USING PROFESSIONAL OS-9®

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OS-9® is a powerful and versatile operating system that can help you fully use your 68000 system's capabilities. OS-9 offers a wide selection of functions because it was designed to serve the needs of a broad audience. Whether you are a casual user or a professional programmer, you will find many useful features in OS-9.

Professional OS-9 is designed to provide a friendly software interface for personal computers, educational systems, and the professional programmer. The Professional OS-9 package includes over 70 utility programs.

Using Professional OS-9 has been designed for use as a reference and learning guide. It is divided into three distinct parts. Chapters 1-4 discuss the file structure and utilities available for using OS-9. Chapter 5, 6, and 7 discuss some of the advanced utilities in detail. Chapter 8 discusses topics of interest to system managers.

This manual is the basic user reference manual for OS-9. The ***OS-9 Technical Manual*** is a companion manual for advanced programmers who wish to learn about the internal operation and function of the system.

At first glance, the OS-9 manual set, especially the ***OS-9 Technical Manual***, may seem overwhelming. Fortunately, you only need to know a fairly small percentage of the material presented in this manual to

use OS-9 effectively. You will find that it is easy to learn about OS-9 as you continue to work and experiment with it.

The secret to getting up to speed quickly with OS-9 is to first identify and learn only the basic, everyday functions necessary to run applications programs and programming languages.

This manual contains eight chapters:

Chapter 1 is a general introduction to OS-9. It introduces the concept of an operating system and explains some of OS-9's basic features.

Chapter 2 describes how to get OS-9 up and running. This includes formatting and backup procedures.

Chapter 3 helps you get started using the operating system. The more frequently used system commands are discussed. These are utilities that every user should be familiar with.

Chapter 4 is a detailed explanation of the tree-structured file and directory system of OS-9. This includes:

- Directories
- Types of files
- File security
- Movement around the file/directory system

Chapter 5 contains a detailed description of the shell, the OS-9 user interface.

Chapter 6 explains the make utility in detail. This utility is used to maintain and regenerate software from a group of files.

Chapter 7 explains the concept of incremental backups. The OS-9 utilities to create the backups are detailed here. This chapter also offers two different strategies for making backups.

Chapter 8 contains information of interest to system managers. Some of the topics covered include setting up your system defaults, making a startup file, and installing OS-9 on a hard disk.

Detailed descriptions of all OS-9 commands are located in the ***OS-9 Utilities*** section.

1

An Overview of OS-9

What Is an Operating System?

An operating system is the master supervisor of the resources and functions of a computer system. Computer resources consist of memory, CPU time, and input/output devices such as terminals, disk drives, and printers.

OS-9 is a sophisticated operating system for microcomputers. OS-9's basic functions are to:

- Provide an interface between the computer and the user.
- Manage the input/output (I/O) operations of the system.
- Provide for the loading and execution of programs.
- Create and manage a system of directories and files.
- Manage timesharing and multi-tasking.
- Allocate memory for various purposes.

Using OS-9 as Your Operating System

The most visible function of the operating system is its role as an interface between you and the complex internal hardware and software functions of the system. OS-9 was designed to make its powerful features easy to use, even by persons with limited technical knowledge.

Because an operating system provides only part of the overall software necessary to make the computer useful, ***application programs*** such as word processors and accounting packages tend to be the most frequently used programs. They are not part of the operating system, but they rely heavily on services such as input and output provided by the operating system. Most application programs are written by users or obtained from commercial software suppliers.

Similarly, programming languages are tools used to create application programs. These rely heavily on and are closely related to the operating system.

To help make OS-9 easy to use, a set of over 70 programs called ***utilities*** are included. Utilities are not part of the basic operating system. Instead, they are actually small application programs that provide essential housekeeping, management, customization, and maintenance functions. Some utilities, such as the μMACS text editor, are useful, general-purpose application programs.

Using OS-9's Functions

OS-9's many capabilities and functions can be used in two basic ways.

The first method uses the utility command set and the shell command interpreter program. This allows you to type OS-9 commands directly on your keyboard. These commands are translated into the more complex internal system calls actually required to carry out the desired operations. The OS-9 utilities are described in detail in the ***OS-9 Utilities*** section.

The second method uses system calls. System calls are requests made to OS-9 within programs written in assembler or a high-level language. These system calls are available to load programs into memory; create new tasks; create or delete files; read, write, open, or close files; and so on. All OS-9 programming languages have statements that cause the program to use OS-9 system calls, often in a hidden manner. System calls are largely of interest to advanced programmers and are discussed in detail in the ***OS-9 Technical Manual***.

Storing Information

Another basic function of any operating system is storing information. Without some way to store and organize your programs, data, and text, working on a computer would be extremely complicated.

> + OS-9 stores information in files and directories located on mass-storage devices such as floppy disks. OS-9 provides easy access methods for updating, storing, and retrieving files and directories through standard utilities.

OS-9 organizes all files into organizational structures called ***directories***. A directory is actually a special file containing the names and locations of each file it contains. Directories can contain files and subdirectories. In turn, these subdirectories may contain other files and subdirectories. This is called a ***tree structure***, or ***hierarchical***, organization for file storage.

For more information, refer to the chapter on the OS-9 file system.

Multi-tasking and Multi-user Features

OS-9 is a ***multi-tasking*** and ***multi-user*** operating system.

Multi-tasking, or ***multi-processing***, allows the computer to run many different programs at the same time. By rapidly switching from one program to the next, many times per second, programs appear to be running at the same time.

Each program running on the system is called a ***task***, or ***process***. OS-9 allows you to have one or more tasks running in the background, while a task is running in the foreground.

A foreground process is a task that requires your interaction. For example, if you are editing a file, it is a foreground process because you are actively using it. A program that prompts you for information is also a foreground process because you need to respond to it.

A background process is a task that does not require your attention. For example, if you are printing a text file, you do not have to supervise the printing process. Therefore you can have the file printing in the background while you edit another file. This frees the computer from the limitation of doing only one thing at a time.

+	A ***foreground process*** requires your interaction. A ***background process*** does not require your attention.

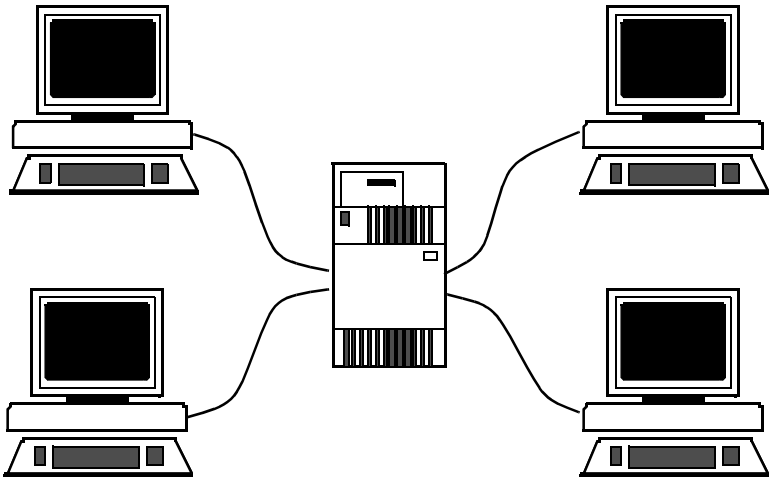
OS-9's multi-tasking capabilities make it possible for efficient memory use, CPU time, and I/O operations to be shared by all programs without conflict.

Typical Multi-tasking Usage:

Editing a file (foreground process)
Listing a file to a printer (background process)
Sorting and merging datafiles (background process)

Multi-user, or ***timesharing***, operation is a natural extension of the system's basic multi-tasking functions. It allows several people to use the computer simultaneously. OS-9 provides additional security-related timesharing functions to control access to the system and privacy within the system.

Typical Multi-user System Configuration:
Four terminals on one OS-9 Computer



The multi-tasking and multi-user capabilities tremendously increase OS-9's versatility. OS-9 is often used as a single-user/multi-tasking system on small computers. It is also used as a multi-user/multi-tasking system on larger computer systems. In either case, there is no difference in OS-9 itself, the application software, or how either works.

The Memory Module and Modular Software

A unique feature of OS-9 is its support of modular software techniques based on ***memory modules***. The use of memory modules can:

- Provide more efficient use of available disk and memory storage.
- Make the system run faster.
- Simplify programming jobs.
- Make it easy to customize and adapt OS-9 itself.

All OS-9 programs are kept in the form of one or more ***program modules*** containing pure program code. They do not contain variable storage; OS-9 assigns variable storage in a separate block of memory at run-time. Each module has a unique name and can be loaded into memory or stored on disk or tape. OS-9 automatically keeps track of the names and locations of all modules present in memory.

An important characteristic of memory modules is the sharing of one module by several tasks or users at the same time. For example, if four users want to run BASIC at the same time, only one copy of the BASIC program module will be loaded into memory. Other operating systems would typically load four exact copies of BASIC into memory, thus requiring 300% more memory. The shared module system is completely automatic and usually transparent to the user.

Another advantage of memory modules is that frequently used functions can share common ***library*** modules. For example, a standard OS-9 module called Math provides basic floating point arithmetic operations for virtually all programming languages and programs. Again, this eliminates the need for each program to include its own math package. It also means that if you add a hardware floating point processor to your system, you only need to replace this one module and all your other software will automatically be converted without modification. In addition, large and complex programs can be split up into smaller, testable modules.

End of Chapter 1

2

Starting OS-9

Booting OS-9

Before using OS-9 on your computer, you must ***boot*** the system. Booting is also called a ***cold start*** or ***bootstrapping***. It involves the computer reading a portion of the system disk (or tape) into memory.

If your system is a standard disk-based computer, the system disk contains all the modules that make up OS-9. The system disk usually contains other files and directories frequently used during normal operations. This includes a directory for each user, a shared commands directory, and files used by the system. A description of the directories commonly supplied with Professional OS-9 is provided at the end of this chapter.

Two files, which are called startup and OS9Boot by convention, need to be discussed here. startup is a shell procedure file that is processed immediately after the system starts running. startup may contain any legal OS-9 command or program. OS9Boot contains the OS-9 system modules that are read into memory. The chapter on OS-9 system management contains information on changing the startup and OS9Boot files.

> + The boot procedure varies depending on the requirements of the specific hardware. The manufacturer supplies detailed instructions outlining the boot procedure for the specific system involved. You should follow the instructions as specified.

If the system fails to boot, recheck the hardware setup instructions, especially if you made any modifications to your computer. Make sure the disk (or tape) was inserted correctly, and try the boot sequence again. If the boot sequence fails several times, contact your supplier.

When the system boots correctly, a welcoming message is displayed followed by the setime prompt. The setime utility starts the system clock and allows OS-9 to keep track of the date and time of the creation of new files. The clock must be running for multi-tasking to take place.

The clock may be started by the Init module (refer to the chapter on OS-9 system management for more information). If it is not started and you have a system with a battery-backed clock, type the following command to start the system clock:

```
$ setime -s
```

Otherwise, execute setime by typing:

```
$ setime
```

setime prompts with the following:

```
yy/mm/dd hh:mm:ss [am/pm]
Time ?
```

At the prompt, enter the year, month, day, hour, minutes, seconds, and optionally am or pm. Unless am or pm is specified, setime uses the 24 hour clock. For example, 15:20 is the same as 3:20 pm. The input is one or two digit numbers with a space, colon, semicolon, comma, or slash used as a field delimiter. If a semicolon is used, the entire date string must be within quotes. For example, to set the time on May 14, 1991 at 1:24 pm, type:

91/5/14/1/24/pm or **91 05 14 1 24 pm** or **91,5,14,13,24** or
91:5:14:13:24 or **91/5/14/13/24** or **"91;5;14;13;24"**

To find out if the system clock is running or if the date and time was set correctly, use the date command. For example:

```
$ date
July 2, 1990 Monday 1:25:26pm
```

Once the time and date have been properly set, the system displays the following prompt:

```
$
```

The $ prompt means the operating system is active and waiting for you to enter a command line. This prompt is the default system prompt. This manual uses the $ prompt for all examples. For information on changing the shell prompt, refer to the chapter on the shell.

> **NOTE:** The following sections are specifically intended for systems distributed with floppy disk system disks. These sections are also of general interest in terms of formatting and backing up floppy disks. If you have a hard disk or are booting from a media other than a disk, refer to the OS-9 system management chapter.

Backing Up the System Disk

Before experimenting with OS-9, you should make a backup of your master system disk. The backup procedure involves making an exact copy of a disk. If for any reason your system disk becomes damaged, it may become unreadable. For this reason, it is important to have another copy stored safely away.

Before you can backup your system disk, you need a properly formatted disk. New disks cannot be read from or written to until they have been formatted. The format utility initializes new disks for reading and writing. backup, the OS-9 utility that makes copies of disks, *requires* the backup disk to be the same size and format as the original disk.

The following section describes the steps to be taken to backup a disk on a typical OS-9 system that boots from a floppy drive (usually called /d0).

NOTE: Before formatting your first disk, it is strongly recommended that you read the entire section on formatting disks.

> **NOTE:** A list of the naming conventions OS-9 uses is located in the chapter on the shell.

Formatting a Disk

The format of OS-9 system disks vary by the type of disk drive and by manufacturer. Usually, the format is set to be the maximum capacity of the disk drive.

You can place several parameters on the command line with the format command:

-sd	for single density disks
-dd	for double density disks
-ss	for single sided disks
-ds	for double sided disks

Refer to your hardware documentation for the maximum capacity of your drives. Refer also to the label of your system disk for the proper format of your backup copy. Consult the format utility description in the ***OS-9 Utilities*** section for other available parameters.

Multiple Drive Format

If your system has two disk drives, place the system disk in the first drive and the new disk in the second drive. The second drive is usually called /d1. At the $ prompt, type format, the drive name of the new disk, any desired options and press the <return> key to enter the command line:

```
$ format /d1
```

This command line specifies that the disk in the second drive will be formatted as a double-sided, double-density disk. If your disk is different, your options will be different.

Single Drive Format

If your system has only one disk drive, you will need to load the format utility into memory. The load utility puts a copy of a program into the memory of the computer. Once format has been loaded into memory, you can remove your system disk from the drive. OS-9 can execute the copy of format that resides in memory. Any OS-9 utility can be loaded and executed in this fashion.

To load the format utility into memory, type the following command at the $ prompt:

```
load format
```

When format has been loaded, remove the system disk from the drive. Place the disk to format into the drive. At the $ prompt, type:

```
format /d0
```

This command line formats the disk.

Continuing the Formatting Process with Either a Single Drive or a Multiple Drive

In the case of both single and multiple drive systems, format displays the specific disk format settings, followed by a prompt:

```
Formatting device: <drive name>
proceed?
```

NOTE: <drive name> is replaced by the name of the device on which you are trying to format. For example, /d0.

If the drive name in the prompt is not the name of the drive with the blank disk, type q to quit, or your only system disk may be erased.

If the drive name and parameters in the prompt are correct, type y for yes. If you type y at the prompt, there will be a pause while the disk is being formatted. format then prompts for the name of the disk:

```
volume name:
```

After you have entered the volume name, format prints:

verifying media, building bitmap...

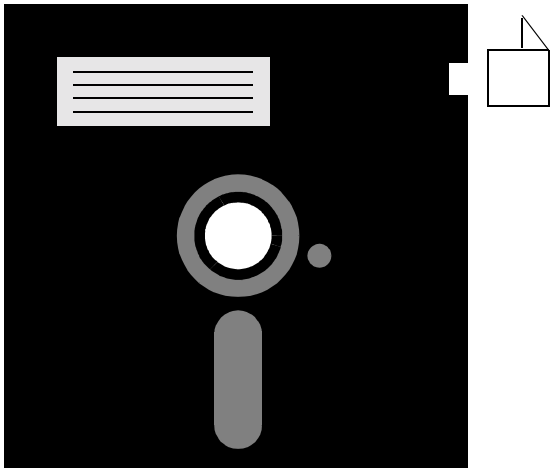
During the final phase of the process, the hexadecimal number of each track is displayed as each track is verified to see if any sectors are bad. If any bad sectors are found, an error message is displayed along with the number of the bad sector. The number of good sectors, the number of unusable sectors, and the total number of verified sectors is also displayed.

WARNING: Never backup a system disk to a disk that has any bad sectors reported by format.

The Backup Procedure

After a disk is formatted, you can run backup. The backup utility makes an exact copy of the OS-9 system disk. There are other ways to make a copy of a disk, but this method is the least complicated. The backup process involves copying everything from your system disk to a formatted disk. During the backup procedure, the system disk is referred to as the ***source disk***. The backup disk is called the ***destination disk***.

NOTE: This procedure makes copies of any disk, not just the system disk.



NOTE: You may wish to ***write protect*** your source disk with a write protect tab when using the backup procedure. This prevents any accidental confusion in exchanging the source and destination disks.

backup makes two passes. The first pass reads a portion of the source disk into a buffer in memory and writes it to the destination disk. The second pass verifies that everything was copied to the new disk correctly.

If an error occurs on the first pass, something is wrong with the source disk or the drive it is in.

If an error occurs during the second pass, the problem is with the destination disk. If backup repeatedly fails on the second pass, reformat the disk to make sure it has no bad sectors. If the disk reformats correctly, try the backup procedure again.

Multiple Drive Backup

If your system has two disk drives, place the source disk in the first drive (/d0) and the destination disk in the second drive (/d1). At the $ prompt, type backup and press the <return> key.

The system assumes you want to backup the disk in /d0. It responds to backup with the following prompt:

ready to BACKUP /D0 to /D1?

If you have placed the correct disks in the correct drives, type y for yes. Otherwise, type q for quit. If you type y, the system copies all information on the disk in /d0 on to the disk in /d1 and returns the $ prompt.

Single Drive Backup

If your system has only one drive, the backup utility needs to be loaded into memory. Make sure your system disk is in /d0 and type the following command:

load backup

After you have loaded backup, you may proceed with the backup procedure. Type the following command:

backup /d0 -b=100k

This tells the system that you are performing a single drive backup and that you want to use a 100K buffer for the backup. If your system will allow you to use a larger buffer, increase this number. The larger the buffer, the fewer swaps you will have to make. The system responds with the following prompt:

ready to BACKUP /D0 to /D0?

Type y if you are ready to perform the backup. Otherwise, type q for quit. If you type y, the system begins a series of prompts to complete the backup procedure. This consists of swapping the source and destination disks in the disk drive as prompted by the system.

The first prompt is:

ready destination, hit a key

At this prompt, remove the source disk from the drive and insert the destination disk. Once this is done, press any key to continue the backup procedure. The next system prompt is:

ready source, hit a key

At this prompt, remove the destination disk from the drive and insert the source disk. Once this is done, press any key to continue the backup procedure. The exchanging of disks continues until the backup procedure is completed.

+ When you have backed up the system disk, store the original disk in a safe place and use the duplicate as your working system disk.

Directories Contained on the System Disk

The following is a list of directories commonly distributed with Professional OS-9. They are all contained in the primary directory (the root directory) of your system:

BOOTOBJS Contains the system modules for bootstrap files, system-specific files, etc.

C Contains Cstart source code and an example of trap handlers for user education.

CMDS Contains all the system utilities such as backup, load, setime, etc. Many of the utilities are discussed in the following chapters. The ***OS-9 Utilities*** section contains descriptions of each utility distributed with Professional OS-9.

DEFS Contains several files of symbolic definitions that are useful when using programming languages.

IO Contains the device descriptor source for system customization. For more information on changing device descriptors, refer to the chapter on OS-9 system management.

LIB Contains system library files.

MACROS Contains general macros used in driver development, etc.

SYS Contains system files including:

- Errmsg Contains text for descriptions of error messages. An appendix listing the error messages is included with this manual set.
- password Contains a sample password file for timesharing systems. The password file contains information such as the user name, password, initial process, etc. for each user. For more information on the password file, refer to the chapter on the shell in this manual and the login utility in the ***OS-9 Utilities*** section.
- termcap Contains descriptions of your terminal characteristics. For more information on the termcap file, refer to the chapter on OS-9 system management.

SYSMODS Contains the source for SysGo and init for system customization. For more information on SysGo and init, see the ***OS-9 Technical Manual***.

End of Chapter 2

3

Basic Commands and Functions

Learning the Basics

Now that your system is up and running, it is time to learn about OS-9's basic features and utility commands. This chapter and the chapter on the OS-9 file system provide a "fast-track" introduction to OS-9 designed to get you started quickly.

The secret of getting up to speed quickly with OS-9 is to first identify and learn only the basic, everyday functions necessary to run application programs and programming languages. It is fairly easy to learn more as you continue to work with the system.

The general topics covered in this chapter are:

- Logging on timesharing systems
- An introduction to the shell
- Use of the keyboard and display
- The page pause feature
- help, free, and mfree utilities

Logging on to a Timesharing System

If you are using a single user system such as a personal computer, you can skip this section. Otherwise, you need to know how to log on to a multi-user system. This applies to both ***hardwire*** and ***dial-up*** terminals.

Until you press the <return> key, idle terminals on multi-user systems do nothing but beep at you. Pressing the <return> key starts the log-on program called login. login's function is to maintain system security and start each user with a personalized environment.

The system asks you for your user name and the password the system manager assigned to you. The system echoes your user name but for security purposes, your password is not echoed. You have three chances to enter a valid user name and password.

An example of the login procedure is given below:

```
OS-9/68000 V2.4 Microware Systems P32 90/11/24 14:51:12

User Name: smith
Password: [not echoed]

Process #10 logged on  90/11/24 14:51:20

Welcome!

$
```

Depending on how the system is set up, a system-wide ***message of the day*** may be displayed on your screen. You can also automatically run one or more initial programs. In addition, you are normally set up in your own main working directory.

To log off, simply press the <escape> (end-of-file) key or type logout any time your main shell is active.

For more information, see the login and tsmon utility descriptions in the ***OS-9 Utilities*** section.

An Introduction to the Shell

Every operating system has a command interpreter. A command interpreter is a translator between the commands you type in and the commands the operating system understands and executes.

> + OS-9's command interpreter is called the shell.

The shell is normally started as part of the system startup sequence on a single user system or after logging on to a timesharing system. It is the primary interface with the system. When you enter a command, it is the shell's job to translate the command into something OS-9 can understand.

The shell provides many functions and options. A chapter is exclusively devoted to an in-depth discussion of the features available. This section is intended to provide just enough familiarity with the shell for you to run basic OS-9 commands.

The shell functions in two ways:

- Accepting interactive commands from your keyboard.
- Reading a sequence of command lines from a special type of file called a ***procedure file***. The shell executes each command line in the procedure file just as if the command lines had been typed in manually from the keyboard. Procedure files are a convenient way to eliminate typing frequently used, identical sequences of commands.

When the shell is ready for command input, it displays a $ prompt. You can now enter a command line followed by a carriage return.

The first word of the command line is the name of a command. It may be in upper or lower case. The command may be the name of:

- An OS-9 utility command
- An application program or programming language
- A procedure file

Most commands require or accept additional parameters or options. These parameters and options provide the program and/or the shell with additional information such as file names and directory names to search. Almost all options are preceded by a hyphen (-) character. All parameters are separated by space characters.

The shell follows a special searching sequence to locate the command in memory or on disk. If it cannot find the command you specified, the error #000:216, "file not found" is generally reported.

Here is an example of a simple shell command line:

```
$ list myfile
```

The name of the program is list. The file name myfile is passed to the program.

Using the Keyboard

Most input to OS-9, programming languages, and application programs is line oriented. This means that as you type, the characters are collected but not sent to the program until you press the <return> key. This gives you a chance to correct typing errors before they are sent to the program.

OS-9 has several features to make data entry and error correction simple. These are called ***line editing features***. Each of these features use control keys generated by simultaneously pressing the <control> key and some other character key.

The line editing control keys are:

Key	Function
<control>A	Repeats the previous input line. The last line entered is redisplayed but not executed. The cursor is positioned at the end of the line. You may enter the line as it is or you can add more characters to it. You can edit the line by backspacing and typing over old characters.
<control>D	Redisplays the current input line. This is mainly used for hardcopy terminals that cannot erase deleted characters.
<control>H	Backspaces to erase previous characters. Most keyboards have a special <backspace> key that can be used directly without using the <control> key.
<control>Q	Resumes the input and output previously stopped by <control>S. The <control>Q function is known as X-on.
<control>S	Halts input and output until <control>Q is entered. The <control>S function is known as X-off. This is a function used by many serial I/O devices such as printers to control output speed.
<control>W	Temporarily halts output so you can read the screen before data scrolls off. Output resumes when any other key is pressed. See the section on the page pause feature.
<control>X	Deletes line; erases the entire current line.
ESCAPE or <control>[	Indicates the end-of-file: all OS-9 I/O devices, including terminals, are accessed as files. This simulates the effect of reaching the end of a disk file.

There are also two important control keys called ***interrupt*** keys. They work differently than the line editing keys because they can be used at any time, not just when a program has requested input. They are normally used to halt or alter a running program.

Key	Function
<control>C	Sends an interrupt signal to the most recent program. This functions differently from program to program. If a program does not make specific interrupt provisions, it aborts the program. If a program has provisions for interrupts, <control>C usually provides a way to stop the current function and return to a master menu or command mode. In the shell, <control>C can be used to convert the ***foreground*** program to a ***background*** program, if the program has not begun I/O to the terminal.
<control>E	Sends a ***program abort*** signal to the program presently running. In most cases, this key prematurely aborts the current program and returns you to the shell.

The control keys described above are the key assignments commonly used in most OS-9 systems. The correspondence between control keys and their functions is changeable, so your keys may be different. You can use the tmode utility to redefine the function of control keys. This command allows you to customize OS-9 to the specific computer's keyboard layout.

NOTE: For more information about tmode, see the chapter on OS-9 system management and the ***OS-9 Utilities*** section.

The Page Pause Feature

The page pause feature eliminates the annoyance of having output scroll off the screen before you can read it. OS-9 counts output lines until a full screen has been displayed. It then halts output until you press any key. This is repeated for each screen of output.

Page pause can be fooled by lines longer than the physical width of the screen. These long lines wrap around to the next line. The system does not distinguish this, and consequently does not count them properly.

tmode may be used to turn this feature on and off, or to change the number of lines per screen:

Key	Function
tmode pause	Turns the page pause mode on.
tmode nopause	Turns the page pause mode off.
tmode pag=10	Sets the page length to ten lines.

Basic Utilities

OS-9 provides over seventy standard utilities and built-in shell commands. The majority of them are used rarely, if ever, by casual users. You will frequently use less than a dozen of them and less frequently use about a dozen more.

The utilities have been broken down into three groups to give you an idea of what you should and should not bother learning immediately. You should get acquainted with the first group now, and the second group as time permits. If you plan to do advanced programming or systems-level work, you can study the third group at your convenience.

Group 1: Basic Utilities

attr	backup	build	chd	chx	copy	date
del	deldir	dir	dsave	echo	edt	format
free	help	kill	list	makdir	merge	mfree
pd	pr	procs	rename	set	setime	shell
w	wait					

Group 2: Programmer Utilities

binex	cfp	cmp	code	compress	count	dump
ex	exbin	expand	frestore	fsave	grep	load
logout	make	printenv	profile	qsort	save	setenv
tape	tee	tmode	touch	tr	unsetenv	

Group 3: System Management Utilities

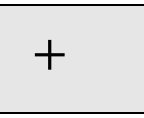
break	dcheck	deiniz	devs	diskcache	events	fixmod
ident	iniz	irqs	link	login	mdir	moded
os9gen	romsplit	setpr	sleep	tapegen	tsmon	unlink
xmode						

The Help Utility and the -? Option

The most important command to learn when beginning to use the OS-9 utilities is help. The help utility is an on-line quick reference manual. To use this utility, type help, a utility name, and a carriage return. The utility function, syntax, and available options are listed. For example, if you cannot remember the function or syntax of the backup utility, you could type help backup after the $ prompt:

```
$ help backup
Syntax: backup [<opts>] [<srcpath> <dstpath>] [<opts>]
Function: backup disks
Options:
        -b=<size>       use larger buffer (default is 4k)
        -r              don't exit if read error occurs
        -v              do not verify
$
```

The descriptions are short and precise. Try it. This is a quick way to find information without looking up the utility in the documentation.



