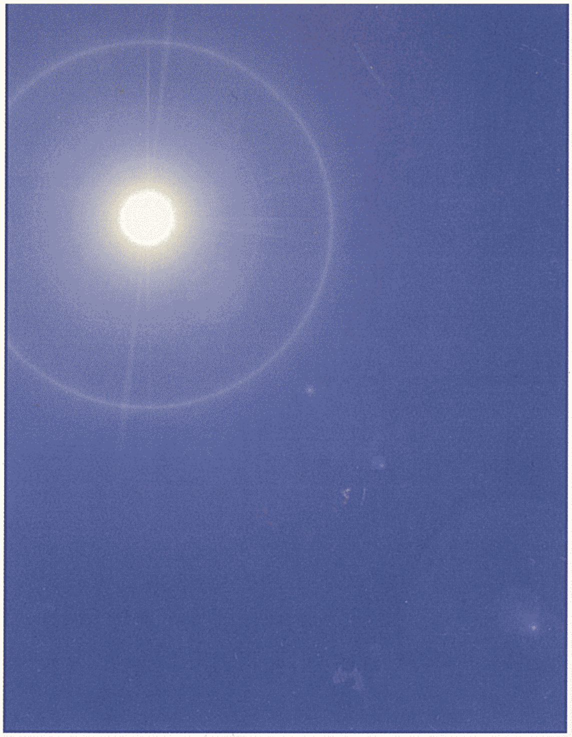

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Solaris™

SYSTEM ADMINISTRATOR'S GUIDE, *Second Edition*

MTP
MACMILLAN TECHNICAL PUBLISHING U·S·A

Janice Winsor

Sun microsystems

MACMILLAN TECHNICAL SERIES

Solaris®

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INTRODUCTION

THIS BOOK—TEN CHAPTERS, ONE APPENDIX, AND ONE GLOSSARY— IS FOR beginning system administrators, system administrators new to the Solaris® 2.x environment, or any user who wants a task-oriented quick-reference guide to basic administrative commands.

A Quick Tour of the Contents

Chapter 1, "Introducing Solaris System Administration," describes basic administration tasks, superuser status, and how to communicate with users, start up and shut down systems, and monitor processes. It also introduces some frequently used commands and the Administration Tool new to the Solaris 2.*x* environment.

Chapter 2, "Using Basic OS Commands," describes basic commands for finding user information and environment information for creating and editing files, combining commands and redirecting output, displaying manual pages, and locating disk information.

Chapter 3, "Administering Devices," describes how to use tapes and diskettes to store and retrieve files, and how to administer disks. It also introduces the Service Access Facility and provides instructions for setting up port monitors for printers and modems.

Chapter 4, "Administering File Systems," describes the types of file systems provided in the Solaris 2.*x* environment, the default file system, the virtual file system table, and the file system administrative commands. It shows you how to make file systems available and how to back up and restore file systems.

Chapter 5, "Administering Network Services," describes commands used to check on remote system status, log in to remote systems, and transfer files between systems. It also describes how to use the Administration Tool to make changes to NIS+ databases once NIS+ is up and running.

Chapter 6, "Administering Printing," introduces the LP print service, which is completely different from the print service of the SunOS 4.*x* system software. It describes how to set up printing services and how to use the printing commands.

Chapter 7, "Administering User Accounts and Groups," describes how to add and remove user accounts and how to set up new group accounts.

Chapter 8, "Understanding Shells," describes some commands common to all shells and provides basic information about the Bourne, C, and Korn shells.

Chapter 9, "Administering Systems," describes commands used to display system-specific information, configure additional swap space without reformatting a disk, and create a local mail alias.

Chapter 10, "Recognizing File Access Problems," provides information on how to recognize problems with search paths and with permissions and ownership.

Appendix A, "Major Differences: SunOS 4.*x* versus SunOS 5.*x* Operating Systems," briefly describes key differences between SunOS 4.*x* and SunOS 5.*x* system software and provides a table of SunOS 4.*x* commands with the SunOS 5.*x* equivalents.

The Glossary contains basic system administration terms and definitions.

Important: Read This Before You Begin

Because we assume that the root path will include the `/sbin`, `/usr/sbin`, `/usr/bin`, and `/etc` directories, the steps show the commands in these directories without absolute path names. Steps that use commands in other, less common directories show the absolute path in the example.

The examples in this book are for a basic SunOS 5.*x* software installation without the Binary Compatibility Package installed and without `/usr/ucb` in the path.

CAUTION! *If* `/usr/ucb` *is included in a search path, it should always be at the end. Commands like* `ps` *or* `df` *are duplicated in* `/usr/ucb` *with different formats and options from those of SunOS 5.*x *commands.*

This book does not contain all the information you need to administer systems. Refer to the complete system administration documentation for comprehensive information. See Appendix A for discussion of the differences between the Solaris 1.0 (SunOS 4.x) and Solaris 2.*x* (SunOS 5.x) environments.

Because the SunOS 5.*x* system software provides the Bourne (default), Korn, and C shells, examples in this book show prompts for each of the shells. The default C shell prompt is *`system-name%`*. The default Bourne and Korn shell prompt is `$`. The default root prompt for all shells is a pound sign (`#`). In examples that affect more than one system, the C shell prompt (which shows the system name) is used to make it clearer when you change from one system to another.

Conventions Used in This Book

Commands In the steps and the examples, the commands to be entered are in bold type. For example: "Type **`su`** and press Return." When following steps, press Return only when instructed to do so, even if the text in the step breaks at the end of a line.

Variables Variables are in an italic typeface. When following steps, replace the variable with the appropriate information. For example, to print a file, the step instructs you to "type **`lp`** ***`filename`*** and press Return." To substitute the file named "quest" for the **`filename`** variable, type **`lp quest`** and press Return.

Mouse-Button Terminology This book describes mouse buttons by function. The default mapping of mouse buttons on a three-button mouse is:

- SELECT is Left
- ADJUST is Middle
- MENU is Right

The SELECT mouse button is used to select unselected objects and activate controls. The ADJUST mouse button is used to adjust a selected group of objects, either adding to the group or deselecting part of the group. The MENU mouse button is used to display and choose from menus.

Storage-Medium Terminology In this book, we distinguish between three different types of media storage terminology in this way:

- *Disc* is used for an optical disc or CD-ROM.
- *Disk* is used for a hard-disk storage device.
- *Diskette* is used for a floppy diskette storage device. (Note: Sometimes, screen messages use the term *floppy*.)

Icons Marginal icons distinguish between three different types of information:

SVR4
- The New with SVR4 icon marks material that is new with Solaris 2.x system software (not available in Solaris 1.x).

2.6
- The New with 2.6 icon marks features that are new with Solaris 2.6 system software.

NEW
- The New in this edition icon marks new information that has been added to this edition. Some of the new information describes new commands and features that were introduced between the Solaris 2.1 and 2.5.1 releases. Other new information was available in the Solaris 2.0 release but was not included in the first edition. Where possible, the text next indicates the release number where the command or functionality was added.

SPARC and x86 Information

2.6

This book provides system administration information for both SPARC and x86 systems. Unless otherwise noted, information throughout this book applies to both types of systems. Table I–1 summarizes the differences between the SPARC and x86 system administration tasks.

Table I–1 SPARCand x86 System Adminstration Differences

Category	SPARC	x86
System operation before kernel is loaded	A programmable read-only memory (PROM) chip with a monitor program runs diagnostics and displays device information.	The basic input/output system (BIOS) runs diagnostics and displays device information.
	The PROM is also used to program default boot parameters and test the devices connected to the system.	A Solaris Device Configuration Assistant boot diskette with the Multiple Device Boot (MDB) program is used to boot from non-default boot partitions, the network, or the CD-ROM.
Booting the system	Commands and options at the PROM level are used to boot the system.	Commands and options at the MBD, primary, and secondary boot subsystems level are used to boot the system.
Boot programs	bootblk, the primary boot program, loads ufsboot.	mboot, the master boot record, loads pboot.
	ufsboot, the secondary boot program, loads the kernel.	pboot, the Solaris partition boot program, loads bootblk.
		bootblk, the primary boot program, loads ufsboot.
		ufsboot, the secondary boot program, loads the kernel.
System shutdown	The `shutdown` and `init` commands can be used without additional operation intervention.	The `shutdown` and `init` commands are used but require operator intervention at the type any key to continue prompt.
Disk controllers	SCSI	SCSI and IDE
Disk slices and partitions	A disk may have a maximum of eight slices, numbered 0-7.	A disk may have a maximum of four fdisk partitions.
		The Solaris fdisk partition may contain up to 10 slices, numbered 0–9, but only 0–7 can be used to store user data.
Diskette drives	Desktop systems usually contain one 3.5-inch diskette drive.	Systems may contain two diskette drives: a 3.5-inch and a 5.25-inch drive.

Solaris System Software Evolution

2.6

To help you understand how Solaris is evolving, Table I–2 provides a list of the major system administration feature differences for each release.

Table I–2 Solaris System Software Evolution

Release	New Features
Solaris 1.0	Berkeley (BSD) UNIX with Solaris 4.*x* functionality.
Solaris 2.0 (SunOS 5.0)	A merger of AT&T System V Release 4 (SVR4) and BSD UNIX. To facilitate customer transition, Solaris uses SVR4 as the default environment, with BSD commands and modes as an option. Administration Tool provides a graphical user interface Database Manager and Host Manager.
Solaris 2.1 (SunOS 5.1)	Administration Tool adds a graphical user interface Printer Manager and User Account Manager.
Solaris 2.2 (SunOS 5.2)	Volume management integrates access to CD-ROM and diskette files with the File Manager, and provides a command-line interface. Users no longer need superuser privileges to mount CD-ROMs and diskettes. Solaris 2.0 and 2.1 procedures do not work with volume management because volume management controls and owns the devices. (Refer to Appendix A of the *Solaris Advanced System Administrator's Guide.*)
Solaris 2.3 (SunOS 5.3)	Volume management changes Solaris 2.2 mount point naming conventions.
	Administration Tool adds a graphical user interface Serial Port Manager with templates that provide default settings, which makes adding character terminals and modems much easier.
	The automounter is split into two programs: an automounted daemon and a separate automount program. Both are run when the system is booted. The `/tmp_mnt mount` point is not displayed as part of the path name, and the local path is displayed as `/home/username`. Additional predefined automount map variables are provided. (Refer to the *Solaris Advanced System Administrator's Guide.*)
	Online: Backup 2.1 is included with the release (Not documented in this book.)
	Pluggable Authentication Model (PAM) is included with the release. PAM provides a consistent framework to allow access control applications, such as login, to be able to choose any authentication scheme available on a system, without concern for implementation details of the scheme. (Not documented in this book.)
	C2 Security is included in this release. (Not documented in this book.)
	Format(1) changes for SCSI disks. (Not documented in this book.)
	PPP network protocol product that provides IP network connectivity over a variety of point-to-point connections is included in this release. (Not documented in this book.)
	Cache File System (CacheFS) for NFS is included in this release. CacheFS is a generic, nonvolatile caching mechanism to improve performance of certain file systems by using a small, fast, local disk. (New in this edition.)

Table I–2 Solaris System Software Evolution (continued)

Release	New Features
	New NIS+ setup scripts are included in this release. The nisserver(1M), nispopulate(1M), and nisclient(1M) scripts described in Table I.2 let you set up an NIS+ domain much more quickly and easily than if you used the individual NIS+ commands to do so. With these scripts, you can avoid a lengthy manual process.
Solaris 2.4 (SunOS 5.4)	New Motif GUI for Solaris software installation. (Not documented in this book.)
Solaris 2.5 (Solaris 5.5)	New pax(1M) portable archive interchange command for copying files and file systems to portable media.
	Solstice AdminTools utility used only to administer local systems.
	Solstice AdminSuite product available for managing systems in a network for SPARC and x86 systems.
	New process tools are available in /usr/proc/bin that display highly detailed information about the active processes stored in the process file system in the /proc directory.
	Telnet client upgraded to the 4.4 BSD version. rlogin and telnetd remote login capacity improved. (Not documented in this book.)
Solaris 2.5.1 (SunOS 5.5.1)	The limit on user ID and group ID values has been raised to 2147483647, or the maximum value of a signed integer. The nobody user and group (60001) and the no access user and group (60002) retain the same UID and GID as in previous Solaris 2.*x* releases.
Solaris 2.6 (SunOS 5.6)	Changes to the Solaris 2.6 printing software provide a better solution than the LP print software in previous Solaris releases. You can easily set up and manage print clients using the NIS or NIS+ name services to enable centralization of print administration for a network of systems and printers. New features include redesign of print packages, print protocol adapter, bundled SunSoft Print Client software, and network printer support.
	New nisbackup and nisrestore commands provide a quick and efficient method of backing up and restoring NIS+ namespaces.
	New patch tools, including patchadd and patchrm commands, add and remove patches. These commands replace the installpatch and backoutpatch commands that were previously shipped with each individual patch. (Refer to the *Solaris Advanced System Administrator's Guide*.)
	New filesync command nomadic support ensures that data is moved automatically between a portable computer and a server. (Not documented in this book.)
	Restructuring of the previous flat /proc file system into a directory hierarchy contains additional subdirectories for state information and control functions. It also provides a watchpoint facility to monitor access to and modifications of data in the process address space. The adb(1) command uses this facility to provide watchpoints.
	Large files are supported on UFS, NFS, and CacheFS file systems. Applications can create and access files up to one Tbyte on UFS-mounted file systems and up to the limit of the NFS server for NFS- and CacheFS-mounted file systems. A new -mount option is provided to disable the large-file support on UFS file systems. Using the -mount option enables system administrators a way to ensure that older applications that are not able to safely handle large files do not accidentally operate on large files.

Table I–2 Solaris System Software Evolution (continued)

Release	New Features
	NFS Kerberos authentication now uses DES encryption to improve security over the network. The kernel implementations of NFS and RPC network services now support a new RPC authentication flavor that is based on the Generalized Security Services API (GSS-API). This support contains the hooks to add stronger security to the NFS environment. (Refer to the *Solaris Advanced System Administrator's Guide.*)
	The PAM authentication modules framework enables you to "plug in" new authentication technologies. (Refer to the *Solaris Advanced System Administrator's Guide.*)
	Font Admin enables easy installation and use of fonts for the X Window System. It supports TrueType, Type0, Type1, and CID fonts for multibyte languages and provides comparative font preview capability. It is fully integrated into the CDE desktop. (Not documented in this book.)
	TrueType fonts are supported through X and Display PostScript. Font Admin enables easy installation and integration of third-party fonts into the Solaris environment. (Not documented in this book.)
	The Solaris 2.6 operating environment is year 2000 ready. It uses unambiguous dates and follows the X/Open guidelines where appropriate. (Not documented in this book.)
	WebNFS software enables file systems to be accessed through the Web using the NFS protocol. This protocol is very reliable and provides greater throughput under a heavy load. (Not documented in this book.)
	The Java Virtual Machine 1.1 integrates the Java platform for the Solaris operating environment. It includes the Java runtime environment and the basic tools needed to develop Java applets and applications. (Not documented in this book.)
	For x86 systems, the Configuration Assistant interface is part of the new booting system for the Solaris (Intel Platform Edition) software. It determines which hardware devices are in the system, accounts for the resources each device uses, and enables users to choose which device to boot from. (Not documented in this book.)
	For x86 systems, the `kdmconfig` program is used to configure the mouse, graphics adapter, and monitor. If an `Owconfig` file already exists, `kdmconfig` extracts any usable information from it. In addition, this updated version of `kdmconfig` also retrieves information left in the `devinfo` tree by the defconf program and uses that information to automatically identify devices. (Not documented in this book.)
	Full X/Open UNIX 95, POSIX 1003.1b and ISO 10646 standards compliance. (Not documented in this book.)

CONTENTS AT A GLANCE

TABLE OF CONTENTS

CHAPTER

1

Introducing Solaris System Administration

Defining the System Administrator's Job

Understanding Superuser Status

Communicating with Users

Starting Up and Shutting Down Systems

Monitoring Processes

Reviewing Essential Administration Tools

Winchester Mystery House [in San Jose, California] . . . was designed to baffle the evil spirits that haunted Sarah Winchester, eccentric heiress to the Winchester Arms fortune and mistress of the house. With 160 rooms and 2,000 doors, 13 bathrooms, 10,000 windows, 47 fireplaces, blind closets, secret passageways and 40 staircases, the house is so complex that even the owner and servants needed maps to find their way.
—AAA, California/Nevada TourBook, 1991

Sarah Winchester, listening to the advice of psychics, believed that if she kept adding rooms to the house, she would not die and be subject to the influences of spirits who had been killed with the Winchester rifles manufactured by her husband.

The UNIX operating system is much like the Winchester Mystery House without, we hope, the evil spirits. The original operating system has been continually enhanced and expanded. There are many ways to get about, and, like the owner and the servants in the Winchester house, system administrators frequently need a map to help them get from place to place.

To add to the complexity, there are many versions of the UNIX operating system based on either Berkeley (or BSD) UNIX or AT&T's System V. This book serves as a map to some of the most frequently used "rooms" of the SunOS 5.*x* system software, which is an enhanced implementation of UNIX System V, Release 4 (usually referred to as SVR4). The book also provides comparative information to help you learn the differences between the SunOS 4.*x* versions (the BSD UNIX operating system) and the SunOS 5.*x* version (the SVR4 operating system).

Defining the System Administrator's Job

The system administrator's job is to keep the software (and perhaps hardware) functioning for a stand-alone system or for a set of systems on a network so that others can use them.

Typical duties of system administrators vary, depending on the number of systems supported and how the duties are divided up. It is not uncommon for system administrators to be experts in administering one or more areas and be inexperienced in others. Some administrators specialize in network administration; others in user accounts; and still others in areas such as printing.

Here's a list of typical system administration duties that are described in part or in full in this book:

- Administering devices
  - Using tape cartridges
  - Formatting diskettes
  - Monitoring disk use

- Understanding the Service Access Facility
- Setting up a bidirectional modem

- Administering file systems
  - Mounting and unmounting file systems
  - Backing up and restoring files and file systems
- Administering network services
  - Finding network information
  - Transferring files between systems
  - Administering NIS+ databases
- Administering printing
  - Setting up a print client and print server
  - Using printing commands
- Administering users and groups
  - Adding users
  - Removing users
  - Changing user information
  - Creating new group accounts
- Understanding shells
  - Using Generic shell commands
  - Using Bourne shell commands
  - Using C shell commands
  - Using Korn shell commands
- Administering systems
  - Finding system information
  - Creating local mail aliases
  - Configuring additional swap space
  - Administering the system date and time
- Recognizing file access problems
  - Problems with search paths
  - Problems with permission and ownership
  - Problems with network access

The organization of this book matches the tasks listed above. To accomplish these tasks, you need to know when and how to:

- Gain full access to all file systems and resources
- Communicate with users
- Shut down and start up systems
- Monitor processes

However, information about the following system administration tasks is beyond the scope of this book: installing system software, installing third-party software, setting up and administering network services, setting up and administering mail services, adding and removing hardware, administering security and accounting, and monitoring system and network performance.

The rest of the sections in this chapter, which describe how to accomplish the system administrator's tasks, introduce some basic commands and administrative tools.

Understanding Superuser Status

The *superuser* is a privileged user with unrestricted access to all files and commands. The superuser has the special UID (user ID) 0. The user name for this account is *root*. Note that the terms *root* and *superuser* have the same meaning and are used interchangeably in this book. You must be root to perform many system administration tasks, such as mounting and unmounting file systems, changing ownership or permissions for a file or directory you do not own, backing up and restoring file systems, creating device files, and shutting down the system.

You can become superuser in two ways:

- When logged in as another user, by typing the **su** (switch user) command with no arguments, and then typing the root password
- From a login prompt, by typing **root** and then typing the root password

When you have superuser privileges, the shell provides a special # (pound sign) prompt to remind you that you have extra access to the system. The system keeps a log that records each time the `su` command is used and who uses it. You can keep track of who is using the superuser account by consulting the log file `/var/adm/sulog`.

You should only become superuser when it is required and avoid doing routine work as superuser. Occasionally, you may need to log out of your user account and log in again as root. When a task requires you to log in as root, you will be instructed to do so. You should switch user (**su**) to root, perform the required tasks, and exit superuser status when the tasks are complete.

Because unauthorized access to root can be a serious security breach, always add a password to the root account. For enhanced security, change the root password frequently.

NOTE. *The default shell for root is the Bourne shell. See Chapter 8 for more information.*

Becoming Superuser (*su*)

You should become superuser only when you need to perform a task that requires root permissions. Here's how to become superuser:

1. At the shell prompt (`$` or `%`), type **`su`** and press Return. You are prompted for the superuser (root) password, if one has been set up.
2. Type the superuser password and press Return. If you enter the password correctly, you have superuser (root) access to the system and the root prompt (`#`) is displayed:

   ```
   oak% su
   Password:
   #
   ```

   If you want to use root's environment variables, type **`su -`** and press Return.

Exiting Superuser Status

To exit superuser status, simply type **`exit`** and press Return. The shell prompt is redisplayed:

```
# exit
oak%
```

Logging In as Root

To log in as root, you must be at a login prompt:

1. At a login prompt, type **`root`** and press Return. You are prompted for the root password.
2. Type the root password and press Return. If you enter the password correctly, you have superuser (root) access to the system, and the root prompt (`#`) is displayed:

   ```
   login: root
   Password:
   #
   ```

Communicating with Users

An important part of your job as a system administrator is communicating with users to let them know that a task you are performing will affect their ability to use a system. Always let users know when you are about to perform a task that will affect them, such as rebooting a system, installing new software, or changing the environment in some way.

You can communicate with users by personal visit or phone, but the most common way is by using the system to:

- Display a system-specific message at login using the message of the day.
- Send a message directly to an individual user's terminal using the `write` command.
- Send a message to all users on a system using the `wall` command.
- Send a message to all users on a network using the `rwall` command.
- Send a message to an individual or a group of users by electronic mail.

Displaying System-Specific Messages at Login

Each time a user logs in to a system, the message of the day in the file `/etc/motd` is displayed. The message is not displayed to users who are already logged in and are using the system. Use `motd` to give users information specific to the system which someone logging in would want to know. This information might include which operating system release is installed, changes to system software, the name of the newly installed (or deleted) third-party software, or a list of scheduled downtimes.

Be sure to keep the `motd` file current. If `motd` displays outdated messages, users may begin to ignore all the messages, thereby missing out on critical information when it is presented. Keep the message short: If the message is longer than a screenful of information, users won't be able to read the beginning.

Root should own the `/etc/motd` file and be the only user who has write permission to it:

```
oak% ls -l /etc/motd
-rw-r--r--   1 root     sys      49 Jan  1  1970 /etc/motd
oak%
```

NOTE. *When the system software is installed, several files, including* `/etc/motd`, *have a time stamp of "Jan 1 1970." This date is the beginning of UNIX time. When you edit these files, the time stamp is updated.*

Creating a Message of the Day

Follow these steps to create a message of the day:

1. Become superuser.
2. Use an editor such as vi to edit the `/etc/motd` file.
3. Delete any obsolete messages and type the new one.
4. Save the changes. The message is changed and is displayed the next time a user logs in to the system.

Sending a Message to an Individual User

You can send a message to the terminal of an individual user using the `write` command. When using a windowing system such as CDE or OpenWindows, each window is considered a separate login. If the user is logged in more than once, the message is directed to the console window.

Typing a Short Message to an Individual User

Use these steps to send a short, one-time message to an individual user:

1. Type **write** ***username*** and press Return. *username* is the login name of the user.
2. Type the message you want to send.
3. When the message is complete, press Control-D. The message is displayed in the user's console window.

   Here is an example of a message a system administrator might type:

   ```
   oak% write ignatz@elm
   I'll come by at 12:00 to look at your problem.
   oak%
   ```

   This is how the message would display in the user's console window:

   ```
   Message from fred@oak on ttyp1 at 11:20 ...
   I'll come by at 12:00 to look at your problem.
   EOF
   ```

Sending a Message from a File to an Individual User

If you have a longer message that you want to send to a number of users, follow these steps to create the message in a file and then use the file name as an argument to the `write` command:

1. Create a file containing the text of the message you want to send.
2. Type **write** ***username* < *filename*** and press Return.

In this example, the system administrator uses the `cat` command to create a file containing a short message:

```
oak% cat > message
I'll come by at 12:00 to look at your problem.
oak% write ignatz@elm < message
write: ignatz logged in more than once ... writing to console
oak%
```

If the user is logged in to more than one window, the message is displayed in the console window. This is how the message displays in the user's console window:

```
Message from fred@oak on ttyp1 at 11:20 ...
I'll come by at 12:00 to look at your problem.
EOF
```

As you can see, the user doesn't see any difference in the output created from a typed message and the message included from a file. The user can initiate a dialogue by using the `write` command to respond, but the dialogue is not truly interactive. There are two `write` paths open, one in each direction. See the `write`(1) manual page for more information. For more information about manual pages, see Chapter 2, "Using Basic OS Commands."

Sending a Message to All Users on a System or Network

You can use the `wall` (write all) command to simultaneously send a message to every user on a system. You can use the `rwall` (remote write all) command to simultaneously send a message to every user on a network.

To send a message to all users on a system:

1. Type **`wall`** and press Return.
2. Type the message you want to send.
3. When the message is complete, press Control-D. The message is displayed in the console window of each user on the system.

This is an example of a message a system administrator might type:

```
oak% wall
System will be rebooted at 12:00.
oak%
```

This is how the message would display in the users' console windows:

```
Broadcast message from root on console ...
System will be rebooted at 12:00.
EOF
```

NOTE. *Use the* `rwall` *command carefully because it consumes extensive system and network resources.*

To send a message to all users on a network:

1. Type **`rwall -n`** ***netgroup*** and press Return.
2. Type the message you want to send.
3. When the message is complete, press Control-D. The message is displayed in the console window of each user on the system.

This is a message the system administrator might type to send to all members of the netgroup `Eng`:

```
oak% rwall -n Eng
System oak will be rebooted at 12:00.
oak%
```

This is how the message would display in the users' console windows:

```
Broadcast message from root on console ...
System will be rebooted at 12:00.
```

You can also use the rwall command to send a message to all users on a system by typing `rwall` ***hostname***.

Sending a Message by E-Mail

E-mail is an effective way to communicate some system administration informational messages. However, this book does not describe how to use electronic mail. See the `mail`(1), `mailtool`(1), `mailx`(1), and `dtmail`(1X) manual pages for information about the mail programs.

Starting Up and Shutting Down Systems

Starting up and shutting down systems is an integral part of performing system administration tasks. This section describes procedures for routinely starting up and shutting down systems. If a system does not start up gracefully, see your system documentation for information on how to diagnose booting problems.

The SunOS 5.*x* system software is designed to be left running continuously so that the e-mail and network software can work correctly. You must, however, halt or shut down a system when:

- Turning off system power
- Installing a new release of the operating system
- Anticipating a power outage
- Adding hardware to the system
- Performing maintenance on a file system

Choosing an Init State

The init state (also called run level) determines what programs are started or initialized when a system is booted. The SunOS system software has eight init states; the default init state for each system is specified in the `/etc/inittab` file. The default init state for the SunOS 5.*x* system software is run level 3. Table 1–1 shows the seven available run levels and the state of the system at each level.

The `/sbin/init` command is responsible for keeping the system running correctly and is the command you use to change init states. You can also use the init states (with the -i option) as arguments to the `shutdown` command. There are four types of system states:

Table 1–1 System Init States

Init State	Function
0	Power-down state
1, S, s	System administrator state (single-user)
2	Multiuser state (resources not exported)
3	Multiuser state (resources exported)
4	Alternative multiuser state (currently unused)
5	Software reboot state (unused)
6	Reboot

- Power-down (run level 0)
- Single-user (run levels 1 and s or S)
- Multiuser (run levels 2 and 3)
- Reboot (run levels 5 and 6)

When preparing to do a system administration task, you need to determine which init state is appropriate for the system and the task at hand.

Finding the Run Level for a System

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To find the run level for a system, type `who -r` and press Return. The run level, date and time, process termination status, process ID, and process exit status are displayed.

In this example, the system named `drusilla` is at the default multiuser run level (3), the date and time are `Feb 6 15:46`, the process termination status is `3`, the process ID is 0, and process exit status is `S`:

```
drusilla% who -r
    .     run-level 3  Feb 6 15:46    3    Ø S
drusilla%
```

The next sections describe how you might use each init state.

Using Power-Down State, Run Level 0

Use this level to shut down the system so that it is safe to turn off the power.

Using System Administrator State, Run Level 1

Use this level when performing administrative tasks that require you to be the only user on the system. Root and `/usr` are the only file systems mounted, and you can access only minimum kernel utilities. The terminal from which you issue the `init 1` command becomes the console. No other users are logged in.

Using Multiuser State, Run Level 2

Use this level for normal operations. Multiple users can access the system and the entire file system. All daemons are running except for NFS server, syslog, and remote file sharing.

NOTE. *A* daemon *is a special type of program that, once activated, starts itself and carries out a specific task without any need for user input. Daemons typically are used to handle jobs that have been queued, such as printing, mail, and communication.*

Using Remote Resource-Sharing State, Run Level 3

Use this level for normal operations with NFS resource-sharing available.

Using Alternative Multiuser State, Run Level 4

This level currently is unavailable.

Using Interactive Reboot State, Run Level 5

Use this level when you want to be prompted for a device other than the default boot devices. You can also change to this level using the `reboot -a` command.

Using Reboot State, Run Level 6

Use this level to shut down the system to run level 0, and then reboot to multiuser level (or to whatever level is the default in the inittab file).

Using Single-User State, Run Level s or S

Use this level to run as a single user with all file systems mounted and accessible.

Changing Run Levels

Use either the `telinit` or `init` command to change run levels. The `telinit` command takes a one-character argument that tells init what run level to use. Although you can use the `init` command directly, `telinit` is the preferred command to use to change system run states.

To change run levels:

1. Become superuser.
2. Type **`telinit`** *n* and press Return. Replace the variable *n* with the number of the init state you want to use.

To shut down the system:

```
oak% su
Password:
# telinit 0
```

To change to single-user state:

```
oak% su
Password:
# telinit 1
```

To change to multiuser state, with no NFS server daemons:

```
oak% su
Password:
# telinit 2
```

To change to multiuser state, with NFS server daemons:

```
oak% su
Password:
# telinit 3
```

To shut down and reboot a system:

```
oak% su
Password:
# telinit 6
```

Choosing Which Shutdown Command to Use

When preparing to do a system administration task, you need to determine which shutdown command is appropriate for the system and the task at hand. The next sections describe how you might use each of the available shutdown commands:

- `/usr/sbin/shutdown`
- `/etc/telinit` and `/sbin/init`
- `/usr/sbin/halt`
- `/usr/sbin/reboot`

These commands, respectively, initiate shutdown procedures, kill all running processes, write out any new data to the disk, and shut down the SunOS 5.*x* system software to the appropriate run level.

shutdown

Use the `shutdown` command when shutting down a system with multiple users. The `shutdown` command sends a warning message to all users who are logged in, waits 60 seconds (the default), and then shuts down the system to single-user state. You can choose a different default wait time.

telinit and *init*

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- Use the `telinit` or `init` command to shut down a single-user system or to change its run level. The `init` command changes the run level of the system. The `telinit` command tells `init` what run level you want. You can use the commands interchangeably, but `telinit` is the preferred command. You can use `telinit` to place the system in power-down state (`init 0`) or in single-user state (`init 1`).

NOTE. *Use* `telinit`/`init` *and* `shutdown` *as the preferred method of changing system state. These programs are the most reliable way to shut down a system because they use a number of* `rc` *scripts to kill running processes.*

halt

Use the `halt` command when the system must be stopped immediately and it is acceptable not to warn any current users. The `halt` command shuts down the system without any delay and does not warn any other users on the system. The `halt` command does not run the `rc` shutdown scripts properly and is not the preferred method for shutting down a system.

reboot

Use the `reboot` command to shut down a system that does not have multiple users to bring it back into multiuser state. The command `reboot` does not warn users on the system, does not run the `rc` scripts properly, and is not the preferred method for shutting down a system.

Booting a System

If a system is powered off, turning it on starts the multiuser boot sequence. The following procedures tell you how to boot in different states from the `ok` PROM prompt. If the PROM prompt is >, type **n** to display the `ok` prompt, and then follow the appropriate steps.

NOTE. *The PROM prompt description is for SPARC systems.*

Booting in Multiuser State

To boot in multiuser state, at the `ok` PROM prompt, type **`boot`** and press Return. The automatic boot procedure starts on the default drive, displaying a series of start-up messages. The system is brought up in multiuser state.

Booting in Single-User State

To boot in single-user state, at the `ok` PROM prompt, type **`boot -s`** and press Return. The system boots to single-user state and prompts you for the root password:

```
ok boot -s

INIT: SINGLE USER MODE
Type Ctrl-d to proceed with normal start-up,
(or give root password for system maintenance)
```

Type the root password and press Return.

NOTE. *To continue the process and bring the system up in multiuser state, press Control-D.*

Booting Interactively

You may boot interactively if you want to make a temporary change to the system file or the kernel. In this way, you can test your changes and recover easily if you have any problems:

1. At the `ok` PROM prompt, type **`boot -a`** and press Return. The boot program prompts you interactively.
2. Press Return to use the default `/kernel/unix kernel`, or type the name of the kernel to use for booting.
3. Press Return to use the default `/etc/system file`, or type the name of the system file and press Return.
4. Press Return to use the default modules directory path, or type the default path for the modules directory and press Return.
5. Press Return to use the default root file system. Type **`ufs`** for local disk booting or **`nfs`** for diskless clients.
6. Press Return to use the default physical name of the root device, or type the device name.
7. Press Return to use the `swapfs` default swap file system type. (Note that `swapfs` is the only permitted swap file system type.)

In the following example, the default choices (shown in square brackets `[ ]`) were accepted by pressing Return:

```
ok boot -a
(Hardware configuration messages)
rebooting from -a
Boot device: /sbus/esp@0,800000/sd@0,0 File and args: -a
Enter <filename> [/kernel/unix]:
(Copyright notice)
Name of system file [/etc/system]:
Name of default directory for modules [<null string>]:
root filesystem type [ufs]
Enter physical name of root device
[/sbus@1,f8000000/esp@0,800000/sd@0,0:a]:
Swap filesystem type [swapfs]
Configuring network interfaces:  le0
Hostname: cinderella
(fsck messages)
The system is coming up. Please wait.
(More messages)
cinderella login:
```

Looking at the Boot Messages

The most recent boot messages are stored in the `/var/adm/messages` file. To see these messages after you have booted the system, type **`/usr/sbin/dmesg`** and press Return. The boot messages are displayed. Or, type **`more /var/adm/messages`** and press Return.

NOTE. *You cannot view* `/usr/sbin/dmesg` *text from a CDE terminal window. If you are running CDE, use more* `/var/adm/messages` *to review boot messages. Alternatively, you can open a Command Tool window by typing* `/usr/openwin/bin/cmdtool&` *and use that window to view* `/usr/sbin/dmesg` text.

This example shows the contents of the `dmesg` file:

```
castle% /usr/sbin/dmesg

Sep 13 10:53
SunOS Release 5.6 Version Generic [UNIX(R) System V Release 4.0]
Copyright (c) 1983-1997, Sun Microsystems, Inc.
pac: enabled - SuperSPARC/SuperCache
cpu0: TI,TMS390Z55 (mid 8 impl 0x0 ver 0x1 clock 50 MHz)
mem = 65536K (0x4000000)
avail mem = 61177856
Ethernet address = 8:0:20:18:69:71
root nexus = SUNW,SPARCstation-
iommu0 at root: obio 0xe0000000
sbus0 at iommu0: obio 0xe0001000
espdma0 at sbus0: SBus slot f 0x400000
esp0:esp-options=0x46
esp0 at espdma0: SBus slot f 0x800000 sparc ipl 4
sd3 at esp0: target 3 lun 0
sd3 is /iommu@f,e0000000/sbus@f,e0001000/espdma@f,400000/esp@f,800000/sd@3,0
<SEAGATE-ST51080N-0958 cyl 4824 alt 2 hd 4 sec 109>
root on /iommu@f,e0000000/sbus@f,e0001000/espdma@f,400000/esp@f,800000/sd@3,0:a
fstype ufs
obio0 at root
zs0 at obio0: obio 0x100000 sparc ipl 12
zs0 is /obio/zs@0,100000
zs1 at obio0: obio 0x0 sparc ipl 12
zs1 is /obio/zs@0,0
cgsix0 at sbus0: SBus slot 3 0x0 SBus level 5 sparc ipl 9
cgsix0 is /iommu@f,e0000000/sbus@f,e0001000/cgsix@3,0
cgsix0: screen 1152x900, single buffered, 1M mappable, rev 8
cpu 0 initialization complete - online
dump on /dev/dsk/c0t3d0s1 size 112036K
castle%
```

Booting After Adding New Hardware

When you add new hardware to your system, you must use the `-r` option to the `boot` command so that the operating system knows to look for new device drivers and incorporate them as part of the boot process:

1. Load the new device driver, following the instructions included with the hardware.
2. Shut down your system and install the new hardware.
3. Type **`boot -r`** and press Return. A reconfiguration script is run to load all the device drivers listed in the modules directories and to create the corresponding hardware nodes.

Aborting a Booting Process

Occasionally, you may need to abort the booting process. The specific abort key sequence depends on your keyboard type. For example, you might press Stop-A or L1-A. On tty terminals, press the Break key.

To abort the booting process, type the abort key sequence for your system. When you abort the boot process, the monitor displays the `ok` PROM prompt:

```
ok
```

Type **`boot`** and press Return to restart the boot process, or type **`help`** and press Return to display a list of help options. If your terminal shows the > monitor prompt, type **`n`** to get the ok prompt.

Shutting Down a System

The following sections describe how to use the `shutdown` and `init` commands to shut down a system.

Shutting Down a Multiuser System

Before shutting down a multiuser system, inform the other users on the system and give them time to complete critical procedures such as saving changes:

1. Type **`who`** and press Return. A list of all logged in users is displayed.
2. Type **`ps -ef`** and press Return. A list of system activities is displayed. If the activity is acceptable for running shutdown, go to the next step.
3. Become superuser.
4. Type **`cd /`** and press Return. You must be in the root directory to run the shutdown command.
5. Type **`shutdown`** and press Return. You are asked to confirm that you want to shut down the system.
6. Type **`y`**. A message is broadcast to all users. After a 60-second wait, the system is shut down to single-user state and you are prompted for the root password.
7. Type the root password. The system is in single-user state and you can perform any maintenance task.
8. Press Control-D to return to the default run system level:

```
# cd /
# shutdown
Shutdown started Fri Aug 6 10:50:35 EDT 1993

Broadcast message from root (console) on earth Fri Aug 9 10:59:35.
THE SYSTEM IS BEING SHUT DOWN NOW ! ! !
LOG OFF NOW OR RISK YOUR FILES BEING DAMAGED
```

```
Do you want to continue?  (y or n):  y

The system is down.
Changing to init state s - please wait.

INIT: New run level S
INIT: SINGLE USER MODE
Type Ctrl-d to proceed with normal start-up,
(or give root password for system maintenance):
```

Shutting Down a System: Alternative Ways

If you want to change the default actions of the `shutdown` command, choose one of the tasks in the following six sections.

Shutting Down a System Without Confirmation

To shut down a system without confirmation, follow these steps:

1. Become superuser.
2. Type **cd /** and press Return. You must be in the root directory to run the `shutdown` command.
3. Type **shutdown -y** and press Return. The shutdown proceeds without asking you to type **y** to confirm it.

Changing the Shutdown Grace Period The default is for the `shutdown` command to provide a 60-second grace period to enable users to save their changes. To change the shutdown 60-second grace period, follow these steps:

1. Become superuser.
2. Type **cd /** and press Return. You must be in the root directory to run the shutdown command.
3. Type **shutdown -g** ***nnn*** and press Return. The grace period is changed to the number of seconds you specify.

The following example changes the grace period to 120 seconds:

```
# cd /
# shutdown -g120
```

Shutting Down and Rebooting a Multiuser System To shut down and reboot a multiuser system, follow these steps:

1. Become superuser.
2. Type **cd /** and press Return. You must be in the root directory to run the `shutdown` command.

3. Type `shutdown -i6` and press Return. A message is broadcast to all users and the rc script is executed; the system is shut down to power-down state and then brought back up to multiuser state.

Shutting Down a Single-User System To shut down a single-user system, type `telinit 0` (or `init 0`) and press Return. The `init` command runs scripts that bring the system down cleanly. No warning messages are broadcast.

Shutting Down and Rebooting a Single-User System To shut down and reboot a single-user system, type `telinit 6` (or `init 6`) and press Return. Information is written to the disk, all active processes are killed, and the system is brought to a power-down state. The system is then rebooted to the default level (usually multiuser).

Shutting Down a System in a Hurry To shut down a system in a hurry, type `uadmin 2 0` and press Return. Information is written to the disk and the system is brought to power-down state, displaying the PROM prompt.

Monitoring Processes

The programs that are running on a system at any one time are called *processes*. You can monitor the status of processes, control how much CPU time a process gets, and suspend or halt the execution of a process.

NEW

Commands for Monitoring Processes

The `ps` (process status) command is your main tool for obtaining information about processes. You can use the `ps` command in combination with the `grep` command to focus your search for specific information.

You can also use the `dispadmin`, `priocntl`, and `nice` commands to manage processes. Table 1–2 lists the commands for managing processes.

Table 1–2 Commands for Managing Processes

Command	Description
`ps`	Check the status of active processes on a system and display detailed information about the processes.
`dispadmin`	List default scheduling policies.
`priocntl`	Assign processes to a priority class and manage process priorities.
`nice`	Change the priority of a timesharing process.

Refer to the ps(1M), dispadmin(1M), priocntl(1M), and nice(1M) manual pages for complete information about these commands.

In addition, the /usr/proc/bin directory contains process tools that you can use to display highly detailed information about the processes listed in /proc. The /proc directory is also known as the process file system (procfs). It stores images of active processes by their process ID number. For more information about the /proc file system see "Types of File Systems" on page 145.

The process tools are similar to some options of the ps command, except that the output provided by the tools is more detailed. In general, the process tools:

- Display more details about processes, such as fstat and fcntl information, working directories, and trees of parent and child processes
- Provide control over processes, enabling users to stop or resume them

Table 1–3 summarizes the new /usr/proc/bin utilities.

Table 1–3 Process Tools in the */usr/proc/bin* Directory

Command	Description
pstop *pid*	Stop the process.
prun *pid*	Restart the process.
ptime *pid*	Time the process using microstate accounting.
pwait *pid*	Wait for the specified processes to terminate.
pcred *pid*	Display credentials.
pfiles *pid*	Display fstat and fcntl information for open files.
pflags *pid*	Show /proc tracing flags, pending and held signals, and other status information for each lwp.
pldd *pid*	Show dynamic libraries linked into each process.
pmap *pid*	Show address map space.
psig *pid*	Display signal actions.
pstack *pid*	Display hex+symbolic stack trace for each lwp.
ptree *pid*	Show process trees containing specified PIDs.
pwdx *pid*	Display current working directory.

For a complete description of the process tools, refer to the proc(1) manual page. For information about how to use the process tools commands to display details about processes and start and stop them, see "Using the /usr/proc/bin Commands."

The *ps* Command

You can use the ps command to determine which processes are running (or not running) and get detailed information about an individual process, such as:

- PID (process ID)
- UID (user ID)
- Priority
- Control terminal
- Memory use
- CPU time
- Current status

The ps command takes a snapshot of system activity at the time you type the command. If you are monitoring system activity by time, be aware that the results are already slightly out-of-date by the time you read them. Table 1–4 shows the most frequently used options for the ps command. See the ps(1) manual page for a complete list of options.

Table 1–4 Most Frequently Used Options for the *ps* Command

Option	Description
-e	Report on all processes.
-f	Show the owner of the process, by name instead of by UID, in the first column. This option turns off -1, -t, -s, and -r and turns on -a.
–l	Generate a long report, which includes all fields except STIME.

What the *ps* Command Reports

When you type `ps -e` and press Return, you get a report that looks like this:

```
oak%/usr/bin/
ps -e
PID         TTY         TIME        COMD
0           ?           0:02        sched
1           ?           0:01        init
2           ?           0:00        pageout
192         ?           0:00        sac
79          ?           0:10        inetd
75          ?           0:01        in.route
136         ?           0:04        automoun
143         ?           0:01        cron
123         ?           0:01        statd
104         ?           0:01        rpcbind
106         ?           0:01        rpc.rwal
108         ?           0:01        rpc.ruse
110         ?           0:01        rpc.spra
113         ?           0:01        ypbind
115         ?           0:00        keyserv
117         ?           0:01        kerbd
127         ?           0:02        lockd
251         pts/0       0:00        ps
165         ?           0:00        sendmail
193         ?           0:01        ttymon
174         ?           0:03        syslogd
156         ?           0:01        lpsched
209         ?           0:02        in.rlogi
211         pts/0       0:03        csh
164         ?           0:00        lpNet
oak%
```

The columns are:

- **PID:** Process identification number.
- **TTY:** The terminal from which the process (or its parent) started. If the process has no controlling terminal, this column contains a question mark (?). Processes with question marks usually are system processes.
- **TIME:** The cumulative amount of CPU time used by the process.
- **COMD:** The name of the command that generated the process. Note that for the `ps -e` command only the first eight characters of the file name are displayed.

When you type `ps -el` and press Return, you get a listing that looks like this:

```
oak% /usr/bin/ps -el
 F S   UID   PID  PPID  C PRI NI     ADDR     SZ    WCHAN TTY      TIME COMD
19 T     Ø     Ø     Ø 8Ø   Ø SY fØ1Øf1c8      Ø          ?      Ø:Ø2 sched
 8 S     Ø     1  Ø251      1 2Ø ff1ad8ØØ     48 ff1ad9c4 ?      Ø:Ø1 init
19 S     Ø     2     Ø  Ø   Ø SY ff1adØØØ      Ø ff1adØ7d ?      Ø:ØØ pageout
 8 S     Ø   192     1 49   1 2Ø ff1f7ØØØ    238 ff2de348 ?      Ø:ØØ sac
 8 S     Ø    79     1 8Ø   1 2Ø ff2328ØØ    291 fØ1Øf1a4 ?      Ø:1Ø inetd
 8 S     Ø    75     1 8Ø   1 2Ø ff249ØØØ    258 fØ1Øf1a4 ?      Ø:Ø1 in.route
 8 S     Ø   136     1 8Ø   1 2Ø ff2c3ØØØ    327 fØ1Øf1a4 ?      Ø:Ø4 automoun
 8 S     Ø   143     1149   1 2Ø ff293ØØØ    287 ff2de448 ?      Ø:Ø1 cron
 8 S     Ø   123     1 8Ø   1 2Ø ff28eØØØ    27Ø fØ1Øf1a4 ?      Ø:Ø1 statd
 8 S     Ø   1Ø4     1 8Ø   1 2Ø ff25aØØØ    3Ø1 fØ1Øf1a4 ?      Ø:Ø1 rpcbind
 8 S     Ø   1Ø6     1 77   1 2Ø ff2588ØØ    272 fØ1Øf1a4 ?      Ø:Ø1 rpc.rwal
 8 S     Ø   1Ø8     1 8Ø   1 2Ø ff26Ø8ØØ    272 fØ1Øf1a4 ?      Ø:Ø1 rpc.ruse
 8 S     Ø   11Ø     1 78   1 2Ø ff2668ØØ    272 fØ1Øf1a4 ?      Ø:Ø1 rpc.spra
        (More information, not shown here)
```

Table 1–5 describes the fields in the long listing report.

Table 1–5 Summary of Fields in a *ps -el* Report

Field	Description	
F	Hexadecimal flags, which, added together, indicate the process's current state, as follows:	
	00	The process has terminated. Its place in the process table is free.
	01	The process is a system process and is always in memory.
	02	The process is being traced by its parent.
	04	The process is being traced by its parent and has been stopped.
	08	The process cannot be awakened by a signal.
	10	The process is currently in memory and is locked until an event completes.
	20	The process cannot be swapped.
S	The current state of the process, as shown by one of the following letters:	
	O	Currently running on the processor.
	S	Sleeping; waiting for an I/O event to complete.
	R	Ready to run.
	I	Idle; process is being created.
	Z	Zombie. The process has terminated and the parent is not waiting, but the dead process is still in the process table.
	T	Stopped because parent is tracing the process.
	X	Waiting for more memory.
UID	The user ID of the owner of the process.	

Table 1–5 Summary of Fields in a *ps -el* Report (continued)

Field	Description
PID	The process identification number.
PPID	The parent process's identification number.
C	The process's CPU use (that is, an estimate of the percentage of CPU time used by the process).
PRI	The process's scheduling priority. Higher numbers mean lower priority.
NI	The process's nice number, which contributes to its scheduling priority. Making a process "nicer" means lowering its priority so it does not use up as much CPU time.
SZ	The amount of virtual memory required by the process. This is a good indication of the demand the process puts on system memory.
TTY	The terminal from which the process (or its parent) started, or a question mark to indicate there is no controlling terminal (which usually indicates a system process).
TIME	The total amount of CPU time used by the process since it began.
COMD	The command that generated the process.

Using the *ps* Report

When you need to check on which processes or daemons are running, use the `ps -e` option. If you need more detailed information about a process, use the `ps -el` options. See the `ps`(1) manual page for a complete list of options. With experience, you will know how the report should look and be able to to judge what is out of the ordinary.

Here are some guidelines on how to spot potential problems:

- Look for many identical jobs owned by the same user. This may result from someone running a script that starts a lot of background jobs without waiting for any of the jobs to terminate. Talk to the user to find out if that's the case. If necessary, use the `kill` command to terminate some of the processes. See the following section for more information on killing a process.
- Look at the **TIME** field for processes that have accumulated a large amount of CPU time. Such processes might be in an endless loop.
- Look at the **C** field to find unimportant processes that consume a large percentage of CPU time. If you do not think a process warrants so much attention, use the `priocntl` command to lower its priority. See the `priocntl`(1M) manual page for more information.
- Look at the SZ field for processes that consume too large a percentage of memory. If a process is a memory hog, kill the process. If many processes are using lots of memory, the system may need more memory.

- Watch for a runaway process that uses progressively more CPU time. You can check this by using the `-f` option to see the start time (`STIME`) of the process and by watching the `TIME` field for the accumulation of CPU time.

Killing Processes

Sometimes you need to eliminate a process entirely. Use the kill command to do this. The syntax of the `kill` command is `kill -signal PID`, where *`signal`* is a number or a name.

CAUTION! *Kill a process only if you cannot get it to quit in the usual way.*

Sometimes processes do not die when you use the `kill` command. The three most common cases are:

- The process is waiting for a device, such as a tape drive, to complete an operation before exiting.
- The process is waiting for resources that are unavailable because of NFS problems. To kill such a process, type **`kill -QUIT`** ***`PID`***.
- The process is a zombie, as shown by the message *`defunct`* in the `ps` report. A zombie process is one that has had all its resources freed, but has not received an acknowledgment from a parent process, receipt of which would ordinarily remove its entry from the process table. The next time a system is booted, zombie processes are cleared. Zombies do not affect system performance, and you do not need to remove them.

To kill a process:

1. Become superuser. You must be superuser to kill a process that you do not own.
2. Type **`ps -e`** and press Return. A list of the processes is displayed. Use the PID (process ID) number in the first column as input to the next step. If you know which process is causing the problem, you can type **`ps -e | grep`** ***`process-name`*** and press Return to focus your search.
3. Type **`kill`** ***`PID`*** and press Return. When you type **`kill`** with no arguments, signal 15 is sent.
4. Type **`ps -e`** and press Return. Check to see if the process has terminated. If it's still there, go to step 5.
5. Type **`kill -9`** ***`PID`*** and press Return. The process should be terminated. Type **`man -s5 signal`** and press Return to see a description of the signals used by `kill`.

For example, if OpenWindows is frozen on the system `oak`, you must log in remotely and kill the process from another system:

```
elm% rlogin oak
Password:
oak% ps -e | grep openwin
```

```
PID TTY      TIME COMD
2212 pts/0   0:00 openwin
2213 pts/1    0:00 grep openwin
oak% su
Password:
oak# kill 2212
oak# exit
oak% logout
elm%
```

Using the */usr/proc/bin* Commands

The Solaris 2.6 release provides you with a set of commands that you can use to display detailed, technical information about active processes. These commands are summarized in Table 1–6.

Table 1–6 Process Tools in the */usr/proc/bin* Directory

Command	Description
`pstop pid`	Stop the process.
`prun pid`	Restart the process.
`ptime pid`	Time the process using microstate accounting.
`pwait pid`	Wait for specified processes to terminate.
`pcred pid*`	Display credentials.
`pfiles pid*`	Display `fstat` and `fcntl` information for open files.
`pflags pid*`	Show `/proc` tracing flags, pending and held signals, and other status information for each `lwp`.
`pldd pid*`	Show dynamic libraries linked into each process.
`pmap pid*`	Show address map space.
`psig pid*`	Display signal actions.
`pstack pid*`	Display hex+symbolic stack trace for each `lwp`.
`ptree pid`	Show process trees containing specified PIDs.
`pwdx pid*`	Display current working directory.

*Must be superuser to execute.

NOTE. *If you use the* `/usr/proc/bin` *commands frequently, add the process tool directory to your* PATH *variable to make the commands more easily accessible.*

All of the `/usr/bin/proc` commands use the process ID (PID) as the argument to the command. You can obtain the PID by using the `ps -e` and the `grep` commands to search for the name of the process you want more information about. The following example displays the PID for the `openwin` process in the first column:

```
oak% ps -e ¦ grep openwin
PID TTY       TIME COMD
2212 pts/0    0:00 openwin
2213 pts/1     0:00 grep openwin
oak%
```

Displaying and Controlling Information About Processes

Follow these steps to display and control information about a process:

1. Type `ps -e ¦ grep` ***process-name*** and press Return. The first column of the output displays the PID for the appropriate process name.
2. Become superuser to use `pcred`, `pfiles`, `pflags`, `pldd`, `pmap`, `psig`, `pstack`, and `pwdx` commands.
3. Type ***pcommand PID*** and press Return. The information for the specified command is displayed.

The following examples show the output for each of the `/usr/proc/bin` commands for the `dtlogin` PID of 283:

```
castle% ps -e ¦ grep dtlogin
   283 ?        0:00 dtlogin
   270 ?        0:01 dtlogin
castle%
# /usr/proc/bin/pcred 283
283:     e/r/suid=0  e/r/sgid=0
         groups: 1 0 2 3 4 5 6 7 8 9 12
# exit
castle% /usr/proc/bin/ptime 283
/ptime: exec failed

real        0.016
user        0.000
sys         0.016
castle%
# /usr/proc/bin/pfiles 283
283:     /usr/dt/bin/dtlogin -daemon
  Current rlimit: 64 file descriptors
   0: S_IFDIR mode:0755 dev:32,24 ino:2 uid:0 gid:0 size:1024
      O_RDONLY¦O_LARGEFILE
   1: S_IFDIR mode:0755 dev:32,24 ino:2 uid:0 gid:0 size:1024
      O_RDONLY¦O_LARGEFILE
   2: S_IFREG mode:0644 dev:32,24 ino:326220 uid:0 gid:0 size:49
      O_WRONLY¦O_APPEND¦O_LARGEFILE
   3: S_IFCHR mode:0666 dev:32,24 ino:406038 uid:0 gid:3 rdev:13,12
      O_RDWR
   4: S_IFIFO mode:0666 dev:171,0 ino:4124779288 uid:0 gid:0 size:0
      O_RDWR¦O_NONBLOCK
   5: S_IFREG mode:0644 dev:32,24 ino:326221 uid:0 gid:0 size:4
      O_WRONLY¦O_LARGEFILE
```

```
      advisory write lock set by process 270
   7: S_IFSOCK mode:0666 dev:166,0 ino:32032 uid:0 gid:0 size:0
      O_RDWR
   8: S_IFDOOR mode:0444 dev:171,0 ino:4124780632 uid:0 gid:0 size:0
      O_RDONLY|O_LARGEFILE FD_CLOEXEC  door to nscd[174]
#
# /usr/proc/bin/pflags 283
283:    /usr/dt/bin/dtlogin -daemon
  /1:   flags = PR_PCINVAL|PR_ORPHAN|PR_ASLEEP [ wait() ]
#
# /usr/proc/bin/pldd 283
283:    /usr/dt/bin/dtlogin -daemon
/usr/openwin/lib/libXmu.so.4
/usr/openwin/lib/libX11.so.4
/usr/dt/lib/libDtSvc.so.1
/usr/lib/libresolv.so.2
/usr/lib/libdl.so.1
/usr/lib/libbsm.so.1
/usr/lib/libauth.so.1
/usr/lib/libsocket.so.1
/usr/lib/libnsl.so.1
/usr/dt/lib/libSDtFwa.so.1
/usr/lib/libc.so.1
/usr/openwin/lib/libXt.so.4
/usr/openwin/lib/libSM.so.6
/usr/openwin/lib/libICE.so.6
/usr/openwin/lib/libXext.so.0
/usr/lib/libm.so.1
/usr/openwin/lib/libtt.so.2
/usr/dt/lib/libXm.so.3
/usr/lib/libmp.so.2
/usr/lib/nss_files.so.1
/usr/lib/libpam.so.1
#
# /usr/proc/bin/pmap 283
283:    /usr/dt/bin/dtlogin -daemon
00010000    108K read/exec           /usr/dt/bin/dtlogin
0003A000     32K read/write/exec     /usr/dt/bin/dtlogin
00042000     80K read/write/exec       [ heap ]
EEE90000     12K read/shared         dev:32,24 ino:196384
EEEA0000     12K read/shared         dev:32,24 ino:196384
EEEB0000     12K read/shared         dev:32,24 ino:196384
EEEC0000      8K read/write            [ anon ]
EEF11000      4K read/write            [ anon ]
EEF89000      4K read/write            [ anon ]
EF001000      4K read/write            [ anon ]
EF060000     24K read/exec           /usr/lib/libpam.so.1
EF075000      4K read/write/exec     /usr/lib/libpam.so.1
(More information, not shown here)
EF7C0000      4K read/exec/shared    /usr/lib/libdl.so.1
EF7D0000    112K read/exec           /usr/lib/ld.so.1
EF7FB000      8K read/write/exec     /usr/lib/ld.so.1
EF7FD000      4K read/write/exec       [ anon ]
EFFF9000     28K read/write/exec       [ stack ]
 total     5480K
#
```

```
# /usr/proc/bin/psig 283
283:    /usr/dt/bin/dtlogin -daemon
HUP     ignored
INT     caught  RESETHAND,NODEFER
QUIT    ignored
ILL     default
TRAP    default
ABRT    default
EMT     default
FPE     default
KILL    default
BUS     default
SEGV    default
SYS     default
PIPE    ignored
ALRM    default
TERM    caught  RESETHAND,NODEFER
USR1    caught  RESETHAND,NODEFER
USR2    default
CLD     default NOCLDSTOP
PWR     default
WINCH   default
URG     default
POLL    default
STOP    default
TSTP    default
CONT    default
TTIN    ignored
TTOU    default
VTALRM  default
PROF    default
XCPU    ignored
XFSZ    ignored
WAITING default
LWP     default
FREEZE  default
THAW    default
CANCEL  default
LOST    default
RTMIN   default
RTMIN+1 default
RTMIN+2 default
RTMIN+3 default
RTMAX-3 default
RTMAX-2 default
RTMAX-1 default
RTMAX   default
#
# /usr/proc/bin/pstack 283
283:    /usr/dt/bin/dtlogin -daemon
 ef479154 wait     ()
 ef479154 _libc_wait (0, 3ec4c, 3b000, 12d, ef4e227c, 1e340) + 8
 0001e340 ManageSession (43000, 43000, 482f8, ef001230, 81010100, c) + 454
 00019348 StartDisplay (482f8, 3c954, 43000, 3b224, ef001240, ff00) + 7bc
 0001a324 ForEachDisplay (189a8, 0, 2400, 41800, 42e48, 17ca8) + 1c
 00017d54 main     (0, effffefc, efffff08, 3b000, 0, 0) + 228
```

```
 0001541c _start   (0, 0, 0, 0, 0, 0) + dc
#
# /usr/proc/bin/pwdx 283
283:    /
#
castle% /usr/proc/ptime 283

real        0.066
user        0.000
sys         0.032
castle%
castle% ptree 283
270   /usr/dt/bin/dtlogin -daemon
  283   /usr/dt/bin/dtlogin -daemon
    301   /bin/ksh /usr/dt/bin/Xsession
      311   /usr/openwin/bin/fbconsole
      346   /usr/dt/bin/sdt_shell -c unsetenv _ PWD;             unsetenv DT;
        349   -csh -c unsetenv _ PWD;              unsetenv DT;      setenv DISP
          366   /usr/dt/bin/dtsession
            373   dtwm
            374   dtterm -session dt0vPI0t -sdtserver
              387   /bin/csh
                407   ./textedit
                528   sh
              390   /bin/csh
              393   /bin/csh
                417   /usr/openwin/bin/cmdtool
                  420   /bin/csh
              531   /bin/csh
                553   ptree 283
            375   dtfile -session dtbfiQD_
              405   dtfile -session dtbfiQD_
            376   snapshot -Wp 781 588 -Ws 326 201 -WP 6 6 +Wi -f snapshot.rs
castle%
```

NEW

The Priority Control Command (*priocntl*)

You can use the `priocntl` command to display or set scheduling parameters of specified processes. You can also use it to display the current configuration information for the process scheduler of a system or to execute a command with specified scheduling parameters.

Each process has a distinct class with a separate scheduling policy assigned to each class. The possible classes that are configured on your system are:

- System (SYS)
- Interactive (IA)
- Real-time (RT)
- Timesharing (TS)

For the timesharing class the user-supplied priority ranges from -20 to +20. The priority of a timeshare process, referred to as the user-mode priority, is inherited from the parent process. The system looks up the user-mode priority in its timesharing dispatch parameter table and adds in any `nice` or `priocntl` (user-supplied) priority and ensures a 0–59 range to create a global priority.

In the default configuration, a runnable real-time process runs before any other process. Inappropriate use of real-time processes can have a dramatic negative impact on system performance.

Displaying Basic Information About Process Classes

Follow this procedure to display basic information about process classes:

- Type `priocntl -l` and press Return. The process class and scheduling parameters for the system are displayed.

In this example, all classes are defined:

```
castle% priocntl -l
CONFIGURED CLASSES
==================

SYS (System Class)

TS (Time Sharing)
        Configured TS User Priority Range: -60 through 60

IA (Interactive)
        Configured IA User Priority Range: -60 through 60
RT (Real Time)
        Maximum Configured RT Priority: 59
castle%
```

Displaying the Global Priority of a Process

You can use the `ps -ecl` command to display the global priority of a process. The global priority is listed under the `PRI` column.

