to retrieve the `/etc/inet/hosts` file from the tape.
3. Change to the `/etc/inet` directory on the tape, and list the files in the directory.

4. Add the `hosts` file to the list of files to extract, and display the list.
5. Extract the `hosts` file from tape. Specify volume number 1. Do not set the owner and mode for `.`, and then quit the `ufsrestore` command.
6. Verify that the `etc/inet/hosts` file exists below the `/var/tmp` directory.

## Task 4 – Destroy and Restore the / (root) File System

Complete the following steps:

1. Change to the `/` (root) directory, and remove the following critical system directories and their contents: `/kernel`, `/platform`, and `/devices`.
2. Press the Stop-A key sequence to abort the operating system. Attempt to boot the system from the boot disk.  
What happens?
3. Insert the Solaris 9 Software 1 of 2 CD-ROM. Boot the system from the CD-ROM to run level S.
4. Use the `newfs` command to create a new file system on the `/` (root) slice. (The slice should match the one you used earlier in the exercise when you created a backup of the `/` (root) file system.) Run the `fsck` command on the file system that you create.
5. Verify that your `root` backup tape is in the tape drive. Mount the new file system as the `/a` file system. Change to the `/a` directory.
6. Use the `ufsrestore` command to load the `/` (root) data into the new file system.
7. Remove the `restoresymtable` file.
8. Install a new boot block in Sectors 1 through 15 of the `/` (root) slice, by changing to the directory containing the boot block and entering the `installboot` command.

```
# cd /usr/platform/`uname -m`/lib/fs/ufs
# installboot bootblk /dev/rdisk/c0t0d0s0
```

9. Change to the `/` (root) directory, and unmount the new file system.
10. Reboot the system.
11. Log in as the `root` user, and open a terminal window. Eject the Solaris 9 Software 1 of 2 CD-ROM.



## Exercise: Recovering Backup Files and File Systems (Level 3)

In this exercise, you read the backup tape from the previous exercise. You back up the / (root) file system, restore a single file from tape, and destroy and restore the / (root) file system.

### Preparation

This exercise requires a system that is configured with a tape drive and a / (root) file system that is separate from the /usr and /var file systems. Identify the slice that holds the / (root) file system. From the instructor get a tape appropriate for your system.

### Task Summary

In this exercise, you accomplish the following:

- Read the contents of both `ufsdump` files on the backup tape written in the previous exercise.
- Reboot the system to run level S. Use the `ufsdump` command to create a backup tape of the / (root) file system on your system. Verify that the tape contains valid data for this file system. Allow the system to continue to boot to run level 3.
- Use the `ufsrestore i` command to restore the `/etc/inet/hosts` file from tape, and place it below the `/var/tmp` directory.
- Remove the `/kernel`, `/platform`, and `/devices` directories recursively. Abort the operating system, and attempt to boot the system from disk. Record what happens. Boot the system from the Solaris 9 Software 1 of 2 CD-ROM to run level S. Create a new file system on the / (root) slice. Use the `ufsrestore` command to reload the / (root) file system. Install a new boot block. Reboot the system, and eject the CD-ROM.

## Tasks and Solutions

Complete the following tasks.

### Task 1 – Read Your Previous Backup Tape

Complete the following steps:

1. Locate the backup tape written in the previous exercise, and load it into your tape drive.
2. Use the interactive restore command to view the contents of the first Level 0 backup tape. Verify that the files are from the /export/home directory that you backed up. Enter **q** to quit the interactive restore.

```
# ufsrestore iv
Verify volume and initialize maps
Media block size is 64
Dump   date: Fri Jan 25 08:38:53 2002
Dumped from: the epoch
Level 0 dump of /export/home on sys43:/dev/dsk/c0t0d0s7
Label: none
Extract directories from tape
Initialize symbol table.
ufsrestore > ls
.:
  2 */              3712 default/          6 file3
  2 */              4  file1              3 lost+found/
  7 core            5  file2
```

*You should see the files from your /export/home directory.*

```
ufsrestore > quit
```