Typing help by itself displays the syntax and use of the help utility.

The same information is also available by typing the utility name followed by a question mark (-?). Each utility has the -? option.

Free and Mfree

During the format procedure, a disk is divided into data sectors of a pre-defined number of bytes. These sectors, in turn, are allocated into groups called ***clusters***. The number of sectors per cluster is dependent on the storage capacity and physical characteristics of the given device. This means that small amounts of free space, given in sectors, may not be divisible into the same number of files.

free displays the amount of unused disk space in the number of sectors and in the number of bytes. It also displays the disk name, its creation date and the cluster size of the device. For example:

```
$ free
"Tazz: /H0 Wren V" created on: Oct 6, 1989
Capacity: 2347860 sectors (256-byte sectors, 8-sector clusters)
1477296 free sectors, largest block 1356000 sectors
378187776 of 601052160 bytes (360.66 of 573.20 Mb) free on media (62%)
347136000 bytes (331.05 Mb) in largest free block
```

free uses a 4K buffer by default. To increase the buffer size, use the -b option. For example, to use a 10K buffer you could type:

```
$ free -b=10
```

or

```
$ free -b10
```

mfree displays the address and size of unused memory available for allocation. For example:

```
$ mfree
Current total free RAM:  164.00 K-bytes
```

For even more information concerning the unused memory, the -e option may be used with mfree. For example:

```
mfree -e
Minimum allocation size:       4.00 K-bytes
Number of memory segments:   6
Total RAM at startup:       8192.00 K-bytes
Current total free RAM:     2084.00 K-bytes

Free memory map:

  Segment Address        Size of Segment
 -----------------   --------------------------
    $5B000          $1000          4.00 K-bytes
    $5F000          $2000          8.00 K-bytes
    $99000          $1E3000     1932.00 K-bytes
    $29C000         $3000         12.00 K-bytes
    $2A1000         $1F000       124.00 K-bytes
    $2C5000         $1000          4.00 K-bytes
```

End of Chapter 3

4

The OS-9 File System

OS-9 File Storage

All information stored on an OS-9 computer system is organized into files and directories. Files and directories provide a way for you to organize your information. A file may contain a program, data, or text. A directory is a file containing the names and locations of the files and directories it contains. This allows you to organize your files by topic, work group, etc.

When a file is created, the information is stored as an ordered sequence of ***bytes***. These bytes are organized into ***sectors***. A sector is a pre-defined group of bytes. For example, a sector may be composed of 256 bytes. This means that every 256 bytes are grouped together as a sector.

During the format procedure, each sector is marked as being unused. The allocation map keeps track of each sector. If a sector is in use, it is marked in the allocation map located at the beginning of each disk as being in use. When a file is created, the information is stored in sectors. When a file is expanded, the new information is stored in sectors. When a file is shortened or deleted, the previously used sectors are unmarked in the allocation map and are available for use by other files.

Within a text file, each byte contains one character. Data is written to a file in the order it is provided. Data is read from a file exactly as it is stored in the file.

When a file is created or opened, a file pointer is also created and maintained for it. The file pointer holds the address of the next byte to be written or read (see Figure 4a). As data in the file is read or written, the file pointer is automatically moved. Therefore, successive read or write operations transfer data sequentially (see Figure 4b).

You can directly access any part of a file by positioning the file pointer to any location in the file using an OS-9 system call: seek. You can access the seek system call through the various languages available for OS-9 or directly with the macro assembler command: I$SEEK. I$SEEK is described in the ***OS-9 Technical Manual***.

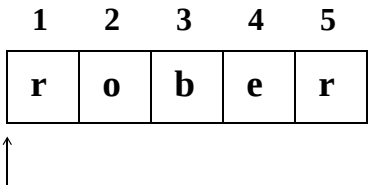


Figure 4a: When creating or opening a file, the file pointer is positioned to read from or write to the first component.

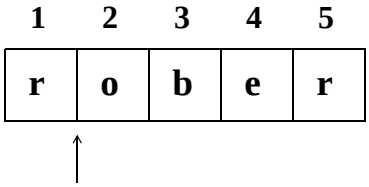


Figure 4b: After reading or writing the first component of a file, the file pointer points to the second component.

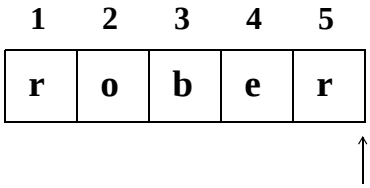


Figure 4c: The file pointer is pointing to the current end-of-file. Attempting another read operation causes an error. Another write operation increases the size of the file.

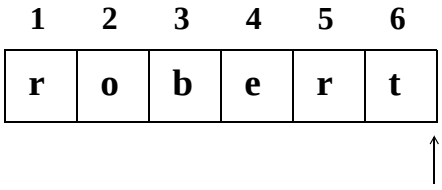


Figure 4d: The next write operation adds a new component to the file and moves the file pointer to the new end-of-file.

Reading up to the last byte of the file causes the next read operation to return an end-of-file status (see Figure 4c). Trying to read past the end-of-file mark causes an error. To expand a file, simply write past the previous end of the file (see Figure 4d).

Because all OS-9 files have the same physical organization, you can generally use file manipulation utilities on any file regardless of its logical usage. The main logical types of files used by OS-9 are:

- Text files
- Executable program module files
- Data files
- Directories

Directory files are an exception and are discussed separately.

Text Files

Text files contain variable length lines of ASCII characters. Each line is terminated by a carriage return (hex $OD). Text files typically contain documentation, procedure files, program source code, etc. You can create text files with any text editor or the build utility.

Executable Program Module Files

Executable program modules store programs generated by assemblers and compilers. Each file may contain one or more modules with standard OS-9 module format. See the ***OS-9 Technical Manual*** for more information on modules.

Random Access Data Files

A random access data file is created and used primarily by high level languages such as C, Pascal, and BASIC. The file is organized as an ordered sequence of records of varying sizes. If each record has exactly the same length, its beginning address within the file can be computed to allow records to be accessed in any order. OS-9 does not directly deal with records other than providing the basic file manipulation functions high level languages that support random access records require.

File Ownership

When you create a file or directory, a ***group.user ID*** is automatically stored with it. The group.user ID is formed from your group number and your user number. The group number allows people that work on the same project or work in the same department to share a common group identification. The user number identifies a specific user. Therefore, a group.user ID identifies a specific user in a specific group or department.

The group.user ID determines file ownership. OS-9 users are divided into two classes:

- The ***owner***
- The ***public***

The owner is any user with the same group or user number as the person who created the file. This means that any user with the same group number as the person who created the file can access the file in the same way as the creator of the file. Likewise, any user with the same user number is considered the owner.

The public is any person with a group.user ID that differs from the person who created the file.

> + A user with a group.user ID of 0.0 is referred to as a ***super user***. A super user can access and manipulate any file or directory on the system regardless of the file's ownership.

On multi-user systems, the system manager generally assigns the group.user ID for each user. This number is stored in a special file called a password file. A super user on a multi-user system is generally the system manager, although other people such as group managers or project leaders may also be super users.

NOTE: Password files are discussed in the chapter on the shell.

On single-user systems, users have super user status by default.

Attributes and the File Security System

File use and security are based on file attributes. Each file has eight attributes. These attributes are displayed in an eight character listing.

The term ***permission*** is used when one of the eight possible attribute characters is set. Permission determines who can access a file or directory and how it can be used. If a permission is not valid for the file or directory being examined, a hyphen (-) is in its position.

Here is an attribute listing for a directory in which all permissions are valid:

```
dsewrewr
```

By convention, attributes are read from right to left. They are:

Attribute	Abbreviation	Description
Owner Read	r	The owner can read the file. When off, this denies any access to the file.
Owner Write	w	The owner can write to the file. When off, this attribute can be used to protect files from accidentally being deleted or modified.
Owner Execute	e	The owner can execute the file.
Public Read	pr	The public can read the file.
Public Write	pw	The public can write the file.
Public Execute	pe	The public can execute the file.
Single user	s	When set, only one user at a time can open the file.
Directory	d	When set, indicates a directory.

The OS-9 File System

OS-9 uses a ***tree-structured***, or hierarchical, organization for its file system on mass storage devices such as disk systems (see Figure 4e). Each mass storage device has a master directory called the ***root directory***.

The root directory is created automatically when a new disk is formatted. It contains the names of the files and the sub-directories on the disk. Every file is listed in a directory by name, and each file has a unique name within a directory.

An OS-9 directory can contain both files and sub-directories. Each sub-directory can contain more files and sub-directories. This allows subdirectories to be imbedded within other subdirectories. The only limit to this division is the amount of available disk space.

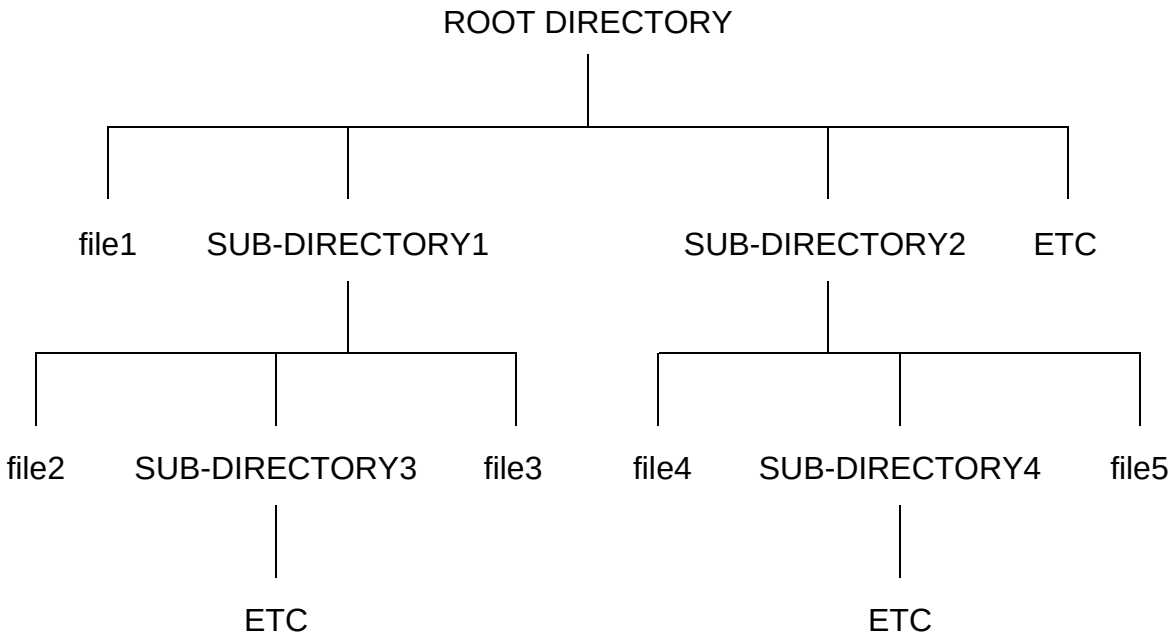


Figure 4e: The File System

With the exception of the root directory, each file and directory in the system has a ***parent*** directory. A parent directory is the directory directly above the file or directory being discussed. For example in Figure 4e, the parent directory of file2 is SUB-DIRECTORY1. Likewise, the parent directory of SUB-DIRECTORY1 is the root directory.

Current Directories

Two working directories are always associated with each user or process. These directories are called the ***current data directory*** and the ***current execution directory***.

> + A ***data directory*** is where you create and store your text files.
>
> An ***execution directory*** is where executable files such as utilities and programs you have created are located.

The current directory concept allows you to organize your files while keeping them separate from other users on the system. The word ***current*** is used because you can use the chd command to move through the tree structure of the OS-9 file system to a different directory. This new directory then becomes your current data or execution directory.

NOTE: The chd utility is discussed later in this chapter.

On a single user system, OS-9 chooses the root directory of your system disk as your initial current data directory. Your initial current execution directory is the CMDS directory. The CMDS directory is located in the root directory of the system disk.

On a multi-user system, your current data and execution directories are established for you as part of the initial login sequence. When you login, your initial directories are set up according to your password file entry. A password entry is established for each user on a multi-user system. This entry lists the user's password, current directories, etc. For more information on password files, see the chapter in this manual on the shell and the login utility in the ***OS-9 Utilities*** section.

Your execution directory on a multi-user system is usually the CMDS directory. The CMDS directory is shared with other users. CMDS contains OS-9 utilities and other executable files. If all users had their own copy of all OS-9 commands, a great deal of disk space would be wasted. Private execution directories are also possible and are discussed later in this chapter.

The Home Directory

On typical multi-user systems, all users have their own data directory, but share an execution directory. The private data directory allows you to organize your own files by project, function, or any other method without affecting other user's files. The data directory specified in the password file entry is known as your ***home directory***. When you first login to the system, you are placed in this directory. Using the chd utility with no parameters also places you in this directory. The chd utility is discussed later in this chapter.

On single user systems, you may establish a home directory by setting the HOME environment variable. Refer to the chapter on the shell for more information on setting the HOME environment variable.

Directory Characteristics

Some important characteristics relating to directory files are:

- Directories have the same ownership and attributes as regular files. However, directories always have the d attribute set.
- Each file name within a directory must be unique. For example, you cannot store two files with the name of trial in the same directory. Files can have identical names, as long as they are stored in different directories.
- All files are stored on the same device as the directory in which they are listed.
- The only limit to the number of files that can be stored in a directory is the amount of free disk space.

Accessing Files and Directories: The Pathlist

You can access all files or directories in your current data directory by specifying the name of the file or directory after the proper command. When only a file or directory name is given, OS-9 will not look outside your current data directory to find it.

If you want to access a file that is not in your current data directory or run a program that is not in your current execution directory, you must either change your current directory or specify a ***pathlist*** through the file system for OS-9 to follow.

There are two types of pathlists:

- Full pathlists
- Relative pathlists

A full pathlist starts at the root directory and follows the directory names in the list down the file structure to a specific file or directory. A full pathlist must begin with a slash character (/). Slashes separate names within the pathlist.

The following example is a full pathlist from the root directory, /d1, through two subdirectories, PASCAL and TESTS, to the file futureval.

/d1/Pascal/tests/futureval

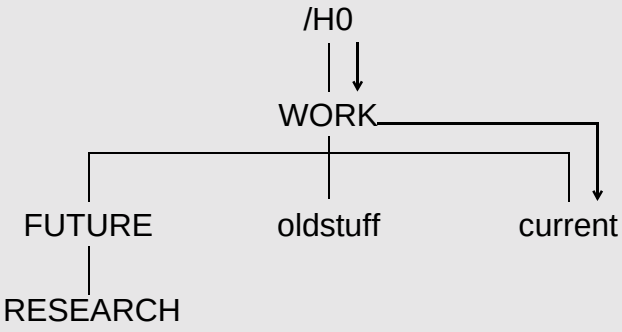
The next example specifies a path from the root directory, /h0, through the USR subdirectory to the NICHOLLE subdirectory.

/h0/usr/nicholle

Full Pathlist:

A full pathlist begins at the root directory regardless of where your current data directory is located. It lists each directory located between the root directory and a specific file or subdirectory.

Example: Your data directory is RESEARCH. A full pathlist to current is /h0/work/current.



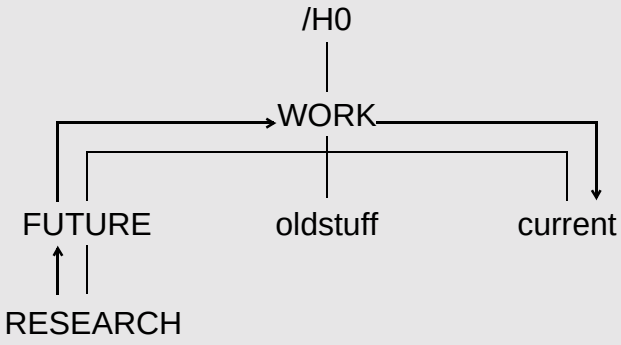
A ***relative*** path starts at the current directory and proceeds up or down through the file structure to the specified file or directory. A relative pathlist does not begin with a slash (/). Slashes separate names within a relative pathlist.

When you use a relative pathlist and the desired destination requires going up the directory tree, you can use special naming conventions to make moving around the pathlist easier. A single period (.) refers to the current directory. Two periods (..) refer to the current directory's parent directory. Add a period for each higher directory level. For example, to specify a directory two levels above the current directory, three periods are required. Four periods refer to a directory three levels above the current directory.

Relative Pathlist:

A relative pathlist begins at your current directory regardless of its location in the overall file structure.

Example: Your data directory is RESEARCH. A relative pathlist to current is .../current .



NOTE: Using these name substitutes does not change the actual directory's name.

The following example is a relative pathlist which begins in your current directory and goes through the subdirectories DOC and LETTERS to the file jim.

doc/letters/jim

The next pathlist goes up to the next directory above your current directory and then through the subdirectory CHAP to the file page.

../chap/page

The next pathlist specifies a file within your current directory. No directories are searched other than the current directory.

accounts

Basic File System Oriented Utilities

This section explains some of the OS-9 utility commands that manipulate the file system. The utilities include dir, chd, chx, pd, build, makdir, list, copy, dsave, del, deldir, and attr. The examples given refer to the file system diagram in Figure 4f.

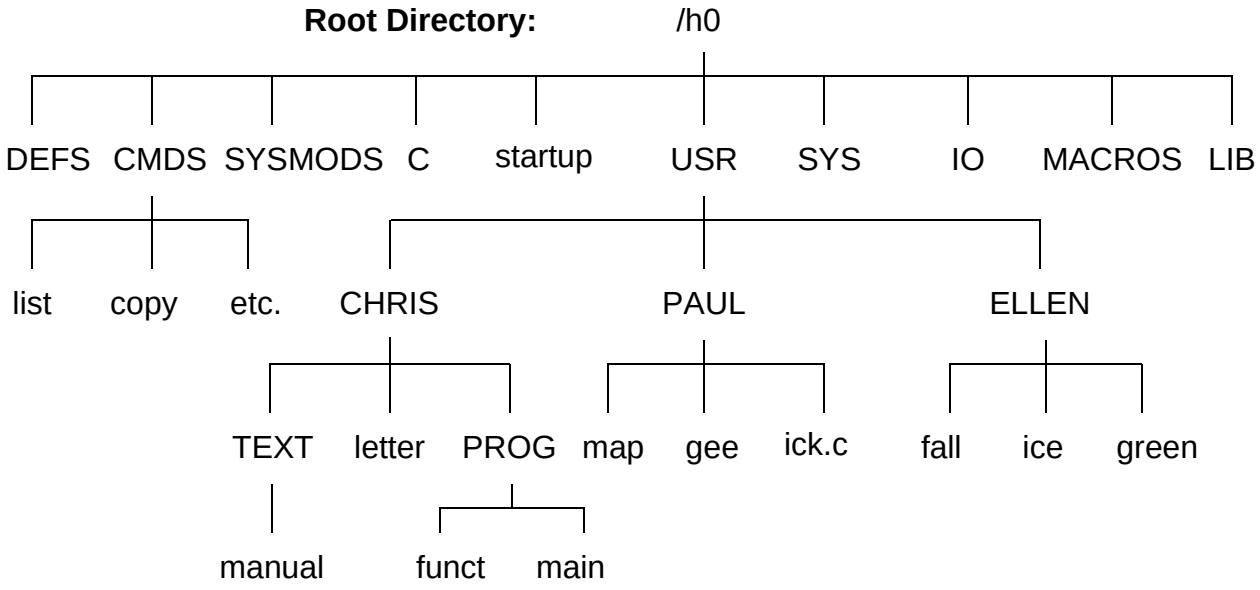


Figure 4f: Diagram of a Typical File System

Dir: Displaying the Contents of Directories

The dir utility displays the contents of directories. Typing dir by itself displays the contents of your current data directory. For the following example, the current data directory is /h0 in Figure 4f:

```
$ dir

 directory of .  13:56:58
C           CMDS        DEFS        IO          LIB
MACROS      SYS         SYSMODS     USR         startup
```

To look at directories other than your current data directory, you must either provide a pathlist to the desired directory or change your current data directory. Changing directories is discussed later in this chapter.

> + To display the contents of another directory without changing your current data directory, type dir and the pathlist to the directory.

For example, if you are in the root directory and you want to see what is in the DEFS directory, type:

```
dir defs
```

dir now displays the names of the files in the DEFS directory. The name defs is a relative pathlist. You can type dir defs because DEFS is in your current data directory. You can also use the full pathlist, dir /h0/defs, and get the same result.

To display the contents of your current execution directory, type dir -x.

You may also use wildcards with the dir utility and with most other utilities as well. OS-9 recognizes two wildcards: the asterisk (*) and the question mark (?). An asterisk is replaced by any number of letter(s), number(s), or special characters. Consequently, an asterisk by itself expands to include all of the files in a given directory. A question mark is replaced by a single letter, number, or special character.

For example, the command dir * lists the contents of all directories located in the current data directory. The command dir /h0/cmds/d* lists all files and directories in the CMDS directory that begin with the letter d. The command dir prog_? lists all files in your current directory that have a file name with prog_ followed by a single character.

For more information, see the section on wildcards in the chapter on the shell.

Dir Options

dir has several options which are fully documented in the ***OS-9 Utilities*** section. Some of these options are discussed here. Try each of the options and see what information is displayed.

The -e option gives an ***extended directory listing***. An extended directory listing displays all files within the specified directory with their attributes, the size of the file, and the sector where the file is stored. The following example uses the file structure shown in Figure 4f.

```
$ dir usr/chris -e

                                        Directory of USER/CHRIS 12:30:00
 Owner    Last Modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 12.4     89/06/17 1601  ------wr   3458      5744 letter
 12.4     89/07/03 1148  d-----wr   104A0    15944 PROG
 12.4     89/05/13 1417  d-----wr    DODO    11113 TEXT
```

The -r option displays the contents of the specified directory and any files contained within its subdirectories. Using Figure 4f as an example, typing dir usr/chris -r lists the following:

```
                        Directory of . 12:30:15
PROG                    TEXT                    letter

                        Directory of PROG 12:30:15
funct                   main

                        Directory of TEXT 12:30:15
manual
```

You can use the dir options with each other. Typing dir -er displays all files within the current data directory, all files within its sub-directories, and provides an extended listing of their attributes, sizes, etc.

Chd and Chx: Moving Around in the File System

The chd and chx utilities allow you to travel around the file system.

- The chd utility allows you to change your current data directory.
- The chx utility allows you to change your current execution directory.

To change your current data directory, type chd followed by a full or relative pathlist. For example, if your current data directory is /h0 and you want your current data directory to be USR, you would type chd and the pathlist of USR.

For example, with a relative pathlist, type:

```
chd usr
```

With a full pathlist, type:

```
chd /h0/usr
```

Your current data directory is now USR. If you type dir, you will see the contents of USR:

```
                        directory of . 14:04:32
CHRIS                   ELLEN                   PAUL
```

If you want to see which files are in the CHRIS directory, type dir chris. Or change directories by typing chd chris and after the new prompt, type dir.

If you want to return to your home directory, which in this case is /h0, type chd without a pathlist. After changing directories, dir displays the contents of /h0.

The chx command allows you to redefine an existing directory as a personal execution directory. This may be important if you have programs you do not want other people to execute. To use this command, type chx, followed by a full or relative pathlist to the directory. When using a relative pathlist with chx, the pathlist is relative to your current execution directory.

If your current data directory is USR and you want to change your current execution directory from CMDS to PAUL, you could type the relative pathlist chx ../usr/paul or the full pathlist chx /h0/usr/paul. When you type a command after you have changed your current execution directory, PAUL is searched instead of CMDS.

Typing dir -x displays the contents of your current execution directory, PAUL:

```
                              directory of . 14:05:06
gee                           ick.c                         map
```

Climbing Directory Trees

You can use OS-9's special naming conventions to move around the file system. As a reminder, the naming conventions are periods specifying the current directories and directories higher in the file structure. For example:

- **.** refers to the current directory
- **..** refers to the parent directory
- **...** refers to two directory levels higher

etc.

When used as the first name in a path, you can use these naming conventions in conjunction with relative pathlists.

NOTE: If you are planning to port your code to other operating systems, you must remember that most operating systems only use this convention as it refers to the current and parent directories. For example, if you use ... to refer to the directory above a parent directory, most operating systems require you to use ../.. instead.

The examples below relate to the file structure in Figure 4g. The examples assume your initial current data directory is PROG.

The following example displays the contents of PROG. It is functionally the same command as dir:

```
dir .

 directory of . 14:04:32
funct                         main
```

The next command displays the contents of PROG's parent directory, CHRIS.

```
dir ..

 directory of ..  14:05:58
PROG                    TEXT                    letter
```

This example displays the contents of TEXT by specifying a path starting with the parent directory (..):

```
dir ../text

 directory of ../text 14:06:47
manual
```

The following command changes the current data directory from PROG to ELLEN:

```
chd .../ellen
```

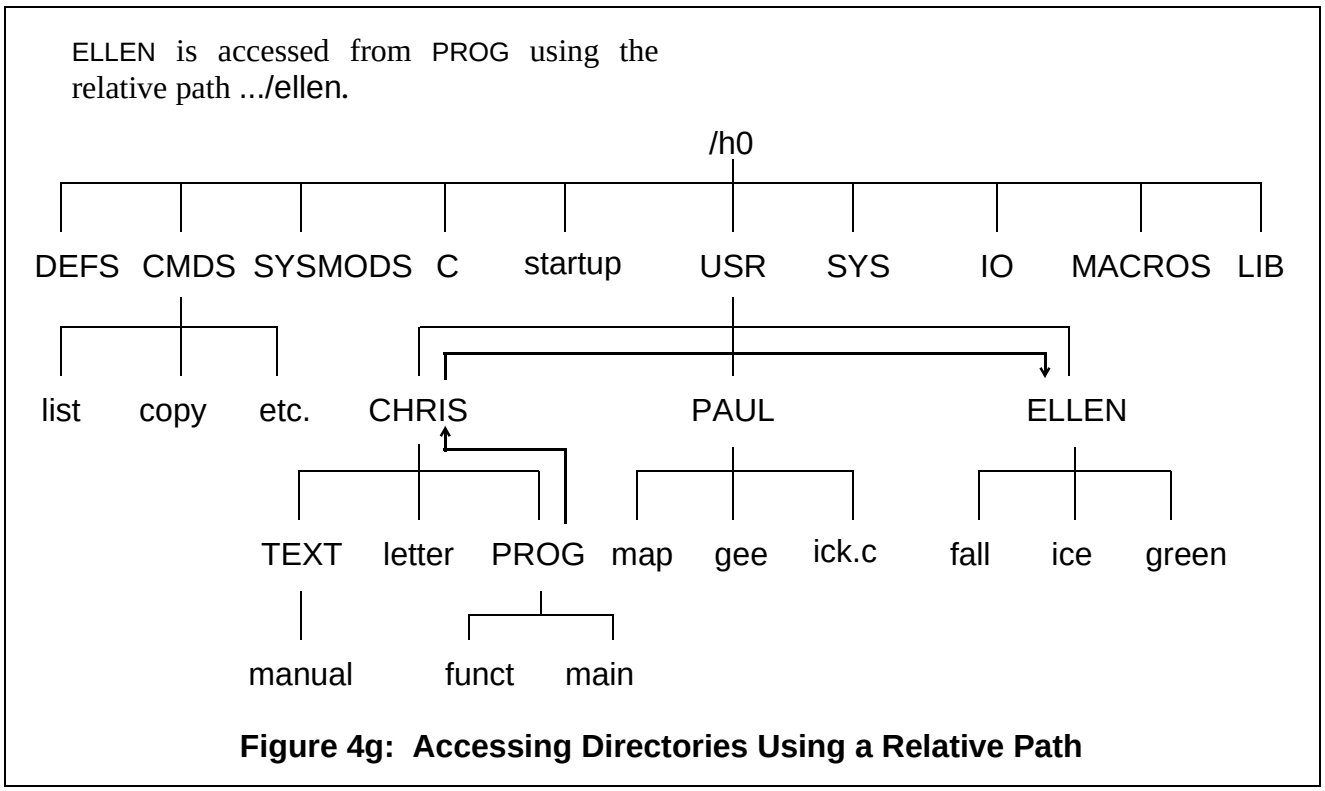


Figure 4g: Accessing Directories Using a Relative Path

You can use any number of periods (.) to access higher directories. One period is added for each additional level. An error is not returned if you specify a greater number of directory levels above your current data directory than actually exist. Instead, this indicates the root directory on your system. For example, this command displays the contents of the root directory:

```
dir .....
```

This may be helpful if you are not sure how far down you are in the directory structure. The next example changes your current data directory from PROG to MACROS:

```
chd ...../macros
```

Using the Pd Utility

When the file system becomes complex, you may become confused as to where the directory you are currently working in is located in relation to the overall file system.