The following example shows the output from the `ps -ecl` command. Data in the `PRI` column shows that `pageout` has the highest priority at 98, and `powerd` has the lowest at 16:

```
castle% ps -ecl
 F S   UID   PID  PPID  CLS PRI     ADDR     SZ    WCHAN TTY       TIME CMD
19 T     0     0     0  SYS  96 f0274e38      0          ?         0:01 sched
 8 S     0     1     0   TS  58 f5b2d888    162 f5b2da80 ?         0:00 init
19 S     0     2     0  SYS  98 f5b2d1c8      0 f02886a4 ?         0:00 pageout
19 S     0     3     0  SYS  60 f5b2cb08      0 f028aeb4 ?         0:11 fsflush
 8 S     0   205     1   TS  58 f5b2b6c8    448 f5d47b26 ?         0:00 sendmail
 8 S     0    91     1   TS  58 f5d10890    340 f597e07e ?         0:00 in.route
 8 S     0   277     1   TS  58 f5b2b008    350 f591ac78 ?         0:00 sac
 8 S     0   101     1   TS  58 f5b2bd88    445 f597e02e ?         0:00 rpcbind
 8 S     0   174     1   TS  52 f5b2c448    480 f5b2c640 ?         0:00 nscd
 8 S     0   128     1   TS  42 f5d101d0    446 f5d47f86 ?         0:00 inetd
```

```
 8 S     0   103     1   TS  20 f5d0fb10    462 f5d47fae ?         0:00 keyserv
 8 S     0   150     1   TS  58 f5d0f450    558 f5d47d7e ?         0:00 automoun
 8 S     0   133     1   TS  53 f5d0ed90    502 f5d47f5e ?         0:00 statd
 8 S     0   135     1   TS  33 f5d0e6d0    409 f5d47ee6 ?         0:00 lockd
 8 S     0   280   257   TS  48 f5d0e010    380 f5cc5706 ?         0:00 mibiisa
 8 S     0   154     1   TS  32 f5dea898    697 f5d47d56 ?         0:00 syslogd
 8 S     0   168     1   TS  48 f5dea1d8    360 f591aeb8 ?         0:00 cron
 8 S     0   184     1   TS  53 f5de9b18    648 f5d47c66 ?         0:00 lpsched
 8 S     0   285     1   IA  59 f5de9458    471 f5d47716 ?         0:00 fbconsol
 8 S     0   227     1   TS  52 f5de8d98    518 f5d479be ?         0:01 vold
 8 S     0   202     1   TS  16 f5de86d8    215 f5de88d0 ?         0:00 powerd
 8 S     0   215     1   TS  59 f5de8018    214 f5d47b4e ?         0:00 utmpd
 8 S  1001   282   270   IA  59 f5e4c8a0   2360 f5d47806 ?         0:34 Xsun
 8 S     0   278     1   TS  38 f5e4a6e0    368 f5d4782e console   0:00 ttymon
 8 S     0   257     1   TS  58 f5e4a020    444 f5d4791e ?         0:00 snmpdx
 8 S     0   268     1   TS  58 f5e6e8a8    738 f5eaf1f6 ?         0:00 snmpXdmi
 8 S     0   283   270   IA  59 f5e4bb20   1370 f5e4bb90 ?         0:00 dtlogin
 8 S     0   266     1   TS  58 f5e4b460    591 f5d478f6 ?         0:00 dmispd
 8 S     0   270     1   TS  48 f5e4ada0   1344 f597e6e6 ?         0:01 dtlogin
 8 S     0   281   277   TS  58 f5e4c1e0    371 f5e4c3d8 ?         0:00 ttymon
 8 S  1001   311   301   IA  59 f5e6e1e8    471 f5d476ee ?         0:00 fbconsol
 8 S  1001   301   283   IA  59 f5e6db28    392 f5e6db98 ?         0:01 Xsession
 8 S  1001   349   346   IA  59 f5e6d468    256 f5e6d660 pts/2     0:00 csh
 8 S  1001   315     1   IA  59 f5e6cda8    982 f5d476c6 ?         0:00 speckeys
 8 S  1001   366   349   IA  42 f5e6c6e8   1410 f5d47586 pts/2     0:01 dtsessio
 8 S  1001   374   366   IA  59 f5e6c028   1655 f5d474be ??        0:16 dtterm
 8 S  1001   346   301   IA  59 f5ef38b0   1211 f5d47676 pts/2     0:00 sdt_shel
 8 S  1001   347     1   IA  59 f5ef31f0    478 f5d47626 ?         0:00 dsdm
 8 S     0   367   128   TS  32 f5ef2b30    676 f5d475ae ?         0:00 rpc.ttdb
 8 S  1001   365     1   IA  59 f5ef2470    903 f5d475d6 pts/2     0:01 ttsessio
 8 S  1001   375   366   IA  49 f5ef1db0   1702 f5d474e6 ?         0:03 dtfile
 8 S  1001   376   366   IA  48 f5ef16f0   1118 f5d4750e ?         0:01 snapshot
 8 S  1001   373   366   IA  59 f5ef1030   1710 f5d4755e ?         0:04 dtwm
 8 S  1001   393   374   IA  43 f5f468b8    253 f5f93386 pts/5     0:00 csh
 8 S  1001   378     1   IA  59 f5f461f8    385 f5f46268 ?         0:00 sdtvolch
 8 S  1001   405   375   IA  59 f5f45b38   1687 f5f76738 ?         0:00 dtfile
 8 S  1001   445   378   IA  55 f5f45478    193 f591aaf8 ?         0:00 cat
 8 S  1001   387   374   IA  59 f5f44db8    255 f5f44fb0 pts/3     0:00 csh
 8 S  1001   407   387   I   48 f5f446f8   1140 f5d4732e pts/3     0:02 textedit
 8 S  1001   390   374   IA  55 f5f44038    252 f5f93986 pts/4     0:00 csh
 8 S  1001   417   393   IA  48 f5fa58c0    916 f5d472de pts/5     0:01 cmdtool
 8 S  1001   420   417   IA  48 f5fa5200    252 f5fc2b96 pts/6     0:00 csh
 8 S  1001   531   374   I   49 f5fa4480    256 f5fa4678 pts/7     0:00 csh
 8 O     0    56   531   IA  29 f5fa3dc0    199          pts/7     0:00 ps
 8 S     0   528   387   IA  58 f5fa3040     69 f5f8427e pts/3     0:00 sh
castle%
```

You can also use the `/usr/sbin/dispadmin -l` command to display process scheduler information.

The following example shows the output from the `displadmin -l` command:

```
castle% /usr/sbin/dispadmin -l
CONFIGURED CLASSES
==================
```

```
SYS     (System Class)
TS      (Time Sharing)
IA      (Interactive)
castle%
```

For complete information, refer to the `dispadmin`(1M) manual page.

Designating a Process Priority

Follow these steps to designate a process priority:

1. Become superuser.
2. Type **`priocntl -e -c`** ***`class -m user-limit -p priority command-name`*** and press Return. The `-e` option executes the command, the `-c` class option specifies the class. Default classes are `TS` (timesharing) or `RT` (real-time). The `-m` user-limit option specifies the maximum amount you can raise or lower your priority with the `-p` option. The `-p` priority command-name option enables you to specify the relative priority, in the RT class for a real-time thread. For a timesharing process, the -p option enables you to specify the user-supplied priority, which ranges from -20 to +20.
3. While the process is running, in another shell, type **`ps -ecl ¦ grep`** ***`command-name`*** and press Return.
4. Review the output of the `PRI` column to verify that you have changed the process status successfully.

The following example starts the `find` command with the highest possible user-supplied priority:

```
castle% priocntl -e -c TS -m 20 -p 20 find / -name core -print
castle% ps -ecl ¦ grep find
 8 S     0   632   528    TS  60 f5fa4b40    200 f5ff7ba0 pts/3    0:03 find
castle%
```

Changing the Scheduling Parameters of a Timeshare Process

Follow these steps to schedule the parameters of a timeshare process:

1. Become superuser.
2. Type **`priocntl -s -m`** ***`user-limit [-p priority] -i id-type id-list`*** and press Return. The `-s` option enables you to set the upper limit on the user priority range and change the current priority. The `-m` user-limit option specifies the maximum amount you can raise or lower your priority with the `-p` option. The `-p` priority command-name option enables you to designate a priority. The `-i` *`id-type`* and *`id-list`* option uses a combination of *`id-type`* and *`id-list`* to identify the process. The *`id-type`* specifies the type of ID, such as PID or UID.
3. Type **`ps -ecl ¦ grep`** ***`id-list`*** and press Return.

4. Review the output of the PRI column to verify that you have changed the process status successfully.

The following example executes a command with a 500-millisecond time slice, a priority of 20 in the `RT` class, and a global priority of 120:

```
oak% priocntl -s -c RT -t 500 -p 20 myprog
oak% ps -ecl ¦ grep myprog
```

Changing the Class of a Process

Follow these steps to change the class of a process:

NOTE. *You must be superuser or working in a real-time shell to change the class of a process from or to real-time.*

1. Become superuser.
2. Type `priocntl -s -c` ***`class -i id-type id-list`*** and press Return. The `-s` option enables you to set the upper limit on the user priority range and change the current priority. The `-c` class option specifies the class, `TS` or `RT`, to which you are changing the process. The *`-i id-type`* and *`id-list`* options uses a combination of *`id-type`* and *`id-list`* to identify the process. The *`id-type`* specifies the type of ID, such as PID or UID.
3. Type `ps -ecl ¦ grep` ***`id-list`*** and press Return.
4. Review the output of the PRI column to verify that you have changed the process status successfully.

The following example changes all the processes belonging to user 1001 to real-time processes:

```
# priocntl -s -c RT -i uid 1001
# ps -ecl ¦ grep 1001
 8 S  1001   282   270   RT 100 f5e4c8a0  2392 f5d47806 ?       0:48 Xsun
 8 S  1001   311   301   RT 100 f5e6e1e8   471 f5d476ee ?       0:00 fbconsol
 8 S  1001   301   283   RT 100 f5e6db28   392 f5e6db98 ?       0:01 Xsession
 8 S  1001   349   346   RT 100 f5e6d468   256 f5e6d660 pts/2   0:00 csh
 8 S  1001   315     1   RT 100 f5e6cda8   982 f5d476c6 ?       0:00 speckeys
 8 S  1001   366   349   RT 100 f5e6c6e8  1410 f5d47586 pts/2   0:01 dtsessio
 8 S  1001   374   366   RT 100 f5e6c028  1814 f5d474be ??      0:24 dtterm
 8 S  1001   346   301   RT 100 f5ef38b0  1211 f5d47676 pts/2   0:00 sdt_shel
 8 S  1001   347     1   RT 100 f5ef31f0   478 f5d47626 ?       0:00 dsdm
 8 S  1001   365     1   RT 100 f5ef2470   903 f5d475d6 pts/2   0:01 ttsessio
 8 S  1001   375   366   RT 100 f5ef1db0  1702 f5d474e6 ?       0:03 dtfile
 8 S  1001   376   366   RT 100 f5ef16f0  1118 f5d4750e ?       0:01 snapshot
 8 S  1001   373   366   RT 100 f5ef1030  1710 f5d4755e ?       0:06 dtwm
 8 S  1001   393   374   RT 100 f5f468b8   253 f5f93386 pts/5   0:00 csh
 8 S  1001   378     1   RT 100 f5f461f8   385 f5f46268 ?       0:00 sdtvolch
 8 S  1001   405   375   RT 100 f5f45b38  1687 f5f76738 ?       0:00 dtfile
 8 S  1001   445   378   RT 100 f5f45478   193 f591aaf8 ?       0:00 cat
 8 S  1001   387   374   RT 100 f5f44db8   255 f5f44fb0 pts/3   0:00 csh
 8 S  1001   407   387   RT 100 f5f446f8  1140 f5d4732e pts/3   0:03 textedit
```

```
 8 S  1001   390   374   RT 100 f5f44038    252 f5f93986 pts/4    0:00 csh
 8 S  1001   417   393   RT 100 f5fa58c0    916 f5d472de pts/5    0:01 cmdtool
 8 S  1001   420   417   RT 100 f5fa5200    252 f5fc2b96 pts/6    0:00 csh
 8 S  1001   531   374   RT 100 f5fa4480    256 f5ff62a6 pts/7    0:00 csh
 8 S  1001   634   374   RT 100 f5fa3dc0    252 f5ff68a6 pts/8    0:00 csh
#
```

NEW

Changing the Priority of a Process (*nice*)

You can use the `nice` command to raise or lower the priority of a command or a process. When you use the `nice` command without an argument, the default is to increase the `nice` number by four units, thus lowering the priority of the process.

NOTE. *You must be superuser to change the priority of a process by using the nice command.*

Use the following command to lower the priority of a command by four units (the default):

`/usr/bin/nice` *`command-name`*

Use the following command to lower the priority of a command by increasing the nice number by ten units:

`/usr/bin/nice +10` *`command-name`*

NOTE. *The plus sign (+) is optional for positive numbers. The minus sign (-) is required for negative numbers.*

Use the following command to raise the priority of a command by lowering the `nice` number by 10 units:

`/usr/bin/nice -10` *`command-name`*

Use the following command to raise the priority of a command by lowering the nice number by 10 units. The first minus sign is the option sign, and the second minus sign indicates a negative number:

`/usr/bin/nice - -10` *`command-name`*

NEW

Troubleshooting Processes

The following list provides some tips for troubleshooting problems with processes:

- Look for several identical jobs owned by the same user. This situation may result from running a script that starts a lot of background jobs without waiting for any of the jobs to finish.
- Look for a process that has accumulated a large amount of CPU time in the `TIME` field. The process may be in an endless loop.

- Look for a process running with a priority that is too high. Type `-s -c` to display the `CLS` field with the scheduler class of each process. A process executing as a real-time (`RT`) process can monopolize the CPU. Alternatively, look for a timeshare (`TS`) process with a high `nice` value. A user with superuser privileges may have bumped up the priorities of this process. You can lower the priority by using the `nice` command.
- Look for a runaway process—one that progressively uses more and more CPU time. You can monitor the process by looking at the time when the process started (`STIME`) and by watching the accumulation of CPU time (`TIME`) for a while.

Reviewing Essential Administration Tools

The SunOS 5.*x* system software provides you with three kinds of administration tools:

- The usual collection of operating system commands.
- An administration tool (Admintool) with a graphical user interface.
- The unbundled Solstice AdminSuite with a graphical user interface. For an introduction to the Solstice AdminSuite, see "Introducing the Solstice AdminSuite Product."

Frequently Used Commands

The following sections briefly introduce basic SunOS 5.*x* commands that you are likely to use regularly as part of routine system administration; they are grouped by tasks. See "Basic OS Commands" in Chapter 2 for more frequently used commands. See Appendix A for a list of SunOS 4.*x* commands and their SunOS 5.*x* equivalents.

Getting Around in the File System

SunOS 5.*x* system software has a hierarchical file system. When administering systems, you need to know where you are in the file hierarchy and how to change to a different directory.

Finding Where You Are in the File System To find out where you are in the file system hierarchy, type **pwd** and press Return. The print working directory command displays the current directory.

```
oak& pwd
/etc
oak%
```

Changing Directories To change directories, type **cd *pathname*** and press Return. The change directory command puts you in the directory name you type:

```
oak% cd /usr
oak% pwd
```

```
/usr
oak%
```

If you type `cd` and press Return without typing a path name, you are returned to the login home directory.

Finding Information About Files

Using the `ls` command, you can list the contents of a directory and display permissions, links, ownership, group, size (in bytes), modification date and time, and file name for files. Many user problems related to accessing files can be traced to problems with incorrect permissions or ownership. See Chapter 10, "Recognizing File Access Problems," for more information.

Displaying File Information

To display information about an individual file, type **`ls -l`** ***`filename`*** and press Return. Permissions, links, owner, group, file size in bytes, modification date and time, and the file name are displayed:

```
oak% ls -l /etc/passwd
-r--r--r--   1 root     sys          659 Feb 24 17:28 /etc/passwd
oak%
```

To see a complete list for all the files in the directory, type **`ls -l`** and press Return. See the `ls` manual page for a complete list of options.

Finding a File

To find a file by searching from the home directory, type **`find $HOME -name`** ***`filename`*** **`-print`** and press Return. The `$HOME` variable starts the search with the home directory. The `-name` option looks for the name specified in the *`filename`* variable. The `-print` option displays the results of the find. If the named file is not found, the prompt is redisplayed.

This example shows the results of a find looking for core files:

```
oak% find $HOME -name core -print
/home/ignatz/core
oak%
```

Table 1–7 shows some of the options to the find command that you can use to focus your searches.

Table 1–7 Options to the *find* Command

Option	Description
`-fstype type`	Finds files of the file system type you specify (typically `ufs` or `nfs`).
`-prune`	Limits the search to the specified directory.
`-nouser`	Finds files that belong to a user not in the `/etc/passwd` database.
`-nogroup`	Finds files that belong to a group not in the `/etc/group` database.
`-atime n`	Finds files that have been accessed within the last n days.
`-mtime n`	Finds files that have been modified within the last n days.
`-ctime n`	Finds files that have been changed within the last n days. Changes can include changing its attribute such as the number of links, its owner, or its group.
`-Xdev`	Restrict search to one file system.

See the `find`(1) manual page for a complete list of options.

Finding the Type of a File

Sometimes you need to determine the type of a file. To find the type of a file, type **`file`** ***`filename`*** and press Return. The output of the command makes an educated guess about the type of the file.

For example, if a user is trying to execute an ASCII file that does not have execute permissions, or execute an empty file, displaying the file type will tell you whether the system recognizes the file as a command.

In this example, the file is empty:

```
anastasia% file junk
junk: empty file
anastasia%
```

In this example, the file is an ASCII text file:

```
anastasia% file junk
junk: ascii text
anastasia%
```

In this example, the file is a text file with executable permissions, so the `file` command reports that the file contains commands and is text:

```
anastasia% chmod 777 junk
anastasia% file junk
```

```
junk: commands text
anastasia%
```

NOTE. *You can, of course, determine if the command has execute permissions using the* `ls -l` *command.*

To show the file type for all files in a directory, type **`file *`** and press Return. The files are listed in alphabetical order followed by the file type:

```
$ file *

coterie:     directory
course:      ascii text
dead.letter  ascii text
ksyms        English text
people:      directory
personal:    directory
showrev:     ascii text
status:      directory
text:        directory
todo:        ascii text
$
```

Finding Information in Files

You can use the `grep` and `egrep` commands to search files and command output for specific information.

Searching Files for Text Strings To search files for a specific text string, type **`grep`** ***`search-string filenames`*** and press Return. Lines in the files containing the string are displayed.

In this example, the `passwd` file is searched for lines containing `csh`:

```
oak% grep csh /etc/passwd
ignatz::6693:10:Iggy Ignatz 64607:/home/ignatz:/bin/csh
fred::14072:10:Fred Lux:/home/fred:/bin/csh
oak%
```

You can search more than one file by specifying a series of file names separated by spaces, or by using *metacharacters* such as the asterisk (`*`) or question mark (`?`) together with (or in place of) the file name.

To print out lines that do not contain the specified string, type **`grep -v`** ***`search-string filename`*** and press Return. Lines in the file that do not contain the string are displayed.

Searching Input for Lines with a Given Pattern You can use the `grep` command with pipes in combination with many administrative commands. For example, if you want to find all of a user's current processes, pipe the output of the `ps` command to `grep` and search for the user name, type **`ps -e | grep`** ***`name`***, and press Return. The listing for the name you specify is displayed.

For example, to find the OpenWindows process:

```
oak% ps -e | grep openwin
PID TTY      TIME COMD
2212 pts/0    0:00 openwin
oak%
```

Looking at Files

You will undoubtedly spend lots of time looking at the content of files. When you need to look at the entire file, use the `more` command. When the information you need is at the end of the file (for example, in a log file), use the `tail` command to display the last 10 lines of the file. When important information is at the beginning of the file, use the `head` command to display the first 10 lines of the file.

Viewing a File

To view a file, type **more *filename*** and press Return. The file is displayed one screen at a time. Press the Spacebar to view the next screen.

To search for a specific string in a file you are viewing with more, type **/ *search-string*** and press Return. The text scrolls to display the place in the file that contains the text you type as the *search-string* variable and displays the search string and the message `. . . skipping` at the top of the window. If there is no match, the message `Pattern not found` is displayed at the bottom of the window and the text does not scroll.

For example, to find the words **Local aliases** in the `/etc/mail/aliases` file, type **/Local aliases** and press Return:

```
/Local aliases
...skipping

########################
# Local aliases below #
########################
```

NOTE. *You must use exact capitalization in the search string for the* `more` *command. If you type* **/local aliases** *in the previous example, the pattern is not found.*

To search for the next occurrence of the search string, type **n**. To quit `more`, type **q**. The shell prompt is redisplayed.

Another way to quit `more`, if Control-C is set as your shell kill character, is to press Control-C. The shell prompt is redisplayed.

To display the shell intr character, type **stty -a** and press Return. A list of the `stty` settings is displayed. In this example, `^c` is the shell `intr` character:

NEW

```
castle% stty -a
ispeed 88840 baud; ospeed 88824 baud;
rows = 36; columns = 113; ypixels = 478; xpixels = 801;
eucw 1:0:0:0, scrw 1:0:0:0
intr = ^c; quit = <undef>; erase = ^h; kill = ^u;
eof = ^d; eol = <undef>; eol2 = <undef>; swtch = <undef>;
start = ^q; stop = ^s; susp = ^z; dsusp = ^y;
```

```
rprnt = ^r; flush = ^o; werase = ^w; lnext = ^v;
-parenb parodd cs8 cstopb hupcl cread -clocal loblk crtscts crtsxoff parext
-ignbrk -brkint -ignpar -parmrk -inpck -istrip -inlcr -igncr icrnl -iuclc
ixon -ixany ixoff -imaxbel
isig icanon -xcase echo echoe echok -echonl -noflsh
-tostop echoctl -echoprt echoke -defecho -flusho -pendin iexten
opost -olcuc onlcr -ocrnl -onocr -onlret -ofill -ofdel
castle%
```

Looking at the End of a File

To look at the end of a file, type **tail** ***filename*** and press Return. The last 10 lines of the file (by default) are displayed.

This example shows the tail of the `/etc/lp/Systems` file:

NEW

```
castle% /usr/bin/tail /etc/lp/Systems
#
#ident  "@(#)Systems    1.8     97/06/09 SMI"   /* SVr4.0 1.2   */
# This file previously contained an LP private interface.  It's
# contents are no longer used by the printing system and therefore
# obsolete.  Expect the file to be removed in a subsequent release
# of Solaris, along with the lpsystem(1M) command.
+:x:-:bsd:-:n:10:-:-:Allow all connections
castle%
```

By default, the head and tail commands display 10 lines. You can change the number of lines displayed by using the `-n` option. Substitute the number of lines you want to display for the letter *n*. For example, to display the last 20 lines of a file, type `tail` **`-20`** ***`filename`*** and press Return.

NOTE. `tail` *shows a maximum of 4096 bytes (about 400 lines).*

Looking at the Beginning of a File

To look at the beginning of a file, type **`head`** ***`filename`*** and press Return. The first 10 lines of the file are displayed.

This example shows the head of the `/etc/passwd` file:

NEW

```
castle% /usr/bin/head /etc/passwd
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:
smtp:x:0:0:Mail Daemon User:/:
uucp:x:5:5:uucp Admin:/usr/lib/uucp:
nuucp:x:9:9:uucp Admin:/var/spool/uucppublic:/usr/lib/uucp/uucico
listen:x:37:4:Network Admin:/usr/net/nls:
castle%
```

Changing File Ownership or Permissions

Many user problems can be traced to file ownership or permissions problems. Use the `ls` command to check the permissions and ownership on a file. If you need to change one or both, use the `chown`, `chmod`, and `chgrp` commands.

Changing File Ownership You must own a file or directory (or have root permission) to be able to change its owner:

1. Type **`ls -l`** ***`filename`*** and press Return. The owner of the file is displayed in the third column.
2. Become superuser.
3. Type **`chown`** ***`new-owner filename`*** and press Return. Ownership is assigned to the new owner you specify:

```
oak% ls -l quest
-rw-r--r--   1 fred    staff    6023 Aug  5 12:06 quest
oak% su
Password:
# chown ignatz quest
# ls -l quest
-rw-r--r--   1 ignatz   staff    6023 Aug  5 12:06 quest
#
```

See Chapter 10, "Recognizing File Access Problems," for more information.

Changing File Permissions You can change file permissions by using the symbolic values `r`, `w`, `x`, and `-`. You can also change file permissions by using a set of octal numbers. Table 1–8 shows the octal values for setting file permissions. You use these numbers in sets of three to set permissions for owner, group, and other. For example, the value `644` sets read/write permissions for owner and read-only permissions for group and other.

Table 1–8 Octal Values for File Permissions

Value	Description
0	No permissions
1	Execute-only
2	Write-only
3	Write, execute
4	Read-only
5	Read, execute
6	Read, write
7	Read, write, execute

1. Type `ls -l` ***filename*** and press Return. The long listing shows the current permissions for the file.
2. Type `chmod` ***nnn filename*** and press Return. Permissions are changed using the numbers you specify.

NOTE. *You can change permissions on groups of files, or on all files in a directory using metacharacters such as (*?) in place of file names or in combination with them.*

This example changes the permissions of a file from 666 (read/write, read/write, read/write) to 644 (read/write, read-only, read-only):

```
oak% ls -l quest
-rw-rw-rw-  1 ignatz   staff    6023 Aug  5 12:06 quest
oak% chmod 644 quest
oak% ls -l
-rw-r--r--  1 ignatz   staff    6023 Aug  5 12:06 quest
oak%
```

Changing File Group Ownership

To change the group ownership of a file, type `chgrp` ***gid filename*** and press Return. The group ID for the file you specify is changed:

```
$ ls -lg junk
-rw-r--r-- 1 other 0 Oct 31 14:49 junk
$ chgrp 10 junk
$ ls -lg junk
-rw-r--r-- 1 staff 0 Oct 31 14:49 junk
$
```

Group IDs are defined in the Group database or the local `/etc/group` file. See Chapter 7, "Administering User Accounts and Groups," for more information about groups.

Setting or Displaying the System Environment

The shell maintains an environment with a set of specifications that it gets from the shell initialization files. Users can also modify the shell environment for a session by issuing commands directly to the shell. The shell receives its information about the environment from environment variables. The SunOS 5.*x* system software provides several default environment variables:

- `PS1`: Defines the shell prompt. The default prompt for the Bourne and Korn shells is `$`. The default prompt for the C shell is `%`. The default prompt for root in either shell is `#`. Users can specify a different shell prompt in the `.profile`, `.login`, or `.cshrc` files.
- `HOME`: Defines the absolute path to the user's home directory. The default value for `HOME` is automatically defined and set to the login directory specified in the `/etc/passwd` file as part of the login process. The shell subsequently uses this information to determine the directory to change to when you type the `cd` command without an argument.

- **LOGNAME:** Defines the user's login name. The default value for LOGNAME is automatically defined and set to the login name specified in the /etc/passwd file as part of the login process.
- **PATH:** Lists, in order, the directories that the shell searches to find the program to run when the user types a command. If the directory is not in the search path, users must type the complete pathname of a command. The default PATH is automatically defined and set as specified in .profile (Bourne or Korn shell), or .cshrc (C shell) as part of the login process. The order of the search path is very important. When identically named commands exist in different locations, the first command found with that name is used. For example, suppose that PATH is defined (in Bourne and Korn shell syntax) as PATH=/bin:/usr/bin:/usr/sbin:$HOME/bin and a file named sample resides in both /usr/bin and /home/jean/bin. If the user types the command sample without specifying its full path name, the version found in /usr/bin is used.

NEW

The LANG and LC environment variables specify the locale-specific conversions and conventions for the shell, such as time zones, collation order, format of dates, time, currency, and numbers. In addition, you can use the stty command in a user initialization file to set whether the system supports multibyte characters.

LANG sets all possible conversions and conventions for the given locale. If you have special needs, you can set various aspects of localization separately by using the following LC variables:

- LC_COLLATE
- LC_CTYPE
- LC_MESSAGES
- LC_NUMERIC
- LC_MONETARY
- LC_TIME

Table 1–9 lists the values for the LANG and LC environment variables.

Table 1–9 Values for *LANG* and *LC* Variables

Value	Locale
DE	German
FR	French
ISO_8859_1	English and European
IT	Italian
JAPANESE	Japanese
KOREAN	Korean

Table 1–9 Values for *LANG* and *LC* Variables (continued)

Value	Locale
SV	Swedish
TCHINESE	Taiwanese

Other environment variables include:

- **CALENDAR:** Sets the path to the Calendar executables.
- **CDPATH (or cdpath in the C shell):** Sets a variable used by the cd command. If the target directory of the cd command is specified as a relative path name, the cd command first looks for the target directory in the current directory (.). If the target is not found, the path names listed in the CDPATH variable are searched consecutively until the target directory is found and the directory change is completed.
- **DESKSET:** Sets the path to the DeskSet™ executables.
- **history:** Sets history for the C shell.
- **HZ:** Sets history for Bourne and Korn shells.
- **LPDEST:** Sets the user's default printer.
- **MAIL:** Tells the shell where to look for new mail.
- **MANPATH:** Sets the hierarchies of man pages available.
- **MANSECTS:** Sets the available sections of manual pages.
- **OPENWINHOME:** Sets the path to the OpenWindows executables.
- **prompt:** Defines the shell prompt for the C shell.
- **SHELL:** Sets the default shell used by make, vi, and other tools.
- **TERM (or term in the C shell):** Defines the terminal. This variable should be reset in /etc/profile or /etc/.login. When the user invokes an editor, the system looks for a file with the same name as the definition of this environment variable. The system searches the directory referenced by TERMINFO to determine the terminal characteristics.
- **TERMINFO:** Specifies the path name for an unsupported terminal that has been added to the terminfo file. Use the TERMINFO variable in /etc/profile or /etc/.login.
- **TZ:** Sets time zone.

Users and system administrators can define additional variables for their own use. When you define an environment variable from a shell command, the variable remains in effect while you remain in the shell. When you exit the shell, the environment variable is not retained. Store "permanent" environment variables that are likely to be used during each login session in the `.profile`, `.login`, or `.cshrc` file. The syntax for defining environment variables depends on the shell.

Common Desktop Environment Environment Variables

NEW

The Common Desktop Environment (CDE) has its own set of environment variables. Desktop search paths are created at login by the desktop utility `dtsearchpath`. The `dtsearchpath` utility uses a combination of environment variables and built-in locations to create the search paths.

The environment variables that `dtsearchpath` reads are called *input variables*. These are variables set by the system administrator or end user. The input variables use the naming convention `DTSP*`.

When `dtsearchpath` runs at login, it assembles the values assigned to these variables, adds built-in locations, and creates values for output variables. Each search path has an output variable, as shown in Table 1–10.

Table 1–10 CDE Search Path Environment Variables

Search Path	Output Environment Variable	Systemwide Input Variable	Personal Input Variable
Applications	DTAPPSEARCHPATH	DTSPSYSAPPHOSTS	DTSPUSERAPPHOSTS
Database (actions, data types, and front panel definitions)	DTDATABASESEARCHPATH	DTSPSYSDATABASEHOSTS	DTSPUSERDATABASEHOSTS
Icons	XMICONSEARCHPATH, XMICONBMSEARCHPATH	DTSPSYSICON	DTSPUSERICON
Help data	DTHELPSEARCHPATH	DTSPSYSHELP	DTSPUSERHELP

CDE components use the values of the output variables. For example, Application Manager uses the value of the application search path (`DTAPPSEARCHPATH`) to locate application groups. For more information about CDE, refer to *Solaris Common Desktop Environment: Advanced User's and System Administrator's Guide*.

Defining Bourne and Korn Shell Environment Variables

To define an environment variable for the Bourne and Korn shells, type ***VARIABLE=value***`;export` ***VARIABLE*** and press Return:

```
$ PS1=oak$;export PS1
$
```

Defining C Shell Environment Variables

To define an environment variable for the C shell, type **`setenv`** ***VARIABLE value*** and press Return:

```
% setenv DISPLAY rogue:0
%
```

Displaying Environment Variable Settings

To display a list of the current environment variable settings, type **env** and press Return:

```
$ env
HOME=/home/irving
HZ=100
LOGNAME=irving
MAIL=/var/mail/irving
MANSECTS=\1:1m:1c:1f:1s:1b:2:\3:3c:3i:3n:3m:3k:3g:3e:3x11:3xt:3w:3b:9:4:5:7:8
PATH=/usr/bin
SHELL=/bin/sh
TERM=sun
TZ=EST5EDT
$
```

NEW

The following example shows all the environment variables for a system running CDE:

```
castle% env
MANPATH=/usr/openwin/share/man:/usr/openwin/man:/usr/share/man:/usr/dt/share/man
:/usr/dt/man:/usr/man:/opt/SUNWrtvc/man
DTDATABASESEARCHPATH=/export/home/winsor/.dt/types,/etc/dt/appconfig/types/%L,/e
tc/dt/appconfig/types/C,/usr/dt/appconfig/types/%L,/usr/dt/appconfig/types/C
DTXSERVERLOCATION=local
LANG=C
HELPPATH=/usr/openwin/lib/locale:/usr/openwin/lib/help
DTSOURCEPROFILE=true
PATH=/usr/openwin/bin:/usr/dt/bin:/bin:/usr/bin:/usr/ucb:/etc:.
AB_CARDCATALOG=/usr/dt/share/answerbooks/C/ab_cardcatalog
DTUSERSESSION=winsor-castle-0
XMICONBMSEARCHPATH=/export/home/winsor/.dt/icons/%B%M.bm:/export/home/winsor/.dt
/icons/%B%M.pm:/export/home/winsor/.dt/icons/%B:/usr/dt/appconfig/icons/%L/%B%M.
bm:/usr/dt/appconfig/icons/%L/%B%M.pm:/usr/dt/appconfig/icons/%L/%B:/usr/dt/appc
onfig/icons/C/%B%M.bm:/usr/dt/appconfig/icons/C/%B%M.pm:/usr/dt/appconfig/icons/
C/%B
SESSION_SVR=castle
OPENWINHOME=/usr/openwin
EDITOR=/usr/dt/bin/dtpad
LOGNAME=winsor
DTSCREENSAVERLIST=StartDtscreenSwarm StartDtscreenQix     StartDtscreenFlame
StartDtscreenHop StartDtscreenImage StartDtscreenLife     StartDtscreenRotor
StartDtscreenPyro StartDtscreenWorm StartDtscreenBlank
MAIL=/var/mail/winsor
USER=winsor
DISPLAY=:0.0
SHELL=/bin/csh
DTAPPSEARCHPATH=/export/home/winsor/.dt/appmanager:/etc/dt/appconfig/appmanager/
%L:/etc/dt/appconfig/appmanager/C:/usr/dt/appconfig/appmanager/%L:/usr/dt/appcon
fig/appmanager/C
HOME=/export/home/winsor
XFILESEARCHPATH=/usr/openwin/lib/locale/%L/%T/%N%S:/usr/openwin/lib/%T/%N%S
XMICONSEARCHPATH=/export/home/winsor/.dt/icons/%B%M.pm:/export/home/winsor/.dt/i
cons/%B%M.bm:/export/home/winsor/.dt/icons/%B:/usr/dt/appconfig/icons/%L/%B%M.pm
:/usr/dt/appconfig/icons/%L/%B%M.bm:/usr/dt/appconfig/icons/%L/%B:/usr/dt/appcon
```

```
fig/icons/C/%B%M.pm:/usr/dt/appconfig/icons/C/%B%M.bm:/usr/dt/appconfig/icons/C/
%B
TERM=dtterm
dtstart_sessionlogfile=/dev/null
TZ=US/Pacific
DTHELPSEARCHPATH=/export/home/winsor/.dt/help/winsor-castle-0/%H:/export/home/wi
nsor/.dt/help/winsor-castle-0/%H.sdl:/export/home/winsor/.dt/help/winsor-castle-
0/%H.hv:/export/home/winsor/.dt/help/%H:/export/home/winsor/.dt/help/%H.sdl:/exp
ort/home/winsor/.dt/help/%H.hv:/usr/dt/appconfig/help/%L/%H:/usr/dt/appconfig/he
lp/%L/%H.sdl:/usr/dt/appconfig/help/%L/%H.hv:/usr/dt/appconfig/help/C/%H:/usr/dt
/appconfig/help/C/%H.sdl:/usr/dt/appconfig/help/C/%H.hv
XMBINDDIR=/usr/dt/lib/bindings
WINDOWID=79691820
TERMINAL_EMULATOR=dtterm
PWD=/export/home/winsor
castle%
```

Using the *PATH* Variable

The PATH environment variable is very important. When the user executes a command using the full path name, the shell finds the command using that path name. However, when the user specifies only a command name, the shell searches the directories for the command in the order specified by the PATH variable. If the command is found in one of the directories, the shell executes it.

A default su PATH (/sbin:/usr/sbin:/usr/bin:/etc) is set by the system, but most users modify it to add additional command directories. Many user problems related to setting up the environment and accessing the right version of a command or a tool can be traced to incorrectly defined paths.

CAUTION! *Including . in the path to search the current directory is a potential security problem. If security is an issue at your site, do not include . as part of a user's path. Never use . as part of the root path.*

Setting the Path for Bourne and Korn Shells

The path for the Bourne and Korn shells is specified in the user's $HOME/ .profile file in this way:

```
PATH=/usr/bin:/$HOME/bin:.
```

Setting the Path for the C Shell

The path for the C shell is specified in the user's $HOME/.cshrc file (with the set path environment variable) in this way:

```
set path = (/usr/bin $home/bin.)
```

See the appropriate manual pages for an in-depth description of these commands and Chapter 10, "Recognizing File Access Problems," for more information about troubleshooting problems with paths.

Using Admintool

Admintool is a graphical user interface that you can use to administer local systems. You can use Admintool to administer:

- User accounts
- Groups
- Hosts
- Printers
- Serial ports
- Software packages

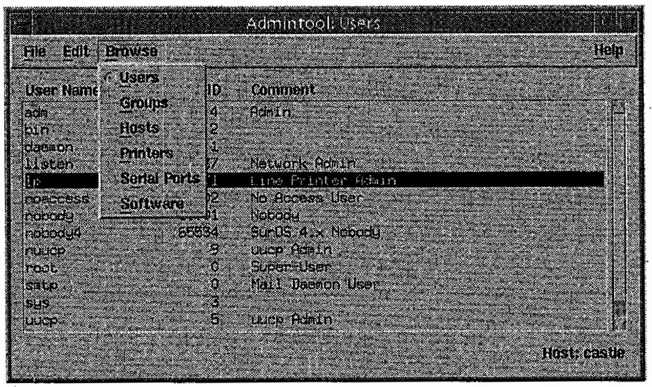
The next section describes how to start Admintool.

Starting Admintool

When using Admintool, you must be a member of the sysadmin UNIX group (GID 14) to run Admintool using your own UID, not as root. Anyone with root permissions on a local system can use Admintool to modify, create, or delete information in the local `/etc` files for that system. Use the following steps to start Admintool:

1. Start Admintool from a command line by typing **`admintool&`** and pressing Return. The Admintool window is displayed.
2. Choose the Admintool view that you want to use from the Browse menu, shown in Figure 1–1.

Figure 1–1
The Browse menu.



Introducing the Solstice AdminSuite Product

The Solstice AdminSuite 2.3 unbundled product provides a suite of graphical user interface tools and commands that you can use to perform system administration tasks.

Solstice AdminSuite is included as part of the Solaris Server Intranet Extension 1.0 CD-ROM that is shipped with each SMCC server. The following information is provided to help you evaluate whether the Solstice AdminSuite product is useful in your system administration environment.

The Solstice AdminSuite software enables you to locally or remotely manage:

- Important system database files, such as aliases and hosts
- User accounts and groups
- File systems
- Disk slices and `fdisk` partitions
- Terminals and modems
- Diskless and dataless clients
- AutoClient systems
- Stand-alone systems
- JavaStations
- Servers
- Printers

The Solstice AdminSuite software to perform system administration benefits you in the following ways:

- Using the tools and commands is faster than using numerous Solaris commands to perform the same tasks.
- System files are updated automatically without the risk of making errors by editing important system files manually.
- You can manage systems remotely from one system.

Table 1–11 lists the Solstice AdminSuite tools that run under an X Window System, such as the OpenWindows environment.

Table 1–11 Solstice AdminSuite Tools

AdminSuite Tool	Description
Host Manager	Use to manage system information and server support for AutoClient and stand-alone systems, diskless and dataless clients, and JavaStations.
Group Manager	Use to manage UNIX group information.

Table 1-11 Solstice AdminSuite Tools (continued)

AdminSuite Tool	Description
User Manager	Use to manage user account information.
Serial Port Manager	Use to manage serial port software for terminals and modems.
Printer Manager	Use to manage printer software for print servers and clients.
Database Manager	Use to manage network-related system files such as aliases and hosts.
Storage Manager (comprising of Disk Manager and File System Manager)	Use to manage disk slices and `fdisk` partitions on a single disk or a group of equivalent disks (Disk Manager) and file systems for a server or for a group of clients on a server (File System Manager).

Because the Solstice AdminSuite product is unbundled, describing how to use the AdminSuite tools is beyond the scope of this book. For more information on obtaining Solstice AdminSuite, contact your Sun Microsystems sales representative or visit Sun's Web site at `http://www.sun.com` and click on the Products & Solutions link.

CHAPTER

2

Using Basic OS Commands

Finding User Information

Finding Environment Information

Creating and Editing Files

Combining Commands and Redirecting Output

Using Manual Pages

Finding Disk Information

THIS CHAPTER EXPLAINS SOME BASIC OPERATING SYSTEM COMMANDS THAT help you find information about users and the system environment. It also describes several ways to create and edit files, combine commands and redirect output, display manual pages, and locate basic disk information.

Finding User Information

When administering systems, you often need to find out who is using the system and what they are doing. This section describes the commands—`who`, `finger`, `rusers -l`, `whodo`, `id`—that you can use to find information about users.

Determining Who Is Logged In to a System (*who, finger, rusers -l, whodo*)

You can use any one of four commands (`who`, `finger`, `rusers -l`, or `whodo`) to find out who is logged on to a system. Each command gives you different additional information.

Using the *who* Command

The `who` command displays a list of the users logged on to a system, with the login TTY port and the date and time. When a user is logged on remotely, the remote system name for that user is also displayed. To use the `who` command, type **`who`** and press Return.

In this example, `irving` is logged on remotely (as shown by the system name), and `ignatz` is logged in locally to the system `oak`:

```
oak% who
irving pts/1   Oct 31 14:33 (elm)
ignatz console Oct 31 12:22
oak%
```

Using the *finger* Command

The `finger` command displays a list of the login names of users logged on to a system, along with the user's complete name (from the `Information` field of their `/etc/password` entry), the TTY port, the day of the week, the login time, and the remote system name if the user is logged in remotely. To use the `finger` command, type **`finger`** and press Return.

In this example, user `winsor` is logged on remotely from `castle`:

```
oak% rlogin drusilla
drusilla% finger
Login   Name           TTY   Idle When      Where
winsor Janice Winsor pts/Ø 11   Thu Ø9:59 castle
drusilla%
```

Using the *rusers -l* Command

The `rusers -l` (remote users, login) command displays a list of login names of users who are logged in on remote systems, along with the name of the system a user is logged in to, the TTY port, the month, date, login time, and idle time. If the host is not idle, no time is displayed in the last field. To use the `rusers -l` command, type **rusers -l** and press Return:

```
cinderella% rusers -l
Sending broadcast for rusersd protocol version 3...
Sending broadcast for rusersd protocol version 2...
jah       caps:console           Mar  3 13:03   22:03
amber     facehole:console       Mar  2 07:40
sebree    ondine:console         Mar  2 10:35      14
tut       cairo:console          Mar  2 10:48
jrt       cairo:ttyp5            Mar  2 16:20   47:54 (gap)
ramseyis mowthelawn:console      Mar  2 16:33      28
ramseyis mowthelawn:ttyp6        Mar  3 14:20   25:14 (:0.0)
(More logins not shown)
cinderella%
```

This example shows six users logged in to the console and two users logged in to TTY ports.

Using the *whodo* Command

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The `whodo` command displays the date, time, and system name. For each user logged in, the device name, UID, and login time are shown, followed by a list of active processes associated with the UID. The list includes the device name, PID, CPU minutes and seconds used, and process name.

To find out who is logged in and doing what, type **whodo** and press Return:

```
castle% whodo
Thu Oct  9 14:38:59 PDT 1997
castle

console      winsor   12:56
     ?            377     0:00 Xsession
    pts/2         422     0:00 sdt_shell
    pts/2         441     0:00 ttsession
    pts/2         442     0:00 dtsession
     ?            453     0:00 snapshot
     ?            452     0:02 dtterm
    pts/3         464     0:00 csh
    pts/3         618     0:00 whodo
    pts/5         478     0:00 csh
    pts/4         474     0:00 csh
     ?            451     0:02 dtfile
     ?            489     0:00 dtfile
     ?            449     0:02 dtwm
     ?            450     0:00 dtpad
    pts/2         425     0:00 csh
     ?            387     0:00 fbconsole
     ?            423     0:00 dsdm
```

```
pts/3       winsor   12:57

pts/4       winsor   12:57

pts/5       winsor   12:57
castle%
```

This example shows that user `winsor` is running a number of CDE applications.

Finding User UID and GID Settings (*id*)

Use the `id` command to display the user ID and group ID number for a user who is logged in. This information can be helpful for troubleshooting problems when users cannot access files they think they own, or when users want to find out which group they belong to. To use the `id` command, have the user log in, type **id**, and press Return. If the UID or GID does not match those for the troublesome file, you may need to change the ownership or group on the file or add the user to the appropriate group. See Chapter 5, "Administering Network Services," for more information.

This example shows the UID for user `winsor` is `6693` and the GID is `10`. For superuser, the UID is `0` and the GID is `0`:

```
anastasia% id
uid=6693(winsor) gid=10(staff)
anastasia% su
Password:
# id
uid=0(root) gid=1(other)
#
```

Finding Environment Information

Each shell maintains an environment with a set of specifications that it gets from the user's initialization files (`.profile` for the Bourne and Korn shells or `.cshrc` and `.login` for the C shell) or from environment variables set interactively from a shell. These environment variables can specify information such as the user's home directory, login name, default printer, location for e-mail messages, and path for accessing the OpenWindows environment. This section describes how to find environment variable settings (`env`). See Chapter 8, "Understanding Shells," for more information.

To find a user's environment variable settings, type **env** and press Return. A list of the environment variables and their settings is displayed. See Chapter 1, "Introducing Solaris System Administration," for a list of the default environment variables and for information on how to set them.

This example shows the environment variable settings for user `ignatz`:

```
oak% env
HOME=/
```

```
PATH=.:/home/ignatz:/usr/bin:
/home/ignatz/bin:/bin:/home/bin: /etc:/usr/etc
LOGNAME=ignatz
HZ=100
TZ=PST8PDT
TERM=sun
SHELL=/bin/csh
MAIL=/var/mail/ignatz
PWD=/
MANSECTS=\1:1m:1c:1f:1s:1b:2:\3:3
c:3i:3n:3m:3k:3g:3e:3x11:3xt:3w: 3b :9:4:5:7:8
oak%
```

Creating and Editing Files

This section describes how to create and edit files using these commands: `cat`, `touch`, `cp`, `mv`, Text Editor, and `vi`.

Using the *cat* Command

Use the `cat` command to create short files or to append a small amount of text to an existing file. Follow these steps to create files using the `cat` command:

1. Type **cat >** ***filename*** and press Return.
2. Type the text into the new file.
3. Press Return.
4. Press Control-D. The text is saved and the shell prompt is redisplayed.

Follow these steps to append text to an existing file:

1. Type **cat >>** ***filename*** and press Return.
2. Type the text to be appended to the file.
3. Press Return.
4. Press Control-D. The text is saved and the shell prompt is redisplayed.

To view the contents of the file, type **cat** ***filename*** and press Return. The contents of the file are displayed. If the file is too long to fit in the terminal window, it'll fly by and show you the lines at the end of the file that fit in the window or on the screen.

The following example creates a file named `kookaburra` with the first verse of the kookaburra song, displays the contents of the file, appends the second verse to the file, and displays the contents again:

```
castle% cat > kookaburra
Kookaburra sits in the old gum tree
Merry merry king of the bush is he
```

```
Laugh kookaburra, laugh kookaburra
Gay your life must be.

^D
castle% cat kookaburra
Kookaburra sits in the old gum tree
Merry merry king of the bush is he
Laugh kookaburra, laugh kookaburra
Gay your life must be.

castle% cat >> kookaburra
Kookaburra sits in the old gum tree
Eating all the gumdrops he can see
Stop kookaburra, stop kookaburra
Leave some there for me.
^D
castle% cat kookaburra
Kookaburra sits in the old gum tree
Merry merry king of the bush is he
Laugh kookaburra, laugh kookaburra
Gay your life must be.

Kookaburra sits in the old gum tree
Eating all the gumdrops he can see
Stop kookaburra, stop kookaburra
Leave some there for me.
castle%
```

Using the *touch* Command

The `touch` command sets the access and modification times for each file to the current time. If a file does not exist, an empty one is created. You can use the `touch` command to create an empty file to check permissions and ownership or to create a file to which you will add text at a later time.

To create an empty file, type **touch** ***filename*** and press Return. A new empty file is created. If the file exists, then its modification time is updated to the current date and time.

The following example uses the `ls` command to determine that there is not a file named `junk`, creates the file, and uses the `ls` command to verify that the empty file is created:

```
oak% ls -l junk
junk:  No such file or directory
oak% touch junk
oak% ls -l junk
-rw-r--r--   1 irving     staff 0 Sep 11 15:06 junk
oak%
```

Copying (*cp*) or Renaming (*mv*) an Existing File

You can create a new file by copying or renaming an existing file.

To copy an existing file, type **cp** ***old-filename new-filename*** and press Return. You have made a copy of the file, retaining the original one:

```
oak% cp quest oldquest
oak%
```

To move (and rename) an existing file, type `mv` ***old-filename new-filename*** and press Return. You have changed the name of the file and removed the old one.

```
oak% mv quest /tmp/quest.old
oak%
```

Using Text Editor

You can use the OpenWindows Text Editor to create and edit files. You may, however, have problems using Text Editor to edit files that have root permissions.

To start Text Editor from the OpenWindows workspace from the Workspace menu, choose Programs. Then choose Text Editor from the Programs menu. To start Text Editor from a command line, type `/usr/openwin/bin/textedit &` and press Return. A Text Editor window is displayed. Use the commands from the Edit menu or the Cut, Copy, Paste, and Undo keys from the keyboard to make editing changes.

NEW

If you are running CDE you can use the CDE Text Editor to create and edit files. To start Text Editor from the CDE front panel, click on the Personal Applications menu and click on Text Editor. To start the CDE Text Editor from the command line, type `/usr/dt/bin/dtpad&` and press Return. A Text Editor window is displayed. Use the commands from the Edit menu or the Cut, Copy, Paste, and Undo keys from the keyboard to make editing changes.

Using vi

The visual editor, vi, is commonly used by system administrators to edit text files. Whole books have been written about using vi. This section provides only a quick-reference table of some of the most commonly used editing commands.

To start vi, type `vi` ***filename*** and press Return. If the file does not exist, a new file is opened. The new file is created when you save changes made to it. If the file exists, the beginning of the file is displayed.

Table 2–1 shows a few of the many vi editing commands.

Table 2–1 Some Basic *vi* Commands

Task	Command
How to save/quit a file	
Quit without saving changes	`:q!`
Write changes	`:w`
Write changes and quit	`:wq`

Table 2–1 Some Basic *vi* Commands (continued)

Write changes and quit	ZZ
How to move around in a file	
Move cursor one character left	h
Move cursor one character right	l
Move cursor up one line	k
Move cursor down one line	j
Go to end of the file	G
How to add text	
Insert text (insert mode)	`i` *text* `Esc`
Append text at cursor location	`a` *text* `Esc`
Append text at end of the line	`A` *text* `Esc`
How to exit to command mode	Esc
How to make changes to a file	
Delete line	dd
Delete character	x
Delete word	dw
Open new line above	`O` *text* `Esc`
Open new line below	`o` *text* `Esc`
Yank/copy line	Y
Put before	P
Put after	p

Combining Commands and Redirecting Output

The SunOS 5.*x* system software lets you combine commands in several ways. This section describes the three ways you can combine commands.

Typing Several Commands on the Same Command Line

You can type more than one command on a single command line by typing a semicolon (`;`) between the commands.

For example, you can change to a directory and list the commands by typing **cd /usr/bin;ls** and pressing Return. Another example is setting an environment variable for the Bourne shell and then exporting the variable:

```
PATH=.:/usr/bin:$HOME/bin;export PATH
```

Redirecting Output (<>)

Unless you indicate otherwise, commands normally display their results on the screen. You can, however, redirect the output of a command using the redirect symbols < and >. For example, to save the output to a file instead of displaying it on the screen, use the > redirect symbol to tell the shell to put the contents in a file. In this example, the output of the date command is redirected to a new file called `sample.file`:

```
$ date > sample.file
$
```

Here are the contents of `sample.file`:

```
$ more sample.file
Tue May 26 13:26:59 PDT 1992
$
```

You can also redirect input in the other direction. For example, to mail the contents of a file to user `ignatz@oak`, type **mail ignatz@oak < report.file** and press Return. The file called `report.file` is sent by electronic mail to `ignatz@oak`.

Combining Commands (/)

You can use the pipe (¦) operator to connect two or more commands, using the output from one command as the input to the next one. This section provides only two examples of the many ways you can combine commands in a pipeline.

To print the `cat`(1) manual page, type **man cat | lp** and press Return. The manual page is not displayed on the screen. Instead, the output is sent to the `lp` command, which prints it on the default printer.

You can search the process list for a particular command by piping the output of `ps -e` to the `grep` command. The output is displayed on the screen. For example, to display process information for OpenWindows:

```
cinderella% ps -e ¦ grep openwin
   260 ?        0:00 openwin
cinderella%
```

If you want to print the information, you can add an additional pipe command (¦ `lp`) to the end of the sequence and send it to the printer:

```
anastasia% ps -e ¦ grep openwin ¦ lp
request id is castle-51 (request id is castle-51 (standard input)
)
anastasia%
```

Using Manual Pages

Manual pages are on-line technical references for each SunOS 5.*x* command. Manual pages are grouped into sections, with similar types of commands within the same section. For example, most user commands are in section (1), and system administration commands are in section (1M). Manual pages may be installed on a local system, or NFS mounted from a server. This section tells you how to display manual pages and how to find out the section numbers for an individual command.

Displaying a Manual Page (*man*)

To display a manual page, type `man` ***command-name*** and press Return. The manual page is displayed:

```
cinderella% man grep

grep(1)    USER COMMANDS   grep(1)

NAME
  grep - search a file for a pattern

SYNOPSIS
     grep   [   -bchilnsvw    ] limited-regular-expression    [
(More information not shown in this example)
```

Finding the Section Number for a Manual Page (*whatis, man*)

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Some commands are listed in more than one section. You can find the section number(s) for a manual page using the `whatis` command.

NOTE. *The* `whatis` *command only works if you have used the* `catman` *command to set up your manual pages. To use the* `catman` *command to set up manual pages, become super user and type* **`catman`** ***n*** *and press Return, where* `n` *is the number of the section you want to set up.*

Follow these steps to find the section number for a manual page:

1. Type **`whatis`** ***command-name*** and press Return. The first line of the manual page for the command is displayed. Use the section number to display the manual page in the next step.

2. Type `man` **-s*section-number* *command-name*** and press Return. The manual page is displayed:

```
oak% whatis chown
chown   chown (1)    - change owner of file
chown   chown (1b)   - change owner
chown   chown (1m)   - change owner
chown   chown (2)    - change owner and group of a file
oak% man -s2 chown
chown(2)              SYSTEM CALLS              chown(2)
```

```
NAME
 chown, lchown, fchown - change owner and group of a file

SYNOPSIS
 #include <unistd.h>
 #include <sys/types.h>

int chown(const char *path, uid_t owner, gid_t group);

int lchown(const char *path, uid_t owner, gid_t group);

int fchown(int fildes, uid_towner, gid_t group);

DESCRIPTION
chown() sets the owner ID and group ID of the file specified by path or
referenced by the open file descriptor fields to owner and group
respectively. If owner or group is specified as -1, chown() does not change
the corresponding ID of the file.

(More text not shown here)
```

Finding Disk Information

Use the commands in the following sections to find disk use, and to tell if a file system is local (UFS) or remote (NFS).

Displaying Used Disk Space in Kilobytes and Percentage of Capacity (*df-k*)

The output from the `df` command, when used without arguments, is changed with the SunOS 5.*x* system software. Use the `-k` option to display disk information in the table format used with SunOS 4.*x* system software. Type **`df -k`** and press Return. The file system, total kilobytes, used kilobytes, available kilobytes, percentage of capacity used, and mount point for local disk partitions are displayed:

```
cinderella% df -k
dev/dsk/c0t0d0s0      30383    19926    7427     73%   /
/dev/dsk/c0t0d0s6     189683   66503    104220   39%   /usr
/proc                 0        0        0         0%   /proc
fd                    0        0        0         0%   /dev/fd
swap                  44268    12       44256     0%   /tmp
/dev/dsk/c0t0d0s7     331953   116133   182630   39%   /opt
/dev/dsk/c0t3d0s7     189858   24293    146585   14%   /export/home
cinderella:(pid146)   0        0        0         0%   /net
cinderella:(pid146)   0        0        0         0%   /home
cinderella:(pid146)   2448597  2055423  148315   93%   /usr/dist
cinderella:(pid146)   763573   574664   112552   84%   /usr/svr4
cinderella:(pid146)   818627   540672   196093   73%   /usr/netinstall
cinderella:(pid146)   0        0        0         0%   /nse
ud5-52a:/export/dist  2448597  2055423  148315   93%   /tmp_mnt/usr/dist
cinderella%
```

Determining If File Systems Are Local or NFS Mounted (*df*)

To find out whether file systems are local or NFS mounted, type `df` ***filesystem*** and press Return. Disk formatting information (including disk location or mount point) for the file system you specify is displayed.

In this example, the file system is NFS mounted:

```
oak% df /home/ignatz
bigriver:/export/home/ignatz
    538980  399435  85647   82%    /tmp_mnt/home/ignatz
oak%
```

In this example, the file system is on a local disk:

```
# df /
/dev/dsk/c0t0d0s0  30383   11885  15468    43%    /
#
```

Finding All Mounted File Systems of a Specific Type (*df-F*)

If you want to display all the mounted file systems of one file system type, use the `-F` option followed by the file system type. The most common file system types are `ufs` for local file systems and `nfs` for network file systems. To find all mounted file systems of a specific type, type `df -F` ***filesystem-type*** and press Return.

In this example, the mounted NFS file systems are displayed:

```
cinderella% df -F nfs
/net  (cinderella:(pid153)):       0 blocks        -1 files
/usr/dist cinderella:(pid153)):    1276248 blocks  -1 files
/home  (cinderella:(pid153)):      0 blocks        -1 files
/usr/man     (oak:/export/man):    272934 blocks   -1 files
cinderella%
```

In this example, the mounted UFS (local) file systems are displayed:

```
cinderella% df -F ufs
/  (/dev/dsk/c0t0d0s0): 36992   blocks   13558 files
/usr  (/dev/dsk/c0t0d0s6):  274346 blocks   94403 files
/export/home/cinderella (/dev/dsk/c0t3d0s7):379670 blocks    96046 files
cinderella%
```

In this example, information about the mounted temporary file system is displayed:

```
cinderella% df -F tmpfs
/tmp                (swap              ):   88528 blocks    3156 files
cinderella%
```

NOTE. *You cannot use the* `df` *command to display SWAPFS file systems because they are never mounted.*

CHAPTER

3

Administering Devices

THIS CHAPTER DESCRIBES HOW TO USE TAPES AND DISKETTES TO COPY FILES. It also describes how to use Volume Management to access diskettes and CD-ROMs. You can also find information about devices in the following chapters of this book:

- See Chapter 4, "Administering File Systems," for information about how to back up and restore complete file systems. Chapter 4 also explains disk device names and commands used for administering disks, introduces the Service Access Facility (SAF)—which you must use to administer terminals, modems, and other network devices with the SunOS 5.*x* system software—provides steps for setting up port monitors for print servers and print clients, and provides steps for adding a bidirectional Hayes-compatible modem to a system.
- See Chapter 6, "Administering Printing," for information about administering printers.

Using Tapes

NEW

This section describes tape device–naming conventions, useful commands for streaming tape cartridges, and how to use the `tar`, `cpio`, and `pax` commands to archive and retrieve files from tapes.

The `tar`, `cpio`, and `pax` commands can be used to copy files and file systems to tape. The command you choose depends on how much flexibility and precision you require for the copy.

Use `tar` to copy files and directory subtrees to a single tape. Note that the SunOS 5.*x* `tar` command can archive special files (block and character devices, fifos), but the SunOS 4.*x* `tar` command cannot extract them. The `cpio` command provides better portability.

Use `cpio` to copy arbitrary sets of files, special files, or file systems that require multiple tape volumes, or when you want to copy files from SunOS 5.*x* systems to SunOS 4.*x* systems. The `cpio` command packs data onto tape more efficiently than `tar` and skips over any bad spots in a tape when restoring. The `cpio` command also provides options for writing files with different header formats (`tar`, `ustar`, `crc`, `odc`, `bar`) for portability between systems of different types.

Use `pax` to copy files, special files, or file systems that require multiple tape volumes or when you want to copy files to and from POSIX-compliant systems.

Because `tar`, `cpio`, and `pax` use the raw device, you do not need to format or make a file system on tapes before you use them. The tape drive and device name you use depend on the hardware and configuration for each system.

Tape Device-Naming Conventions

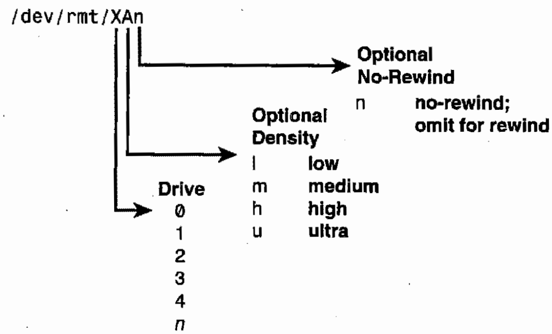
Tape drive-naming conventions use a logical—not a physical—device name. Tape drives fall into two categories according to controller type:

- Xylogics 472 for ½-inch rack-mounted (top-loaded) reel-to-reel drives (maximum four units per controller)
- SCSI for ¼-inch cartridge, ½-inch front-loaded reel-to-reel, and 4 mm or 8 mm helical scan drives (maximum eight units per controller)

Within the `/dev/rmt` subdirectory is a single set of tape device files that support different output densities. In general, you specify a tape drive device as shown in Figure 3–1.

Figure 3–1

Tape drive device names.



Specifying the Drive Number Using the Default Density

Normally, you specify a tape drive by its *logical unit number*, which is a number from 0 to *n*. If you do not specify a density, the drive writes at its "preferred" density, which is usually the highest density the tape supports.

To specify the first drive, use:

```
/dev/rmt/0
```

To specify the second drive, use:

```
/dev/rmt/1
```

NOTE. *Most device names start their numbering sequence with zero (0). Consequently, when you talk about the first disk or target, its number is 0, not 1.*

Specifying Different Densities for a Tape Drive

You may want to transport a tape to a system whose tape drive supports only a certain density. In that case, specify a device name that writes at the desired density. Use this convention:

```
/dev/rmt/XA
```

The unit and density characters are shown in Table 3–1. For example, to specify a raw magnetic tape device on the first (0) drive with medium density, use:

```
/dev/rmt/0m
```

Table 3–1 Unit and Density Characters in Tape Device Names

Device Name	= /dev/rmt/*XA*
X	Tape drive number (digit) from 0 to *n*, regardless of controller type
A	Density (character), depending on controller and drive type
null	Default, preferred (highest) density
l	Low
m	Medium
h	High
u	Ultra
c*	Compressed

*New in this edition.

Specifying the No-Rewind Option

After the command is executed, the tape is automatically rewound unless you specify the no-rewind option as part of the device name. To specify no rewinding, type n at the end of the device name.

For example, to specify a raw magnetic tape device on the first (0) drive with medium density, use:

```
/dev/rmt/0mn
```

Understanding Device Abbreviations for Different Tape Controllers and Media

You can have both SCSI and non-SCSI tape drives on the same system. A SCSI controller can have a maximum of eight SCSI tape drives, and a non-SCSI controller can have a maximum of four tape drives. For each drive number (*X*), the density character depends on the controller and drive type, as described in the following paragraphs.