- Using a non-rewind device, move the tape to the next record, and view the contents of the second, incremental backup. Verify that the files you see are from the incremental backup. (The uucp directory is the one you added after the Level 0 backup.)

```
# mt -f /dev/rmt/0n fsf 1
# ufsrestore ivf /dev/rmt/0
Verify volume and initialize maps
Media block size is 64
Dump   date: Fri Jan 25 08:41:12 2002
Dumped from: Fri Jan 25 08:38:53 2002
Level 1 dump of /export/home on sys43:/dev/dsk/c0t0d0s7
Label: none
Extract directories from tape
Initialize symbol table.
ufsrestore > ls
.:
    2 *.*/          2 *.*./          7424  uucp/
```

## Task 2 – Create a Backup of the / (root) File System

Complete the following steps:

- Log in as the root user, and open a terminal window. Shut down the system to run level 0. Then boot the system to run level S. Supply the root password as required to enter run level S.

```
# init 0
(shutdown messages)
ok boot -s
```

- Verify that a tape is in your tape drive.
- Use the `ufsdump` command to create a backup tape for the / (root) file system.

```
# ufsdump 0uf /dev/rmt/0 /dev/rdisk/c0t0d0s0
```

- Verify that the / (root) file system is on the tape.

```
# ufsrestore tvf /dev/rmt/0
```

*The screen should scroll directory structures under / (root) first, followed by files.*

- Allow the system to continue to boot to run level 3.

```
# <Control-D>
```

### Task 3 – Restore the /etc/inet/hosts File From a Tape

Complete the following steps:

1. Log in as the **root** user, and open a terminal window. Change to the **/var/tmp** directory.

```
# cd /var/tmp
```

2. Enter the **ufsrestore i** command to retrieve the **/etc/inet/hosts** file from the tape.

```
# ufsrestore if /dev/rmt/0
```

```
ufsrestore > ls
```

*You should see files and directories for the / (root) file system.*

3. Change to the **/etc/inet** directory on the tape, and list the files in the directory.

```
ufsrestore > cd /etc/inet
```

```
ufsrestore > ls
```

*You should see files and directories for the /etc/inet file system.*

4. Add the **hosts** file to the list of files to extract, and display the list.

```
ufsrestore > add hosts
```

```
ufsrestore > marked
```

*You should see the hosts file listed.*

5. Extract the **hosts** file from tape. Specify volume number 1. Do not set the owner and mode for **.**, and then quit the **ufsrestore** command.

```
ufsrestore > extract
```

```
Extract requested files
```

```
You have not read any volumes yet.
```

```
Unless you know which volume your file(s) are on you should start  
with the last volume and work towards the first.
```

```
Specify next volume #: 1
```

```
set owner/mode for '.'? [yn] n
```

```
ufsrestore > q
```

6. Verify that the **etc/inet/hosts** file exists below the **/var/tmp** directory.

```
# ls etc/inet/hosts
```

```
etc/inet/hosts
```

## Task 4 – Destroy and Restore the / (root) File System

Complete the following steps:

1. Change to the / (root) directory, and remove the following critical system directories and their contents: /kernel, /platform, and /devices.

```
# cd /
# rm -r /kernel /platform /devices
```

2. Press the Stop-A key sequence to abort the operating system. Attempt to boot the system from the boot disk.

ok boot

What happens?

*The system fails to boot and displays the message:*

Boot load failed.

The file just loaded does not appear to be executable

3. Insert the Solaris 9 Software 1 of 2 CD-ROM. Boot the system from the CD-ROM to run level S.

ok boot cdrom -s

4. Run the newfs command to create a new file system on the / (root) slice. (The slice should match the one you used earlier in the exercise when you created a backup of the / (root) file system.) Enter the fsck command on the file system that you create.

```
# newfs /dev/rdsk/c0t0d0s0
# fsck /dev/rdsk/c0t0d0s0
```

5. Verify that your root backup tape is in the tape drive. Mount the new file system as the /a file system. Change to the /a directory.

```
# mount /dev/dsk/c0t0d0s0 /a
# cd /a
```

6. Use the ufsrestore command to load the / (root) data into the new file system.

```
# ufsrestore rf /dev/rmt/0
```

7. Remove the restoresymtable file.

```
# rm restoresymtable
```

8. Install a new boot block in Sectors 1 through 15 of the / (root) slice, by changing to the directory containing the boot block and entering the installboot command.

```
# cd /usr/platform/`uname -m`/lib/fs/ufs
# installboot bootblk /dev/rdsk/c0t0d0s0
```