> + The pd utility displays the complete pathlist from the root directory to your current data directory.

For example, if your current data directory is PAUL:

```
pd
/h0/USR/PAUL
```

Likewise, if you forget which directory is your current execution directory, type pd -x to display the pathlist to the current execution directory.

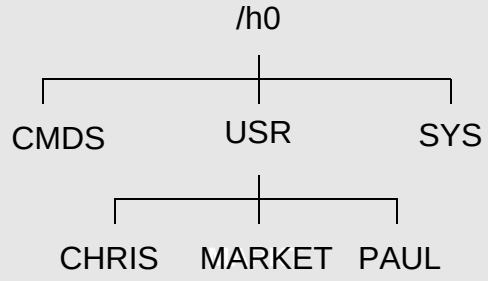
Using Makdir to Create New Directories

You create new directories using the makdir utility. For example, to create a directory called BUS.DEPT, type:

```
makdir BUS.DEPT
```

BUS.DEPT now is a new entry in your current directory.

If you want the new directory created somewhere other than your current directory, you must specify a pathlist. For example, makdir /h0/usr/BUS.DEPT creates the new directory in USR.

> + The makdir /h0/usr/MARKET command creates a new directory called MARKET in the USR directory.
>
> 
>

Rules for Constructing File Names

When creating files and directories, you must follow certain rules. Any file name can contain from 1 to 28 upper or lower case letters, numbers, or special characters as listed below. While the file name may begin with any of the following characters or digits, each file name must contain at least one letter or number. Within these limitations, a name can contain any combination of the following:

upper case letter:	A - Z	underscore:	_
lower case letter:	a - z	period:	.
decimal digits:	0 - 9	dollar sign:	$

File names may not contain spaces. Instead, use the underscore (_) or the period (.) to improve the readability of file and directory names. OS-9 does not distinguish upper case letters from lower case letters. The names FRED and fred are considered the same name.

> **NOTE:** By OS-9 convention, directory names are in upper case and file names are in lower case. This allows you to easily distinguish directories from files. This is only a recommendation for easy use; you may develop your own style.

Here are some examples of legal names:

raw.data.2 **project_review_backup**
X6809 **$SHIP.DIR**
...c **12345**

Here are some examples of illegal names:

Max*min	** is not a legal character*
open orders	*name cannot contain a space*
this.name.obviously.has.more.than.28.characters	*too long*

NOTE: File names that start with a period are not displayed by dir unless the -a option is used. This allows you to hide files within a directory.

Creating Files

You can create files in many ways. Text files are generally created with the build utility, the edt utility, or the µMACS text editor. These file building tools are provided with the Professional OS-9 package for your convenience.

Use the build utility to create short text files. To use the build utility, type build, followed by the name of the file you want to create. build responds with the prompt:

```
?
```

This tells you that build is waiting for input. To terminate build, type a carriage return at the ? prompt. For example:

```
$ build test
? Some programmers have been known to
? howl at full moons.
?

$
```

You cannot edit files with build.

You may also use the edt utility to create files. edt is a line-oriented text editor that allows you to create and edit source files. To use the edt utility, type edt and the desired pathlist. If the file is new or cannot be found, edt creates and opens the file. edt then displays a question mark (?) prompt and waits for an edit command. If the file is found, edt opens it, displays the last line, and then displays the ? prompt. edt is fully detailed in the ***OS-9 Utilities*** section.

The preferred method of creating and editing files is with µMACS. µMACS is a screen-oriented text editor designed for creating and modifying test files and programs. Through the use of multiple buffers, µMACS allows you to display different files or different portions of the same file on the same screen. In addition, extensive formatting commands allow you to reformat paragraphs with new user-defined margins, transpose characters, capitalize words, and change words or sections into upper or lower case. For a more detailed description, see the ***Using µMACS*** manual.

Examining File Attributes with Attr

When you create a file using build or µMACS, only the owner read and owner write permissions are set. When you create a directory, it initially has all the permissions set except the single user permission.

To examine file attributes, use the attr utility. To use this utility, type attr, followed by the name of a file. For example:

```
$ attr newtest
------wr
```

The file newtest has the permissions set for owner reading and owner writing. Access to this file by anyone other than the owner is denied.

> **Just a reminder:** Users with the same group.user ID as the person who created the file are considered owners. However, if the file is created by a group 0 user, only users in the super group can read, write, or execute the file.

If you use attr with a list of one or more attribute abbreviations, the file's attributes are changed accordingly, provided you have the proper write permission to access the file. The attribute abbreviations do not have to be listed in any particular order. The letter n preceding an attribute removes that permission.

The following command enables public read and write permission and removes execution permission for both the owner and the public:

```
$ attr newtest -pw -pr -ne -npe
```

If you are the owner of a file, you can change the access permissions regardless of what the permissions indicate. Thus, the owner always has the right to delete a file, change the user privileges, etc. Users in the same group have the same permissions as the owner.

The directory attribute is somewhat different than the other attributes. It could be dangerous to be able to change directory files to normal files or a normal file to a directory. For this reason, you cannot use attr to turn the directory (d) attribute on; use makdir to turn this attribute on. Furthermore, you can only use attr to turn the directory attribute off if the directory is empty.

Listing Files

Use the list utility to display the contents of files. By default, list displays the lines of text on your terminal screen. To examine a file, type list, followed by the name of the file. For example:

```
$ list test
Some programmers have been known to
howl at full moons.
$
```

It is important to remember that you cannot list a directory. If you type the command list USR, the following error message and error number are returned:

```
list: can't open "USR".  Error# 000:214.
```

This means that you cannot access USR because it is a directory.

list displays text files. All distributed files in CMDS are executable program module files. If you try to list the contents of a random access data file or an executable program module file, you see what appears to be random data displayed on your screen. This may also include unprintable characters, such as escape or delete, that could change your terminal's operating parameters. If the operating characteristics of your terminal are affected, first try turning the terminal off and on. If this does not re-initialize the terminal, consult your terminal operating manual.

Copying Files

Use the copy utility to make a duplicate of a file. To copy a file, type copy, followed by the name of the file to be copied, followed by the name of the duplicate file. For example:

```
$ copy test newtest
```

If you list the file newtest, it is an exact copy of test.

The file you are copying and the duplicate file may be located in any directory; they do not have to be in your current data directory. For files located outside of your current data directory, you may use full or relative pathlists. The following example uses Figure 4h. The first command copies the file gee in the PAUL directory to a file named new.info in the TEXT directory:

```
copy /h0/usr/paul/gee /h0/usr/chris/text/new.info
```

Assuming your data directory is USR, the following commands would have the same effect:

```
copy /h0/usr/paul/gee chris/text/new.info
copy paul/gee chris/text/new.info
```

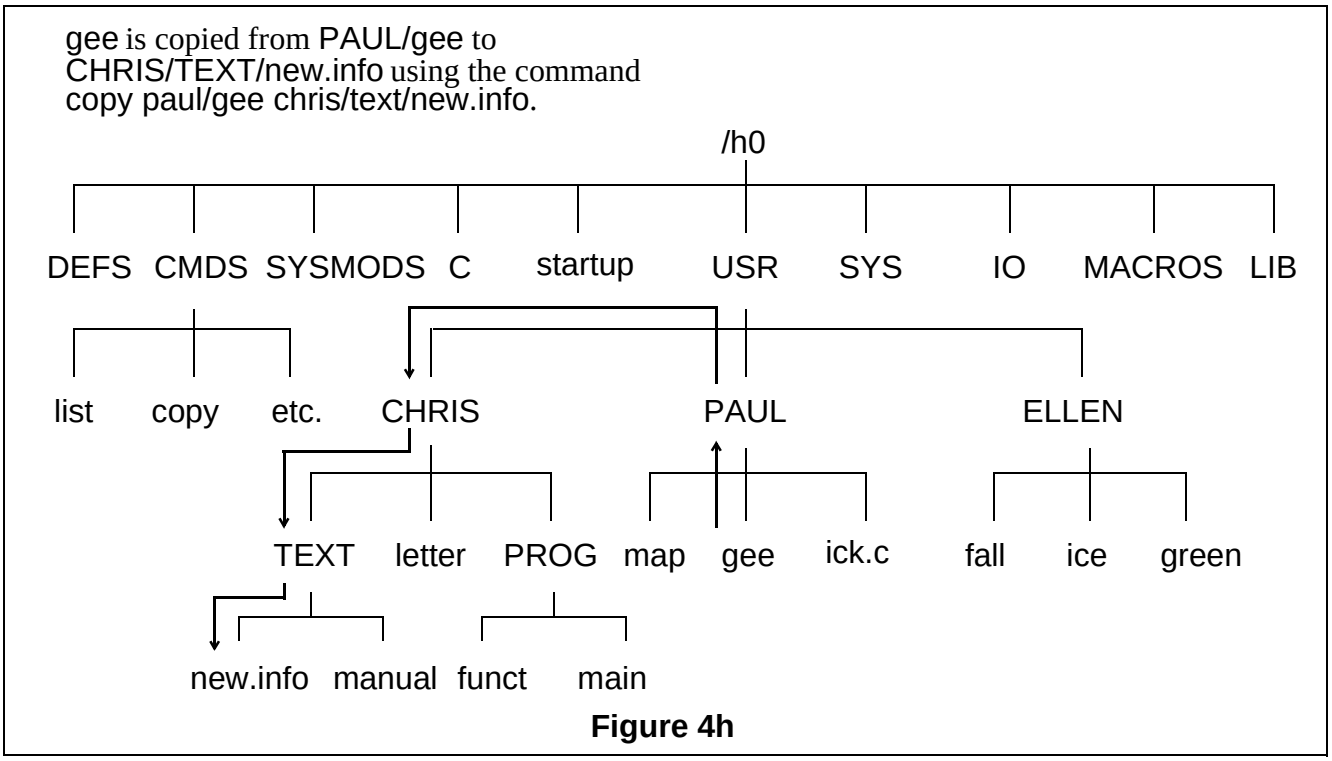


Figure 4h

If you try to copy the contents of one file into an existing file, you will receive Error #000:218 Tried to create a file that already exists. If you know the file exists but you want to overwrite it anyway, use the -r option. For example, the following command replaces the contents of green with the contents of fall.

```
$ copy fall green -r
```

If you list the contents of both files, you will see that they are identical.

At some point, you may want to copy more than one file at a time into another directory. By using the -w=<dir> option of copy, you can copy more than one file with a single command. For example, if your current directory is PROG and you want to copy all of the files in PROG into the TEXT directory, you could type the following command line:

```
$ copy * -w=../text
```

This option will print the name of the file after each successful copy. If an error occurs, the prompt continue (y/n) is displayed.

Remember that an asterisk is a wildcard. For more information about wildcards, refer to the section on wildcards in the chapter on the shell.

+	copy uses a 4K memory buffer by default. This means that only 4K of information is read from the original file and written to the new file at one time.

If you have a large file, the copy procedure may be slow because the system has to perform multiple read and write statements. The -b option may be used to increase the buffer size. This would make the copy procedure faster for large files. To use the -b option, type copy, the original file name, the new file name, and -b=<num>k.

For example, typing copy gee mine -b=20k allocates a 20K buffer for copying the file gee into the file mine.

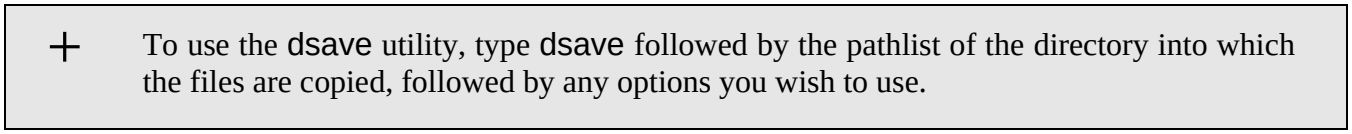
NOTE: You must have permission to copy the file. That is, you must be the owner of the file to be copied or the public read permission must be set in order to copy the file. You must also have permission to write in the directory you specify. In either case, if the copy procedure is successful, the new file has your group.user number unless you are the super user. If you are the super user, the new file will have the same group.user number as the original file.

For more information concerning copy, refer to the ***OS-9 Utilities*** section.

Dsave: Copying Files Using Procedure Files

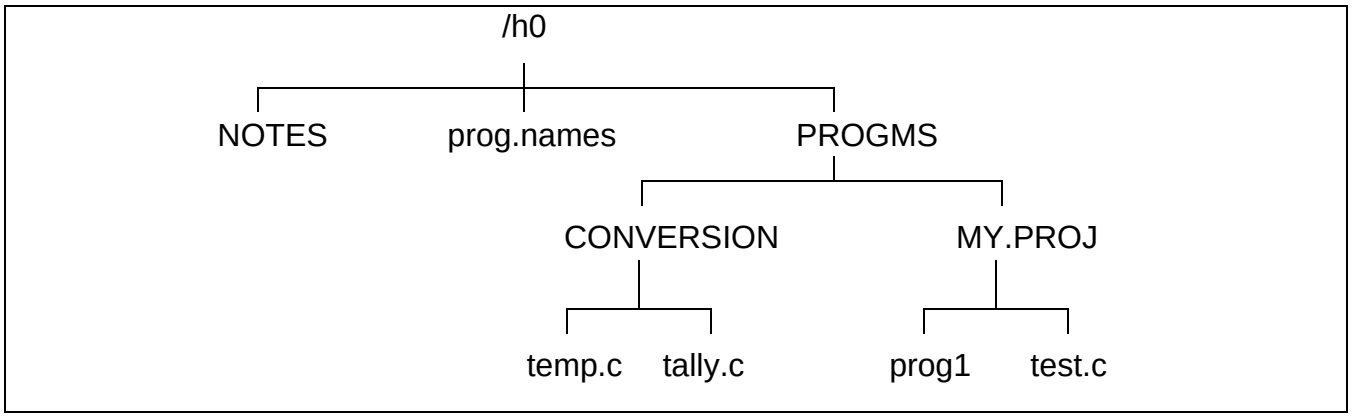
Use the dsave utility to copy all files and directories within a specified directory by generating a procedure file. The procedure file is either executed later to actually perform the copy or, by specifying the -e option, executed immediately.

NOTE: A procedure file is a special OS-9 file. It contains OS-9 commands. Each command is specified on a line, one command per line. When the procedure file is executed, the OS-9 commands it contains are executed in the order they are listed in the procedure file. Procedure files are discussed in more detail in the chapter on the shell.



If no pathlist is specified for the destination, the files are copied to the current data directory at the time the procedure file is executed. If you do not specify the -e option or redirect the output to a file, dsave sends the output to the terminal.

The example below uses the following directory structure:



If PROGMS is your current data directory and you type dsave ../notes, the following appears on your screen:

```
$ dsave ../notes
-t
chd ../notes
tmode -w=1 nopause
load copy
Makdir MY.PROJ
Chd MY.PROJ
Copy -b=10 /h0/PROGMS/MY.PROJ/prog1
Copy -b=10 /h0/PROGMS/MY.PROJ/test.c
Chd ..
Makdir CONVERSION
Chd CONVERSION
Copy -b=10 /h0/PROGMS/CONVERSION/temp.c
Copy -b=10 /h0/PROGMS/CONVERSION/tally.c
Chd ..
unlink copy
tmode -w=1 pause
$
```

Because the output was not redirected to a procedure file and the -e option was not used, the above commands were not executed. They were just echoed to your screen.

If you now type dsave ../notes -e, the commands are again echoed to the screen. However, the contents of the PROGMS directory are copied into the NOTES directory.

You can also redirect the output of dsave to a file. When you redirect the output, the commands that are output from dsave are essentially captured in a file. You can later execute this file to actually perform the dsave operation.

To redirect the output from dsave to a file, use the redirection modifier for standard output. The standard output modifier is the > symbol.

For example, from the PROGMS directory, you can redirect the output from dsave into a file called make.bckp by typing:

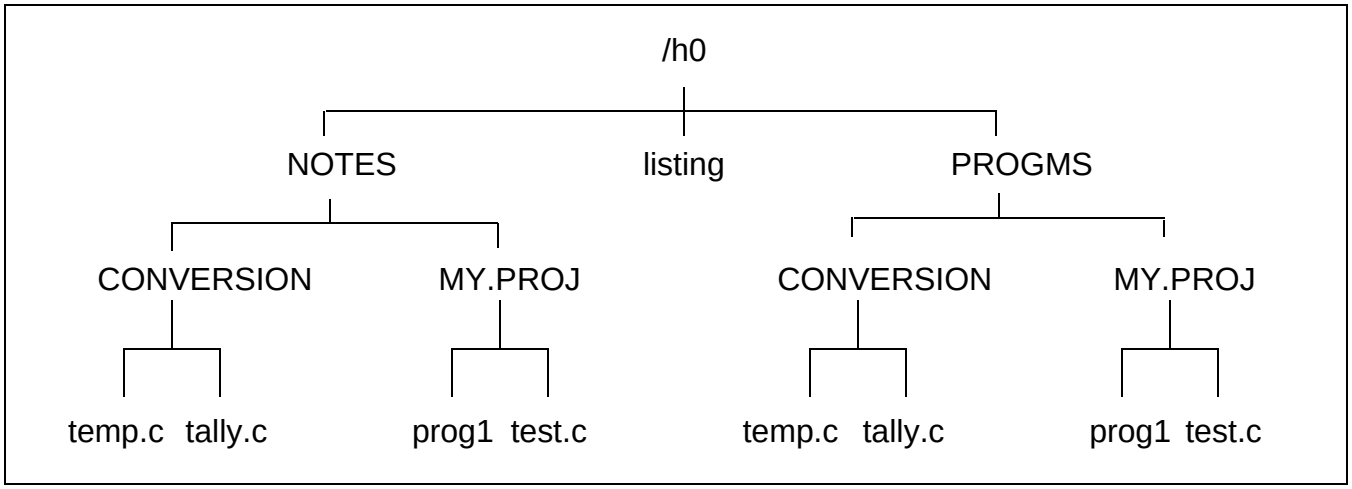
dsave >make.bckp

This command creates make.bckp in the current data directory. To perform the dsave, type make.bckp at the command line.

Redirecting the output to a file is helpful when you want to save most, but not all, of the files in the directory or directories being saved. You can edit make.bckp before performing the dsave. This allows you to save only selected files.

Regardless of how you decide to perform the dsave, if dsave encounters a directory file, it automatically creates a new directory and changes to that directory before generating copy commands for files in the subdirectory.

In the dsave example, the directory structure looks like the following after dsave has finished:



If the current working directory is the root directory of the disk, dsave creates a file that backups the entire disk, file by file. This is useful when you need to copy many files from different format disks or from a floppy disk or a hard disk.

If an error occurs during the dsave process, the following prompt is displayed:

continue (y,n,a,q)?

A y indicates that you wish to continue with dsave. An n indicates that you do not wish to continue with dsave. An a indicates that all possible files should be copied and the prompt should not be displayed on error. A q indicates that you want to exit the dsave procedure.

If for any reason you do not wish to be bothered by the prompt, the -s option is available. This skips any file which cannot be copied and continues the dsave routine without the error prompt.

When you copy several subdirectories, you can use the -i option to indent for directory levels. This helps to keep track of which files are located in which directories.

You can use dsave to keep current directory backups. Use the -d or -d=<date> options to compare the date of the file to be copied with a file of the same name in the directory where it is to be copied. The -d option copies any file with a more recent date. The -d=<date> option copies any file with a date more recent than that specified. The following example shows the use of dsave with the -d option:

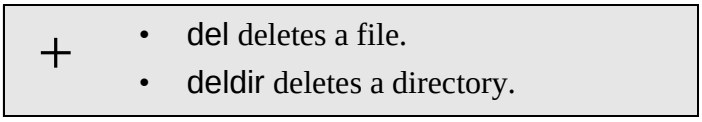
```
$ chd /d0/BACKUP
$ dir
                                        Directory of . 14:14:32
 Owner    Last Modified  Attributes Sector Bytecount Name
-------  -------------  ---------- ------ --------- ----
 12.4     90/11/12 1417  ------wr   20CO     11113 program.c
 12.4     90/10/05 1601  ------wr   313D      5744 prog.2
$ chd /d0/WORKFILES
$ dir
                                        Directory of . 14:14:32
 Owner    Last Modified  Attributes Sector Bytecount Name
-------  -------------  ---------- ------ --------- ----
 12.4     90/11/12 1417  ------wr   DODO     11113 program.c
 12.4     90/11/12 1601  ------wr   3458      5780 prog.2
$ dsave -deb32 /d0/BACKUP
$ chd /d0/BACKUP
$ dir
                                        Directory of . 14:14:32
 Owner    Last Modified  Attributes Sector Bytecount Name
-------  -------------  ---------- ------ --------- ----
 12.4     90/11/12 1417  ------wr   5990     11113 program.c
 12.4     90/11/12 1601  ------wr   A12B      5780 prog.2
```

Only prog.2 was copied to the BACKUP directory because the date was more recent in the WORKFILES directory.

For more information about dsave, refer to the ***OS-9 Utilities*** section.

Del and Deldir: Deleting Files and Directories

Use the del and deldir utilities to eliminate unwanted files and directories. If you no longer need a file, deleting the file frees disk space. You *must* have permission to write to the file or directory in order to delete it.



To delete a file, type del, followed by the name of the file that you want deleted. For example, to delete the file test that you created with build, you would type:

```
del test
```

If you execute dir you see that test is no longer displayed.

When deleting files, you may use wildcards. For example, if you have three files, trial, trial1, and trial.c, in a directory and you want to use wildcards to delete trial and trial1, you may be tempted to type del trial*, but this would also delete trial.c, a file you want to keep. **Use caution when you use wildcards with utilities like del and deldir**. It is easy to unintentionally delete files you want to save.

NOTE: Wildcards are discussed in the chapter on the shell.

The del -p option displays the following prompt before deleting a file:

```
delete <filename> ? (y,n,a,q)
```

Type y to delete the file; n if you do not want to delete the file; a if you want to delete all specified files without further prompts; and q if you want to quit the deleting process. This helps prevent deleting files you want to keep.

Deleting a directory is a little different. Use the deldir utility to delete directories. deldir first deletes all the files and directories in the given directory, and then, if no errors occur, finally deletes the directory name. For example:

```
$ deldir USER2

Deleting directory: USER2
Delete, List, or Quit (d, l, or q) ?
```

At the prompt, type l to list the contents of the directory, d to delete the directory, or q to quit and not delete anything.

Just a reminder: Never delete a file or directory unless you are sure you do not need it.

End of Chapter 4

5

The Shell

The Function of the Shell

The shell is the OS-9 command interpreter program. The shell translates the commands you enter into commands the operating system understands and executes. This allows you to use commands such as dir, copy, and procs without knowing the complex machine language OS-9 understands.

The shell also provides a user-configurable environment to personalize the way OS-9 works on your system. You can use the shell to change the shell prompt, send error messages to a file, or backup your disk before you log out.

The shell command starts the shell program. This command is automatically executed following system startup or after logging on to a timesharing terminal. When the shell is ready for commands, it displays the prompt:

```
$
```

This prompt indicates that the shell is active and waiting for a command from your keyboard. You can now type a command line followed by a carriage return.

A number of options are available to the shell. By default, some are automatically turned on following startup or log on. The available shell options are:

Option	Description
-e=<file>	Prints error messages from <file>. If no file is specified, /dd/sys/errmsg is used. Without this option, the shell prints only error numbers with a brief message description. Each error is described in the appendix on error codes.

Option	Description
-ne	Prints no error messages. This is the default option.
-l	The logout built-in command is required to terminate the login shell. <eof> does not cause the shell to terminate.
-nl	<eof> terminates the login shell. <eof> is normally caused by pressing the <Esc> key. This is the default option.
-p	Displays prompt. The default prompt is a dollar sign ($).
-p=<string>	Sets the current shell prompt equal to <string>.
-np	Does not display the prompt.
-t	Echoes input lines.
-nt	Does not echo input lines. This is the default option.
-v	Verbose mode: displays a message for each directory searched when executing a command.
-nv	Turns off verbose mode. This is the default option.
-x	Aborts process upon error. This is the default option.
-nx	Does not abort process upon error.

You can change shell options with either of two methods. The first method involves typing the option on the command line or after the shell command. For example:

$ -np	Turns off the shell prompt.
$ shell -np	Creates a new shell that does not prompt. When the new shell is exited, the original shell will prompt.

The second method uses set, a special shell command. To set shell options, type set, followed by the options desired. When using the set command, a hyphen (-) is unnecessary before the letter option. For example:

$ set np	Turns off the shell prompt.
$ shell set np	Creates a new shell that does not prompt. When the new shell is exited, the original shell will prompt.

As you can see, the two methods accomplish the same function. They are both provided for your convenience. You should use the method that is clearer to you.

The Shell Environment

The shell maintains a unique list of ***environment*** variables for each user on an OS-9 system. These variables affect the operation of the shell or other programs subsequently executed and can be set according to your preference.

You can access all environment variables by any process called by the environment's shell or by descendant shells. This essentially allows you to use the environment variables as ***global*** variables.

> + If a subsequent shell redefines an environment variable, the variable is only redefined for that shell and its descendents. The environment variable is not redefined for the parent shell.

Four environment variables are automatically set up when you log on to a time-sharing system:

Variable	Description
PORT	This specifies the name of the terminal. An example of a valid name is /t1. PORT is automatically set up by the tsmon utility.
HOME	This specifies your ***home*** directory. The home directory is specified in your password file entry and is your current data directory when you first log on the system. This is also the directory used when the command chd with no parameters is executed.
SHELL	This is the first process executed when you log on to the system.
USER	This is the user name you typed when prompted by the login command.

On single user systems, you can set these variables with the setenv command. You can also set up a procedure file with your normal configuration of these variables. This procedure file could then be executed each time you startup your terminal.

There are four other important environment variables:

Variable	Description
PATH	This specifies any number of directories. A colon (:) must separate directory paths. The shell uses PATH as a list of commands directories to search when executing a command. If the default commands directory does not include the file/module to execute, each directory specified by PATH is searched until the file/module is found or the list is exhausted.

Variable	Description

PROMPT This specifies the current prompt. By specifying an "at" sign (@) as part of your prompt, you may easily keep track of how many shells you have running under each other. @ is a replaceable macro for the shell level number. The base level is set by the environment variable _sh.