Table 3–2 shows the device abbreviations for different tape controllers/units and media. Note that the first character in the device abbreviation for drive number does not have to be 0 as shown, but could be 1, 2, or 3, and so on, depending on how many tape drives are attached to the system.

Table 3–2 Device Abbreviations for Tape Controllers/Units and Media

Controller	Drive Unit	Size	Type	Format	Tracks	Device Abbreviation
Xylogics 472	Fujitsu M2444	1/2-inch	Reel	1600 bpi	9	/dev/rmt/0m
		1/2-inch	Reel	6250 bpi	9	/dev/rmt/0h
SCSI front-loaded	HP	1/2-inch	Reel	800 bpi	9	/dev/rmt/0m
				6250 bpi	9	/dev/rmt/0h
SCSI	Sysgen	1/4-inch	Cartridge	QIC-11	4	/dev/rmt/0l
				QIC-24	4	/dev/rmt/0m
				QIC-11	9	/dev/rmt/0l
				QIC-24	9	/dev/rmt/0m
	Emulex MT-02	1/4-inch	Cartridge	QIC-11	4	/dev/rmt/0l
				QIC-24	4	/dev/rmt/0m
				QIC-11	9	/dev/rmt/0l
				QIC-24	9	/dev/rmt/0m
	Archive QIC-150	1/4-inch	Cartridge	QIC-150	18	/dev/rmt/0h
	Wangtek QIC-150	1/4-inch	Cartridge	QIC-150	18	/dev/rmt/0h
	Desktop Backup Pack	1/4-inch	Cartridge	QIC-150	18	/dev/rmt/0h
	Exabyte 8200 (2.3 Gbyte)*	8 mm	Cartridge	8 mm	Helical scan	/dev/rmt/0m
	Exabyte 8500 (2.3 Gbyte)*	8 mm	Cartridge	8 mm	Helical scan	/dev/rmt/0l
	Exabyte 8500 (5 Gbyte)*	8 mm	Cartridge	8 mm	Helical scan	/dev/rmt/0m
	Archive Python*	4 mm	Cartridge	4 mm	Helical scan	/dev/rmt/0

*New in this edition.

Using Rack-Mounted Non-SCSI 1/2-Inch Reel Drives

For 1/2-inch rack-mounted tape drives with either a Tapemaster or Xylogics 472 controller, substitute the density from Table 3–3 for the *A* variable in the device name (`/dev/rmt/XA`).

Table 3–3 Designating Density for Rack-Mounted ½ -Inch Tape Drives

Character	Density
null	Default "preferred" (highest) density (usually 6250 bpi uncompressed)
l	800 bpi
m	1600 bpi
h	6250 bpi
u	6250 bpi compressed

If you omit the density character, the tape is usually written at its highest density, not compressed.

Using SCSI ¼-Inch Cartridge and ½-Inch Front-Loaded Reel Drives

For SCSI ¼-inch cartridge and ½-inch front-loaded reel drives, substitute the density from Table 3–4 for the *A* variable in the device name (`/dev/rmt/XA`).

Table 3–4 Designating Format or Density for SCSI Tape Drives

Character	Density, ¼ -Inch Cartridge	Density, ½-Inch Front-Loaded Reel-to-Reel
null	Default, preferred (highest) density	Default, preferred (highest) density
l	QIC-11 format	800 bpi
m	QIC-24 format	1600 bpi
h	QIC-150	6250 bpi
u	Reserved	Reserved

For ¼-inch cartridges, density is specified by the format in which the data is written: the QIC format. The QIC-11 and QIC-24 formats write approximately 1000 bpi on each track. The density for QIC-150 is somewhat higher. The preferred density for a 60-Mbyte ¼-inch cartridge drive is QIC-24 and for a 150-Mbyte ¼-inch cartridge drive is QIC-150.

A 150-Mbyte drive can write only QIC-150; it cannot be switched to write QIC-24 or QIC-11. Format selection is only useful for drives that can write both QIC-24 and QIC-11.

Specifying Helical Scan Drives

Helical scan drives (for example, Exabyte 8 mm or Wang/DAT 4 mm) are a special case of SCSI drives. They write only at the preferred density. Consequently, you always specify them using only the drive number, for example, `/dev/rmt/0`.

Useful Commands for Streaming Tapes

The following sections contain a few commands for use with streaming tapes.

Retensioning a Magnetic Tape

If errors occur when reading a tape, retension the tape, clean the tape drive, and then try again. Type **mt -f /dev/rmt/*n* retension** and press Return. The tape in the tape drive you specify is retensioned.

In this example, the tape in drive /dev/rmt/1 is retensioned:

```
oak% mt -f /dev/rmt/1 retension
oak%
```

Rewinding a Magnetic Tape

To rewind a magnetic tape, type **mt -f /dev/rmt/*n* rewind** and press Return. The tape in the tape drive you specify by the device number *n* is rewound.

In this example, the tape in drive /dev/rmt/1 is rewound:

```
oak% mt -f /dev/rmt/1 rewind
oak%
```

Showing the Status of a Magnetic Tape Drive

To show the status of a magnetic tape drive, type **mt -f /dev/rmt/*n* status** and press Return. Status for the tape drive you specify is displayed.

In this example, there is no tape in drive /dev/rmt/1:

```
oak% mt -f /dev/rmt/1 status
/dev/rmt/1: no tape loaded or drive offline
oak%
```

In this example, status is shown for the tape in drive /dev/rmt/1:

```
oak% mt -f /dev/rmt/1 status
Archive QIC-150 tape drive:
   sense key(0x6)= unit attention   residual= 0   retries= 0
   file no= 0   block no= 0
oak%
```

The *tar* Command

2.6 Use the tar command to copy files and directory subtrees to a single tape. The advantages of the tar command are that it is available on most UNIX operating systems and public domain versions are readily available. The disadvantages of the tar command are that tar is not aware of file system boundaries, full path name length cannot exceed 255 characters, it does not copy empty directories or special files such as device files, and it cannot be used to create multiple tape volumes.

The following sections describe how to use the `tar` command to copy files to a tape, list the files, append the files, and retrieve the files.

Copying Files to a Tape (*tar*)

Follow these steps to copy files to a tape:

1. Change to the directory that contains the file you want to copy.
2. Insert a write-enabled tape into the tape drive.

CAUTION! *Copying files to a tape using the* `c` *option to* `tar` *destroys any files already on the tape. If you want to preserve the files already on the tape, use the* `r` *option described in "Appending Files to a Tape (*`tar`*)" later.*

3. Type **`tar cvf /dev/rmt/`*`n filename filename filename`*** `...` and press Return. The `c` (copy) option copies the files you specify, the `v` (verbose) option displays information about the files as they are copied, and the `f` (files) option followed by the tape device name specifies where the tar files are to be written. The file names you specify are copied to the tape, overwriting any existing files on the tape.

NOTE. *You can use metacharacters (*`?` *and* `*`*) as part of the file names you specify. For example, to copy all documents with a* `.doc` *suffix, type* **`*.doc`** *as the file name argument. If you specify a directory name as the file name, the directory and all its subdirectories are recursively copied to the tape.*

4. Remove the tape from the drive and write the names of the files on the tape label.

In this example, two files are copied to a tape in tape drive 0:

```
oak% cd /home/winsor
oak% ls evaluation*
evaluation.doc   evaluation.doc.backup
oak% tar cvf /dev/rmt/0 evaluation*
a evaluation.doc 86 blocks
a evaluation.doc.backup 84 blocks
oak%
```

Listing the Files on a Tape (*tar*)

Follow these steps to list the files on a tape:

1. Insert a tape into the tape drive.
2. Type **`tar tvf /dev/rmt/`*`n`*** and press Return. The `t` (table) option lists the files you specify, the `v` (verbose) option displays complete information about the files as they are listed in a form similar to the `ls -l` command, and the `f` (files) option followed by the tape device name specifies the device where the `tar` files are located.

In this example, the table of contents for the tape in drive 0 contains two files:

```
oak% tar tvf /dev/rmt/0
rw-rw-rw-6693/10  44032 Apr 23 14:54 1991 evaluation.doc
```

```
rw-rw-rw-6693/10  43008 Apr 23 14:47 1991 evaluation.doc.backup
oak%
```

Reading from left to right, the first column shows the permissions for the file; the second column shows the UID and GID file ownership; the third column shows the number of characters (bytes) in the file; the fourth, fifth, sixth, and seventh columns contain the month, day, date, and year the file was last modified, and the final column contains the name of the file.

Appending Files to a Tape (*tar*)

Follow these steps to append files without overwriting files already on the tape:

1. Change to the directory that contains the file you want to copy.
2. Insert a tape that is not write-protected into the tape drive.
3. Type **tar rvf /dev/rmt/*n* *filename filename filename*** ... and press Return. The file names you specify are appended to the files already on the tape in the drive you specify.

NOTE. *You can use metacharacters (? and *) as part of the file names you specify. For example, to copy all documents with a* .doc *suffix, type* ***.doc** *as the file name argument.*

4. Remove the tape from the drive and write the names of the files on the tape label.

In this example, one file is appended to the files already on the tape in drive 0:

```
oak% cd /home/winsor
oak% tar cvf /dev/rmt/0 junk
a junk 1 blocks
oak% tar rvf /dev/rmt/0
rw-rw-rw-6693/10  44032 Apr 23 14:54 1991 evaluation.doc
rw-rw-rw-6693/10  43008 Apr 23 14:47 1991 evaluation.doc.backup
rw-rw-rw-6693/10     18 Dec 10 11:36 1991 junk
oak%
```

You can put more than one set of tar files on a tape if you use the n (no-rewind) option as part of the tape device name. For example, type **tar cvf /dev/rmt/*n*n *filename***. The tape is not rewound after the files are copied, and the next time you use the tape, the files are written at the end of the previous set of files.

Retrieving Files and Directories from a Tape (*tar*)

Follow these steps to retrieve files from a tape:

1. Change to the directory where you want to put the files.
2. Insert the tape into the tape drive.
3. Type **tar xvf /dev/rmt/*n*** and press Return. All the files on the tape in the drive you specify are copied to the current directory.

In this example, all files are copied from the tape in drive 0:

```
oak% cd /home/winsor/Evaluations
oak% tar xvf /dev/rmt/0
x evaluation.doc, 44032 bytes, 86 tape blocks
x evaluation.doc.backup, 43008 bytes, 84 tape blocks
oak%
```

To retrieve individual files from a tape, type **tar xvf /dev/rmt/*n filename filename filename*** . . . and press Return. The file names you specify are extracted from the tape and placed in the current working directory. In this example, files with the prefix `evaluation` are copied from the tape in drive 0:

```
oak% cd /home/winsor/Evaluations
oak% tar xvf /dev/rmt/0 evaluation*
x evaluation.doc, 44032 bytes, 86 tape blocks
x evaluation.doc.backup, 43008 bytes, 84 tape blocks
oak%
```

Follow these steps to retrieve directories and subdirectories recursively from a tape:

1. Change to the parent directory where you want to copy the files. If the directory already exists, be sure you are in the parent directory, and that it is okay to overwrite the contents of the directory before you copy the files from the tape. For example, to restore the contents of a directory named `Book` that is in `/home/winsor/Book`, you would change to `/home/winsor` and type **tar xvf /dev/rmt/*n* Book** and press Return. If you are in the directory `/home/winsor/Book`, the files will be restored as `/home/winsor/Book/Book`.
2. Type **tar xvf /dev/rmt/*n directory-name*** and press Return. The directory and all its subdirectories are recursively copied from the tape.

NOTE. *The names of the files extracted from the tape exactly match the names of the files stored on the archive. If you have any doubts about the names or paths of the files, first list the files on the tape. See "Listing the Files on a Tape (*`tar`*)" earlier for instructions and the* `tar`*(1) manual page for more information.*

The *cpio* Command

2.6

The `cpio` command copies files, special files (files used to represent peripheral devices attached to a system), and file systems that require multiple tape volumes, and provides compatibility for copying files from SunOS 5.*x* systems to SunOS 4.*x* systems. Advantages of using the `cpio` command are that it packs data onto tape more efficiently than the `tar` command, skips over any bad spots in a tape when restoring files, provides options for writing files with different header formats (`tar`, `ustar`, `crc`, `odc`, `bar`) for portability between different system types, and creates multiple tape volumes.

When you use the `cpio` command to create an archive, it takes a list of files or path names from standard input and writes to standard output. The output is almost always redirected to a file or device. The following sections describe how to use the `cpio` command to copy files to a cartridge tape, list the files, retrieve all files, and retrieve a subset of the files from a cartridge tape.

Copying All Files in a Directory to a Tape (*cpio*)

Follow these steps to copy all files in a directory to a tape:

1. Insert a write-enabled tape into the tape drive.
2. Type `ls ¦ cpio -oc > /dev/rmt/n` and press Return. The `o` option copies the files. The `c` option writes header information in ASCII character form for portability. All the files in the directory are copied to the tape in the drive you specify, overwriting any existing files on the tape, and the total number of blocks copied is displayed.
3. Remove the tape from the drive and write the names of the files on the tape label.

In this example, all the files in the directory `/home/winsor/TOI` are copied to the tape in tape drive 0:

```
oak% cd /home/winsor/TOI
oak% ls ¦ cpio -oc > /dev/rmt/Ø
31 blocks
oak%
```

Listing the Files on a Tape (*cpio*)

To list files on a tape:

1. Insert a tape into the tape drive.
2. Type `cpio -civt < /dev/rmt/n` and press Return. The `i` option reads in the contents of the tape. The `v` option displays the output in a format similar to the output from the `ls -l` command. The `t` option lists the table of contents for the files on the tape in the tape drive you specify.

NOTE. *Listing the table of contents takes as long as it does to read the archive file because the* `cpio` *command must process the entire archive.*

In this example, the table of contents for the tape in drive 0 contains four files:

```
oak% cpio -civt < /dev/rmt/Ø
1ØØ666 winsor   3895  Feb 24 15:13:Ø2 1992  Boot.chapter
1ØØ666 winsor   3895  Feb 24 15:13:23 1992  Directory.chapter
1ØØ666 winsor   6491  Feb 24 15:13:52 1992  Install.chapter
1ØØ666 winsor   1299  Feb 24 15:14:ØØ 1992  Intro.chapter
31 blocks
oak%
```

The first column shows permissions in octal form; the second column shows the owner of the file; the third column displays the number of characters (bytes) in the file; the fourth, fifth, sixth, and seventh columns show the month, date, time, and year the file was last modified; and the final column shows the name of the file.

Retrieving All Files from a Tape (*cpio*)

If the archive was created using relative path names, the input files are built as a directory within the current directory. If, however, the archive was created with absolute path names, the same absolute paths are used to re-create the file.

CAUTION! *Using absolute path names can be dangerous because you can overwrite the original files.*

Follow these steps to retrieve all files from a tape:

1. Change to the directory where you want to put the files.
2. Insert the tape into the tape drive.
3. Type **cpio -icv < /dev/rmt/*n*** and press Return.

All the files on the tape in the drive you specify are copied to the current directory. In this example, all files are copied from the tape in drive 0:

```
oak% cpio -icv < /dev/rmt/0
Boot.chapter
Directory.chapter
Install.chapter
Intro.chapter
31 blocks
oak%
```

Retrieving a Subset of Files from a Tape (*cpio*)

You can retrieve a subset of the files from the archive by specifying a pattern to match using shell wildcard characters enclosed in quotation marks after the options:

1. Change to the directory where you want to put the files.
2. Insert the tape into the tape drive.
3. Type **cpio -icv "****file*" < /dev/rmt/*n*** and press Return. All the files that match the pattern are copied to the current directory. You can specify multiple patterns, but each must be enclosed in quotation marks.

In this example, all files that end in the suffix `chapter` are copied from the tape in drive 0:

```
oak% cd /home/winsor/Book
oak% cpio -icv "*chapter" < /dev/rmt/0
Boot.chapter
Directory.chapter
Install.chapter
Intro.chapter
31 blocks
oak%
```

See the `cpio`(1) manual page for more information.

The *pax* Command

The 2.5 release and later provide the pax command, which stands for *portable archive interchange*. The pax command provides better portability than the tar or cpio commands for POSIX-compliant systems. Use the pax command to copy files, special files, or file systems that require multiple tape volumes or when you want to copy files to and from POSIX-compliant systems. Disadvantages of the pax command are that it is not aware of file system boundaries and the full path name length cannot exceed 255 characters.

Copying All Files in a Directory to a Tape (*pax*)

Follow these steps to use the pax command to copy all the files in the current directory to a tape:

1. Change to the directory that contains the files you want to copy.
2. Insert a write-enabled tape into the tape drive.
3. Type **pax -w -f </dev/rmt/*n*.** and press Return. The -w option writes the current directory contents to tape. The -f option identifies the tape drive. The pax command does not list the files as they are copied.
4. Type **pax -l -f </dev/rmt/*n*** and press Return. The -l option lists the files on the tape to verify that the files are copied.
5. Remove the tape from the drive and write the names of the files on the tape label.

In this example, all files are copied from the tape in drive 0:

```
castle% pax -w -f /dev/rmt/0 .
castle% pax -l -f /dev/rmt/0
.
./addusr-1.rs
./addusr-2.rs
./at-addmn.rs
./at-base.rs
./at-menu.rs
castle%
```

See the pax(1) manual page for more information.

NOTE. *When you use the* pax *command to copy files to a single-volume tape, you can also list and retrieve files from that tape by using the* tar *command.*

Retrieving All Files on a Tape (*pax*)

Follow these steps to use the pax command to copy all the files on a tape into the current directory:

1. Change to the directory where you want to copy the files.
2. Insert a write-enabled tape into the tape drive.

3. Type **pax -r -f </dev/rmt/*n*.** and press Return. The -r option reads the contents of the tape to the current directory. The -f option identifies the tape drive. The pax command does not list the files as they are copied.
4. Type **ls -l** and press Return. The ls -l command lists the files in the current directory and shows their permissions to verify that the files are copied.
5. Remove the tape from the drive and write the names of the files on the tape label.

In this example, all files are copied from the tape in drive 0:

```
castle% pax -r -f /dev/rmt/0 .
pax: . :not owner
castle% ls -l
-rw-rw-rw-   1 winsor   staff      245660 Sep 12 11:52 addusr-1.rs
-rw-rw-rw-   1 winsor   staff      245660 Sep 12 10:31 addusr-2.rs
-rw-rw-rw-   1 winsor   staff      181315 Sep 12 10:29 at-addmn.rs
-rw-rw-rw-   1 winsor   staff      181309 Sep 12 10:27 at-base.rs
-rw-rw-rw-   1 winsor   staff      181315 Sep 12 10:28 at-menu.rs
castle%
```

Volume Management

NEW

Starting with the Solaris 2.2 system software, volume management automates mounting of CD-ROMs and diskettes; users no longer need to have superuser permissions to mount a CD-ROM or a diskette.

CAUTION! *The Solaris 2.0 and 2.1 procedures for mounting CD-ROMs and diskettes will not work for Solaris 2.2 and later releases. Volume management controls the* /dev/dsk/c0t6d0s0 *path to a CD-ROM drive and the* /dev/diskette *path to the diskette drive. If you try to access a CD-ROM or diskette using these paths, an error message is displayed.*

Volume management provides users with a standard interface for dealing with diskettes and CD-ROMs. Volume management provides three major benefits:

- Automatically mounting diskettes and CDs simplifies their use.
- Users can access diskettes and CDs without having to become superuser.
- Users on the network can gain automatic access to diskettes and CDs mounted on remote systems.

Mounting devices manually requires the following steps:

1. Insert media.
2. Become superuser.
3. Determine the location of the media device.

4. Create a mount point.
5. Make sure you are not in the mount point directory.
6. Mount the device using the proper mount options.
7. Exit the superuser account.
8. Work with files on media.
9. Become superuser.
10. Unmount the media device.
11. Eject media.
12. Exit the superuser account.

Using volume management requires the following steps:

1. Insert media.
2. For diskettes, use the `volcheck` command.
3. Work with files on media.
4. Eject media.

Volume Management Files

Volume management consists of the `/usr/sbin/vold` volume management daemon, the `/etc/vold.conf` configuration file used by the `vold` daemon to determine which devices to manage, the `/etc/rmmount.conf` file used to configure removable media mounts, and actions in `/usr/lib/rmmount`. The volume daemon logs messages in the `/var/adm/vold.log` file.

The default `/etc/vold.conf` file is shown as:

```
# @(#)vold.conf 1.21     96/05/10 SMI
#
# Volume Daemon Configuration file
#

# Database to use (must be first)
db db_mem.so

# Labels supported
label dos label_dos.so floppy rmscsi pcmem
label cdrom label_cdrom.so cdrom
label sun label_sun.so floppy rmscsi pcmem

# Devices to use
use cdrom drive /dev/rdsk/c*s2 dev_cdrom.so cdrom%d
use floppy drive /dev/rdiskette[0-9] dev_floppy.so floppy%d
use pcmem drive /dev/rdsk/c*s2 dev_pcmem.so pcmem%d forceload=true
```

```
# use rmscsi drive /dev/rdsk/c*s2 dev_rmscsi.so rmscsi%d

# Actions
insert dev/diskette[0-9]/* user=root /usr/sbin/rmmount
insert dev/dsk/* user=root /usr/sbin/rmmount
eject dev/diskette[0-9]/* user=root /usr/sbin/rmmount
eject dev/dsk/* user=root /usr/sbin/rmmount
notify rdsk/* group=tty user=root /usr/lib/vold/volmissing -p

# List of file system types unsafe to eject
unsafe ufs hsfs pcfs
```

If a system has additional diskette drives, volume management automatically creates two subdirectories in `/vol/dev` for each additional drive—one to provide access the file systems and the other to provide access to the raw device. For a second diskette drive, volume management creates directories named `diskette1` and `rdiskette1`. For a third diskette drive, it creates directories named `diskette2` and `rdiskette2` (and so on for additional drives).

If you want additional CD-ROM drives on a system, you must edit the `/etc/vold.conf` file and add the new devices to the `Devices to use` list. The syntax for a `Devices to use` entry is shown as:

`use` *`device type special shared-object symname options`*

Table 3–5 describes each of the fields for the `Devices to use` syntax.

Table 3–5 Device Control Syntax Descriptions

Field	Supported Default Values	Description
`device`	`cdrom, floppy`	The removable media device.
`type`	`drive`	The type of device—multiple or single media support.
`special`	`/dev/dsk/c0t6 /dev/diskette`	Pathname of the device to be used in the `/dev` directory.
`shared-object`	`/usr/lib/vold/shared-object-name`	Location of the code that manages the device.
`symname`	`cdrom0, floppy0`	The symbolic name that refers to this device. The *symname* is placed in the device directory either `/cdrom` or `/floppy`).

`options`	`user=nobody`
	`group=nobody`
	`mode=0666`
		The user, group, and mode permissions for the inserted media.

The `/etc/rmmount.conf` file is shown as:

```
# @(#)rmmount.conf 1.3     96/05/10 SMI
#
# Removable Media Mounter configuration file.
```

```
#

# File system identification
ident hsfs ident_hsfs.so cdrom
ident ufs ident_ufs.so cdrom floppy rmscsi pcmem
ident pcfs ident_pcfs.so floppy rmscsi pcmem

# Actions
action cdrom action_filemgr.so
action floppy action_filemgr.so
action rmscsi action_filemgr.so
```

The files in the /usr/lib/vold directory are listed as:

```
castle% ls -1 /usr/lib/vold
db_mem.so.1
db_nis.so.1
dev_cdrom.so.1
dev_floppy.so.1
dev_pcmem.so.1
dev_rmscsi.so.1
dev_test.so.1
eject_popup
label_cdrom.so.1
label_dos.so.1
label_sun.so.1
label_test.so.1
volcancel
volmissing
volmissing_popup
volstat
castle%
```

The files in the /usr/lib/rmmount directory are listed as:

```
oak% ls -1 /usr/lib/rmmount
action_filemgr.so.1
action_workman.so.1
oak%
```

If you encounter problems with volume management, check the /var/adm/vold.log file for information. An example of this file follows:

```
oak% more /var/adm/vold.log
Tue Jun  1 17:34:24 1993 warning: dev_use: couldn't find a driver for drive
cdrom at /dev/dsk/c0t6
Tue Jun  1 17:39:12 1993 warning: dev_use: couldn't find a driver for drive
cdrom at /dev/dsk/c0t6
Tue Jun  1 18:24:24 1993 warning: dev_use: couldn't find a driver for drive
cdrom at /dev/dsk/c0t6
Wed Jun 23 15:08:47 1993 warning: check device 36.2: device not managed
Wed Jun 23 15:09:58 1993 warning: check device 36.2: device not managed
Wed Jun 23 15:11:08 1993 warning: check device 36.2: device not managed
Thu Jul 15 13:51:23 1993 warning: check device 36.2: device not managed
Thu Jul 15 13:52:53 1993 warning: check device 36.2: device not managed
Thu Jul 15 14:04:37 1993 warning: check device 36.2: device not managed
Thu Jul 15 14:05:52 1993 warning: check device 36.2: device not managed
```

```
Thu Jul 15 14:06:16 1993 warning: check device 36.2: device not managed
Wed Jul 21 16:33:33 1993 fatal: svc_tli_create: Cannot create server handle
Thu Jul 22 16:32:28 1993 warning: cdrom: /dev/rdsk/c0t6d0s2; Device busy
castle%
```

If you want to display debugging messages from the volume daemon, you can start the daemon by typing **`/usr/sbin/vold -v -L 10`**. With these flags set, the volume daemon logs quite a bit of information in `/var/adm/vold.log`.

Another way to gather debugging information is to run the `rmmount` command with the debug flag. To do so, edit `/etc/vold.conf` and change the lines that have `/usr/sbin/rmmount` to include the `-D` flag, as shown in the following example:

```
insert /vol*/dev/diskette[0-9]/* user=root /usr/sbin/rmmount -D
```

Volume Management Mount Points

Volume management automatically mounts CD-ROM file systems on the `/cdrom` mount point when you insert the media into the drive.

When you insert a diskette in the diskette drive, you must ask the system to check the diskette drive. You can check for a diskette in any one of the following ways:

- From the command line, type **`volcheck`** and press Return.
- From the CDE front panel, click on the Folders menu and then click on Open Floppy.
- From the CDE File Manager File menu, choose Open Floppy.
- From the OpenWindows File Manager File menu, choose Check for Floppy.

When you use any of these methods, the files are mounted on the `/floppy` mount point. Table 3–6 describes the mount points and how volume management uses them.

Table 3–6 Volume Management Mount Points

Medium	Mount Point	State of Medium
Diskette	`/floppy/floppy0`	Symbolic link to mounted diskette in local diskette drive
	`/floppy/`*`floppy-name`*	Mounted named diskette
	`/floppy/unnamed_floppy`	Mounted unnamed diskette
CD-ROM	`/cdrom/cdrom0`	Symbolic link to mounted CD-ROM in local CD-ROM drive
	`/cdrom/CD-ROM-`*`name`*	Mounted named CD-ROM
	`/cdrom/`*`CD-ROM-name/partition`*	Mounted named CD-ROM with partitioned file system
	`/cdrom/unnamed_cdrom`	Mounted unnamed CD-ROM

If the medium does not contain a file system, volume management provides block and character devices in the `/vol` file system, as shown in Table 3–7.

Table 3–7 Solaris 2.3 CD-ROM and Diskette Device Locations When No File System Is Present

Medium	Device Location	State of Medium
Diskette	`/vol/dev/diskette0/unnamed_floppy`	Formatted unnamed diskette-block device access
	`/vol/dev/rdiskette0/unnamed_floppy`	Formatted unnamed diskette—raw device access
	`/vol/dev/diskette0/unlabeled`	Unlabeled diskette—block diskette-raw device access
CD-ROM	`/vol/dev/dsk/c0t6/unnamed_cdrom`	CD-ROM—block device access
	`/vol/dev/rdsk/c0t6/unnamed_cdrom`	CD-ROM—raw device access

CD-ROMs and Volume Management

The following sections describe how to access files from local and remote CD-ROM drives.

Mounting a Local CD-ROM

Use the following procedure to mount a CD-ROM from a local drive:

1. Remove the protective film and remove the CD-ROM from its plastic case.
2. Place the CD-ROM into its caddy so that the CD label is visible.
3. Insert the caddy into the drive slot. The CD-ROM is automatically mounted on the `/cdrom` mount point. If File Manager is running, a window displays the contents of the CD-ROM, as shown in Figure 3–2.
4. To access files on the CD-ROM from a command line, type **`cd /cdrom/cdrom0`** and press Return.
5. Type **`ls -L`** and press Return. The list of files in the `/cdrom/cdrom0` directory is displayed. Use the `-L` option because some of the files on the CD may be symbolic links.

You can use the File Manager CD-ROM window and the command line interchangeably. For example, you can eject a CD-ROM either from a command line by typing **`eject cdrom`** or by clicking SELECT on the Eject button in the File Manager CD-ROM window.

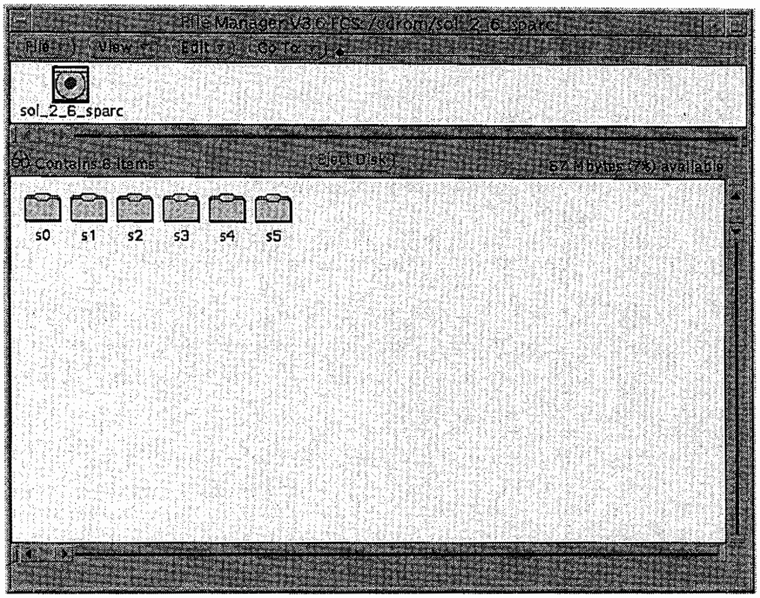


Figure 3–2
The File Manager CD-ROM window.

Sharing Files from a Remote CD-ROM Drive

Before you can share CD-ROM files from a command line, the `mountd` daemon must be running. On the system with the CD-ROM drive attached, type **`ps -ef | grep mountd`** and press Return.

If the `mountd` daemon is running, other systems can access shared files. If the `mountd` daemon is not running, you need to stop NFS services and restart them. Be sure to notify any users of the system that NFS services will be interrupted momentarily when you use the following procedure.

Use the following steps to start the `mountd` daemon:

1. Become superuser.
2. Type **`/etc/rc3.d/S15nfs.server stop`** and press Return. NFS services are stopped.
3. Type **`/etc/rc3.d/S15nfs.server start`** and press Return. NFS services are restarted and the CD files are exported.

The following example uses the `ps` command to verify that the `mountd` daemon is not already running, and as superuser it runs the `S15nfs.server` script to stop NFS services and restart them again:

```
oak% ps -ef ¦ grep mountd
    root  4571  4473  5 12:53:51 pts/3    0:00 grep mountd
oak% su
Password:
# /etc/rc3.d/S15nfs.server stop
# /etc/rc3.d/S15nfs.server start
```

Use the following steps to share CD files from a remote CD-ROM drive:

1. Insert the CD-ROM into the caddy and insert the caddy into the drive. The CD-ROM is mounted.

2. Become superuser on the Solaris 2.2 (or later) system with the CD-ROM drive attached.

3. Type `share -F nfs -o ro /cdrom/cdrom0` and press Return.

NOTE. *Volume management does not recognize entries in the* `/etc/dfs/dfstab` *file. With Solaris 2.3 volume management, you can set up remote CD-ROM mounts to be automatically shared by editing the* `/etc/rmmount.conf file`. *Refer to the* `rmmount.conf` *manual page for more information.*

The following example shares the files on the `/cdrom/cdrom0` mount point as NFS files and uses the `ps` command to verify that the `mountd` daemon is running:

```
oak% su
Password:
# share -F nfs -o ro /cdrom/cdrom0
# ps -ef ¦ grep mountd
    root  4655  4473  6 12:56:05 pts/3    0:00 grep mountd
    root  4649     1 47 12:55:25 ?        0:00 /usr/lib/nfs/mountd
#
```

How to Access Shared CD-ROM Files

You can use the `/mnt` directory as the mount point for the CD-ROM files, or you can create another directory.

NOTE. *Do not use the* `/cdrom` *mount point to mount local files. Volume management may interfere with accessing files on the volume management* `/cdrom` *mount point.*

When the CD-ROM is in the remote drive and the files are shared, follow these steps to access the shared files on a local system:

1. On the local system, become superuser.

2. Type `mount` ***`remote-system-name:/cdrom/cdrom0 /mount-point`*** and press Return. The files from the remote system directory `/cdrom/cdrom0` are mounted on the *`/mount-point`* directory. The `cdrom0` subdirectory is symbolically linked to the actual name of the CD-ROM that has a name assigned by the application vendor.

In the following example, the files from the remote system `castle` are mounted on the `/mnt` mount point:

```
oak% su
Password:
# mount castle:/cdrom/cdrom0 /mnt
# cd /mnt
# ls
SUNWssser  SUNWsssra  SUNWsssrb  SUNWsssrc  SUNWsssrd  SUNWssstr
#
```

How to Unmount Shared CD-ROM Files

When you are through using the CD-ROM files, use the following steps to unmount the remote CD-ROM:

1. On the local system, become superuser.
2. Type **cd** and press Return.
3. Type **umount** ***/mount-point*** and press Return. The files from the remote system directory /cdrom/cdrom0 are unmounted.

Diskettes and Volume Management

When you insert a diskette into the diskette drive, volume management does not mount the diskette automatically; this prevents excessive reads, which can quickly wear out the diskette drive. You must use a command that checks for the presence of a diskette in the diskette drive.

Command-Line Access

Follow these steps to format a diskette from a command line:

1. Insert a diskette into the diskette drive.
2. Type **volcheck** and press Return. The system has access to the unformatted diskette.
3. Type **fdformat** and press Return to format a UFS file system or **fdformat -d** to format an MS-DOS file system.
4. When prompted, press Return to begin formatting the diskette.
5. For UFS file systems, you must also make a new file system on the diskette. To do so, become a superuser, type **newfs /vol/dev/rdiskette0/unnamed_floppy**, and press Return.

Follow these steps to access files on a formatted diskette:

1. Insert a formatted diskette in the diskette drive.
2. Type **volcheck** and press Return. If there is a formatted diskette in the drive, volume management mounts it on the /floppy mount point. If no diskette is in the drive, no error message is displayed. The volcheck command redisplays the prompt. When the diskette is mounted on the /floppy mount point, you can access files on it either

from the command line or from the File Manager Floppy window, described in "Open Windows File Manager Access" or "CDE File Manager Access."

3. Type `cd /floppy` and press Return.
4. Type `ls` and press Return. The name of the diskette is displayed.
5. Type `cd` ***diskette-name*** and press Return.
6. Type `ls` and press Return. The names of the files on the diskette are displayed. You can copy files to and from the diskette using the `cp` command.

In the following example, the diskette is not mounted, so the only directory in `/floppy` is `ms-dos_5`. After `volcheck` mounts the diskette, the directory with the name of the diskette is displayed. The diskette in this example contains only a `lost+found` directory:

```
oak% cd /floppy
oak% ls
ms-dos_5
oak% volcheck
oak% ls
ms-dos_5        unnamed_floppy
oak% cd unnamed_floppy
oak% ls
lost+found
oak% cp /home/winsor/Appx/appxA.doc .
oak% ls
appxA.doc lost+found
oak%
```

You cannot unmount a file system whose current working directory is in use. If you get the message `Device busy` a process has its current working directory on the diskette. Use the `fuser` command to find out what process is using the diskette. See the `fuser`(1M) manual page for information.

Use the following steps to eject the diskette:

1. Type `cd` and press Return. You have changed out of the `/floppy` directory.
2. Type `eject` and press Return. After a few seconds, the diskette is ejected from the drive.

OpenWindows File Manager Access

If you are running File Manager, you can use it to format a diskette, display the contents, and copy files to and from the diskette. Follow these steps to format a diskette, display its contents, and eject it:

1. Insert the diskette into the diskette drive.

2. Choose Check for Floppy from the File menu, as shown in Figure 3–3.

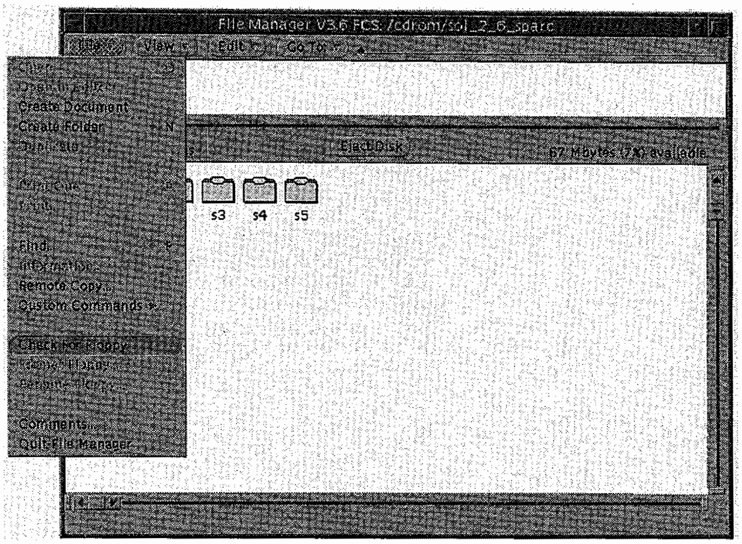


Figure 3–3
Choose Check for Floppy from the File menu.

3. If the diskette is not formatted, a window is displayed, as shown in Figure 3–4. Click SELECT on the Cancel & Eject button if you want to eject the diskette without formatting it.

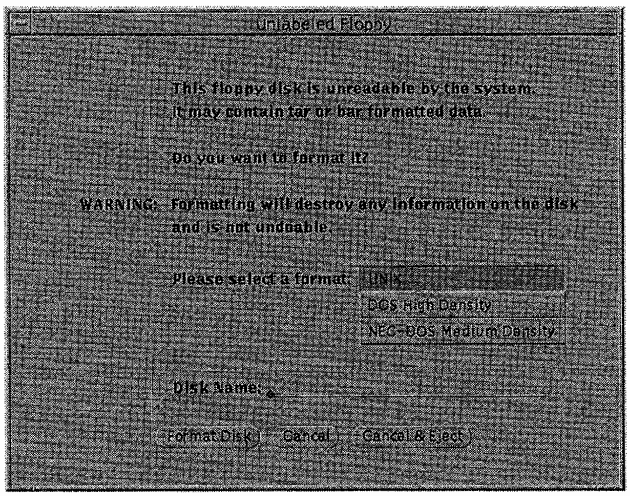
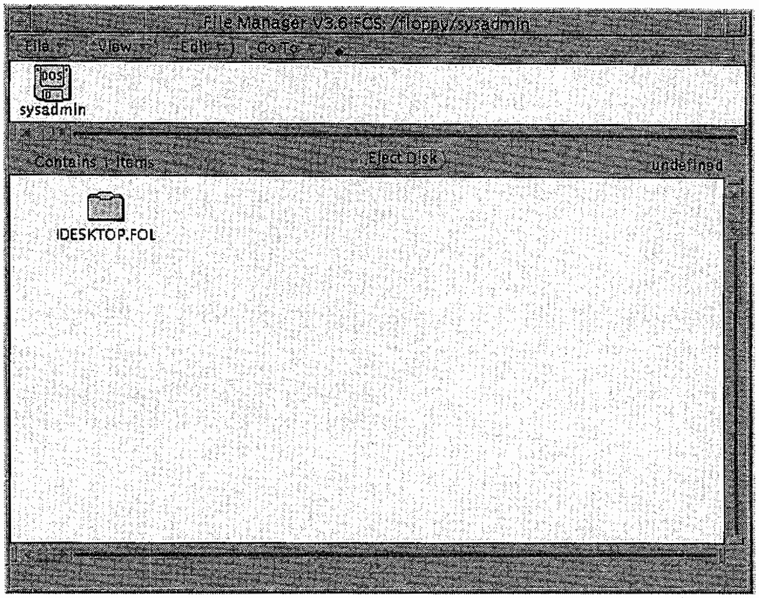


Figure 3–4
The File Manager Unformatted Floppy window.

4. Click SELECT on the format you want to use, then click on Format Disk. The diskette is formatted and a new file system is created.

5. When the diskette is formatted and contains the file system, the File Manager Floppy window displays the contents of the diskette, as shown in Figure 3–5.

Figure 3–5
The File Manager Floppy window.



You can drag and drop files to and from the Floppy window in the same way that you manipulate other files using the File Manager.

To eject the diskette, click SELECT on the Eject Disk button. After a few seconds, the diskette is ejected and the File Manager Floppy window is dismissed.

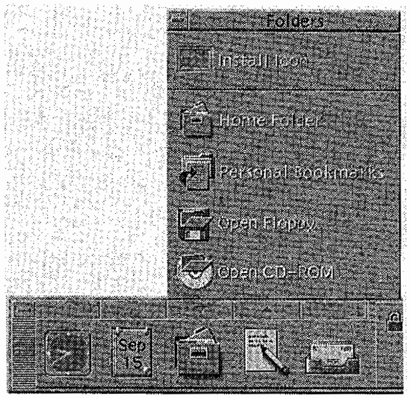
CDE Front Panel Access

If you are running CDE, you can use the Folders menu on the front panel to display the contents of a floppy. Follow these steps to open a floppy from the front panel:

1. Insert a formatted or unformatted diskette into the diskette drive.

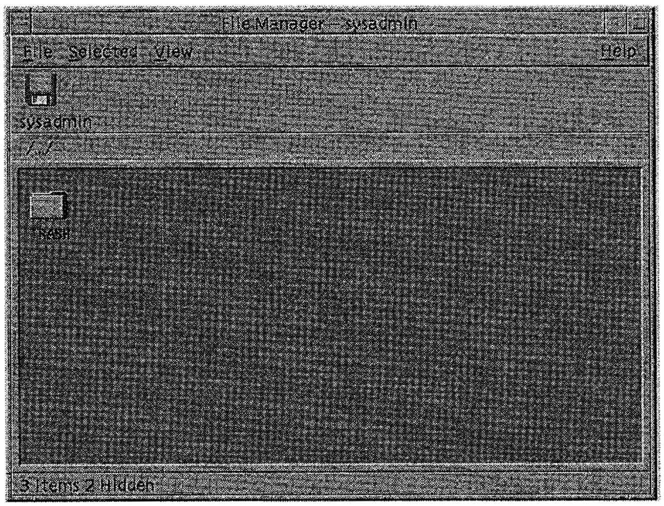
2. From the front panel, open the Folders menu, shown in Figure 3–6, and click on Open Floppy.

Figure 3–6
The Front Panel Folders menu.



After the light on the front panel stops flashing (about 5 to 10 seconds), the floppy is mounted to `/floppy` and a File Manager window opens. Figure 3–7 shows an example of the File Manager floppy window for a formatted floppy.

Figure 3–7
The CDE File Manager floppy window.

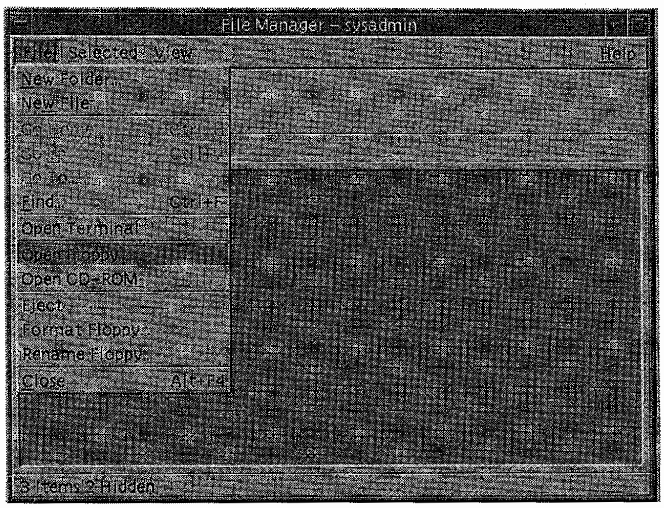


CDE File Manager Access

If you are running CDE File Manager, you can use it to format a diskette, display the contents, and copy files to and from the diskette. Follow these steps to open a diskette from the CDE File Manager:

1. Insert a formatted or unformatted diskette into the diskette drive.
2. From the File Manager File menu, shown in Figure 3–8, choose Open Floppy. After the light on the front panel stops flashing (abut 5 to 10 seconds), the floppy is mounted to `/floppy` and a File Manager window opens.

Figure 3–8
The CDE File Manager menu.



3. From the File Manager File menu you can also eject, format, and rename the diskette.

Using the *tar* and *cpio* Commands with Diskettes

If a diskette contains `tar` or `cpio` files, volume management does not mount it. You cannot access files on the diskette from the old `/dev/rdiskette` device name because volume management provides access to the media, not to the device.

You can access `tar` and `cpio` files on a diskette using the symbolic link to the character device for the media that is in floppy drive 0, as:

```
/vol/dev/aliases/floppy0
```

Use the following steps to copy a file to a formatted diskette using the `tar` command:

1. Insert a formatted diskette into the diskette drive.
2. Type **`volcheck`** and press Return.

3. Type `tar cvf /vol/dev/aliases/floppy0` ***filename*** and press Return. The files are copied to the diskette.
4. Type `eject` and press Return. After a few seconds, the diskette is ejected.

Use the following steps to copy all `tar` files from a diskette:

1. Insert a formatted diskette into the diskette drive.
2. Change to the directory where you want to put the files.
3. Type `volcheck` and press Return. The diskette is mounted.
4. Type `tar xvf /vol/dev/aliases/floppy0` and press Return. The files are copied to the diskette.
5. Type `eject` and press Return. After a few seconds, the diskette is ejected.

Alternatively, with Solaris 2.2 (and later) systems, you can access `tar` or `cpio` files using the following device name syntax:

`/vol/dev/rfd0/`*`media-name`*

The most common *`media-name`* is `unlabeled`.

With Solaris 2.3, the device name syntax is changed. You access `tar` or `cpio` files using the following device name syntax:

`/vol/dev/rdiskette0/`*`media-name`*

The most frequent *`media-name`* for media without a file system is `unlabeled`.

For example, to copy a `tar` file to a diskette, type `tar cvf /vol/dev/rdiskette0/unlabeled` ***filename*** and press Return. To retrieve all `tar` files from a diskette, type `tar xvf /vol/dev/rdiskette0/unlabeled` and press Return.

Troubleshooting Volume Management

From time to time, you may encounter problems with mounting diskettes (or, less frequently, a CD-ROM). If you encounter a problem, first check to find out whether volume management knows about the diskette. The best way to check is to look in `/vol/dev/rdiskette0` to see if something is there. If the files are not mounted, you may have forgotten to run the `volcheck` command, or you may have a hardware problem. If references to `/vol` hang, the `/usr/sbin/vold` daemon has probably died, and you should restart it.

If you find a name in `/vol/dev/rdiskette0` and nothing is mounted in `/floppy/`*`media-name`*, it is likely that the data on the media is not a recognized file system. It may be a `tar`, `cpio`, or Macintosh file system. You can access these media through the block or character devices found in `/vol/dev/rdiskette0` or `/vol/dev/diskette0` and use your own tools to interpret the data on them.

Using workman with Volume Management

Many people use the workman program to play music from their CD-ROM drive. workman is not a Sun product, but it is in wide use. To use workman with volume management, add the line shown in bold to the /etc/rmmount.conf file. Be sure the line comes before the cdrom action_filemgr line:

```
# @(#)rmmount.conf 1.2     92/09/23 SMI
#
# Removable Media Mounter configuration file.
#

# File system identification
ident hsfs ident_hsfs.so cdrom
ident ufs ident_ufs.so cdrom floppy
ident pcfs ident_pcfs.so floppy

# Actions
action cdrom action_workman.so pathname
action cdrom action_filemgr.so
action floppy action_filemgr.so
```

A *pathname* is the name of the path where users access the workman program—for example, /usr/apps/pkgs/exe/workman.

When you have made this change, audio CD-ROMs are automatically detected and the workman program is started when a CD-ROM is inserted into the CD-ROM drive.

NOTE. *When you set up workman in the way described here, users should not try to start workman from the application, because volume management may get confused. In addition, with Solaris 2.2 (and later) volume management, if you are using workman, you must eject the CD-ROM from the workman application. If you eject the CD-ROM from a nother window, workman hangs. This problem is fixed in Solaris 2.3 and later system software.*

Changes with Solaris 2.3 System Software

With Solaris 2.2, you cannot automatically export CD-ROM and diskette drives or use the /etc/vfstab file. You must use the share command to export the file system after every reboot.

NOTE. *You cannot share a PCFS file system with Solaris 2.2 system software.*

With Solaris 2.3 system software, a share cdrom* instruction is provided in the /etc/rmmount.conf file so that a CD-ROM is automatically shared when it is inserted into the CD-ROM drive. You can specify flags in the same way as you do for the share command. You can also use the name of a particular piece of media, if desired. Refer to the rmmount.conf manual page for more details.

With Solaris 2.3, the device names for the physical device have changed to be consistent with /dev. In Solaris 2.2 system software, the device names are /vol/dev/rfd0 and

/vol/dev/fd0. With Solaris 2.3 system software, the device names are /vol/dev/rdiskette0 and /vol/dev/diskette0. The symbolic link in /vol/dev/aliases always points to the correct device.

Disabling Volume Management

You may want to disable volume management for some users. To do so, use the following steps:

1. Become superuser.
2. Remove or rename the /etc/rc2.d/S92volmgt script.
3. Type **/etc/init.d/volmgt stop** and press Return.

You can disable part of volume management and leave other parts functional. You may, for example, want to automatically mount CD-ROMs, but use the Solaris 2.0 method for accessing files on a diskette. You can do so by commenting out the lines for diskettes in the /etc/vold.conf file, as shown:

```
# @(#)vold.conf 1.21     96/05/10 SMI
#
# Volume Daemon Configuration file
#

# Database to use (must be first)
db db_mem.so

# Labels supported
label dos label_dos.so floppy rmscsi pcmem
label cdrom label_cdrom.so cdrom
label sun label_sun.so floppy rmscsi pcmem

# Devices to use
use cdrom drive /dev/rdsk/c*s2 dev_cdrom.so cdrom%d
# use floppy drive /dev/rdiskette[0-9] dev_floppy.so floppy%d
use pcmem drive /dev/rdsk/c*s2 dev_pcmem.so pcmem%d forceload=true
# use rmscsi drive /dev/rdsk/c*s2 dev_rmscsi.so rmscsi%d

# Actions
insert dev/diskette[0-9]/* user=root /usr/sbin/rmmount
insert dev/dsk/* user=root /usr/sbin/rmmount
eject dev/diskette[0-9]/* user=root /usr/sbin/rmmount
eject dev/dsk/* user=root /usr/sbin/rmmount
notify rdsk/* group=tty user=root /usr/lib/vold/volmissing -p

# List of file system types unsafe to eject
unsafe ufs hsfs pcfs
```

Using Diskettes Without Volume Management

Use double-sided (DS), high-density (HD) 3.5-inch diskettes. Before you can copy ufs files or file systems to diskette, you must format the diskette. Use the `tar` command to copy ufs files to a single formatted diskette. Use `cpio` if you need to copy ufs files to multiple formatted diskettes. The `cpio` command recognizes end of media and prompts you to insert the next volume.

You also can make a DOS-file system on a diskette. To use a DOS-formatted diskette, you mount the diskette as a pcfs file system and use basic OS commands such as `cp` and `mv` to archive and retrieve files from the diskette.

Diskette Device Names

The device name for the diskette drive has changed with the SunOS 5.*x* system software. The device name for the diskette drive is `/dev/diskette`. The raw device file for a diskette is `/dev/rdiskette`.

Diskettes for ufs File Systems

The following sections describe how to format diskettes for use with ufs file systems, and describe how to copy files using the `tar` and `cpio` commands. They also describe how to retrieve files that were created using the SunOS 4.*x* `bar` command.

Formatting a ufs Diskette

Follow these steps to format a diskette for use with SunOS 5.*x* ufs file systems:

1. Check the diskette to make sure that it is not write protected.
2. Put the diskette in the drive.

CAUTION! *Reformatting destroys any files already on the diskette.*

3. Type **`fdformat`** and press Return. The message `Press return to start formatting floppy` is displayed.
4. Press Return. While the diskette is being formatted, a series of dots (...) is displayed. When formatting is complete, the prompt is redisplayed:

```
oak% fdformat
Press return to start formatting floppy.
...........................................................................
oak%
```

Removing a Diskette from the Drive

Use the `eject` command to remove a diskette from the disk drive. You can also use the `eject` command to remove a CD-ROM disc from a CD-ROM drive. The default for the `eject` command is `/dev/diskette` when you type it with no arguments. To remove a diskette from the diskette drive, type **`eject`** and press Return. The diskette is ejected.

NOTE. *If the drive jams, you can eject a diskette manually by sticking a straightened wire paper clip into the pinhole under the diskette slot.*

To eject a CD-ROM disc from a CD-ROM drive, type **`eject cdrom`** and press Return.

Copying ufs Files to a Single Formatted Diskette

This section provides steps for using the `tar` command to copy files to a single formatted diskette. Note that the `tar` command does not require the raw device name, `/dev/rdiskette`. You can use either the `/dev/rdiskette` or `/dev/diskette` device name. The examples in this book use the raw device name.

Use the following steps to copy ufs files to a single formatted diskette:

1. Change to the directory that contains the file(s) you want to copy.
2. Insert a write-enabled formatted diskette protected into the drive.

CAUTION! *Copying files to a formatted diskette using the* `c` *option destroys any files already on the diskette. If you want to preserve the files already on the diskette, use the* `r` *option described in "Appending Files to a Formatted Diskette (*`tar`*)" later.*

3. Type **`tar cvf /dev/rdiskette`** ***`filename filename filename`*****`...`** and press Return. The file names you specify are copied to the diskette, overwriting any existing files on the diskette.

NOTE. *You can use metacharacters (*`?` *and* `*`*) as part of the file names you specify. For example, to copy all documents with a* `.doc` *suffix, type* **`*.doc`** *as the file name argument.*

4. Type **`eject`** and press Return to remove the diskette from the drive. The diskette is ejected from the drive.
5. Write the names of the files on the diskette label.

In this example, two files are copied to a diskette:

```
oak% cd /home/winsor
oak% ls evaluation*
evaluation.doc   evaluation.doc.backup
oak% tar cvf /dev/rdiskette evaluation*
a evaluation.doc 86 blocks
a evaluation.doc.backup 84 blocks
oak% eject
oak%
```

Listing the Files on a Diskette (*tar*)

Follow these steps to list files that were copied using the `tar` command:

1. Insert a diskette into the drive.

2. Type `tar tvf /dev/rdiskette` and press Return. The `t` option lists the table of contents for the files on the diskette.

In this example, the table of contents for the diskette contains two files:

```
oak% tar tvf /dev/rdiskette
rw-rw-rw-6693/10  44032 Apr 23 14:54 1991 evaluation.doc
rw-rw-rw-6693/10  43008 Apr 23 14:47 1991 evaluation.doc.backup
oak%
```

See the `tar`(1) manual page for more information.

If you need a multiple-volume interchange utility, use `cpio`. The `tar` command is only a single-volume utility.

Appending Files to a Formatted Diskette (*tar*)

When you copy `tar` files to a formatted diskette, any files already on the diskette are overwritten. If you want to keep the files already on the diskette and add other files, follow these steps:

1. Change to the directory that contains the file you want to copy.
2. Insert a write-enabled formatted diskette protected into the drive.
3. Type `tar rvf /dev/rdiskette` ***filename filename filename...*** and press Return. The file names you specify are appended to the files already on the diskette.

NOTE. *You can use metacharacters (`?` and `*`) as part of the file names you specify. For example, to copy all documents with a `.doc` suffix, type `*.doc` as the file name argument.*

4. Type `eject` and press Return to remove the diskette from the drive. The diskette is ejected from the drive.
5. Write the names of the additional files on the diskette label.

In this example, one file is appended to the files already on the diskette:

```
oak% cd /home/winsor
oak% tar rvf /dev/rdiskette junk
a junk 1 blocks
oak% tar tvf /dev/rdiskette
rw-rw-rw-6693/10  44032 Apr 23 14:54 1991 evaluation.doc
rw-rw-rw-6693/10  43008 Apr 23 14:47 1991 evaluation.doc.backup
rw-rw-rw-6693/10     18 Dec 10 11:36 1991 junk
oak% eject
oak%
```

Retrieving Files from a Diskette (*tar*)

Follow these steps to retrieve files from a diskette:

1. Change to the directory where you want to put the files.
2. Insert the diskette into the drive.

3. Type **tar xvf /dev/rdiskette** and press Return. All the files on the diskette are copied to the current directory.

4. Type **eject** and press Return to remove the diskette from the drive. The diskette is ejected from the drive.

In this example, all files are copied from the diskette:

```
oak% cd /home/winsor/Evaluations
oak% tar xvf /dev/rdiskette
x evaluation.doc, 44032 bytes, 86 tape blocks
x evaluation.doc.backup, 43008 bytes, 84 tape blocks
oak% eject
oak%
```

To retrieve individual files from a diskette, type **tar xvf /dev/rdiskette** ***filename filename filename*** ... and press Return. The file names you specify are extracted from the diskette and placed in the current working directory. In this example, all files with the prefix `evaluation` are copied from the diskette:

```
oak% cd /home/winsor/Evaluations
oak% tar xvf /dev/rdiskette
x evaluation.doc, 44032 bytes, 86 tape blocks
x evaluation.doc.backup, 43008 bytes, 84 tape blocks
oak% eject
oak%
```

Retrieving *bar* Files from Diskettes (*cpio*)

The SunOS 4.*x* `bar` command is not provided with the SunOS 5.*x* system software. You can retrieve files from diskettes that were archived using the SunOS 4.*x* `bar` command by using the `-H bar` option to `cpio`.

NOTE. *You can use the* `-H bar` *option with* `-i` *to retrieve files only. You cannot create files with the* `bar` *header option. It is good practice to list the contents of an archive before extracting them.*

Follow these steps to retrieve `bar` files from a diskette:

1. Change to the directory where you want to put the files.

2. Insert the diskette that contains `bar` files into the drive.

3. Type **cpio -ivH bar < /dev/diskette** and press Return. All the files on the diskette are copied to the current directory.

4. Type **eject** and press Return to remove the diskette from the drive.

Multiple Diskettes for Archiving Files (*cpio*)

If you are copying large files or file systems onto diskettes, you will want to be prompted to replace a full diskette with another formatted diskette. The `cpio` command provides this capability. The `cpio` options you use are the same as you would use to copy files to tape, except you would specify `/dev/rdiskette` as the device instead of the tape device name. See "The `cpio` Command" earlier for information on how to use `cpio`.

Making a ufs File System on a Diskette (*newfs /dev/rdiskette*)

If you want to mount a ufs diskette, you must make a file system on it first:

1. Format the diskette.
2. Become superuser.
3. Type **`newfs /dev/rdiskette`** and press Return.

A ufs file system is created on the diskette:

```
oak% fdformat
Press return to start formatting floppy.
................................................................................
oak% su
Password:
# newfs /dev/rdiskette
#
```

Diskettes for pcfs (DOS) File Systems

You can format diskettes with the pcfs file system for use with DOS systems. The following sections describe how to format a DOS diskette and how to mount the diskette for use with the SunOS 5.*x* system software. See Chapter 4, "Administering File Systems," for a description of the pcfs file system.

Formatting a Diskette with a pcfs (DOS) File System

Follow these steps to format a diskette with the pcfs file system:

1. Put a diskette in the drive.

CAUTION! *Reformatting destroys any files already on the diskette.*

2. Type **`fdformat -d`** and press Return. The message `Press return to start formatting floppy` is displayed.
3. Press Return. While the diskette is being formatted, a series of dots (...) is displayed. When formatting is complete, the prompt is redisplayed, as shown in the following example:

   ```
   oak% fdformat -d
   Press return to start formatting floppy.
   ................................................................................
   oak%
   ```

Mounting a pcfs Diskette

You can mount a pcfs diskette that was formatted using the `fdformat -d` command, or a DOS diskette that was formatted on a DOS system. When you mount a pcfs file system, you can create, read, write, and delete files in the file system using SunOS file utilities, subject to DOS naming conventions. See the `pcfs`(7) manual page for more information about the format and features of the pcfs file system.

To mount a pcfs file system from a diskette:

1. Insert the pcfs diskette in the drive.
2. Become superuser.
3. Type **`mount -F pcfs /dev/diskette`** ***`mount-point`*** and press Return. The file system is mounted on the *`mount-point`* you specify.

You can mount a pcfs file system with different mount options (for example, `-o rw`). See the `mount_pcfs`(1M) manual page for a description of the options that can be included in the list.

If you use pcfs diskettes frequently, you may want to add this entry to your `/etc/vfstab` file:

```
/dev/diskette   -    /pcfs    pcfs   -   no   rw
```

Create a directory named `/pcfs` to use as the mount point for the diskette. With the mount point and the entry in the `/etc/vfstab` file, you can mount a pcfs diskette by becoming superuser and typing **`mount /pcfs`** and pressing Return. Once the diskette is mounted, you can use any of the SunOS file utilities such as `cp` or `mv` to copy files to and from the diskette.

Unmounting a pcfs Diskette

When you are done with the pcfs diskette, you must unmount it before you can eject it. To unmount the diskette, type **`umount`** ***`mount-point`*** and press Return. To eject the diskette, type **`eject`** and press Return.

Administering Disks

The following sections describe the SunOS 5.*x* disk naming conventions, commands for finding disk information (`du`, `prtvtoc`), and how to repair or replace a bad disk.

Disk-Naming Conventions

2.6 The SunOS 5.*x* disk-naming conventions are different from the SunOS 4.*x* disk-naming conventions. This section describes the new disk-naming conventions; these are based on logical (not physical) device names. SunOS 5.*x* disks have both block and raw (character) device files. The device name is the same, regardless of whether the command requires the block or raw device file.

Instead of using an `r` to the beginning of the disk device name (the naming convention in the SunOS 4.*x* system software), each type of device file has its own subdirectory in `/dev`: `/dev/dsk` (the block interface) or `/dev/rdsk` (the raw interface).

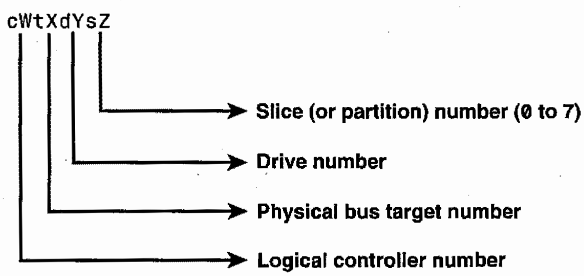
Some commands, such as `mount`, use the block interface device name from the `/dev/dsk` directory to specify the disk device. Other commands, such as `newfs`, require the raw interface device name from the `/dev/rdsk` directory to specify the disk device.

The device name you use to identify a specific disk with either type of interface depends on the controller type: bus-oriented (SCSI or IPI) or direct.

Using Disks with Bus Controllers

Figure 3–9 shows the device-naming convention for disks with bus controllers.

Figure 3–9
Naming convention for disks with bus controllers.