9. Change to the / (root) directory, and unmount the new file system.

```
# cd /  
# umount /a
```

10. Reboot the system.

```
# init 6
```

11. Log in as the root user, and open a terminal window. Eject the Solaris 9 Software 1 of 2 CD-ROM.

```
# eject cdrom
```

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

## Introducing Disaster Recovery Fundamentals

This section introduces some basic concepts and criteria for the planning and anticipation of a disaster. Understanding what disaster recovery is should be the first step you take toward defining and implementing a disaster recovery plan.

Identifying the fundamentals of a disaster recovery plan start with defining what a disaster is. In most cases, it can be defined as follows: any unplanned, extended loss of critical business applications due to a lack of computer processing capabilities. In this definition, extended is defined by the individual business at hand. Some businesses might suffer severe losses in one hour while other businesses might not suffer severe losses.

### Disaster Scenarios That Can Result in a Loss of Data

Disasters, both natural and man-made, happen every day. For example, flooding in Chicago might disrupt operations in 400 data centers in Chicago or all over the United States, or a hurricane could disable the reservation system of a major airline. A major storm could interrupt power to a geographic area for an extended period of time. A fire could destroy business critical infrastructure.

Many scenarios could involve the loss of major components of a business-critical system or systems. You have many reasons to consider having a well-thought-out disaster recovery plan in place. The most important reasons might be the ones you cannot think of.

### Disaster Recovery Plan

No single document can present a comprehensive analysis of how to prepare a disaster recovery plan. However, this section describes some of the key steps to create a plan.



## Solicit Department Input

Gather input from the departments within your company. Individuals in these departments know the type of data they create and the importance of the data. If you work at a large company, you might organize a planning team so that the team can inform management on the status of the disaster recovery program. Departments might be tasked to complete periodic tests to verify implementation of the disaster recovery program. The departments can present any findings of gaps or risks they encounter.

## Acquire Management Approval

Involve management early in the decision-making process. This is an important step if you are to obtain the necessary resources and time required from each area of your organization.

You, or your planning team, should complete a study of the disaster recovery plan and include an estimate of the cost of a disaster, as well as an estimate of the possible costs and time to implement a disaster recovery strategy. When management understands the financial, physical, and business costs associated with a disaster, the planning team is able to build a strategy and ensure that the strategy is implemented across the organization.

## Develop a Budget

Cost-justifying a disaster recovery program is relatively simple. No competitive organization can afford to be without a comprehensive program. In developing a budget for your program, you should consider the following:

- Your current cost of downtime
  - Look at both the total cost per minute as well as the cost per event, and include the intangible or *soft-dollar* costs, such as loss of productivity and diminished customer confidence.
- The cost of re-creating data
  - Consider the time lost re-creating files, the expense of retrieving data from crashed hard disks, the cost of unavailable data when you need it, and the additional costs involved in re-creating lost data when there is no backup copy available.
- The cost of expert assistance
  - Compared to the costs of downtime, the costs of hiring experts to assist with the disaster recovery program are minimal.

### Evaluating the Critical Factors for the Plan

Creating the actual disaster recovery plan varies from one company to another. Every company must first evaluate the following critical factors for a disaster recovery plan:

- What is the greatest risk?  
Is your company most susceptible to natural events, such as earthquakes, fires, or floods; mechanical failures, such as hardware and software problems; human error; or intrusions, such as hacker attacks and viruses?
- How are various groups or departments within your company affected by downtime?
  - For each group, how vital is access to data?
  - How long could each group or department function without access to data?
  - Is the hardware and data all centrally located, or are there alternative sites or departments that can provide the resources lost in the event of a disaster?
- What preventative measures are in place right now?
  - Is there a disaster team?
  - Have you defined a backup strategy?
  - Where is the most valuable data stored, and is it adequately protected?
  - Have you documented inventory with schematics, specifications, passwords, menus, utilities, and startup files?
  - Do your facilities have backup data lines and connections?
- How can you recover your data?
  - Who is in charge of managing this process?
  - Is there a communication procedure?
  - Could you recover your data at a different facility or geographical area, or with different personnel?
  - Do you have the need for a hotsite? If so, do you establish the hotsite or use a hotsite vendor?
  - How long would it take to fix your existing facility under various disaster scenarios?