_sh This specifies the base level for counting the number of shell levels. For example, set the shell prompt to "@howdy: " and _sh to 0:

```
$ setenv _sh 0
$ -p="@howdy: "
howdy: shell
1.howdy: shell
2.howdy: eof
1.howdy: eof
howdy:
```

TERM This specifies the type of terminal being used. TERM allows word processors, screen editors, and other screen dependent programs to know what type of terminal configuration to use.

NOTE: Environment variables are case sensitive. OS-9 does not recognize a variable if you do not use the proper case.

Changing the Shell Environment

Three utility programs are available to use with environment variables: setenv, unsetenv, and printenv.

+	setenv:	Declares the variable and sets the value of the variable.
	unsetenv:	Clears the value and removes the variable from storage.
	printenv:	Prints the variables and their values to standard output.

setenv declares the variable and sets its value. The variable is put in an environment storage area accessed by the shell. For example:

```
$ setenv PATH ..:/h0/cmds:/d0/cmds:/dd/cmds
$ setenv _sh 0
```

These variables are only known to the shell in which they are defined and any descendant processes from that shell. This command does not change the environment of the parent process of the shell which issued setenv.

unsetenv clears the value of the variable and removes it from storage. For example:

```
$ unsetenv PATH
$ unsetenv _sh
```

printenv prints the variables and their values to standard output. For example:

```
$ printenv
PATH=..:/h0/cmds:/d0/cmds:/dd/cmds
PROMPT=howdy
_sh=0
```

These three commands are described in the ***OS-9 Utilities*** section.

Built-In Shell Commands

The shell has a special set of commands, or option switches, built-in to the shell. You can execute these commands without loading a program and creating a new process. You can execute them regardless of your current execution directory.

The built-in commands and their functions are:

Command	Description
* <text>	Indicates a comment: <text> is not processed. This is especially useful in procedure files.
chd <path>	Changes the current data directory to the directory specified by the path.
chx <path>	Changes the current execution directory to the directory specified by the path.
ex <name>	Directly executes the named program. This replaces the shell process with a new execution module.
kill <proc ID>	Aborts the process specified by <proc ID>.
logout	Terminates the current shell. If the login shell is to be terminated, the .logout file in the home directory is executed and then the login shell is terminated.
profile <path>	Reads input from a named file and then returns to the shell's original input source.
set <options>	Sets options for the shell.
setenv <env var> <value>	Sets environment variable to the specified value.
setpr <proc ID> <priority>	Changes the process's priority.
unsetenv <env var>	Deletes an environment variable from the environment.
w	Waits for a child process to terminate.
wait	Waits for all child processes to terminate.

Shell Command Line Processing

The shell reads and processes command lines one at a time from its input path, which is usually your keyboard. Each line is first scanned, or ***parsed***, to identify and process any of the following parts which may be present:

keyword	A name of a program, procedure file, built-in command, or pathlist.
parameters	The names of files, programs, values, variables, constants, etc. to pass to the program being executed.
execution modifiers	These modify a program's execution by redirecting I/O or changing the priority or memory allocation of a process.
separators	When multiple commands are placed on the same command line, separators specify whether they should execute sequentially or concurrently.

The shell can process a command line with only the keyword present. Parameters, execution modifiers, and separators are optional. After it identifies the keyword, the shell processes any execution modifiers and separators. The shell assumes that any text not yet processed are parameters; they are passed to the program called.

The keyword must be the first word in the command line. If the keyword is a built-in command, it is immediately executed.

If the keyword is not a built-in command, the shell assumes it is a program name and attempts to locate it. The shell searches for the command in the following sequence:

¿ The shell checks the memory to see if the program is already loaded into the module directory. If it is already in memory, there is no need to load another copy. The shell then calls the program to be executed.

¡ If the program was not in memory, your current execution directory is searched. If it is found, the shell attempts to load the program. If this fails, the shell tries to execute it as a procedure file. If this fails, the shell attempts the same procedure using the next directory specified in the PATH environment variable. This continues until the command is successfully executed or the list of directories is exhausted.

Ç¬ The shell searches your current data directory. If it finds the specified file, it is processed as a procedure file. Procedure files are assumed to contain one or more shell command lines. These command lines are processed by a newly created, or ***child***, shell as if they had been typed in manually. After all commands from the procedure file execute, control returns to the old, or ***parent***, shell. Because the child shell processes the commands, all built-in commands in the procedure file such as chd and chx only affect the child shell.

The shell returns an error if the program is not found. If the program is found and executed, the shell waits until the program terminates. When the program terminates, it reports any errors returned. If there are more input lines, the shell gets the next line and the process is repeated.

This sample command line calls a program:

```
$ prog #12K sourcefile  -l -j >/p
```

In this example:

prog	Is the keyword.
#12K	Is a modifier which requests that an alternate memory size be assigned to this process. In this case, 12K is used as memory.
sourcefile -l -j	Are parameters passed to prog.
>	Is a modifier, which redirects output to a file or device. In this case, > redirects the output to the printer (/p).
/p	Is the system's printer.

Special Command Line Features

In addition to basic command line processing, the shell facilitates:

- Memory allocation
- I/O redirection, including filters
- Process priority
- Wildcard pattern matching
- Multi-tasking: concurrent execution

These functions are accessed through the use of execution modifiers, separators, and wildcards. There are virtually unlimited combinations of ways to use these capabilities.

Characters which comprise execution modifiers, separators, and wildcards are stripped from the part(s) of the command line passed to a program as parameters. These characters cannot be passed as parameters to programs unless contained in quotes:

Modifiers:	#	Additional memory size
	^	Process priority
	>	Redirect output
	<	Redirect input
	>>	Redirect error output

Separators:	;	Sequential execution
	&	Concurrent execution
	!	Pipe construction
Wildcards:	*	Matches any character
	?	Matches a single character

Execution Modifiers

The shell processes execution modifiers before the program is run. If an error is detected in any of the modifiers, the run is aborted and the error reported.

Additional Memory Size Modifier

Every executable program is converted to machine language for storage. During the conversion process, a ***module header*** is created for the program. A module header is part of all executable programs and holds the program's name, size, memory requirements, etc. You can find a complete explanation of module headers in the ***OS-9 Technical Manual***.

When the shell processes an executable program, it allocates the minimum amount of working memory specified in the program's module header. To increase the default memory size, you can assign memory in 1K increments using the pound sign modifier (#), followed by a number of allocated kilobytes: `#10k` or `#10`. If the specified memory allocation is smaller than would otherwise be used, the modifier is ignored.

The increase in memory allocation only affects one command. If you want to increase the allocation for the next command, you must add the modifier (#) again.

NOTE: Programs written in C use the additional memory for stack space only.

I/O Redirection Modifiers

Redirection modifiers redirect the program's standard I/O paths to alternate files or devices. Usually, programs do not use specific file or device names. This makes the redirection of standard I/O to any file or device fairly simple, without altering the program.

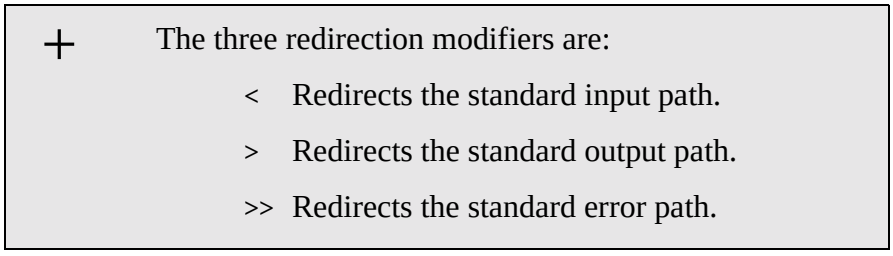
Programs which normally receive input from a terminal or send output to a terminal use one or more of these standard I/O paths:

- ***Standard Input Path:*** Normally passes data from a terminal's keyboard to a program.
- ***Standard Output Path:*** Normally passes output data from a program to a terminal's display.
- ***Standard Error Path:*** Can be used for either input or output, depending on the nature of the program using it. This path is commonly used to output routine status messages such as prompts and errors to the terminal's display. By default, the standard error path uses the same device as the standard output path.

A new process can only be created by an existing process. The new process is known as the ***child process***. The process that created the child process is known as the ***parent process***. Each child process inherits the parent process's standard I/O paths.

When the shell creates a new process, it inherits the shell's standard I/O paths. Upon startup or logging in, the shell's standard input is the terminal keyboard. The standard output and standard error are directed to the terminal's display. Consequently, the child's standard input is the terminal keyboard. The child's standard output and standard error are directed to the terminal's display.

When a redirection modifier is used on a shell command line, the shell opens the corresponding paths and passes them to the new process as its standard I/O paths.



When you use redirection modifiers on a command line, they must be immediately followed by a path describing the file or device to or from which the I/O is to be redirected.

Each physical input/output device supported by the system must have a unique name. Although the device names used on a system are somewhat arbitrary, it is customary to use the names Microware assigns to standard devices in OS-9 packages. They are:

Device	Description
TERM	Primary System Terminal
t1, t2, etc.	Other Serial Terminals
p	Parallel Printer
p1	Serial Printer
dd	Default Disk Drive
d0	Floppy Disk Drive Unit 0
d1, d2, etc.	Other Floppy Disk Drives
h0, h1, etc.	Hard Disk Drives (Format-inhibited)
h0fmt, h1fmt, etc.	Hard Disk Drives (Format-enabled)
n0, n1, etc.	Network Devices
mt0, mt1	Tape Devices
r0	Ram Disk
pipe	Pipe Device
nil	Null Device

NOTE: The h0fmt, h1fmt, etc. device descriptors have a bit set that allows you to use the format and os9gen utilities on them. To prevent accidentally formatting a hard disk, you should normally use the device names h0, h1, etc.

You may only use device names as the first name of a pathlist. The device name must be preceded by a slash (/) to indicate that the name is an I/O device. If the device is not a mass storage multi-file device like a disk drive, the device name must be the only name in the path. This restriction is true for devices such as terminals and printers.

For example, you can redirect the standard output of list to write to the system printer instead of the terminal:

```
$ list correspondence >/p
```

The shell automatically opens or creates, and closes (as appropriate) files referenced by I/O redirection modifiers. In the next example, the output of dir is redirected to the path /d1/savelisting:

```
$ dir >/d1/savelisting
```

If list is used on the path /d1/savelisting, output from dir is displayed as follows:

```
$ List /d1/savelisting

  directory of .   10:15:00
file1        myfile        savelisting
```

You can use redirection modifiers before and/or after the program's parameters, but you can use each modifier only once in a given command line. You can use redirection modifiers together to cause more than one redirection of the standard paths. For example, shell <>>>/t1 causes redirection of all three standard paths to /t1.

The addition and hyphen characters (+ and -) can be used with redirection modifiers. The ">-" modifier redirects output to a file. If the file already exists, the output overwrites it. The ">+" modifier adds the output to the end of the file. The following example overwrites dirfile with output from the execution directory listing:

```
dir -x >-dirfile
```

The next example adds the listing of newfile to the end of oldfile.

```
list newfile >+oldfile
```

NOTE: Spaces may not occur between redirection operators and the device or file path.

Process Priority Modifier

On multi-user systems or when multi-tasking, many processes seem to execute simultaneously. Actually, OS-9 uses a scheduling algorithm to allocate execution time to active processes.

All active processes are sorted into a queue based on the ***age*** of the process.

+	The age is a number between 0 and 65535 based on how long a process has waited for execution and its initial priority.

On a timesharing system, the system manager assigns the initial priority for processes started by each user. This priority for the initial process is listed in the password file. The initial process is usually the shell. On a single user system, processes have their priority set in the Init module. All child processes inherit their parent process's priority.

NOTE: Password files are discussed later in this chapter.

When a process enters the active queue, it has an age set to its initial priority. Every time a new active process is submitted for execution, all earlier processes's ages are incremented. The process with the highest age executes first.

If you want a program to run at a higher priority, use the caret modifier (^). By specifying a higher priority, a process is placed higher in the execution queue. For example:

```
$ format /d1 ^255
```

In this example, the process format is given the assigned priority of 255. By assigning a lower number, you can specify a lower priority.

WARNING: Specifying too high of a priority for a process can cause all other processes to be locked out until their ages mature. For example, if you specify a priority of 2000 for a large program and all the other processes have an age of less than 100, your program is the only process executed on the system until either your program terminates or another process's age reaches 2000. If another process's age reaches 2000, it is run once and entered back in the queue at its initial priority. Once again, your program either runs until it terminates or until another process's age reaches 2000.

Wildcard Matching

The shell uses some alternate ways to identify file and directory names. It accepts wildcards in the command line. The two recognized wildcard characters are the asterisk and the question mark (* and ?).

An asterisk (*) matches any group of zero or more characters. A question mark (?) matches any single character. The shell searches the current data directory or the directory given in a path for matching file names.

For the following examples, a directory containing the following files is used:

directory of FILES 14:45:20				
diary	**diary2**	**form**	**form.backup**	**forms**
login.names	**logistics**	**logs**	**old**	**oldstuff**
setime.c	**shellfacts**	**sizes**	**sizes.backup**	**utils1**

The command list log* lists the contents of login.names, logistics, and logs. The pattern log* matches all file names beginning with log followed by zero or more characters. The following commands demonstrate the function of this wildcard.

list s*	Lists all files in the current data directory beginning with s: Shellfacts, setime.c, and sizes.
del *	Deletes every file in the directory FILES.
dir ../*.backup	Lists all files in the parent directory that end with .backup.
dir -x d*	Lists all files in the current execution directory that start with the letter d. This can be helpful if you are unsure of the spelling of a particular utility.

The question mark (?) matches any single character in the position where the wildcard character is located. For example, the command line list log? only lists the contents of the file logs. The following commands demonstrate the function of this wildcard.

del form?	Deletes the file forms but not form.
list s????	Lists the contents of sizes, but not setime.c or shellfacts.

In both examples, the shell only searches for names with five characters.

Wildcards may also be used together. For example, the command list *.? lists any files that end in a period followed by any letter, number, or special character, regardless of what comes before the period. In this case, list *.? lists the contents of the file setime.c.

The shell only attempts to expand a character string containing a wildcard if the character string could be a pathlist. The shell does not expand wildcards used in the keyword of a command line. For example, the shell does not expand the asterisk in the following:

```
d* forms
```

NOTE: The shell disregards wildcard characters enclosed in double quotes. For example:

```
echo "*"
```

This echoes an asterisk (*) to standard output, which is usually the terminal. If you left out the double quotes around the asterisk, the shell would expand the wildcard to include every file name in the current directory and output each name to the terminal. Try it.

WARNING: You must be careful when using wildcards with utilities such as del and deldir. You **should not** use wildcards with the -x or -z options of most utilities.

Command Separators

A single shell input line can include more than one command line. These command lines may be executed sequentially or concurrently. Sequential execution causes one program to complete its function and terminate before the next program is allowed to begin execution. Concurrent execution allows several command lines to begin execution and run simultaneously.

Execute commands sequentially by separating the command lines with a semicolon (;). Execute commands concurrently by separating the command lines with an ampersand (&).

Sequential Execution

When you enter one command per line from the keyboard, programs execute one after another, or sequentially. All programs executed sequentially are individual processes created by the shell. After initiating execution of a program to be executed sequentially, the shell waits until the program it created terminates. The command line prompt does not return until the program has finished.

For example, the following command lines are executed one after another. The copy command is executed first, followed by the dir command.

```
$ copy myfile /D1/newfile
$ dir >/p
```

Specify more than one program on a single shell command line for sequential execution by separating each program name and its parameters from the next one with a semicolon (;). For example:

```
$ copy myfile /D1/newfile;  dir >/p
```

The shell first executes copy and then dir. No command line prompt appears between the execution of the copy and dir commands. The command line executes exactly as the previous two command lines, unless an error occurs.

If any program returns an error, subsequent commands on the same line are not executed regardless of the -nx option. In all other regards, a semicolon (;) and a carriage return act as identical separators.

The following example copies the contents of oldfile into newfile. When the copy command is finished, oldfile is deleted. Then, the contents of newfile are listed.

```
$ copy oldfile newfile; del oldfile; list newfile
```

In the next example, the output from dir is redirected into myfile in the d1 directory. The output from list is then redirected to the printer. Finally, temp is deleted.

```
$ dir >/d1/myfile ; list temp >/p; del temp
```

Multi-tasking: Concurrent Execution

Use the ampersand (&) separator to execute programs concurrently. This allows programs to run at the same time as other programs, including the shell. The shell does not wait to complete a process before processing the next command. Concurrent execution is how a background program is started.

Use the concurrent execution separator for multi-tasking. The number of programs that can run at the same time is not fixed; it depends on the amount of free memory in the system and the memory requirements of the specific programs.

Here is an example:

```
$ dir >/P&  list file1&  copy file1 file2 ; del temp
```

The dir, list, and copy utilities run concurrently because they are separated by an ampersand (&). del does not run until copy terminates because sequential execution (;) was specified.

If you add an ampersand (&) to the end of a command line, regardless of the type of execution specified, the shell immediately returns command to the keyboard, displays the $ prompt, and waits for a new command. This frees you from waiting for a process or sequence of processes to terminate.

This is especially useful when making a listing of a long text file on a printer. Instead of waiting for the listing to print to completion, you can use the concurrent execution separator to use your time more efficiently.

If you have several processes running at once, you can display a ***status summary*** of all your processes with the procs utility. procs lists your current processes and pertinent information about each process. The procs utility is discussed later in this chapter.

Pipes and Filters

The third kind of separator is the exclamation point (!) used to construct ***pipelines***. Pipelines consist of two or more concurrent programs whose standard input and/or output paths connect to each other using ***pipes***.

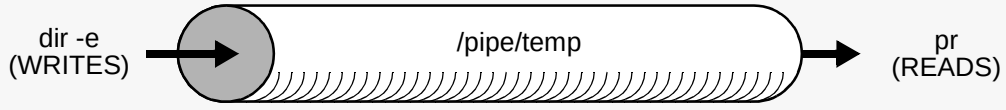
A pipe is simply a way to connect the output of a process to the input of another process, so the two run as a sequence of processes: a pipeline. Pipes are one of the primary means by which data is transferred from process to process for interprocess communications. Pipes are first-in, first-out buffers. They may hold up to 90 bytes of data at a time.

All programs in a pipeline are executed concurrently. The pipes automatically synchronize the programs so the output of one never gets ahead of the input request of the next program in the pipeline. This ensures that data cannot flow through a pipeline any faster than the slowest program can process it.

Any program that reads data from standard input can read from a pipe. Any program that writes data to standard output can write data to a pipe. Several utilities are designed so that the standard output of one can be piped to the standard input of another. For example:

```
$ dir -e ! pr
```

This example causes the standard output of dir to be piped to the standard input of the pr utility instead of on the terminal screen. pr reads the output of dir even though pr reads standard input by default. pr then displays the result.



The standard output of the dir -e command is piped to the standard input of the pr command through an un-named pipe. The pr utility displays the results of the dir -e command.

OS-9 uses two types of pipes: named pipes and un-named pipes.

Un-named Pipes

Un-named pipes are created by the shell when an input line with one or more exclamation point (!) separators is processed. For each exclamation point, the standard output of the program named to the left of the exclamation point is redirected by a pipe to the standard input of the program named to the right of the exclamation point. Individual pipes are created for each exclamation point present. For example:

```
$ update <master_file ! sort ! write_report >/p
```

In this example, the input for the program update is redirected from master_file. update's standard output becomes the standard input for the program sort. sort's output, in turn, becomes the standard input for the program write_report. write_report's standard output is redirected to the printer.

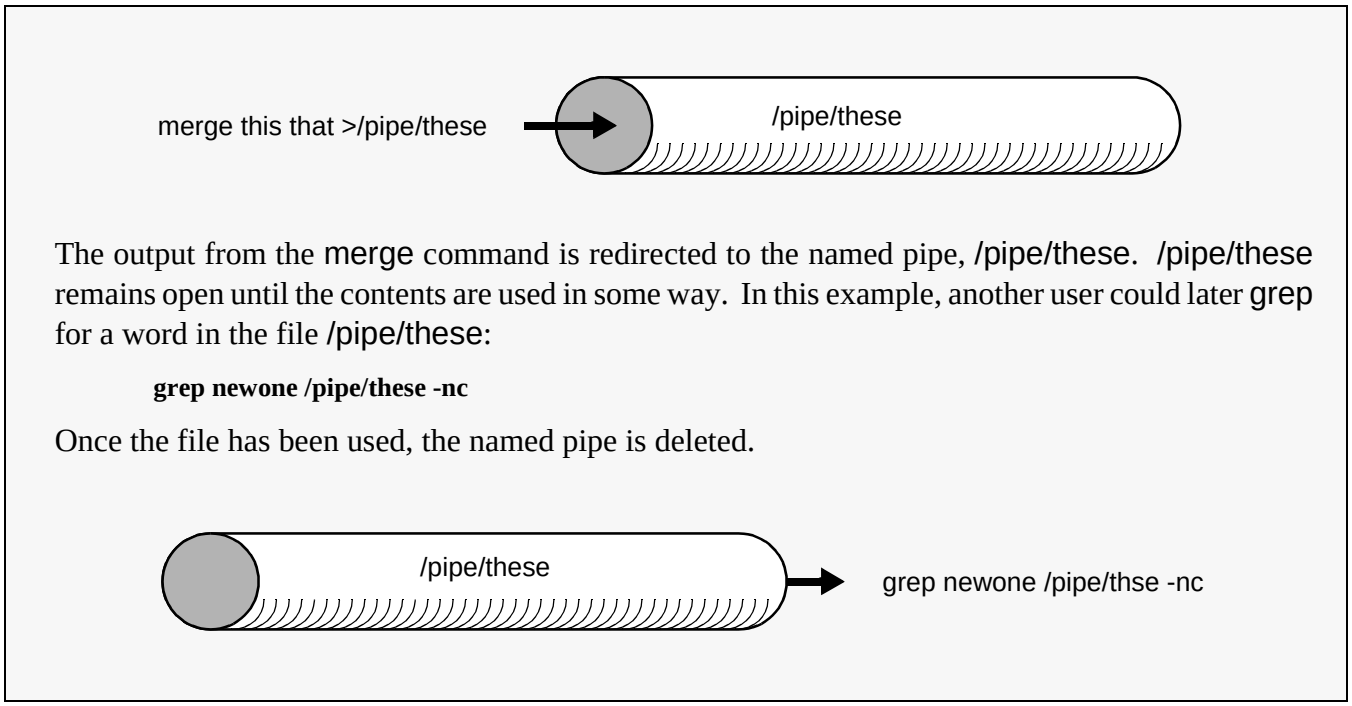
Named Pipes

Named pipes are similar to un-named pipes with one exception: a named pipe works as a holding buffer that can be opened by another process at a different time.

Create named pipes by re-directing output to /pipe/<file>, where <file> is any legal OS-9 file name. For example:

```
$ list letters >/pipe/letters
```

The output from the list command is redirected into a named pipe, /pipe/letters. The information remains in the pipe until it is listed, copied, deleted, or used in some other manner.



The output from the merge command is redirected to the named pipe, /pipe/these. /pipe/these remains open until the contents are used in some way. In this example, another user could later grep for a word in the file /pipe/these:

```
grep newone /pipe/these -nc
```

Once the file has been used, the named pipe is deleted.

You can also create named pipes by writing to the named pipe from a program. Named pipes are similar to mass-storage files. Named pipes have attributes and owners. They may be deleted, copied, or listed using the same syntax one would use to delete, copy, or list a file. You may change the attributes of a named pipe just as you would change the attributes of a file.

dir works with /pipe. This displays all named pipes in existence. A dir -e command may be deceiving. If any utility other than copy creates a named pipe, the pipe size equals 90 bytes. copy expands the size of the pipe to the size of the file. This indicates that the first 90 bytes of the output are in the named pipe. However, if the procs utility is executed, you will see that a path remains open to /pipe. If you were to copy or list the pipe, for example, the pipe would continue to receive input and pass it to its output path until the input process is finished. When the pipe is empty, the named pipe is deleted automatically.

Some of the most useful applications of pipelines are character set conversion, data compression/decompression and text file formatting. Programs which are designed to process data as components of a pipeline are often called ***filters***.

Command Grouping

You can enclose sections of shell input lines in parentheses (()). This allows you to apply modifiers and separators to an entire set of programs. The shell processes them by calling itself recursively as a new process to execute the enclosed program list. For example, the following commands produce the same result:

```
$ (dir /d0; dir /d1) >/p
$ dir /d0 >/p; dir /d1 >/p
```

However, one subtle difference exists. The printer is continuously controlled by one user in the first example, while in the second case, another user could conceivably use the printer in between the dir commands.

Command grouping can be used to cause a group of programs to be executed sequentially with respect to each other and concurrently with respect to the shell that initiated them. For example:

```
$ (del *.backup; list stuff_* >p)&
```

This command begins to sequentially delete all files ending in .backup and then list to the printer the contents of any files that start with stuff_. At the same time, a $ prompt will appear, indicating that the shell is waiting for a new command.

A useful extension of this form is to construct pipelines consisting of sequential and/or concurrent programs. For example:

```
$ (dir CMDS; dir SYS) ! makeuppercase ! transmit
```

This command line outputs the dir listings of CMDS and SYS, in that order, through a pipe to the program makeuppercase. The total output from makeuppercase is then piped to the program transmit.

It is important to remember that OS-9 processes commands from left to right. In the following example, the dir command is executed first, instead of the procs and del commands located inside the parentheses.

```
$ dir& (procs; del whatever)
```

Shell Procedure Files

A procedure file is a text file containing one or more command lines that are identical to command lines manually entered from the keyboard. The shell executes each command line in the exact sequence given in the procedure file.

A simple procedure file could consist of dir on one line and date on another. When the name of this procedure file is entered from the command line, dir would run, followed by date.

Procedure files have a number of valuable applications. They can:

- Eliminate repetitive manual entry of commonly used command sequences.
- Allow the computer to execute a lengthy series of programs in the background unattended, or while you are running other programs in the foreground
- Initialize your environment when you first log in.

In addition, you can use a procedure file to redirect the standard input, standard output, and standard error paths from programs and utilities to procedure files. This has many useful purposes. For example, instead of receiving the sometimes annoying output of shell messages to your terminal at random times, you could redirect the shell's output to a procedure file and review the messages at a more convenient time.

You can also run procedure files in the background by adding the ampersand operator:

```
$ procfile&
+4
```

WARNING: If a procedure file is run in the background, it should not contain any terminal I/O. Any terminal I/O caused by a background procedure file will minimally cause confusion as two or more processes try to control the same I/O path.

Notice the +4 returned by the shell in the example above. This is the process number assigned to the shell running procfile. You could achieve the same effect by using the <control>C interrupt:

```
$ procfile
[<control>C is typed]
+4
```

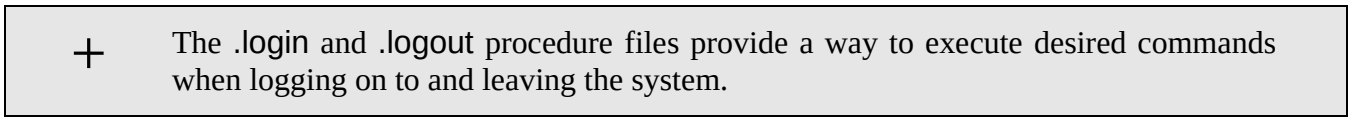
Using <control>C to place a procedure in the background only works if the procedure has not yet performed I/O to the terminal. Another limitation of the <control>C interrupt occurs when the shell has not had time to set up the command for execution. If the shell has not loaded files from the disk, established pipelines, etc., the <control>C causes the shell to abort the operation and return the shell prompt. For this reason, you should usually use the ampersand to place a procedure in the background.

OS-9 does not have any limit on the number of procedure files that can be simultaneously executed as long as memory is available.

NOTE: Procedure files themselves can cause sequential or concurrent execution of additional procedure files.