Each file system on a disk is assigned to a *slice*— a group of cylinders set aside for use by that file system. To specify a slice (partition) on a disk with a bus controller (either SCSI or IPI), use a device name with these conventions: `/dev/dsk/cWtXdYsZ` (the block interface) or `/dev/rdsk/cWtXdYsZ` (the raw interface).

NOTE. *SunOS 5.*x *disk device names use the term* slice *(and the letter* `s` *in the device name) to refer to the slice number.* Slice *is simply another name for a disk partition.*

Here are some guidelines for determining the values for the device file name:

- If you have only one controller on your system, *W* is always 0.
- For SCSI controllers, *X* is the target address set by the switch on the back of the unit.
- *Y* is the number of the drive attached to the target. If the disk has an embedded controller, *Y* is always 0.

- *z* is the slice (partition) number, with a value ranging from 0 to 7. To specify the entire disk, use slice 2. Table 3–8 shows conventional assignments of slice (partition) numbers for the disk on which root is found.

Table 3–8 Customary Assignments of Slices for Disk with Root

Slice	File System	Use
0	`root`	Operating system
1	`swap`	Virtual memory space
2	-	Entire disk
3–5		Available for use according to your administrative policy
6	`/usr`	Executable programs, program libraries, and documentation

Table 3–9 shows some examples of raw device names for disks with bus-oriented controllers.

Table 3–9 Examples of Device Names for Disks with Bus-Oriented Controllers

Device Name	Description
`/dev/rdsk/c0t0d0s0`	Raw interface to the first slice (root) on the first disk at the first SCSI target address on the first controller.
`/dev/rdsk/c0t0d0s2`	Raw interface to the third slice (which represents the whole disk) on the first disk at the first SCSI target address on the first controller.
`/dev/rdsk/c0t1d0s6`	Raw interface to seventh (`/usr`) slice on the first disk at the second SCSI target address on the first controller.

Using Disks with Direct Controllers

Disks with direct controllers do not have a target entry as part of the device name. To specify a slice (partition) on a disk with a direct controller, use a device name with these conventions: `/dev/dsk/cXdYsZ` (the block interface) or `/dev/rdsk/cXdYsZ` (the raw interface).

Figure 3–10 shows the naming convention for disks with direct controllers. If you have only one controller on your system, *x* is always 0. Use slice 2 to specify the entire disk.

Figure 3–10
Naming convention for disks with direct controllers.

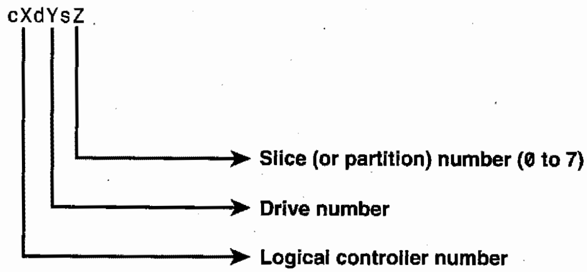


Table 3–10 shows some examples of raw device names for disks with direct controllers.

Table 3–10 Examples of Device Names for Disks with Direct Controllers

Device Name	Description
/dev/rdsk/c0d0s0	Raw interface to the first controller on the first disk to the first slice (root).
/dev/rdsk/c0d0s2	Raw interface to the first controller on the first disk to the third slice (the entire disk).
/dev/rdsk/c0d1s6	Raw interface to the first controller on the second disk to the seventh (/usr) slice. By convention, the slice numbers are assigned to specific file systems, as shown in Table 3–8.

NEW

Setting Up Disk Slices

Files are stored within file systems. Each disk slice is treated as a separate disk drive both by the operating system and by the system administrator. When setting up slices, remember:

- Each disk slice holds only one file system.
- No file system can span multiple slices.

You set up slices differently on SPARC and x86 platforms, as described in Table 3–11.

SPARC Disk Slices

On SPARC systems, you define eight disk slices, and assign each to a conventional use, as described in Table 3–12.

Table 3–11 Slice Differences on Platforms

SPARC Platform	x86 Platform
Entire disk is used for Solaris environment	Disk is divided into `fdisk` partitions, one per operating environment.
Disk is divided into eight slices, numbered 0–7	The Solaris `fdisk` partition is divided into 10 slices, numbered 0–9.

Table 3–12 SPARC Disk Slice Conventions

Slice	File System	Client/Server	Description
0	`root`	Both	Holds files and directories that make up the operating system.
1	`swap`	Both	Provides virtual memory or swap space.
2	—	Both	By convention, refers to the entire disk. The entire disk is defined automatically by the `format` command and the Solaris installation programs. Do not change the size of this slice.
3	`/export`	Server	Holds alternative versions of the operating system that are required by client systems whose architecture differs from that of the server. Clients with the same architecture type as the server obtain executables from the `/usr` file system, usually slice 6.
4	`/export/swap`	Server	Provides virtual memory/swap space for client systems.
5	`/opt`	Both	Holds application software added to a system. If a slice is not allocated for this file system during installation, the `/opt` directory is put in slice 0.
6	`/usr`	Both	Holds operating system commands—also known as *executables*—designed to be run by users. This slice also holds documentation, system programs such as `init` and `syslogd`, and library routines.
7	`/home` or `/export/home`	Both	Holds files created by user accounts.

x86 Disk Slices

On x86 systems, you divide disks into `fdisk` partitions. Each `fdisk` partition is a section of the disk reserved for a particular operating environment. For a Solaris `fdisk` partition, you define 10 slices, numbered from 0 through 9, and assign each to a conventional use. The uses for slices 0 through 7 are the same as on Solaris systems, described in Table 3–12. Table 3–13 describes slices 8 and 9.

Determining Which Slices to Use

When you set up file systems for a disk, you choose not only the size of each slice but which slices to use. Your decisions depend on the configuration of the system and the software you want to install on the disk.

Table 3–13 x86 Conventions for Slices 8 and 9

Slice	File System	Client/Server	Description
8	—	Both	Contains the boot slice information at the beginning of the Solaris partition that enables Solaris to boot from the hard disk.
9	—	Both	Provides an area reserved for alternate disk blocks. Slice 9 is known as the alternate sector slice.

You can set up five system configurations:

- Servers
- Diskless clients
- Stand-alone systems
- Dataless clients
- Solstice AutoClient systems.

Each system configuration requires the use of different slices, as listed in Table 3–14.

Table 3–14 System Configurations and Slice Requirements

Slice	Servers	Diskless Clients	Stand-alone Systems	AutoClient Systems
0	`root`	(on server)	`root`	`root`
1	`swap`	(on server)	`swap`	`swap`
2	—	—	—	—
3	`/export`	—	—	—
4	`/export/swap`	—	—	—
5	`/opt`	(on server)	`/opt`	(on server)
6	`/usr`	(on server)	`/usr`	(on server)
7	`/export/home`	(on server)	`/home`	(on server)

Disk Use Check (*du*)

To find the number of 512-byte disk blocks used per file or directory, type **du** and press Return. When directories contain subdirectories, the subdirectories and their contents are included in the block count:

```
oak% du
2913    ./3.Øtemplates
```

```
639     ./Art
347     ./Howto
1998    ./Clipart
6Ø7     ./Newtemplates
38      ./Modemstuff
2ØØ4    ./Config/Art
6593    ./Config
1328Ø   .
oak%
```

The output is displayed in 512-byte blocks. To convert to megabytes, divide by 2048. In this example 13280/2048 = 6.48 Mbytes.

Disk Information Check (*prtvtoc*)

SVR4

Use the `prtvtoc` (print volume table of contents) command to display information about disk partitioning. The `prtvtoc` command works only when the slice you specify has space allocated to it. Otherwise, it displays the error message `No such device or address`. If you use the standard slice-naming conventions, specifying slice 2 displays the contents of the entire disk.

Follow these steps to display information about disk partitioning:

1. Become superuser.
2. Type **prtvtoc** **/dev/rdsk/*cntndnsn*** and press Return. Information for the disk you specify is displayed:

```
oak% su
Password:
oak# prtvtoc /dev/rdsk/cØt1dØs2
* /dev/rdsk/cØt1dØs2 partition map
*
* Dimensions:
*     512 bytes/sector
*      35 sectors/track
*       6 tracks/cylinder
*     21Ø sectors/cylinder
*    1Ø19 cylinders
*     974 accessible cylinders
*
* Flags:
*   1: unmountable
*  1Ø: read-only
*

*                        First
* Partition  Tag  Flags   Sector
       Ø      Ø    ØØ         Ø
       1      Ø    ØØ     2415Ø
       2      Ø    ØØ         Ø
       6      Ø    ØØ     7455Ø
Sector    Last
Count    Sector  Mount Directory
```

```
24150      24149
50400      74549
204540     204539   /
129990     204539
oak#
```

Bad-Disk Repair

The following sections describe the steps for repairing a bad disk or reinstalling a new one.

Try Archiving the Files

If you can access the drive, do a `ufsdump` of all the file systems on the disk. See Chapter 4, "Administering File Systems," for information on how to use the `ufsdump` command.

Try Copying Data from the Disk

If you cannot run `ufsdump` on the disk, find another disk of the same type, connect it to the system, and use either the `dd` or `volcopy` commands to copy the data from the bad disk. See the `dd`(1M) and `volcopy`(1M) manual pages for complete information on how to use these commands.

NEW

The `dd` command makes a literal (block) copy of a complete UFS file system to another file system or to a tape. By default, the `dd` command copies its standard input to its standard output.

NOTE. *Do not use the* `dd` *command with variable-length tape drives.*

You can specify a device name in place of the standard input, the standard output, or both. In the following example, contents of a diskette are copied to a file in the `/tmp` directory:

```
oak% dd < /floppy/floppy0 > /tmp/output.file
2400+0 records in
2400+0 records out
oak%
```

The `dd` command reports on the number of blocks it reads and writes. The number after the + is a count of the partial blocks that were copied.

The `dd` command syntax is different from most other commands. You specify options as *`keyword=value pairs`*, where *`keyword`* is the option you want to set and *`value`* is the argument for that option. For example, you can replace the standard input and output with the following syntax:

```
dd if=input-file of=output-file
```

For example, to use the *`keyword=value`* pairs instead of the redirect symbols in the previous example, you would type:

```
oak% dd if=/floppy/floppy0 of=/tmp/output.file
```

Follow these steps to clone a disk using the `dd` command:

1. Make sure the source and destination disks have the same geometry.
2. Become superuser.
3. On the system with the master disk, type **touch /reconfigure** and press Return. The /reconfiguration file is required on the system with the master disk so that it recognizes the clone disk once it is rebooted.
4. Type **init 0** and press Return to shut down the system.
5. Attach the clone disk to the system and turn on the system.
6. At the ok prompt type **boot** and press Return.
7. Type **dd if=*/dev/dsk/device-name* of=*/dev/dsk/device-name* bs=*blocksize*** and press Return. The input file, if, is the master disk device. The output file, of, is the clone disk device.
8. Type **fsck */dev/rdsk/device-name*** and press Return to check the new file system.
9. Type **mount */dev/rdsk/device-name* /mnt** and press Return to mount the clone disk's root file system.
10. Edit the /etc/vfstab file on the clone disk to reference the correct device names.
11. Type **umount /mnt** and press Return to unmount the clone disk's root file system.
12. Type **init 0** and press Return to shut down the system.
13. Type **boot disk*n* -s** and press Return to boot the clone disk in single-user mode.
14. Type **sys-unconfig** and press Return to unconfigure the clone disk. The system is shut down after the disk is unconfigured.
15. Type **boot disk*n*** and press Return to boot the clone disk.
16. Provide the relevant system information such as host name, time zone, and so on.
17. Log in as root to verify the system information once the system has booted:

```
oak% su < /floppy/floppy0 > /tmp/output.file
oak# boot
oak# dd if=/dev/dsk/c0t0d0s2 of=/dev/dsk/c0t2d0s2 bs=100k
oak# fsck /dev/rdsk/c0t2d0s2
oak# mount /dev/dsk/c0t2d0s2 /mnt
oak# cd /mnt/etc
oak# vi vfstab
(Modify entries for the new disk)
oak# cd /
oak# umount /mnt
oak# init 0
oak# boot disk2 -s
oak# sys-unconfig
oak# boot disk2
```

Try Repairing Any Bad Blocks

If the disk has bad blocks, you may be able to repair them using the `format` command. See the `format`(1M) manual page for more information.

Try Reformatting the Disk

If the disk is bad, reformatting it may fix the problem. Use the `format` command to reformat a disk. See the `format`(1M) manual page for more information.

CAUTION! *Remember that formatting the disk destroys all data.*

Replacing the Bad Disk

If reformatting and repairing bad blocks do not work, replace the disk. See the disk installation manual for more information.

Adding Defect List, Format, Partition, and Label Disk (*format*)

Follow these steps to put a defect list on a new disk, format, partition, and label it:

CAUTION! *You must format the disk after you add the defect list. Any data on the disk will be destroyed by formatting. If the disk is not new, be sure the data is backed up before you proceed. See Chapter 4, "Administering File Systems," for complete information on how to back up and restore file systems.*

1. Become superuser.
2. Type **`format`** and press Return. A list of available disks is displayed:

   ```
   AVAILABLE DISK SELECTIONS:
    Ø. cØtØdØ at scsibusØ slave 24
    sdØ: <SUNØ2Ø7 cyl 1254 alt 2 hd 9 sec 36>
   ```

3. Type the number of the new disk from the list that is displayed. The Format menu and the `format>` prompt are displayed.
4. Type **`defect`** and press Return.
5. Type **`primary`** and press Return. The original defect list is added to the disk:

   ```
   defect> primary
   Extracting primary defect list . . . Extraction complete.
   Current Defect List updated, \
   total of 3Ø defects.
   ```

6. Type **`quit`** and press Return. The `format>` prompt is displayed.
7. Type **`format`** and press Return. The disk begins formatting. Formatting takes about 10 minutes for a 107-Mbyte disk, longer for bigger disks.
8. When the `format>` prompt is redisplayed, type **`partition`** and press Return.
9. Re-create the partitions to match the partitions on the defective disk.

10. Type **label** and press Return. The disk is labeled.
11. Type **quit** and press Return. The Format menu and `format>` prompt are redisplayed.
12. Type **quit** and press Return. The shell prompt is redisplayed:

```
oak% su
Password:
# format
Searching for disks...done


AVAILABLE DISK SELECTIONS:
        Ø. sdØ at espØ slave 24
           sdØ: <SUNØ2Ø7 cyl 1254 alt 2 hd 9 sec 36>
        1. sd2 at espØ slave 16
           sd2: <SUNØ2Ø7 cyl 1254 alt 2 hd 9 sec 36>
Specify disk (enter its number): 1
selecting cØtØdØ
[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
        quit
format > defect
defect > primary
Extracting primary defect list . . . Extraction complete.
Current Defect List updated, total of 3Ø defects.
defect > quit
format > format
format> partition
PARTITION MENU:
        Ø      - change 'Ø' 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
        quit
partition> <partition the disk>
partition> label
partition> quit
format > quit
#
```

Remaking the File Systems (*newfs*)

A disk must be formatted, partitioned, and labeled before you can create ufs file systems on it. If you are re-creating an existing ufs file system, unmount the file system before following these steps:

1. Become superuser.
2. Type `newfs /dev/rdsk/`***cntndnsn*** and press Return. You are asked if you want to proceed.

CAUTION! *Be sure you have specified the correct device name for the partition before performing the next step. If you specify the wrong partition, you will erase its contents when the new file system is created.*

3. Type `y` to confirm. The `newfs` command uses optimized default values to create the file system.

This example creates a file system on `/dev/rdsk/c0t3d0s7`:

```
oak% su
Password:
# newfs /dev/rdsk/c0t3d0s7
newfs: construct a new file system /dev/rdsk/c0t3d0s7 (y/n)? y
/dev/rdsk/c0t3d0s7:     163944 sectors in 506 cylinders of 9 tracks, 36 sectors
        83.9MB in 32 cyl groups (16 c/g, 2.65MB/g, 1216 i/g)
super-block backups (for fsck -b #) at:
 32, 5264, 10496, 15728, 20960, 26192, 31424, 36656, 41888,
 47120, 52352, 57584, 62816, 68048, 73280, 78512, 82976, 88208,
 93440, 98672, 103904, 109136, 114368, 119600, 124832, 130064, 135296,
 140528, 145760, 150992, 156224, 161456,
#
```

Mounting the File System on a Temporary Mount Point (*mount*)

Type `mount /dev/dsk/`***cntndnsn*** `/mnt` and press Return. The file system is mounted on the `/mnt` temporary mount point. To mount the disk, specify the block device directory (`/dev/dsk`), not the raw device directory.

Restoring Files to the File System (*ufsrestore*)

SVR4

Restore the contents of the latest full backup, and then restore subsequent incremental backups from lowest to highest level (`ufsrestore`), by following these steps:

1. Type `cd /mnt` and press Return. You have changed to the mount point directory.

2. Write-protect the tapes for safety.
3. Insert the first volume of the level 0 tape into the tape drive.
4. Type `ufsrestore rvf /dev/rmt/`*`unit`* and press Return. If this is a multivolume restore, when prompted, remove the first tape and insert the last tape in the tape drive. Follow instructions about the order of the rest of the tapes. The level 0 tape is restored.
5. Remove the tape and load the next lowest level tape in the drive. Always restore tapes starting with 0 and continuing until you reach the highest level.
6. Type `ufsrestore rvf /dev/rmt/`*`unit`* and press Return. The next level tape is restored.
7. Repeat steps 5 and 6 for each additional tape.
8. Type `ls` and press Return.
9. A list of files in the directory is displayed. Check the listing to verify that all the files are restored.
10. Type `rm restoresymtable` and press Return. The `restoresymtable` created by `ufsrestore` is removed.

Unmounting the File System from Its Temporary Mount Point (*umount*)

Follow these steps to unmount the file system from its temporary mount point:

1. Type `cd /` and press Return.
2. Type `umount /mnt` and press Return. The file system is unmounted from the temporary mount point.

Checking the File System for Inconsistencies (*fsck*)

Type `fsck /dev/rdsk/`*`cntndnsn`* and press Return. The file system is checked for consistency.

Performing a Level 0 Backup of the Restored File System (*ufsdump*)

SVR4

You always should do an immediate backup of a newly created file system because `ufsrestore` repositions the files and changes the inode allocation.

Follow these steps to perform a level 0 backup of the restored file system:

1. Remove the last tape and insert a new write-enabled tape in the tape drive.
2. Type `ufsdump 0uf /dev/rmt/`*`unit`* `/dev/rdsk/`*`cntndnsn`* and press Return.

Mounting the File System at Its Permanent Mount Point (*mount*)

Type `mount /dev/dsk/`***`cntndnsn`*** and press Return. The restored file system is mounted and available for use.

Understanding the Service Access Facility

The SunOS 5.*x* system software uses the *Service Access Facility (SAF)* to register and monitor port activity for modems, terminals, and printers. SAF is new with the SunOS 5.*x* system software. The SAF controls the resources that let users:

- Log in (either locally or remotely)
- Access printers across the network
- Access files across the network

The SAF is a complex hierarchy of background processes and administrative commands. Explaining the SAF in depth is beyond the scope of this book. The following sections provide a brief introduction to the elements of the SAF. For complete information about SAF, see the *Solaris Advanced System Administrator's Guide* available from Sun Microsystems Press and Macmillan Technical Publishing.

Admintool GUI for SAF Functionality

NEW

Starting with the Solaris 2.3 release, Admintool provides a graphical user interface to work with printers, monitors, and modems.

Starting Admintool

Follow these steps to access the Admintool: Serial Ports windows:

1. In a terminal window, type **`admintool&`** and press Return. The Admintool: Users window is displayed.

2. From the Browse menu, choose Serial Ports as shown in Figure 3–11.

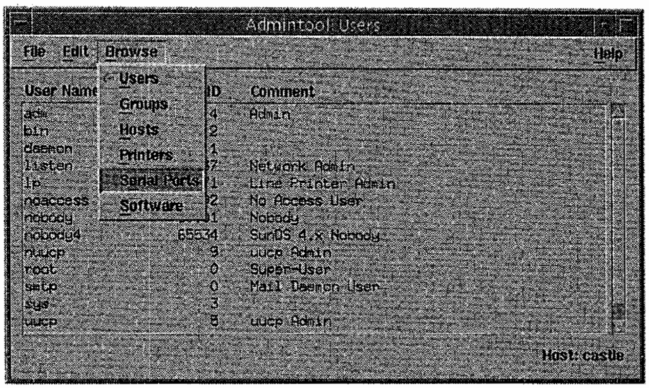


Figure 3–11
The Admintool Browse menu.

The Admintool: Serial Ports window is displayed, as shown in Figure 3–12.

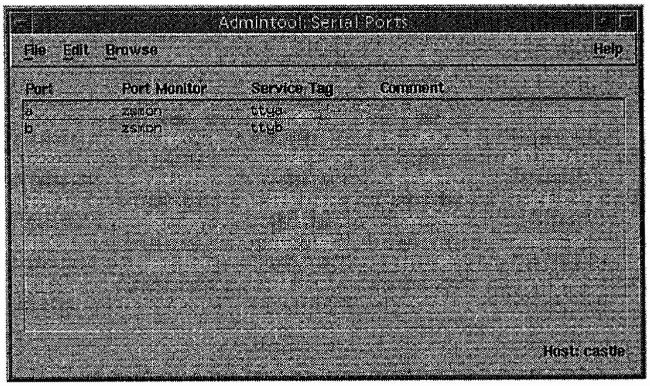
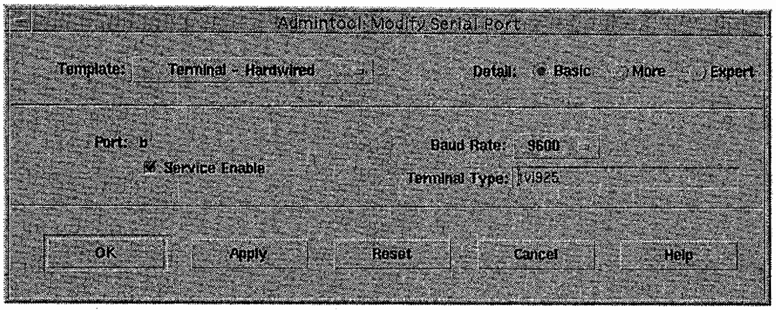


Figure 3–12
The Admintool: Serial Ports window.

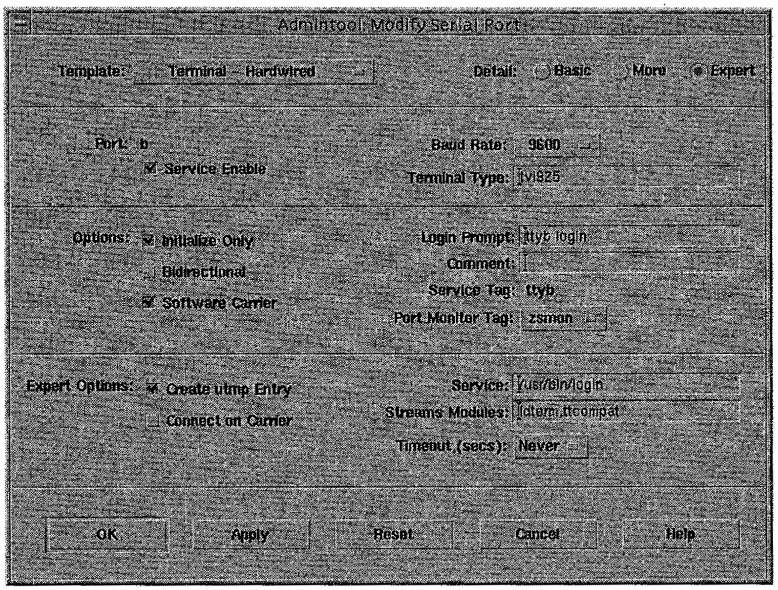
Click on one of the ports to highlight it, and choose Modify from the Edit menu. The Admintool: Modify Serial Port window is displayed, as shown in Figure 3–13.

Figure 3–13
The Admintool: Modify Serial Port window.



This window shows information at three different levels: Basic, More, and Expert. Figure 3–14 shows the Expert options.

Figure 3–14
The Admintool: Modify Serial Port window with Expert options.



Port Monitors and Service Access

A *port monitor* is a program that continuously watches out for requests to log in or requests to access printers or files. When a port monitor detects a request, it sets the parameters that are needed to establish communication between the operating system and the device that is requesting service. Then the port monitor transfers control to other processes that provide the services needed.

The SunOS 5.*x* system software provides two types of port monitors: listen and ttymon. The *listen port monitor* controls access to network services, fielding remote print and file system requests. The *ttymon port monitor* controls access to login services. You will need to set up a ttymon port monitor (using SAF) to process login requests from modems.

NOTE. *The ttymon port monitor replaces the SunOS 4.*x *getty port monitor. A single ttymon can replace multiple getties.*

SAF Control of Port Monitors and Services

You use three SAF commands to administer modems and alphanumeric terminals: `sacadm`, `pmadm`, and `ttyadm`.

The `sacadm` command adds and removes port monitors. This command is your main link with the Service Access Controller (SAC) and its administrative file (`/etc/saf/_sactab`).

The `pmadm` command adds or removes a service and associates a service with a particular port monitor.

The `ttyadm` command formats information for inclusion in various SAF administrative files. A `ttyadm` command often is embedded within a `sacadm` or `pmadm` command to provide some of the data needed by those commands. Table 3–15 lists the programs associated with specific SAF functions. See the manual pages for more information about each command.

Table 3–15 SAF Functions and Associated Programs

Function	Program	Description
Overall administration	sacadm	Command for adding and removing port monitors
Service Access Controller	sac	SAF's master program
Port monitors	ttymon	Monitors serial port login requests
	listen	Monitors requests for network services
Port monitor service administrator	pmadm	Command for controlling port monitors' services
Services	logins; remote procedure calls; other	Services to which SAF provides access

Setting Up Printer Port Monitors

This section provides steps for setting up port monitors for printing. Each SunOS 5.*x* print server and print client must have the port monitor configured to be able to handle network printing requests. If you use the Printer Manager (available with SunOS 5.1), you do not need to follow these steps. The Printer Manager automatically sets up the port monitors as part of the printer configuration process:

1. Become superuser.
2. Type `sacadm -a -p tcp -t listen -c "/usr/lib/saf/listen tcp" -v 'nlsadmin -V' -n 9999` and press Return. The network listen service that listens for incoming TCP/IP requests is started. The options are described in Table 3–16.

Table 3–16 The *sacadm* Command Options

Option	Description
-a	Adds the -p port
-t	Identifies the type of service
-c	Tells which command to use to start the port monitor
-v	Indicates the version of the network listen process
-n	Specifies the number of times the Service Access Controller will restart the process, if it dies

3. Type `sacadm -l` and press Return. Look at the output to verify that the network listen status is enabled, as shown in this example:

```
# sacadm -l
PMTAG        PMTYPE     FLGS RCNT STATUS      COMMAND
tcp          listen      -    9999 ENABLED     /usr/lib/saf/listen tcp #
```

NOTE. *It may take several minutes before the network listen service is enabled.*

4. Type `lpsystem -A` and press Return. The system's universal address is displayed, as shown in this example:

```
# lpsystem -A
000202038194180e0000000000000000
```

The universal address has four parts, as shown in Figure 3–15. The last part, RFU, means Reserved for Future Use and could be used for other families of addresses (for example, Open Systems Interface) in the future.

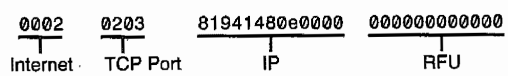


Figure 3–15
Parts of the universal address.

The first four digits identify the Internet family. The fifth through eighth digits identify the TCP port. For the modified version, replace the fifth through eighth digits with `0ACE`. For example, the modified version of the universal address shown in the example above is:

`00020ACE819418 0e0000000000000000`

NOTE. *You must type the characters* `\x` *at the beginning of the universal (or modified universal) address in the next steps exactly as shown. In addition, the address must be enclosed in single quotation marks so the backslash is not stripped off.*

Follow these steps to set up a printer port monitor:

1. To register listen service 0, type **`pmadm -a -p tcp -s 0 -i root -m 'nlsadmin -c /usr/lib/saf/nlps_server -A '\x`*`modified_address`*`'' -v 'nlsadmin -V'`** and press Return. The port monitor is configured to listen for requests from listen service 0.
2. To receive print requests from SunOS 5.0 print clients, type **`pmadm -a -p tcp -s lp -i root -m 'nlsadmin -o /var/spool/lp/fifos/listenS5' -v 'nlsadmin -V'`** and press Return. The port monitor is configured to listen for requests from `listenS5`, which registers print requests from SunOS 5.*x* print clients.
3. To receive print requests from SunOS 4.*x* print clients, type **`pmadm -a -p tcp -s lpd -i root -m 'nlsadmin -o /var/spool/lp/fifos/listenBSD -A '\xaddress'' -v 'nlsadmin -V'`** and press Return. The port monitor is configured to listen for requests from `listenBSD`, which registers print requests from SunOS 4.*x* print clients.
4. Type **`cat /var/saf/tcp/log`** and press Return. Examine the messages displayed to make sure that the services are enabled and initialized. In this example, all three network listen services are registered:

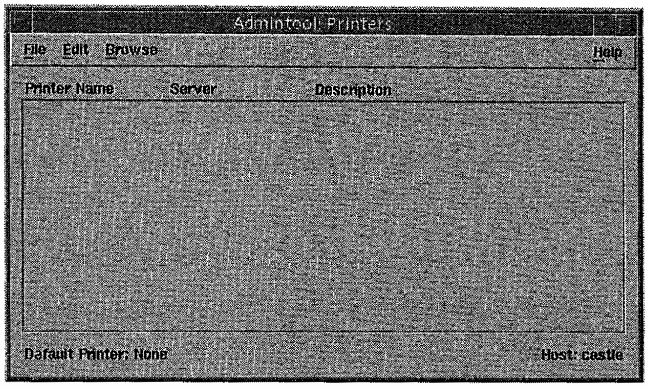
```
# lpsystem -A
000202038194180e0000000000000000
# pmadm -a -p tcp -s lp -i root -m `nlsadmin -o
/var/spool/lp/fifos/listenS5` -v `nlsadmin -V`
# pmadm -a -p tcp -s lpd -i root -m `nlsadmin -o
/var/spool/lp/fifos/listenBSD -A
'\x000202038194180e0000000000000000'` -v `nlsadmin -V`
# pmadm -a -p tcp -s 0 -i root -m `nlsadmin -c
/usr/lib/saf/nlps_server -A
'\x00020ACE8194180e0000000000000000'` -v `nlsadmin -V`
pine# cat /var/saf/tcp/log
10/28/91 10:22:51; 178; @(#)listen:listen.c     1.19.9.1
10/28/91 10:22:51; 178; Listener port monitor tag: tcp
10/28/91 10:22:51; 178; Starting state: ENABLED
10/28/91 10:22:51; 178; Service 0: fd 6 addr
\x00020ACE8194180e0000000000000000
10/28/91 10:22:51; 178; Service lpd: fd 7 addr
\x000202038194180e0000000000000000
10/28/91 10:22:52; 178; Net opened, 2 addresses bound, 56 fds free
10/28/91 10:22:52; 178; Initialization Complete
#
```

Setting Up a Local Printer by Using Admintool

You can use Admintool to set up access to a printer or to configure a local printer. Use the following steps to access a network printer:

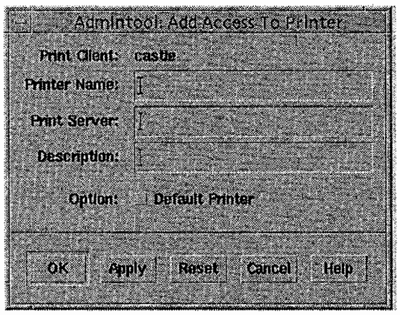
1. Type `admintool&` and press Return to start Admintool (if necessary).
2. From the Browse menu, choose Printers. The Admintool: Printers window is displayed, as shown in Figure 3–16.

Figure 3–16
The Admintool: Printers window.



3. From the Edit menu, choose Add and Access to Printer. The Admintool: Add Access to Printer window is displayed, as shown in Figure 3–17.

Figure 3–17
The Admintool: Add Access to Printer window.

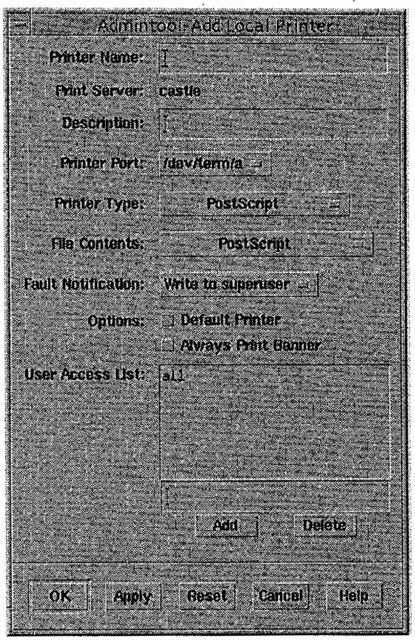


4. Enter the printer name, print server name, and description.
5. If you want this printer to be the default printer, click on the Default Printer check box.
6. Click on the OK button. The printer is configured and the printer information is added to the list in the Admintool: Printers window.

Use the following steps to add a local printer:

1. Type `admintool&` and press Return to start Admintool (if necessary).
2. From the Browse menu, choose Printers.
3. From the Edit menu, choose Add and Local Printer. The Admintool: Add Local Printer window is displayed, as shown in Figure 3–18.

Figure 3–18
The Admintool: Add Local Printer window.



4. Enter the printer name and description.
5. Choose the printer port, printer type, file contents, and fault notification.
6. If you want to specify this printer as the default printer, check the Default Printer check box.
7. If you want to always print the banner, check the Always Print Banner check box.
8. Modify the User Access List (if necessary).

9. When you have completed the setup, click on the OK button. The printer is configured and the printer information is added to the list in the Admintool: Printers window, as shown in Figure 3–19.

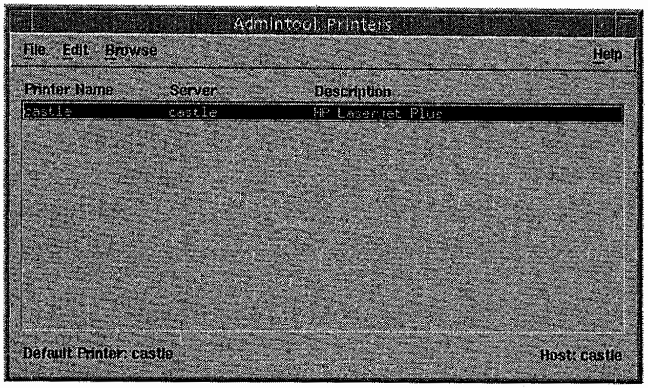


Figure 3–19
The Admintool: Printers window.

Setting Up a Bidirectional Modem

To set up a bidirectional modem you need information for these variables:

- *port-name* Which port the modem is connected to (typically, `ttya` or `ttyb`).
- *svctag* The name of the port monitor service (for Sun systems, `zsmon`)
- *port-device-name* The name of the device for the port (typically `/dev/cua/a` or `/dev/cua/b`).
- *short-port-device-name* The name for the port without the complete path.
- *modem-label* The entry in the `/etc/ttydefs` file that is used to set the proper baud rate and line discipline.
- *modem-type* The type of the modem from the `/etc/uucp/Dialers` file. For example, the type for a Hayes modem is `hayes`.

Follow these steps to configure a modem:

1. Halt the system.
2. Make sure hardware carrier detect is disabled. On Sun systems, you can use the `eeprom` command or type **`setenv ttyb-ignore-cd=false`** and press Return.
3. Reboot the system.
4. Connect the modem and make sure any modem switches are set to allow bidirectional use.

5. To remove the existing service for the port name so that the modem can be connected, type `pmadm -r -p` ***`svctag`*** `-s` ***`port-name`***, and press Return. If you get the message `Invalid request, svctag does not exist`, the *svctag* port monitor is not configured. To configure the *svctag* port monitor, type **`sacadm -a -p`** ***`svctag`*** **`-t ttymon -c /usr/lib/saf/ttymon -v 'ttyadm -V'`** and press Return.

6. To set up the port monitor for use with the modem, type **`pmadm -a -p zsmon -s ttyb -i root -fu -v 1 -m "'ttyadm -b -d /dev/term/b -1 contty3H -m ldterm,ttcompat -s /usr/bin/login -S n'"`** and press Return. The `-b` option sets the bidirectional flag. The `-m` options specify `STREAMS` modules to be pushed.

7. To make sure the `/etc/remote` file has an entry for `/dev/cua/`*n* and that it is set to the correct baud rate, type **`grep cua`*****`n`*** **`/etc/remote`** and press Return. In this example, the information for `cuab` is correct:

```
# grep cuab /etc/remote
cuab:dv=/dev/cua/b:br#2400*
#
```

   If the entry is not in the `/etc/remote` file, edit the file and add the entry.

8. Edit the `/etc/uucp/Devices` file and add this entry:

ACU term/*short-port-device-name*,M - *modem-label modem-type*

Follow these steps to configure a bidirectional Hayes-compatible modem for dialing in and dialing out on serial port B. The default switch settings for a Hayes Smartmodem 2400 work properly:

1. Halt the system.

2. Hardware carrier detect must be disabled. To reset the PROM setting to disable hardware carrier detect on Sun systems, type **`setenv ttyb-ignore-cd=false`** and press Return.

3. Reboot the system.

4. Connect the modem and make sure any modem switches are set to allow bidirectional use. Note that the Hayes Smartmodem 2400 requires no changes to the default switch settings to work properly. Connect the modem cable to serial port B.

5. To remove the existing service for ttyb so that the modem can be connected, type **`pmadm -r -p zsmon -s ttyb`** and press Return. If you get the message `Invalid request, zsmon does not exist`, the `zsmon` port monitor is not configured. To configure the `zsmon` port monitor, type **`sacadm -a -p zsmon -t ttymon -c /usrlib/saf/ttymon -v 'ttyadm -V'`** and press Return.

6. To set up the port monitor for use with the modem, type **`pmadm -a -p zsmon -s b -i root -fu -v 1 -m "'ttyadm -b -d /dev/cua/b -l contty3H -m ldterm,ttcompat -s /usr/bin/login -S y'"`** and press Return. The `-b` option sets the bidirectional flag. The `-m` options specify `STREAMS` modules to be pushed.

7. To make sure the `/etc/remote` file has an entry for `/dev/cua/b` and that it is set to the correct baud rate, type **`grep cuab /etc/remote`**. If the following information is displayed, the entry is correct:

```
# grep cuab /etc/remote
cuab:dv=/dev/cua/b:br#2400*
#
```

If the entry is not in the `/etc/remote` file, edit the `/etc/uucp/Devices` file and type **`ACU term/b,M - contty3H hayes`**.

Using a Modem

To connect through the modem, type **`tip`** ***-baud rate phone number*** and press Return. With the Hayes Smartmodem 2400, this command dials and connects to the system. When the software on the connecting system is configured properly, the remote system dials the modem phone number and the modem answers automatically.

This example uses the information phone number, which is not a dial-in modem number:

```
oak% tip -2400 5551212
dialing ... connected
<Login messages>
```

CHAPTER

4

Administering File Systems

A FILE SYSTEM IS A STRUCTURE OF DIRECTORIES USED TO LOCATE AND STORE *files*. The term *file system* is used in several different ways:

- To describe the entire file tree from the root directory downward
- To describe a particular type of file system: disk-based, network-based, or pseudo
- To describe the data structure of a disk slice or other media storage device
- To describe a portion of a file tree structure that is attached to a mount point on the main file tree so that that portion is accessible

Usually, you can tell from context which meaning is intended.

The SunOS 5.*x* system software uses the *virtual file system (VFS)* architecture, which provides a standard interface for different file system types. The *kernel* handles basic operations—such as reading, writing, and listing files—without requiring the user or program to know about the underlying file system type.

The file system administrative commands provide a common interface that allows you to maintain file systems of different types. These commands have two components: a generic component and a component specific to each type of file system. The generic commands apply to most types of file systems; the specific commands apply to only one type of file system.

Administering the SunOS 5.*x* file system is one of your most important system administration tasks. The file system story is a complex one, and understanding it can help you more effectively administer file systems. This chapter describes:

- The types of file systems
- The default SunOS 5.*x* file system
- The virtual file system table (`/etc/vfstab`)
- The file system administrative commands
- Making local and remote files available to users
- Backing up and restoring file systems

New File System Features in Solaris 2.6

2.6

The Solaris 2.6 release provides some new file system features. Each of these new features is introduced in the following sections.

Large Files

The `mount` command provides a new option, `-largefiles`, that is the default mount option for the Solaris 2.6 environment. This option enables you to create file systems that can contain files larger than 2 Gbytes. When files are mounted with the `-largefiles` option, a file system may contain files larger than 2 Gbytes, but it is not required. See "Making File Systems Available" for more information.

NFS Client Failover

With the NFS client failover feature, you can specify additional hosts from which to mount a file system in case the first host cannot be reached. You can either set this feature in the `/etc/vfstab` file or issue your list of hosts from the command line.

WebNFS

The WebNFS feature, sometimes called *Public NFS*, provides two additional options to the `mount` command:

- The `-index` *`filename`* option automatically loads a file matching *`filename`* if it is found in a directory referenced by an NFS URL.
- The `-public` option resets the public file handle to the current directory. This option enables you to access files through an NFS URL even if the file system cannot be mounted in the usual way.

See "Making File Systems Available" on page 138 for more information.

Types of File Systems

The SunOS 5.*x* system software supports three types of file systems:

- Disk-based
- Network-based
- Virtual (previously called pseudo)

Disk-Based File Systems

Disk-based file systems are stored on physical media such as hard disks, CD-ROMs, and diskettes. Disk-based file systems can be written in different formats. The available formats are:

- **UFS** UNIX file system (based on the BSD Fat Fast File system that was provided in the 4.3 Tahoe release). The default disk-based file system in SunOS 5.*x* system software is UFS.

NEW

- **S5FS** x86 UNIX file system (based on the BSD Fat Fast File system that was provided in the 4.3 Tahoe release). The default disk-based file system in SunOS 5.*x* x86 system software is S5FS.
- **HSFS** High Sierra and ISO 9660 file system. High Sierra is the first CD-ROM file system; ISO 9660 is the official standard. The HSFS file system is used on CD-ROM, and is a read-only file system. The SunOS 5.*x* hsfs supports Rock Ridge extensions, which provide all UFS file system semantics and file types except for writability and hard links.
- **PCFS** PC file system, which allows read/write access to data and programs on DOS-formatted floppy disks written for DOS-based personal computers.

The System V (S5) file system traditionally provided with System V releases is not included in the SunOS 5.*x* system software because of significant limitations, such as a maximum of 64,000 files in a file system, a restriction of 14 characters for file names, and lack of a quota facility.

Each type of disk-based file system is customarily associated with a particular media device:

- UFS and S5FS with hard disk and any other media (tape, CD-ROM, diskette)
- HSFS with CD-ROM
- PCFS with diskette

These associations are not, however, restrictive. For example, CD-ROMs and diskettes can have UFS file systems installed on them.

Network-Based File Systems

Network-based file systems are file systems that are accessed over the network. Typically, network-based file systems are file systems that reside on one system and are accessed by other systems across the network. The available network-based file systems are:

- NFS—network or distributed file system
- RFS—remote file sharing

The default SunOS 5.*x* distributed file system is NFS. You administer distributed file systems by sharing them (exporting them from a server) and mounting them on individual systems. See “Making File Systems Available” later in the chapter for more information.

NEW

Virtual File Systems

Virtual file systems (previously called pseudo file systems) are virtual or memory-based file systems that provide access to special kernel information and facilities. Most virtual file systems do not use file system disk space. Some pseudo file systems, such as the temporary file system, may, however, use the swap space on a physical disk. Cache file systems use a file system on the disk to contain the cache.

NEW

The Cache File System

You can use the Cache File System (CacheFS) to improve performance of remote file systems or slow devices such as CD-ROM drives. When a file system is cached, the data read from the remote file system or CD-ROM is stored in a cache on the local system. See "Creating Cache File Systems" on page 155 for more information.

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The Temporary File System (TMPFS)

The TMPFS file system, uses local memory for disk reads and writes. Access to files in a TMPFS file system is typically much faster than access to files in a UFS file system. Files in the TMPFS file system are not permanent. They are deleted when the file system is unmounted and when the system is shut down or rebooted.

The default file system type for the `/tmp` directory in the SunOS 5.*x* system software is TMPFS. You can copy or move files into or out of the `/tmp` directory, just as you would in a `ufs /tmp` file system.

UsingTMPFS file systems can improve system performance by saving the cost of reading and writing temporary files to a local disk or across the network. For example, temporary files are created when you compile a program. The operating system generates a lot of disk or network input and output activity while manipulating these files. Using TMPFS file systems to hold these temporary files may significantly speed up their creation, manipulation, and deletion.

The TMPFS file system uses swap space as a temporary storage area. If a system with a TMPFS file system does not have adequate swap space, two problems can occur:

- The TMPFS file system can run out of space, just as a regular file system can fill up.
- Because TMPFS allocates swap space to save file data (if necessary), some programs may not be able to execute because there is not enough swap space.

See Chapter 9, "Administering Systems," for information about increasing swap space.

The Loopback File System (LOFS)

The LOFS file system lets you create a new virtual file system. You can access files using an alternative path name. For example, you can create a loopback mount of `/onto/tmp/newroot`. The entire file system hierarchy looks like it is duplicated under `/tmp/newroot`, including any file systems that were mounted from NFS servers. All files are accessible either with a path name starting from `/` or with a path name starting from `/tmp/newroot` until a different file system is mounted in `/tmp/newroot` or any of its subdirectories.

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The Process File System (PROCFS)

The PROCFS file system resides in memory. It contains a list of active processes, by number, in the `/proc` directory. Information in the `/proc` directory is used by commands such as `ps`. Debuggers and other development tools can also access the address space of the processes using file system calls. This example shows a partial listing of the contents of the `/proc` directory:

NEW

```
castle% ls -l /proc
total 116
dr-x--x--x   5 root     root         736 Sep 15 09:00 0
dr-x--x--x   5 root     root         736 Sep 15 09:00 1
dr-x--x--x   5 root     root         736 Sep 15 09:01 103
dr-x--x--x   5 root     root         736 Sep 15 09:01 113
dr-x--x--x   5 root     root         736 Sep 15 09:01 115
dr-x--x--x   5 root     root         736 Sep 15 09:01 140
dr-x--x--x   5 root     root         736 Sep 15 09:01 145
(Some processes removed from this example)
dr-x--x--x   5 winsor   staff        736 Sep 15 11:13 545
dr-x--x--x   5 winsor   staff        736 Sep 15 11:46 645
dr-x--x--x   5 winsor   staff        736 Sep 15 12:52 679
dr-x--x--x   5 root     root         736 Sep 15 13:03 717
dr-x--x--x   5 winsor   staff        736 Sep 15 13:15 806
dr-x--x--x   5 winsor   staff        736 Sep 15 13:22 808
dr-x--x--x   5 winsor   staff        736 Sep 15 15:49 876
castle%
oak% ls -l /proc
total 144944
-rw-------   1 root     root           0 Dec 19 15:45 00000
-rw-------   1 root     root      196608 Dec 19 15:45 00001
-rw-------   1 root     root           0 Dec 19 15:45 00002
-rw-------   1 root     root     1028096 Dec 19 15:46 00073
-rw-------   1 root     root     1445888 Dec 19 15:46 00091
-rw-------   1 root     root     1142784 Dec 19 15:46 00093
-rw-------   1 root     root     1142784 Dec 19 15:46 00095
(Some processes removed from this example)
-rw-------   1 ignatz   staff    1576960 Dec 19 15:50 00226
-rw-------   1 ignatz   staff     192512 Dec 19 15:51 00236
-rw-------   1 ignatz   staff    1269760 Dec 19 15:52 00240
-rw-------   1 ignatz   staff    6090752 Dec 19 15:52 00241
-rw-------   1 ignatz   staff     188416 Dec 19 15:52 00247
-rw-------   1 ignatz   staff    2744320 Dec 19 15:52 00256
castle%
```

CAUTION! *Do not delete the files in the* `/proc` *directory. Deleting processes from the* `/proc` *directory is not the recommended way to kill them. See Chapter 1 for information on how to kill a process. Remember,* `/proc` *files do not use disk space, so there is little reason to delete files from this directory. The* `/proc` *directory does not require any system administration.*

2.6

Enhancements to the */proc* File System and Watchpoints

The previous flat `/proc` file system has been restructured into a directory hierarchy that contains additional subdirectories for state information and control functions. It also provides a watchpoint facility that is used to remap read/write permissions on the individual pages of the address space of a process. This facility has no restrictions and is multithread (MT) safe.

The new `/proc` file structure provides complete binary compatibility with the old `/proc` interface except that the new watchpoint facility cannot be used with the old interface. Debugging tools have been modified to use the new `/proc` watchpoint facility, which means the entire watchpoint process is faster.

The following restrictions have been removed when setting watchpoints using the `dbx` debugging tool:

- Setting watchpoints on local variables on the stack because of SPARC register windows
- Setting watchpoints on multithreaded processes

For more information, refer to the `proc`(4), `core`(4), and `adb`(4) manual pages.

Additional Virtual File Systems

These additional types of virtual file systems are listed for your information. They do not require administration.

- **FIFOS** (first-in first-out) Named pipe files that give processes common access to data
- **FDFS** (file descriptors) Provides explicit names for opening files using file descriptors
- **NAMEFS** Used mostly by `STREAMS` for dynamic mounts of file descriptors on top of files
- **SPECFS** (special) Provides access to special character and block devices
- **SWAPFS** File system used by the kernel when you create additional swap space with the `mkfile` and `swap` commands

The Default SunOS 5.*x* File System

The SunOS 5.*x* file system is hierarchical, starting with the root directory (/) and continuing downward through a number of directories. The SunOS 5.*x* system software installs a default set of directories and uses a set of conventions to group similar types of files together. Table 4–1 describes the default SunOS 5.*x* file system, and shows the type of each file system.

The root (`/`) and `/usr` file systems are both needed to run a system. Some of the most basic commands from the `/usr` file system (such as `mount`) are included in the root file system so that they are available when the system boots up or is in single-user mode.

Table 4-1 The Default SunOS 5.*x* File System

File System	File System Type	Description
/	UFS	The top of the hierarchical file tree. The root directory contains the directories and files critical for system operation, such as the kernel (`/kernel/unix`), the device drivers, and the programs used to start (boot) the system. It also contains the mount point directories where local and remote file systems can be attached to the file tree.
/etc	UFS	Contains system-specific files used in system administration.
/usr	UFS	Contains system files and directories that can be shared with other users. Files that run on only certain types of systems are in the `/usr` directory (for example, SPARC executables). Files (such as manual pages) that can be used on all types of systems are in `/usr/share`.
/home	NFS, UFS	The mount point for the users' home directories, which store users' work files. By default, `/home` is an automounted file system. On stand-alone systems, `/home` may be a `ufs` file system on a local disk slice.
/var	UFS	Contains system files and directories that are likely to change or grow over the life of the local system. These include system logs, `vi` and `ex` backup files, `uucp` files, and mail and calendar files.
/opt	NFS, UFS, S5FS	Mount point for optional, third-party software. On some systems, /opt may be a `ufs` file system on a local disk slice.
/tmp	TMPFS	Temporary files, cleared each time the system is booted or unmounted.
/proc	PROCFS	Contains a list of active system processes, by number.

The Virtual File System Table (*/etc/vfstab*)

SVR4

Each system has a virtual file system table, `/etc/vfstab`, that lists all the disk slices and file systems available to the system. The file system table also specifies the mount point and options for each file system. In the SunOS 4.*x* system software, the file system table is called `/etc/fstab`. The `/etc/vfstab` file replaces `/etc/fstab` and functions in a similar manner. The default file system configuration table (the `/etc/vfstab` file) depends on the selections made for each system when system software was installed. You should edit the `/etc/vfstab` file for each system to automatically mount local UFS file systems, essential NFS file systems, and any other appropriate file systems.

This section describes the contents of the `/etc/vfstab` file and provides information on how to edit and use the file. The file system table is an ASCII file. Comment lines begin with #. This example shows an /etc/vfstab file for a system with two disks and two NFS file systems mounted:

NEW

```
castle% more /etc/vfstab
#device          device          mount            FS      fsck    mount   mount
#to mount        to fsck         point            type    pass    at boot options
#
#/dev/dsk/c1d0s2 /dev/rdsk/c1d0s2 /usr            ufs     1       yes     -
fd      -        /dev/fd fd      -       no       -
/proc   -        /proc   proc    -       no       -
/dev/dsk/c0t3d0s1        -       -       swap     -       no      -
/dev/dsk/c0t3d0s0        /dev/rdsk/c0t3d0s0       /       ufs     1       no
-
swap    -        /tmp    tmpfs   -       yes      -
castle%
```

Note that, for / and /usr, the automount field value is specified as no because these file systems are mounted as part of the boot sequence before the mountall command is run. If the automount field value is specified as yes, the mountall program redundantly (and unnecessarily) tries to mount these already mounted file systems.

The file system table has seven fields, each separated by a tab, as described in Table 4–2.

Table 4–2 Fields in the *letc/vfstab* File

Field	Description
device to mount	The device to mount can be • The block special device for local ufs file systems (for example, /dev/dsk/c0t0d0s0) • The resource name for remote file systems (for example, myserver:/export/home for an NFS file system) • The name of the slice on which to swap (for example, /dev/dsk/c0t3d0s1) • The /proc directory and proc file system type • CD-ROM as HSFS file system type • /dev/diskette as PCFS or UFS file system type. This field is also used to specify swap file systems.
device to fsck	The raw (character) special device that corresponds to the file system identified by the *special* field (for example, /dev/rdsk/c0t0d0s0). This determines the raw interface that is used by fsck. Use a hyphen (-) when there is no applicable device, such as for a read-only file system or a network-based file system.
mount point	The default mount point directory (for example, /usr for /dev/dsk/c0t0d0s6).
FS type	The type of file system identified by the *special* field.

Table 4–2 Fields in the */etc/vfstab* File *(continued)*

Field	Description
`fsck pass*`	The pass number used by `fsck` to decide whether to check a file system. When the field contains a hyphen (`-`), the file system is not checked. When the field contains a value of 1 or more, the file system is checked; non-`ufs` file systems with a zero `fsck` pass are checked. For `ufs` file systems only, when the field contains a zero (`0`), the file system is not checked. When `fsck` is run on multiple `ufs` file systems that have `fsck` pass values greater than 1 and the `preen` option (`-o p`) is used, `fsck` automatically checks the file systems on different disks in parallel to maximize efficiency. When the field contains a value of 1, the file system is checked sequentially. Otherwise, the value of the pass number does not have any effect.
`mount at boot`	Indicate yes or no for whether the file system should be automatically mounted by `mountall` when the system is booted. Note that this field has nothing to do with the automounter software.
`mount options`	A list of comma-separated options (with no spaces) that are used in mounting the file system. Use a hyphen (`-`) to show no options. See the `mount_`*`file-system-type`*(1M) manual page for a list of the available options.

*In SunOS 5.*x* system software, `fsck` pass does not explicitly specify the order in which file systems are checked as it did with SunOS 4.*x* system software.

NOTE. *You must have an entry in each field in the* `/etc/vfstab file`. *If there is no value for the field, be sure to enter a hyphen (-).*

Creation of an Entry in the File System Table

Follow these steps to create an entry in the file system table:

1. Become superuser.
2. Edit the `/etc/vfstab` file using an editor such as vi.
3. Add the entry, separating each field with white space (a space or a Tab). If a field has no entry, enter a hyphen (-).
4. Save the changes.
5. Check to be sure the mount point directory is present. If it's not, create it by changing to the directory where you want to create the mount point, typing **`mkdir`** ***`directory-name`***, and pressing Return.
6. Type `mount` ***`mount-point`*** and press Return. The entry is mounted.

NEW

This example mounts the disk slice `/dev/dsk/c0t3d0s7` as a `ufs` file system attached to the mount point directory `/files1` with the default mount options (read/write). It specifies the raw character device /dev/rdsk/c0t3d0s7 as the device to fsck. The fsck pass value of 2 means that the file system will be checked, but not sequentially:

```
#device          device             mount        FS     fsck   mount    mount
#to mount        to fsck            point        type   pass   at boot  options
#
/dev/dsk/c0t3d0s7 /dev/rdsk/c0t3d0s7 /files1    ufs    2      yes      -
```

This example mounts the directory /export/man from the system oak as an NFS file system on mount point /usr/man. You do not specify a device to fsck or a fsck pass for NFS file systems. In this example, mount options are ro (read-only) and soft. For greater reliability, for read/write NFS file systems, specify the hard mount option (rw,hard):

```
#device          device             mount        FS     fsck   mount    mount
#to mount        to fsck            point        type   pass   at boot  options
oak:/export/man   -                 /usr/man     nfs    -      yes      ro,soft
```

This example mounts a CD-ROM drive on a mount point named /hsfiles. CD-ROM files typically are read-only, so you specify ro for the mount options. Specify no for mount at boot because you are most likely to mount and unmount a CD-ROM from the command line or by using volume management. Because the hsfs is read-only, specify no device to fsck and no fsck pass number:

```
#device          device             mount        FS     fsck   mount    mount
#to mount        to fsck            point        type   pass   at boot  options
/dev/dsk/c0t6d0s2 -                 /hsfiles     hsfs   -      no       ro
```

This example mounts the diskette drive on a mount point named /pcfiles. Specify no for mount at boot because you are most likely to mount and unmount a diskette from the command line or by using volume management. Specify no to fsck or fsck pass, because the pcfs file system does not support fsck.

```
#device          device             mount        FS     fsck   mount    mount
#to mount        to fsck            point        type   pass   at boot  options
/dev/diskette    -                  /pcfiles     pcfs   -      no       rw
```

This example mounts the root file system on a loopback mount point named /etc/newroot. Specify yes for automount, no device to fsck, and no fsck pass number. Loopback file systems must always be mounted after the file systems used to make up the loopback file system. Be sure that the loopback entry is the last entry in the /etc/vfstab file so that it follows the entries that it depends on:

```
#device          device             mount        FS     fsck   mount    mount
#to mount        to fsck            point        type   pass   at boot  options
/                -                  /tmp/newroot lofs   -      yes      -
```

File System Administrative Commands

This section lists the file system administrative commands and describes the syntax.

Most file system administrative commands have a generic and a file system-specific component. Use the generic commands, which use the file system-specific component.

Table 4–3 lists the generic file system administrative commands, which are located in the `/usr/sbin` directory. Most of these commands also have file system-specific counterparts.

Table 4–3 Generic File System Administrative Commands

Command	Description
`clri`(1M)	Clears inodes.
`df`(1M)	Reports the number of free disk blocks and files.
`ff`(1M)	Lists file names and statistics for a file system.
`fsck`(1M)	Checks the integrity of a file system and repairs any damage found.
`fsdb`(1M)	File system debugger.
`fstyp`(1M)	Determines the file system type.
`labelit`(1M)	Lists or provides labels for file systems when copied to tape (for use by the volcopy command only).
`mkfs`(1M)	Makes a new file system.
`mount`(1M)	Mounts file systems and remote resources.
`mountall`(1M)	Mounts all file systems specified in a file system table.
`ncheck`(1M)	Generates a list of path names with their i-numbers.
`umount`(1M)	Unmounts file systems and remote resources.
`umountall`(1M)	Unmounts all file systems specified in a file system table.
`volcopy`(1M)	Makes an image copy of a file system.

CAUTION! *Do not use the file system–specific commands directly. If you specify an operation on a file system that does not support it, the generic command displays this error message:* `command: Operation not applicable for FSType type`.

Syntax of Generic Commands

Most of the generic commands use this syntax:

```
command [-F type] [-V] [generic-options] [-o specific-options]
[special|mount-point] [operands]
```

The options and arguments to the generic commands are shown in Table 4–4.

Table 4–4 Generic File System Command Syntax

Option	Description
`-F type`	Specifies the type of file system. If you do not use this option, the command looks for an entry that matches special, raw device, or mount point in the `/etc/vfstab` file. Otherwise, the default is taken from the file `/etc/default/fs` for local file systems and from the file `/etc/dfs/fstypes` for remote file systems.
`-V`	Echoes the completed command line. The echoed line may include additional information derived from `/etc/vfstab`. Use this option to verify and validate the command line. It does not execute the command.
`generic-options`	Options common to different types of file systems.
`-o specific-options`	A list of options specific to the type of file system. The list must have the following format: -o followed by a space, followed by a series of *keyword* [=value] pairs separated by commas with no intervening spaces.
`special¦mount-point`	Identifies the file system. Name either the *mount point* or the *special* device file for the slice holding the file system. For some commands, the *special* file must be the raw (character) device, and for other commands it must be the block device. See Chapter 3, "Administering Devices," for more information about disk device names. In some cases, this argument is used as a key to search the file `/etc/vfstab` for a matching entry from which to obtain other information. In most cases, this argument is required and must come immediately after *specific-options*. However, it is not required when you want a command to act on all the file systems (optionally limited by type) listed in the `/etc/vfstab` file.
`Operands`	Arguments specific to a type of file system. See the specific manual page of the command (for example, `mkfs_ufs`) for a detailed description.

Manual Pages for Generic and Specific Commands

Both the generic and specific commands have manual pages. The specific manual page is a continuation of the generic manual page. To look at a specific manual page, append an underscore and the file system type abbreviation to the generic command name. For example, to see the specific manual page for mounting an HSFS file system, type **`man mount_hsfs`** and press Return. LOFS, PCFS, and PROCFS do not have specific manual pages for the `mount` command.

How File System Commands Determine File System Type

The generic file system commands determine the file system type by following this sequence:

1. From -F, if supplied.
2. By matching a special device with an entry in /etc/vfstab (if *special* is supplied). For example, fsck first looks for a match against the fsck device field; if no match is found, it then checks against the *special* device field.
3. By using the default specified in /etc/default/fs for local file systems and in /etc/dfs/fstypes for remote file systems.

Type of File System

If you want to determine the type of a file system, you can obtain the information from the same files that the generic commands use:

- The FS type field in the file system table (/etc/vfstab)
- The /etc/default/fs file for local file systems
- The /etc/dfs/fstypes file for remote file systems

To find a file system's type in the /etc/vfstab file, type **grep *mount-point* /etc/vfstab** and press Return. Information for the mount point is displayed:

```
drusilla% grep /tmp /etc/vfstab
swap            -               /tmp            tmpfs   -       yes     -
drusilla%
```

If vfstab does not have an entry for a file system, use one of the following procedures to determine the file system's type.

To identify a mounted file system's type, type **grep *mount-point* /etc/mnttab** and press Return. Information on the mount point is displayed:

```
drusilla% grep /home /etc/mnttab
drusilla:(pid129)  /home nfs  ro,ignore,map=/etc/auto_home,indirect,dev=21c0004
693606637
bigriver:/export/home/bigriver  /tmp_mnt/home/bigriver  nfs     rw,dev=21c0005
695409833
drusilla%
```

Or type **mount** and press Return. A list of the mounted file systems is displayed:

```
drusilla% mount
/ on /dev/dsk/c0t3d0s0 read/write on Tue Dec 24 12:29:22 1991
/usr on /dev/dsk/c0t1d0s6 read/write on Tue Dec 24 12:29:22 1991
/proc on /proc read/write on Tue Dec 24 12:29:22 1991
/usr/man on swsvr4-50:/export/svr4/man read/write/remote on Mon Dec 30 12:49:11
1991
/usr/openwin on swsvr4-50:/export/svr4/openwinV3 read/write/remote on Mon Dec
30 \  13:50:54 1991
/tmp on swap o on Wed Jan  8 13:38:45 1992
/mnt on swsvr4-50:/export/svr4 read/write/remote on Fri Jan 10 15:51:23 1992
/tmp_mnt/home on bigriver:/export/home read/write/remote on Tue Jan 14 \
```

```
09:23:53 1992
drusilla%
```

Or follow these steps:

1. Type `devnm` ***mount-point*** and press Return. The raw device name is displayed.
2. Become superuser.
3. Type `fstyp /dev/rdsk/c`*n*`t`*n*`d`*n*`s`*n* and press Return. The type of the file system is displayed:

```
drusilla% devnm /usr
/dev/dsk/c0t1d0s6 /usr
drusilla% su
Password:
# fstyp /dev/rdsk/c0t3d0s0
ufs
#
```

Making File Systems Available

When you have created a file system, you need to make it available; you do this by mounting it. A mounted file system is attached to the system directory tree at the specified mount point and becomes available to the system. The root file system is always mounted. Any other file system can be connected or disconnected from the root file system.