- Should you out-source the data recovery process to a third-party company?
- Do you have emergency contacts with your suppliers?
- What are the approval procedures for emergency planning?
- What happens if you cannot reach key personnel?

### Create a Procedure

After you have analyzed the previous choices, you are ready to establish the actual procedures that you must follow in the event of a disaster. The procedures must:

- Define how to handle various aspects of the network, including loss of servers, bridges and routers, communications links, and so on
- Specify who arranges for repairs or reconstruction and how the data recovery process occurs
- Include a checklist or test procedure to verify that everything works when the repairs and data recovery have taken place

### Test the Procedure

You must test the plan—not just once, but often. You should determine how frequently you test the plan, by considering the following factors:

- Personnel changes
- System changes
- Network changes

You must measure the success of each test. You must define the objective measurements to verify that your plan is effective.

### Keep Pace With Changes

Change is the only constant in the corporate world, and it is important that your disaster recovery plan takes into account the impact of change. Consider the following:

- Are there processes in place to include new departments and facilities in the disaster recovery plan?
- Is there a regularly scheduled review of the plan?

- Who maintains the disaster management team roster?
- Could someone new execute the plan?
- How do you communicate changes or modifications to the plan to people who are affected by the changes?

## Importance of Off-Site Backups

Having a comprehensive and quality backup program is vital to a good disaster recovery plan. The value of backed-up data depends on the security and physical protection of that media.

Many scenarios can account for data loss or corruption. These scenarios fall short of what is typically considered a disaster. In some instances, you might need to recover data lost due to human error or a minor hardware failure. To recover from data corruption you need to gain quick access to backup media, such as tape.

Many Information Technology (IT) providers keep a local copy of their backups and send a tested copy of the same backups to an off-site storage service provider. Off-site storage gives you the opportunity to keep an integrity-tested copy of all your data in a safe location away from the site of business. Off-site providers store your backups in a disaster-ready environment. These sites usually are built to protect your backups from most known disaster scenarios, such as fire, flood, theft, and so on. Without an off-site storage solution, you could place even the most comprehensive disaster recovery program at great risk.

## Components Required to Operate a Hotsite

You might decide that there is sufficient need and business justification to implement a hotsite as part of your disaster recovery plan. A hotsite is a virtual replication of your critical business computer operations. A hotsite is also known as a disaster recovery site.

If the cost of establishing a hotsite is too high, you can use commercial hotsite vendors. Some disaster recovery vendors offer a variety of options. In a hotsite environment you might get pre-installed computers, networking equipment, telecommunications equipment, raised flooring, air conditioning, technical support, and uninterruptable power supplies.

## Importance of Disaster Recovery Drills

As part of a comprehensive disaster recovery plan, testing is one of the most critical steps. After successfully testing your disaster recovery plan, you must continue to test your plan on a regular basis through disaster recovery drills.

Conducting disaster recovery drills allows you the opportunity to adjust and update your disaster recovery plan as needed. You have the opportunity to account for personnel changes, system changes, application changes, and so on.

Conducting disaster recovery drills on a regular basis also keeps the importance of disaster recovery as a priority in your every day computer operations. The more you practice for disaster recovery scenarios, the quicker you are able to recover, saving more of your customer base and your business earnings.



# Backing Up a Mounted File System With a UFS Snapshot

---

## Objectives

Upon completion of this module, you should be able to:

- Create a UFS snapshot
- Back up the snapshot file

The following course map shows how this module fits into the current instructional goal.