The Login Shell and Two Special Procedure Files: .login and .logout

The ***login shell*** is the initial shell created by the login sequence to process the user input commands after logging in.



To make use of these files, they must be located in the home directory.

.login is executed each time the login command is executed. This allows you to run a number of initializing commands without remembering each and every command. .login is processed as a command file by the login shell immediately after successfully logging on to a system. After all commands in the .login file are processed, the shell prompts the user for more commands. The main difference in handling .login is that the login shell itself actually executes the commands rather than creating another shell to execute the commands.

You can issue commands such as set and setenv within .login and have them affect the login shell. This is especially useful for setting up the environment variables PATH, PROMPT, TERM, and _sh.

Here is an example .login file:

```
setenv PATH ..:/h0/cmds:/d0/cmds:/dd/cmds:/h0/doc/spex
setenv PROMPT "@what next: "
setenv _sh 0
setenv TERM abm85h
querymail
date
dir
```

.logout is executed to exit the login shell and leave the system. .logout is processed before the login shell terminates. It only processes the .logout file when given to the login shell; other subsequent shells simply terminate. You could use this to execute any cleaning up procedures that should be performed on a regular schedule. This might be anything from instigating a backup procedure of some sort to printing a reminder of things to do. Here is an example .logout file:

```
procs
wait
echo "all processes terminated"
* basic program to instigate backup if necessary *
disk_backup
echo "backup complete"
```

The Profile Command

The profile built-in shell command can be used to cause the current shell to read its input from the named file and then return to its original input source, which is usually the keyboard. To use the profile command, enter profile and the name of a file:

```
profile setmyenviron
```

The specified file (in this case, setmyenviron) may contain any utility or shell commands, including commands to set or unset environment variables or to change directories. These changes will remain in effect after the command has finished executing. This is in contrast to calling a normal procedure file by name only. If you call a normal procedure file without using the profile command, the changes would not affect the environment of the calling shell.

Profile commands may be nested. That is, the file itself may contain a profile command for another file. When the latter profile command is completed, the first one will resume.

A particularly useful application for profile files is within a user's .login and .logout files. For example, if each user includes the following line in the .login file, then system-wide commands (common environments, news bulletins, etc.) can be included in the file /dd/SYS/login_sys:

```
profile /dd/SYS/login_sys
```

A similar technique can be used for .logout files.

Setting up a Time-Sharing System Startup Procedure File

OS-9 systems used for timesharing usually have a procedure file that brings the system up by means of one simple command or by using the system startup file. This procedure file initiates the timesharing monitor for each terminal. It begins by starting the system clock and initiating concurrent execution of a number of processes that have their I/O redirected to each timesharing terminal.

> + tsmon is a special program which monitors a terminal for activity. Typically, tsmon is executed as part of the start-up procedure when the system is first brought up and remains active until the system shuts down.

tsmon is normally used to monitor I/O devices capable of bi-directional communication, such as CRT terminals. However, you can also use tsmon to monitor a named pipe. If you do this, tsmon creates the named pipe and then waits for data to be written to it by some other process.

You can run several tsmon processes concurrently, each one watching a different group of devices. Because tsmon can monitor up to 28 device name pathlists, you must run multiple tsmon processes when more than 28 devices are to be monitored. Multiple tsmon processes can be useful for other reasons. For example, you may want to keep modems or terminals suspected of hardware trouble isolated from other devices in the system.

Here is a sample procedure file for a timesharing system with terminals named T1, T2, T3, and T71:

```
* system startup procedure file
echo Please Enter the Date and Time
setime
tsmon /t1 /t2 /t3&
tsmon /t71                          * This terminal has been mis-behaving
```

NOTE: This login procedure will not work until a file called /d0/SYS/Password with the appropriate entries has been created.

NOTE: For more information on tsmon, see the ***OS-9 Utilities*** section.

The Password File

A password file is found in the SYS directory. Each line in the password file is a login entry for a user. The line has several fields separated by a comma. The fields are:

- ¿ **User name**. The user name may contain up to 32 characters including spaces. If this field is empty, any name will match.
- ¡ **Password.** The password may contain a maximum of 32 characters including spaces. If this field is omitted, no password is required for the specified user.
- Ç¬ **Group.user ID number.** Both the group and the user portion of this number may be from 0 to 65535. 0.0 is the super user. The file security system uses this number as the system-wide user ID to identify all processes initiated by the user. The system manager should assign a unique ID to each potential user.
- Ð **Initial process priority**. This number may be from 1 to 65535. It indicates the priority of the initial process.
- ƒ **Initial execution directory**. This field is usually set to /d0/CMDS. Specifying a period (.) for this field defaults the initial execution directory to the CMDS file.
- Ý **Initial data directory**. This is usually the specific user directory. Specifying a period (.) for this directory defaults to the current directory.
- ý **Initial Program.** This field contains the name and parameters of the program to be initially executed. This is usually shell.

NOTE: Fields left empty are indicated by two consecutive commas.

The following is a sample password file:

```
superuser,secret,0.0,255,.,.,shell -p="@howdy"
suzy,morning,1.5,128,.,/d0/SUZY,shell
don,dragon,3.10,100,.,/d0/DON,Basic
```

For more information on password files, see the login utility in the ***OS-9 Utilities*** section.

Creating a Temporary Procedure File

You can create temporary procedure files to perform tasks which require a sequence of commands. The cfp utility creates a temporary procedure file in the current data directory and calls the shell to execute it. After the task is complete, cfp automatically deletes the procedure file, unless you use the -nd option to specify that you do not want the procedure file deleted.

The following is the syntax for the cfp utility:

cfp [<opts>] [<path1>] {<path2>} [<opts>]

To use the cfp utility, type cfp, the name of the procedure file (<path1>), and the file(s) (<path2>) used by the procedure file. The name of the procedure file may be omitted if the -s=<string> option is used.

All occurrences of an asterisk (*) in the procedure file are replaced by the given pathlist(s) unless preceded by the tilde character (~). For example, ~* translates to *. The command procedure is not executed until all input files have been read.

For example, if you have a procedure file in your current data directory called copyit that consists of a single command line: copy *, you could put all of your C programs from two directories, PROGMS and MISC.JUNK, into your current data directory by typing:

$ cfp copyit ../progms/*.c ../misc.junk/*.c

If you do not have a procedure file, you can use the -s option. The -s option causes the cfp utility to read the string surrounded by quotes instead of a procedure file. For example:

$ cfp -s="copy *" ../progms/*.c ../misc.junk/*.c

In this case, the cfp utility creates a temporary procedure file to copy every file ending in .c in both PROGMS and MISC.JUNK to the current data directory. The procedure file created by cfp is deleted when all the files have been copied.

Using the -s option is convenient because you do not have to edit the procedure file if you want to change the copy procedure. For example, if you are copying large C programs, you may want to increase the memory allocation to speed up the process. You could allocate the additional memory on the cfp command line:

$ cfp "-s=copy -b100 *" ../progms/*.c ../misc.junk/*.c

You can use the -z and -z=<file> options to read the file names from either standard input or a file. The -z option is used to read the file names from standard input. For example, if you have a procedure file called count.em that contains the command count -l * and you want to count the lines in each program to see how large the programs are before you copy them, you could type the following command line:

```
$ cfp -z count.em
```

The command line prompt does not appear because the cfp utility is waiting for input. Type in the file names on separate command lines. For example

```
$ cfp -z count.em
../progms/*.c
../misc.junk/*.c
```

When you have finished typing the file names, press the carriage return a second time to get the shell prompt.

If you have a file containing a list of the files that you want copied, you could type:

```
$ cfp -z=files "-s=copy *"
```

For more information, read the cfp utility discussion in the ***OS-9 Utilities*** section.

Multiple Shells

Like all OS-9 utilities, the shell can be simultaneously executed by more than one process. This means that in addition to each user having their own shell, an individual user can have multiple shells.

New shells can be created with procedure files. For example, to execute a shell whose standard input is obtained from procfile, type:

```
$ shell <procfile
```

The new shell automatically accepts and executes the command lines from the procedure file instead of a terminal keyboard. This technique is sometimes called ***batch*** processing.

Shells can also fork new shells by simply processing the procedure file:

```
$ procfile
```

Basically, both of the above commands execute the commands found in the procfile file.

By creating new shells, you can also move around the file system more efficiently. To demonstrate this concept, the directory system in Figure 5a is used.

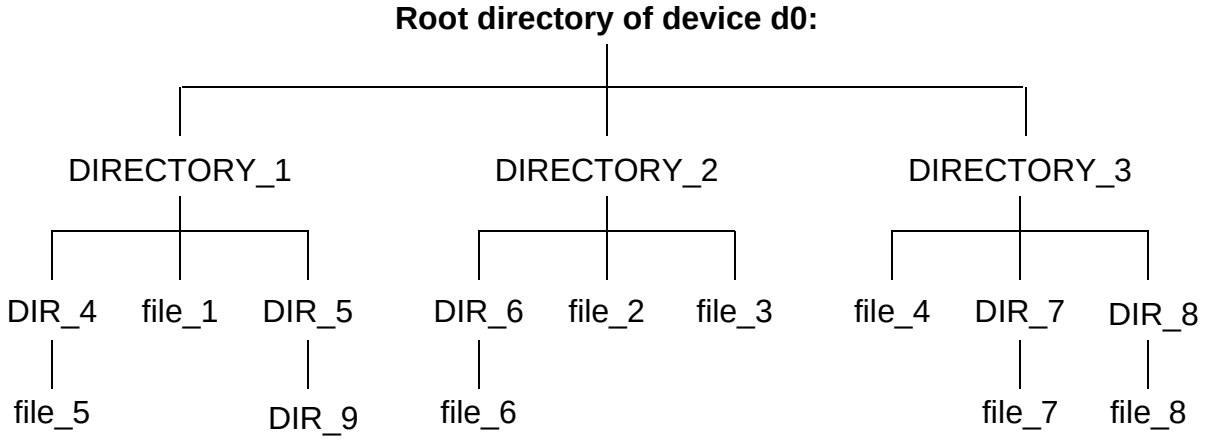


Figure 5a: An example directory

If your current data directory is DIR_9 and you want to work on file_8, you would normally change your current data directory to DIR_8 and access the file by typing:

```
chd /d0/DIRECTORY_3/DIR_8
```

To return to DIR_9 you would execute a similar command. This is somewhat inconvenient and involves always knowing the path to each directory.

Instead, you can create a shell and change directories:

```
$ (chd /d0/DIRECTORY_3/DIR_8)
```

This makes your current directory DIR_8, but you can return to DIR_9 by pressing the <escape> (Esc) key. By this method, you may use any directory as a base directory and ***fork*** a shell out to any other directory.

You may continue to imbed as many shells as you like. Each time you press the <Escape> key, you are taken to the previous shell. In this fashion you could conceivably escape from DIRECTORY_2 to DIR_8 to DIR_6 to DIR_9.

REMINDER: Because of the nature of jumping from shell to shell, it is easy to get lost. pd displays a complete pathlist from the root directory to your current data directory. Likewise, when running multiple shells, it is easy to forget how many shells are running. If the _sh environment variable is set to 1 and the shell prompt includes an "at" sign (@), the number of shells replaces the @ in the prompt. For example, if three shells are run under each other, the prompt might look like this:

```
3.what next:
```

> + You should experiment with the multiple shell aspects to fully use OS-9.

The Procs Utility

Because of OS-9's multi-tasking abilities, you often have more than one process executing at a time. You may become confused as to which processes are still running and which processes have run to completion. The procs utility displays a list of processes running on the system that are owned by the user running procs. This allows the user to keep track of their current processes.

> + Processes can switch states rapidly, usually many times per second. Therefore, the procs display is a snapshot taken at the instant the command is executed and shows only those processes running at that exact moment.

procs displays ten pieces of information for each process:

Id	The process ID
PId	The parent process ID
Grp.usr	The group and user number of the owner of the process
Prior	The initial priority of the process
MemSiz	The amount of memory the process is using
Sig	The number of any pending signals for the process

S — The process status:

w	Waiting
s	Sleeping
a	Active
*	Currently executing

CPU Time — The amount of CPU time the process has used

Age — The elapsed time since the process started

Module & I/O — The process name and standard I/O paths:

<	Standard input
>	Standard output
>>	Standard error output

If several of the paths point to the same pathlist, the identifiers for the paths are merged.

The following is an example of procs:

```
$ procs

Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
 2   1  0.0   128   0.25k   0 w       0.01   ??? sysgo <>>>term
 3   2  0.0   128   4.75k   0 w       4.11 01:13 shell <>>>term
 4   3  0.0     5   4.00k   0 a   12:42.06 00:14 xhog <>>>term
 5   3  0.0   128   8.50k   0 *       0.08 00:00 procs <>>term
 6   0  0.0   128   4.00k   0 s       0.02 01:12 tsmon <>>>t1
 7   0  0.0   128   4.00k   0 s       0.01 01:12 tsmon <>>>t2
```

procs -a displays nine pieces of information: the process ID, the parent process ID, the process name and standard I/O paths, and six new pieces of information:

Aging — The age of the process based on the initial priority and how long it has waited for processing

F$calls — The number of service request calls made

I$calls — The number of I/O requests made

Last — The last system call made

Read — The number of bytes read

Written — The number of bytes written

The following is an example of procs -a:

```
$ procs -a

Id PId  Aging  F$calls I$calls Last     Read Written Module & I/O
```

```
2  1  129     5     1 Wait      0     0 sysgo <>>>term
3  2  132   116   127 Wait    282   129 shell <>>>term
4  3   11     1     0 TLink     0     0 xhog  <>>>term
5  3  128     7     4 GPrDsc    0     0 procs <>>>term
6  0  130     2     7 ReadLn    0     0 tsmon <>>>t1
7  0  129     2     7 ReadLn    0     0 tsmon <>>>t2
```

The -b option displays all information from procs and procs -a. The -e option displays information for all processes in the system.

For more information on procs, see the ***OS-9 Utilities*** section.

Waiting For The Background Procedures

If you use OS-9's multi-tasking ability, there will be times when a number of procedures are running in the background. If it is important to wait for these tasks to finish before running a new procedure, use the w or wait built-in shell command.

+	w waits for a child process to be executed to finish. wait waits for all child processes running in the background to finish.

REMINDER: A child process is a process that the current shell or a child of the shell is executing.

For example, if a document needs to be created from three different files and each file has to be sorted by different fields, the following procedure files can be used to create the same result:

```
*start of first procedure file*
qsort -f=1 file1&
qsort -f=2 file2&
qsort -f=3 file3&
wait
merge file1 file2 file3 >report
```

```
*start of second procedure file*
qsort -f=1 file1
qsort -f=2 file2
qsort -f=3 file3
merge file1 file2 file3 >report
```

The first procedure file is much quicker because each of the files are processed concurrently.

Stopping Procedures

You can use two methods to stop a procedure. The first method involves the <control>C or <control>E signals. The second method uses the kill utility.

The shell handles these keyboard generated signals in the following manner. If either of these signals are received while the shell is waiting for keyboard input, the following messages are issued:

```
$ Read I/O error - Error #000:002   [ ^E typed ]
$ Read I/O error - Error #000:003   [ ^C typed ]
```

These are the standard messages given whenever an I/O error occurs when reading command input data. These keyboard signals are useful to get the shell's attention while it is waiting for a process to terminate.

If the shell is waiting for keyboard input and <control>E is typed, the shell forwards the keyboard abort signal to the current process and immediately prompts for command input:

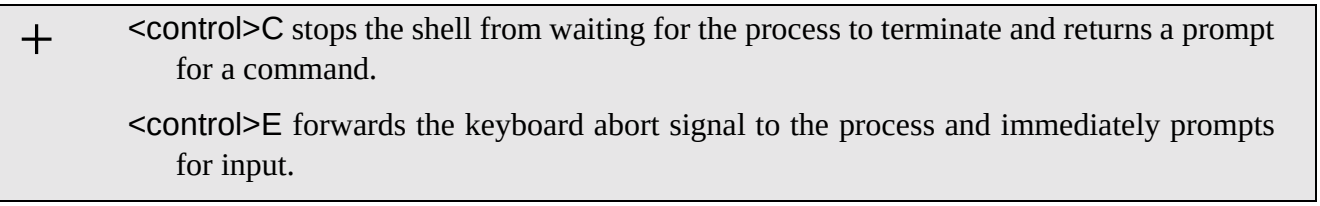
```
$ sleep 500
[ ^E is typed]
abort
$
```

The abort message is typed by the shell to acknowledge receipt of the interrupt.

If the shell is waiting for keyboard input and <control>C is typed, the shell stops waiting for the current process to terminate and prompts for command input. This action is similar to using an ampersand on the command line. For example:

```
$ sleep 500
[ ^C is typed]
+8
$
```

It is important to remember that using <control>C in this fashion is possible only if the command in question has not yet performed I/O to the terminal. The signal is only received by the last process to perform I/O. If the shell has not yet finished setting up the command for execution, the signal causes the shell to abort the operation and return the prompt.



You can also use the kill utility to terminate background processes by specifying the process number of the process to kill. Obtain the process number of the process to kill from procs. kill is used in the following manner:

```
kill <proc num>
```

For example, if you want to terminate a process called xhog, you would first execute a procs:

```
$ procs
Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
 3   2   7.03   128    4.75k   0 w       4.11 01:13 shell <>>>term
 4   3   7.03     5    4.00k   0 a   12:42.06 00:14 xhog <>>>term
 5   3   7.03   128    8.50k   0 *       0.08 00:00 procs <>>term
```

From procs, you can see that the process number for xhog is 4. You then type:

```
$ kill 4
```

When you execute procs again, xhog is no longer shown.

+ To use the kill utility:
  - Get the process number using the procs utility
  - Type kill <proc num>

Either of these methods terminate any process running in the background with one exception: if a process is waiting for I/O, it may not die until the current I/O operation is complete. Therefore, if you terminate a process and procs shows it still exists, it is probably waiting for the output buffer to be flushed before it can die.

NOTE: You must either own the procedure or be the super user to kill a specified process.

Error Reporting

Many programs, including the shell, use OS-9's standard error reporting function. This displays a brief description of the error and an error number on the standard error path. An appendix listing all of the standard error codes is included with this manual.

If a longer description of errors is desired, set the -e and the -v shell options. This prints error messages from /dd/SYS/errmsg on standard output.

Running Compiled Intermediate Code Programs

Before the shell executes a program, it checks the program module's language type. If its type is not 68000 machine language, the shell calls the appropriate run-time system for that module. Versions of the shell supplied for various systems are capable of calling different run-time systems

For example, if you wanted to run a BASIC I-code module called adventure, you could type either of the two commands given below; they accomplish exactly the same thing:

```
$ BASIC adventure
$ adventure
```

End of Chapter 5

6

Making Files

The Make Utility

Many types of files are dependent on various other files in their creation. If the files that make up the final product are updated, the final product becomes out-of-date. The make utility is designed to automate the maintenance and re-creation of files that change over a period of time.

make maintains the files by using a special type of procedure file known as a ***makefile***. The makefile describes the relationship between the final product and the files that make up the final product. For the purpose of this discussion, the final product is referred to as the ***target file*** and the files that make up the target file are referred to as ***dependents***.

+ A makefile contains three types of entries:
  - Dependency entries
  - Command entries
  - Comment entries

¿ A dependency entry specifies the relationship of a target file and the dependents used to build the target file. The entry has the following syntax:

<target>:[[<dependent>],<dependent>]

The list of files following the target file is known as the ***dependency list***. Any number of dependents can be listed in the dependency list. Any number of dependency entries can be listed in a makefile. A dependent in one entry may also be a target file in another entry. There is, however, only one main target file in each makefile. The main target file is usually specified in the first dependency entry in the makefile.

¡ A command entry specifies the particular command that must be executed to update, if necessary, a particular target file. make updates a target file only if its dependents are newer than itself. If no instructions for update are provided, make attempts to create a command entry to perform the operation.

make recognizes a command entry by a line beginning with one or more spaces or tabs. Any legal OS-9 command line is acceptable. More than one command entry can be given for any dependency entry. Each command entry line is assumed to be complete unless it is continued from the previous command with a backslash (\). Comments should not be interspersed with commands. For example:

```
<target>:[[<file>],<file>]
    <OS-9 command line>
    <OS-9 command line>\
    <continued command line>
```

¬ A comment entry consists of any line beginning with an asterisk (*). All characters following a pound sign (#) are also ignored as comments unless a digit immediately follows the pound sign. In this case, the pound sign is considered part of the command entry. All blank lines are ignored. For example:

```
<target>:[[<file>],<file>]

    * the following command will be executed if the dependent
    * files are newer than the target file
    <OS-9 command line>  # this is also a comment
```

Any entry may be continued on the following line by placing a space followed by a backslash (\) at the end of the line to be continued. All entries longer than 256 characters must be continued on another line. All continuation lines must adhere to the rules for its type of entry. For example, if a command line is continued on a second line, the second line must begin with a space or a tab:

```
FILE: aaa.r bbb.r ccc.r ddd.r eee.r \
fff.r ggg.r
    touch aaa.r bbb.r ccc.r \
    ddd.r eee.r fff.r ggg.r
```

NOTE: Spaces and tabs preceding non-command, continuation lines are ignored.

> + To run the make utility, type make, followed by the name of the file(s) to be created and any options desired.

make processes the makefile three times.

During the first pass, make examines the makefile and sets up a table of dependencies. This table of dependencies stores the target file and the dependency files exactly as they are listed in the makefile. When make encounters a name on the left side of a colon, it first checks to see if it has encountered the name before. If it has, make connects the lists and continues.

After reading the makefile, make determines the target file on the list. It then makes a second pass through the dependency table. During this pass, make tries to resolve any existing ***implicit dependencies***. Implicit dependencies are discussed below.

make does a third pass through the list to get and compare the file dates. When make finds a file in a dependency list that is newer than its target file, it executes the specified command(s). If no command entry is specified, make generates a command based on the assumptions given in the next section. Because OS-9 only stores the time down to the closest minute, make re-makes a file if its date matches one of its dependents.

When a command is executed, it is echoed to standard output. make normally stops if an error code is returned when a command line is executed.

To understand the relationship of the target file, its dependents, and the commands necessary to update the target file, the structure of the makefile must be carefully examined.

Implicit Definitions

Any time a command line is generated, make assumes that the target file is a program to compile. Therefore if the target file is not a program to compile, any necessary command entries must be specified for each dependency list. make uses the following definitions and rules when forced to create a command line.

object files:	Files with no suffixes. An object file is made from a relocatable file and is linked when it needs to be made.
relocatable files:	Files appended by the suffix: .r. Relocatable files are made from source files and are assembled or compiled if they need to be made.
source files:	Files having one of the following suffixes: .a, .c, .f, or .p.
default compiler:	cc
default assembler:	r68

default linker: cc

default directory
for all files: current data directory (.)

NOTE: The default linker should only be used with programs using Cstart.

Macro Recognition

In addition to recognizing compilation rules and definitions, make recognizes certain macros. make recognizes a macro by the dollar sign ($) character in front of the name. If a macro name is longer than a single character, the entire name must be surrounded by parentheses. For example, $R refers to the macro R, $(PFLAGS) refers to the macro PFLAGS, $(B) and $B refer to the macro B, and $BR is interpreted as the value for the macro B followed by the character R.

Macros may be placed in the makefile for convenience or on the command line for flexibility. Macros are allowed in the form of <macro name> = <expansion>. The expansion is substituted for the macro name whenever the macro name appears.

+ If you define a macro in your makefile and then redefine it on the command line, the command line definition overrides the definition in the makefile. This feature is useful for compiling with special options.

To increase make's flexibility, special macros can be defined in the makefile. make uses these macros when assumptions must be made in generating command lines or when searching for unspecified files. For example, if no source file is specified for program.r, make searches either the directory specified by SDIR or the current data directory for program.a (or .c, .p, .f).

make recognizes the following special macros:

Macro	Definition
ODIR=<path>	make searches the directory specified by <path> for all files with no suffix or relative pathlist. If ODIR is not defined in the makefile, make searches the current directory by default.
SDIR=<path>	make searches the directory specified by <path> for all source files not specified by a full pathlist. If SDIR is not defined in the makefile, make searches the current directory by default.
RDIR=<path>	make searches the directory specified by <path> for all relocatable files not specified by a full pathlist. If RDIR is not defined, make searches the current directory by default.

Macro	Definition
CFLAGS=<opts>	These compiler options are used in any necessary compiler command lines.
RFLAGS=<opts>	These assembler options are used in any necessary assembler command lines.
LFLAGS=<opts>	These linker options are used in any necessary linker command lines.
CC=<comp>	make uses this compiler when generating command lines. The default is cc.
RC=<asm>	make uses this assembler when generating command lines. The default is r68.
LC=<link>	make uses this linker when generating command lines. The default is cc.

Some reserved macros are expanded when a command line associated with a particular file dependency is forked. These macros may only be used on a command line. When you need to be explicit about a command line but have a target program with several dependencies, these macros can be useful. In practice, they are wildcards with the following meanings:

Macro	Definition
$@	Expands to the file name made by the command.
$*	Expands to the prefix of the file to be made.
$?	Expands to the list of files that were found to be newer than the target on a given dependency line.

Make Generated Command Lines

make can generate three types of command lines: compiler command lines, assembler command lines and linker command lines.

¿ Compiler command lines are generated if a source file with a suffix of .c, .p or .f needs to be recompiled. The compiler command line generated by make has the following syntax:

$(CC) $(CFLAGS) -r=$(RDIR) $(SDIR)/<file>[.c, .f, or .p]

¡ Assembler command lines are generated when an assembly language source file needs to be re-assembled. The assembler command line generated by make has the following syntax:

$(RC) $(RFLAGS) $(SDIR)/<file>.a -o=$(RDIR)/<file>.r

¬ Linker command lines are generated if an object file needs to be relinked in order to re-make the program module. The linker command line generated by make has the following syntax:

$(LC) $(LFLAGS) $(RELS)/<file>.r -f=$(ODIR)/<file>

WARNING: When make is generating a command line for the linker, it looks at its list and uses the first relocatable file that it finds, but only the first one. For example:

prog: x.r y.r z.r

generates

cc x.r, not **cc x.r y.r z.r** or **cc prog.r**

Make Options

Several options allow make even greater versatility for maintaining files/modules. These options may be included on the command line when you run make or they may be included in the makefile for convenience.

When a command is executed, it is echoed to standard output, unless the -s, or silent, option is used or the command line starts with an "at" sign (@). When the -n option is used, the command is echoed to standard output but not actually executed. This is useful when building your original makefile.

make normally stops if an error code is returned when a command line is executed. Errors are ignored if the -i option is used or if a command line begins with a hyphen.

Sometimes, it is helpful to see the file dependencies and the dates associated with each of the files in the list. The -d option turns on the make debugger and gives a complete listing of the macro definitions, a listing of the files as it checks the dependency list and all the file modification dates. If it cannot find a file to examine its date, it assumes a date of -1/00/00 00:00, indicating the necessity to update the file.

If you want to update the date on a file, but do not want to remake it, you can use the -t option. make merely opens the file for update and then closes it, thus making the date current.

If you are quite explicit about your makefile dependencies and do not want make to assume anything, you may use the -b option to turn off the built-in rules governing implicit file dependencies.

Options	Description
-?	Displays the options, function, and command syntax of make.
-b	Does not use built in rules.
-bo	Does not use built in rules for object files.
-d	Prints the dates of the files in makefile (Debug mode).
-dd	Double debug mode. Very verbose.
-f-	Reads the makefile from standard input.
-f=<path>	Specifies <path> as the makefile. If <path> is specified as a hyphen (-), make commands are read from standard input.
-i	Ignores errors.
-n	Does not execute commands, but does display them.
-s	Silent Mode: executes commands without echo.
-t	Updates the dates without executing commands.
-u	Does the make regardless of the dates on files.
-x	Uses the cross-compiler/assembler.
-z	Reads a list of make targets from standard input.
-z=<path>	Reads a list of make targets from <path>.