You can mount a local file system in these ways:

- By creating an entry in the `/etc/vfstab` (virtual file system table) file. The `/etc/vfstab` file contains a list of file systems that are automatically mounted when the system is booted in multiuser state. See the section "The Virtual File System Table (`/etc/vfstab`)" earlier in this chapter for a description of the `/etc/vfstab` file.
- From a command line using the `mount` command.

File systems on disk slices must always be mounted on the server system and shared (exported) before other systems can access them. See "Sharing Files from a Server" later in this chapter for information about sharing file systems. When file systems are shared from a server, a client can mount them as NFS file systems in any of these three ways:

- By adding an entry to the `/etc/vfstab` file so that the file system is automatically mounted when the system is booted in multiuser state.
- By using the `automount` program to automatically mount or unmount the file system when a user changes into (`mount`) or out of (`umount`) the automounting directory.
- By using the `mount` command at a command line.

Understanding Mounting and Unmounting

File systems can be attached to the hierarchy of directories available on a system. This process is called *mounting*. To mount a file system you need:

- To be superuser.
- A mount point on the local system. The mount point is a directory to which the mounted file system is attached.
- The resource name of the file system to be mounted (for example, `/usr`).

As a general rule, local disk slices should always be included in the `/etc/vfstab` file. Any software from servers, such as CDE, OpenWindows, or manual pages, and home directories from a server can either be included in the `/etc/vfstab` file or be automounted, depending on the policy at your site.

When you mount a file system, any files or directories that might be present in the mount point directory are unavailable as long as the file system is mounted. These files are not permanently affected by the mounting process and become available again when the file system is unmounted. However, mount directories usually are empty because you usually do not want to obscure existing files.

The system tracks the mounted file systems in the `/etc/mnttab` (mount table) file. Whenever you mount or unmount a file system, the `/etc/mnttab` file is modified to show the list of currently mounted file systems. You can display the contents of the mount table using the `cat` or `more` command but you cannot edit the mount table as you would the `/etc/vfstab` file. Here is an example of a mount table file:

```
drusilla% more /etc/mnttab
/dev/dsk/c0t3d0s0       /       ufs     rw,suid 693186371
/dev/dsk/c0t1d0s6       /usr    ufs     rw,suid 693186371
/proc   /proc   proc    rw,suid 693186371
swap    /tmp    tmpfs   ,dev=0 693186373
swsvr4-50:/export/svr4/openwinV3 /usr/openwin    nfs     rw,dev=21c0000
693186443
swsvr4-50:/export/svr4/man      /usr/man        nfs     rw,dev=21c0001
693186447
drusilla:(pid127)     /nse  nfs
ro,ignore,map=/etc/auto.nse,indirect,dev=21c0002 693186449
drusilla:(pid127)     /net    nfs
ro,ignore,map=-hosts,indirect,dev=21c0003   693186449
drusilla:(pid127)       /home   nfs
ro,ignore,map=/etc/auto_home,indirect,dev=21c0004       693186449
bigriver:/export/home/bigriver  /tmp_mnt/home/bigriver  nfs     rw,dev=21c0005
693186673
drusilla%
```

Using Mount and Unmount File System Commands

Table 4–5 lists the commands in the `/usr/sbin` directory that you use to mount and unmount file systems.

Table 4–5 Commands for Mounting and Unmounting File Systems

Command	Description
mount(1M)	Mounts file systems and remote resources.
mountall(1M)	Mounts all file systems specified in a file system table.
umount(1M)	Unmounts file systems and remote resources.
umountall(1M)	Unmounts all file systems specified in a file system table.

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The mount commands will not mount a read/write file system that has inconsistencies. If you receive an error message from the mount or mountall command, you may need to check the file system.

The umount command will not unmount a file system that is busy. A file system is considered busy if a user is in a directory in the file system or if a program has a file open in that file system.

NEW

Table 4–6 describes the general mount options that you can specify with the -o option of the mount command. If you specify multiple options, separate them with commas (no spaces). For example, `-o ro,nosuid`.

Table 4–6 Commands for Mounting and Unmounting File Systems

Option	File System	Description
-rw ¦ ro	CacheFS, NFS, PCFS, UFS, S5FS	Specifies read/write or read-only. If you do not specify this option, the default is read/write.
-nosuid	HSFS, NFS, UFS	Prevents setuid execution and prevents devices on the file system from being opened. The default is to enable setuid execution and enable devices to be opened.
-remount	NFS, UFS, S5FS	With rw, remounts a file system with read/write access.
-f	UFS, S5FS	Fakes an entry in /etc/mnttab, but does not really mount any file systems.
-n	UFS, S5FS	Mounts the file system without making an entry in /etc/mnttab.
-bg ¦ fg	NFS	If the first attempt fails, retries in the background (bg) or in the foreground (fg). The default is fg.
-soft ¦ hard	NFS	Specifies the procedure if the server does not respond. soft indicates that an error is returned. hard indicates that the retry request is continued until the server responds. The default is hard.
--intr ¦ nointr	NFS	Specifies whether keyboard interrupts can be used to kill a process hung while waiting for a response on hard-mounted file systems. The default is intr (interrupts allowed).
-retry=n	NFS	Retries the mount operations when it fails.

Table 4–6 Commands for Mounting and Unmounting File Systems (continued)

Option	File System	Description
`-largefiles`	NFS	A file system mounted using this option may contain files larger than 2 Gbyte, but it is not a requirement. This option is the default.
`-nolargefiles`	NFS	Disables the -largefiles mount option to provide backward compatibility with previous file system behavior and enforcing the 2 Gbyte maximum file size limit.
`-index filename`	NFS URL	Automatically loads a file matching filename if it is found in a directory referenced by an NFS URL.
`-public`	NFS URL	Resets the public file handle to the current directory to enable you to access an NFS URL even if the file system cannot be mounted in the usual way.

Finding the Mounted File Systems

To display a list of f mounted file systems, type **`mount`** and press Return. All the file systems currently mounted are displayed:

```
oak% mount
/ on /dev/dsk/c0t0d0s0 read/write/setuid on Wed Oct 23 10:08:50 1991

/usr on /dev/dsk/c0t0d0s6 read/write/setuid on Wed Oct 23 10:08:50 1991

/proc on /proc read/write/setuid on Wed Oct 23 10:08:50 1991

/tmp on swap on Wed Oct 23 10:08:52 1991

/usr/openwin on cheers:/export/openwin hard/remote on Wed Oct 23
10:11:08 1991

/home on blowup:(pid136) read only/intr/map=auto.home/indirect on Wed Oct 23
10:11:10 1991

/vol on blowup:(pid136) read only/intr/map=auto.vol/indirect on Wed Oct 23
10:11:10 1991

/nse on blowup:(pid136) read only/intr/map=/etc/auto.nse /indirect on Wed Oct
23 10:11:10 1991
oak%
```

Mounting All File Systems in the */etc/vfstab* File

Follow these steps to mount all ffile systems in the `/etc/vfstab` file:

1. Become superuser.
2. Type **`mountall`** and press Return.

All the file systems in the local `/etc/vfstab` file are mounted:

```
oak% su
Password:
mountall
oak#
```

Mounting All File Systems of a Specific Type

Follow these steps to mount all f file systems of a specific type that are in the `/etc/vfstab` file. The most common file system types are ufs for local disk slices and NFS for network file systems. See "Types of File Systems" early in the chapter for a complete list of file system types.

1. Become superuser.
2. Type `mountall -F` ***filesystem-type*** and press Return.

All the file systems of the type you specify that are in the local `/etc/vfstab` file are mounted.

In this example, all NFS file systems are mounted:

```
oak% su
Password:
mountall -F nfs
oak#
```

2.6

With the Solaris 2.6 release, the `-largefiles` mount option is used as the default for mounting UFS file systems. If you want to prevent users from mounting file systems that contain files larger than 2 Gbyte, you must explicitly use the `nolargefiles` mount option to disable the default behavior.

Mounting a Single File System (*mount*)

Follow these steps f to mount a single file system that has an entry in the `/etc/vfstab` file:

1. Become superuser.
2. Type `mount` ***mount-point*** and press Return.

The file system is mounted, as shown in this example:

```
oak% su
Password:
# mount /opt
#
```

2.6

Remounting a UFS File System Without Large Files (*mount*)

After you mount a fil fe system with the default `largefiles` mount option and large files have been created, you cannot remount the file system with the `nolargefiles` option until you remove any large files and run `fsck` to reset the state to `nolargefiles`.

The `nolargefiles` mount option provides total compatibility with previous file system behavior and enforces the 2 Gbyte maximum file size limit.

Follow these steps to remount a UFS file system without large files:

1. Become superuser.
2. Type `cd /filesystem` and press Return.
3. Type `find . -xdev -size +2000000 -exec ls -l {} \;` and press Return.
4. Remove any large files listed as the result of the `find` command.
5. Type `umount /filesystem` and press Return.
6. Type `fsck /dev/rdsk/device-name` and press Return.
7. Type `mount -o nolargefiles /dev/rdsk/device-name` and press Return. The file system is mounted.

In the following example, the directory `/files1` is searched for large files, unmounted, fscked, and mounted again with the `nolargefiles` option:

```
oak% su
Password:
# cd /files1
# find . -xdev -size +2000000 -exec ls -l {} \;
# umount /files1
# fsck /dev/rdsk/c0t3dos7 /files1
# mount -o nolargefiles /dev/dsk/c0t3d0s7 /files1
```

Unmounting All Remote File Systems (*umountall -F nfs*)

Follow thes fe steps to unmount all remote file systems:

1. Become superuser.
2. Type `umountall -F nfs` and press Return.

All the remote file systems in the local `/etc/vfstab` file are unmounted:

```
oak% su
Password:
umountall -F nfs
oak#
```

CAUTION! *If you unmount all file systems (*`umountall` *without any arguments), the system may be unusable and you may need to reboot it.*

Unmounting Individual File Systems (*umount*)

You cannot unmount a fdirectory that is being used. If you want to unmount a directory that is being used, all users must change out of the directory:

1. Become superuser.
2. If necessary, have users change out of the directory you want to unmount.
3. Type `umount mount-point` and press Return.

The file system you specify is unmounted.

In this example, the `mount` command is used first to find the mount point for the file system to be unmounted:

```
oak% mount
/ on /dev/dsk/c0t0d0s0 read/write/setuid on Wed Oct 23 10:08:50 1991

/usr on /dev/dsk/c0t0d0s6 read/write/setuid on Wed Oct 23 10:08:50 1991

/proc on /proc read/write/setuid on Wed Oct 23 10:08:50 1991

/tmp on swap on Wed Oct 23 10:08:52 1991

/usr/openwin on cheers:/export/openwin hard/remote on Wed Oct 23
10:11:08 1991

/home on blowup:(pid136) read only/intr/map=auto.home/indirect on Wed Oct 23
10:11:10 1991

/vol on blowup:(pid136) read only/intr/map=auto.vol/indirect on Wed Oct 23
10:11:10 1991

/nse on blowup:(pid136) read only/intr/map=/etc/auto.nse /indirect on Wed Oct 23
10:11:10 1991
[41]oak% su
Password:
# cd /
# umount /home
#
```

Automounting Directories

You can mount file systems shared through NFS using a method called *automounting*. The AutoFS program runs in the background and mounts and unmounts remote directories as they are needed. Whenever a user on a client system running AutoFS accesses a remote file or directory available through the automounter, AutoFS mounts the file system on the user's system. The remote file system remains mounted as long as the user remains in the directory and is using a file. If the remote file system is not accessed for a certain period of time, it is automatically unmounted. AutoFS mounts and unmounts file systems, as required without any intervention on the part of the user other than changing into or out of a directory.

You can mount some file hierarchies with AutoFS and you can change others using the `/etc/vfstab` file and the mount command. A diskless machine *must* have entries for `/` (root), `/usr`, and `/usr/kvm` in the `/etc/vfstab` file.

CAUTION! *Because shared file systems should always remain available, do not use AutoFS to mount* `/usr/share`.

AutoFS works with the file systems specified in maps. These maps can be maintained as NIS, NIS+, or local files. The AutoFS maps can specify several remote locations for a particular file. This way, if one of the servers is down, the automounter can try to mount from another machine.

You can specify which servers are preferred for each resource in the maps by assigning each server a weighting factor. AutoFS starts automatically when a system enters run level 3. You can also start it from a command line. (Describing how to set up and administer the automounter is beyond the scope of this book.) By default, the SunOS 5.*x* system software automounts `/home`.

Sharing Files from a Server

NFS is a distributed file system that can be used to tie together computers that are running different operating systems. For example, systems running DOS can share files with systems running UNIX.

NFS makes the actual physical location of the file system irrelevant to the user. You can use NFS to allow users to see all the relevant files, regardless of location. Instead of placing copies of commonly used files on every system, NFS allows you to place one copy on one system's disk and let all other systems access it across the network. Under NFS, remote file systems are virtually indistinguishable from local ones.

A system becomes an NFS server if it has file systems to share or export over the network. A server keeps a list of currently exported file systems and their access restrictions (such as read/write or read-only).

You may want to share resources, such as files, directories, or devices from one system on the network (typically, a server) with other systems. For example, you might want to share third-party applications or source files with users on other systems.

When you share a resource, you make it available for mounting by remote systems. You can share a resource in these ways:

- Using the `share` or `shareall` command
- Adding an entry to the `/etc/dfs/dfstab` (distributed file system table) file

The default `/etc/dfs/dfstab` file shows the syntax and an example of entries:

```
cinderella% more /etc/dfs/dfstab

#  place share(1M) commands here for automatic execution
#  on entering init state 3.
#
#  share [-F fstype] [ -o options] [-d "<text>"] <pathname> [resource]
#  .e.g,
#  share  -F nfs  -o rw=engineering  -d "home dirs"  /export/home2
share -F nfs /var/mail

cinderella%
```

Checking the Data Consistency of a File System (*fsck*)

The UFS file system relies on an internal set of tables to keep track of inodes and used and available blocks. When these internal tables are not properly synchronized with data on a disk, inconsistencies result and file systems need to be repaired.

File systems can be damaged or become inconsistent because of abrupt termination of the operating system in these ways:

- Power failure
- Accidental unplugging of the system
- Turning off the system without proper shutdown procedure
- A software error in the kernel

File system corruption, though serious, is not common. When a system is booted, a file system consistency check is done automatically. Most of the time, this file system check repairs problems it encounters.

File systems are checked with the `fsck` (file system check) program. The `fsck` command puts files and directories that are allocated but unreferenced in the `lost+found` directory in that file system. The inode number of each file is assigned as the name. If the `lost+found` directory does not exist, `fsck` creates it. If there is not enough space in the `lost+found` directory, `fsck` increases its size.

You may need to interactively check file systems when:

- They cannot be mounted
- They develop problems while in use

NOTE. *When an in-use file system develops inconsistencies, strange error messages may be displayed in the console window, or the system may crash. Before using* `fsck`*, you may want to refer to the* `fsck`*(1M) manual page for more information.*

Finding Out Whether a File System Needs Checking

Follow these steps to determine whether a file system needs to be checked:

1. Become superuser.
2. Type `fsck -m /dev/rdsk/c`*n*`t`*n*`d`*n*`s`*n* and press Return.

The state flag in the superblock of the file system you specify is checked to determine whether the file system is clean or requires checking.

If you omit the device argument, all the UFS file systems listed in `/etc/vfstab` with a `fsck` pass value greater than 0 are checked. In this example, the first file system needs to be checked; the second file system does not:

```
# fsck -m /dev/rdsk/c0t0d0s6
** /dev/rdsk/c0t0d0s6
ufs fsck: sanity check: /dev/rdsk/c0t0d0s6 needs checking
# fsck -m /dev/rdsk/c0t0d0s7
** /dev/rdsk/c0t0d0s7
ufs fsck: sanity check: /dev/rdsk/c0t0d0s7 okay
#
```

Checking File Systems Interactively

Follow these steps to check all file systems interactively:

1. Become superuser.
2. Unmount the file system.
3. Type `fsck` and press Return.

All file systems in the `/etc/vfstab` file with entries in the `fsck pass` field greater than zero are checked. You can also specify the mount point directory or `/dev/rdsk/cntndnsn` as arguments to fsck. Any inconsistency messages are displayed.
In this example, `/dev/rdsk/c0t0d0s6` is checked and the incorrect block count is corrected:

```
# fsck /dev/rdsk/c0t0d0s6
checkfilesys: /dev/rdsk/c0t0d0s6
** Phase 1 - Check Block and Sizes
INCORRECT BLOCK COUNT I=2529 (6 should be 2)
CORRECT? y

** Phase 2 - Check Pathnames
** Phase 3 - Check Connectivity
** Phase 4 - Check Reference Counts
** Phase 5 - Cylinder Groups
Dynamic 4.3 FFFS
929 files, 8928 used, 2851 free (75 frags, 347 blocks, 0.6% fragmentation)
/dev/rdsk/c0t0d0s6 FILE SYSTEM STATE SET TO OKAY

***** FILE SYSTEM WAS MODIFIED *****
```

Backing Up and Restoring File Systems

Backing up files means making copies of them, usually on removable media, as a safeguard in case the originals get lost or damaged. Backup tapes are convenient for restoring accidentally deleted files, but they are essential in case of serious hardware failures or other disasters.

Backing up files is one of the most crucial system administration functions. You must plan and carry out a procedure for regularly scheduled backups of your file systems for three major reasons:

- To ensure file system integrity against a possible system crash
- To protect user files against accidental deletion
- To act as an important safeguard before reinstalling or upgrading a system

When you back up file systems as scheduled, you have the assurance that you can restore anyone's files to a reasonably recent state. In addition, you may want to back up file systems to transport them from one system to another or to *archive* them—saving files on a transportable media—so that you can remove or alter the files that remain on the system.

When you plan a backup schedule, you need to consider:

- Which command to use to back up the file systems
- What media to use
- What backup schedule to use
- Which file systems to back up
- Which files are critical to users on this system
- Where the files are located—are they in a single file system?
- How often these files change
- How quickly you would need to restore these files in the event of damage or loss
- How often the relevant file systems can be unmounted so that they are available for backup

Outlining possible backup strategies is beyond the scope of this book. See the `ufsdump`(1M) manual page for a suggested dump schedule. The discussions that follow describe how to use the `ufsdump` command to make backups and how to retrieve files using the `ufsrestore` command.

NEW

Table 4–7 lists the commands that you can use to back up and restore individual files and file systems.

Table 4–7 Commands for Backing Up and Restoring Files and File Systems

Task	Command
Back up and restore complete or individual file systems to a local or remote tape device	`ufsdump` and `ufsrestore`.
Back up complete file systems for all systems on a network from a server	Solstice Backup software. Refer to the *Solstice Backup 4.2 User Guide*.
Back up and restore an NIS+ master server	`nisbackup` and `nisrestore`. Refer to the `nisbackup` and `nisrestore` manual pages.

NEW

Specifying Tape Characteristics

The `ufsdump` command uses a set of defaults when you do not specify any tape characteristics. You can specify tape cartridge (`-c`), density (`-d`), size (`-s`), and number of tracks (`-t`). Note that you can specify the options in any order as long as the arguments that follow match the order of the options. Table 4–8 provides some arguments to the `ufsdump` command that work well for different types of tape cartridges.

Table 4–8 Tape Capacity Arguments to the *ufsdump* Command

Medium	Arguments
Diskette	`ufsdump Ds 1422`
60-Mbyte cartridge	`ufsdump cdst 1000 425 9`
150-Mbyte cartridge	`ufsdump cdst 1000 700 18`
1/2-inch tape	`ufsdump dsb 1600 2300 126`
2.3-Gbyte 8-mm tape	`ufsdump dsb 54000 13000 126`
5.0-Gbyte 8-mm tape	`ufsdump dsb 54000 13000 126`
5.0-Gbyte 4-mm tape	`ufsdump b 96`

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Backing Up a File System Using QIC-150 Cartridge Tapes (*ufsdump*)

To do a full backup on a file system, all users must be logged out and you must bring the system to single-user mode. (See “Tape Device Naming Conventions” in Chapter 3 if you need information about tape device names.)

You can dump or restore files from a remote drive by adding ***remote-host:*** to the front of the tape device name. Here is the syntax:

remote-host:/dev/rmt/*unit*

For example, the device name for a remote tape drive /dev/rmt/0, on the system oak, would be oak:/dev/rmt/0.

Follow these steps to do a level 0 (full) backup of a file system:

1. Type **init s** and press Return. The system is brought to single-user mode, which ensures that no users can change the file system you are backing up.
2. Insert a tape cartridge in the QIC-150 tape drive.
3. Type **ufsdump 0cuf /dev/rmt/*unit* c*n* t*n* d*n* s*n*** and press Return. The 0 option specifies a level 0 (complete) dump. The c option specifies cartridge tape. The u option updates the dump record. The f option followed by the device name specifies the device file. Type the raw disk slice for the file system you want to back up, for example, **c0t0d0s7** for /files1.

   The following example does a level 0 dump of the c0todos7 slice:

   ```
   oak% su
   Password:
   # init s
   # ufsdump Øcuf /dev/rmt/Ø cØtØdØs7
     DUMP: Date of this level Ø dump: Wed Mar 11 1Ø:16:53 1992
     DUMP: Date of last level Ø dump: the epoch
     DUMP: Dumping /dev/rdsk/cØt3dØs7 (/export/home) to /dev/rmt/Ø
     DUMP: mapping (Pass I) [regular files]
     DUMP: mapping (Pass II) [directories]
     DUMP: estimated 956 blocks (478KB)
     DUMP: Writing 63 Kilobyte records
     DUMP: dumping (Pass III) [directories]
     DUMP: dumping (Pass IV) [regular files]
     DUMP: level Ø dump on Wed Mar 11 1Ø:16:53 1992
     DUMP: 956 blocks (478KB) on 1 volume
     DUMP: DUMP IS DONE
   #
   ```

4. If the dump requires more than one tape, the ufsdump command tells you when to change to a new tape.
5. Label the tape with the command, file system, and date so that you can easily find the backup tape if you need to restore files.

Accomplishing Incremental Backups

You can specify different backup levels with the ufsdump command, making it possible to back up only those files that were changed since a previous backup at a lower level. Follow these steps to back up incremental changes since the last complete dump:

1. Bring the system to single-user mode.
2. Become superuser.
3. Put a tape into the tape drive.
4. Type `ufsdump` ***[1-9]***`ucf /dev/rmt/`***unit*** `/dev/rdsk/c`***n*** `t`***n*** `d`***n*** `s`***n*** and press Return. Type the level of the backup at the beginning of the ufsdump arguments. For example, for a level 9 backup, type **`9ucf`**.
5. Remove the tape from the tape drive and label it.

Restoring a Backed-Up File System (*ufsrestore*)

The `ufsrestore` command copies files from backups created using the `ufsdump` command into the current working directory. You can use `ufsrestore` to reload an entire file system hierarchy from a level 0 dump and incremental dumps that follow it, or to restore one or more single files from any dump tape. Files are restored with their original owner, last modification time, and mode (permissions).

Before you start to restore files or file systems, you need to know:

- Which tapes (or diskettes) you need
- The raw device name for the file systems you want to back up
- The type of tape drive you will use
- The device name (local or remote) for the tape drive

Determining Which Tapes to Use

Before you can begin restoring file systems or files, you must determine which backup tapes you need. When restoring an entire file system, you always need the most recent level 0 backup tape. You also need the most recent incremental backup tapes made at each of the higher levels. Refer to the backup plan that you are using to determine the levels and number of tapes you need. For example, if you make level 0 and level 9 backups, you need the most recent level 0 and level 9 backup tapes made.

Use the following steps to determine which tapes to use to restore individual files or file systems:

1. Ask the user the date when the file or file system was lost, or the approximate date of the files to be recovered.
2. Refer to your backup plan to find the date of the last backup that would have the file or file system on it. Note that you do not necessarily use the most recently backed up version of the file. To retrieve the most recent version of a file, work backward through the incremental backups from highest to lowest level and most recent to least recent.

3. If you have on-line archive files created using the `ufsdump -a` option, type `ufsrestore ta` ***archive-name*** `/path/`***filename(s)*** and press Return. Be sure to use the complete path for the *file-name*(s). A list of the files and the media they are stored on is displayed.
4. Retrieve the media containing the backups. Be aware of the storage organization of backup media at your site so that you can locate media that are months or years old.
5. This step is optional. Insert media in the drive and type **`ufsrestore tf`** ***device-name /path/filename***(s) and press Return. Be sure to use the complete path for the *file-name*(*s*). If a file is in the backup, its name and inode number are listed. Otherwise, a message says it is not on the volume.
6. If you have multiple dump files on the same tape, you can use the `-s` *n* option to position the tape at the dump you want to use. For example, type **`ufsrestore xfs /dev/rmt0 5`** and press Return to position the tape at the fifth dump and restore it.

Restoring a Full Backup

Follow these steps to restore a full backup of a file system using QIC-150 cartridge tape:

CAUTION! *This procedure completely destroys any data already in the file system by creating a new file system on the slice.*

1. Become superuser.
2. Type **`init s`** and press Return. The system is brought to single-user mode, which ensures that no one is using the file system you are restoring.
3. Type **`umount`** ***mount-point*** and press Return. The mount point you specify (for example, `/files1`) is unmounted.
4. Type **`newfs /dev/rdsk/c`*n*`t`*n*`d`*n*`s`*n*** and press Return. The raw device file for the disk slice (for example, `/dev/rdsk/c0t0d0s7` for the `/home` slice) is wiped clean and the file system is rebuilt.
5. Type **`mount /dev/dsk/c`*n*`t`*n*`d`*n*`s`*n*** and press Return. The file system, specified as the block file device (for example, `/dev/dsk/c0t0d0s7` for `/files1`), is remounted at the mount point you specify.
6. Type **`cd`** ***mount-point*** and press Return. You are in the directory you want to restore.
7. Insert the tape cartridge in the QIC-150 tape drive.
8. Type **`ufsrestore rvf /dev/rmt/0h`** and press Return. The file system is restored.

In this example, the `/files1` slice `c0t0d0s7` is restored:

```
oak% su
Password:
# init s
# umount /files1
# newfs /dev/rdsk/c0t0d0s7
```

```
# mount /dev/dsk/c0t0d0s7 /files1
# cd /files1
# ufsrestore rvf /dev/rmt/0h
#
```

Restoring Files Interactively

When restoring individual files and directories, it is a good idea to restore them to a temporary directory such as `/var/tmp`. After you verify them, you can move the files to their proper locations. You can restore individual files and directories to their original locations. If you do so, be sure you are not overwriting newer files with older versions from the backup tape.

Follow these steps to restore files interactively:

1. Become superuser.
2. Write-protect the tape for safety.
3. Put the backup tape in the tape drive.
4. Type *`cd /var/tmp`* and press Return. If you want to restore the files to a different directory, substitute the directory name for `/var/tmp` in this step.
5. Type **`ufsrestore if /dev/rmt/`*`unit`*** and press Return. Some informational messages and the `restore>` prompt are displayed.
6. Create a list of files to be restored:
   - To list the contents of a directory, type **`ls`** and press Return.
   - To change directories, type **`cd`** ***`directory-name`*** and press Return.
   - To add a directory or file name to the list of files to be restored, type **`add`** ***`file-name`*** and press Return.
   - To remove a directory or file name from the list of files to be restored, type **`delete`** ***`file-name`*** and press Return.
   - To keep the mode of the current directory unchanged, type **`setmodes`** and press Return. Then type **`n`** and press Return.
7. When the list is complete, type **`extract`** and press Return. Then, `ufsrestore` asks you which volume number to use.
8. Type the volume number and press Return. If you have only one volume, type **`1`** and press Return. The files and directories in the list are extracted and restored to the current working directory.
9. Type **`quit`** and press Return. The shell prompt is displayed.
10. Use the `ls -l` command to list the restored files and directories. A list of files and directories is displayed.

11. Check the list to be sure all the files and directories you specified in the list have been restored.

12. Use the `mv` command to move the files to the proper directories.

In this example, the files `backup.examples` and `junk` are restored from the `pubs` directory:

```
# cd /var/tmp
# ufsrestore if /dev/rmt/0
ufsrestore > ls
.:
 lost+found/   pubs/

ufsrestore > cd pubs
ufsrestore > ls
 ./pubs:
 .Xauthority          .login               .profile             backup.examples%
 .Xdefaults           .mtdeletelog         .wastebasket/        core
 .cshrc               .openwin-init        Junk/                dead.letter
 .desksetdefaults     .openwin-init.BAK    backup.examples      junk

ufsrestore > add backup.examples
ufsrestore > add junk
ufsrestore > setmodes
set owner/mode for '.'? [yn] n
ufsrestore > extract
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 > quit
# ls -l
total 6
drwxrwxrwt   3 sys      sys          512 Mar 11 10:36 ./
drwxrwxr-x  18 root     sys          512 Mar 10 16:43 ../
drwxr-xr-x   2 pubs     staff        512 Mar 11 10:11 pubs/
# pwd
/var/tmp
# cd pubs
# ls
./                ../                backup.examples   junk
#
```

Restoring a Single File from a Backup Tape (*ufsrestore*)

Follow these steps to restore a single file from a backup tape:

1. Become superuser.

2. Put the backup tape in the tape drive.

3. Type **`cd /var/tmp`** and press Return. If you want to restore the files to a different directory, substitute the directory name for `/var/tmp` in this step.

4. Type `ufsrestore xf /dev/rmt/unit file-name` and press Return. The `x` option tells ufsrestore to copy specific files or directories in the *filename* argument. The message `set owner/mode for '.'? [yn]` is displayed.
5. Type `n` and press Return. Directory modes remain unchanged.
6. Type the volume number where files are located and press Return. If there is only one volume, type `1` and press Return. The file is restored to the current working directory.
7. Type `ls -l file-name` and press Return. A listing for the file is displayed.
8. Use the `mv` command to move the file to the proper directory.

Creating Cache File Systems

NEW

You can use the Cache File System (CacheFS) to improve NFS server performance and scalability by reducing server and network load. CacheFS is designed as a layered file system that enables the system to cache one file system on another. In an NFS environment, CacheFS increases the client per server ratio, reduces server and network loads, and improves performance for clients on slow links such as Point-to-Point Protocol (PPP).

Understanding CacheFS

With CacheFS you can enable a client system to cache a file system from a server. Initial access to the file system may seem slow, but subsequent uses of the same file by the user are faster. Typically you would cache an NFS or HSFS file system. You create cache file systems individually on each client system that needs improved NFS performance.

NOTE. *CacheFS does not support caching of the* `root` *(*`/`*) and* `/usr` *file systems. To cache these file systems, you must purchase the Solstice AutoClient product.*

1. Use the `cfsadmin`(1M) command to create a cache on a client system so that file systems you specify to be mounted in the cache can be accessed by the user locally instead of across the network. To prevent conflicts within the CacheFS software, after you have created the cache you should not perform any operations within the cache directory on the client system.
2. Create a mount point where the file system from the server, called the *back file system,* is mounted.
3. Mount a file system in a cache by using the mount command, adding an entry to the `/etc/vfstab` file, or using AutoFS to automount the file system.

After you have completed setup of the CacheFS, files are dynamically placed in the cache as the user accesses them.

NOTE. *You can mount only file systems that are shared. Refer to the* `share(1M)` *manual page for more information or see section on page 145.*

Creating a Cache

Follow these steps on a client system to create a cache:

1. Decide what name you want to use for the cache directory.
2. On the client system, become superuser.
3. Type `cfsadmin -c` ***cache-directory*** and press Return.

In this example, a cache file system named `cachefile` is created in the `/local` directory:

```
oak% su
# cfsadmin -c /local/cachefile
```

Specifying a File System to Be Mounted in the Cache

You can specify file systems to be mounted in the cache so that users can locally access files in the cache file system you create. You can specify the file systems to be cached in three ways:

- Using the `mount`(1M) command. When you use the `mount` command, the files must be mounted from the command line every time the system is rebooted.
- Editing the `/etc/vfstab` file. When you add an entry to the `/etc/vfstab` file, the specified files are available for caching even when the system is rebooted.
- Using AutoFS. When you modify AutoFS maps, the specified files are available for caching even when the system is rebooted.

Creating a Mount Point

Regardless of the mechanism you choose to mount the file system, you need to create a mount point on the client system where CacheFS mounts the files. The mounted files are then cached in the cache directory that you created.

Type `mkdir` ***cache-directory*** and press Return. In this example, a mount point named `/cachemount` is created:

```
# mkdir /docs-cachemount
```

Specifying a File System (*mount*) You provide the following parameters for the `mount` command:

- The file system type of the back file system on the server: `backfstype=`***fstype***.
- The name of the cache directory: `cachedir=`***cache-directory***.
- The name of the back file system: ***back-filesystem***.
- The mount point: ***mount-point***.

Follow these steps to mount a cache file system from a command line:

1. On the client system, become superuser.
2. Type `mount -F cachefs -o backfstype=`***fstype***`,cachedir=`***cache-directory[,options] back-file-system mount-point*** and press Return.
3. Type `cachefsstat` ***mount-point*** and press Return. The output from this command verifies that the cache you created was mounted.

In this example, a mount point named `/docs-cachemount` is created and the NFS file system `castle:/docs` is mounted as a cached file system named `/docs-cachemount` in the cache named `/local/cachfile`:

```
oak% su
# mkdir /docs-cachemount
# mount -f cachefs -o backfstype=nfs,cachedir=/local/cachefile castle:/docs
/docs-cachemount
# cachefsstat /docs-cachemount
/docs
            cache hit rate:100% (0 hits, 0 misses)
        consistency checks:1 (1 pass, 0 fail)
                  modifies:0
        garbage collection:0
```

If the file system was not mounted in the cache, an error message similar to the following is displayed:

```
# cachefsstat /docs-cachemount
cachefsstat: /docs-cachemount not a cachefs mountpoint
```

Specifying a File System (*/etc/vfstab file*) When you add a cache file system to the `/etc/vfstab` file on the client system, the back file system remains available to users as a cached file system.

Follow these steps to mount a cache file system the `/etc/vfstab` file:

1. On the client system, become superuser.
2. Using an editor, add the following line to the /etc/vfstab file:

   `/dev/dsk/`***device-name*** `/dev/rdsk/`***device-name /mount-point*** `cachefs 2 yes -`
3. Type `mount` ***mount-point*** and press Return or reboot the system to mount the file system.

In this example, the `/usr/local` directory is mounted in the cache directory:

```
/dev/disk/c0t1d0s0  /dev/rdsk/c0t1d0s0  /cache  ufs  2  yes  -
```

Specifying a File System (AutoFS Map) You add a cache file system to the `auto_direct` AutoFS map by specifying the `-fstype=cachefs` mount option. Note that you also specify the CacheFS mount options (for example, `backfstype` and `cachedir`).

Refer to the `automount(1M)` manual page for more information about automount maps or refer to the *Solaris Advanced System Administrator's Guide* available from Sun Microsystems Press.

Follow these steps to specify a cache file system in the AutoFS map:

1. Become superuser.
2. Using an editor, add the following line to the `auto_direct` map:

   `/`***`mount-point`*** `-fstype=cachefs,cachedir=/`***`directory,`*** `backfstype=nfs`
   `server:/file-system`

3. Reboot the system.
4. Type `cd` ***`files-system`*** and press Return.
5. Type `ls` ***`files-system`*** and press Return. Review the output of the `ls` command to verify that the entry was made correctly.

Maintaining Caches

After you set up cache file systems, you can perform the following maintenance tasks on them:

- Modify file systems in the cache by unmounting, deleting, re-creating, and remounting the cache
- Display cache information
- Check cache consistency
- Delete a file system from the cache
- Check cached file system integrity

If you are using the `/etc/vfstab` file to mount file systems, you modify the cache by editing the file system options in the `/etc/vfstab` file. If you are using AutoFS, you modify the cache by editing the file system options in the AutoFS maps.

Table 4–9 lists the commands that you can use to perform cache maintenance. Refer to the appropriate manual page for more details.

Table 4–9 Commands for Maintaining Cache File Systems

Command	Description
`cfsadmin`	Enables you to display information about cached file systems, delete a cached file system from a specified cache, and specify consistency checking on demand. See the `cfsadmin`(1M) manual page for more information.
`cachefspack`	Enables you to create packing lists that specify individual files and directories that you want packed in the cache. A packing list contains files or directories to be packed in the cache. If a directory is in the packing list, all its subdirectories and files are also packed. See the `cachefspack`(1M) manual page for more information.
`cachefslog`	Specifies the location of a CacheFS log file. This command also displays were statistics are currently being logged and enables you to halt logging. See the `cachefslog`(1M) manual page for more information.
`cachefswssize`	Interprets the log file to give a recommended cache size. See the `cachefsswsize`(1M) manual page for more information.
`cachefsstat`	Displays statistical information about a specific file system or all cached file systems. The information provided in the output of this command is taken directly from the cache. See the `cachefsstat`(1M) manual page for more information
`fsck -F cachefs {-m} {-o noclean} cache-directory`	Checks the integrity of cached file systems and automatically corrects problems without requiring user interaction. See the `fsck_cachefs`(1M) manual page for more information.

CHAPTER

5

Administering Network Services

Checking on Remote System Status

Logging In to a Remote System (`rlogin`)

Transferring Files Between Systems (`rcp`, `ftp`)

Administering NIS+ Databases (`solstice`)

THIS CHAPTER CONTAINS INFORMATION ABOUT CHECKING ON REMOTE SYSTEM status, logging in to a remote system, transferring files between systems, and administering the Network Information Service Plus (NIS+) databases.

Checking on Remote System Status

This section describes commands you use to find out the status of remote systems: `rup`, `ping`, and `rpcinfo -d`.

Determining How Long a Remote System Has Been Up (*rup*)

To find out how long a system has been up and the load average, type `rup` ***system-name*** and press Return. The host name, uptime, and load average are displayed:

```
oak% rup ash
ash    up 59 days,  3:42, load average: 0.12, 0.12, 0.01
oak%
```

You can also display a list of all remote hosts in the subnet by typing `rup` and pressing Return. If you display a list, you can use the options shown in Table 5–1 to sort the output.

Table 5–1 Options to the *rup* Command

Option	Description
-h	Sorts the display alphabetically by host name
-l	Sorts the display alphabetically by load average
-t	Sorts the display by uptime

In this example, the output is sorted alphabetically by host name:

```
oak% rup -h
ash    up  1 day,   1:42,   load average: 0.00, 0.31, 0.34

elm    up 14 days,  0 min,  load average: 0.07, 0.01, 0.00

maple  up 32 days,  14:39,  load average: 0.21, 0.05, 0.00

oak    up  8 days,  15:44,  load average: 0.02, 0.00, 0.00
oak%
```

Determining Whether a Remote System Is Up (*ping, rup, rpcinfo -p*)

Follow these steps to determine whether a remote system is up:

1. Type `ping` ***system-name*** and press Return. The message *`system-name`* `is alive` means the system is accessible over the network. The message `ping: unknown host` *`system-name`* means the system name is not known on the network. The message `ping: no answer from` *`system-name`* means the system is known on the network but is not up at this time.
2. Type `rup` ***system-name*** and press Return. Information about how long the system has been up and the load average is displayed.
3. Type `rpcinfo -p` ***system-name*** and press Return. Information about RPC services is displayed.
4. Type `rlogin` ***system-name*** and press Return. You are logged in to the remote system.

```
cinderella% ping drusilla
drusilla is alive
cinderella% rup drusilla
   drusilla    up  3 days,  15:10   load average: 0.07, 0.08, 0.09
cinderella% rpcinfo -p drusilla
program  vers proto port  service
100000    3   udp    111  portmapper
100000    2   udp    111  portmapper
100000    3   tcp    111  portmapper
100000    2   tcp    111  portmapper
100007    3   tcp   1029  ypbind
100007    3   udp   1025  ypbind
100021    1   tcp   1030  nlockmgr
100021    1   udp   1026  nlockmgr
100024    1   tcp   1028  status
100024    1   udp   1027  status
100021    3   tcp   1030  nlockmgr
100021    3   udp   1026  nlockmgr
100020    2   tcp   4045  llockmgr
100020    2   udp   4045  llockmgr
100021    2   tcp   1030  nlockmgr
100021    2   udp   1026  nlockmgr
100087   10   udp   1031  adm_agent
100011    1   udp   1034  rquotad
100002    1   udp   1037  rusersd
100002    2   udp   1037  rusersd
100012    1   udp   1041  sprayd
100008    1   udp   1043  walld
100001    2   udp   1046  rstatd
100001    3   udp   1046  rstatd
100001    4   udp   1046  rstatd
100068    2   udp   1049  cmsd
100068    3   udp   1049  cmsd
100083    1   tcp   4049
cinderella% rlogin drusilla
Password:
```

```
Last login: Mon Mar  2 10:31:55 from cinderella
drusilla%
```

You can also use `ping` with a system's IP address by typing **`ping`** ***`IP-address`*** and pressing Return. The message *`IP-address is alive`* means the system is accessible over the network. The message `ping: no answer from` *`IP-address`* means the system is not available to the network. The message `ping: unknown host` *`IP-address`* means the system name is not known on the network:

```
oak% ping 129.144.52.119
129.144.52.119 is alive
oak% ping 129.137.67.234
ping: unknown host 129.137.67.234
oak% ping 129.145.52.119
ping: no answer from 129.145.52.119
oak%
```

Logging In to a Remote System (*rlogin*)

Follow these steps to log in to a remote system:

1. Type **`rlogin`** ***`system-name`*** and press Return. You may be prompted for a password.
2. If you have a local account on that system, type your local password. Otherwise, type your NIS+ password. Unless you have a home directory that is accessible on the remote system (because it is local on that system, or because it is hard-mounted or automounted), you log in to the root (/) directory:

```
oak% rlogin ash
Password:
No directory!  Logging in with home=/
Last login: Tue Sep 17 13:54:28 from 129.144.52.119
Sun Microsystems, Inc. SunOS 5.0 June 1992.
ash%
```

Transferring Files Between Systems (*rcp, ftp*)

If the automounter is set up for your site, you can transfer files between systems by using commands such as `cp` and `mv`. This section describes how to use the `rcp` and `ftp` commands to transfer files between systems.

Using the *rcp* Command

To transfer a file from a remote system to your system by using the remote copy command, type **`rcp`** ***`system-name:source-pathname destination`*** and press Return. If you have proper security to access the remote system, the file is copied to the destination you specify.

In this example, the file `quest` is copied from the `/tmp` directory on the system `ash` to the current working directory on the system `oak`:

```
oak% rcp ash:/tmp/quest .
oak%
```

To transfer a file from a local system to a remote system, type **`rcp`** ***`pathname system-name:destination-pathname`*** and press Return. If you have proper security to access the remote system, the file is copied from the local system to the remote destination you specify.

In this example, the file `quest` is copied from the current working directory on the system `oak` to the `/tmp` directory on the system `ash`:

```
oak% rcp quest ash:/tmp
oak%
```

If you want, you can rename the file as part of the destination path name. For example, to rename the file `quest` to `questions` and put it in the `/tmp` directory, type **`/tmp/questions`** as the destination path name.

Using the File Transfer Program (ftp)

Follow these steps to transfer files from your local system to a remote system by using the file transfer program.

NOTE. *You may need to have an account on each system and an entry in the* `/ .rhosts` *file to use the file transfer program. Some systems allow read-only* `ftp` *access to anybody who logs in as* `anonymous` *and types a login name at the password prompt.*

If you have an NIS or an NIS+ account, you can use your login name and network password to access a remote system by using ftp:

1. Type **`ftp`** and press Return. The `ftp>` prompt is displayed.
2. Type **`open`** ***`remote-system-name`*** and press Return. System connection messages are displayed, and you are asked for a user name.
3. Type the user name for your account on the remote system and press Return. If a password is required, you are asked to enter it.
4. Type the password (if required) for your account on the remote system and press Return. A system login message and the `ftp>` prompt are displayed.
5. Type **`bin`** to set binary format or **`asc`** to set ASCII format and press Return. The file type is set.
6. Type **`put`** ***`local-filename destination-filename`*** and press Return. File transfer messages and the `ftp>` prompt are displayed.
7. Type **`quit`** and press Return. A goodbye message and the command prompt are displayed.

The following example establishes an `ftp` connection from the system `oak` to the system `elm`, specifies ASCII format, puts the file `quest` from `oak` into the `/tmp/quest` directory on `elm`, and quits the session:

```
oak% ftp
ftp> open elm
Connected to elm
220 elm FTP server (UNIX(r) System V Release 4.0) ready.

Name (elm:ignatz): ignatz
331 Password required for ignatz.
Password:
230 User ignatz logged in.
ftp> asc
ftp> put quest /tmp/quest
200 PORT command successful.

150 ASCII data connection for /tmp/quest (129.144.52.119,1333).

226 Transfer complete.
ftp> quit
221 Goodbye.
oak%
```

You can use the `send` command as an alternative to the `put` command. You can copy multiple files by using the `mput` command. There is no `msend` command. See the `ftp`(1) manual page for more information.

NOTE. *You must have an account on each system to use the file transfer program.*

If you have an NIS or an NIS+ account, you can use your login name and network password to access a remote system by using `ftp`. Follow these steps to transfer files from a remote system to your local system by using the file transfer program:

1. Type **`ftp`** and press Return. The `ftp>` prompt is displayed.
2. Type `open` ***`remote-system-name`*** and press Return. System connection messages are displayed, and you are asked for a user name.
3. Type the user name for your account on the remote system and press Return. If a password is required, you are asked to enter it.
4. Type the password (if required) for your account on the remote system and press Return. A system login message and the `ftp>` prompt are displayed.
5. Type **`bin`** to set binary format or **`asc`** to set ASCII format and press Return. The file type is set.
6. Type **`get`** ***`remote-filename destination-filename`*** and press Return. File transfer messages and the `ftp>` prompt are displayed.
7. Type **`quit`** and press Return. A goodbye message and the command prompt are displayed.

The following example establishes an `ftp` connection from the system `oak` to the system `elm`, specifies ASCII format, gets the file quest from `elm`, puts it into the `/tmp/quest` directory on `oak`, and quits the session:

```
oak% ftp
ftp> open elm
Connected to elm
220 elm FTP server (UNIX(r)System V Release 4.0) ready.

Name (elm:ignatz): ignatz
331 Password required for ignatz.
Password:
230 User ignatz logged in.

ftp> asc
ftp> get quest /tmp/quest
200 PORT command successful.
150 ASCII data connection for /tmp/quest (129.144.52.119,1333).
226 Transfer complete.

ftp> quit
221 Goodbye.
oak%
```

NOTE. *You can copy multiple files by using the* `mget` *command. See the* `ftp`*(1) manual page for more information.*

Administering NIS+ Databases (*solstice*)

NIS+ provides a central store of information for network resources such as hosts, users, and mailboxes. NIS+ replaces NIS (Network Information Service) and provides these enhancements:

- An organizational framework that is simpler to administer in large companies.
- Improved security.
- Improved distribution time to propagate changes through the network.

In addition, the Solaris 2.*x* environment provides a new name service switch file, `/etc/nsswitch.conf`, that lets you use several different network information services at once. The `/etc/nsswitch.conf` file also lets you specify which service provides which type of information. In previous SunOS releases, selection of the name service was hard-coded into the services, which made it difficult to switch to a new name service. The `/etc/nsswitch.conf` file defines the order in which local files and network databases are searched for information. Describing how to set up NIS+ is beyond the scope of this book.

Solstice Host Manager

NEW

In previous Solaris releases, you may have used Admintool to manage server and client support. In the Solaris 2.5 and later releases, you must use the Solstice Host Manager tool, which offers ease of use and provides support for the following name services:

- NIS+ tables
- NIS maps
- Local `/etc` files

Because the Solstice Host Manager is sold as a separate product, describing how to use Host Manager is beyond the scope of this book. The information in the following sections is provided to help you evaluate whether the Solstice Host Manager product is useful in your system administration environment.

Host Manager is a graphical user interface that enables you to add and maintain server and client support on a network. With a name service like NIS+, you can manage system information in a centralized manner so that important system information, such as host names, does not have to be duplicated on every system on the network.

Host Manager enables you to:

- Add and modify support
- Update system types
- Convert system types
- Add and remove OS services
- Set up remote installation services
- Queue tasks
- Set root passwords
- Enable scripts
- Add a multihomed host

The following sections provide a brief description of each of these capabilities.

Add and Modify Support

Host Manager enables you to add and modify support for the following Solaris system types:

- Solaris AutoClient systems
- Solaris diskless clients

- Solaris stand-alone systems
- Solaris OS servers
- JavaStations (modify support only)

Update System Types

Host Manager initially marks the system types of previously added systems as generic. You can, however, choose Update System Types from the File menu to probe previously added systems and determine their system types automatically. If Host Manager cannot determine the system type (for example, if the system is not running the Solaris software), the systems remain marked as generic.

NOTE. *Systems running Solaris 2.5 or later must also have the Solstice AdminSuite software installed to enable Host Manager to automatically update the system type.*

The system type information is stored in the `bootparams` file in the local `/etc` files or a name service database. Host Manager either modifies an existing `bootparams` entry or adds a new one such as the following example for a Solaris stand-alone system named `castle`:

```
castle: boottyp=:st
```

Convert System Types

Host Manager enables you to convert one system type to another. You can make the following conversions:

- Stand-alone system to an AutoClient system or OS server
- Dataless system to an AutoClient system or OS server
- AutoClient system to a stand-alone system
- Generic system to a stand-alone or AutoClient system or to an OS server

Add and Remove OS Services

A Solaris OS server is a server that provides OS services to support client systems. By using Host Manager, you can add support for an OS server or convert a stand-alone system to an OS server.

For each platform group and Solaris release that you want to support, you must add the particular OS service to the OS server. For example, if you want to support SPARC Sun4m systems running the Solaris 2.4 release, you must add Sun4m/Solaris 2.4 OS services to the OS server. You would also still need to add OS services to support SPARC Sun4c systems or x86 systems running the Solaris 2.4 release, because they are different platform groups.

You must have access to the appropriate Solaris CD image to add OS services.

NOTE. *Although Host Manager enables you to add support for diskless clients running the SunOS 4.x release, you cannot add SunOS 4.x OS services using Host Manager. You must use the install4x commands to add OS services to an OS server, and then use Host Manager to add support for the SunOS 4.x client.*

You can remove OS services from an OS server by using Host Manager. For example, if you no longer want to support SPARC Sun4m systems running the Solaris 2.4 release, you can remove these OS services from the server by using Host manager.

Set Up Remote Installation Services

Host Manager enables you to set up systems to provide Solaris 2.*x* installation services for other systems on the network. You can set up the following types of installation services on a system:

- An install server — A system on the network that provides a Solaris CD image (either from a CD-ROM drive or the copy on the hard disk) for other systems to install from.
- A boot server — A system that provides boot information to other systems on the network. The boot server and the install server are usually the same system.
- A profile server — A system that contains JumpStart files for systems to perform a custom JumpStart installation.

NOTE. *A boot server and install server are typically the same system. However, if the system to be installed is on a different subnet than the install server, a boot server is required on that subnet.*

Queue Tasks

Host Manager enables you to queue tasks such as converting system types and adding OS services. Because these tasks may require several minutes to process, Host Manager enables you to set up tasks to be performed without requiring you to wait for each task to be completed. After setting up the tasks and choosing Save Changes from the File menu, you can monitor the progress of the tasks in a status bar located at the bottom of the window.

Set Root Passwords

You can now set the root password just as you do when setting the group or user password when adding a Solstice AutoClient or Solaris diskless client using Host Manager.

Enable Scripts

When you add a Solstice AutoClient by using Host Manager, you have the option to enable scripts that you have created to customize the addition or deletion of AutoClient systems. You can run these scripts on the server before or after you add the AutoClient to the server, or on the client before or after the cache is configured on the AutoClient.

Scripts must be located in the `/opt/SUNWadmd/Scripts` directory so that the AdminSuite software can read them.

Adding a Multihomed Host

Host Manager enables you to add a multihomed host alias for servers with multiple network interfaces. If a server has more than one IP address because it is on multiple networks, it is considered a multihomed host. With Host Manager, you can specify more than one IP address for a host to make it a multihomed host.

Restrictions of Host Manager

Host Manager has the following limitations:

- Host Manager cannot automatically recognize all previously added system types.
- Host Manager cannot add SunOS 4.*x* service to an OS server.
- Host Manager cannot provide remote installation services for SunOS 4.*x* systems.
- Host Manager does not enable you to install patches on existing clients and servers. However, if you have used the `admclientpatch` command to set up a patch spool directory, Host Manager references this spool directory and adds appropriate patches for all new hosts.

Using NIS+ Tables

NIS+ tables correspond to NIS maps. The Solaris 2.*x* environment provides 16 types of tables (shown in Figure 5–1) that store the network information used by NIS+.

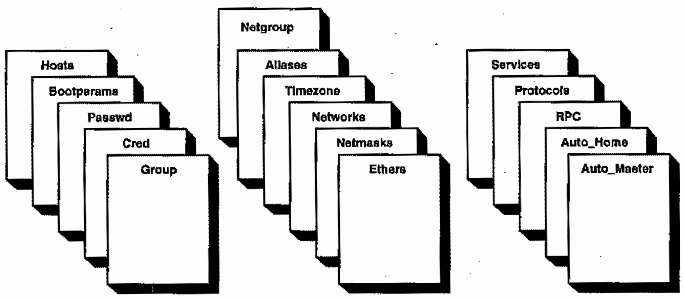


Figure 5–1
The 16 NIS+ tables.

Each table stores a different type of information about users, workstations, or resources on the network. For instance, the Hosts table stores the hostname and network address of every workstation in the domain; the Bootparams table stores the location of the root, swap, and dump directories of the diskless clients in the domain.

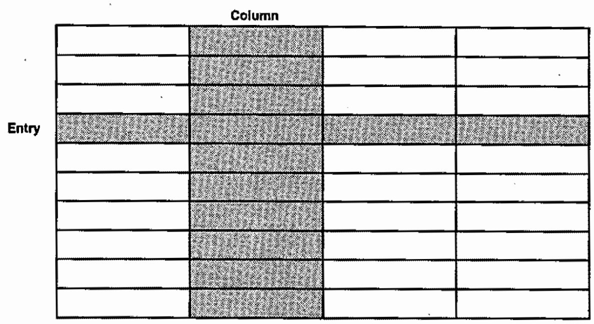
Each domain may have its own set of these NIS+ tables, which store all the NIS+ information for that particular domain. Table 5–2 lists the 16 NIS+ tables and the information they store.

Table 5–2 NIS+ Tables

Table	Information in the Table
Hosts	Network address and hostname of every workstation in the domain
Bootparams	Location of the root, swap, and dump partition of every diskless client in the domain
Password	Password information about every NIS+ principal in the domain, plus a pointer to the shadow file
Cred	Credentials for principals who have permission to access the information or objects in the domain
Group	Password, group ID, and members of every group in the domain
Netgroup	The netgroups to which workstations and users in the domain may belong
Aliases	Information about the aliases of workstations in the domain
Timezone	The time zone of every workstation in the domain
Networks	The networks in the domain and their canonical names
Netmasks	The networks in the domain and their associated netmasks
Ethers	The Ethernet address of every workstation in the domain
Services	The names of IP services used in the domain and their port numbers
Protocols	The list of IP protocols used in the domain
RPC	The RPC program numbers for RPC services available in the domain
Auto_Home	The location of all users' home directories in the domain
Auto_Master	Automounter map information

You can access information in NIS+ tables either by entry row or by column, as shown in Figure 5–2.

Figure 5–2
Entry row and columns in a table.



For example, if you want to find the network address of a workstation named `drusilla`, you can ask a search program to look through the `hostname` column until it finds `drusilla`, as shown in Figure 5–3. The program then searches the `drusilla` entry row to find its network address, as shown in Figure 5–4.

Figure 5–3
Searching the Hostname column.

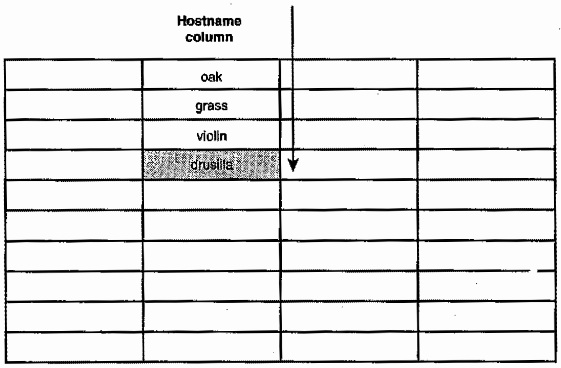
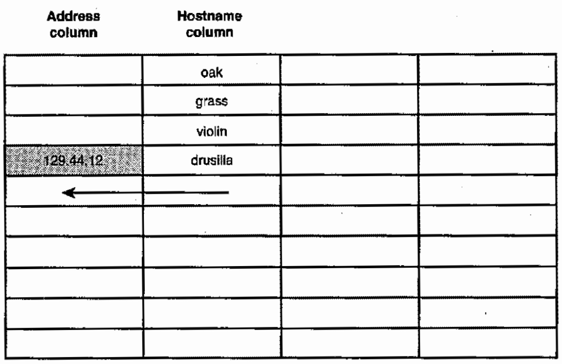


Figure 5–4
Finding a network.



You can use either NIS+ commands or Solstice AdminSuite to perform these types of searches for you. Table 5–3 lists the NIS+ administrative commands.

Table 5–3 NIS+ Administrative Commands

Command	Description
`nistbladm`	Displays, adds, modifies, and deletes information in an NIS+ table
`nisgrep`	Searches for information in an NIS+ table
`nismatch`	Searches for information in an NIS+ table
`niscat`	Displays the entire contents of an NIS+ table

See the manual pages for information about how to use these commands.

NIS+ Security

NIS+ uses a security authorization model that is similar to the UNIX file system model. It specifies that each item in the namespace as well as each record, each column, and each row has associated with it a set of access rights that are granted to three broad classes of principals:

- The owner of the item
- A group owner of the item
- All other principals

The specific access rights are different from the traditional read, write, and execute rights of file systems because of the nature of information services. Refer to your system manual for more information about NIS+ security.

CHAPTER

6

Administering Printing

PRINTING IN THE SOLARIS 2.X ENVIRONMENT IS COMPLETELY DIFFERENT FROM printing with SunOS 4.x. Descriptions of printers are no longer stored in the `/etc/printcap` files. Instead, they are described by entries in the `terminfo` database. If you install the binary compatibility package (BCP), you can continue to use the `lpr` and `lpc` printing commands. These commands do not, however, use the `lpr` printing system. Instead, they call the appropriate LP print service commands to perform the requested actions.

The new printing service consists of the LP print service software, any print filters (programs that process data before printing) you may provide, and the hardware (the printer, workstation, and network connections).

This chapter briefly describes the LP print service; lists the files, daemons, and logs used by the LP print service; provides steps for setting up print servers and clients; and describes the basic commands used for printing.

What's New in Printing

2.6

The Solaris 2.6 print software provides better centralized print administration than the LP print software in previous Solaris releases. With the Solaris 2.6 release, you can easily set up and manage print clients by using the NIS or NIS+ name services.

Solaris 2.6 print software features include:

- Redesign of print packages
- Print protocol adapter
- SunSoft print client
- Network printer support

The Solaris 2.6 print software limitations include:

- No support for print servers defined as S5 (the System V print protocol) in previous Solaris 2.*x* releases.
- No print filtering on print clients.

Redesign of Print Packages

The Solaris 2.6 print packages have been redesigned to provide greater flexibility and modularity of print software installation and to enable installation of a smaller print client footprint.

With the Solaris 2.6 redesign, the default is to install all the packages. Print servers require installation of all packages, including both client and server. For print clients, you can choose to install only the print client packages. PostScript filter software is provided in its own print package. Table 6–1 describes the new set of print packages.

Table 6–1 Solarit Packages

Package	Base Directory	Description
SUNWpcr	root (/)	SunSoft Print—Client
SUNWpcu	usr	SunSoft Print—Client
SUNWpsr	root (/)	SunSoft Print—LP Server
SUNWpsu	usr	SunSoft Print—LP Server
SUNWPSF	usr	PostScript Filters
SUNWscplp	usr	SunSoft Print—Source Compatibility

The following print packages have been removed from the Solaris 2.6 release:

- `SUNWlpr`—LP print service (`root`)
- `SUNWlpu`—LP print service—Client (`usr`)
- `SUNWlps`—LP print service—Server (`usr`)

Print commands from `SUNWscpu` have been moved into the `SUNWscplp` (SunSoft Print—Source Compatibility) package.

Print Protocol Adaptor

The Solaris 2.6 print protocol adapter replaces the Service Access Facility (SAF), the network listener, and `lpNet` on the inbound side of the LP spooler with a more modular and modern design.

The print protocol adapter provides the following features:

- Implementation of the complete BSD print protocol plus extended Solaris functionality.
- Multiple spooling systems can coexist on the same host and have access to the BSD print protocol.
- Third-party application developers can extend the print protocol adapter to support other printing protocols such as Apple and Novell.

The new print protocol adapter is compatible with print clients set up in previous Solaris 2.*x* releases if the BSD protocol was used to configure these clients. If the BSD protocol was not used, you must modify the previous Solaris 2.*x* print client configuration to use the BSD protocol by using Admintool, Solstice Printer Manager, or the `lpsystem` command.

SunSoft Print Client

The SunSoft Print Client software is now bundled with the Solaris 2.6 release as packages `SUNWpcr` and `SUNWpcu`. This software was previously released as an unbundled product. It was available on the Solaris Migration CD and as part of the AdminSuite 2.*x* suite of administration products.

The SunSoft Print Client software uses an NIS map, an NIS+ table, or a single file to provide centralized client administration in the Solaris 2.6 release. Features of the Print Client software include:

- Replacing the `/etc/lp` directory structure with a configuration database that can be stored in a user file (`$HOME/.printers`), a system file (`/etc/prints.conf`), an NIS map (`printers.conf.byname`), or an NIS+ FNS context.
- Using a more streamlined implementation providing reduced client overhead and quicker and more accurate responses to print status requests.
- Using the `lpset`(1M) command to create the `printers.conf` file.
- Reducing the size of the package (183 Kbyte total) from previous Solaris releases.
- Providing interoperability with the BSD protocol available with SunOS 4.*x*, Solaris 2.*x*, HPUX, and other systems, as described in RFC-1179.

Enhanced Network Printer Support

The Solaris 2.6 print software provides better support for network printers than in previous Solaris releases. Features include:

- A new interface script, `/usr/lib/lp/model/netstandard`, which is specifically designed to support network printers. This script collects the spooler and print database information needed to perform network printing and passes it to the print output module.
- A new print output module, `netpr`, is called from the netstandard interface script to print the print job. It opens a network connection to the printer, creates the correct protocol instructions, and sends the data to the printer. The `netpr` program currently supports two protocols: BSD print protocol and a TCP pass-through.
- New arguments to the `lpadmin -o` command are used to specify destination name, protocol, and time-out values for the network printer.
- Solstice AdminSuite 2.3 Printer Manager can be used to set up and manage network printers.