### Performing System Backups and Restores

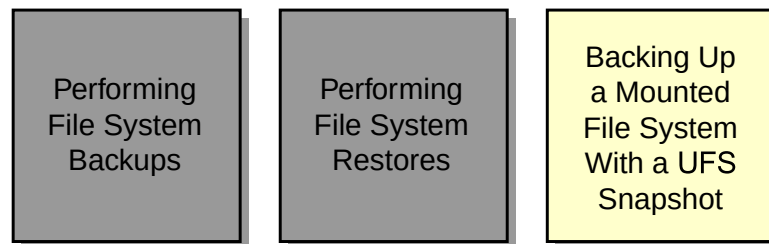


**Figure 17-1** Course Map

## Creating a UFS Snapshot

The UFS Copy on Write Snapshots feature provides administrators of non-enterprise-level systems an online backup solution for ufs file systems. This utility enables you to create a point-in-time copy of a ufs file system, called a snapshot, as an online backup. You can create the backup while the file system is mounted and the system is in multiuser mode.



---

**Note** – The UFS snapshots are similar to the Instant Image product. Instant Image allocates space equal to the size of the entire file system that is being captured. However, the file system data saved by UFS snapshots occupies only as much disk space as needed.

---

## Using the fssnap Command

You use the `fssnap` command to create, query, or delete temporary read-only snapshots of ufs file systems.

The format for the `fssnap` command is:

```
/usr/sbin/fssnap -F FSType -V -o special_option(s) mount-point | special
```



Table 17-1 shows some of the options for the `fssnap` command.

**Table 17-1** Options for the `fssnap` Command

| Option                        | Description                                                                                                                                                                                                                                                                                                                |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>-d</code>               | Deletes the snapshot associated with the given file system. If the <code>-o unlink</code> option was used when you built the snapshot, the backing-store file is deleted together with the snapshot. Otherwise, the backing-store file (which contains file system data) occupies disk space until you delete it manually. |
| <code>-F <i>FSType</i></code> | Specifies the file system type to be used.                                                                                                                                                                                                                                                                                 |
| <code>-i</code>               | Displays the state of an <i>FSType</i> snapshot.                                                                                                                                                                                                                                                                           |
| <code>-V</code>               | Echoes the complete command line but does not execute the command.                                                                                                                                                                                                                                                         |
| <code>-o</code>               | Enables you to use <i>special_options</i> , such as the location and size of the backing-store (bs) file.                                                                                                                                                                                                                  |

To create a UFS snapshot, specify a backing-store path and the actual file system to be captured. The following is the command format:

```
# fssnap -F ufs -o bs=backing_store_path /file-system
```



**Note** – The *backing\_store\_path* can be a raw device, the name of an existing directory, or the name of a file that does not already exist.

The following example uses the `fssnap` command to create a snapshot of the `/export/home` file system.

```
# fssnap -F ufs -o bs=/var/tmp /export/home
/dev/fssnap/0
```

The snapshot subsystem saves file system data in a file called a backing-store file before the data is overwritten. Some important aspects of a backing-store file are:

- A backing-store file is a bit-mapped file that takes up disk space until you delete the UFS snapshot.
- The size of the backing-store file varies with the amount of activity on the file system being captured.
- The destination path that you specify on the `fssnap` command line must have enough free space to hold the backing-store file.

- The location of the backing-store file must be different from that of the file system you want to capture in a UFS snapshot.
- A backing-store file can reside on different types of file systems, including another ufs file system or a mounted nfs file system.

The `fssnap` command creates the backing-store file and two read-only virtual devices. The block virtual device, `/dev/fssnap/0`, can be mounted as a read-only file system. The raw virtual device, `/dev/rfssnap/0`, can be used for raw read-only access to a file system.

These virtual devices can be backed up with any of the existing Solaris OE backup commands. The backup created from a virtual device is a backup of the original file system when the UFS snapshot was taken.



---

**Note** – When a UFS snapshot is first created, the file system locks temporarily. Users might notice a slight pause when writing to this file system. The length of the pause increases with the size of the file system. There is no performance impact when users are reading from the file system.

---

## Limiting the Size of the Backing-Store File

Before creating a UFS snapshot, use the `df -k` command to check that the backing-store file has enough disk space to grow. The size of the backing-store file depends on how much data has changed since the previous snapshot was taken.

You can limit the size of the backing-store file by using the `-o maxsize=n` option of the `fssnap` command, where *n* (k, m, or g) is the maximum size of the backing-store file specified in Kbytes, Mbytes, or Gbytes.

Additionally, you can place a minimum size on the backing-store file by using the `-o minsize=n` option with the `fssnap` command.