Examples of the Make Utility

The rest of this chapter is designed to show you different ways to maintain programs with make. These examples are not meant to be totally inclusive of the ways in which make can be used.

Example One: Updating a Document

The following example shows how make can be used to maintain current documentation that is made up of different sections:

```
utils.man: chap1 chap2 apdx
    del utils.man.old;rename utils.man utils.man.old
    merge chap1 chap2 apdx >utils.man
chap1: c1a c1b c1c c1d
    del chap1.old rename chap1 chap1.old
    list c1a c1b c1c c1d ! lxfilter >chap1
chap2: c2a c2b c2c
    del chap2.old rename chap2 chap2.old
    list c1a c1b c1c c1d ! lxfilter >chap1
apdx: functions header footer
    del apdx.old rename apdx apdx.old
    qsort functions >/pipe/func
    list header /pipe/func footer ! lxfilter >apdx
```

The above makefile creates the file utils.man. utils.man is created from three files: chap1, chap2, and apdx. Each of these files is in turn created from the files listed in their dependency lists.

If chap1, chap2, and/or apdx have dependencies with a more recent date, the commands following their respective dependency entries are executed. If chap1, chap2, and/or apdx are re-created, the commands following the initial dependency entry are executed.

Example Two: Compiling C Programs

In this example, make is used to compile high level language modules. Each command and dependency is specified.

```
program: xxx.r yyy.r
   cc xxx.r yyy.r -xf=program
xxx.r: xxx.c /d0/defs/oskdefs.h
   cc xxx.c -r
yyy.r: yyy.c /d0/defs/oskdefs.h
   cc yyy.c -r
```

This makefile specifies that program is made up of two .r files: xxx.r and yyy.r. These files are dependent upon xxx.c and yyy.c respectively and both are dependent on the oskdefs.h file.

If either xxx.c or /d0/defs/oskdefs.h has a date more recent than xxx.r, the command cc xxx.c -r is executed. If yyy.c or /d0/defs/oskdefs.h is newer than yyy.r, then cc yyy.c -r is executed. If either of the former commands are executed, the command cc xxx.r yyy.r xf=program is also executed.

In this example, make specifies each command it must execute. Often this is unnecessary as make uses specific definitions, macros, and built-in assumptions to facilitate program compilation to generate its own commands.

Refining the C Compiler Example

Knowing how make works and understanding the implicit rules can simplify coding immensely:

```
program: xxx.r yyy.r
  cc xxx.r yyy.r -xf=program
xxx.r yyy.r: /d0/defs/oskdefs
```

The above makefile now exploits make's awareness of file dependencies. No mention is made of the C language files; therefore, make looks in the directory specified by the macro definition SDIR = <path> and adjusts the dependency list accordingly. In this case, make looks in the current directory by default. make also generates a command line to compile xxx.r and yyy.r if one or both needs to be updated.

Further simplification would be possible, if program was made up of only one source file:

```
program:
```

make assumes the following from this simple command:

- program has no suffix. It is an object file and therefore needs to rely on relocatable files to be made.
- No dependency list is given; therefore, make creates an entry in the table for program.r.

- After creating an entry for program.r, make creates the entry for a source file connected to the relocatable file.

Assuming it found program.a, it checks the dates on the various files and generates one or both of the following commands if required:

```
r68 program.a -o=program.r
cc program.r -f=program
```

Example Three: A Makefile that Uses Macros

Using these inherent features of make can be especially helpful if you have several object files you want make to check:

```
* beginning
ODIR = /d0/cmds
RDIR = rels
UTILS = attr copy load dir backup dsave
SDIR = ../utils/sources

utils.files: $(UTILS)
    touch utils.files

* end
```

make looks in rels for attr.r, copy.r, etc. and looks in ../utils/sources for attr.c, copy.c, etc. make then generates the proper commands to compile and/or link any of the programs that need to be made. If one of the files in UTILS is made, the command touch utils.files is forked to maintain a current overall date.

Example Four: Putting It All Together

The following example is a makefile to create make:

```
* beginning
ODIR = /h0/cmds
RDIR = rels
CFILES = domake.c doname.c dodate.c domac.c
RFILES = domake.r doname.r dodate.r
PFLAGS = -p64 -nh1
R2 = ../test/domac.r
RFLAGS = -q
make: $(RFILES) $(R2) getfd.r
   linker
$(RFILES): defs.h
$(R2): defs.h
   cc $*.c -r=../test
print.file: $(CFILES)
   pr $? $(PFLAGS) >-/p1
   touch print.file
*end
```

The makefile in this example looks for the .r files listed in RFILES in the directory specified by RDIR: rels. The only exception is ../test/domac.r, which has a complete pathlist specified.

Even though getfd.r does not have any explicit dependents, its dependency on getfd.a is still checked. The source files are all found in the current directory.

Notice that this makefile can also be used to make listings. By typing make print.file on the command line, make expands the macro $? to include all of the files updated since the last time print.file was updated. If you keep a dummy file called print.file in your directory, make will only print out the newly made files. If no print.file exists, all files are printed.

End of Chapter 6

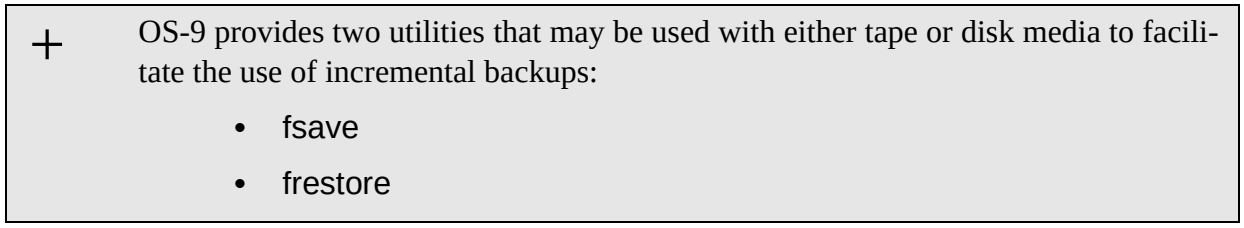
7

Making Backups

Incremental Backups

Whether it's caused by system failure or accidental erasure, loss of stored data is a programmer's nightmare. Consequently, backups of files, programs, and disks are a normal part of existence. Backing up a hard disk is usually slow and tedious because the entire system is backed-up.

You can use incremental backups instead of full system backups. Incremental backups save only the files that have changed since the last backup. You must still perform a full system backup, but by using incremental backups you can perform them less often.



+ OS-9 provides two utilities that may be used with either tape or disk media to facilitate the use of incremental backups:
  - fsave
  - frestore

Certain terms must be defined to discuss incremental backups. A full system backup is referred to as a ***level 0 backup***. Consequent incremental backups are referenced by different level numbers. For example, a level 5 backup includes all files changed since the most recent backup with a level less than 5. While this sounds complex, it is actually quite easy to use and extremely helpful.

Two other terms need to be defined. A ***source device*** is the directory structure or file you are backing up. A ***target device*** is the tape or disk you are using to hold your backup information.

Making an Incremental Backup: The fsave Utility

The fsave utility performs an incremental backup of a directory structure to tape(s) or disk(s). The syntax for the fsave utility is:

fsave [<opts>] [<path>] [<opts>]

Typing fsave by itself on the command line makes a level 0 backup of the current directory onto a target device with the name /mt0.

> **NOTE:** /mt0 is the default OS-9 device name for tape device just as /h0 is the default OS-9 device name for a hard disk.

/h0/sys/backup_date is a backup log file maintained by fsave. Each time you execute an fsave, the backup log is updated. The backup log keeps track of the name of the backup, the date it was created, and more importantly, the level of the backup. When you execute fsave, this backup log is examined to find the specified level of the current backup and the previous backups with the same name. Once the backup is finished, a new entry is made in the file indicating the date, name, level, etc. of the current backup.

During the discussion of the actual fsave procedure, references to fsave's options are made. The options are:

Option	Description
-?	Displays the use of fsave.
-b[=]<int>	Allocates <int>k buffer size to read files from the source disk.
-d[=]<dev>	Specifies the target device to store the backup. The default is /mt0.
-e	Does not echo file pathlists as they are saved to the target device.
-f[=]<path>	Saves to the file specified by <path>.
-g[=]<int>	Specifies a backup of files owned by group number <int> only.
-j[=]<number>	Specifies the minimum system memory request.
-l[=]<int>	Specifies the level of the backup to be performed.
-m[=]<path>	Specifies the pathlist of the date backup log file to use. The default is /h0/sys/backup_dates.
-p	Turns off the mount volume prompt for the first volume.
-s	Displays the pathlists of all files needing to be saved and the size of the entire backup without actually executing the backup procedure.
-t[=]<dirpath>	Specifies the alternate location for the temporary index file.

Option	Description
-u[=]<int>	Specifies a backup of files owned by user number <int> only.
-v	Does not verify the disk volume when mounted.
-x[=]<int>	Pre-extends the temporary file. <int> is given in kilobytes.

The fsave Procedure

Upon starting an fsave procedure, fsave prompts you to mount the first volume to use. Volume in this case refers to the disk or tape used to store the backup:

```
fsave: please mount volume.
(press return when mounted).
```

If a disk is used as the backup medium, fsave verifies the disk and displays the following information:

```
verifying disk

Bytes held on this disk: 546816
Total data bytes left:   62431
Number of Disks needed:  1
```

NOTE: The numbers above are used only as an example.

If a tape is used as the backup medium, no preliminary information is displayed and the backup begins at this point.

As each file is saved to the backup device, its pathlist is echoed to the terminal. If this is a long backup, you may want to use the -e option to turn off the pathlist echoing.

If fsave receives an error when trying to backup a file, it displays the following message and continues the fsave operation:

```
error saving <file>, error - <error number>, its incomplete
```

NOTE: The most common error found when executing fsave is a record lock error. Record lock errors are caused when another user has the file in question open.

> + To prevent record lock errors, perform fsave operations only when no one else is using the system.

If the backup requires more than one volume, fsave prompts you to mount the next volume before continuing.

At the end of the backup, fsave prints the following information:

```
fsave: Saving the index structure

Logical backup name:
Date of backup:
Backup made by:
Data bytes written:
Number of files:
Number of volumes:
Index is on volume:
```

The index to the backup is saved on the last volume used.

fsave performs recursive backups for each pathlist if one or more directories are specified on the command line. You can specify a maximum of 32 directories on the command line.

The following options are provided:

- -d Specifies an alternate target device. The default device is /mt0.
- -m Specifies an alternative backup log file. The default pathlist is /h0/sys/backup_dates.
- -l Specifies different levels of backups. A higher level backup only saves files that have changed since the most recent backup with the next lower number. For example, a level 1 backup saves all files changed since the last level 0 backup.

WARNING: When using disks for backup purposes, fsave does not use an RBF file structure to save the files on the target disk. It creates its own file structure. This makes the backup disk unusable for any purpose other than fsave and frestore without reformatting the disk. Any data stored on the disk before using fsave is destroyed by the backup.

Example fsave Commands

Typing fsave by itself on a command line specifies a level 0 backup of the current directory. This assumes the /mt0 device is used and that /h0/SYS/backup_dates is used as the backup log file for this backup.

The following command specifies a level 2 backup of the current directory using the /mt1 device. /h0/misc/my_dates is used as the backup log file:

```
$ fsave -l=2 -d=/mt1 -m=/h0/misc/my_dates
```

The following command specifies a level 0 backup of all files owned by user 0.0 in the CMDS directory, if CMDS is in your current directory:

```
$ fsave -pb=32 -g=0 -u=0 -d=/d2 CMDS
```

This backup uses /d2 as the target device and /h0/sys/backup_dates as the backup log file. The mount volume prompt is not generated for the first volume. A 32K buffer is used to read the files from the CMDS directory.

Restoring Incremental Backups: The frestore Utility

The frestore utility restores a directory structure from multiple volumes of tape or disk media. The syntax for the frestore utility is:

frestore [<opts>] [<path>] [<opts>]

Typing frestore by itself on the command line attempts to restore a directory structure from the /mt0 device to the current directory.

Specifying the pathlist of a directory on the command line causes the files to be restored in that directory. fsave creates the directory structure and an index of the directory structure.

If more than one tape/disk is involved in the fsave backup, each tape/disk is considered to be a different ***volume***. The volume count begins at one (1). When you begin an frestore operation, you must use the last volume of the backup first because it contains the index of the entire backup.

frestore first attempts to locate and read the index of the directory structure of the source device. frestore then begins an interactive session with you to determine which files and directories in the backup should be restored to the current directory.

During the discussion of the actual frestore procedure, references are made to frestore's options. The options are:

Option	Description
-?	Displays the use of frestore.
-a	Forces access permission for overwriting an existing file. You must be the owner of the file or a super user to use this option.
-b[=]<int>	Specifies the buffer size used to restore the files.
-c	Checks the validity of files without using the interactive shell.
-d[=]<path>	Specifies the source device. The default is /mt0.
-e	Displays the pathlists of all files in the index, as the index is read from the source device.
-f[=]<path>	Restores from a file.
-i	Displays the backup name, creation date, group.user number of the owner of the backup, volume number of the disk or tape, and whether the index is on the volume. This option will not cause any files to be restored. The information is displayed, and frestore is terminated.
-j[=]<int>	Sets the minimum system memory request.
-p	Suppresses the prompt for the first volume.

Option	Description
-q	Overwrites an already existing file when used with the -s option.
-s	Forces frestore to restore all files from the source device without an interactive shell.
-t[=]<dirpath>	Specifies an alternate location for the temporary index file.
-v	Displays the same information as the -i option, but does not check for the index. This option will not cause any files to be restored. The information is displayed and frestore is terminated.
-x[=]<int>	Pre-extends the temporary file. <int> is given in kilobytes.

The Interactive Restore Process

Once you call frestore, the following prompt is displayed:

```
frestore> mount the last volume
(press return when ready)
```

When you are ready, frestore attempts to read in the index and create the directory structure of the backup. It then displays the prompt:

```
frestore>
```

This prompt tells you that you are in the interactive shell. If the index is not on the mounted volume, frestore displays an error message and again prompts you to mount the last volume.

Once in the interactive shell, the frestore commands and options are displayed when you type a return at the prompt:

```
frestore> commands:
  add [<path>] [-g=<#> -u=<#> -r -a] -- marks files for restoration
  del [<path>] [-g=<#> -u=<#> -r -a] -- unmarks files for restoration
  dir [<dir names>] [-e] -- displays a directory or directories
  chd <path> -- changes directories within the restore file structure
  pwd -- gives the pathlist to current dir in the restore file structure
  cht <path> -- changes directories on target system
  rest [<path>] [-f -q] -- restores marked files in and below the current dir
  check [-f] -- checks validity if marked files in and below the current dir
  dump [<file>] -- dumps the contents of a file to stdout
  $   -- forks a shell
  quit -- quit frestore program
options:
  -g=<group#> -- only mark files with 'group#'
  -u=<user#> -- only mark files with 'user#'
  -r -- mark directories recursively
  -e -- display directory with extended format
  -f -- force restoration of already restored files
  -q -- overwrite already existing files without question
  -a -- force marking or unmarking of an already restored file or dir
   * -- matches any string of characters on 'add' or 'del' only
   ? -- matches any single character on 'add' or 'del' only
frestore>
```

The index from the source device sets up a restore file structure that parallels the usual OS-9 file/directory structure.

Use the dir and chd shell commands to display the restore file structure. For example:

```
frestore>dir
                Directory of .
DIR1          file1          file2          file3
```

All files to be backed up on to the source device appear in the restore file structure regardless of what volume they appear in. Information concerning the file structure is available using the -e option with the dir command:

```
frestore>dir -e

                Directory of .

  Owner   Last modified  Attributes Volume Block Offset   Size    Name
   ------  -------------- ---------- ------ ----- ------  -----   ------
1.23    89/08/22 16/14  ----r-wr      1     0      0   CF12    file1
1.23    89/08/25 11/00  ----r-wr      1     2      0   A356    file2
1.23    89/08/21 11/12  ----r-wr      1     4      0   45F0    file3
1.23    89/08/24 10/57  d-ewrewr      0     5      0    120    DIR1
```

The interactive shell allows you to mark the files you want restored with the add command. You can mark groups of files using the options of the add command:

-g Marks files by group number.

-u Marks files by user number. You can mark all directories within a specified directory using the -r option.

+
- Files may be marked one at a time by specifying relative or complete pathlists within the restore file structure.
- Entire directories may be marked by specifying a pathlist of a directory.

Marking files does not restore them. It merely marks them as ***to be restored***. You can see this when you use the dir command. Each file added to the "to be restored" list is marked by a plus sign (+) by its filename.

For example, the following directory has file1 and file2 marked for restoration, but file3 is not marked. The directories DIR1 and DIR2 also have marked files:

```
frestore>add file1 file2 dir1/file5 dir1/file6 dir2/file7

frestore>dir
        Directory of .
+DIR1           +DIR2           +file1          +file2
file3

frestore>dir dir1
        Directory of DIR1
file4           +file5          +file6

frestore>dir dir2
        Directory of DIR2
+file7          file8
```

The del command can unmark files. Entire directories may be unmarked by specifying the directory's name on the command line. If the -r option is also used, all files and directories included in the specified directory are unmarked. For example:

```
frestore>del -r dir2

frestore>dir
        Directory of . 10:42:32
+DIR1           DIR2            +file1          +file2
file3

frestore>dir dir2
        Directory of DIR2
file7           file8
```

Once files are marked, the rest command may be used to restore the target device's current directory.

Files existing on the target system with the same name are overwritten without prompting if del -q is used. Otherwise, frestore displays the following prompt:

```
frestore> file1 already exists
      write over it or skip it (w/s)
```

The cht command allows you to change directories on the target device. This allows you to selectively restore files to specific directories.

After restoring files, you may continue marking and unmarking files. Files previously restored have a hyphen (-) displayed next to their names in the restore file structure:

```
frestore>dir
        Directory of . 10:42:32
-DIR1           DIR2            -file1          -file2
file3

frestore>dir dir1
            Directory of DIR1
file4           -file5          -file6
```

> + An asterisk (*) preceding the name of a file in a dir listing indicates an error occurred while backing up this file. This file is incomplete and should not be restored.

There are two methods of restoring files more than once. The first method uses the -a option with the add command. This forces the file(s) previously marked as restored to be marked as "to be restored." The second method requires the -f option to be used with the rest command. This forces any file previously marked as restored to be restored in the current directory.

The -s option forces frestore to restore all files/directories of the backup from the source device without the interactive shell.

Using the -d option allows you to specify a source device other than /mt0. For example, to restore all files/directories found on the /mt1 source device to the directory BACKUP without using the interactive shell, type:

```
$ frestore -d=/mt1 -s BACKUP
```

The -v option causes frestore to identify the name and volume number of the backup mounted on the source device. The date the backup was made and the group.user number of the person who made the backup is also displayed. This option does not restore any files. For example:

```
$ frestore -v

Backup: DOCUMENTATION
Made:   1/16/91 10:10
By:     0.0
Volume: 0
```

The -i option displays the above information and also indicates whether the index is on the volume. Both the -v and -i options terminate frestore after displaying the appropriate information. These options are useful when trying to locate the last volume of the backup if any mix-up has occurred.

The -e option echoes each file pathlist as the index is read off the source device.

Example Command Lines

To restore files/directories from the source device /mt0 to the current directory by way of an interactive shell, type:

```
$ frestore
```

The following example restores files/directories from the source device /d0 to the current directory using a 32K buffer to write the restored files. As each file is read from the index, the file's pathlist is echoed to the terminal.

```
$ frestore -eb=32 -d=/d0
```

Incremental Backup Strategies

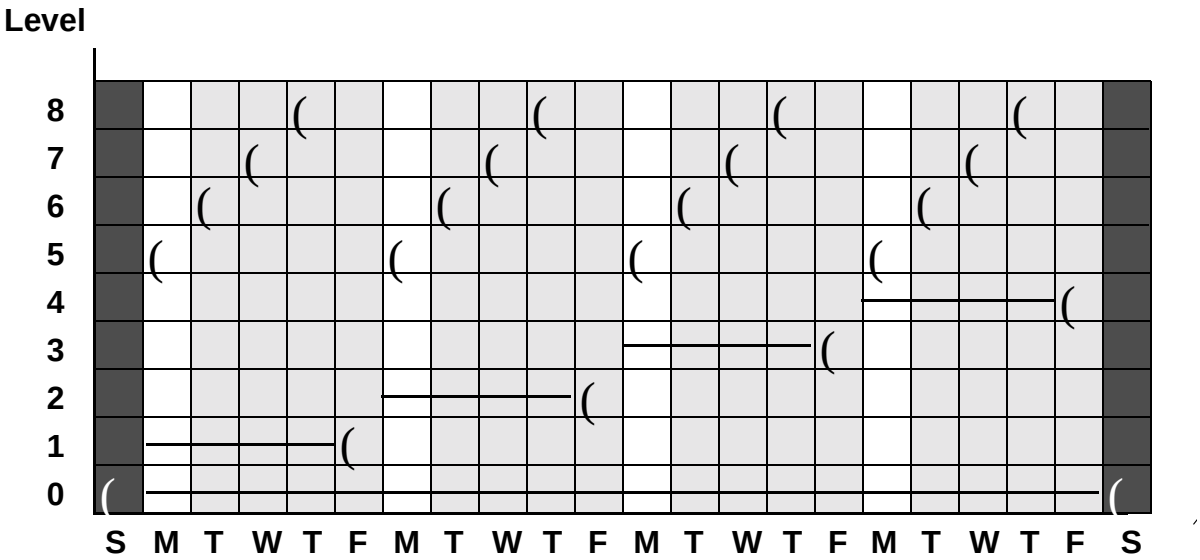
Many different strategies are available for those concerned with regularly scheduled backups. Most strategies are well documented in computer books and magazines. The following two strategies are offered as examples of methods that can be used.

The Small Daily Backup Strategy

This strategy requires making a level 0 backup once every four weeks. Level 1, level 2, level 3, and level 4 backups are made on the weeks following the level 0 backup. Between each major backup, four daily backups would be made: level 5, 6, 7, and 8. A recommended daily schedule is graphically presented below.

This strategy is ideal for small microcomputer systems backed up by floppy disks. Mounting disks is much easier and faster than tapes. Each daily backup can usually be kept on one disk to make warehousing simple. This strategy is perfect for small timely backups with little redundancy in the backups.

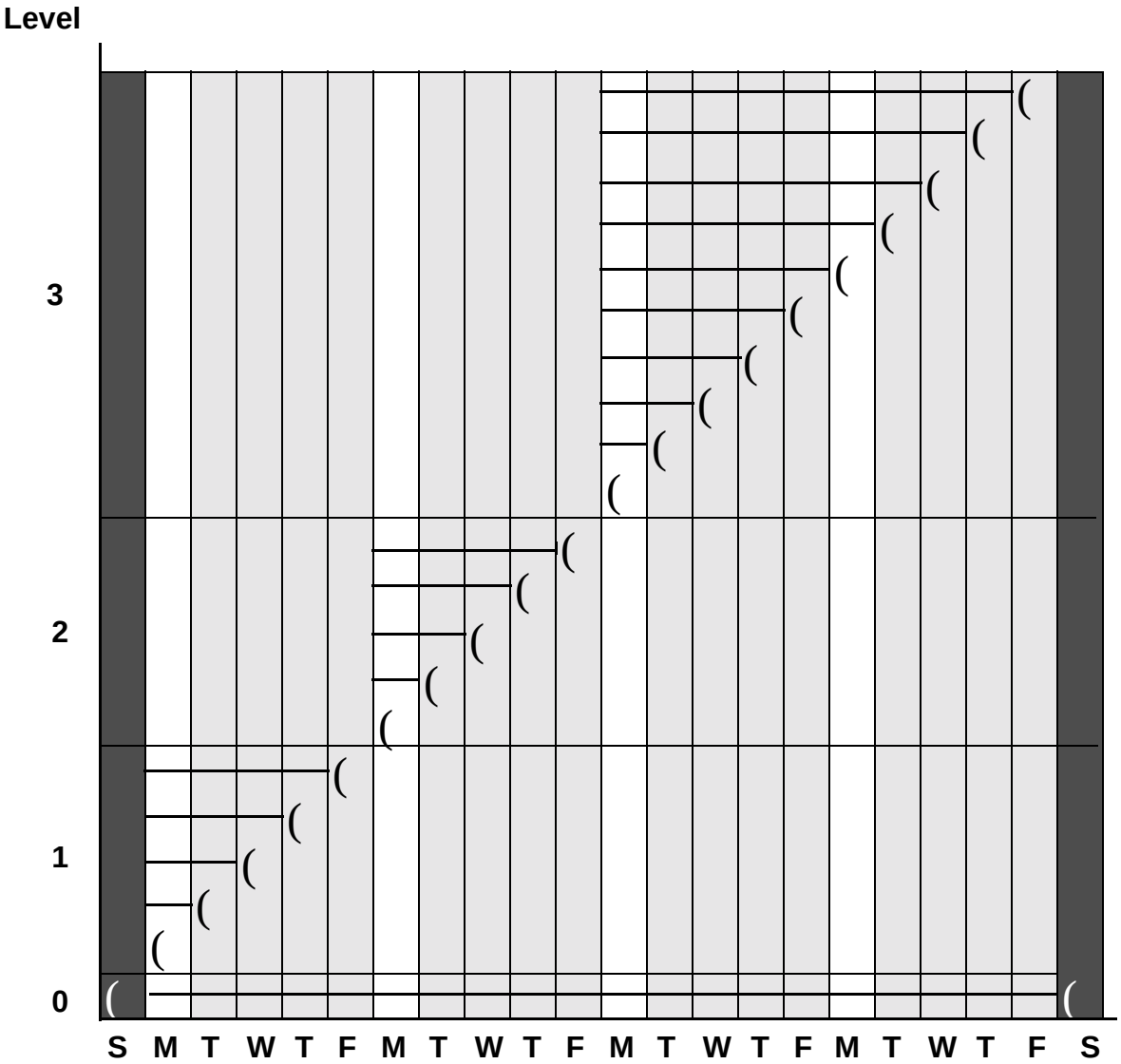
One major disadvantage of this scheme is the restore time necessary in case of a major system failure such as a hard disk being formatted, erased, or corrupted. Because of the lack of redundancy, more frestore operations are necessary to re-create the systems file structure. On large systems with tape backups, this is a major consideration.



Small Daily Backup Strategy

The Single Tape Backup Strategy

While most strategies rely on scheduled backup level changes, the ***single tape backup*** strategy depends on the size of the backup. The idea behind this strategy is to increase the level of the backup only when the backup cannot fit on a single tape. The only scheduled level backup is the level 0 backup. The level 0 backup occurs only when a higher level backup would not fit on a single tape or once a month, whichever occurs first. An example month's schedule is graphically presented below.



Single Tape Backup Strategy

This strategy is designed for tape backups of larger systems. Tapes are used efficiently because a question as to how many tapes are needed never arises. This strategy also cuts down on person hours, tape mounting, and storage space used for tapes. It allows for enough redundancy to make restoring a full system fairly painless.

Disadvantages, however, do exist. Each time you do a backup, you must determine the size of the back using fsave -s. As you near a full tape's worth of data, this takes an increasing amount of time.

Use of Tapes/Disks

Whatever strategy you use, you must make a decision concerning the number of tapes or disks to use. This decision must weigh the emphasis placed on redundancy, resources, person-hours, and storage. It must be offset with the possibility of tape or disk failure and system restoration.

In the first example strategy, you must make the daily backups on different volumes to overcome the lack of redundancy. You can use the four daily volumes week after week as daily backup volumes because of the lower level backups at the beginning of each week.