Print Administration Tools in the Solaris 2.6 Environment

The Solaris 2.6 printing software provides an environment for setting up and managing client access to printers on a network. The Solaris 2.6 printing software contains the following components:

- *SunSoft Print Client software*, previously available only with the Solstice AdminSuite set of administration tools, enables you to make printers available to print clients by using a name service.
- *Admintool*, a graphical user interface used to manage printing on a local system.
- *The LP print service commands*, a command-line interface used to set up and manage printers that provide additional functionality not available with the other print management tools.
- *The Solstice AdminSuite Print Manager*, a graphical user interface used to manage printers in a name service environment, is available with the Solaris 2.6 server product.

NOTE. *If you do not use Solstice Printer Manager to set up and manage printing, you must use some combination of the other components to completely manage printing in the Solaris 2.6 environment.*

Table 6–2 summarizes the features of the Solaris 2.6 printing components.

Table 6–2 Solaris 2.6 Printing Component Features

Component	Graphical User Interface	Set Up Print Clients	Manage Print Clients and Servers	NIS OR NIS+ Support
SunSoft Print Client	No	Yes	No	Yes
Admintool	Yes	Yes	Yes	No
LP commands	No	Yes	Yes	No
Solstice AdminSuite	Yes	Yes	Yes	Yes

Choosing a Method to Manage Printers

The Solaris 2.6 print client software and the Printer Manager application in Solstice AdminSuite offer a graphical solution for setting up and managing printers on a network. The advantage of the Solaris 2.6 print client software is that it supports a name service

(NIS or NIS+), which enables you to centralize print administration for a network. You can also use the `lpadmin` command to configure printers on individual systems.

Admintool provides an alternative method to install printers in the Solaris environment. Admintool is a graphical user interface for the LP print service commands that simplifies tasks for setting up and managing printers.

You must run Admintool on the system the printer is connected to because you cannot make changes to a remote system by using Admintool. When you set up a printer, Admintool makes the appropriate changes in the `/etc/printers.conf` file and `/etc/lp` directories on the system, as required. You can use Admintool to set up a system as a print server or print client only if it is running the SunOS 5.*x* operating system.

Admintool should meet most of your needs for setting up printing services. However, if you have special needs, such as writing scripts, you may want to use the LP print service commands directly.

Introducing the LP Print Service

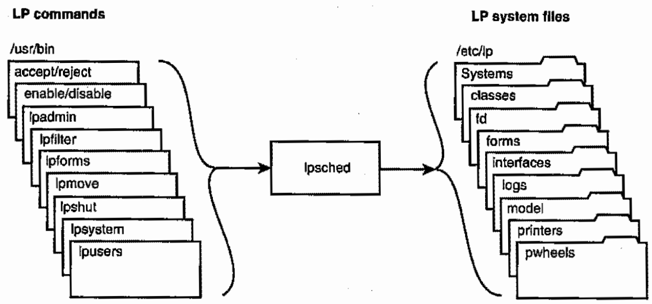
The LP print service performs the following functions:

- Administers files and schedules local print requests
- Schedules network requests
- Filters files (if necessary) so that they print properly
- Starts programs that interface with the printers
- Tracks the status of jobs
- Tracks forms mounted on the printer
- Tracks printwheels that are currently mounted
- Delivers alerts to mount new forms or different printwheels
- Delivers alerts about printing problems

Administering Files and Scheduling Print Requests

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, as shown in Figure 6–1.

Figure 6–1
The `lpsched` scheduler updates the LP system files.



2.6

In the Solaris 2.6 release, all of the LP commands have been moved from `/usr/bin` into `/usr/sbin` except for `enable` and `disable`. The `enable` and `disable` commands are located in `/usr/bin` and `/usr/lib/lp/local` and are symbolically linked to the `accept` and `reject` commands.

The `lpsched` daemon also schedules all local print requests, as shown in Figure 6–2, regardless of whether the requests are issued by users from an application or from the command line. In addition, the scheduler tracks the status of printers and filters. When a printer finishes printing a request, the scheduler schedules the next request, if there is one in the queue.

Each print client and print server must have only one LP scheduler running. The scheduler is started when a system is booted (or enters run level 2) by the control script `/etc/rc2.d/S80lp`. Without rebooting the system, you can stop the scheduler with the `/usr/sbin/lpshut` command and restart the scheduler with the `/usr/lib/lp/lpsched` command. The scheduler for each system manages its own print requests. It waits for requests issued by the LP commands and then handles the requests in an appropriate manner.

Scheduling Network Print Requests

Each print client and print server must have at least one (and maybe several) `lpNet` daemon. The `lpNet` daemon schedules network print requests. The `lpNet` daemon is also started when a system is booted. If you stop and restart the scheduler (using the lpshut and `lpsched` commands), the `lpNet` daemon is also stopped and restarted.

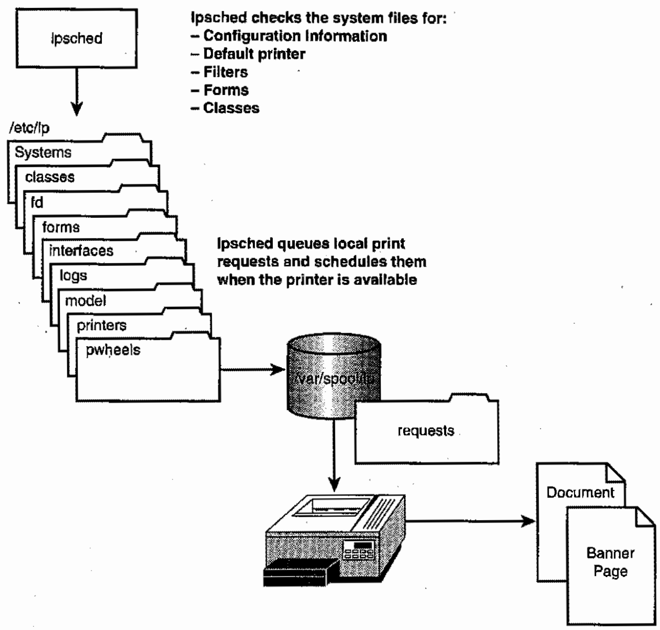
Although the Service Access Facility—`sacadm`(1M), `pmadm`(1M)— is not part of the LP print system, the `lpNet` daemon needs a configured port monitor and registered listen services to handle incoming network requests on each print server running SunOS 5.0 system software. See Chapter 3, "Administering Devices," for more information about the Service Access Facility.

2.6

NOTE. *The Solaris 2.6 release does not use the* `lpNet` *daemon to schedule network requests. Instead, network scheduling is handled by the* `inetd` *Internet services daemon. The* `inetd` *daemon listens for a request and starts* `in.lpd` *and then* `in.lpd` *looks at the request and* `loads bsd_lpsched.so`. `in.lpd` *passes the request through* `bsd_lpsched.so` *to* `lpsched` *for local printing.*

Figure 6–2

The `lpsched` *scheduler schedules local print requests.*



Filtering Print Files

Print filters are programs that convert the content of a file from one format to another so that it can be printed. In network printing, print filters process the file on the print client before it gets transmitted to the server. The LP print service uses filters to:

- Convert a file from one data format to another so that it can be printed properly on a specific type of printer
- Handle the special modes of printing that users may request using the `-y` option to the `lp` command—for example, two-sided printing, landscape printing, draft- or letter-quality printing
- Detect printer faults and notify the LP print service of them so that the print service can deliver alerts

Not every print filter can perform all of these tasks. However, because each task is printer specific, it can be implemented separately.

A print filter can be as simple or as complex as needed. SunOS 5.*x* system software provides print filters in the `/usr/lib/lp/postscript` directory to cover most PostScript printing situations where the destination printer requires the data to be in PostScript format. You have to create and add filters to the system for non-PostScript printers.

Starting the Printer Interface Program

The LP print service uses a standard printer interface program to interact with other parts of the operating system to:

- Initialize the printer port, if necessary. The standard printer interface program uses the `stty` command to initialize the printer port.
- Initialize the printer. The standard printer interface program uses the terminfo database and the TERM shell variable to find the appropriate control sequences.
- Print a banner page, if necessary.
- Print the correct number of copies specified by the print request.

The LP print service uses the standard interface program (found in the `/usr/lib/lp/model` directory) unless you specify a different one. You can create custom interface programs, but you must be careful that the custom program does not terminate the connection to the printer or interfere with proper printer initialization.

Tracking the Status of Print Jobs

The `lpsched` daemons on both the print server and the print client each keep a log of every print request that is processed and note any errors that occurred during the printing process. This log is kept in the `/var/lp/logs/lpsched` file. Every night, the `lp cron` job renames `/var/lp/logs/lpsched` to a new file `lpsched.`*n* and starts a new log file. If errors occur or jobs disappear from the print queue, you can use the log files to determine what `lpsched` has done with a print job.

Tracking Forms

The LP print service helps you track which forms are mounted on each printer and notifies you when it cannot find the description of how to print on a form. You are responsible for creating form descriptions and mounting and unmounting the paper form in each printer, either as part of setting up a printer or in response to alerts from the LP print service.

Users can specify the form on which they want a job to print. You (root) can mount a specific form and then tell the LP print service that the form is available and on which printer it is mounted. Alternatively, users can submit print requests specifying a particular form and whether the form is mounted. When the LP print service receives the request, it sends an alert message to the system administrator (root) requesting that the form be mounted.

Tracking Printwheels

The procedure for tracking printwheels is similar to the procedure for tracking forms. Some printers (usually letter-quality printers), such as daisy wheels or print balls, have removable print heads that provide a particular font or character set. A user can request a named character set. If that character set is not available, the LP print service notifies the system administrator (root) of the request. The job is stored in the print queue until the printwheel is changed.

Receiving Printing Problem Alerts

The LP print service performs sophisticated error checking. If a printing problem occurs, alerts are sent to the originator of a print request or to the system administrator, depending on the nature of the problem and what is required to fix it. Users are notified when a print request cannot be completed. Users can request notification by e-mail when a job is successfully completed. Administrators are alerted to problems with printers, and to requests for filters, forms, or character sets.

For problems that require an administrator's attention, the LP print service default is to write an alert message to the system administrator's console window (that is, to the terminal on which root is logged in).

As the system administrator, you can change the policy to receive alert messages via e-mail or a program of your choice. Or you can choose to receive no alerts when printing problems occur.

Understanding the Structure of the LP Print Service

The following sections explain the structure and directory hierarchy for the LP print service. The many files of the LP print service are distributed among seven directories, as shown in Table 6–3.

Table 6–3 Directories for the LP Print Service

Directory	Description
`/usr/bin`	The `lp`, `lpstat`, `enable`, and `disable` commands
`/etc/lp`	A hierarchy of LP configuration files

Table 6–3 Directories for the LP Print Service (continued)

Directory	Description
`/usr/share/lib`	The `terminfo` database directory
`/usr/sbin`	The LP commands
`/usr/lib/lp`	The LP daemons, directories for binary files and PostScript filters, and the model directory (which contains the standard printer interface program)
`/var/lp/logs`	The logs for LP activities
`lpsched.n`	Messages from `lpsched`
`/var/spool/lp`	The spooling directory where files are queued for printing
`requests.n*`	Information about completed print requests

*Moved from `/var/lplogs` in the Solaris 2.6 release. Note that the `lpNet` log was removed completely from the `/var/lp/logs` directory because the `lpNet` daemon is replaced by `inetd` in the Solaris 2.6 release.

User Commands

The `/usr/bin` directory contains the `lp` and `lpstat` commands, with which users submit and monitor print requests. The directory also contains the enable and disable commands, with which printers are enabled and disabled.

Users can customize their print requests by using options for the `lp` command, specifying forms, character sets, filters, titles, banners, and so forth. Table 6–4 summarizes the frequently used options for the `lp` command. These options can be used individually or combined in any order on the command line. When combining options, use a space between options and repeat the dash (`-`). For example, the following command specifies a destination printer, requests e-mail notification, and prints six copies of a file:

```
% lp -d printer-name -m -n6 filename
```

Table 6–4 Summary of Frequently Used *lp* Command Options

Option	Name	Description
`-d`	Destination	Specifies a destination printer by name.
`-m`	Mail	Sends e-mail to the user who submitted the print request when the file has been printed successfully.
`-n`	Number	Specifies the number of copies to be printed.
`-t`	Title	Specifies a title for a print request (printed only on the banner page).
`-o nobanner`	Option	Suppresses printing of the banner page for an individual request.

Table 6–4 Summary of Frequently Used *lp* Command Options (continued)

-h	Header	Puts a header on each page of the print request.
c	Copy	Copies the file before printing.
-w	Write	Writes a message to root's terminal when the file has printed successfully.

See the `lp(1)` manual page for a complete list of options.

LP Configuration Files

The scheduler stores configuration information in LP configuration files located in the `/etc/lp` directory. These configuration files serve the function of the `/etc/printcap` file in SunOS 4.1. You can check the contents of these files, but you should not edit them directly. The LP administrative commands provide input for the configuration files in the `/etc/lp` directory. The `lpsched` daemon administers and updates the configuration files. You should use the administrative commands any time you need to update any configuration file. Table 6–5 describes the contents of the `/etc/lp` directory.

Table 6–5 Contents of the */etc/lp* Directory

File	Type	Description
`alerts*`	Directory	Contains `form`, `jobdone`, `printer`, and `sendMsg` scripts for sending print system alerts to users.
`classes`	Directory	Contains files that identify classes provided by the `lpadmin -c` command.
`fd`	Directory	Contains descriptions of existing filters.
`filter.table*`	File	Print filter lookup table.
`forms`	Directory	Location to put files for each form. Initially, this directory is empty.
`interfaces`	Directory	Contains printer interface program files.
`logs`	Link to `/var/lp/logs`	Contains log files of printing activities.
`model`	Link to `/usr/lib/lp/model`	Contains the standard printer interface program.
`printers`	Directory	Contains directories for each (remote or local) printer setup. Each directory contains configuration information and alert files for an individual printer.
`pwheels`	Directory	Contains printwheel or cartridge files.

*New in Solaris 2.6. Note that the Systems ASCII file is no longer a part of the `/etc/lp` directory in the Solaris 2.6 printing environment

The printers directory has a subdirectory for each printer (local or remote) known to the system. This example shows the subdirectories for the printers pinecone and sparc1:

```
%ls -l /etc/lp/printers
drwxrwxr-x 2 lp lp 512 Jan 23 23:53 pinecone
drwxrwxr-x 2 lp lp 512 Jan 11 17:50 sparc1
```

Within each of the printer-specific directories, the following files can describe the printer:

- alert.sh = Shell to execute in response to alerts
- alert.vars = Alert variables
- configuration = Configuration file
- users.deny = List of users to deny printer access
- comment = Printer description

A typical configuration file for the printer pinecone, /etc/lp/printers/pinecone/configuration, would look like this:

```
Banner: on: Always
Content types: PS
Device: /dev/term/b
Interface: /usr/lib/lp/model/standard
Printer type: PS
Modules: default
```

Printer Definitions

The LP print service uses the terminfo database to initialize a local printer; to establish a selected page size, character pitch, line pitch, and character set; and to communicate the sequence of codes to a printer. The terminfo database directory is located in /usr/share/lib.

Each printer is identified in the terminfo database with a short name. If necessary, you can add entries to the terminfo database, but it is a tedious and time-consuming process. Describing how to add entries to the terminfo database is beyond the scope of this book.

Daemons and LP Internal Files

The /usr/lib/lp directory contains daemons and files used by the LP print service, as described in Table 6–6.

Table 6–6 Contents of the /usr/lib/lp Directory

File	Type	Description
bin	Directory	Contains files for generating printing alerts, slow filters, and queue management programs.
local*	Directory	Contains LP executables for the local system.

Table 6–6 Contents of the */usr/lib/lp* Directory (continued)

File	Type	Description
`locale*`	Directory	Contains locale information.
`lpsched`	Daemon	Manages scheduling of LP print requests.
`model`	Directory	Contains the standard printer interface program.
`postscript`	Directory	Contains all PostScript filter programs provided by the SunOS 5.0 LP print service. These filters come with descriptor files in the `/etc/lp/fd` directory that tell the LP print service the characteristics of the filters and where to locate them.

*New in Solaris 2.6. Note that the `lpNet` daemon and lpdata executable files are no longer a part of the `/usr/lib/lp` directory in the Solaris 2.6 printing environment.

LP Administrative Commands

The commands used to set up and administer the LP print service are in the `/usr/sbin` directory, as shown in Table 6–7.

Table 6–7 The LP Commands in the */usr/sbin* Directory

Command	Purpose
`accept/reject`	Accepts print requests into the printer's queue or rejects print requests.
`lpadmin`	Defines printer names, printer types, file content types, print classes, printer devices, and printer comments; removes printers or print classes; specifies fault recovery, interface programs (either custom or standard), printing options, banner/no banner; mounts forms; mounts printwheels or cartridges; defines allow and deny user lists.
`lpfilter`	Adds, changes, deletes, and lists filters.
`lpforms`	Adds, changes, deletes, and lists forms.
`lpmove`	Moves queued print requests from one printer to another
`lpshut`	Halts the LP print service (the command lpsched, which starts the LP print service, is in the `/usr/lib/lp` directory)
`lpsystem`	Registers print servers and print clients with the LP print service
`lpusers`	Sets queue priorities for users

Log Files

The LP print service maintains two sets of log files: a list of current requests that are in the print queue (`/var/spool/lp`) and an ongoing history of print requests (`/var/lp/logs/requests`).

Print Queue Logs

The scheduler for each system keeps a log of print requests in the directories `/var/spool/lp/requests/`*`system`* and `/var/spool/lp/tmp/`*`system`*. Each print request has two files (one in each directory) that contain information about the request. The information in the `/var/spool/lp/requests/`*`system`* directory can be accessed only by `root` or `lp`. The information in the `/var/spool/lp/tmp/`*`system`* directory can be accessed only by `root`, `lp`, or the user who submitted the request.

The following example shows the contents of the `/var/spool/lp/tmp/pine` directory. See Table 6–8 later in the chapter for an explanation of the LP requests log codes.

```
pine% ls /var/spool/lp/tmp/pine
20-0 21-0
pine% cat 21-0
C 1
D slw2
F /etc/default/login
P 20
t simple
U winsor
s 0x1000
```

These files remain in their directories only as long as the print request is in the queue. Once the request is finished, the information in the files is combined and appended to the file `/var/lp/logs/requests`, which is described in the next section.

Use the information in the `/var/spool/lp` logs if you need to track the status of a print request that is currently in the queue.

History Logs

The LP print service records a history of printing services in three log files: `lpNet`, `lpsched`, and `requests`. These log files are located in the `/var/lp/logs` directory. You can use the information in these logs to diagnose and troubleshoot printing problems. Here is an example of the contents of the `/var/lp/logs` directory:

```
# cd /var/lp/logs
# ls
lpsched.1    requests    requests.2
lpsched     lpsched.2    requests.1
#
```

The files with the `.1` and `.2` suffixes are copies of the previous day's logs. Each day, the `lp cron` job cleans out the `lpsched` and requests log files; it keeps copies for two days.

The most important log file for troubleshooting is the `lpsched` log, which contains information about local printing requests.

The requests log contains information about print requests that have completed and are no longer in the print queue. Once a request is finished printing, the information in the `/var/spool/lp` log files is combined and appended to the `/var/lp/logs/requests` file.

The requests log has a simple structure, and you can extract data by using common UNIX shell commands. Requests are listed in the order they are printed and are separated by lines showing their request IDs. Each line below the separator line is marked with a single letter that identifies the kind of information contained in that line. Each letter is separated from the data by a single space.

Here is an example of the contents of a requests log:

```
# pwd
/var/lp/logs
# tail requests.2
= slw2-20, uid 200, gid 200, size 5123, Mon Nov 18 01:24:01 EST 1991
z slw2
C 1
D slw2
F /etc/motd
P 20
t simple
U irving
s 0x0100
#
```

Table 6–8 shows the codes in the LP requests log.

Table 6–8 Codes in the LP Requests Log

Character	Content of Line
=	The separator line. It contains the following items, separated by commas: the request ID, the user ID and group IDs of the user, the total number of bytes in the original (unfiltered) files, and the time when the request was queued. The user ID, group IDs, and file size are preceded by the words `uid`, `gid`, and `size`, respectively.
C	The number of copies printed.
D	The printer or class destination, or the word any.
F	The name of the file printed. The line is repeated for each file printed; files were printed in the order shown.
f	The name of the form used.
H	One of three types of special handling: `resume`, `hold`, and `immediate`. The only useful value found in this line will be `immediate`.
N	The type of alert used when the print request was successfully completed. The type is the letter *M* if the user was notified by e-mail or *W* if the user was notified by a message to the terminal.
O	The `-o` options.
P	The priority of the print request.
p	The list of pages printed.
r	This single-letter line is included if the user asks for raw processing of the files (the `-r` option of the `lp` command).

Table 6–8 Codes in the LP Requests Log (continued)

Character	Content of Line
S	The character set or printwheel (or cartridge) used.
s	The outcome of the request, shown as a combination of individual bits expressed in hexadecimal form. Although several bits are used internally by the print service, the most important bits are listed here: 0x0004 Slow filtering finished successfully. 0x0010 Printing finished successfully. 0x0040 The request was canceled. 0x0100 The request failed filtering or printing.
T	The title placed on the banner page.
t	The type of content found in the file(s).
U	The name of the user who submitted the print request.
x	The slow filter used for the print request.
Y	The list of special modes to give to the print filters used to print the request.
z	The printer used for the request. This printer differs from the destination (the D line) if the request was queued for any printer or a class of printers, or if the request was moved to another destination.

Spooling Directories

Files queued for printing are stored in `/var/spool/lp` directory until they are printed. Table 6–9 shows the contents of the `/var/spool/lp` directory.

Table 6–9 Contents of the */var/spool/lp* Directory

File	Type	Description
SCHEDLOCK	File	Lock file for the scheduler. Check for this file if the scheduler dies and won't restart.
`admins`	Directory	Linked to `/etc/lp`.
`bin`	Directory	Linked to `/usr/lib/lp/bin`.
`fifos`	Directory	Contains pipes that convey networked print requests to and from the `lpNet` daemon.
`logs`	Link	Linked to `../lp/logs` where completed print requests are logged.
`model`	Link	Linked to `/usr/lib/lp/model`.
`requests`	Directory	Contains a directory for each configured printer where print requests are logged until printed. Users cannot access this log.
`system`	Directory	Contains a print status file for the system.

Table 6–9 Contents of the */var/spool/lp* Directory (continued)

File	Type	Description
`temp`	Link	Linked to `/var/spool/lp/tmp/`*`printer-name`*, which contains the spooled requests.
`tmp`	Directory	Contains a directory for each configured printer where print requests are logged until printed. Changes to existing print requests are also recorded in this log.

Using the SunSoft Print Client

2.6

This section describes how the SunSoft print client works. The SunSoft print client is now provided as part of the Solaris 2.6 release. It was available previously only as an unbundled product.

A system becomes a SunSoft print client when you install the SunSoft print client software and enable access to remote printers on the system. The SunSoft print client commands have the same names and produce the same output as the print commands of the previous Solaris releases.

The Solaris 2.6 SunSoft print client commands use a greater number of options to locate printer configuration information than in the previous Solaris operating environment and the client communicates directly with the print server.

The print command locates a printer and printer configuration information in the following sequence:

1. It checks whether the user specified a destination printer name or printer class in one of the three valid styles.
2. If the user did not specify a printer name or class in a valid style, the command checks the user's `PRINTER` or `LPDEST` environment variable for a default printer name.
3. If neither environment variable for the default printer is defined, the command checks the `.printers` file in the user's home directory for the `_default` printer alias.
4. If the command does not find a `_default` printer alias in the `.printers` file, it then checks the SunSoft print client's `/etc/printers.conf` file for configuration information.
5. If the printer is not found in the `/etc/printers.conf` file, the command checks the name service (NIS or NIS+) if any.

The client does not have a local print queue. The SunSoft print client sends its requests to the queue on the specified print server. The client writes the print request to a temporary spooling area only if the print server is not available or if an error occurs. This streamlined path to the server decreases the print client's use of resources, reduces the chance for printing problems, and improves performance.

Printer Configuration Resources

This section describes the resources that the SunSoft print client commands use to locate printer names and printer configuration information.

The SunSoft print client commands can use a name service, which is a shared network resource, for storing printer configuration information for all printers on the network. The name service (either NIS or NIS+) simplifies the maintenance of printer configuration information. When you add a printer in the name service, all SunSoft print clients on the network can access it.

The SunSoft print client software locates printers by checking the following resources:

- Atomic, POSIX, or context-based printer name or class
- User's `PRINTER` or `LPDEST` environment variable for the default printer
- User's `.printers` file for a printer alias
- SunSoft print client's `/etc/printers.conf` file
- Name service (NIS or NIS+)

Submitting Print Requests

Users submit a print request from a SunSoft print client by using either the `lp` or `lpr` command. The user can specify a destination printer name or class in any of three styles:

- *Atomic style*, which is the print command and option followed by the printer name or class and the file name: `lp -d` ***`printer-name file-name`***
- *POSIX style*, which is the print command and option followed by `server:printer` and the file name: `lpr -P` ***`server-name:printer-name file-name`***
- *Context-based style*, as defined in the *Federated Naming Service Guide* in the *Solaris 2.6 Software Developer AnswerBook*: `lpr -d` ***`department-name/service-name/printer-name file-name`***

Summary of the SunSoft Print Client Process

The following list summarizes how the SunSoft print client process works:

1. A user submits a print request from a SunSoft print client by using a SunSoft print client command.
2. The print client command checks a hierarchy of print configuration resources to determine where to send the print request.

3. The print client command sends the print request directly to the appropriate print server. A print server can be any server that accepts BSD printing protocol, including SVR4 (LP) print servers and BSD print servers such as the SunOS 4.x BSD print server.
4. The print server sends the print request to the appropriate printer.
5. The print request is printed.

Setting Up Printing Services

You need to decide which systems will have local printers directly cabled to them and which systems will connect to printers over the network. The system that has the printer connected to it and makes the printer available to other systems is called a *print server.* The system that has its printing needs met by a print server is called a *print client.*

Setting up printing services is comprises of three basic tasks:

- Setting up local printers
- Setting up print servers
- Setting up print clients

You can have the following client/server combinations, as illustrated in Figure 6–3:

- SunOS 5.0 print clients with a SunOS 5.0 print server
- SunOS 5.0 and SunOS 4.1 print clients with a SunOS 5.0 print server
- SunOS 5.0 and SunOS 4.1 print clients with a SunOS 4.1 print server

This section describes how to set up a SunOS 5.*x* print client.

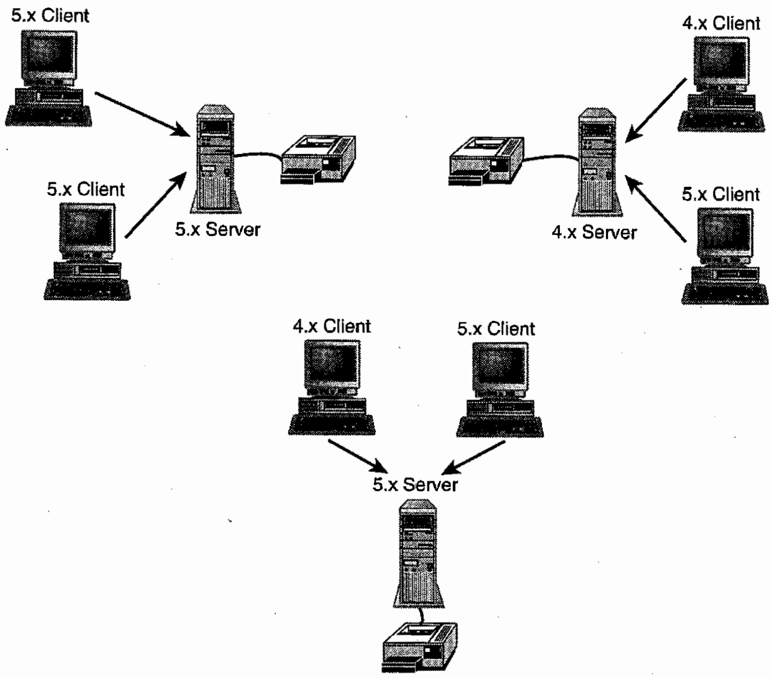
NEW Setting Up a Local Printer by Using Admintool

You can use Admintool to set up access to a printer or to configure a local printer. To use the Admintool: Printers windows, you must be a member of the UNIX sysadmin group (GID 14).

To set up a print client, you need this information:

- Printer name
- Print server name
- Description
- Whether this is the default printer for the print client system

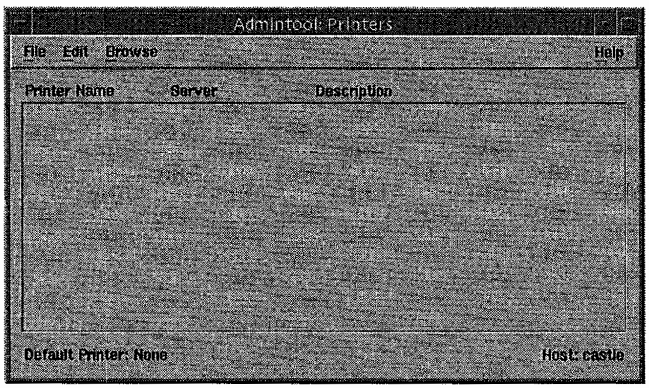
Figure 6–3
Print client/server configurations.



Use the following steps to access a network printer:

1. Type `admintool&` and press Return to start Admintool (if necessary).
2. From the Browse menu, choose Printers. The Admintool: Printers window is displayed, as shown in Figure 6–4.

Figure 6–4
The Admintool: Printers window.



3. From the Edit menu, choose Add and Access to Printer. The Admintool: Add Access To Printer window is displayed, as shown in Figure 6–5.

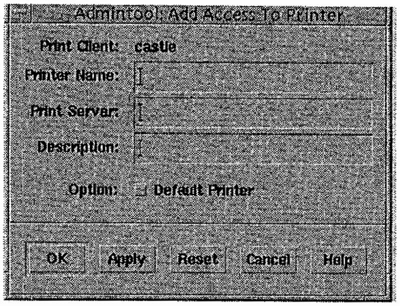


Figure 6–5
The Admintool: Add Access To Printer window.

4. Enter the printer name, print server name, and description.
5. If you want this printer to be the default printer, click on the Default Printer check box.
6. Click on the OK button. The printer is configured and the printer information is added to the list in the Admintool: Printers window.

To set up a local printer, you need this information:

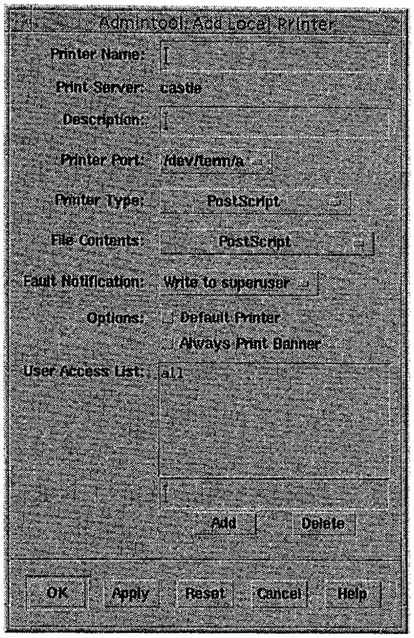
- Printer name
- Print server name
- Description
- Printer port
- Printer type
- File contents
- Type of fault notification
- Whether this is the default printer for the print client system
- Whether you want to always print a banner page
- Whether to specify a custom user access list

Use the following steps to add a local printer:

1. Type **admintool&** and press Return to start Admintool (if necessary) .
2. From the Browse menu, choose Printers.

3. From the Edit menu, choose Add and Local Printer. The Admintool: Add Local Printer window is displayed, as shown in Figure 6–6.

Figure 6–6
The Admintool: Add Local Printer window.



4. Enter the printer name and description.
5. Choose the printer port, printer type, file contents, and fault notification.
6. If you want to specify this printer as the default printer, click on the Default Printer check box.
7. If you want to always print the banner, click on the Always Print Banner check box.
8. (If necessary) modify the user access list.
9. When you have completed all of the setup, click on the OK button. The printer is configured and the printer information is added to the list in the Admintool: Printers window, as shown in Figure 6–7.

NEW

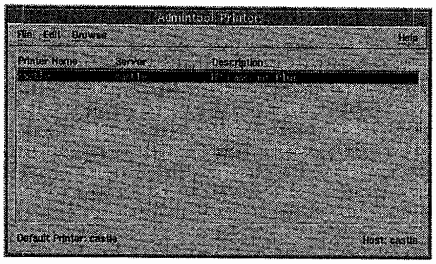
Setting Up a Print Server (Solaris 2.*x*)

This section describes how to add a network printer by using LP commands.

You need this information to set up a Solaris 2.*x* print server:

- Printer name.
- Server name.

Figure 6–7
The Admintool: Printers window.



- Network printer access name, sometimes qualified by a port name.
- IP address for the printer.
- Protocol. The print subsystem uses the BSD print protocol and raw TCP to communicate with the printer. In general, the TCP protocol is more generic. The printer vendor documentation will provide the information about which protocol to use.
- Timeout value. The `timeout` option specifies the amount of time in seconds to wait between successive attempts to connect to the printer. The default is 10 seconds. Some printers have a long warm-up time and a longer timeout is advised.
- Printer type. The default is PostScript.
- File content type. The default is PostScript
- Fault notification policy for this print server. The default is write to superuser.

Follow these steps to set up a print server:

1. Connect the printer to the network and turn on the power to the printer. Consult the printer vendor installation documentation for information about hardware switches and cabling requirements. Get an IP address and select a name for the printer node. These procedures are equivalent to those for adding any new node to the network.
2. Become superuser.
3. Type `lpadmin -p` ***`printer-name`*** `-v /dev/null` and press Return. This step defines the printer name and the port device the printer uses. The device to use is `/dev/null`.
4. Type `lpadmin -p` ***`printer-name`*** `-i /usr/lib/lp/model/netstandard` and press Return. This step defines the interface script the printer uses.
5. Type `lpadmin -p` ***`printer-name`*** `-o dest=`***`access-name:port -o`*** `protocol=`***`protocol -o`*** `timeout=`***`value`*** and press Return. This step sets the printer destination, protocol, and timeout values.
6. Type `lpadmin -p` ***`printer-name`***`-I` ***`content-type`*** `-T` ***`printer-type`*** and press Return. This step specifies the file content type and the printer type.
7. Type `cd /etc/lp/fd` and press Return. You are in the filter directory.

8. Type `for filter in *.fd;do` and press Return.
9. At the > prompt, type `name='basename $filter .fd'` and press Return.
10. At the > prompt, type `lpfilter -f $name -F $filter` and press Return.
11. At the > prompt, type `done` and press Return. You have installed filters.
12. Type `accept` ***printer-name*** and press Return. The printer is able to accept requests.
13. Type `enable` ***printer-name*** and press Return. The printer is enabled to print the requests.
14. Type `lpstat -p` ***printer-name*** and press Return. This step verifies that the printer is configured correctly.
15. Set up any print clients that you want to be able to access this printer.

The following example sets up a print server by using the following information:

- Printer name: `seachild`
- Network printer access name: `nimquat:9100`
- Protocol: `tcp`
- Timeout: `5`
- Interface: `/usr/lib/lp/model/netstandard`
- Printer type: `PS`
- Content types: `postscript`
- Device: `/dev/null`

```
# lpadmin -p seachild -v /dev/null
# lpadmin -p seachild -i /usr/lib/lp/model/netstandard
# lpadmin -p seachild -o dest:nimquat:9100 -o protocol=tcp -o timeout=5
# lpadmin -p seachild -I postscript -T PS
# cd /etc/lp/fd
# for filter in *.fd;do
   > name='basename $filter .fd'
   > lpfilter -f $name -F $filter
   > done
# accept castle
destination ' 'castle' ' now accepting requests
# enable castle
printer ' 'castle' ' now enabled
# lpadmin -p castle -D "PostScript printer"
# lpstat -p castle
  printer castle is idle. enabled since Mon Sep 15 08:45 1997.
available
```

Setting Up a PostScript Print Client by Using LP Commands

This section describes how to set up a SunOS 5.0 print client to print on a SunOS 4.*x* print server that has a PostScript printer installed. You must complete the following tasks so the print client can use the printer connected to the print server:

- Identify the printer and server system to which the printer is connected.
- Define the characteristics of the printer.
- Set up the print filters.

You must have a network that enables access between systems to set up print clients. If your network is running NIS or NIS+, follow the appropriate procedures for enabling access between systems. If your network is not running NIS or NIS+, you must include the Internet address and system name for each print client in the `/etc/hosts` file on the print server. You must also include the Internet address and system name of the print server in the `/etc/hosts` file of each print client system.

Before you start, you need superuser privileges on the print client system. You also need the name of the printer and the name of the print server system. You do not need to specify a printer type or file content type for a printer client. If no printer type is specified, the default is `unknown`. If no file content type is specified, the default is `any`, which allows both PostScript and ASCII files to be printed on a PostScript printer.

To set up a PostScript print client:

1. Become superuser on the print client system.
2. Type **`lpsystem -t bsd`** ***`server-system-name`*** and press Return. The print server system is identified as a BSD (SunOS 4.*x*) system.
3. Type **`lpadmin -p`** ***`printer-name`*** **`-s`** ***`server-system-name`*** and press Return. The printer and the server system name are registered with the client LP print service.
4. Type **`cd /etc/lp/fd`** and press Return.
5. Type **`lpfilter -f download -F download.fd`** and press Return.
6. Type **`lpfilter -f dpost -F dpost.fd`** and press Return.
7. Type **`lpfilter -f postio -F postio.fd`** and press Return.
8. Type **`lpfilter -f postior -F postior.fd`** and press Return.
9. Type **`lpfilter -f postprint -F postprint.fd`** and press Return.
10. Type **`lpfilter -f postreverse -F postreverse.fd`** and press Return. The PostScript filters are installed.
11. Type **`accept`** ***`printer-name`*** and press Return. The printer is now ready to begin accepting (queuing) print requests.

12. Type `enable` ***printer-name*** and press Return. The printer is now ready to process print requests in the print queue.
13. (This step is optional but recommended.) Type `lpadmin -d` ***printer-name*** and press Return. The printer you specify is established as the default printer for the system. You should define a default printer even if there is only one printer configured for a system.
14. Type `lpstat -t` and press Return. Check the messages displayed to verify that the printer is accepted and enabled.
15. Type `lp` ***file-name*** and press Return. If you have not specified a default printer, type `lp -d` ***printer-name file-name*** and press Return. The file you choose is sent to the printer.

If you want to set up SunOS 5.0 print clients and print servers in addition to setting up the LP print system, you must also configure the port monitors using the Service Access Facility. See Chapter 3, "Administering Devices," for information on how to set up the port monitors. If you use the Solaris 2.1 Printer Manager, the port monitors are configured for you automatically. See Appendix A, "Major Differences: SunOS 4.*x* Versus SunOS 5.*x* Operating Systems," for information about the Printer Manager. To set up a SunOS 5.0 print client, in place of step 2 in the procedure described above, type `lpsystem` ***server-system-name*** and press Return. The print server system is identified as a SunOS 5.*x* system.

Using Printing Commands

The following sections describe how to use `lp` to submit requests from a command line. When a request is made, the LP print service places it in the queue for the printer, displays the request ID number, and then redisplays the shell prompt. The `lp` command has many options that can modify the printing process, as summarized in Table 6–4 earlier in the chapter. For a complete list of options, see the `lp`(1) manual page.

Printing to the Default Printer

When the LP print service is set up with a default printer, users can submit print requests without typing the name of the printer. Type `lp` ***file-name*** and press Return. The file specified is placed in the print queue of the default printer, and the request ID is displayed.

The following example will print the `/etc/passwd` file:

```
pine% lp /etc/passwd
request id is pinecone-8 (1 file)
pine%
```

Printing to a Printer by Name

Whether or not a default printer has been designated for your system, you can submit print requests to any printer that is configured for your system. To submit a print request to an individual printer, type `lp -d` ***printer-name file-name*** and press Return. The file specified is placed in the print queue of the destination printer, and the request ID is displayed.

The following example will print the `/etc/passwd` file on the printer `acorn`:

```
pine% lp -d acorn /etc/passwd
request id is acorn-9 (1 file)
pine%
```

If you submit a request to a printer that is not configured on your system, an information message is displayed, as shown in this example:

```
pine% lp -d thorn /etc/passwd
UX:lp: ERROR: Destination "thorn" is unknown to the
              LP print service.
pine%
```

Requesting Notification When a File Is Done Printing

When you submit a large file to be printed, you may want the LP print service to notify you when printing is complete. You can request that the LP print service notify you either via an e-mail message or via a message to your console window.

To request e-mail notification, use the `-m` option when you submit the print request. Type `lp -m` ***file-name*** and press Return.

To request that a message be written to your console window, use the `-w` option when you submit the print request. Type `lp -w` ***file-name*** and press Return.

Printing Multiple Copies

You can print more than one copy of a file. When you request more than one copy, the file is printed the number of times you specify by using the `-n` option to the `lp` command. The print request is considered as one print job, and only one header page is printed. To request multiple copies, type `lp -n`***number file-name*** and press Return.

The following example will print four copies of the `/etc/passwd` file:

```
pine% lp -n4 /etc/passwd
request id is pinecone-9 (1 file)
pine%
```

Determining Printer Status

Use the lpstat command to find out about the status of the LP print service. You can check on the status of your own jobs in the print queue, determine which printers are available for you to use, or determine request IDs of your jobs if you want to cancel them.

The Status of Your Print Requests

To find out the status of your own spooled print requests, type **lpstat** and press Return. A list of the files that you have submitted for printing is displayed.

In this example, on the system pine, one file is queued for printing to the printer pinecone:

```
pine% lpstat
pinecone-10            fred            1261   Mar 12 17:34 on pine
pine%
```

The lpstat command displays one line for each print job, showing the request ID and followed by the user who spooled the request, the output size in bytes, and the date and time of the request.

Availability of Printers

To find out which printers are configured on your system, type **lpstat -s** and press Return. The status of the scheduler is displayed, followed by the default destination and a list of the systems and printers that are available to you.

In this example, on the system elm, the scheduler is running, the default printer is pinecone, and two network printers are available:

```
elm% lpstat -s
scheduler is running
system default destination: pinecone
system for pinecone: pine
system for acorn: oak
elm%
```

Display of All Status Information

The -t option for lpstat gives you a short listing of the status of the LP print service. To display a short listing of all status information, type **lpstat -t** and press Return. All available status information is displayed.

In this example, there are no jobs in the print queue. When files are spooled for printing, the status of those print requests is also displayed:

```
elm% lpstat -t
scheduler is running
system default destination: tom
system for slw2: bertha
system for slw1: bertha
device for tom: /dev/term/b
slw2 accepting requests since Mon May 11 11:01:54 EDT 1992
slw1 accepting requests since Wed May 27 16:26:38 EDT 1992
```

```
tom accepting requests since Wed Jun  3 14:25:41 EDT 1992
printer slw2 is idle. enabled since Mon May 11 11:01:55 EDT 1992. available.
printer slw1 is idle. enabled since Wed May 27 16:26:38 EDT 1992. available.
printer tom is idle. enabled since Wed Jun  3 14:25:41 EDT 1992. available.
character set usascii
character set english
character set finnish
character set japanese
character set norwegian
character set swedish
character set germanic
character set french
character set canadian_french
character set italian
character set spanish
character set line
character set security
character set ebcdic
character set apl
character set mosaic
elm%
```

The `-l` option for `lpstat`, when used with one of the other options, gives you a long listing of the status of the LP print service. To display a long listing of all status information, type **`lpstat -tl`** and press Return. All available status information is displayed.

In this example for the same system, additional information is displayed. When files are spooled for printing, the status of those print requests is also displayed:

```
{:44} lpstat -tl
scheduler is running
system default destination: tom
system for slw2: bertha
system for slw1: bertha
device for tom: /dev/term/b
slw2 accepting requests since Mon May 11 11:01:54 EDT 1992
slw1 accepting requests since Wed May 27 16:26:38 EDT 1992
tom accepting requests since Wed Jun  3 14:25:41 EDT 1992
printer slw2 is idle. enabled since Mon May 11 11:01:55 EDT 1992. available.
        Content types: any
        Printer types: unknown
        Description:
        Users allowed:
                 (all)
        Forms allowed:
                (none)
        Banner not required
        Character sets:
                 (none)
        Default pitch:
        Default page size:

printer slw1 is idle. enabled since Wed May 27 16:26:38 EDT 1992. available.
        Content types: simple
        Printer types: unknown
        Description: Located in ia lab
```

```
        Users allowed:
                (all)
        Forms allowed:
                (none)
        Banner not required
        Character sets:
                (none)
        Default pitch:
        Default page size:

printer tom is idle. enabled since Wed Jun  3 14:25:41 EDT 1992. available.
        Form mounted:
        Content types: PS
        Printer types: la100
        Description: hi
        Connection: direct
        Interface: /usr/lib/lp/model/standard
        After fault: continue
        Users allowed:
                (all)
        Forms allowed:
                (none)
        Banner required
        Character sets:
                usascii
                english
                finnish
               japanese
              norwegian
                swedish
               germanic
                 french
        canadian_french
                italian
                spanish
                   line
               security
                 ebcdic
                    apl
                 mosaic
        Default pitch: 10 CPI 6 LPI
        Default page size: 132 wide 66 long
(More information not shown in this example)
```

Display of Status for Printers

You can request printer status information for individual printers by using the `-p` option to `lpstat`. This option shows whether the printer is active or idle, when it was enabled or disabled, and whether it is available to accept print requests.

To request status for all printers on a system, type **`lpstat -p`** and press Return. In this example, two printers are idle, enabled, and available. If one of those printers had jobs in the print queue, those jobs would also be displayed:

```
elm% lpstat -p
printer pinecone is idle. enabled since Wed Jan  1 18:20:22 PST 1992. available.
printer acorn is idle. enabled since Mon Mar  2 15:53:44 PST 1992. available.
elm%
```

To request status for an individual printer by name, type **lpstat -p** ***printer-name*** and press Return.

Display of Printer Characteristics

If you want to see all of the characteristics for a printer, use the `-p` option together with the `-l` (long) option to `lpstat`. This command can be especially useful for finding the printer type and content type.

To show characteristics for all printers on a system, type **lpstat -p -l** and press Return. A table shows all the configuration information that is used by the LP print service for each printer.

In this example, all the fields are blank except for the content type and the printer type of the printer `pinecone`:

```
elm% lpstat -p pinecone -l
printer pinecone is idle. enabled since Wed Jan  1 18:20:22 PST 1992. available.
        Content types: PS
        Printer types: PS
        Description:
        Users allowed:
                (all)
        Forms allowed:
                (none)
        Banner not required
        Character sets:
                (none)
        Default pitch:
        Default page size:
elm%
```

Summary Table of *lpstat* Options

You can request different types of printing status information by using the `lpstat` command. Table 6–10 summarizes the frequently used options for the `lpstat` command. Use these options individually or combine them in any order on the command line. When you combine options, use a space between options and repeat the hyphen (`-`). For example, to show a long list of status for an individual printer, type **lpstat -p** ***printer-name*** **-l** and press Return. See the `lpstat`(1) manual page for a complete list of options.

Table 6–10 Summary of Frequently Used Options to the *lpstat* Command

Option	Description
`-a`	Accept. Show whether print destinations are accepting requests.
`-c`	Class. Show classes and their members.
`-d`	Destination. Show default destination.
`-f`	Forms. Show forms.
`-o`	Output. Show status of output.
`-p [list][-D][-l]`	Printer/description/long list. Show status of printers.
`-r`	Request. Request scheduler status.
`-R`	Show position of job in the queue.
`-S`	Sets. Show character sets.
`-s`	Status. Show status summary.
`-u [username]`	User. Show requests by user.
`-v`	Show devices.

Canceling a Print Request

Use the `cancel` command to cancel a print request while it is in the queue or while it is printing. To cancel a request, you need to know its request ID. The request ID always includes the name of the printer, a hyphen, and the number of the print request. When you submit the print request, the request ID is displayed. If you do not remember your request ID, type **`lpstat`** and press Return. Only the user who submitted the request, or someone logged in as `root` or `lp`, can cancel a print request.

Canceling of Print Request by ID Number

To cancel a print request, type **`cancel`** ***`request-ID`*** and press Return. A message is displayed telling you that the request is canceled. The next job in the queue begins printing.

In this example, two print requests are canceled:

```
elm% cancel pinecone-3 pinecone-4
request "pinecone-3" cancelled
request "pinecone-4" cancelled
elm%
```

Canceling a File That Currently Is Printing by Printer Name

You can also cancel just the job that currently is printing (if you submitted it) by typing the printer name in place of the request ID. Type **`cancel`** ***`printer-name`*** and press Return.

A message is displayed telling you that the request is canceled. The next job in the queue begins printing.

In this example, the currently printing request has been canceled:

```
elm% cancel pinecone
request "pinecone-3" cancelled
elm%
```

As system administrator, you can log in as `root` or `lp` and cancel the currently printing request by using the printer name as the argument for the cancel command.

CHAPTER

7

Administering User Accounts and Groups

NEW

THIS CHAPTER DESCRIBES HOW TO SET UP AND ADMINISTER USER ACCOUNTS AND groups by using Admintool. You can use Admintool to edit only files in the local `/etc` directory. Functionality that enabled you to edit NIS+ databases and view NIS maps from Admintool has been moved into the unbundled Solstice AdminSuite product.

NOTE. *Solaris 2.*x *provides the following SVR4 useradd commands:* `useradd`, `userdel`, `usermod`, `groupadd`, `groupmod`, *and* `groupdel`. *Because these commands are only minimally network-aware, they are not described in this chapter. If you want to use these commands to administer user accounts on standalone systems, refer to the appropriate manual pages.*

Tools for Adding and Administering User Accounts

NEW

Table 7–1 lists the recommended tools for adding and administering user accounts on systems with a graphics monitor running an X Window system such as CDE or OpenWindows.

Table 7–1 Recommended Tools for Administering User Accounts

Environment	Recommended Tool	Availability/Documentation
Remote and/or local systems in a networked, name service (NIS, NIS+) environment	User and Group Manager (graphical user interface) from the Solstice AdminSuite	Available as a separate product. Refer to the *Solstice AdminSuite 2.3 Administration Guide.*
Local system	Admintool (graphical user interface)	Provided with Solaris 2.6. Instructions provided in this chapter.
Command-line	Terminal window (CDE Environment) or shell tool or command tool (OpenWindows Environment)	Provided with Solaris 2.6. See Table 7–2 for a list of available commands. Refer to the appropriate manual pages.

You can add and administer user accounts from the command line if you choose not to use Admintool or the Solstice AdminSuite. Table 7–2 lists the Solaris commands you can use to administer user accounts.

Table 7–2 Using Solaris Commands to Administer User Accounts

Task	Name Service	Commands
Add a user account	NIS +	`nistbladm` `nisclient`
	NIS	`useradd` `make`

Table 7–2 Using Solaris Commands to Administer User Accounts (continued)

Task	Name Service	Commands
	None	`useradd`
Modify a user account	NIS+	`nistbladm`
	NIS	`usermod` `make`
	None	`usermod`
Delete a user account	NIS+	`nistbladm` `nisclient`
	NIS	`userdel` `make`
	None	`userdel`
Set up user account defaults	NIS+	`not available`
	NIS	`useradd -D` `make`
	None	`useradd -D`
Disable a user account	NIS+	`nistbladm`
	NIS	`passwd -r nis -l` `make`
	None	`passwd -r files -l`
Change a user's password	NIS+	`passwd -r nisplus`
	NIS	`passwd -r nis`
	None	`passwd -r files`
Sort user accounts	NIS+	`niscat` `sort`
	NIS	`ypcat` `sort`
	None	`awk` `sort`
Find a user account	NIS+	`nismatch`
	NIS	`ypmatch`
	None	`grep`
Add a group	NIS+	`nistbladm`
	NIS	`groupadd` `make`
	None	`groupadd`
Modify users in a group	NIS+	`nistbladm`

Table 7–2 Using Solaris Commands to Administer User Accounts (continued)

Task	Name Service	Commands
	NIS	`groupmod` `make`
	None	`groupmod`
Delete a group	NIS+	`nistbladm`
	NIS	`groupdel` `make`
	None	`groupdel`

The following sections describe how to use Admintool to add and delete user accounts.

NEW

You may find it useful to create a form from the following checklist to ensure that you have all the needed information about a user account before you create it:

- User name
- UID
- Primary group
- Secondary groups
- Comment
- Default shell
- Password status and aging
- Home directory server name
- Home directory path name
- Mounting method
- Permissions on home directory
- Mail server
- Department name
- Department administrator
- Manager
- Employee name
- Employee title
- Employee status

- Employee number
- Start date

Adding User Accounts

Before you add users to the network, the users' systems must be installed and configured. When appropriate, NIS+ or NIS software should be installed and running on the network. (Only 4.*x* systems can be NIS servers. You can have either 4.*x* or 5.*x* systems installed as NIS clients.)

Adding users so that they can log in and start working has two steps: setting up the user account and providing the user with a working environment.

When you set up a user account, you

- Edit the `/etc/passwd` file
- Define the user's group(s)
- Create a home directory
- Define the user's environment
- Create a password

The next sections provide background information and describe how to do these tasks.

Editing the */etc/passwd* File

Before you can use Admintool to edit the local `/etc/passwd` file, you must be a member of the sysadmin group (GID 14).

If you have the appropriate permissions, you can use Admintool to make changes to the `/etc/passwd` file on a local system.

You need the following information for each user you plan to add:

- Login name
- User ID (UID)
- Primary group ID (GID)
- Identifying information (name, office, extension, home phone)
- Home directory
- Login shell

NEW

User ID Number

A UID is always associated with each user name and is used by systems to identify the owners of files and directories and to identify the user at login. If you create user accounts for a single individual on more than one system, always use the same user name and UID. In that way, the user can easily move and copy files between systems without ownership problems.

A UID must be a whole number less than or equal to 2147483647. The maximum UID was increased from 60000 to 2147483647 starting with the Solaris 2.5.1 release.

UIDs are required for both regular user accounts and special system accounts. Table 7–3 lists the UIDs that are reserved for user accounts and system accounts.

Table 7–3 Reserved UIDs

UIDs	Login Accounts	Description
0	`root`	Root account
1	`daemon`	Daemon account
2	`bin`	Pseudo-user bin account
3–99	`sys, uucp logins, who, tty, and ttytype`	System accounts
100–60000	Regular users	General-purpose accounts
60001	`nobody`	Unauthenticated users
60002	`noaccess`	Compatibility with previous Solaris 2.*x* and SVR4 releases
60003–2147483647	Regular users	General-purpose accounts

CAUTION! *Be careful when using UIDs in the 60000 to 2147483647 range. These numbers do not have full functionality and are incompatible with many Solaris features. See Table 7–4 for more information.*

Even though UIDs 0 through 99 are reserved for use by system accounts, you can add a user with one of these UIDs. You should not, however, use these UIDs for regular user accounts. Use the numbers 0 through 99 to assign system accounts, uucp logins, and pseudo-user logins.

Large User IDs and Group IDs

Previous Solaris 2.*x* releases used 32-bit data types to contain UIDs and GIDs. UIDs and GIDs were constrained to a maximum useful value of 60000. The limit on UID and GID values has been raised to the maximum value of a signed integer, or 2147483647 with the

Solaris 2.5.1 release. Table 7–4 lists the interoperability issues with Solaris 2.*x* products and commands.

Table 7–4 Interoperability Issues for UIDs and GIDs over 60000

Category	Product/Command	Issues/Cautions
NFS Interoperability	SunOS 4.*x* NFS software	SunOS 4.*x* NFS server and client code truncates large UIDs and GIDs to 16 bits. This truncation can create security problems if SunOS 4.*x* systems are used in an environment where large UIDs and GIDs are being used. SunOS 4.*x* systems require a patch.
Name Service Interoperability	NIS name service File-based name service	Users with UIDs above 60000 can log in and use the su command on systems running earlier versions of the Solaris 2.*x* operating environment, however, their UIDs and GIDs are set to 60001 (nobody).
	NIS+ name service	Users with UIDs above 60000 are denied access on systems running older Solaris 2.*x* versions and the NIS+ name service.
Printed UIDs/GIDs	OpenWindows File Manager	Large UIDs and GIDs are not displayed correctly if the OpenWindows File Manager is used with the extended file listing display option.

Table 7–5 summarizes the limitations of using large UIDs and GIDs.

Table 7–5 Limitations of Using UIDs and GIDs over 60000

UID/GID Number	Limitation
60003 or greater	Users logging in to systems running previous Solaris releases and the NIS or files name service are assigned a UID and GID of nobody.
65536 or greater	SunOS 4.*x* systems running the NFS version 2 software truncate UIDs in this category to 16 bits, creating possible security problems.
	Using the `cpio` command with the default archive format to copy files displays an error message for each file and the UID and GID are set to nobody in the archive.
	`SPARC systems:` SunOS 4.*x*-compatible applications display `EOVERFLOW` messages from some system calls and the UID and GID are set to `nobody`.
	x86 systems: SVR3-compatible applications on an x86 system is likely to display `EOVERFLOW` messages from system calls.
	x86 systems: If users create a file or directory on a mounted System V file system, the System V file system returns an `EOVERFLOW` error.
100000 or greater	The `ps -l` command displays a maximum five-digit UID so the printed column is not aligned when it includes a UID or GID greater than 99999.

Table 7-5 Limitations of Using UIDs and GIDs over 60000 (continued)

UID/GID Number	Limitation
2622144 or greater	Using the `cpio` command with `-H odc` format or the `pax -x cpio` command to copy files returns an error message for each file and the UIDs and GIDs are set to nobody in the archive.
10000000 or greater	Using the `ar` command sets UIDs and GIDs to nobody in the archive.
2097152 or greater	UIDs and GIDs are set to nobody when using the tar command, the `cpio -H ustar` command, or the `pax -x tar` command.

Creating a Home Directory

The *home directory* is that portion of a file system that is allocated to an individual user for storing private files. The amount of space you allocate for a home directory may vary, depending on the kinds of files the users create and the type of work they do. You should probably allocate at least 15 Mbyte of disk space for each user's home directory.

A user's home directory can be either on the local system or on a remote file server. In either case, by convention the home directory is created as `/export/home/`*`login-name`*. Note that this convention is new with Solaris 2.*x*. The server name is no longer included as part of the user's home directory path. On a large server that supports a number of users' home directories, there may be a number of directories under `/export`—such as `home1`, `home2`, `home3`, and so on—with directories for different users under them. Regardless of where their home directory is located, users access their home directory through a mount point named `/home/`*`login-name`*.

NEW

Always refer to the home directory as `$HOME`, not as `/export/home/username`. In addition, use relative paths to create any symbolic links in a user's home directory (for example, `../../../x/y/x`), so that the links are valid no matter where the home directory is mounted.

This section describes the default procedure for Solaris 2.*x*, which assumes that the user's system is on a network and that AutoFS is used to make the home directory accessible. Whether the home directory originates on a server or on the local system, you need to make it accessible to other systems by using the share command to export the file system so that the user can access the home directory from other systems on the network.

In addition, you need to define how the home directory is mounted, by either:

- Adding an entry to the `NIS+ Auto_home` database, `NIS auto.home map`, or local `/etc/auto_home` files so that the home directory is automatically mounted. This is the preferred method.
- Adding an entry in the `/etc/vfstab` file on the user's system to NFS-mount the home directory.

To support automatic mounting of home directories, the SunOS 5.*x* system software includes this entry in the `/etc/auto_master` file:

```
/home       /etc/auto_home
```

This entry tells AutoFS to mount the directories specified in the `auto_home` database onto the `/home` mount point on the local system. The entries in `auto_home` use this format:

```
login-name     system-name:/export/home/login-name
```

When a user logs in with *`login-name`*, AutoFS mounts the specified directory (`/export/home/`*`login-name`*) from f the specified system (*`system-name`*) onto the `/home` mount point on the system to which the user is logged in.

This method works even when the home directory is stored on the same system to which the user has logged in. But more importantly, the user can log in to any other system and have his or her home directory mounted on `/home` on that system.

NOTE. *When AutoFS is used to mount home directories, you are not permitted to create any directories under the* `/home` *mount point on the user's system. The system recognizes the special status of* `/home` *when AutoFS is active.*

To create a home directory, you must already have created the user's account. You need this information:

- User's login name and UID.
- The name of the system on which to create the home directory. If the home directory is accessed over the network, the home directory system should be on the same network segment as the user's local system. Use the `df` command to check the servers to make sure there is enough space for a new home directory.
- The name of the directory where you will create the user's account. By convention, the home directory is named `/export/home`. However, on a large file server you may have multiple directories—`/export/home1`, `/export/home2`, and so on. Under each directory, different subdirectories are created for different users (for example, `/export/home/`*`login-namea`*, `/export/home/`*`login-nameb`* ... `/export/home1/`*`login-namey`* ... `/export/home2/`*`login-namez`*, and so forth).

All these steps apply regardless of whether the home directory is created on the local system or on a remote file server:

1. Become superuser on the system where you want to create the home directory.
2. Type **`cd /export/`*`home-dir`*** and press Return. The *`home-dir`* is the name of the directory where you want to create the user's home directory. For example, to change to the directory `/export/home1`, type:

```
# cd /export/home1
```

3. Type `mkdir` ***login-name*** and press Return. *login-name* is the login name of the user. You have created a directory that matches the login name of the user. For example, to create a directory for a user withf a login name of `ignatz`, type:

```
# mkdir ignatz
```

4. Type `chown` ***login-name login-name*** and press Return. The user now owns the home directory. For example, for user `ignatz`, type:

```
# chown ignatz ignatz
```

5. Type `chgrp` ***primary-GID login-name*** and press Return. The user is assigned to the primary group you specified in the Passwd database for the user account, for example, the `staff` group:

```
# chgrp staff ignatz
```

6. Type `chmod 755 /export/`***home-dir/login-name*** and press Return. The user's home directory permissions are set to `rwx` for owner, `r-x` for group, and `r-x` for other:

```
# chmod 755 /export/home1/ignatz
#
```

The following steps describe how to share a home directory from a 5.*x* server. The procedure for sharing home directories from a 4.*x* server uses the `export` command.

1. Type **share** and press Return to find out whether the home directory has already been shared. If the home directory is listed, you will see information that looks like this:

```
oak% su
Password:
# share
-              /export/home       rw     ""
#
```

If the home directory is not listed, perform the following steps to set it up so that it can be shared by other systems. You perform these steps once for each `/export/`*home-dir* directory. By convention, these are named `/export/home`, `/export/home1`, `/export/home2`, and so on.

2. Edit the file `/etc/dfs/dfstab` and add this line:

```
share -F nfs /export/<home-dir>
```

3. Type **`shareall -F nfs`** and press Return. All the `share` commands in the `/etc/dfs/dfstab` file are executed so that you do not need to reboot the system. If you reboot the system, the `share` command is automatically run.

4. Type **`ps -ef ¦ grep mountd`** and press Return. If the daemon `mountd` is running, the procedure is complete. This example shows that a `mountd` is not running. If `mountd` is not running, follow the next step.

```
# ps -ef | grep mountd
    root    221    218  16   18:07:25 pts/1  0:00 grep mountd
```

5. Type `/etc/init.d/nfs.server start` and press Return. The daemons required for sharing file directories are started.

NEW

NOTE. *If your network is not running NISf or NIS+, you need to add the home directory server's Internet Protocol (IP) address and system name to the* `/etc/hosts` *file on the user's system. You can use the Admintool: Hosts window to edit the local* `/etc/hosts` *file.*

If you use disk quotas, set up a disk quota for the user.

After you have created the user's home directory, you must make it available. You make the home directory available either by adding it to the `Auto_home` database (the preferred method) for use by AutoFS, or by adding an entry to the `/etc/vfstab` file on the user's system for NFS mounting.