---

**Caution** – If the backing-store file runs out of disk space, the system automatically deletes the UFS snapshot, which causes the backup to fail. The active ufs file system is not affected. Check the `/var/adm/messages` file for possible UFS snapshot errors.

---



**Note** – You can force an unmount of an active ufs file system, for which a snapshot exists (for example, with the `umount -f` command). This action deletes the appropriate snapshot automatically.

The following example creates a snapshot of the `/export/home` file system, and limits the backing-store file to 500 Mbytes.

```
# fssnap -F ufs -o bs=/var/tmp,maxsize=500m /export/home
/dev/fssnap/0
```

## Displaying Information for a ufs File System Snapshot

You can use either `fssnap` command to display UFS snapshot information.

The following example displays a list of all the current UFS snapshots on the system. The list also displays the corresponding virtual device for each snapshot.

```
# fssnap -i
0    /export/home
1    /usr
2    /database
```

You use the `-i` option to the `/usr/lib/fs/ufs/fssnap` command to display detailed information for a specific UFS snapshot that was created by the `fssnap` command.

The following example shows the details for the `/export/home` snapshot.

```
# /usr/lib/fs/ufs/fssnap -i /export/home
Snapshot number      : 0
Block Device         : /dev/fssnap/0
Raw Device           : /dev/rfssnap/0
Mount point          : /export/home
Device state         : idle
Backing store path    : /var/tmp/snapshot0
Backing store size    : 0 KB
Maximum backing store size : 512000 KB
Snapshot create time  : Mon Apr 22 08:58:33 2002
Copy-on-write granularity : 32 KB
```

## Backing Up the UFS Snapshot File

The virtual devices that contain the UFS snapshot act as standard read-only devices, which enable you to back up the virtual device in the same manner as you would back up a file system.

### Performing a Backup of a UFS Snapshot

You can use the `tar` command or the `ufsdump` command to back up a UFS snapshot.

#### Using the `tar` Command to Back Up a Snapshot File

If you use the `tar` command to back up the UFS snapshot, mount the snapshot before backing it up. The following procedure demonstrates how to do this type of mount.

1. Create the mount point for the block virtual device.

```
# mkdir -p /backups/home.bkup
```

2. Mount the block virtual device to the mount point.

```
# mount -F ufs -o ro /dev/fssnap/0 /backups/home.bkup
```

3. Change directory to the mount point.

```
# cd /backups/home.bkup
```

4. Use the `tar` command to write the data to tape.

```
# tar cvf /dev/rmt/0 .
```

#### Using the `ufsdump` Command

If you use the `ufsdump` command to back up a UFS snapshot, you can specify the raw virtual device during the backup.

```
# ufsdump 0uf /dev/rmt/0 /dev/rfssnap/0
```

Verify that the UFS snapshot is backed up.

```
# ufsrestore tf /dev/rmt/0
```

## Performing an Incremental Backup of a UFS Snapshot

Incremental snapshots contain files that have been modified since the last UFS snapshot. You use the `ufsdump` command with the `N` option to create an incremental UFS snapshot, which writes the name of the device being backed up, rather than the name of the snapshot device to the `/etc/dumpdates` file.

The following example shows how to use the `ufsdump` command to create an incremental backup of a file system.

```
# ufsdump 1ufN /dev/rmt/0 /dev/rdisk/c0t1d0s0 /dev/rfssnap/0
```

Next you would verify that the UFS snapshot is backed up to tape.

```
# ufsrestore tf /dev/rmt/0
```

To understand incremental backups of snapshots, consider the following demonstration:

1. Create a snapshot of the `/extra` file system that is going to be backed up while the file system is mounted.

```
# fssnap -o bs=/var/tmp /extra
/dev/fssnap/0
#
```

2. Verify that the snapshot was successful, and view detailed information about the snapshot.

```
# fssnap -i
    0      /extra
# /usr/lib/fs/ufs/fssnap -i /extra
Snapshot number      : 0
Block Device         : /dev/fssnap/0
Raw Device           : /dev/rfssnap/0
Mount point          : /extra
Device state         : idle
Backing store path    : /var/tmp/snapshot0
Backing store size    : 0 KB
Maximum backing store size : Unlimited
Snapshot create time  : Thu Apr 04 10:34:21 2002
Copy-on-write granularity : 32 KB
```