In the second example, theoretically, you could use the same tape for each day until a new level backup is reached. This insures no redundancy and minimal storage. It is also the most dangerous in case of tape failure. Using a number of alternating tapes for each level cuts down on storage and still allows a safety net in the case of tape failure. Using alternating level 0 tapes is another possibility.

The tape Utility

OS-9 provides a tape controller utility to facilitate setting up, reading, and rewinding tapes from the terminal. When using tape media to backup or restore your system, the tape utility is very practical. The syntax of the tape utility is:

tape {<opts>} [<dev>] {<opts>}

tape uses the default device /mt0 if you do not specify the tape device <dev> on the command line and you do not use the -z option.

tape has the following available options:

Options	Description
-?	Displays the use of tape.
-b[=<num>]	Skips a specified number of blocks. Default is one block. If <num> is negative, the tape skips backward.
-e=<num>	Erases a specified number of blocks of tape.
-f[=<num>]	Skips a specified number of tapemarks. Default is one tapemark. If <num> is negative, the tape skips backward.
-o	Puts tape off-line.
-r	Rewinds the tape.
-s	Determines the block size of the device.
-t	Retensions the tape.
-w[=<num>]	Writes a specified number of tapemarks. Default is one tapemark.
-z	Reads a list of device names from standard input. The default is /mt0.
-z=<file>	Reads a list of device names from <file>.

If you specify more than one option, tape executes each option function in a specific order. Therefore, it is possible to skip ahead a specified number of blocks, erase, and then rewind the tape all with the same command. The order of options executed is as follows:

- ¿ Gets device name(s) from the -z option.
- ¡ Skips the number of tapemarks specified by the -f option.
- ¬ Skips the number of blocks specified by the -b option.
- Ð Writes a specified number of tapemarks.
- *f* Erases a specified number of blocks of tape.
- Ý Rewinds the tape.
- ý Puts the tape off-line.

For example, the following command skips four files on the /mt0 device, erases the next two blocks, rewinds the tape, and takes the tape off-line:

```
tape -e=2 -f=4 -ro
```

The next example determines the block size of the device:

```
tape -s
```

The next example retensions the tape, rewinds it, and then takes it off-line:

```
tape -rot
```

End of Chapter 7

8

OS-9 System Management

System managers have a range of options to consider. OS-9 allows system managers to tailor their system to the needs of users by changing system modules, setting up the system defaults, etc. OS-9 also allows system managers to maximize the performance of their system by using RAM disks, making bootfiles, making a startup file, etc.

This chapter discusses the following topics of importance to system managers:

- Setting the system defaults using the Init module
- Adding customization modules
- Changing system modules
- Making bootfiles
- Using a RAM disk
- Making a startup file
- Shutting down the system
- Installing OS-9 on a hard disk
- Managing processes in a real-time environment
- Using the tmode and xmode utilities
- Using termcap

Setting Up the System Defaults: the Init Module

The Init module is sometimes referred to as the configuration module. It is a non-executable module located in memory in the OS9Boot file or in ROM. The Init module contains system parameters used to configure OS-9 during startup. The parameters set up the initial table sizes and system device names. For example, the amount of memory to allocate for internal tables, the name of the first program to run (usually either SysGo or shell), an initial directory, etc. are specified. You can examine the system limits in the Init module at any time.

> + **NOTE:** The Init module MUST be present in the system in order for OS-9 to work.

The values in the Init module's table are the system defaults. You can change these defaults in two ways. The first method involves editing the CONFIG macro in the systype.d file. The systype.d file is located in the DEFS directory. After systype.d is edited, the Init module is remade and placed in the new bootfile. The second method involves modifying the Init module with the moded utility. Both methods are discussed later in this chapter. Regardless of the method you use, the changes become the system defaults.

The following is a list of the system defaults listed in the Init module. The term ***offset*** refers to the location of a module field, relative to the starting address of the module. Module offsets are resolved in assembly code by using the names shown here and linking the module with the relocatable library: sys.l or usr.l .

Offset	Name	Description
$30	Reserved	This field is currently reserved for future use.
$34	M$PollSz	***Number of Entries in the IRQ Polling Table*** This is the number of entries in the IRQ polling table. One entry is required for each interrupt generating device control register. The IRQ polling table has 32 entries by default. Each entry in the IRQ polling table is 18 bytes long.
$36	M$DevCnt	***Device Table Size*** This is the number of entries in the system device table. One entry is required for each device in the system. The system device table has 32 entries by default. Each entry in this table is 18 bytes long.

Offset	Name	Description
$38	M$Procs	***Initial Process Table Size*** This indicates the initial number of active processes allowed in the system. If this table becomes full, it automatically expands as needed. By default, 64 active processes are allowed. Each entry in the initial process table requires 4 bytes.

$3A	M$Paths	***Initial Path Table Size*** This is the initial number of open paths in the system. If this table becomes full, it automatically expands as needed. By default, 64 open paths are allowed. Each entry in the initial path table requires 4 bytes.
$3C	M$SParam	***Offset to Parameter String for Startup Module*** This is the offset to the parameter string (if any) to be passed to the first executable module. An offset of zero indicates that no parameter string is required. The parameter string itself is located elsewhere, usually near the end of the Init module.
$3E	M$SysGo	***First Executable Module Name Offset*** This is the offset to the name string of the first executable module; usually SysGo or shell.
$40	M$SysDev	***Default Directory Name Offset*** This is the offset to the initial default directory name string; usually /d0 or /h0. The kernel does a chd and chx to this device prior to forking the initial device. If the system does not use disks, this offset must be zero**.**
$42	M$Consol	***Initial I/O Pathlist Name Offset*** This is the offset to the initial I/O pathlist string. This offset usually points to the /TERM string. This pathlist is opened as the standard I/O path for the initial process. It is generally used to set up the initial I/O paths to and from a terminal. This offset should contain zero if no console device is in use.

Offset	Name	Description
$44	M$Extens	***Customization Module Name Offset*** This is the offset to a name string of a list of customization modules (if any). A customization module is intended to complement or change OS-9's existing standard system calls. These modules are searched for during startup. Typically these modules are found in the bootfile. They are executed in system state if found. Modules listed in the name string are separated by spaces. The default name string to be searched for is OS9P2. If there are no customization modules, set this value to zero. **NOTE:** A customization module may only alter the d0, d1, and ccr registers. **NOTE:** Refer to the following section for more information on customization modules.

$46	M$Clock	***Clock Module Name Offset*** This is the offset to the clock module name string. If there is no clock module name string, set this value to zero.
$48	M$Slice	***Timeslice*** The number of clock ticks per timeslice. The number of clock ticks per timeslice defaults to two.
$4A	Reserved	This field is currently reserved for future use.
$4C	M$Site	This is the offset to the installation site code. This value is usually set to zero. OS-9 does not currently use this field.
$50	M$Instal	***Offset to Installation Name*** This is the offset to the installation name string.
$52	M$CPUTyp	***CPU Type*** CPU type: 68000, 68008, 68010, 68020, 68030, 68040, 68070, or 683XX. The default is 68000.
$56	M$OS9Lvl	***Level, Version, and Edition*** This four byte field is divided into three parts: level: 1 byte version: 2 bytes edition: 1 byte For example, level 1, version 2.4, edition 1 would be 1241.

Offset	Name	Description
$5A	M$OS9Rev	***Revision Offset*** This is the offset to the OS-9 level/revision string.
$5C	M$SysPri	***Priority*** This is the system priority at which the first module (usually SysGo or shell) is executed. This is generally the base priority at which all processes start. The default is 128.
$5E	M$MinPty	***Minimum Priority*** This is the initial system minimum executable priority. The default is zero. M$MinPty is discussed later in this chapter and in the ***OS-9 Technical Manual***.
$60	M$MaxAge	***Maximum Age*** This is the initial system maximum natural age. The default is zero. M$MaxAge is discussed later in this chapter and in the ***OS-9 Technical Manual***.

$62 Reserved This field is currently reserved for future use.

$66 M$Events ***Number of Entries in the Events Table***
This is the initial number of entries allowed in the events table. If the table becomes full, it automatically expands as needed. The default is zero. Each entry in the events table requires 32 bytes. See the ***OS-9 Technical Manual*** for a discussion of event usage. This value is no longer used.

$68 M$Compat ***Revision Compatibility***
This byte is used for revision compatibility. The default is 0. The following bits are currently defined:

Bit 0: Set to save all registers for IRQ routines.

Bit 1: Set to prevent the kernel from using stop instructions.

Bit 2: Set to ignore "sticky" bit in module headers.

Bit 3: Set to disable cache burst operation (68030 systems).

Bit 4: Set to patternize memory when allocated or deallocated.

Bit 5: Set to prevent kernel cold-start from starting system clock.

Offset	Name	Description

$69 M$Compat2 ***Compatibility Bit #2***
This byte is used for revision compatibility. The following bits are currently defined:

Bit	Function	
0	0	External instruction cache is *not* snoopy*
	1	External instruction cache is snoopy or absent
1	0	External data cache is *not* snoopy
	1	External data cache is snoopy or absent
2	0	On-chip instruction cache is *not* snoopy
	1	On-chip instruction cache is snoopy or absent
3	0	On-chip data cache is *not* snoopy
	1	On-chip data cache is snoopy or absent
7	0	Kernel disables data caches when in I/O
	1	Kernel *does not* disable data caches when in I/O

* snoopy = cache that maintains its integrity without software intervention.

$6A	M$MemList	***Colored Memory List*** This is an offset to the memory segment list. The colored memory list contains an entry for each type of memory in the system. The list is terminated by a long word of zero. If this field contains a 0, colored memory is not used in this system. For a complete discussion on colored memory, see the ***OS-9 Technical Manual***.
$6C	M$IRQStk	This field contains the size (in longwords) of the kernel's IRQ stack. The value must be 0 or between 256 and $ffff. If the value is zero, the kernel uses a small default IRQ stack. A larger IRQ stack is recommended. The default value is 256 longwords.
$6E	M$ColdTrys	This is the retry counter if the kernel's initial chd to the system device fails. The default value is zero.

+ Throughout this chapter, the system directories referred to are the defaults found in the Init module, unless otherwise specified.

The following is a portion of the distributed init.a file:

```
_INITMOD equ 1 flag reading init module

CPUTyp  set 68000   cpu type (68008/68000/68010)
Level   set 1       OS-9 Level One
Vers    set 2       Version 2.4
Revis   set 3
Edit    set 1       Edition
IP_ID   set 0       interprocessor identification code
Site    set 0       installation site code
MDirSz  set 128     initial module directory size (unused)
PollSz  set 32      IRQ polling table size (fixed)
DevCnt  set 32      device table size (fixed)
Procs   set 64      initial process table size (divisible by 64)
Paths   set 64      initial path table size (divisible by 64)
Slice   set 2       ticks per time slice
SysPri  set 128     initial system priority
```

For more information on the Init module, see the ***OS-9 Technical Manual***.

Customization Modules

Customization modules can be attached to OS-9 during the system's cold-start procedure to increase OS-9's functionality and to allow hardware customization such as special bus arbitration modes. While customization modules extend its capabilities, OS-9 itself is not changed.

NOTE: A customization module may only alter the d0, d1, and ccr registers.

In the Init module, the M$Extens offset points to a list of module names. By default, the name of the list is OS9P2. If the modules are found during cold-start, they are called. If an error is returned, the system stops. Two of these modules are listed here:

- ***Syscache:*** The syscache module allows the system to enable and control any hardware caches present. The default syscache module supplied by Microware controls the on-chip cache(s) for the 68020 and 68030. You can customize this module to take advantage of any external (off-chip) cache hardware the system may have. The syscache module installs the F$CCtl system call routines. If the syscache module is not installed, no system caching takes place.

- ***SSM:*** The system security module (SSM) allows memory protection. The SSM uses the memory management unit (MMU) hardware to grant and deny users permission to access memory.

Changing System Modules

The provided system modules are configured to satisfy the needs of the majority of users. However, you may wish to alter the existing modules or create new modules. You can make new system modules and alterations to existing system modules by either using the moded utility or changing the defaults in the systype.d file. The system modules most commonly altered are the device descriptors and the Init module.

Using the Moded Utility

Use the moded utility to edit individual fields of certain types of OS-9 modules. You can change the Init module and any OS-9 device descriptor modules with moded.

To use the moded utility, type moded, the name of the desired device descriptor, and any options.

The moded: prompt shows that the editor's command mode has been entered.

When moded is invoked, it attempts to read the moded.fields file. moded.fields contains module field information for each type of module to edit. Without this file, moded cannot function.

The provided moded.fields file comes with module descriptions for standard RBF, SBF, SCF, PIPE, NETWORK, UCM, and GFM module descriptors. It also includes a description for the Init module.

To edit the current module, use the e command. If there is no current module, the editor prompts for the module name to edit. The editor prints the name of a field, its current value, and prompts for a new value.

You can enter the following edit commands:

Command	Description
<expr>	A new value for the field
-	Re-display last field
.	Leave edit mode
?	Print edit mode commands
??	Print description of the current field
<cr>	Leave current value unchanged

If the definition of any field is unfamiliar, use the ?? command. This provides a short description of the current field.

Once you have made all necessary changes to the module, exit the edit mode by reaching the end of the module or by typing a period. At this point, the changes made to the module exist only in memory. To write the changes to the actual file, use the w command. This also updates the module header parity and CRC.

NOTE: moded is mainly used for editing existing descriptors. It is somewhat restrictive, and as a result, if you are building a device descriptor or changing a field such as the file manager names, you may not want to use moded.

Complete documentation is available for the moded utility in the ***OS-9 Utilities*** section.

Editing the Systype.d File

The second method of changing system modules requires editing the systype.d file located in the DEFS directory. The systype.d file contains macros such as TERM, DiskH0, etc. for each device descriptor and the Init module. These macros contain basic memory map information, exception vector methods (for example, vectors in RAM or ROM), I/O device controller memory addresses, and initialization data, etc. for each device descriptor and the init module.

The systype.d file consists of five main sections that are used when installing OS-9:

- Init module CONFIG macro
- SCF Device Descriptor macros and definitions
- RBF Device Descriptor macros and definitions
- ROM configuration values
- Target system specific definitions

The CONFIG macro is used when creating the Init module to determine six or more system dependent variables:

Name	Description
MainFram	MainFram is a character string programs such as login use to print a banner which identifies the system. You can modify this string.
SysStart	SysStart is a character string the OS-9 kernel uses to locate the initial process for the system. This process is usually stored in a module called SysGo. Two general versions of SysGo have been provided in the files: SysGo.a for disk-based OS-9 and SysGo_nodisk.a for ROM-based OS-9.
SysParam	SysParam is a character string that is passed to the initial process. This usually consists of a single carriage return.

Name	Description
SysDev	SysDev is a character string containing the name of the path to the initial system disk. The kernel coldstart routine sets the initial execution and data directories to this device prior to forking the SysStart process. Set this label to zero for a ROM-based system. For example, SysDev set 0.
ConsolNm	ConsolNm is a character string that contains the name of the path to the console terminal port. Messages to be printed during startup appear here.
ClockNm	ClockNm is a character string that contains the name of the clock module.

You can set other system parameters in this macro to override the default values created by the init.a source file. This allows you to perform "system tuning" without modifying the generic init.a file.

The following is a portion of an example systype.d file:

```
CONFIG macro

 endm
 Slice set 10
 ifdef _INITMOD
Compat set ZapMem patternize memory
 endc
```

When editing the Init module, constants may use either values or labels. CPUTyp set 68020 is an example of a constant that uses a value. These constants may appear anywhere in the systype.d file. Compat set ZapMem is an example of a constant that uses a label. These constants must appear outside the CONFIG macro and must be conditionalized to be invoked only when init.a is being assembled. If these values are placed inside the CONFIG macro, the old defaults are still used. If a constant that requires a label is placed outside the macro and not conditionalized, illegal external reference errors result when making other files. You can use the _INITMOD label to avoid these errors.

The SCF and RBF device descriptor macro definitions are used when creating device descriptor modules. Five elements are common to SCF and RBF:

Name	Description
Port	Port is the address of the device on the bus. Generally, this is the lowest address that the device has mapped. Port is hardware dependent.
Vector	Vector is the vector that is given to the processor at interrupt time. Vector is hardware/software dependent. Some devices can be programmed to produce different vectors.
IRQLevel	IRQLevel is the interrupt level (1 - 7) for the device. When a device interrupts the processor, the level of the interrupt is used to mask out lower priority devices.
Priority	Priority is the interrupt polling table priority and is software dependent. A non-zero priority determines the position of the device within the vector. Lower values are polled first. A priority of zero indicates that the device desires exclusive use of the vector. OS-9 does not allow a device to claim exclusive use of a vector if another device has already been installed on the vector, nor does it allow the vector to be used by another device once the vector has been claimed for exclusive use.
DriverName	DriverName is the module name of the device driver. This name is determined by the programmer and is used by the I/O system to attach the device descriptor to the driver.

RBF macros may also contain an optional sixth element to describe various standard floppy disk formats. These values are defined in the file rbfdesc.a in the IO directory.

SCF macros contain two additional elements: Parity and BaudRate. The driver uses these values to determine the parity, word length, and baud rate of the device. These values are usually standard codes used by device drivers to access device specific index tables. These codes are defined in the ***OS-9 Technical Manual***.

You should place definitions such as control register definitions that are system specific in systype.d. This allows you to maintain all system specific definitions in a single, system specific file.

Examine the systype.d file. If it does not accurately describe your system, use any text editor to edit the appropriate macro(s) in the systype.d file.

After editing the macro, change your data directory to the IO directory. Use the make utility to generate the required descriptors. For example, the make d0 would generate the descriptors d0 and dd.d0. The output files are placed in the CMDS/BOOTOBJS directory. Include these new descriptors in the bootfile.

NOTE: For more information on the make utility, refer to the chapter on making files and the make utility description in the ***OS-9 Utilities*** section.

Making Bootfiles

A ***bootfile*** contains a list of modules to be loaded into memory during the system's bootstrap sequence. The provided bootfiles have been configured to satisfy the majority of users, but you may want to add or remove modules from an existing bootfile.

Bootlist Files

Bootfiles are usually created using a bootlist file and the -z option of the OS9Gen or TapeGen utilities. The bootlist files contain a list of files, one file per line, to use in creating the bootfile. Using a bootlist file is a convenient way to maintain bootfile contents, as the bootlist file can easily be edited.

The bootlist files are usually located in the CMDS/BOOTOBJS directory, along with the individual files used for constructing the bootfile.

Bootfile Requirements

The contents and module order of a bootfile are usually determined by the end-user's system configuration and requirements. However, note the following points when you construct a bootfile:

- The kernel **MUST** be present in the system, either in ROM or in the bootfile. If the kernel is in the bootfile, **IT MUST BE THE FIRST MODULE**.
- The Init module must be present in the system, either in ROM or in the bootfile.

All other modules are dependent upon the system configuration.

Making RBF Bootfiles

To make a bootfile for an RBF device (hard disk or floppy disk), you need to edit the bootlist file to match your requirements and then run the OS9Gen utility:

```
chd /h0/cmds/bootobjs
<edit bootlist file>
OS9Gen <device> -z=<bootlist>
```

The <device> you specify is the disk that you wish to install the bootfile on. If this device is a hard disk, specify the "format-enabled" device name.

For example, to make a floppy-disk bootfile, type:

```
OS9Gen /d0 -z=bootlist.d0
```

To make a hard disk bootfile, type:

```
OS9Gen /h0fmt -z=bootlist.h0
```

NOTE: Some systems may not support boot files that are greater than 64K in length and/or non-contiguous.

Making Tape Bootfiles

To make a bootfile for an SBF device (tape), you need to edit the bootlist file to match your requirements and then run the TapeGen utility:

```
chd /h0/cmds/bootobjs
<edit bootlist file>
TapeGen /mt0 -bz=bootlist.tape
```

Using the RAM Disk

OS-9 provides support for RAM disks. These disks reside solely in Random Access Memory (RAM). The information stored on a RAM disk can be accessed significantly faster than the same information stored on a hard or floppy disk. Any files may be stored and accessed on a RAM disk.

To use a RAM disk, you must have a device descriptor, a RAM disk driver, and the RBF file manager. You may use multiple RAM disks as long as each RAM disk has a different port address. The only real limitation to the number of RAM disks is the size of the memory. However, some practical considerations exist. For example, using one large RAM disk is more efficient than using many small RAM disks.

In many system configurations, a RAM disk is used as the default system device. When the RAM disk is used as the default system device, it is known as device dd, instead of r0. The name of the device descriptor is dd.r0. Using this descriptor allows compilers to use the RAM disk as a "fast access" device for temporary files, etc. The RAM disk is usually initialized at startup with definition and library files, if it is to be used as the default system device. The init.ramdisk procedure file provided in the root directory accomplishes this.

RAM disks may be ***volatile*** or ***non-volatile***. A volatile RAM disk disappears when the system is reset or the power is shut off. A non-volatile RAM disk resides in a place such as battery backed up RAM and does not disappear when the system is reset or powered down.

Volatile RAM disks may be allocated memory either from free system memory or from outside free system memory. The number of volatile RAM disks allocated from free system memory is governed by the port address. There can be up to 1024 different disks, with each disk having a unique address from 0 to 1023.

Volatile RAM disks not allocated from the free system memory must not be part of the system memory list, and they must have a port address greater than or equal to 1024. This port address indicates the actual start address of the RAM disk.

A non-volatile RAM disk may not be located in any memory search list known to the system's general memory lists. That is, the RAM disk must be "outside" the system's knowledge. If it is located in a memory search list known to the system's general memory lists, the RAM disk may be wiped out because the memory is assumed to be un-allocated and may later be given to another module. In addition, the format protect bit must be set for non-volatile RAM disks and the port address must be greater than or equal to 1024.

Making a Startup File

Using bootfiles is not the only way of loading modules and devices into memory at the time of startup. A startup procedure is executed each time OS-9 is booted and the standard SysGo is used. On disk-based systems, the startup procedure executes a startup file. The startup file is located in the root directory of the system disk.

> + The startup file is an OS-9 procedure file. It contains OS-9 commands to be executed immediately after booting the system.

While some modules and devices, such as the kernel, should be loaded from the bootlist file, loading most modules and devices from the startup file can be advantageous. For example, it is easier to upgrade a system by adding modules to the startup file, or the files contained in the startup file. To change these files, you simply use a text editor and make the changes. To change the bootlist file, you must also use the os9gen utility.

Remember: A procedure file is made up of executable commands. Each command is executed exactly as if it were entered from the shell command line. Each line that begins with an asterisk (*) is a comment and is not executed.

From the root directory, you can examine the startup file by entering:

```
$ list startup
```

A listing similar to the following is displayed:

```
-t -np
*
* OS-9
* Copyright 1984 by Microware Systems Corporation
*
* The commands in this file are highly system dependent and should
* be modified by the user.
*
* setime                          ; * start system clock
link shell cio                    ; * make "shell" and "cio" stay in memory
load math                         ; * load math module
* iniz r0 h0 d0 t1 p1             ; * initialize devices
* load -z=sys/loadfile            ; * make some utilities stay in memory
* load bootobjs/dd.r0             ; * get default device descriptor
* init.ramdisk>/nil >>/nil &      ; * initialize it if its the ramdisk
* tsmon /t1 &                     ; * start other terminals
list sys/motd
```

The first executable line, -t -np, turns on the ***talk mode*** option of the shell and turns off the OS-9 prompt option for the duration of this procedure. The talk mode option echoes each executed command to the terminal display. This allows you to see what commands are being executed.

The other executable lines in the distributed startup file are followed by a comment explaining the purpose of the command. Some standard commands are provided as comments. If you want the command executed during the startup procedure, use a text editor to remove the asterisk preceding the command.

For example, to execute the setime command when the startup file is executed, remove the asterisk preceding the command.

NOTE: For systems with battery backed clocks, run setime to start time-slicing, but use the -s option. The date and time will be read from the clock.

Initializing Devices iniz r0 h0 d0 t1 p1

The iniz r0 h0 d0 t1 p1 commented command initializes the following specific devices:

r0	RAM Disk
h0	Hard Disk
d0	Floppy Disk
t1	Terminal
p1	Serial Printer

Whenever OS-9 opens a path to a device, it first checks to see if the device is ***known*** to OS-9. To be known, a device must be initialized and memory must be allocated for its device driver. If the device is unknown at the time of the request, OS-9 initializes the device, allocates memory, and opens the path. For example, a simple dir /d0 command initiates this sequence of events if d0 has not been previously initialized.

The iniz utility initializes devices. iniz performs an I$Attach system call on each device name passed to it. This initializes and links the device to the system.

To initialize a device after the system has been started, type iniz and the name(s) of the device(s) to attach to the system. iniz goes through the procedure of initializing the device(s) and allocating the memory needed for the device. If the device is already attached, it is not re-initialized, but the link count is incremented.

For example, to increment the link count of modules, t2 and t3, type:

```
$ iniz t2 t3
```

You can read the device names from standard input with the -z option or from a file with the -z=<file> option. To increment the link counts of devices listed in a file called /h0/add.files, type:

```
iniz -z=/h0/add.files
```

You can use the deiniz utility to close a path to a device. deiniz checks the link count before removing the device from storage. If the link count is greater than one, deiniz lowers the link count. If the link count is one, deiniz lowers the link count, making it zero, and removes the device from the system device table. The device then becomes ***unknown*** to OS-9.

To use the deiniz utility, type deiniz followed by the name(s) of the devices(s) to be removed from the system.

For example, to decrement the link count of module p2, type:

```
$ deiniz p2
```

deiniz can read the device names from standard input with the -z option or from a file with the -z=<file> option. To remove the files listed in a file called /h0/not.needed, type:

```
$ deiniz -z=/h0/not.needed
```

+ This initialize/de-initialize sequence can result in slower execution of programs and could cause memory fragmentation problems. To avoid these symptoms, Microware recommends that all devices connected to the system at startup be iniz-ed in the startup file.

NOTE: Non-sharable devices must be placed in a bootfile to become known to the system. If a non-sharable device is iniz-ed, it is unusable because the link count will have been incremented, causing it to appear to be in use.

iniz-ing the connected device at startup initializes the device and allocates memory for its driver for the duration of the time that the system is running, unless specifically deiniz-ed. For example, a system with two floppy drives and one hard disk would iniz these devices in the startup file:

```
iniz h0 d0 d1 t1 p1 p
```

NOTE: For more information on the iniz and deiniz utilities, refer to the ***OS-9 Utilities*** section.

Loading Utilities Into Memory load -z=sys/loadfile

The next line of the startup file loads a number of utilities into memory. If a utility is not already in memory, it must be loaded into memory before it is used. Pre-loading basic utilities at startup time avoids the necessity of loading the utility each time it is executed.

To load utilities into memory at startup, you must create a file containing the names of each utility to load, one utility per line. While the file may have any desired name, Microware recommends loadfile for obvious reasons. This file can be located in any directory as long as you specify its location on the command line. If loadfile were located in the SYS directory, the startup file command line is:

```
load -z=sys/loadfile
```

Previous versions of the Professional OS-9 package had the following commented line in the startup file:

```
load utils
```

This method involved creating a utils file by merging the desired utilities into a single file in the commands directory. While this method may still be used, using loadfile is preferable because it uses less disk space and is easier to edit.

Loading the Default Device Descriptor **load bootobjs/dd.r0**

Many OS-9 compilers and application programs look for definition files and libraries in directories located on the default system device. The default system device is known as dd. dd may be defined as any disk device, but it is usually synonymous for one of the following devices:

r0	RAM Disk
h0	Hard Disk
d0	Floppy Disk

If a default device is to be used (dd) and the device descriptor is not in the bootfile, then you must load the device descriptor. The next line in the startup file loads the device descriptor. The default device is the RAM disk named r0. If you want another device to be the default device descriptor, change the .r0 extension to reflect the appropriate device. If you have a dd device in your bootfile or if no default device is to be used, leave this line as a comment.