NFS-Mounting the Home Directory

If the directory (disk space) for a user's home directory is located on another system and AutoFS is not being used to make that space available, follow these steps to NFS-mount the home directory:

1. Become superuser on the user's system.
2. Edit the `/etc/vfstab` file and create an entry for the user's home directory. For example, to create an entry for user `ignatz` with a home directory on server `oak`, you would add this line to the file:

   ```
   oak:/export/home1/ignatz - /home/ignatz nfs - yes rw,intr
   ```

3. To create the mount point on the user's system, type `mkdir /home/`***`login-name`*** and press Return.

NOTE. *The home directory does not have the same name on the user's system as it does on the server. For example,* `/export/home/ignatz` *on the server is mounted as* `/home/ignatz` *on the user's system.*

4. Type `chown` ***`login-name`*** `/home/`***`login-name`*** and press Return. The user now owns the home directory.
5. Type `chgrp` ***`primary-GID`*** `/home/`***`login-name`*** and press Return. The user's primary group has permission to access the user's home directory.
6. Type `mountall` and press Return. All entries in the current vfstab file (whose `automnt` fields are set to Yes) are mounted.
7. To verify that all entries are mounted, type `mount` and press Return. The file systems that are mounted are displayed.

Defining the User's Environment

To completely set up the user account, you must also:

- Define default initialization files
- Set up a mail account
- Set up a printer

Defining Initialization Files

When a user logs in, the login program sets a number of variables, such as `HOME`, `LOGNAME`, and `TZ`. Then a file called the *system profile (initialization file)* is run to set systemwide defaults such as `PATH`, message of the day, and `umask`. Finally, the user profile initialization file (or files) that sets variables specific to the user is run. For example, the user profile can modify the `PATH` to include applications run by only that user. Each shell has its own initialization file (or files), as shown in Table 7–6.

Table 7–6 Shell User Initialization Files

Shell	Initialization File	Purpose
C	`$HOME/.login`	Defines user's environment at login
	`$HOME/.cshrc`	Defines user's environment for all C shells invoked after login shell
Bourne	`$HOME/.profile`	Defines user's environment at login
Korn	`$HOME/.profile`	Defines user's environment at login
	`$HOME/ksh-env`	Defines user's environment at login in the file specified by the *ksh-env* environment variable

The SunOS 5.*x* system software provides default user initialization files for each shell in the `/etc/skel` directory, as shown in Table 7–7.

Table 7–7 Default Home Directory Initialization Files

Shell	File Name
C	`/etc/skel/local.login`
C	`/etc/skel/local.cshrc`
Bourne or Korn	`/etc/skel/local.profile`

Here is the default `/etc/skel/local.login` file:

NEW

```
# @(#)local.login 1.3     93/09/15 SMI
stty -istrip
# setenv TERM 'tset -Q -'

#
# if possible, start the windows system. tGive user a chance to bail out
#
if ( 'tty' == "/dev/console" ) then

        if ( $TERM == "sun" || $TERM == "AT386" ) then

                if ( ${?OPENWINHOME} == 0 ) then
                        setenv OPENWINHOME /usr/openwin
                endif

                echo ""
                echo -n "Starting OpenWindows in 5 seconds (type Control-C to
interrupt)"
                sleep 5
                echo ""
                $OPENWINHOME/bin/openwin
                clear           # get rid of annoying cursor rectangle
                logout          # logout after leaving windows system
        endif
endif
```

Here is the default /etc/skel/local.cshrc file:

NEW

```
# @(#)cshrc 1.11 89/11/29 SMI
umask 022
set path=(/bin /usr/bin /usr/ucb /etc .)
if ( $?prompt ) then
        set history=32
endif
```

Here is the default /etc/skel/local.profile file:

```
# @(#)local.profile 1.4 93/09/15 SMI
stty istrip
PATH=/usr/bin:/usr/ucb:/etc:.
export PATH

#
# If possible, start the windows system
#
if [ 'tty' = "/dev/console" ] ; then
        if [ "$TERM" = "sun" -o "$TERM" = "AT386" ] ; then
                if [ ${OPENWINHOME:-""} = "" ] ; then
                        OPENWINHOME=/usr/openwin
                        export OPENWINHOME
                fi
                echo ""
                echo "Starting OpenWindows in 5 seconds (type Control-C to
interrupt)"
                sleep 5
                echo ""
               $OPENWINHOME/bin/openwin
```

```
            clear           # get rid of annoying cursor rectangle
            exit            # logout after leaving windows system
        fi
fi
```

As you can see, these files define a minimal t environment. To minimize the need to edit the customization files for each user, you can customize the files in /etc/skel to set as many systemwide default variables as you can. You will need to edit individual users' customization files to set the user's path.

To set up initialization files, you must already have created the user's home directory and know which shell (C, Bourne, or Korn) is set in the user's account entry in the Passwd database. Follow these steps to set up the user's initialization files:

1. Become superuser on the system with the user's home directory.
2. Type cd ***/home-dir/login-name*** and press Return. You are in the user's home directory. For example to change to user ignatz's directory which is in /export/home1, type: # **cd /export/home1/ignatz**.
3. Type **cp /etc/skel/local.* .** and press Return. You have copied all of the default user initialization files to the user's home directory.
4. Type **chmod 744 local.*** and press Return. Permissions are set for the initialization files.
5. Type **chown *login-name* *** and press Return. The user now owns the initialization files:

   ```
   # chown ignatz *
   #
   ```

6. Type **chgrp *primary-GID* local.*** and press Return. The files are assigned to the primary group (for example, sysadmin) you specified in the Passwd database for the user account:

   ```
   # chgrp 10 local.*
   #
   ```

7. Rename the shell initialization files. If the user's shell is the C shell, type **mv local.login .login; mv local.cshrc .cshrc** and press Return. If the user's shell is the Korn or Bourne shell, type **mv local.profile .profile** and press Return.
8. Type **rm local.*** and press Return. You have removed the unused shell initialization files.
9. Mount the user's home directory.
10. On the user's system, log in as the user.
11. Assign the t user an interim password. See "Creating a Password" later in the chapter for information on how to create passwords.

12. Check to make sure the user's environment is set up correctly.
13. Edit the user's initialization file (or files) and make changes as needed.

To edit the user's initialization file (or files):

1. Set the user's default path to include the home directory and directories or mount points for the user's windowing environment and applications.
2. To change the path setting, add or modify the line for `PATH` as follows. For the C shell, type **`set path =(.`** ***`/dirname1 /dirname2 /dirname3 ...`***). For example, enter a line like this in the user's `$HOME/.cshrc` file:

   ```
   set path=(. /usr/openwin/bin /usr/dt/bin /usr/bin /$home/bin /lib /usr/lib)
   ```

   For the Bourne or Korn shell, type `PATH=.:`***`/dirname1:/dirname2:/ dirname3 ...`***`;`**`export PATH`**. For example, enter a line such as the following in the user's `$HOME/.profile` file:

   ```
   PATH=.:/usr/openwin/bin:/usr/dt/bin /usr/bin:/$HOME/bin:/lib:/usr/lib;
   export PATH
   ```

3. To check that the environment variables are set correctly, type **`env`** and press Return. Note that the variables are shown using Bourne or Korn shell syntax, even if the user's shell is the C shell. Type **`man =s5 environ`** and press Return for more information:

   ```
   $ env
   HOME=/home/ignatz
   HZ=100
   LOGNAME=ignatz
   MAIL=/var/mail/ignatz
   MANSECTS=\1:1m:1c:1f:1s:1b:2:\3:3c:3i:3n:3m:3k:3g:3e:3x11:3xt:3w:3b:9:4:5:7:8
   PATH=:/usr/openwin/bin:/sbin:/usr/sbin:/usr/bin:/etc:/$HOME/bin:/lib:/usr/lib
   SHELL=/bin/sh
   TERM=sun
   TZ=EST5EDT
   $
   ```

4. Add or change the settings of environment variables. For the C shell, type **`setenv`** ***`VARIABLE value`*** (or **`set`** ***`variable=value`*** for the path and term variables). For example, this line sets the history to the last 100 commands:

   ```
   setenv HISTORY 100
   ```

   For the Bourne or Korn shell, type ***`VARIABLE=value`***`;`**`export`** ***`VARIABLE.`*** For example, this line sets the user's default mail directory:

   ```
   MAIL=/var/mail/ignatz;export MAIL
   ```

5. Check the `umask` setting. If you need to change it, type **`umask`** ***`nnn`*** and press Return. You can either includet or omit leading zeros. For example, to set file permissions to

644, type **umask 022**. Table 7–8 shows the file permissions that are created for each of the octal values of `umask`.

Table 7–8 Permissions for *umask* Values

Octal Value	File Permissions
0	rwx
1	rw-
2	r-x
3	r--
4	-wx
5	-w-
6	--x
7	--- (none)

The `LANG` variable and `LC` environment variables determine the locale-specific conversions and conventions the shell uses. These conversions and conventions include time zones, collation orders, and formats of dates, time, currency, and numbers. If necessary, set these variables in the user's initialization file. `LANG` sets all possible conversions and conventions for a given locale. If you have special needs, you can set various aspects of localization separately using the `LC` variables `LC_COLLATE`, `LC_CTYPE`, `LC_MESSAGES`, and `LC_NUMERIC`. Table 7–9 shows the values for several locales.

If the system needs to support multibyte characters (for example, Japanese), add this command to the system initialization file (`/etc/profile` or `/etc/.login`): `stty cs8 defeucw`. When the initialization files are complete, log out of the user's account.

Table 7–9 Values for *LANG* and *LC* Variables

Value	Locale
de:	German
fr:	French
iso_8895_1	English and European
it	Italian
japanese	Japanese
korean	Korean
sv	Swedish

Table 7–9	Values for *LANG* and *LC* Variables (continued)
tchinese	Taiwanese

Setting Up a User's Mail Account

Each user has a mailbox either on a local system or on a mail server and a mail alias in the `/etc/mail/aliases` file that points to the location of the mailbox. To set up a mail client with a mailbox on a mail server:

1. Become superuser on the mail client's system.
2. Create a `/var/mail` mount point on the mail client's system.
3. Edit the `/etc/vfstab` file and add an entry for the `/var/mail` directory on the mail server, mounting it on the local `/var/mail` directory. The client's mailbox will automatically be mounted any time the system is rebooted.
4. Type **`mount -a`** to mount the mailbox. The client's mailbox is mounted.
5. Use Admintool to edit the `/etc/hosts` file and add an entry for the mail server.

NOTE. *The sendmail program automatically creates mailboxes in the* `/var/mail` *directory the first time a message is delivered. You do not need to create individual mailboxes for your mail clients.*

If you are using NIS+, follow these steps to set up mail aliases for the user:

1. Compile a list of each of your mail t clients, the locations of their mailboxes, and the names of the mail server systems.
2. Become superuser on any system.
3. For each alias, type **`aliasadm -a`** ***`alias expanded-alias[options comments]`*** and press Return. The alias is added to the NIS+ aliases table. For example, adding an alias for user `iggy.ignatz` would look like this:

   ```
   # aliasadm -a iggy iggy.ignatz@oak "Iggy Ignatz"
   ```

4. Type **`aliasadm -m`** ***`alias`*** and press Return. The entry you created is displayed.
5. Check the entry to be sure it is correct.

Setting Up a User's Printer

After adding users to a system, make sure they have access to a printer. See Chapter 6, "Administering Printing," for information on how to set up printing services.

Creating a Password

Passwords are an important part of system security. Each user account should be assigned a password of 6 to 10 characters using a combination of letters and numbers. See the `passwd`(1), `yppasswd`(1), or `nispasswd`(1) manual pages for information about changing passwords and password attributes.

In the SunOS 4.*x* system, encrypted passwords are stored in the `/etc/passwd` file along with the rest of the information about the user. In SunOS 5.*x*, the encrypted password and associated password aging information are stored in the `Shadow` field of the NIS+ Passwd database (or in the local `/etc/shadow` file). Permissions on the `Shadow` field are restricted. Permissions for the `/etc/shadow` file are `-r--------`. Only root can read the `/etc/shadow` file, and only the `passwd`, `yppasswd`, and `nispasswd` commands can write to the file.

Here is an example of an `/etc/shadow` file:

```
root:XzVuae1vazZsw:8223::::::
daemon:NP:6445::::::
bin:NP:6445::::::
sys:NP:6445::::::
adm:NP:6445::::::
lp:NP:6445::::::
smtp:NP:6445::::::
uucp:NP:6445::::::
nuucp:NP:6445::::::
listen:*LK*:::::::
nobody:NP:6445::::::
noaccess:NP:6445::::::
nobody4:NP:6445::::::
winsor:gzqgrmlKcfy7A:8223::::::
```

To create or modify passwords, use one of these commands:

- `/usr/bin/passwd` (for no naming service)
- `/usr/bin/nispasswd` (for the NIS+ naming service)
- `/usr/bin/yppasswd` (for the NIS naming service)

Users can create or change their own passwords at any time. You must be root to create the initial password for any other user. In addition, to create an NIS+ password, you must have the appropriate NIS+ privileges and you must have established the necessary networkwide credentials. (See the `nispasswd`(1) manual page.)

Follow these steps to create an NIS+ password:

1. Become superuser on the NIS+ server.
2. Type **`nispasswd`** ***`login-name`*** and press Return. The message `New NIS+ password:` is displayed.
3. Type the new password and press Return. The prompt `Retype new NIS+ password:` is displayed.

4. Retype the password and press Return. The password is assigned and added to the NIS+ database.

In this example, a new password is assigned for the user `ignatz`:

```
oak% su
Password:
# nispasswd ignatz
New NIS+ password:
Retype new NIS+ password:
#
```

Follow these steps to change an NIS+ password:

1. Become superuser on the NIS+ server.
2. Type **nispasswd** ***login-name*** and press Return. The prompt `Old password:` is displayed.
3. Type the old password and press Return. The prompt `New password:` is displayed.
4. Type the new password and press Return. The prompt `Re-enter new password:` is displayed.
5. Retype the password and press Return. The password is assigned and added to the `/etc/shadow` file.

In this example, the password for user `ignatz` is changed:

```
oak% su
Password:
# nispasswd ignatz
Old password:
New password:
Re-enter new password:
#
```

NOTE. *You can also use* `nispasswd` *to define, change, and view password attributes, such as password aging. See the* `nispasswd`*(1) manual page for more information.*

Follow these steps to create an NIS password:

1. Become superuser on any system in the NIS domain.
2. Type **yppasswd** ***login-name*** and press Return. The message Changing NIS password for *`login-name`* and the prompt `New password:` are displayed.
3. Type the new password and press Return. The prompt `Retype new password:` is displayed.
4. Retype the password and press Return. The password is assigned and added to the NIS master file.

In this example, the NIS password is changed for user `yaya`:

```
oak% su
Password:
# yppasswd yaya
Changing NIS password for yaya
New password:
Retype new password:
NIS entry changed on eucalyptus
#
```

Changing an NIS password is similar to changing an NIS+ password. When prompted to do so, type the old password, and then the new password two times.

Follow these steps to create a local password:

1. Become superuser on the local system.
2. Type `passwd` ***login-name*** and press Return. The prompt `New password:` is displayed.
3. Type the new password and press Return. The prompt `Re-enter new password:` is displayed.
4. Retype the password and press Return. The password is assigned and added to the `/etc/shadow` file:

```
oak% su
# passwd smallberries
New password:
Re-enter new password:
#
```

NOTE. *You can also use* `passwd` *to define, change, and view password attributes, such as password aging. See the* `passwd`*(1) manual page for more information.*

Changing a local password is similar to changing an NIS+ password. When prompted to do so, type the old password, and then the new password two times.

The Admintool: Users Window

NEW

You can use the Admintool: Users window to add, modify, and delete user accounts on a local system.

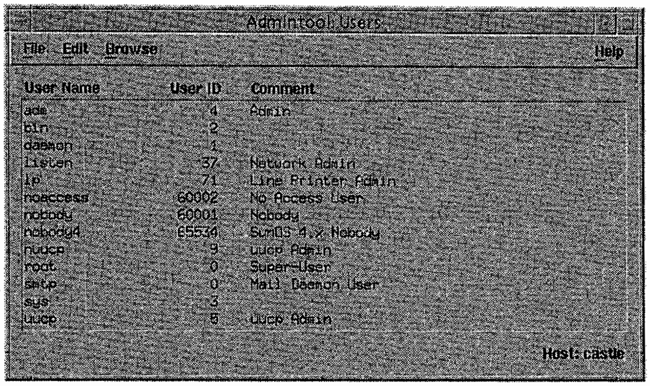
Always run Admintool using your own UID, not as root. You must be a member of the sysadmin group (GID 14). If the network is running NIS+, you also need create and delete permissions on the NIS+ databases.

Adding a User Account

Follow these steps to add a user account to a local system with the Admintool: Users window:

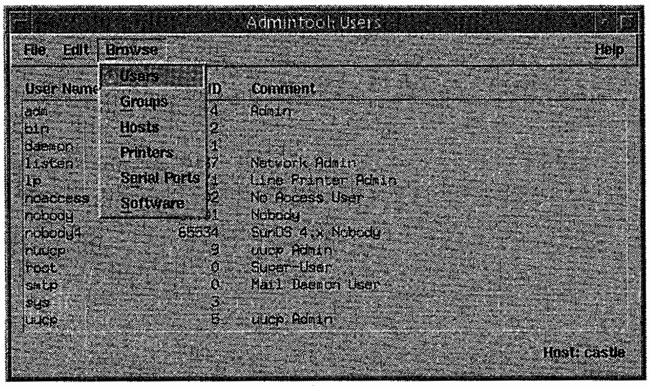
1. In a terminal window, type **admintool&** and press Return. The Admintool: Userswindow is displayed, as shown in Figure 7–1.

Figure 7–1
The Admintool:Users window



2. From the Browse menu, choose Users, as shown in Figure 7–2 (if necessary).

Figure 7–2
The Users Browse menu



3. From the Edit menu, choose Add, as shown in Figure 7–3.

The Admintool: Add User window is displayed, as shown in Figure 7–4.

Figure 7–3

The Users:Edit menu.

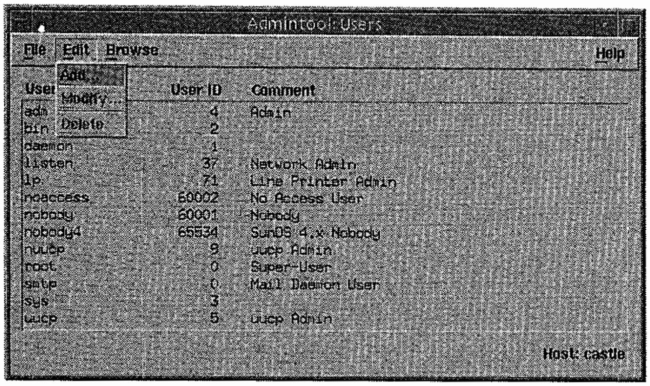
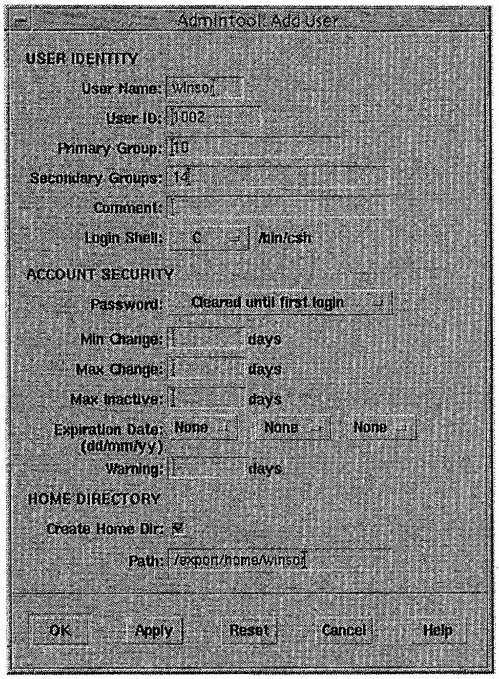


Figure 7–4

The Admintool: Add User window.



4. Type the user's login name in the User Name text field. Choose a login name unique to your organization with two to eight lowercase characters and digits (excluding colons).

5. Type the UID number in the User ID text field. Choose a number between 100 and 60000 or between 60003 and 2147483647 that is unique to your organization. By default the Admintool: Add User window assigns a default UID number, sequentially starting with 1001.
6. Type the user's group name or group number in the Primary Group field. The default primary group number is 10.
7. If the user is assigned to any secondary groups, type the names or numbers of the additional groups in the Secondary Groups text field.
8. Type identifying information about the user in the Comment text field.
9. Choose a default login shell for the user from the Login Shell menu.
10. Choose a password status from the Password menu.
11. If you want additional password aging information, set it in the appropriate text fields.
12. If you want to automatically create the user's home directory, click `SELECT` on the Create Home Dir checkbox.
13. Type the path of the home directory to be entered in the Passwd database in the Path text field. If you checked the Create Home Dir box, the home directory is created.
14. When you have filled in all the information, click on the OK button. The information is added to the `/etc/passwd`, `/etc/shadow`, and `/etc/group` files. If specified, the user's home directory is created with the proper ownership.
15. Set up the user initialization files manually, as described in "Defining the User's Environment."

Administering User Accounts

Administering user accounts includes modifying, removing, and disabling the accounts.

Modifying User Accounts

When information about the user changes, use the Admintool: Users window to edit the information in the `/etc/passwd` file. Unless you define a user (login) name or UID that conflicts with existing ones, you probably will not need to modify a user account's login name or UID.

In a network environment, you may need to change the `Auto_home` database for the user's home directory when users move from one system to another, and from one server to another.

If you need to modify user passwords, use the `passwd` (no naming service), `yppasswd` (NIS), and `nispasswd` (NIS+) commands.

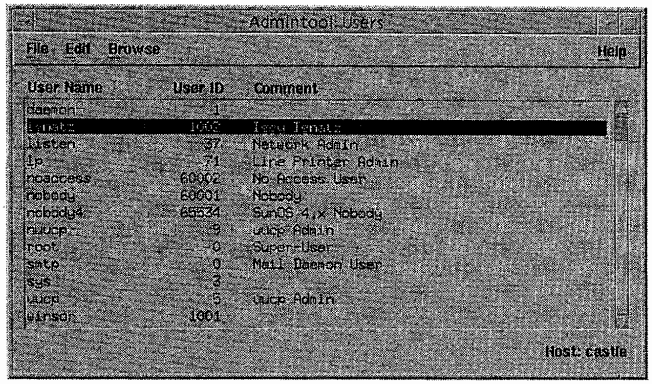
To modify a user account by using Admintool, you must be a member of the sysadmin group (GID 14). If you want to change a user's home directory, create the new directory (`mkdir`) before making changes by using the Admintool: Users window.

Follow these steps to modify a user account:

1. In the Admintool: Users window, click on thei user account you want to modify, as shown in Figure 7–5.

Figure 7–5

Highlighting a user account.



2. From the Edit menu, choose Modify, as shown in Figure 7–6.

The Admintool: Modify User window is displayed, as shown in Figure 7–7.

Figure 7–6

Choosing Modify from the Edit menu.

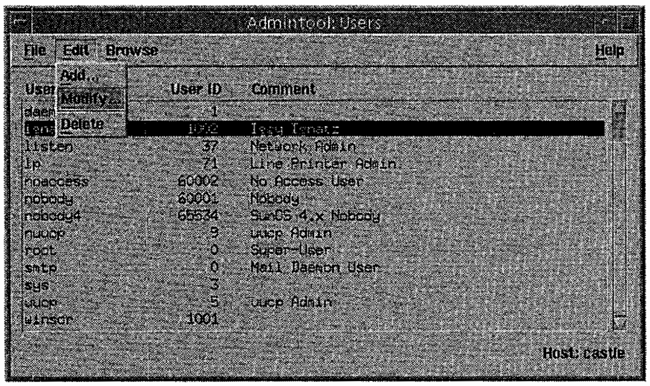
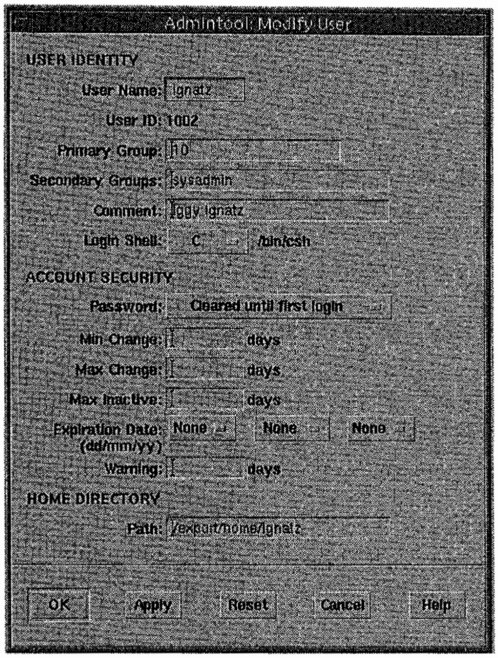


Figure 7–7
The Admintool: Modify User window



3. Make the modifications to the iuser account.
4. When the changes are complete, click on the OK button. The changes are made to the user account.

Deleting User Accounts

Here is a checklist for deleting a user account:

- Delete the user's entry from the NIS+ `Passwd` database, NIS map, or `/etc/passwd` files.
- Remove the user's name from entries in the NIS+ Group database, NIS map, or `/etc/group` files.
- Remove the user from any printer access or deny lists.
- Decide whether you want to delete or archive all of the user's files.
- Delete the user's mail file.
- Remove the user from the `Auto_home` database.

NEW

Deleting a User Account Using Admintool

To delete a user account using Admintool, you must be a member of the sysadmin group (GID 14).

Follow these steps to delete a user account:

1. From the Admintool: Users window, click on the user account you want to delete. The user account is highlighted.
2. From the Edit menu, choose Delete. An alert window is displayed, as shown in Figure 7–8, asking you to confirm or cancel the action.

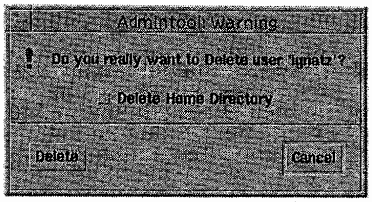


Figure 7–8
Alert window

3. If you want to delete the home directory along with the user account, click on the Delete Home Directory check box.
4. Click on the Delete button to delete the user account. The user account is deleted and removed from the list in the Admintool: Users list. If you checked the Delete Home Directory check box, the home directory is also deleted. If you want to retain the account, click on the Cancel button to dismiss the window.

Disabling User Accounts

Occasionally, you may need to temporarily or permanently disable a login account. You should have good reason for taking such action. For example, the user may be on leave of absence or you may have strong evidence that the account is being misused or security is being violated.

The easiest way to disable a login account is to lock the password for an account. To lock the password on a local system, modify the user account and choose Account is Locked from the Password menu in the Admintool: Modify User window, as shown in Figure 7–9.

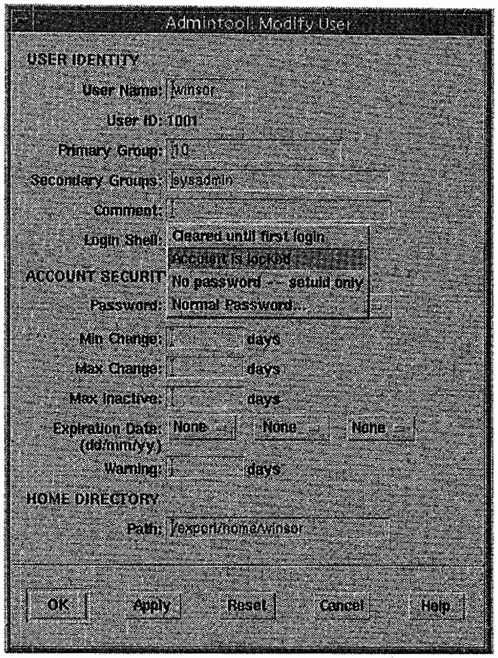


Figure 7-9
The Admintool:Modify User Password menu.

On a local system, you can control access to a user's account by requiring password aging, by setting an expiration date for the login account, or by requiring that a user access the account at regular intervals. Another way that you can disable a login is to temporarily change the password.

Setting Up and Administering Groups

The *Group database* (map, or local `/etc/group` file) stores information about user groups, traditionally called *UNIX groups*. A *user group* is a collection of users who can share files and other system resources. For example, a set of users who are working on the same project could be formed into a user group.

Each group has a GID, which identifies it internally to the system. A group should have a name and a list of user names. User groups can be defined in two ways:

- Implicitly, by the GID for the user's primary group, which is defined in the user account. Whenever a new GID appears in the `Group` field of the `Passwd` database, a new group is defined.
- Explicitly, by name, GID, and user list, as entered into the Group database.

NOTE. *It's best to explicitly define all groups so every group has a name.*

All users belong to at least one group—their primary group—which is indicated by the `Group` field of their user account. Although it is not required by the operating system, you should add the user to the member list of the group you've designated as his or her primary group. Optionally, users can belong to up to 16 secondary groups. To belong to a secondary group, the user must be added to the group's member list.

The `groups` command shows the groups to which a user belongs. For any user, only one group can be considered the primary group at a time. However, users can temporarily change the primary group (with the `newgrp` command) to any other group they belong to.

Some applications, such as the file system, look at the user's primary group only. For example, ownership of files created, and recorded accounting data reflect only the primary group. Other applications may take into account a user's membership across groups. For example, a user has to be a member of the `sysadmin group` to use Admintool to make changes to a database, but it doesn't matter if `sysadmin` is the current primary group.

User groups probably are best known as the groups referred to by the read-write-execute permissions for the user, group, and other on files and directories. These permissions are a cornerstone of security. You cannot access others' files (if they do not allow world access) unless your primary or a secondary group has permission to access the files. For example, a group called `techwrite` could be created for technical writers, and a central directory of document files could be set up with write permission for the `techwrite` group. That way, only writers would be able to change the files.

User groups can be local to a workstation or used across a network. Across the network, user groups allow a set of users on the network to access a set of files on a workstation or file server without making those files available to everyone.

NOTE. *NIS+ supports another, unrelated, kind of group, called NIS+ group, which assigns access rights to NIS+ objects. These groups have nothing to do with using NIS+ to maintain a database of user groups.*

Setting Up Fields in the Group Database

The Group database (map, or local `/etc/group file`) has these fields:

- `Group Name`
- `Group ID`
- `User (Member) List`

There is an additional field that rarely is used: the `Group Password`. The `Group Password` field is a relic of earlier versions of UNIX. It is usually left empty or filled with an asterisk. If a group has a password, the `newgrp` command prompts users to enter it. However, there is no utility to set the password.

Setting Up a Group Name Field

The Group Name field contains the name assigned to the group. For example, members of the chemistry department in a university may be called `chem`. Group names can have a maximum of nine characters.

Setting Up a Group ID Field

The Group ID field contains the group's numerical ID. It must be unique from all other group IDs on a system and should be unique across the entire organization. Each GID must be a whole number between 0 and 60002, but customarily you use numbers from 100 to 60000. (Numbers 60001 and 60002 are assigned to `nobody` and `noaccess`, respectively, and numbers under 100 are reserved for system default group accounts.) When you use Admintool to add user accounts, you must specify the user's primary group; otherwise, the default primary group is root with a GID of 0. For security reasons, you do not want users to have a group of `root`.

NEW

Starting with the Solaris 2.5.1 release, you can also assign GID numbers between 6003 and 2147483647. If you use GID numbers in this range, refer to Table 7-4 and Table 7-5 for information about interoperability issues and limitations on large GID numbers.

Setting Up a User (Member) List Field

The User List field contains a list of the users in the group. User names are separated by commas. These names must be the official login names defined in the `Passwd` database. As already noted, each user can belong to a maximum of 17 groups.

Identifying Default UNIX User Groups

By default, all SunOS 5.*x* workstations and servers have these groups:

NEW

```
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,tty,adm
lp::8:root,lp,adm
nuucp::9:root,nuucp
staff::10:
daemon::12:root,daemon
sysadmin::14:
nobody::60001:
noaccess::60002:
nogroup::65534
```

NOTE. *The* `sysadmin` *group with a GID of 14 is now part of the default set of groups. This group specifies the users who have access to all functions of Admintool.*

Creating New Groups

As a system administrator, you will frequently create new group accounts. You must create a group and assign it a GID before you can assign users to it.

Use Admintool to create and maintain local groups. You must be a member of the `sysadmin` group (GID 14) before you can use Admintool to create or edit group accounts.

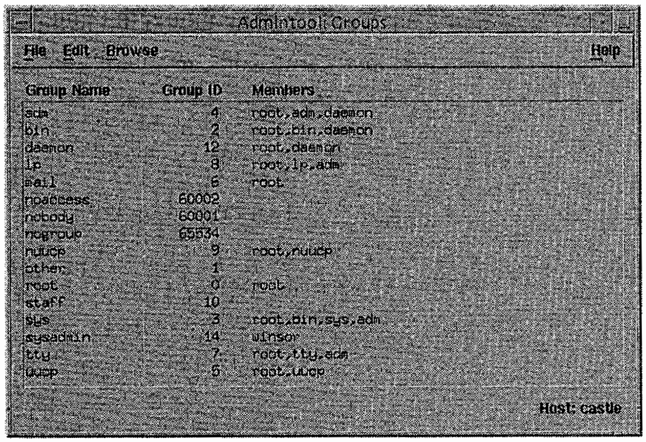
You need this information to create a new group:

- Login names of users who will belong to the group
- UIDs of users who will belong to the group
- Group name
- GID

Follow these steps to add groups to a local `/etc/group` file:

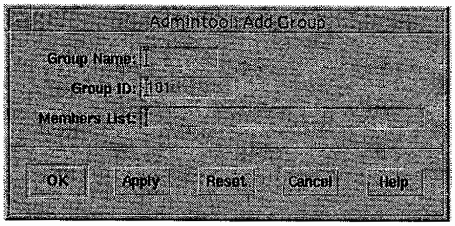
1. Start Admintool (if necessary) by typing **`admintool&`** and pressing Return.
2. From the Browse menu, choose Groups. The Admintool: Groups window is displayed, as shown in Figure 7–10.

Figure 7–10
The Admintool: Groups window.



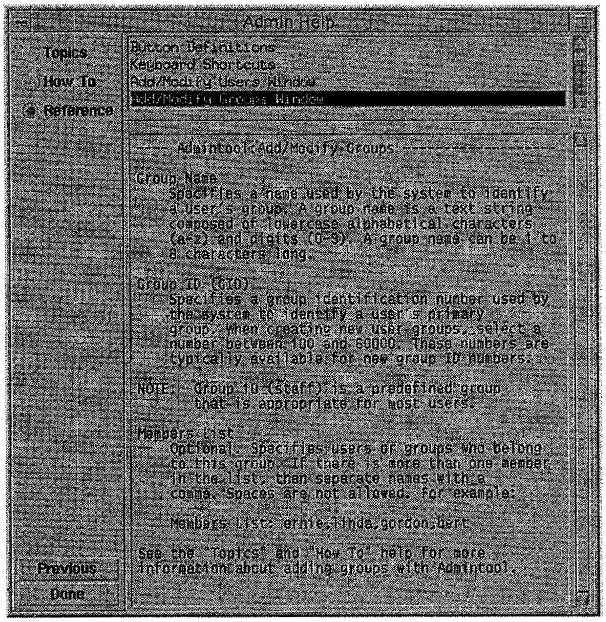
3. From the Edit menu, choose Add. The Admintool: Add Group window is displayed, as shown in Figure 7–11.

Figure 7–11
The Admintool: Add Group window.



4. Type the name of the group, the new group number, and the members of the group. Members of a group are defined as a comma-separated list of login names. Spaces are not allowed. If you need help in determining the format for any of the fields, click on the Help button. A help window is displayed, as shown in Figure 7–12.

Figure 7–12
The Admintool: Help window.



5. When the information is complete, click on the OK button. The group is created and added to the local `/etc/group` file.

Modifying or Deleting Groups

Membership in group accounts can change frequently as new employees are hired and other employees change job responsibilities. Consequently, you have to modify existing group accounts to add or remove users. If you choose to have a user belong to secondary groups, you have to modify those groups to add the user to the user lists. When adding groups, you may make a mistake. The ability to delete groups helps you correct such mistakes.

NOTE. *When projects finish, groups set up for them may no longer be needed, and these groups can be deleted. You should be careful to avoid conflicts if you reuse the GIDs from deleted groups.*

Modifying a Group

Follow these steps to modify a group entry:

1. Start Admintool (if necessary) .
2. From the Browse menu, choose Groups. The Admintool: Groups window is displayed.
3. Click on the group you want to modify. The item is highlighted.
4. From the Edit menu, choose Modify. The Admintool: Modify Group window is displayed.
5. Make the changes to the group.
6. When the changes are complete, click on the OK button. The changes are made to the local `/etc/group` file.

Deleting a Group

If a group account is no longer needed, you can delete it. Follow these steps to delete a group:

1. Click on the group you want to delete. The item is highlighted.
2. From the Edit menu, choose Delete. An alert window is displayed asking if you want to delete the group.
3. Click on the Delete button. The group is deleted from the `/etc/group` file and is removed from the list in the Admintool: Groups window. If you want to retain the group, click on the Cancel button.

Solaris User Registration

Solaris User Registration is a tool for gathering information about new Solaris releases, upgrade offers, and promotions. This tool automatically starts when a user first logs in to the desktop. The Solaris User Registration tool enables a user to register now, later, or never. The registration process provides Sun with the user's Solaris version, survey type, platform, hardware, and locale.

NOTE. *Solaris User Registration is not started when a user is logged in as root or superuser.*

If the user chooses to register, a copy of the completed form is stored in `$HOME/.solregis/uprops`. If the user chooses to never register, he can always start User Registration in one of the following ways:

- By typing **`solregis`** at any command line prompt.
- By clicking on the Registration icon in the Application Manager's desktop tools folder in the CDE environment.

For more information, refer to the `solregis`(1) manual page.

Error Conditions

Table 7–10 suggests ways to resolve user problems with registration.

Table 7–10 Registration Errors

Problem	Solution
Registration form failed to initialize: Web page window is displayed, requesting that user see the system administrator to resolve the problem.	Check for missing registration files.
Form could not be e-mailed: Dialog box is displayed requesting that user see the system administrator to resolve problem.	Check to whether if e-mail is configured correctly. Also ensure that CDE is available on the user system because it must be present to e-mail the completed registration form. Alternatively, users can print the form and fax or mail it.
Form could not be printed: Dialog box is displayed requesting that the user see the system administrator to resolve problem.	Check whether the printer is configured correctly. Alternatively, user can e-mail form.
Form could not be saved: Dialog box is displayed, verifying that registration succeeded; however, the registration information cannot be recalled when updating registration.	Check user's home directory. Required action depends on the system configuration.

Disabling User Registration

If system administrators register for your organization, you may want to disable individual user registration as part of setting up user accounts. You can disable User

Registration either before or after installing Solaris software. Before Solaris software is installed, you can

- Deselect the `SUNWsregu` package (interactive installation).
- Modify a custom JumpStart profile to not install the `SUNWsregu` package.
- Create and run a finish script that creates a file named `solregis` which contains the line: `DISABLE=1` in the `/etc/default` directory on one or more systems.

After Solaris software is installed, you can

- Use the `pkgrm` command to remove the `SUNWsregu` package.
- Create a `solregis` file that contains the line `DISABLE=1` in the `/etc/default` directory.

CHAPTER

8

Understanding Shells

THE SOLARIS 2.X ENVIRONMENT PROVIDES THREE SHELLS FOR USE AS COMMAND interpreters the Bourne shell (the default), the C shell, and the Korn shell. One shell is defined as the default shell for each user, but users can start a new shell from any command line. This chapter describes elements that are common to all three shells and then provides a section for each shell that describes some of the prevalent shell features.

Table 8–1 lists the basic shell features and shows which shells provide each feature.

Table 8–1 Basic Features of Bourne, C, and Korn Shells

Feature	Bourne	C	Korn
Aliases	No	Yes	Yes
Command-line editing	No	Yes	Yes
Enhanced `cd`	No	Yes	Yes
History list	No	Yes	Yes
Ignore CTRL-D (`ignoreeof`)	No	Yes	Yes
Initialization file separate from `.profile`	No	Yes	Yes
Job control	Yes	Yes	Yes
Logout file	No	Yes	No
Protect files from overwriting (`noclobber`)	No	Yes	Yes
Syntax compatible with Bourne shell	Yes	No	Yes

Commands Common to All Shells

The following sections describe commands that can be used with any shell.

Setting a Default Shell

NEW

The user's login shell is set in the last field of the user's entry in the `Passwd` database or `/etc/passwd` file. Use Solstice AdminSuite's User Manager to edit the `Passwd` database. Use Admintool: Users to edit the local `/etc/passwd` file. To run Admintool on a local system, you must be a member of the sysadmin group (GID 14):

1. Type **`admintool&`** and press Return to start Admintool (if necessary).
2. Click on the user account you want to change. The user account is highlighted.
3. From the Edit menu, choose Modify. The Admintool: Modify User window is displayed.

4. Choose the new login shell from the Login Shell menu.
5. Click on the OK button. The next time the user logs out and logs in again, the new shell is used.

Changing Shells from a Command Line (*csh, ksh, sh*)

If you want to use another shell without modifying the `Passwd` database, you can change shells at a command line prompt by simply typing the name of the shell you want to use.

To change to the C shell, type **`csh`** and press Return. The default C shell prompt is the system name followed by a percent sign (`%`):

```
$ csh
oak%
```

To change to the Korn shell, type **`ksh`** and press Return. The default Korn shell prompt is a dollar sign (`$`):

```
oak% ksh
$
```

To change to the Bourne shell, type **`sh`** and press Return. The Bourne shell prompt also is a dollar sign (`$`):

```
$ sh
$
```

Quitting from a Shell (*exit*)

If you start a new shell from the command line, you can quit it and return to the old shell. To quit from a shell, type **`exit`** and press Return. If you have started (layered) another shell, you are returned to the original shell prompt:

```
$ exit
oak%
```

Clearing a Shell Window (*clear*)

You can clear the contents of a shell window and redisplay the prompt to the top of the window. To clear the contents of a shell window, type **`clear`** and press Return:

```
oak% which openwin
no openwin in . /home/ignatz /usr/deskset/bin /usr/bin

/home/ignatz/bin /bin /home/bin /etc /usr/etc /usr/ucb

oak% clear
```

The window is cleared and the prompt is redisplayed at the top.

The Bourne Shell

The default shell for the Solaris 2.*x* environment is the Bourne shell, developed by Steve Bourne when he was at AT&T Bell Laboratories. The Bourne shell is a small shell for general-purpose use. It also provides a full-scale programming language that is used to develop shell scripts to capture frequently performed commands and procedures. Describing how to write shell scripts is beyond the scope of this book.

Reviewing the Bourne Shell Initialization File

The Bourne shell uses one initialization file, `.profile`, in the user's home directory to set the user's environment. When the user logs in or starts a Bourne shell from the command line, the `.profile` file is read. Use this file to set the user's path and any environment variables.

Defining Bourne Shell Environment Variables

The syntax for defining an environment variable is the same for both the Bourne and Korn shells; type ***VARIABLE=value***`;export` ***VARIABLE*** and press Return.

```
$ PS1=oak$;export PS1
$
```

The C Shell

The C shell, written by Bill Joy when he was at UC-Berkeley, is popular with many users of Berkeley UNIX. The C shell is completely different from the Bourne and Korn shells and has its own syntax. The most important advantages of the C shell are command history, command editing, and aliases. *Command history* stores a record of the most recent commands that you have used. You can display these commands and reuse them as originally issued. You can also change a command by editing it. *Aliases* let you type short names for frequently used commands. You can also combine sequences of frequently used commands and provide an alias for the sequence.

Reviewing C Shell Initialization Files

The C shell uses two initialization files in the user's home directory to set the user's environment: `.login` and `.cshrc` (C shell run control).

When the user logs in, the `.login` file is read, and then the `.cshrc` file. When you start the C shell from a command line, only the `.cshrc` file is read. Because the `.login` file is not always read, you should set environment variables and the user's path in the `.cshrc` file.

Defining C Shell Environment Variables

To define an environment variable for the C shell, type **setenv *VARIABLE value*** and press Return:

```
oak% setenv DISPLAY rogue:0
oak%
```

Creating Aliases for the C Shell

Define any aliases for the user in the `.cshrc` file. The syntax for creating an alias is **alias *alias-name command sequence***. For example, you can shortcut the `alias` command so that you type only the letter **a** by adding this line to the `.cshrc` file:

```
alias a alias
```

Here are some examples of aliases from a `.cshrc` file. Note that if the command contains spaces, you enclose the entire command in quotes. In these examples, both double and single quotes are used:

```
alias a alias
a h history
a c clear
a lf ls -F
a ll "ls -l ¦ more"
a la ls -a
a s "source .cshrc"
a f 'find ~ -name core -print'
a copytotape "tar cvf /dev/rmt/0 *"
```

Setting *history* for the C Shell

To set `history` for the C shell, on a command line type **set history=*n*** and press Return. `history` is set to the number of lines you specify:

```
oak% set history=10
oak%
```

You can set `history` temporarily for a shell window or set it "permanently" so that the same history setting is available at each login session by entering the command as a line in your `.cshrc` file.

Using *history* for the C Shell

To display the history for the C shell, on a command line type **history** and press Return. The last *n* commands that you had set for the history are displayed:

```
oak% history
    26  pwd
    27  kermit
    28  cd Howto
    29  tar xvf /dev/rmt/0
    30  ls -l howto*
```

```
    31  cd
    32  cd Config/Art
    33  ls -l
    34  tar cvf /dev/rmt/0
    35  history
oak%
```

To repeat the previous command in a C shell, type `!!` and press Return. The previous command is executed again:

```
oak% history
    26  pwd
    27  kermit
    28  cd Howto
    29  tar xvf /dev/rmt/0
    30  ls -l howto*
    31  cd
    32  cd Config/Art
    33  ls -l
    34  tar xvf /dev/rmt/0
    35  history
oak% !!
history
    27  kermit
    28  cd Howto
    29  tar xvf /dev/rmt/0
    30  ls -l howto*
    31  cd
    32  cd Config/Art
    33  ls -l
    34  tar xvf /dev/rmt/0
    35  history
    36  history
oak%
```

To repeat the last word of the previous command in a C shell, type `!$` and press Return. The last word from the previous command is used as part of the command-line argument.

For example, you might list the complete path name of a file, and then use the path name as the argument to edit the file using `vi`, or to print it:

```
oak% ls -l /home/ignatz/quest
oak% lp !$ lp
/home/ignatz/quest
oak%
```

You can use the `!$` command anywhere within the command line. In this example, the file `/home/ignatz/quest` is copied to the `/tmp` directory:

```
oak% ls -l /home/ignatz/quest
oak% cp !$ /tmp
cp /home/ignatz/quest /tmp
oak%
```

To repeat a numbered command in a C shell, type `!n` and press Return. The number in the shell prompt is *n*. The command is executed again.

```
oak% history
29  tar xvf /dev/rmt/Ø
3Ø  ls -l howto*
31  cd
32  cd Config/Art
33  ls -l
34  tar xvf /dev/rmt/Ø
35  ls -l
36  cd
37  lp howto*
38  history
oak% !32
cd Config/Art
oak%
```

Setting the Backspace Key for the C Shell (*stty erase*)

If you want to change the erase key from Delete to Backspace, type **stty erase**, then press Control and Shift together, and then type H and press Return. The Backspace key is set as the erase key:

```
oak% stty erase ^H
oak%
```

Incorporating a New Command for the C Shell (*rehash*)

The C shell builds an internal table of commands named with the `path` variable. When you add a new command to a directory, the command is not part of the internal table and the shell cannot execute it. To incorporate a new command into the search path internal table, type **rehash** and press Return. Any new commands are incorporated into your command search path:

```
oak% newcommand
newcommand: Command not found
oak% rehash
oak% newcommand
oak%
```

Editing C Shell History Commands

You can edit commands retrieved from the history list using the `s/`*`oldstring/newstring/`* form to substitute in the command as retrieved. In this example, an incorrectly typed command from the history list is corrected:

```
oak% history
    31  cd
    32  ls
    33  cd /home/frame3.1
    34  ls
    35  cd ..
    36  tar cvf /dev/rmt/Ø frame3.1
    37  lp questionnaire
```

```
    38  lpstat -t
    39  echo $PaTH
    40  history
oak% !39:s/a/A/
echo $PATH
.:/home/winsor:/usr/openwin/bin:/usr/deskset/bin:/home/
winsor/bin:/bin:/home/bin:/etc:/usr/etc:/usr/bin:/home/ frame3.1/bin
oak%
```

The Korn Shell

The Korn shell, developed by David Korn of AT&T Bell Laboratories, is a superset of the Bourne shell. That is, the Korn shell uses the same syntax as the Bourne shell, but it has more built-in functions that can be defined directly from the shell. The Korn shell provides a more sophisticated form of command editing than does the C shell. The Korn shell also provides a command history and aliases.

The Korn shell provides a complete command and programming language. The following sections provide a brief introduction to some of the most basic features of the Korn shell.

Reviewing Korn Shell Initialization Files

The Korn shell uses two initialization files in the user's home directory to set the user's environment: `.profile` and *`.ksh-env`*, which is a file with any name you choose that controls the user's environment. You might want to name the file `.kshrc`, because its function is similar to the C shell `.cshrc` file.

When the user logs in, the `.profile` file is read and then the *`.ksh-env`* file. The *`.ksh-env`* file lets you configure the Korn shell session to your needs. Many of the commands that you would include in the *`.ksh-env`* file can be executed only by the Korn shell and cannot be included in the `.profile` file.

You must set the ENV environment variable to point to the *`.ksh-env`* file. The syntax for setting environment variables in the Korn shell is the same as for the Bourne shell: *`VARIABLE=value`*;`export` *`VARIABLE`*. As in the Bourne shell, you must export the variable to make it available to the shell. This example sets the environment variable for a `.kshrc` file:

```
$ ENV=$HOME/.kshrc;export ENV
$
```

You set this environment variable in the `.profile` file; otherwise, the `.kshrc` file will not be found when the user logs in. The ENV variable has no default setting. Unless you set it, the feature is not used. The *`.ksh-env`* file is read each time a user starts the Korn shell from a command line.

Using Korn Shell Options

The Korn shell has a number of options that specify the user's environment and control execution of commands. To display the current option settings, type **set -o** and press Return. In this example, the default options for the Korn shell for Solaris 2.*x* system software are displayed:

```
$ set -o
Current option settings
allexport       off
bgnice          on
emacs           off
errexit         off
gmacs           off
ignoreeof       off
interactive     on
keyword         off
markdirs        off
monitor         on
noexec          off
noclobber       off
noglob          off
nolog           off
nounset         off
privileged      off
restricted      off
trackall        off
verbose         off
vi              off
viraw           off
xtrace          off
$
```

The default options are described in Table 8–2. Customarily, these options are set in the *.ksh-env* file.

Table 8–2 Korn Shell Options

Option	Default	Description
`allexport`	off	Automatically exports variables when defined.
`bgnice`	on	Executes all background jobs at a lower priority.
`emacs`	off	Sets `emacs/gmacs` as the in-line editor.
`errexit`	off	If a command returns the value `False`, the shell executes the `ERR` trap (if set), and immediately exits.
`gmacs`	off	Sets `gmacs` as the in-line editor.
`ignoreeof`	off	When the interactive option is also set, the shell does not exit at end-of-file. Type **`exit`** to quit the shell.

Table 8–2 Korn Shell Options (continued)

Option	Default	Description
`interactive`	on	The shell automatically turns the interactive option on so that shell prompts are displayed.
`keyword`	off	The shell puts each word with the syntax of a variable assignment in the variable assignment list.
`markdirs`	off	Displays a / following the names Kof all directories resulting from path name expansion.
`monitor`	on	Enables job control.
`noclobber`	off	Does not overwrite an existing file when the redirect operator (>) is used.
`noexec`	off	Reads commands but does not execute them. You can use this option to debug shell script syntax errors.
`noglob`	off	Disables file name expansion.
`nolog`	off	Does not store function definitions in the history file.
`nounset`	off	Displays an error message when the shell tries to expand a variable that is not set.
`privileged`	off	When this option is off, the real UID and GID are used. When this option is on, the UID and GID are set to the values that were in effect when you started the shell.
`restricted`	off	Sets a restricted shell.
`trackall`	off	Makes command-tracked aliases when they are first encountered.
`verbose`	off	Displays the input as it is read.
`vi`	off	Sets vi as the in-line editor.
`viraw`	off	Specifies character-at-a-time input from vi.
`xtrace`	off	Displays commands and arguments as they are executed.

To enable an option, type **`set -o`** ***`option-name`*** and press Return. To disable an option, type **`set +o`** ***`option-name`*** and press Return.

For example, entering this line in the user's *`.ksh-env`* file will set the in-line editor to `vi`:

```
set -o vi
```

This turns off vi as the in-line editor:

```
set +o vi
```

You can also set these options from a command line using the same syntax.

Creating Korn Shell Aliases

The syntax for creating aliases for the Korn shell is alias *name=value*. This creates an alias for the `alias` command:

```
$ alias a=alias
$
```

This example aliases the `history` command to the letter `h`:

```
$ a h=history
$
```

The Korn shell comes with a default set of predefined aliases. To display the list, type **alias** and press Return:

```
$ alias
autoload=typeset -fu
false=let 0
functions=typeset -f
hash=alias -t -
history=fc -l
integer=typeset -i
nohup=nohup
r=fc -e -
stop=kill -STOP
suspend=kill -STOP $$
true=:
type=whence -v
$
```

The default aliases are described in Table 8–3.

Table 8–3 Korn Shell Preset Aliases

Alias	Value	Definition
`autoload`	`typeset -fu`	Define an autoloading function.
`false`	`let -0`	Return a nonzero status. Often used to generate infinite `until` loops.
`functions`	`typeset -f`	Display a list of functions.
`hash`	`alias -t -`	Display a list of tracked aliases.
`history`	`fc -l`	List commands from the history file.
`integer`	`typeset -i`	Declare integer variable.
`nohup`	`nohup`	Keep jobs running even if you log out.
`r`	`fc -e -`	Execute the previous command again.
`stop`	`kill -STOP`	Suspend job.
`suspend`	`kill -STOP $$`	Suspend job.

Table 8–3 Korn Shell Preset Aliases (continued)

Alias	Value	Definition
`true`	`:`	Return a zero exit status.
`type`	`whence -v`	Display information about commands.

Editing Commands with the Korn Shell In-line Editor

You can edit the current command before you execute it using the Korn shell in-line editor. You can choose one of three in-line editors: `emacs`, `gmacs`, or `vi`. The in-line editor is specified using the `set -o` *`editor`* option or by setting either the `EDITOR` or `VISUAL` environment variable. This section describes how to use the `vi` in-line editor to edit commands.

The `vi` in-line editor is a modified subset of the `vi` program; it lacks some of the features of `vi`. The `vi` in-line editor is automatically in insert mode. You can type commands and execute them by pressing Return without using the `vi` in-line editor. If you want to edit a command, press Escape to enter command mode. You can move along the command line using the standard cursor movement commands, and use standard `vi` editing commands to edit the contents of the line. When the command is edited, press Return to execute it, or press Escape to return to input mode.

If you want to edit the command line in a `vi` file, type **v** to open a `vi` file containing the contents of the command line. When you leave `vi`, the command is executed. Refer to Table 2–1, "Some Basic vi Commands" for a quick-reference table of common `vi` commands.

Setting History for the Korn Shell

The Korn shell stores history commands in a file specified by the `HISTFILE` variable. If the variable is not set, the files are stored in `$HOME/.sh_history`. You can specify the number of commands stored using the `HISTSIZE` variable. If the variable is not set, the most recent 128 commands are saved. When the history list contains the maximum number of commands, as new commands are entered, the oldest commands become unavailable.

To set a different history size, type **`HISTSIZE=`*`n`*`;export HISTSIZE`** and press Return. History is set to the number of lines you specify.

In this example, the history size is set to 200:

```
$ HISTSIZE=200;export HISTSIZE
$
```

You can set the history temporarily for a shell window or set it "permanently" by entering the command as a line in the user's `.profile` or `.`*`ksh-env`* file.

Displaying Korn Shell History Commands

You can use two commands to show the commands from the history list: `fc` and `history`. Because `history` is aliased to `fc -l` as one of the default aliases, you can use the commands interchangeably.

To display the last 16 commands in the history list, type **history** and press Return. The last 16 commands in the history list are displayed:

```
$ history
    16  pwd
    17  ps -el
    18  ps -el ¦ grep openwin
    19  cd
    20  more questionnaire
    21  su
    22  lp /etc/passwd
    23  lpstat -t
    24  man ksh
    25  du
    26  maker &
    27  tip -2400 5551212
    28  alias h=history
    29  find / -name ksh -print
    30  df -k
    31  history
$
```

An alternative way to display the same information is to type **fc -l** and press Return.

The `history` and `fc` commands take additional arguments that let you specify a range, display the last *n* number of commands, and display the commands in reverse order. See the `ksh`(1) manual page for more information.

Using Korn Shell History Commands

To use a command from the history list, type `r` ***n*** to reuse a command by number. This example would reuse command 27:

```
$ r 27
tip -2400 5551212
(Connection messages are displayed)
```

To repeat the last command in the history list, type **r** and press Return.

Editing Korn Shell History Commands

You can display individual history commands and edit them using the `fc` command, with this syntax:

```
fc [-e <editor>] [-r] [<range>]
```

or this:

```
fc -e - [<old>=<new>] [command]
```

You use the `-e` option to specify an editor. If no editor is specified, the `FCEDIT` environment variable value is used. If no value is set, the default editor is `/bin/ed`. The `-r` option reverses the order of the commands, displaying the most recent commands at the top of the list. If no range is given, the last command is edited.

For example, to use `vi` to edit the last command in a history list, type **`fc -e vi`** and press Return. A `vi` file is created containing the last entry from the history list. When you edit the command and save the changes, the command is executed.

CHAPTER

9

Administering Systems

Displaying System-Specific Information

Configuring Additional Swap Space (`mkfile`, `swap`)

Creating a Local Mail Alias (`/etc/mail/aliases`)

THIS CHAPTER DESCRIBES COMMANDS THAT ARE SPECIFIC TO INDIVIDUAL systems. It also shows how to configure additional swap space and how to create a local mail alias.

Displaying System-Specific Information

Use the commands in this section to find system-specific information such as the host ID number, hardware type, processor type, OS release level, system configuration, how long the system has been up, and system date and time. The following sections also describe how to set the system date and time and change the time zone for a system.