3. Make a directory that will be used to mount and view the snapshot data.

```
# mkdir /extrasnap
#
```

4. Mount the snapshot to the new mount point, and compare the size of the file system and the snapshot device.

```
# mount -o ro /dev/fssnap/0 /extrasnap
# df -k |grep extra
/dev/dsk/c1t0d0s0      1294023          9 1242254      1%    /extra
/dev/fssnap/0          1294023          9 1242254      1%    /extrasnap
```

5. Edit a file under the /extra directory and make it larger, and then compare the size of the file system and the snapshot device.

```
# vi file1
(yank and put text, or read text in from another file)
# df -k |grep extra
/dev/dsk/c1t0d0s0      1294023         20 1242243      1%    /extra
/dev/fssnap/0          1294023          9 1242254      1%    /extrasnap
```

Observe that the file system grew in size while the snapshot file did not.

6. Perform a full backup with the N option of the `ufsdump` command.

```
# ufsdump 0ufN /dev/rmt/0 /dev/dsk/c1t0d0s0 /dev/ufssnap/0
DUMP: Writing 32 Kilobyte records
DUMP: Date of this level 0 dump: Thu 04 Apr 2002 10:49:38 AM MST
DUMP: Date of last level 0 dump: the epoch
DUMP: Dumping /dev/ufssnap/0 (sys41:/extrasnap) to /dev/rmt/0.
DUMP: Mapping (Pass I) [regular files]
DUMP: Mapping (Pass II) [directories]
DUMP: Estimated 262 blocks (131KB).
DUMP: Dumping (Pass III) [directories]
DUMP: Dumping (Pass IV) [regular files]
DUMP: Tape rewinding
DUMP: 254 blocks (127KB) on 1 volume at 1814 KB/sec
DUMP: DUMP IS DONE
DUMP: Level 0 dump on Thu 04 Apr 2002 10:49:38 AM MST
```

7. Verify the backup.

```
# ufsrestore tf /dev/rmt/0
2      .
3      ./file1
4      ./file2
5      ./file3
6      ./file4
#
```

8. Unmount the back up device and remove the snapshot.

```
# umount /extrasnap
# fssnap -d /extra
# rm /var/tmp/snapshot0
#
```

9. Make some changes to the /extra file system, such as copying some files, and then re-create the snapshot.

```
# cp file1 file5
# cp file1 file6
# fssnap -o bs=/var/tmp /extra
/dev/fssnap/0
#
```

10. Re-mount the snapshot device, and compare the size of the file system and the snapshot device.

```
# mount -o ro /dev/fssnap/0 /extrasnap
# df -k |grep extra
/dev/dsk/c1t0d0s0      1294023      46 1242217      1%      /extra
/dev/fssnap/0         1294023      46 1242217      1%      /extrasnap
#
```

11. Perform an incremental backup with the N option of the ufsdump command.

```
# ufsdump 1ufN /dev/rmt/0 /dev/rdisk/c1t0d0s0 /dev/rfssnap/0
DUMP: Writing 32 Kilobyte records
DUMP: Date of this level 1 dump: Thu 04 Apr 2002 10:59:11 AM MST
DUMP: Date of last level 0 dump: Thu 04 Apr 2002 10:49:38 AM MST
DUMP: Dumping /dev/rfssnap/0 (sys41:/extrasnap) to /dev/rmt/0.
DUMP: Mapping (Pass I) [regular files]
DUMP: Mapping (Pass II) [directories]
DUMP: Estimated 294 blocks (147KB).
DUMP: Dumping (Pass III) [directories]
DUMP: Dumping (Pass IV) [regular files]
DUMP: Tape rewinding
DUMP: 254 blocks (127KB) on 1 volume at 1693 KB/sec
DUMP: DUMP IS DONE
DUMP: Level 1 dump on Thu 04 Apr 2002 10:59:11 AM MST
#
```

12. Verify the backup.

```
# ufsrestore tf /dev/rmt/0
2      .
7      ./file5
8      ./file6
#
```

Notice that the backup of the snapshot contains only the files that were added since the previous Level 0 backup.