Determining the Host ID Number (*sysdef -h*)

SVR4

To find a system's host ID number, type **sysdef -h** and press Return. The host ID for the system is displayed. This command replaces the SunOS 4.*x* `hostid` command:

```
oak% sysdef -h
*
* Hostid
*
  554095cc
oak%
```

Determining the Hardware Type (*uname -m*)

SVR4

To find the hardware type of a system, type **uname -m** and press Return. The hardware type (architecture) for the system is displayed. The SunOS 4.*x* `arch` command, which provided similar information, is not available in SunOS 5.*x*:

```
oak% uname -m
sun4m
oak%
```

Determining the Processor Type (*uname -p*)

SVR4

To find the processor type for a system, type **uname -p** and press Return. The processor type for the system is displayed. This command replaces the SunOS 4.*x* `mach` command:

```
oak% uname -p
sparc
oak%
```

Determining the OS Release (*uname -r*)

To find the OS release level for a system, type **uname -r** and press Return. The OS (kernel) release is displayed:

```
oak% uname -r
5.6
oak%
```

Displaying System Configuration Information (*prtconf*)

SVR4

To display the configuration information for a system, type `prtconf` and press Return. The system configuration information is displayed:

NEW

```
castle% prtconf
System Configuration:  Sun Microsystems  sun4m
Memory size: 64 Megabytes
System Peripherals (Software Nodes):

SUNW,SPARCstation-10
    packages (driver not attached)
        disk-label (driver not attached)
        deblocker (driver not attached)
        obp-tftp (driver not attached)
    options, instance #0
    aliases (driver not attached)
    openprom (driver not attached)
    iommu, instance #0
        sbus, instance #0
            espdma, instance #0
                esp, instance #0
                    sd (driver not attached)
                    st (driver not attached)
                    sd, instance #0 (driver not attached)
                    sd, instance #1 (driver not attached)
                    sd, instance #2 (driver not attached)
                    sd, instance #3
                    sd, instance #4 (driver not attached)
                    sd, instance #5 (driver not attached)
                    sd, instance #6 (driver not attached)
            ledma, instance #0
                le, instance #0
            SUNW,bpp (driver not attached)
            SUNW,DBRIe (driver not attached)
                mmcodec (driver not attached)
            cgsix, instance #0
    obio, instance #0
        zs, instance #0
        zs, instance #1
        eeprom (driver not attached)
        counter (driver not attached)
        interrupt (driver not attached)
        SUNW,fdtwo, instance #0
        auxio (driver not attached)
        power (driver not attached)
    memory (driver not attached)
    virtual-memory (driver not attached)
    eccmemctl (driver not attached)
    TI,TMS390Z55 (driver not attached)
    pseudo, instance #0
```

```
(More information not shown in this example)
castle%
```

An alternative way to display system configuration information and show the state of tunable parameters is to type **sysdef** and press Return. System configuration information is displayed:

NEW

```
castle% sysdef
*
* Hostid
*
  727014d0
*
* sun4m Configuration
*
*
* Devices
*
packages (driver not attached)
        disk-label (driver not attached)
        deblocker (driver not attached)
        obp-tftp (driver not attached)
options, instance #0
aliases (driver not attached)
openprom (driver not attached)
iommu, instance #0
        sbus, instance #0
                espdma, instance #0
                        esp, instance #0
                                sd (driver not attached)
                                st (driver not attached)
                                sd, instance #0 (driver not attached)
                                sd, instance #1 (driver not attached)
                                sd, instance #2 (driver not attached)
                                sd, instance #3
                                sd, instance #4 (driver not attached)
                                sd, instance #5 (driver not attached)
                                sd, instance #6 (driver not attached)
                ledma, instance #0
                        le, instance #0
                SUNW,bpp (driver not attached)
                SUNW,DBRIe (driver not attached)
                        mmcodec (driver not attached)
                cgsix, instance #0
obio, instance #0
        zs, instance #0
        zs, instance #1
        eeprom (driver not attached)
        counter (driver not attached)
        interrupt (driver not attached)
        SUNW,fdtwo, instance #0
        auxio (driver not attached)
        power (driver not attached)
memory (driver not attached)
virtual-memory (driver not attached)
eccmemctl (driver not attached)
```

```
TI,TMS390Z55 (driver not attached)
pseudo, instance #0
        clone, instance #0
        ip, instance #0
        tcp, instance #0
        udp, instance #0
        icmp, instance #0
        arp, instance #0
        sad, instance #0
        consms, instance #0
        conskbd, instance #0
        wc, instance #0
        iwscn, instance #0
        ptsl, instance #0
        tl, instance #0
        cn, instance #0
        mm, instance #0
        openeepr, instance #0
        kstat, instance #0
        log, instance #0
        sy, instance #0
        pm, instance #0
        vol, instance #0
        ptm, instance #0
        pts, instance #0
        ksyms, instance #0
*
* Loadable Objects
*
genunix
drv/arp
        hard link:  strmod/arp
drv/arp
drv/be
(More information not shown in this example)
exec/aoutexec
exec/elfexec
exec/intpexec
fs/cachefs
fs/fifofs
fs/hsfs
fs/lofs
fs/nfs
        hard link:  sys/nfs
fs/procfs
fs/sockfs
fs/specfs
fs/tmpfs
fs/ufs
fs/autofs
misc/consconfig
misc/des
misc/ipc
misc/klmmod
misc/klmops
misc/krtld
```

```
misc/nfs_dlboot
misc/nfssrv
misc/rpcsec
misc/rpcsec_gss
misc/scsi
(More information not shown in this example)
sched/TS
sched/TS_DPTBL
strmod/bufmod
strmod/connld
strmod/dedump
strmod/ldterm
(More information not shown in this example)
sys/c2audit
sys/doorfs
sys/inst_sync
sys/kaio
sys/msgsys
sys/pipe
sys/pset
sys/semsys
sys/shmsys
*
* System Configuration
*
  swap files
swapfile             dev  swaplo blocks   free
/dev/dsk/c0t3d0s1   32,25      8 224096 224096
*
* Tunable Parameters
*
 1298432        maximum memory allowed in buffer cache (bufhwm)
     986        maximum number of processes (v.v_proc)
      99        maximum global priority in sys class (MAXCLSYSPRI)
     981        maximum processes per user id (v.v_maxup)
      30        auto update time limit in seconds (NAUTOUP)
      25        page stealing low water mark (GPGSLO)
       5        fsflush run rate (FSFLUSHR)
      25        minimum resident memory for avoiding deadlock (MINARMEM)
      25        minimum swapable memory for avoiding deadlock (MINASMEM)
*
* Utsname Tunables
*
     5.6  release (REL)
  castle  node name (NODE)
   SunOS  system name (SYS)
 Generic  version (VER)
*
* Process Resource Limit Tunables (Current:Maximum)
*
fffffff:fffffffd       cpu time
fffffff:fffffffd       file size
fffffff:fffffffd       heap size
fffffff:fffffffd       stack size
      0:7ffff000       core file size
fffffff:fffffffd       file descriptors
```

```
      0:  800000      mapped memory
*
* Streams Tunables
*
     9  maximum number of pushes allowed (NSTRPUSH)
 65536  maximum stream message size (STRMSGSZ)
  1024  max size of ctl part of message (STRCTLSZ)
*
* IPC Messages
*
     0  entries in msg map (MSGMAP)
     0  max message size (MSGMAX)
     0  max bytes on queue (MSGMNB)
     0  message queue identifiers (MSGMNI)
     0  message segment size (MSGSSZ)
     0  system message headers (MSGTQL)
     0  message segments (MSGSEG)
*
* IPC Semaphores
*
    10  entries in semaphore map (SEMMAP)
    10  semaphore identifiers (SEMMNI)
    60  semaphores in system (SEMMNS)
    30  undo structures in system (SEMMNU)
    25  max semaphores per id (SEMMSL)
    10  max operations per semop call (SEMOPM)
    10  max undo entries per process (SEMUME)
 32767  semaphore maximum value (SEMVMX)
 16384  adjust on exit max value (SEMAEM)
*
* IPC Shared Memory
*
   1048576      max shared memory segment size (SHMMAX)
     1  min shared memory segment size (SHMMIN)
   100  shared memory identifiers (SHMMNI)
     6  max attached shm segments per process (SHMSEG)
*
* Time Sharing Scheduler Tunables
*
60      maximum time sharing user priority (TSMAXUPRI)
SYS     system class name (SYS_NAME)
castle%
```

Determining How Long a System Has Been Up (*uptime*)

To find out how long a system has been up, type `uptime` and press Return. The time, number of users, and load average are displayed for the local system:

```
castle% uptime
  1:16pm  up  4:57,  1 user,  load average: 0.12, 0.06, 0.04
castle%
```

SVR4

To find out when a system was booted, type `who -b` and press Return. The month, day, and time of the last boot are displayed:

```
oak% who -b
 . system boot Jul 14 08:49
oak%
```

Determining the System Date and Time (*date*)

To display the system date and time, type `date` and press Return. The system date and time are displayed:

```
castle% date
Tue Sep 16 13:17:03 PDT 1997
castle%
```

Setting the System Date and Time (*date*)

Follow these steps to reset the system date and time:

6. Become superuser.

7. Type `date` ***mmddhhmmyy*** and press Return, where *mm* is the month, *dd* is the day, *hh* is the hour, *mm* is the minute, and *yy* is the year. The system date and time are reset using the month, day, hour, minute, and year that you specify:

   ```
   # su
   Password:
   # date
   Tue Jul 14 16:07:01 PST 1992
   # date 07141552
   Tue Jul 14 15:52:00 PST 1992
   #
   ```

Changing the System Time Zone (*/etc/TIMEZONE*)

SVR4

The time zone is set in the `/etc/TIMEZONE` file. The available U.S. time zone variables are shown below. Look in the `/usr/share/lib/zoneinfo` directory for a complete list of time zone variables.:

```
US/Arizona
US/Central
US/East-Indiana
US/Hawaii
US/Mountain
US/Pacific
US/Pacific-New
US/Yukon
```

Follow these steps to change the system time zone:

1. Become superuser.

2. Edit the `/etc/TIMEZONE` file, change the `TZ=`*`time-zone`* variable, and save the changes. The time zone is reset.

3. Reboot the system.

NEW

Here is an example of the `/etc/TIMEZONE` file for a system set to Pacific Standard/Pacific Daylight Time. Note that `/etc/TIMEZONE` is now a symbolic link to `/etc/default/init`:

```
castle% more /etc/TIMEZONE
# @(#)init.dfl 1.2 92/11/26
#
# This file is /etc/default/init.  /etc/TIMEZONE is a symlink to this file.
# This file looks like a shell script, but it is not.  To maintain
# compatibility with old versions of /etc/TIMEZONE, some shell constructs
# (i.e., export commands) are allowed in this file, but are ignored.
#
# Lines of this file should be of the form VAR=value, where VAR is one of
# TZ, LANG, or any of the LC_* environment variables.
#
TZ=US/Pacific
castle%
```

Here is an example of how to change the time zone from Pacific to Eastern:

```
oak% su
Password:
# vi /etc/TIMEZONE
TZ=US/East-Indiana;export TZ
:w!
# reboot
oak% date
Tue Jul 14 14:24:52 EST 1992
oak%
```

NOTE. *You may need to make your text editor do a confirmed write of the file. For example, in* `vi` *use the command* `:w!` *to write the changes even if the permissions normally would not allow it.*

Configuring Additional Swap Space (*mkfile, swap*)

SVR4

To create and add additional swap space without reformatting a disk, first you create a swap file using the `mkfile` command. You can specify the size of the swap file in kilobytes (the default) or in blocks or megabytes by using the `b` and `m` suffixes, respectively. The swap file can either be on a local disk or be NFS-mounted. Then you add the swap space using the `swap` command.

To list available swap files, type **swap -l** and press Return. A list of available swap files is displayed. The `swap` command replaces the SunOS 4.*x* `swapon` command:

```
drusilla% swap -l
swapfile             dev   swaplo blocks   free
swapfs                -         0  94520  93512
/dev/dsk/c0t3d0s1   32,25       8  65512  45048
drusilla%
```

Follow these steps to create a swap file:

1. Become superuser. You can create a swap file without root permissions, but it is a good idea to have root be the owner of the swap file so that other processes cannot access it.
2. Type `mkfile` ***nnn***`[k|b|m]` ***file-name*** and press Return. The letter following the number you specify indicates kilobytes, blocks, or megabytes. The swap file of the size and file name you specify is created. In this example, you create a 1-Mbyte swap file named SWAP:

```
oak% su
Password:
# mkfile 1m /files1/SWAP
#
```

Follow these steps to add the swap file:

1. Become superuser.
2. Type **swap -a** ***path-name*** and press Return. You must use the absolute path name to specify the swap file. The swap file is added and available.
3. Type **swap -l** to verify that the swap file is added.

```
# swap -a /files1/SWAP
# swap -l
swapfile             dev  swaplo blocks   free
swapfs                -        Ø  94520Ø  93512

/dev/dsk/cØt3dØs1   32,25      8  65512  45Ø48

/files1/SWAP  -  8   2Ø4Ø   2Ø4Ø
#
```

Follow these steps to remove a specified swap file from use:

1. Become superuser.
2. Type **swap -d** ***path-name*** and press Return. When the swap file is no longer in use, it is removed from the list so that it is no longer available for swapping. The file itself is not deleted:

```
oak% su
Password:
# swap -d /files1/SWAP
# swap -l
swapfile             dev  swaplo
blocks   free
swapfs                -        Ø
94520Ø  93512

/dev/dsk/cØt3dØs1   32,25      8
65512  45Ø48
# ls -l /files1/SWAP
-rw-------   1 root   root     1Ø48576 Jan 31 13:56 SWAP
#
```

When you create additional swap space, if you want the swap space to remain available when the system is rebooted, you must add the entry to the `/etc/vfstab` file. Follow these steps to add a swap file entry to the `/etc/vfstab` file:

1. Become superuser.
2. Edit the `/etc/vfstab` file and add this line: ***`path-name`*** `- - swap - no -`. Be sure the line follows the entry for the partition where the swap file was created.

The next time the system is rebooted, the swap file is added automatically.

The following example adds the swap file `/files1/SWAP` to the `/etc/vfstab` file after the entry that mounts the file system `/files1`:

```
/files1/SWAP - - swap - no -
```

Creating a Local Mail Alias (*/etc/mail/aliases*)

In a network environment, you probably have a central way to administer mail aliases. In addition, users frequently want to set up local aliases for use from their systems. Follow these steps to create mail aliases on a local system:

1. Become superuser.
2. Edit the `/etc/mail/aliases` file.
3. At the end of the file, under the Local Aliases category, type ***`aliasname:username1,username2`***`,...` and press Return after the last *`username`*.
4. Save the changes.

For example, if you want to create an alias called `friends`, edit the `/etc/mail/` aliases file and add an entry like this:

```
friends:dexter@elm,ogden@willow,mary@maple
```

CHAPTER

10

Recognizing File Access Problems

Recognizing Problems with Search Paths

Recognizing Problems with Permissions and Ownership

THIS CHAPTER DESCRIBES HOW TO RECOGNIZE PROBLEMS WITH SEARCH PATHS, permissions, and ownership.

Users frequently experience problems—and call on a system administrator for help—because they cannot access a program, a file, or a directory that they used to be able to access. Whenever you encounter such a problem, investigate one of two areas:

- The user's search path may have been changed, or the directories in the search path may not be in the proper order.
- The file or directory may not have the proper permissions or ownership.

This chapter briefly describes how to recognize problems in each of these areas and suggests possible solutions.

Recognizing Problems with Search Paths

If a user types a command that is not in the search path, the message `Command not found` is displayed. The command may not be found because the command is not available on the system or the command directory is not in the search path.

If the wrong version of the command is found, a directory with a command of the same name is in the search path. In this case, the proper directory may be found later in the search path or may not be present at all.

To diagnose and troubleshoot problems with search paths, follow this procedure:

1. Display the current search path.
2. Edit the file where the user's path is set (`.cshrc` or `.login` for the C shell; `.profile` for the Bourne and Korn shells). Add the directory, or rearrange the order of the path.

NOTE. *For the C shell, always check both the* `.cshrc` *and* `.login` *files to make sure the path information is set all in one place. Duplicate entries can make the search path hard to troubleshoot and make search times less efficient for the user.*

3. Source the file to activate the changes.
4. Verify that the command is found in the right place.
5. Execute the command.

The tasks you use to follow this procedure are described in the following sections.

Displaying the Current Search Path

To display the current search path, type **echo $PATH** and press Return. The current search path is displayed:

```
cinderella% echo $PATH
/sbin:/usr/sbin:/usr/bin:/etc
cinderella%
```

Setting the Path for Bourne and Korn Shells

The path for the Bourne and Korn shells is specified in the user's `$HOME/.profile` file in this way:

```
PATH=/usr/bin:/$HOME/bin:.;export PATH
```

The dot (.) at the beginning of the path specifies that the current directory is always searched first.

Sourcing Bourne and Korn Shell Dot Files

When you have changed information in the `.profile file`, you must source the file to make the new information available to the shell. To source the `.profile file`, type **. .profile** and press Return:

```
$ . .profile
$
```

Setting the Path for the C Shell

The path for the C shell is specified in the user's `$HOME/.cshrc` or `.login` file (with the `set path` environment variable) in this way:

```
set path =  (/usr/bin $home/bin .)
```

The dot (.) at the beginning of the path specifies that the current directory is always searched first.

Sourcing C Shell Dot Files

When you have changed information in the `.cshrc` or `.login file`, you must source the file to make the new information available to the shell. To source the `.cshrc` file, type **source .cshrc** and press Return. To source the `.login` file, type **source .login** and press Return:

```
castle% source .cshrc
castle% source .login
castle%
```

Verifying the Search Path

When you have changed a user's path, use the `which` command to verify that the shell is finding the proper command. The `which` command looks in the `.cshrc` file for information. The `which` command may give misleading results if you execute it from the Bourne or Korn shell and the user has a `.cshrc` file that contains aliases for the `which` command. To ensure accurate results, use the `which` command in a C shell. Alternatively, you can use the `whence` command instead of the `which` command from the Korn shell.

To verify the search path, type **`which`** ***`command-name`*** and press Return. If the command is found in the path, the path and the name of the command are displayed.

This example shows that the OpenWindows executable is not in any of the directories in the search path:

```
oak% which openwin
no openwin in . /home/ignatz /sbin /usr/sbin /usr/bin /etc /home/ignatz/bin
/bin /home/bin /usr/etc
oak%
```

This example shows that the executable for OpenWindows is found among the directories in the search path:

```
oak% which openwin
/usr/openwin
oak%
```

If you cannot find a command, look at the manual page. For example, if you cannot find the `lpsched` command (the LP printer daemon), the `lpsched`(1M) manual page tells you the path is `/usr/lib/lp/lpsched`.

Executing a Command

To execute a command, type ***`command-name`*** and press Return. The command is executed if it is in the search path. You can always execute a command that is not in the search path by typing the full path name for the command.

Recognizing Problems with Permissions and Ownership

When users cannot access files or directories that they used to be able to access, the most likely problem is that permissions or ownership on the files or directories has changed.

Frequently, file and directory ownerships change because someone edited the files as root. When you create home directories for new users, be especially careful to make the user the owner of the dot (.) file in the home directory. When users do not own the dot (.) files, they cannot create files in their own home directory.

Another way access problems can arise is when the group ownership changes or when a group that a user is a member of is deleted from the `/etc/groups` database.

Changing File Ownership

NOTE. *You must own a file or directory (or have root permission) to be able to change its ownership.*

Follow these steps to change file ownership:

1. Type `ls -l` ***file-name*** and press Return. The owner of the file is displayed in the third column.
2. Become superuser.
3. Type **chown** ***new-owner file-name*** and press Return. Ownership is assigned to the new owner you specify, in this case, `ignatz`:

```
oak% ls -l quest
-rw-r--r--   1 fred   staff    6023 Aug  5 12:06 quest
oak% su
Password:
# chown ignatz quest
# ls -l quest
-rw-r--r--   1 ignatz   staff    6023 Aug  5 12:06 quest
#
```

Changing File Permissions

You use the `chmod` command to change file permissions. You can change permissions in two ways. If you use letters, use this syntax:

`chmod [who]`*`operator`*`[permission(s)]` *`file-name`*

For `who`, you can specify `u`, `g`, or `o` (for user, group, or other). You can specify `a` to change all operators. If you do not specify who permissions are for, permissions are changed for all three groups. The operator is either + to add permission or - to take away permission. The permissions are `r`, `w`, or `x`, for read, write, or execute. See the `chmod`(1) manual page for more permissions.
For example, to grant read, write, and execute permissions to everyone, type **chmod +wrx** ***file-name*** and press Return:

```
oak% chmod +wrx dog
oak% ls -l dog
-rwxrwxrwx  1    janice    staff    54  Jul 7  11:33  dog
oak%
```

To grant read and execute permissions to everyone, type **chmod +rx** ***file-name*** and press Return:

```
oak% chmod +rx dog
oak% ls -l dog
```

```
-r-xr-xr-x  1    janice    staff    54  Jul 7  11:34  dog
oak%
```

Another way to change the permissions to read and execute only would be to deny write permission to everyone. Type `chmod -w` ***file-name*** and press Return:

```
oak% chmod -w dog
oak% ls -l dog
-r-xr-xr-x  1    janice    staff    54  Jul 7  11:35  dog
oak%
```

To change ownership for a specific group, type the letter for the group followed by the operator and the permission. In the following example, read, write, and execute permissions have been granted for the owner to the file `dog`:

```
oak% chmod u+wrx dog
oak% ls -l dog
-rwxr-xr-x  1    janice    staff    54  Jul 7  11:36  dog
oak%
```

To deny execute permissions to group and other, type `chmod go-x` ***file-name*** and press Return.

```
oak% chmod go-x dog
oak% ls -l dog
-rwxr--r--  1    janice    staff    54  Jul 7  11:37  dog
oak%
```

You can also use a numeric argument with the `chmod` command that describes the user class and permission to change as a sequence of bits. Table 10–1 shows the octal values for setting file permissions. You use these numbers in sets of three to set permissions for owner, group, and other. For example, the value `644` sets read/write permissions for owner, and read-only permissions for group and other.

Table 10–1 Octal Values for File Permissions

Value	Description
0	No permissions
1	Execute-only
2	Write-only
3	Write, execute
4	Read-only
5	Read, execute
6	Read, write
7	Read, write, execute

Follow these steps to change permissions on a file:

1. Type `ls -l` ***file-name*** and press Return. The long listing shows the current permissions for the file.
2. Type `chmod` ***nnn filename*** and press Return. Permissions are changed using the numbers you specify.

NOTE. *You can change permissions on groups of files or on all files in a directory using metacharacters such as* `*` *and* `?` *in place of file names or in combination with them.*

This example changes the permissions of a file from 666 (read/write, read/write, read/write) to 644 (read/write, read-only, read-only):

```
oak% ls -l quest
-rw-rw-rw-   1 ignatz   staff    6023 Aug  5 12:06 quest
oak% chmod 644 quest
oak% ls -l quest
-rw-r--r--   1 ignatz   staff    6023 Aug  5 12:06 quest
oak%
```

Changing File Group Ownership

If a file has an incorrect group owner, users of the group will not be able to make changes to the file. To change file group ownership, you must either be a member of the group, own the file, or change it as root.

To change the group ID for a file, type `chgrp` ***gid filename*** and press Return. The group ID for the file you specify is changed. With Solaris 2.*x*, the `ls -l` command shows the owner and the group for the file. You can display only the group owner using the `ls -lg` command:

```
$ ls -lg junk
-rw-r--r-- 1 other 0 Oct 31 14:49 junk
$ chgrp 10 junk
$ ls -lg junk
-rw-r--r-- 1 staff 0 Oct 31 14:49 junk
$
```

The group ID is found in the `Group` database or the local `/etc/group` file.

APPENDIX

A

Major Differences: SunOS 4.*x* Versus SunOS 5.*x* Operating Systems

THIS APPENDIX SUMMARIZES THE MAJOR DIFFERENCES BETWEEN THE SUNOS 4.*x* and SunOS 5.*x* operating systems in these areas:

- Installation and configuration
- Startup and shutdown
- File systems
- Printers, terminals, and modems
- Naming services
- TCP/IP
- UUCP
- Document tool differences
- Security

The last section in this appendix contains an alphabetical list of SunOS 4.*x* commands and shows the equivalent SunOS 5.*x* command, if one is available.

Installation and Configuration

Solaris 2.*x* software is distributed on compact disc (CD-ROM) only. You must have access to a CD drive before you can install the software. However, because you can set up a system to act as a remote server when installing the software on systems without local CD drives, you need access to only one CD drive on the network.

Solaris 2.*x* software is bundled into modules called *packages*. You can select packages that are relevant to your system and control the amount of space each installation requires. Sometimes packages are grouped into *clusters* so that you can install a set of packages for typical users, developers, or system administrators without selecting each package separately.

SunOS 5.*x* software includes architecture-specific kernels, rather than the generic kernel configuration provided in earlier SunOS software releases. You will find the installed kernel in `/kernel/unix` instead of `/vmunix`.

You no longer need to manually configure and build new kernels. When you install new device drivers and boot the system using the `boot -r` command, the kernel dynamically reconfigures itself.

When you boot the installation CD, a utility called `sysidtool` checks network databases for system configuration information. The `sysidtool` utility uses the information it finds and prompts you to enter other required information.

What Is Installed on a SunOS 5.*x* System

The `/var/sadm/install/contents` file lists every file that installation puts onto the system. To find out if a specific file was installed, look through `/var/sadm/install/contents` to see if the file is listed. The file contains the complete path, the ownership and protection of the file, and the package from which the file was installed. For example, to display information about the `printf` file, type **`# grep printf /var/sadm/install/contents`**. Your screen will look like this:

2.6

```
# grep printf /var/sadm/install/contents
/usr/bin/printf f none 0555 bin bin 11628 1694 869027018 SUNWloc
/usr/share/man/man1/printf.1 f none 0444 bin bin 10827 6685 867348047 SUNWman
/usr/share/man/man3b/fprintf.3b f none 0444 bin bin 57 3974 867349873 SUNWman
/usr/share/man/man3b/printf.3b f none 0444 bin bin 11825 25632 867349885 SUNWman
/usr/share/man/man3b/sprintf.3b f none 0444 bin bin 57 3987 867349912 SUNWman
/usr/share/man/man3b/vfprintf.3b f none 0444 bin bin 58 4092 867349923 SUNWman
/usr/share/man/man3b/vprintf.3b f none 0444 bin bin 57 3990 867349924 SUNWman
/usr/share/man/man3b/vsprintf.3b f none 0444 bin bin 58 4105 867349926 SUNWman
/usr/share/man/man3c/wsprintf.3c f none 0444 bin bin 1635 4399 867350689 SUNWman
/usr/share/man/man3s/fprintf.3s f none 0444 bin bin 57 4025 867352286 SUNWman
/usr/share/man/man3s/printf.3s f none 0444 bin bin 18972 20693 867352330 SUNWman
/usr/share/man/man3s/snprintf.3s f none 0444 bin bin 58 4145 867352353 SUNWman
/usr/share/man/man3s/sprintf.3s f none 0444 bin bin 57 4038 867352355 SUNWman
/usr/share/man/man3s/vfprintf.3s f none 0444 bin bin 59 4261 867352371 SUNWman
/usr/share/man/man3s/vprintf.3s f none 0444 bin bin 4365 34455 867352374 SUNWman
/usr/share/man/man3s/vsnprintf.3s f none 0444 bin bin 60 4381 867352376 SUNWman
/usr/share/man/man3s/vsprintf.3s f none 0444 bin bin 59 4274 867352376 SUNWman
/usr/share/man/man9f/sprintf.9f f none 0444 bin bin 3571 42682 867356508 SUNWman
/usr/share/man/man9f/vsprintf.9f f none 0444 bin bin 5193 43812 867356551
SUNWman
#
```

NOTE. *When you complete system installation, you may need to type the* `boot -r` *command to reconfigure the device names and modules so that they work with Solaris 2.*x.

Startup and Shutdown

SunOS 5.*x* system software has eight initialization states (init states or run levels). The default init state is defined in the `/etc/inittab` file. See "Choosing an Init State" in Chapter 1 for a description of the initialization states.

The `shutdown` command works differently than in the SunOS 4.*x* version. The SunOS 4.*x* `fastboot` and `fasthalt` commands are available only on SunOS 5.*x* systems with BSD source compatibility package installed.

The `halt` and `reboot` commands (not found in AT&T SVR4 systems) have `shutdown` and `init` equivalents. It is recommended that you use them because `halt` and `reboot` do not run the `rc` scripts properly.

The init command uses a different script for each run level instead of grouping all the run levels together in the /etc/rc, /etc/rc.boot, and /etc/rc.local files. The files, named by run level, are located in the /sbin directory.

Here is a list of the default run control scripts in the /sbin directory:

NEW

```
castle% ls -l /sbin/rc*
-rwxr--r--   3 root     sys         1776 Jan  1  1970 /sbin/rc0
-rwxr--r--   1 root     sys         1159 Jan  1  1970 /sbin/rc1
-rwxr--r--   1 root     sys         1545 Jan  1  1970 /sbin/rc2
-rwxr--r--   1 root     sys          927 Jan  1  1970 /sbin/rc3
-rwxr--r--   3 root     sys         1776 Jan  1  1970 /sbin/rc5
-rwxr--r--   3 root     sys         1776 Jan  1  1970 /sbin/rc6
-rwxr--r--   1 root     sys         6919 Jan  1  1970 /sbin/rcS
castle%
```

NOTE. *The /sbin/rc directory now contains an rcS script used to bring the system to single-user mode. For more information, see "The rcS Script" later in this appendix.*

Run control files are located in the /etc/init.d directory. These files are linked to corresponding run control files in the /etc/rc/etc and /etc/rc*.d directories. The files in the /etc directory define the sequence in which the scripts are performed within each run level. For example, /etc/rc2.d contains files used to start and stop processes for run level 2.

NEW

```
castle% ls /etc/rc2.d
K20spc             S47asppp            S74syslog          S89bdconfig
K60nfs.server      S69inet             S74xntpd           S91agaconfig
K76snmpdx          S70uucp             S75cron            S91leoconfig
K77dmi             S71rpc              S76nscd            S92rtvc-config
README             S71sysid.sys        S80PRESERVE        S92volmgt
S01MOUNTFSYS       S72autoinstall      S80lp              S93cacheos.finish
S05RMTMPFILES      S72inetsvc          S80spc             S99audit
S20sysetup         S73cachefs.daemon   S85power           S99dtlogin
S21perf            S73nfs.client       S88sendmail
S30sysid.net       S74autofs           S88utmpd
castke%
```

The scripts are always run in ASCII sort order. The names of the scripts are names of the forms [K,S][0–9][A–Z][0–99]. Files beginning with K are run to terminate (kill) some system process. Files beginning with S are run to start up a system process. The actions of each run control level script are summarized in the following sections.

The *rc0* Script

- Stops system services and daemons
- Terminates all running processes
- Unmounts all file systems

NEW

```
castle% ls /etc/rc0.d
K00ANNOUNCE   K47asppp     K66nfs.server  K73volmgt
K10dtlogin    K50utmpd     K69autofs      K75nfs.client
K20lp         K55syslog    K69xntpd       K76nscd
K42audit      K57sendmail  K70cron        K85rpc
castle%
```

The *rc1* Script

- Runs the `/etc/rc1.d` scripts
- Stops system services and daemons
- Terminates all running processes
- Unmounts all file systems
- Brings the system up in single-user mode

NEW

```
castle% ls /etc/rc1.d
K00ANNOUNCE   K47asppp     K65nfs.server  K70cron        S01MOUNTFSYS
K10dtlogin    K50utmpd     K67rpc         K76nscd
K20lp         K55syslog    K68autofs      K80nfs.client
K42audit      K57sendmail  K69xntpd       K85power
castle%
```

The *rc2* Script

- Sets the `TIMEZONE` variable
- Runs the `/etc/rc2.d` scripts
- Mounts all file systems
- Saves editing files in `/usr/preserve`
- Removes any files in the `/tmp` directory
- Creates device entries in `/dev` for new disks (only if `boot -r` is run)
- Updates `device.tab` device table
- Prints system configuration (the default is not to save core)
- Configures system accounting
- Configures default router
- Sets NIS domain
- Sets `ifconfig` netmask
- Starts `inetd`
- Starts `named`, if appropriate

- Starts rpcbind
- Starts Kerberos client-side daemon, kerbd
- Starts NIS daemons (ypbind) and NIS+ daemons (rpcnisd), depending on whether the system is configured for NIS or NIS+, and as a client or a server
- Starts keyserv
- Starts statd, lockd
- Mounts all NFS entries
- Starts automount
- Starts cron
- Starts the LP daemons
- Starts the sendmail daemon

NEW

```
castle% ls /etc/rc2.d
K20spc            S47asppp           S74syslog      S89bdconfig
K60nfs.server     S69inet            S74xntpd       S91agaconfig
K76snmpdx         S70uucp            S75cron        S91leoconfig
K77dmi            S71rpc             S76nscd        S92rtvc-config
README            S71sysid.sys       S80PRESERVE    S92volmgt
S01MOUNTFSYS      S72autoinstall     S80lp          S93cacheos.finish
S05RMTMPFILES     S72inetsvc         S80spc         S99audit
S20sysetup        S73cachefs.daemon  S85power       S99dtlogin
S21perf           S73nfs.client      S88sendmail
S30sysid.net      S74autofs          S88utmpd
castle%
```

The *rc3* Script

- Runs the /etc/rc3.d scripts
- Starts syslogd
- Cleans up sharetab
- Starts nfsds
- Starts mountd
- If boot server, starts rarpd and rpc.bootparamd
- Starts nis_cachemanager
- Starts rpc.nisd
- Starts RFS services, if configured

NEW

```
castle% ls /etc/rc3.d
README          S15nfs.server  S76snmpdx      S77dmi
castle%
```

The *rc5* Script

- Runs the `/etc/rc0.d` scripts
- Kills the printer daemons
- Unmounts local file systems
- Kills the `syslog` daemon
- Unmounts remote file systems
- Stops RFS services
- Stops NFS services
- Stops NIS services
- Stops `rpc` services
- Stops `cron` services
- Stops NFS client services
- Kills all active processes
- Initiates an interactive boot (`boot -a`)

The *rc6* Script

- Executes `/etc/rc0.d/K*`
- Kills all active processes
- Unmounts the file systems
- Executes the initdefault entries in `/etc/inittab`

NEW

The *rcS* Script

After the `S30` scripts have executed, the `/ and /usr` (if present) file systems are mounted read-only. Enough network plumbing has been established to perform an NFS mount of `/usr`.

The sequence range `S31-S39` can depend upon these file systems being read-only. No other file systems are mounted by the Solaris product.

After the `S60` scripts have executed, all system supplied device file names have been established. Therefore, the preferred range for the creation of file names for third-party devices is the range S61-S79, however, they may be done anywhere in the S61-S99 range. The environment symbol _INIT_RECONFIG is the key to a reconfiguration boot. Also, the base system mounts have been performed and those file systems are read/write if so specified. The base system mounts are:

```
/
/usr
/proc
/dev/fd
```

The following file systems can be assumed to be writable:

```
/dev            (for logical name creation)
/devices        (for physical name creation)
/etc            (for mnttab and file administration)
```

After the S80 scripts have executed, any other file systems to be mounted in single-user mode are mounted. Currently these are /var and /var/adm.

```
castle% ls /etc/rcS.d
K65pcmcia          S33keymap.sh           S60devlinks
README             S35cacheos.sh          S65pcmcia
S00sxcmem          S40standardmounts.sh   S70buildmnttab.sh
S10initpcmcia      S41cachefs.root
S30rootusr.sh      S50drvconfig
castle%
```

File Systems

The following sections describe changes to the file systems.

NFS and RFS

Solaris 2.*x* software includes a common set of commands and files to administer both network file system (NFS) and remote file sharing (RFS) resources. This set of commands is called distributed file system (DFS) administration. The common DFS commands replace the separate NFS and RFS commands required in SunOS 4.*x* systems, and simplify NFS and RFS resource sharing because it is necessary to remember only one set of commands. See Chapter 4, "Administering File Systems," for more information about file system commands.

Directory Changes

The directory structure is changed. The following sections provide an overview of file and directory information. If you cannot locate a familiar file or directory, it may not be available or its contents may be relocated.

Addition of the */opt* Directory

The `/opt` directory contains optional add-on application software packages. These packages were installed in `/usr` on SunOS 4.*x* systems. Keeping them in `/opt` leaves the `/usr` directory stable as packages are installed and removed.

Addition of the */proc* Directory

The `/proc` directory contains a numerical list of processes. Information in the `/proc` directory is used by commands such as `ps`. Debuggers and other development tools can also access the address space of the processes by using file system calls.

Addition of the */devices* directory

The `/devices` directory contains character and block special device files. Here is an example of the contents of the `/devices` directory:

```
oak% ls -l /devices
total 12
crw-rw-rw-   1 root    sys       28,128 Aug  3 15:10 audio@1,f7201000:audioctl,0

crw-------   1 root    sys       68, 11 Aug  3 13:56 eeprom@1,f2000000:eeprom
brw-rw-rw-   1 root    sys       36,  0 Aug  3 13:56 fd@1,f7200000:a
crw-rw-rw-   1 root    sys       36,  0 Aug  3 13:56 fd@1,f7200000:a,raw
brw-rw-rw-   1 root    sys       36,  1 Aug  3 13:56 fd@1,f7200000:b
crw-rw-rw-   1 root    sys       36,  1 Aug  3 13:56 fd@1,f7200000:b,raw
brw-rw-rw-   1 root    sys       36,  2 Aug  3 13:56 fd@1,f7200000:c
crw-rw-rw-   1 root    sys       36,  2 Aug  3 13:56 fd@1,f7200000:c,raw
drwxrwxrwx   2 root    sys         4608 Aug  3 15:10 pseudo
drwxrwxrwx   3 root    sys          512 Aug  3 13:56 sbus@1,f8000000
crw-rw-rw-   1 root    sys       29,  0 Aug  3 13:56 zs@1,f1000000:a
crw-rw-rw-   1 root    sys       29,131072 Aug  3 13:56 zs@1,f1000000:a,cu
crw-rw-rw-   1 root    sys       29,  1 Aug  3 13:56 zs@1,f1000000:b
crw-rw-rw-   1 root    sys       29,131073 Aug  3 13:56 zs@1,f1000000:b,cu
oak%
```

NEW

Addition of the */kernel* Directory

The `/kernel` directory contains the UNIX kernel and kernel-level object modules. Table A–1 describes the subdirectories that have been added to the `/kernel` directory.

x86 systems also have a `mach` directory that contains x86 hardware support.

Table A–1 Contents of the */kernel* Directory

Directory	Description
drv	Loadable device drivers
exec	The modules that execute programs stored in various file formats
fs	File system modules

Table A–1 Contents of the /*kernel* Directory (continued)

misc	Miscellaneous system-related modules
sched	Operating system schedulers
strmod	System V STREAMS loadable modules
sys	Loadable system calls

Changes in the /*dev* Directory

The /dev directory is changed from a flat directory to a hierarchical one. Table A–2 shows the added subdirectories.

Table A–2 Additions to the /*dev* Directory

Directory	Description
/dev/dsk	Block disk devices
/dev/pts	Pseudo terminal (pty) slave devices
/dev/rdsk	Raw disk devices
/dev/rmt	Raw tape devices
/dev/sad	Entry points for the STREAMS administrative driver
/dev/term	Terminal devices

Changes in the /*etc* Directory

The /etc directory contains system-specific configuration information. Several files and subdirectories are added, removed, or changed from the SunOS 4.*x* /etc directory:

- File system-specific commands, such as mount_rfs, are moved to the /usr/lib/fs directory.
- The /etc/fstab file is replaced with /etc/vfstab.
- Initialization scripts, such as rc, rc.boot, rc.local, and rc.single, are not available in the SunOS 5.*x* release.
- Mail commands that used to be in the /etc directory are moved into the new /etc/mail directory.

Table A–3 describes the subdirectories that have been added to the /etc directory.

Table A–3 Additions to the /etc Directory

Directory	Description
/etc/default	Default system configuration
/etc/inet	Internet services configuration
/etc/lp	LP system configuration
/etc/mail	Mail files (aliases, sendmail, *.rc files)
/etc/opt	Installed optional software
/etc/rcn.d	Run-state transition operations
/etc/saf	Service Access Facility (SAF) configuration

Changes in the /sbin Directory

The /sbin directory contains the rc* scripts used to alter system run levels and the bcheckrc script used to initialize the system prior to mounting file systems.

Changes in the /sys Directory

The /sys directory has been retired. The files used to build the kernel that were stored in this directory are no longer needed because of the dynamic kernel.

Changes in the /usr Directory

The /usr directory contains sharable files and executables provided by the system. Table A–4 shows the added subdirectories.

Table A–4 Additions to the /usr Directory

Directory	Description
/usr/ccs	Compiler support systems
/usr/snadm	Administration tool executables

Table A–5 shows files that have been moved from the /usr directory.

Table A–5 Files Moved from the /usr Directory

SunOS 4.x Location	SunOS 5.x Location
/usr/5bin	/usr/bin
/usr/5include	/usr/include

Table A–5 Files Moved from the /usr Directory (continued)

SunOS 4.*x* Location	SunOS 5.*x* Location
`/usr/5lib`	`/usr/lib`
`/usr/etc`	`/usr/sbin`
`/usr/rfs`	`/etc/rfs`
`/usr/old`	Contents removed
`/usr/xpg2bin`	`/usr/bin`
`/usr/xpg2lib`	`/usr/lib`
`/usr/xpg2include`	`/usr/include`

Changes in the /var Directory

The `/var` directory contains files whose sizes change during normal operation. Several files and subdirectories in the `/var` directory are added, removed, or changed:

- The `/var/opt/`*`packagename`* directory contains software package objects whose sizes change, such as log and spool files.
- The `/var/sadm` directory contains databases that are maintained by the software package management utilities.
- The `/var/saf` directory contains SAF logging and accounting files.
- The `/var/spool/mail` directory has been moved to `/var/mail`.

Device-Naming Conventions

The SunOS 5.*x* release uses device-naming conventions that make it easier to infer certain characteristics of a device from its device name. The SunOS 5.*x* conventions are slightly different from AT&T SVR4 device names, because the SunOS 5.*x* release only allows eight partitions on a disk.

You must use SunOS 5.*x* device-naming conventions with SunOS 5.*x* commands. However, if the binary compatibility package is installed, it creates links from the old device-naming conventions to the new ones, and you can continue to use SunOS 4.*x* device names. See Chapter 3, "Administering Devices," for a description of device-naming conventions.

Table A–6 shows some examples that compare the SunOS 4.*x* and SunOS 5.*x* device-naming conventions.

Table A–6 SunOS 4.x and SunOS 5.x Device Names

Device Description	SunOS 4.x	SunOS 5.x
Disk devices	/dev/sd0g	/dev/dsk/c0t3d0s6
	/dev/rsd3b	/dev/rdsk/c0t0d0s1
	/dev/rsd3a	/dev/rdsk/c0t0d0s0
Tape devices	/dev/nrmt8	/dev/rmt/8hn
	/dev/rst0	/dev/rmt/0h
CD-ROM device	/dev/sr0	/dev/dsk/c0t6d0s2

Printers, Terminals, and Modems

Solaris 2.*x* software includes the SAF, which is used to manage access to local and network system services (such as printers, modems, and terminals) in a similar way, whether they are on the network or attached only to local systems. SAF uses Service Access Control (SAC) commands to set up and manage services.

Terminal and Modem Differences

The SAF controls access to system and network resources. It provides a common interface for managing a range of services, including the ability to:

- Log in (either locally or remotely)
- Access printers across the network
- Access files across the network

SAF provides two major commands: `sacadm` and `pmadm`. The `sacadm` command controls daemons called *port monitors*. The `pmadm` command controls the services associated with the port monitors. The SAF replaces `/usr/etc/getty` for controlling logins.

Printing Differences

The LP print service replaces the `lpd` daemon and `lpr`, `lpq`, `lprm`, and `lpc` commands. The services provided by the `/etc/printcap` file are handled by the `terminfo` database and by the files in the `/etc/lp` directory. SunOS 4.*x* printing commands are provided as part of the BSD compatibility package. However, the compatibility package provides only SunOS 4.*x* command names, which are actually an interface to the underlying LP print services.

The LP print service provides additional functionality not available in SunOS 4.*x* systems. This functionality allows you to control forms, printwheels, and interface programs, and to set up network print services.

Even though some SunOS 4.*x* printing commands are available, encourage users to learn the SunOS 5.*x* versions. Convert your own administration environments as soon as possible because support for compatibility mode may not be available in future releases.

Changes to the Solaris 2.6 printing software provide a better solution than the LP print software in previous Solaris releases. You can easily set up and manage print clients using the NIS or NIS+ name services to enable centralization of print administration for a network of systems and printers. New features include redesign of print packages, print protocol adapter, bundled SunSoft Print Client software, and network printer support.

Naming Services

A new naming service, NIS+, replaces NIS on previous SunOS releases. NIS+ supports the following combinations of systems:

- SunOS 5.*x* software installed on all servers and workstations
- SunOS 5.*x* software installed on one server, but combined with some SunOS 4.*x* servers
- SunOS 5.*x* software installed on some workstations, running with SunOS 4.*x* servers

NIS+ information is stored in tables instead of in NIS maps. You use NIS+ shell commands to set up an NIS+ service. To administer the service, you can use either NIS+ shell commands or the Administration Tool's Database Manager.

NIS+ responds to requests from NIS. SunOS 5.*x* clients can run either NIS or NIS+.

TCP/IP

The user interface for TCP/IP is the same, but you administer NIS+ tables using Solstice AdminSuite. Starting with the Solaris 2.5 release, Admintool can be used only to administer local systems.

UUCP

The UNIX-to-UNIX Copy (UUCP) is the same as the HoneyDanBer UUCP available with SunOS 4.*x* systems. It uses the same set of configuration files, scripts, and commands, so any changes you made in SunOS 4.*x* files and scripts should work with this release.

Table A–7 describes new files and commands that were not part of the SunOS 4.*x* implementation.

Table A–7 New SunOS 5.*x* UUCP Files and Commands

Command or File	Function
`D. data files` `P. data files`	These data files are created when a UUCP command line specifies copying the source file to a spool directory. All data files have the format *`systmxxxxyyy`*. *`systm`* is the first five characters in the name of the destination system, *xxxx* is a four-digit job sequence number, and *yyy* distinguishes between several data files created for one job.
`/etc/uucp/Grades`	Maps text grade names to system names.
`/etc/uucp/Limits`	Specifies the number of concurrent UUCP sessions that can occur. Replaces `Maxuuscheds` and `Maxuuxqts` files in previous versions.
`/etc/uucp/Config`	Contains information to override tunable parameters in UUCP. The only tunable parameter currently available is `Protocol`, so system administrators normally will not have to modify this file.
`uuglist`	Sets service grade permissions available.

UUCP includes a few additional features that can affect system administration:

- Checkpoint-restart facilities
- Job grades that control UUCP transmission
- Two new configuration files to limit the number of concurrent UUCP sessions that the system can run, and to override tunable UUCP parameters

Document Tool Differences

NOTE. *SunOS 5.*x *systems provide a set of PostScript filters and device-independent fonts. However, some SunOS 4.*x *TranScript filters have SunOS 5.*x *equivalents, and others do not. In SunOS 5.*x *systems, there is no TEX filter, no pscat (C/A/T) filter, and no raster image filter.*

The SunOS 5.0 system provides device-independent `troff`, with these changes:

- SunOS 4.*x* `troff` input files work with SunOS 5.*x* `troff`.
- The `troff` default output goes to `stdout` instead of the printer. Therefore, you must specify a printer when you use `troff` formatting or scripts to print the output.

Security

Security combines a number of features from SunOS 4.1 and AT&T SVR4 with functionality added specifically for the Solaris 2.*x* releases. Some of the SunOS 4.*x* security programs are packaged differently.

The following sections describe major security differences and highlight how those changes may affect system administration procedures. The security features are:

- SunOS 4.*x* security features available with SunOS 5.*x* software
- SunOS 5.*x* security features
- The Automated Security Enhancement Tool (ASET)
- Kerberos security

SunOS 4.*x* Security

Most of the security features from SunOS 4.*x* systems are available. These include:

- Internet security
- `.rhosts` and `hosts.equiv` files
- Secure RPC, NFS, and RFS

SunOS 5.*x* Local Security

Security for local systems includes storing encrypted passwords in a separate file, controlling login defaults, and providing restricted shells. Equivalent NIS+ security controls networkwide access to systems. The following sections summarize security features under local system control.

The */etc/passwd* and */etc/shadow* Files

The SunOS 5.*x* password command stores encrypted versions of passwords in a separate file, `/etc/shadow`, and allows root access to the shadow file only. General access to the encrypted passwords is thus restricted. The `/etc/shadow` file also includes entries that force password aging for individual user login accounts.

The */etc/default* Files

Several files that control default system access are stored in the `/etc/default` directory. These files limit access to specific systems on a network. Table A–8 summarizes the files in the `/etc/default` directory.

Table A-8 Files in the */etc/default* Directory

File	Function
/etc/default/login	Controls system login policies, including root access. The default is to limit root logins to the console.
/etc/default/passwd	Controls default policy on password aging.
/etc/default/su	Controls what root (su) access to system will be logged and where it is displayed.

Restricted Shells

System administrators can use restricted versions of the Korn shell (`rksh`) and Bourne shell (`rsh`) to limit the operations allowed for a particular user account. Restricted shells do not allow these operations:

- Changing directories
- Setting the `$PATH` variable
- Specifying path or command names containing `/`
- Redirecting output

Note that the restricted shell and the remote shell have the same command name, with different path names:

Restricted shell	`/usr/lib/rsh`
Remote shell	`/usr/bin/rsh`

ASET Security

The *Automated Security Enhancement Tool (ASET)* is included with the Solaris 2.*x* system. It was available as an unbundled option with SunOS 4.*x* systems. ASET allows you to specify an overall system security level (low, medium, or high) and automatically maintain systems at those levels. It can be set up to run on a server and all of its clients or on individual clients.

ASET performs these tasks:

- Verifies system file permissions
- Verifies system file contents
- Checks integrity of group file entries
- Checks system configuration files
- Checks environment files (`.profile`, `.login`, and `.cshrc`)

- Verifies EEPROM settings to restrict console login access
- Allows establishment of a firewall or gateway system

Kerberos Security

The Solaris 2.*x* system introduces support for Kerberos authentication for secure RPC. Kerberos source code and administrative utilities are available from Massachusetts Institute of Technology.

Solaris 2.*x* Kerberos support includes:

- Client applications library that can use Kerberos
- Kerberos option to secure RPC
- NFS application with Kerberos
- Commands to administer user tickets on the client

Everything else is available in the MIT Kerberos release.

NOTE. *Solaris 2.6 provides the ability to connect to the Kerberos functionality. However, it does not provide the Kerberos package. You can ftp Kerberos 4 source from* `athena-dist.mit.edu` *using anonymous as a username and your e-mail address as a password. The source is located in the* `pub/kerberos` *directory.*

Table of Command Equivalents

Table A–9 lists SunOS 4.*x* commands and files in alphabetical order and describes the new SunOS 5.*x* command, equivalent, or unavailability. Commands that are not listed in this table are completely compatible with previous releases.

Table A–9 System Administration File and Command Equivalents

SunOS 4.*x*	SunOS 5.*x*	Comments
`ac`	`sar`	The System Accounting Resource package (SAR) provides most of the accounting functionality available in ac.
`add_services`	`pkgadd`	
`analyze`	`adb`	Use `adb` on core files to analyze crashes.
`arch`	`uname -m`	SunOS 4.*x* shell scripts used the arch command to determine system architecture. Use `uname -m` as a replacement in SunOS 5.*x* scripts.

Table A-9 System Administration File and Command Equivalents (continued)

SunOS 4.*x*	SunOS 5.*x*	Comments
at, atq, atrm	at, atq, atrm	The at, atq, and atrm commands behave slightly differently than they do in SunOS 4.*x* systems. Security for nonprivileged users is more restricted on SunOS 5.*x* systems.
audit, audit_warn, auditd	Not available	See your system vendor for information on this product.
automount	automount	The auto.master and auto.home files are renamed auto_master and auto_home. The default home directory path is /export/home/*username*. The -m option is not available. The SunOS 5.*x* automount program searches for Auto_master and Auto_home as the default. If these files are not found, it looks for Auto.master and Auto.home files. You do not need to rename these files on SunOS 4.*x* systems.
bar	Not available	Use the tar command to replace bar for most uses. You can use cpio -H bar to restore existing SunOS 4.*x* bar backups.
batch	batch	The c, s, and m options are not in the batch command. By default, the batch job *queuename* is not specified.
biff -y biff -n	chmod o+x /dev/tty chmod o-x /dev/tty	When users log on, start-up shell scripts often use the biff command to set default file protection for the user. Replace those commands to make SunOS 5.*x* scripts work correctly.
/bin/mail	mail	
biod	Not available	
C2conv	Not available	See your system vendor for information on this product.
C2unconv	Not available	See your systeSm vendor for information on this product.
cc	Not available	The C compiler is available only as an unbundled product.
change_login	Not available	
check4	Not available	
chgrp	Changed	The -f option to suppress error reporting is not available.
chmod	Changed	
chown	Changed	The default behavior of symbolic links is changed. SunOS 4.*x* chown changed ownership of the symbolic link. SunOS 5.*x* chown follows the link. To change the ownership of the link, use chown -h. SunOS 5.*x* chown does not allow the group ID of a file to be changed.
client	Not available	
colldef	colltbl	
crash	Changed	The default file name in SunOS 5.*x* software is /kernel/genunix instead of /vmunix.
date	Changed	

Table A–9 System Administration File and Command Equivalents (continued)

SunOS 4.*x*	SunOS 5.*x*	Comments
`dbxtool`	`debugger`	See your system vendor for information on this product.
`dcheck`	Not available	
`dd`	Changed	The Sun OS 4.1 dd command uses 4-byte words. The SunOS 5.*x* dd command uses 2-byte words.
`devinfo`	Changed	
`devnm`	Changed	The *name* argument is required for SunOS 5.*x* devnm. The output format has also changed.
`df`	`df -k`	Output of the `df` command is changed. The SunOS 4.*x* `df -t` *`fstype`* command reSports on files of the specified type. The SunOS 5.*x* df -t command prints full listings with totals.
`dkctl`	Not available	
`dkinfo`	`prtvtoc`	
`dorfs`	`rfstart`	
	`rfstop`	
`du`	`du -k`	The SunOS 4.*x* version of du reports disk usage in kilobytes, but the SunOS 5.*x* du command reports disk usage in 512-byte blocks (by default).
`dump`	`ufsdump`	The `-a` option dumps the archive header of each member of an archive. The `-D` option dumps debugging information. The `-v` option dumps information in symbolic form.
`dumpfs`	Not available	
`etherfind`	Not available	Similar functionality is available in the SunOS 5.*x* `snoop` command.
`exportfs`	`share`	
`extract_files`	Not available	
`extract_patch`	Not available	
`extract_unbundled`	`pkgadd`	
`fastboot`	`init 6`	
`fasthalt`	`init 0`	
`file`	Changed	The `file` command does not have the `-L` option.
`find`	Changed	The `find` command does not have the `-n cpio` option.
`fmt_mail`	Not available	
`fsck`	Changed	`fsck` specifies most options after the file system type. `fsck -m` does a quick file system check. The `-w` option is not available. New options include `-f`, `-v`, and `-o`.

Table A–9 System Administration File and Command Equivalents (continued)

SunOS 4.x	SunOS 5.x	Comments
fsirand	Not available	
hostid	sysdef -h	
hostname	uname -n	
init	Changed	See Chapter 1 for more information on init.
installtxt	msgfmt	
intr	Not available	
iostat	Changed	The -x and -c options are added: -x to provide disk statistics, and -c to report the Stime the system spends in user mode, system mode, and idle.
keyenvoy	Not available	
ldconfig (wrong)	Not available	
leave	Not available	Functionality in cron and at replace the leave command.
lint	Not available	Available with unbundled C compiler for SunOS 5.x systems.
load		
loadc	pkgadd	Provides part of the functionality of the SunOS 4.x load command.
load_package	Not available	
lpc	lpsched	
lpd	lpadmin	
lpq	lpstat	
lpr	lp	
lprm	cancel	
lptest	Not available	
ls	Changed	Default output for the ls command is changed. The ls -l command displays both user and group ownership.
mach	uname -p	
makekey	Not available	
man	Changed	The organization of man pages is changed. All system administration man pages are now located in section 1M. The man command now allows you to set an environment variable to specify a default order of directories and sections for man to search.
mkfs	Changed	mkfs supports different file system types.
mknod	Changed	Users other than root can now create character and block special files.

Table A-9 System Administration File and Command Equivalents (continued)

SunOS 4.*x*	SunOS 5.*x*	Comments
`modstat`	`modinfo`	
`mount`	Changed	Options must be specified after the file system is specified (unless the file system is in `/etc/vfstab`).
`mount_tfs`	`mount -F` *`fstype`*	Options to the `mount` command (instead of separate mount commands) are used to specify file system types.
`ncheck`	Changed	Allows use of specific file system types.
`ndbootd`	Not available	The `-m` option is not available. The -l option changes *addr* immediately. The variable *addr*S cannot be specified in hexadecimal format.
`nlsadmin`		
`nulladm`	Not available	
`pac`	Not available	
`passwd`	Changed	The `-F` *`filename`* option is not available. The `-f` and `-s` options have different meanings. The `-f` option forces the user to change the password at the next login. The `-s` option displays the password attributes for the user's login name.
`pax`	`cpio`	
`paxcpio`	`cpio`	
`portmap`	`rpcbind`	
`praudit`	Not available	Will be available when the unbundled C2 security product is released.
`printenv`	`env`	
`ps`	Changed	Many of the 4.*x* options to ps are not available or the meanings have changed. Instead of `ps -aux`, use `ps -el` for SunOS 5.*x* systems. See the ps(1) manual page for more information.
`pstat`	`sar`	
`pstat -s`	`swap -s`	Shows the total amount of swap space available on the system.
`rc`	Not available	The organization of `rc` files is changed. They are now divided into subdirectories by run levels.
`rc.boot`	Not available	
`rc.local`	Not available	
`rdump`	`ufsdump`	
`reset -s`	Not available	
`restore`	`ufsrestore`	

Table A–9 System Administration File and Command Equivalents (continued)

SunOS 4.*x*	SunOS 5.*x*	Comments
rmail	Changed	The rmail command in the SunOS 4.*x* system handles remote mail. The rmail command in the SunOS 5.*x* system is a link to mail and is used to read mail.
rm_client	Not available	Functionality of admintool replaces this command.
rm_services	Not available	
rpc.etherd	Not available	
rpc.lockd	lockd	
rpc.mountd	mountd	
rpc.rexd	Not available	
rpc.rquotad	Not available	
rpc.showfhd	showfhd	
rpc.statd	statd	
rpc.user_agentd	Not available	
rpc.yppasswdd	Not available	
rpc.ypupdated	ypupdated	
rrestore	ufsrestore	
rusage	Not available	
rwall	Changed	The -f and -n optionsS are not available.
setsid	Not available	
shutdown	Changed	See Chapter 1 for more information on shutdown.
startup	Not available	
stty	Changed	
suninstall	Changed	Although the command name is the same, the installation procedure is changed completely.
swapon	swap -a	In general, options to the swap command replace functionality of individual swap-related commands, such as swapon, in SunOS 4.*x* systems.
sys-config	Not available	Functionality of solstice replaces this command.
tfsd	Not available	
trpt	Not available	
tset	Changed	The -S option is not available.
ttysoftcar	Not available	

Table A–9 System Administration File and Command Equivalents (continued)

SunOS 4.*x*	SunOS 5.*x*	Comments
`tvconfig`	Not available	
`tzsetup`	Not available	
`umount`	Changed	File-specific options may be required.
`umount_tfs`	`umount -F fstype`	
`unlink`	Changed	Any user can unlink a directory.
`unload`	`pkgrm`	
`unset4`	Not available	
`update`	`fsflush`	
`uptime`	Unchanged	You can also use who -b to display the system boot time.
`users`	`who -q`	
`uulog`	Changed	The `-u` option, used to print information sorted by user, is not available.
`uusend`	Not available	
`vipw`	Not available	
`vmstat`	Changed	The `-f` option is not available.
`vswap`	Not available	
`wall`	Not available	
`whereis`	Not available	
`whoami`	`id`	The id command printsS the user name and user and group IDs, instead of just the user name.
`ypbatchupd`	Not available	
`yppasswd`	`nispasswd`	The yppasswd command is still available to access the password information on NIS servers. The equivalent command for NIS+ databases is `nispasswd`, and the equivalent command for systems with no name service is `passwd`.
`ypserv`	Not available	

GLOSSARY

Admintool A CDE and OpenWindows tool from which you can edit `/etc` files on a local system.

archive A copy of files on secondary media, that have been removed from the system because they are no longer active.

***Auto_home* database** The database that you use to add home directories to the automounter. In SunOS 4.*x* releases, this database is a file named `auto.home`.

automounter Software that automatically mounts a directory when a user changes into it and unmounts the directory when it is no longer in use.

backup schedule The schedule you establish for a site that determines when you run the `ufsdump` command on a regular basis at different levels to back up user files and essential file systems.

bang An exclamation point (`!`) that acts as a single-character UNIX command or as a separator between the routes of a route-based e-mail address.

boot block An 8-Kbyte disk block that contains information used during booting: Block numbers point to the location of the `/boot` program on that disk. The boot block directly follows the disk label.

booting The process of powering up a system, testing to determine which attached hardware devices are running, and bringing the operating system kernel into memory and operation at the run level specified by the `boot` command.

cache A small, fast memory area that holds the most active part of a larger and slower memory.

CDE Common Desktop Environment. A windowing system based on the Motif graphical user interface.

core file An image of the state of the software when it failed, used for troubleshooting. The core files can be created by any software, including the operating system kernel.

crash See **hang**.

crash dump A core file image of the operating system kernel that is saved in the swap partition when a system crashes. If crash dumps are enabled, the core image is written from the swap partition to a file.

cylinder group One or more consecutive disk cylinders that include inode slots for files.

cylinder group map A bitmap in a UFS file system that stores information about block use and availability within each cylinder. The cylinder group replaces the traditional free list.

daemon A type of program that, once activated, starts itself and carries out a specific task without any need for user input. Daemons are typically used to handle jobs that have been queued such as printing, mail, and communication.

disc An optical disc or a CD-ROM.

disk A hard-disk storage device.

diskette A nonvolatile storage medium used to store and access data magnetically. SunOS 5.*x* system software supports 3.5-inch double-sided high-density (DS, HD) diskettes.

diskless client A system with no local disk drive that relies on an NFS server for the operating system, swap space, file storage, and other basic services.

disk quotas A mechanism for controlling how much of a file system's resources any individual user can access. Disk quotas are optional and must be configured and administered to be used.

domain A directory structure for e-mail addressing and network address naming. Within the United States, top-level domains include `com` for commercial organizations; `edu` for educational organizations; `gov` for governmentsl; `mil` for the military; `net` for networking organizations; and `org` for other organizations. Outside the United States, top-level domains designate the country. Subdomains designate the organization and the individual system.

domain addressing Using a domain address to specify the destination of an e-mail message.

DS, HD Double-sided, high-density. The type of 3.5-inch diskettes supported by the SunOS 5.*x* system software.

dump The process of copying directories onto media (usually tape) for off-line storage by using the `ufsdump` command. The `ufsdump` command is an enhanced version of the SunOS 4.*x* `dump` command.

e-mail Electronic mail. A set of programs that transmit mail messages from one system to another, usually over communications lines.

environment variable A system- or user-defined variable that provides information about the operating environment to the shell.

file system A hierarchical arrangement of directories and files.

floppy diskette See **diskette**.

free list See **cylinder group map**.

full backup A complete, level 0 backup of a file system done by using the `ufsdump` command.

fully qualified domain name A domain name that contains all the elements needed to specify where an e-mail message should be delivered. See also **domain**.

gateway A system that handles e-mail traffic between different communications networks.

GID The group identification number used by the system to control access to accounts owned by other users.

Group database The database that you use to create new group accounts or to modify existing group accounts.

hang A condition in which a system does not respond to input from the keyboard or mouse.

home directory The part of the file system that is allocated to an individual user for private files.

Hosts database The database you use to control network security.

incremental backup A partial backup of a file system that is performed by using the `ufsdump` command that includes only those files in the specified file system that have changed since a previous backup at a lower level.

initialization files The dot files (files prefixed with .) in a user's home directory that set the path, environment variables, windowing environment, and other characteristics to get users up and functioning.

init state One of the seven initialization states, or run levels, a system can be running in. A system can run in only one init state at a time.

inode An entry in a predesignated area of a disk that describes where a file is located on that disk, the size of the file, when it was last used, and other identification information.

input variables The environment variables that CDE's `dtsearchpath` reads.

IP address A unique Internet protocol number that identifies each system in a network.

kernel The master program set of SunOS software that manages all the physical resources of the computer, including file system management, virtual memory, reading and writing files to disks and tapes, scheduling of processes, printing, and communicating over a network.

login name The name assigned to an individual user that controls access to a system.

manual pages On-line technical references for each SunOS 5.*x* command.

metacharacter A symbol used in file names and extensions to represent another character or string of characters. An asterisk (`*`) matches any number of characters. A question mark (`?`) matches a single character.

monitor The program in the PROM that provides a limited set of commands that can be used before the kernel is available. See **PROM**.

mount point A directory in the file system hierarchy where another file system is attached to the hierarchy.

NFS The default SunOS 5.*x* distributed file system that provides file sharing among systems. NFS servers can also provide kernels and swap files to diskless clients.

NIS The SunOS 4.*x* network information service.

NIS+ The SunOS 5.*x* network information service.

OpenWindows A windowing system based on the OPEN LOOK graphical user interface.

parse To resolve a string of characters or a series of words into component parts to determine their collective meaning. Virtually every program that accepts command input must do some sort of parsing before the commands can be acted on. For example, the sendmail program divides an e-mail address into its component parts to decide where to send the message.

partition A discrete portion of a disk, configured using the `format` program. Also referred to as slice.

Passwd database The database that you use to add, modify, or delete user accounts.

path The list of directories that are searched to find an executable command.

path name A list of directory names, separated with slashes (`/`), that specifies the location of a particular file.

port A physical connection between a peripheral device (such as a terminal, printer, or modem) and the device controller.

port monitor A program that continuously watches for requests to log in or requests to access printers or files. The `ttymon` and `listen` port monitors are part of the Service Access Facility.

power cycling Turning the power to a system off and then on again.

preen To run `fsck` with the `-o p` option, which automatically fixes any basic file system inconsistencies normally found when a system halts abruptly without trying to repair more serious errors.

process A program in operation.

PROM Programmable read-only memory. A chip containing permanent, nonvolatile memory and a limited set of commands used to test the system and start the boot process.

run level See **init state.**

runaway process A process that progressively uses more and more CPU time.

server A system that provides network service such as disk storage and file transfer, or a program that provides such a service.

Service Access Facility (SAF) The part of the system software that is used to register and monitor port activity for modems, terminals, and printers. SAF replaces `/etc/getty` as a way to control logins.

shell The command interpreter for a user, specified in the Passwd database. The SunOS 5.*x* system software supports the Bourne (default), C, and Korn shells.

slice An alternative name for a partition. See also **partition.**

spooling directory A directory where files are stored until they are processed.

spooling space The amount of space that is allocated on a print server for storing requests in the printer queue.

stand-alone system A system that has a local disk and can boot without relying on a server.

state flag A flag in the superblock that the `fsck` file system `check` program updates to record the condition of a file system. If a file system state flag is clean, the `fsck` program is not run on that file system.

superuser A user who is granted special privileges if the correct password is supplied when logging in as root or using the `su` command. For example, only the superuser can edit major administrative files in the `/etc` directory.

swap file A disk partition or file used to temporarily hold the contents of a memory area until it can be loaded back into memory.

symbolic link A file that contains a pointer to the name of another file.

system A computer with a keyboard and terminal. A system can have either local or remote disks, and may have additional peripheral devices such as CD-ROM players, tape drives, diskette drives, and printers.

UFS UNIX file system. The default disk-based file system for the SunOS 5.*x* operating system.

UID User Identification. The user identification number assigned to each login name. UID numbers are used by the system to identify, by number, the owners of files and directories.

user account An account set up for an individual user in the Passwd database that specifies the user's login name, UID, GID, login directory, and login shell.

user mask The setting that controls default file permissions that are assigned when a file or directory is created. The `umask` command controls the user mask settings.

virtual memory A memory management technique that is used by the operating system for programs that require more space in memory than can be allotted to them. The kernel moves only pages of the program currently needed into memory; unneeded pages remain on the disk.

zombie A process that has terminated but remains in the process table because its parent process has not sent the proper exit code. Zombie processes do not consume any system resources and are removed from the process table when a system is rebooted.

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