## Restoring Data From a UFS Snapshot Backup

The backup created from a virtual device is a backup of the original file system when the UFS snapshot was taken.

You restore a UFS snapshot from a backup tape in the same manner as you would the backup of an original file system.

To restore the `demo` directory from the snapshot backup of the `/usr` file system, complete the following steps:

1. Load the tape that contains the snapshot backup of the `/usr` file system into the tape drive.
2. Change to the `/usr` file system.

```
# cd /usr
```

3. Perform the `ufsrestore` command.

```
# ufsrestore if /dev/rmt/0
ufsrestore > add demo
ufsrestore > extract
Specify next volume #: 1
set owner/mode for './'? [yn] n
ufsrestore > quit
```

4. Verify that the `demo` directory exists, and eject the tape.



## Deleting a UFS Snapshot

Deleting a UFS snapshot from the system is a multistep process and order-dependant. First, unmount the snapshot device, and then delete the snapshot. Finally, remove the backing-store file.

```
# umount /dev/fssnap/0  
# fssnap -d /export/home  
# rm /backing_store_file
```

## Performing the Exercises

You have the option to complete any one of three versions of a lab. To decide which to choose, consult the following descriptions of the levels:

- Level 1 – This version of the lab provides the least amount of guidance. Each bulleted paragraph provides a task description, but you must determine your own way of accomplishing each task.
- Level 2 – This version of the lab provides more guidance. Although each step describes what you should do, you must determine the commands (and options) to input.
- Level 3 – This version of the lab is the easiest to accomplish because each step provides exactly what you should input to the system. This level also includes the task solutions for all three levels.

## Exercise: Working With UFS Snapshots (Level 1)

In this exercise, you create a UFS snapshot of the `/opt` file system, display detailed information for the UFS snapshot, and then remove the snapshot and backing-store file.

### Tasks

Complete the following tasks:

- Create a snapshot of the `/opt` file system
- View the contents of the backing-store directory
- Display detailed information about the snapshot
- Remove the snapshot from the system

## Exercise: Working With UFS Snapshots (Level 2)

In this exercise, you create a UFS snapshot of the `/opt` file system, display detailed information for the UFS snapshot, and then remove the snapshot and backing-store file.

### Task Summary

In this exercise, you accomplish the following:

- Create a snapshot of the `/opt` file system
- View the contents of the backing-store directory
- Display detailed information about the snapshot
- Remove the snapshot from the system

### Tasks

Complete the following steps:

1. Create a snapshot of the `/opt` file system without specifying a file name for the backing-store file.
2. View the contents of the `/var/tmp` file system.  
What is the default name assigned to a backing-store file?
3. Display the detailed information about the snapshot.  
What is the maximum backing-store file size for the snapshot?
4. Delete the snapshot from the system.
5. View the contents of the `/var/tmp` file system.  
Has the backing-store file been removed?
6. Remove the backing-store file that you created in Step 1.

## Exercise: Working With UFS Snapshots (Level 3)

In this exercise, you create a UFS snapshot of the /opt file system, display detailed information for the UFS snapshot, and then remove the snapshot and backing-store file.

### Task Summary

In this exercise, you accomplish the following:

- Create a snapshot of the /opt file system
- View the contents of the backing-store directory
- Display detailed information about the snapshot
- Remove the snapshot from the system

### Tasks and Solutions

Complete the following steps:

1. Create a snapshot of the /opt file system without specifying a file name for the backing-store file.

```
# fssnap -F ufs -o bs=/var/tmp /opt
```

2. View the contents of the /var/tmp file system.

What is the default name assigned to a backing-store file?

*snapshot0*

3. Display the detailed information about the snapshot.

```
# /usr/lib/fs/ufs/fssnap -i /opt
```

What is the maximum backing-store file size for the snapshot?

*Unlimited*

4. Delete the snapshot from the system.

```
# fssnap -d /opt
```

5. View the contents of the /var/tmp file system. Has the backing-store file been removed?

*No*

6. Remove the backing-store file you created in Step 1.

```
# rm /var/tmp/snapshot0
```

## Exercise Summary



**Discussion** – Take a few minutes to discuss what experiences, issues, or discoveries you had during the lab exercises.

- Experiences
- Interpretations
- Conclusions
- Applications

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