Initializing the RAM Disk **init.ramdisk>/nil >>/nil &**

If you are going to use the RAM disk, a library and definition file structure may be built on the RAM disk. The next line in the startup file executes the init.ramdisk procedure file. init.ramdisk is located in the root directory. It sets up LIB and DEFS directories on /dd. To name the RAM disk /r0, you must change a single line in init.ramdisk; change chd /dd to chd /r0.

NOTE: RAM disks are discussed elsewhere in this chapter.

Multi-User Systems **tsmon /t1 &**

The tsmon utility is used to make your system a multi-user system. This utility supervises idle terminals and initiates the login procedure for multi-user systems. The startup file command line: tsmon /t1& initiates the time-sharing monitor on the serial port /t1.

tsmon can monitor up to 28 device name pathlists. Therefore, if you have multiple devices for tsmon to monitor, you can specify up to 28 devices on each tsmon command line. You can use the ex built-in shell command to execute tsmon without creating another shell. This conserves system memory. For example:

```
ex tsmon term t1 t2 t3 t4 t5&
```

When a carriage return is typed on any of the specified paths, tsmon automatically forks login and standard I/O paths are opened to the device.

The login procedure uses the password file located in the SYS directory for individual login validation. The provided password file has two example login entries. Each of the fields in an entry in the password file is explained in the chapter on the shell and in the login utility description in the ***OS-9 Utilities*** section. If login fails because you could not supply a valid user name or password, control returns to tsmon.

For more information on the tsmon utility, refer to the ***OS-9 Utilities*** section.

System Shutdown Procedure

There will be times when, for one reason or another, you want to bring your system down. When you reset or power down your system, you may need to do more than just press the reset button. Certain programs need to be shut down gracefully. For example, most network communications, print spoolers, and inter-system processes need special attention. These processes may have options or other arrangements that need to be considered before shutting down your system.

In addition to taking care of processes that require special attention, you should prepare the system's users for the shutdown. If at all possible, allow users enough time to save their files and get off the system. One way of alerting users that the system is going down is by echoing a message using the echo and tee utilities. However, you should realize that messages sent over the system in this manner will not be seen by users who do not press a carriage return after the message has been sent. For example, if a programmer is sitting at a shell prompt, the message will not appear on the terminal screen until a carriage return is entered.

In this case, verbal warnings are important. This means that in addition to sending a warning message out over the system, you may want to use either an intercom system or the telephone to talk to each person connected to the system.

You can simplify the process of actually shutting down your system by creating a procedure file. Once created, you can run the procedure either from the shell command line prompt or you can create a separate password entry for the sole purpose of shutting down the system.

For example, if you have a procedure file called shutdown.sys, you could create the following password file entry:

```
sys,shutdown,0.0,128,.,sys,shell shutdown.sys
```

Once you login as user sys with password shutdown, the shut down procedure begins because the system immediately has the shell execute the shutdown.sys file.

The following is an example of a useful procedure file for shutting down the system:

```
-t -nx -np
*
* System Shutdown Procedure
*
echo WARNING The system will shut down in 3 minutes ! tee /t1 /t2 /t3 /t4 /t5
sleep -s 60
echo WARNING The system will shut down in 2 minutes ! tee /t1 /t2 /t3 /t4 /t5
sleep -s 115
echo WARNING  5 seconds to system shut down ! tee /t1 /t2 /t3 /t4 /t5
sleep -s 5
spl -$                                  ; * terminate spooler
nmon /n0 -d                             ; * shutdown network
sleep -s 3                              ; * wait 3 seconds
break                                   ; * call ROM debugger
```

The first six commands after the comment identifying the function of the procedure broadcast three warnings to the terminals on the system. The first warning tells the users that the system is going down. The other two warnings serve as reminders. Remember that you should also give verbal warnings.

The remaining command lines shut down the system:

spl -$	This command terminates the spooler. All unfinished jobs are lost when the spooler is terminated.
nmon /n0 -d	This command brings the network down. Users from other networks will no longer be able to login to the system being shut down.
sleep -s 3	This command causes the system to wait three seconds before executing the next command line. This allows the previous commands time to complete execution.
break	This command sends a break call to the ROM debugger. When the ROM debugger receives this call, the system shuts down.

Installing OS-9 On a Hard Disk

Once you have brought up the system and tested its basic operations, install OS-9 on the hard disk and use it as the system boot device. Installing the distribution software on the hard disk involves five steps:

- Checking the hard disk device descriptor
- Formatting the hard disk
- Copying the distribution software on to the hard disk
- Making the hard disk the system boot disk
- Test-booting from the hard disk

Checking the Hard Disk Device Descriptor

The installed hard disk may not necessarily match the parameters in the provided /h0 and /h0fmt device descriptors. For example, the number of cylinders, heads, etc. for your hard disk may be different than the default parameters specified in the device descriptors. Before attempting to use the hard disk, carefully examine the disk macros in systype.d.

If the parameters match the drive in use, the supplied descriptors will work. If not, edit systype.d and remake the descriptors or use the moded utility to remake the descriptors. The moded utility makes/changes any device descriptor module and updates its CRC.

Once the descriptors are made, make a new bootfile with the new descriptors replacing the old ones.

Formatting the Hard Disk

Once the descriptors match the type of drive in use, format the hard disk. Formatting the hard disk builds an OS-9 file structure on the media and tests the media for defective areas. Any new descriptors are also checked.

WARNING: If you have any vital information such as data or programs on this disk, you should perform backups to floppy or tape of this information. The format process completely erases any data on the disk.

To turn off page pause and format the hard disk, enter:

```
$ tmode nopause
$ format /h0fmt -c=<cluster size>
```

NOTE: /h0fmt *must* be the device name, as /h0 is format protected. Use the -c option for large drives only.

The format utility asks whether you want to perform a physical format and a physical verify. Answer y to both questions. The physical format operation is a lengthy process. The larger your hard disk is, the longer you can expect to wait. The logical verify reads each cluster from the disk.

Copying the Distribution Software on to the Hard Disk

Once the hard disk has been formatted correctly, use the dsave utility to copy the distribution software on to the hard disk.

To copy the distribution files:

¿ Insert the first system disk in drive /d0. The first system disk contains the CMDS directory.

¡ Change your current data directory to /d0:

```
$ chd /d0
```

¬ Copy all files from /d0 to /h0:

```
$ dsave -eb50 /h0
```

If you have more than one floppy disk to copy:

Ð Remove the disk in /d0 and replace it with the new disk to copy.

ƒ Change your execution directory to /h0/CMDS:

```
$ chx /h0/cmds
```

The hard disk is now your current execution directory.

Ý Copy all files from /d0 to /h0:

```
$ dsave -eb50 /h0
```

Repeat this step until all floppy disks have been copied to the hard disk.

NOTE: The first disk copied to the hard disk is the distribution disk containing the CMDS directory.

Making the Hard Disk the System Boot Disk

Copying files on to the hard disk installs the software on the hard disk. It *does not* make the hard disk a bootable disk. To make the hard disk the system boot disk, use the os9gen utility.

The OS9Boot file is distributed with your system software. An OS9Boot.h0 bootfile may also be included. The only difference between these files is the default system device name string in the Init module. OS9Boot refers to /d0, while OS9Boot.h0 refers to /h0.

Assuming that these files have been copied on to the hard disk, do the following to make the hard disk bootable:

¿ Change your current data directory to /h0:

$ chd /h0

¡ Rename OS9Boot to retain a copy to use with a floppy system:

$ rename OS9Boot OS9Boot.d0

¬ Make the hard disk bootable with the correct bootfile. **NOTE:** You must specify /h0fmt as the device.

$ os9gen /h0fmt OS9Boot.h0

Test Booting from the Hard Disk

Once you have completed the above steps, test that the system actually boots from the hard disk.

If the system fails to boot correctly, reboot the system. Carefully examine the results of the actions previously described.

Managing Processes in a Real-time Environment

The ability to manage processes in a real-time environment is one of OS-9's advantages. OS-9 has three main methods by which system managers can manage processes in a real-time environment:

- Manipulating process' priority
- Using D_MinPty and D_MaxAge to alter the system's process scheduling
- Having system state processes and user state processes

Manipulating Process' Priority

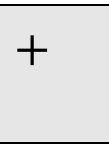
When you execute processes on the command line, you can change their initial priorities using the process priority modifiers discussed in the chapter on the shell. This allows you to set the priority on crucial tasks higher so that they run sooner and more often than processes that are less crucial.

NOTE: The initial priority is also a parameter for the fork and chain system calls.

Using D_MinPty and D_MaxAge to Alter the System's Process Scheduling

The way OS-9 schedules processes can be affected by the D_MinPty and D_MaxAge system global variables. D_MinPty and D_MaxAge are available to super users through the F$SetSys system call. These system variables can be used to effect the aging of processes. **Remember:** A process' initial priority is aged each time it is passed by for execution while it is waiting for CPU time.

D_MinPty defines a minimum priority below which processes are neither aged nor considered candidates for execution. Processes with priorities less than D_MinPty remain in the waiting queue and continue to hold any system resources that they held before D_MinPty was set.

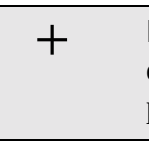


D_MinPty is usually set to zero. All processes are eligible for aging and execution when this value is set to zero because all processes have an initial priority greater than zero.

If you have a critical process that needs to be run and several other users have processes that they want to run, use the process priority modifier to increase the priority of the critical process. Then, set D_MinPty to a value that is less than the priority you assigned to the critical process but greater than the priority of the other processes. The critical process now continues using the CPU until another process with a priority greater than D_MinPty is entered into the waiting queue or the critical process is finished.

For example, if D_MinPty is set to 500 and you set the priority of your process at 600, your process continues to use the CPU while processes with priorities less than 500 cannot run until D_MinPty is reset.

CAVEAT: D_MinPty is potentially dangerous. If the minimum system priority is set above the priority of all running tasks, the system will completely shut down and can only be recovered by a reset. It is crucial to restore D_MinPty to zero when the critical task finishes or to reset D_MinPty or a process' priority in an interrupt service routine.



D_MaxAge defines a maximum age over which processes are not allowed to mature. By default, this value is set to zero. When D_MaxAge is set to zero, it has no effect on the processes waiting to use the CPU.

When set, D_MaxAge essentially divides tasks into two classes: ***low priority*** and ***high priority***. A low priority task is any task with a priority below D_MaxAge. Low priority tasks continue aging until they reach the D_MaxAge cutoff, but they are not executed unless there are no high priority tasks waiting to use the CPU.

A high priority task is any task with a priority above D_MaxAge. A high priority task will receive the entire available CPU time, but it will not be aged. When the high priority task(s) are inactive, the low priority tasks are run.

For example, if D_MaxAge is set to 2000 and three processes with initial priorities of 128 are in the active queue, the processes run just as if D_MaxAge had not been set. Then, if a process with an initial priority of 2500 is entered into the active queue, it receives CPU time when the process currently in the CPU has finished. Once using the CPU, the high priority process runs uninterrupted until a process with a higher priority enters the active queue or the process finishes. When the process finishes executing, the low priority processes will again be able to use the CPU.

NOTE: Any process performing a system call is not pre-empted until the call is finished, unless the process voluntarily gives up its timeslice. This exception is made because these processes may be executing critical routines that affect shared system resources and could be blocking other unrelated processes.

Using System-State Processes and User-State Processes

The second method that OS-9 uses to manage real-time priority processing is the existence of system-state processes. System-state processes are processes running in a supervisor or protected mode. System-state processes basically have unlimited access to system memory and other resources. When a process in system state wants to use the CPU, it waits until it has the highest age. Once it is available to use the CPU, a process in system state runs until it finishes instead of running for a specified timeslice.

Processes that are in user state do not have access to all points in memory and do not have access to all of the commands. When a process in user state gains time in the CPU, it runs only for the time specified by the timeslice. When it finishes using its timeslice, it is entered back in the waiting queue according to its initial priority.

Using the Tmode and Xmode Utilities

The tmode and xmode utilities are also available to help you customize OS-9. Use the tmode utility to display or change the operating parameters of the user's terminal. tmode affects open paths, not the device descriptor itself, so the changes made by it are temporary. The changes made by tmode are inherited if the paths are duplicated, but not if the paths are opened explicitly.

The xmode utility is similar to tmode. Use xmode to display or change the initialization parameters of any SCF-type device such as a video display, printer, RS-232 port, etc. xmode actually updates the device descriptor. The change persists as long as the computer is running even if paths to the device are repetitively opened and closed. Some common uses of xmode are to change the baud rates and control definitions.

In SSM systems, you must have write permission for the descriptor module in order for xmode to work. You can use the fixmod utility to change the permissions.

NOTE: tmode and xmode work only on SCF and GFM devices.

Using the Tmode Utility

To use the tmode utility, type tmode and any parameter(s) to change. If you give no parameters, the present values for each parameter are displayed. Otherwise, the parameter(s) given on the command line are processed. You can give any number of parameters on a command line. Use spaces or commas to separate each parameter.

If a parameter is set to zero, OS-9 no longer uses the parameter until it is re-set to a code OS-9 recognizes. For example, the following command sets xon and xoff to zero:

```
tmode xon=0 xoff=0
```

Consequently, OS-9 will not recognize xon and xoff until the values are re-set.

To re-set the values of a parameter to their default as given in this manual, specify the parameter with no value.

Use the -w=<path#> option to specify the path number affected. If a path number is not provided, standard input is affected.

NOTE: If you use tmode in a shell procedure file, you must use the -w=<path#> option to specify one of the standard paths (0, 1, or 2) to change the terminal's operating characteristics. The change remains in effect until the path is closed. To effect a permanent change to a device characteristic, you must change the device descriptor. You may alter the device descriptor to set a device's initial operating parameters using the xmode utility.

Five parameters need driver support in order to be changed by tmode: type, par, cs, stop, and baud. If you try to change these parameters without driver support, tmode has no effect.

The tmode parameters are documented in the ***OS-9 Utilities*** section.

Using the Xmode Utility

To use the xmode utility, type xmode and any parameter(s) to change. If you give no parameters, the present values for each parameter are displayed. Otherwise the parameter(s) given on the command line are processed. You can give any number of parameters on a command line. Use spaces or commas to separate each parameter. You must specify a device name if the given parameter(s) are to be processed.

Like tmode, if a parameter is set to zero, the device no longer uses the parameter until it is re-set to a recognizable code. To re-set the values of parameters to their default, specify the parameter with no value. This re-sets the parameter to the default value as given in this manual.

Five parameters require further explanation: type, par, cs, stop, and baud. xmode changes these parameters only if the device is iniz-ed directly after the xmode changes and the driver supports these changes. Changing these parameters is usually done in the startup file or by first deiniz-ing a file. For example, the following command sequence changes the baud rate of /t1 to 9600:

```
$ deiniz t1
$ xmode /t1 baud=9600
$ iniz t1
```

This type of command sequence changes the device descriptor and initializes it on the system. Only the five parameters mentioned above need this special sequence to be changed. All other xmode parameters are changed immediately.

xmode's parameters are documented in the ***OS-9 Utilities*** section.

The Termcap File Format

The termcap file is a text file that contains control code definitions for one or more types of terminals. Each entry is a complete description list for a particular kind of terminal.

The first section of a termcap entry is divided into three parts.

- A two character entry
- The most common name
- A long name

Each part is a different way of naming the terminal. A | character separates the parts of a termcap entry. The first part is a two character entry. This is a holdover from early UNIX editions. The second part is the most common name for the terminal. This name must contain no blanks. The final part is a long name fully describing the terminal. This name may contain blanks for readability. For example:

```
kh|abm85h|kimtron abm85h:
```

The TERM environment variable must be set to the name used in the second part of the name section. In the following example, TERM is set to abm85h:

```
$ setenv TERM abm85h
```

NOTE: You can check the values stored in TERM by using the printenv command:

```
$ printenv
TERM=abm85h
```

The rest of the entry consists of a sequence of control code specifications for each control function. Use a colon (:) character to separate each item in the list. You can continue an entry on to the next line by using a backslash (\) character as the last character of the line. It must appear after the last colon of the previous item. The next line must begin with a colon. For example:

```
ka|amb85|kimtron abm85:\
:ct=\E3:  ...
```

Each item begins with a terminal ***capability***. Each capability is a two character abbreviation. Each capability is either a boolean itself or it is followed by a string or a number. If a boolean capability is present in the termcap entry, then the capability exists on that terminal.

All numeric capabilities are followed by a pound sign (#) and a number. For example, the number of columns capability for an 80 column terminal could be described as follows:

co#80:

All string capabilities are followed by an equal sign (=) and a character string. You can enter a time delay in milliseconds directly after the equal sign (=) if padding is allowed in that capability. The padding characters are supplied by tputs() after the remainder of the string is transmitted to provide the time delay. The time delay may be either an integer or a real. The time delay may be followed by an asterisk (*). The asterisk specifies that the padding is proportional to the number of lines affected.

NOTE: It is often useful to specify the time delay using the real format. For example, the clear screen capability is specified as ^z with a time delay of 3.5 milliseconds by the following entry:

cl=3.5*^z:

Escape sequences may be indicated by an \E to indicate the escape character. A control character is indicated by a circumflex (^) preceding the character. The following special character constants are supported:

\b	Backspace	($08)
\f	Formfeed	($0C)
\n	Newline	($0A)
\r	Return	($0D)
\t	Tab	($09)
\\	Backslash	($5C)
\^	Circumflex	($5E)

Characters may be specified as three Octal digits after a backslash (\). For example, if a colon must be used in a capability definition, it must be specified by \072. If it is necessary to place a null character in a capability definition use \200. C routines using termcap strip the high bits of the output, therefore \200 is interpreted as \000.

Termcap Capabilities

The following is a list of termcap capabilities recognized by termcap. Not all of these capabilities need to be present for most programs to use termcap. They are provided for completeness. (P) indicates that padding may optionally be specified. (P*) indicates that the optional padding may be based on the number of lines affected:

Name	Type	Padding	Description
ae	string	(P)	End alternate character set
al	string	(P*)	Add new blank line
am	boolean		End alternate character set
as	string	(P)	Start alternate character set
bc	string		Backspace if not ^H
bs	boolean		Terminal can backspace with ^H
bt	string	(P)	Back tab
bw	boolean		Backspace wraps from column 0 to last column
CC	string		Command character in prototype if terminal settable
cd	string	(P*)	Clear to end of display
ce	string	(P)	Clear to end of line
ch	string	(P)	Horizontal cursor motion only, line stays some
cl	string	(P*)	Clear screen
cm	string	(P)	Cursor motion
co	numeric		Number of columns in line
cr	string	(P*)	Carriage return (default ^M)
cs	string	(P)	Change scrolling region (VT100), like cm
cv	string	(P)	Vertical cursor motion only
da	boolean		Display may be retained above
dB	numeric		Number of milliseconds of backspace delay needed
db	boolean		Display may be retained below
dC	numeric		Number of milliseconds of carriage return delay needed
dc	string	(P*)	Delete character
dF	numeric		Number of milliseconds of formfeed delay needed
dl	string	(P*)	Delete line

Name	Type	Padding	Description
dm	string		Delete mode (enter)
dN	numeric		Number of milliseconds of newline delay needed
do	string		Down one line
dT	numeric		Number of milliseconds of tab delay needed
ed	string		End of delete mode
ei	string		End insert mode **NOTE:** If ic is used, enter :ec=:
eo	string		Can erase overstrikes with a blank
ff	string	(P*)	Hardcopy terminal page eject (default ^L)
hc	boolean		Hardcopy terminal
hd	string		Half-line down (1/2 linefeed)
ho	string		Home cursor (if no cm)
hu	string		Half-line up
hz	string		Hazeltime: cannot print tildas (~)
ic	string	(P)	Insert character
if	string		Name of file containing initialization string
im	boolean		Insert mode (enter). **NOTE:** If ic is specified use :im=:
in	boolean		Insert mode distinguishes nulls on display
ip	string	(P*)	Insert pad after character inserted
is	string		Terminal initialization string
k0-k9	string		Sent by other function keys 0-9
kb	string		Sent by backspace key
kd	string		Sent by down arrow key
ke	string		Take terminal out of ***keypad transmit*** mode
kh	string		Sent by home key
kl	string		Sent by left arrow key
kn	numeric		Number of other keys
ko	string		Termcap entries for other non-function keys
kr	string		Sent by right arrow key
ks	string		Put terminal in keypad transmit mode
ku	string		Sent by up arrow key

Name	Type	Padding	Description
l0-l9	string		Labels on other function keys
li	numeric		Number of lines on screen or page
ll	string		Last line, first column (if no cm entry)
ma	string		Arrow key map
mi	boolean		OK to move while in insert mode
ml	string		Memory lock on above cursor
ms	boolean		OK to move while in standout and underline mode
mu	string		Turn off memory lock
nc	boolean		Carriage return down not work
nd	string		Non-destructive space
nl	string	(P*)	Newline character
ns	boolean		Terminal is a non-scrolling CRT
os	boolean		Terminal overstrikes
pc	string		Pad character (rather than null)
pt	boolean		Has hardware tabs
se	string		End stand out mode
sf	string	(P)	Scroll forwards
sg	numeric		Number of blank characters left by se or so
so	string	(P)	Begin stand out mode
sr	string	(P)	Scroll reverse
ta	string		Tab (other than ^I or without padding)
tc	string		Entry of terminal similar to last termcap entry
te	string		String to end programs that use cm
ti	string		String to begin programs that use cm
uc	string		Underscore one character and move past it
ue	string		End underscore mode
ug	numeric		Number of blank characters left by us or ue
ul	boolean		Terminal underlines but doesn’t overstrike
up	string		Upline (cursor up)
us	string		Start underscore mode

Name	Type	Padding	Description
vb	string		Visible bell
ve	string		Sequence to end open/visual mode
vs	string		Sequence to start open/visual mode
xb	boolean		Beehive terminal (f1=<esc>, f2=^C)
xn	boolean		Hewline is ignored after wrap
xr	boolean		Return acts like ce \r\n
xs	boolean		Standout not erased by writing over it
xt	boolean		Tabs are destructive

Of the capabilities, the most complex and important capability is cm: cursor addressing. The string specifying the cursor addressing is formatted similar to the C function: printf(). It uses % notation to identify addressing encodings of the current line or column position. The line and the column being addressed could be considered the arguments to the cm string. All other characters are passed through unchanged. The following is the notation used for cm strings:

%d	a decimal number (origin 0)
%2	same as %2d
%3	same as %3d
%.	ASCII equivalent of value
%+x	adds x to value, then %
%>xy	if value > x adds y, no output
%r	reverses the order of row and column, no output
%i	increments line/column (for 1 origin)
%%	gives a single %
%n	exclusive or row and column with 0140
%B	BCD (16*(x/10) + (x%10), no output
%D	reverse coding (x-2*(x%16)), no output

The following examples illustrate the use of the preceding notations:

cm=6\E&%r%2c%2Y: This terminal needs a 6 millisecond delay, rows and columns reversed, and rows and columns to be printed as two digits. The <esc>& and Y are sent unchanged. **(HP2645)**

cm=5\E[%i%d;%dH: This terminal needs a 5 millisecond delay, rows and columns separated by a semicolon (;), and because of its origin of 1, rows and columns are incremented. The <esc>[, ; and H are transmitted unchanged. **(VT100)**

cm=\E=%+ %+ : This terminal uses rows and columns offset by a blank character. **(ABM85H)**

Example Termcap Entries

```
ka|abm85|kimtron abm85:\
    :ce=\ET:cm=\E=%+ %+ :cl=^Z:\
    :se=\Ek:so\Ej:up=^K:sg#1
```

If two entries in the same termcap file are very similar, one can be defined as identical to the other with certain exceptions. To do this, tc is used with the name of the similar terminal. This capability must be the last in the entry. All exceptions to the other terminal must appear before the tc listing. If a capability must be cancelled, use <cap>@. For example, this might be a complete entry:

```
kh|abm85h|kimtron abm85h:\
    :se=\EG0:so\EG4:tc=abm85:
```

End of Chapter 8

NOTES

The OS-9 Utilities

System Command Descriptions

This chapter contains descriptions and examples of each of the OS-9 command programs. While you generally execute these programs from a shell command line, you can also call them from most other OS-9 programs.

At the time of this edition, OS-9 supports 78 utilities and built-in shell commands. They range from commonly used functions such as dir, chd, and copy to advanced system management tools such as dcheck and iniz. For quick reference purposes, the format of the information on the utilities is standardized. Each utility has a section concerning syntax, function, options (if any), examples, and any special uses.

The utilities are broken down into three categories:

- **Basic Utilities:** Every user should become familiar with these utilities. Many of them have been discussed in the earlier chapters because of their importance.

attr	backup	build	chd	chx	copy	date
del	deldir	dir	dsave	echo	edt	format
free	help	kill	list	makdir	merge	mfree
pd	pr	procs	rename	set	setime	shell
w	wait					

¡ **Programmer Utilities:** These utility programs are extremely helpful to the intermediate or advanced programmer. They allow greater exploration of OS-9's timesharing environment and more dynamic file manipulation.

binex	cfp	cmp	code	compress	count	dump
ex	exbin	expand	frestore	fsave	grep	load
logout	make	printenv	profile	qsort	save	setenv
tape	tee	touch	tmode	tr	unsetenv	

¬ **System Management Utilities:** These utility programs are used primarily by system managers and advanced assembly language programmers. Beginning programmers rarely need to use these commands:

break	dcheck	deiniz	devs	diskcache	events	fixmod
ident	iniz	irqs	link	login	mdir	moded
os9gen	romsplit	setpr	sleep	tapegen	tsmon	unlink
xmode						

Formal Syntax Notation

Each command section includes a syntactical description of the command line. These symbolic descriptions use the following notations:

[ ] = Enclosed items are optional

{ } = Enclosed items may be used 0, 1, or many times

< > = Enclosed item is a description of the parameter to use:

<path>	=	A legal pathlist
<devname>	=	A legal device name
<modname>	=	A legal memory module name
<procID>	=	A process number
<opts>	=	One or more options specified in the command description
<arglist>	=	A list of parameters
<text>	=	A character string ended by end-of-line
<num>	=	A decimal number, unless otherwise specified
<file>	=	An existing file
<string>	=	An alpha-numeric string of ASCII characters

General Notes

- The utility syntax specified in the command section does not include the shell's built-in options like alternate memory size, I/O redirection, piping, etc. The shell filters out these options from the command line before processing the program being called.
- The equal sign (=) used in many utility options is generally optional. The k used in the alternate memory size option is also generally optional. For example, you may write -b=256k as -b256, -b256k, or -b=256.
- Utilities that use the -z option expect one file name to be input per line. If you use the -z=<file> option of a utility, <file> may contain comments.
- Unless otherwise specified, command line options may appear anywhere on the command line. For example, the following command lines provide the same results:

  attr -a junk -pw
  attr junk -a -pw
  attr junk -pw -a

- Utilities with only the -? option do not allow you to list any other options on the command line. Also, built-in shell commands, such as chd and set, do not have any options including the -? option.
- cio, the utility trap handler, must be in the execution directory or pre-loaded into memory. By using special I/O techniques, cio allows the utilities to be much smaller. Most utility programs fail to execute if cio is missing. cio is typically loaded into memory at startup.

attr — Change/Examine File Security Attributes

SYNTAX: **attr [<opts>] {<path>} {<permissions>}**

FUNCTION: attr is used to examine or change the security attributes (<permissions>) of the specified file(s).

To use the attr utility, type attr, followed by the pathlist for the file(s) whose security permissions you want to change or examine. Then, enter a list of permissions to turn on or off.

You turn on a permission by giving its abbreviation preceded by a hyphen (-). You turn it off by preceding its abbreviation with a hyphen followed by the letter n (-n). Permissions not explicitly named are unaffected.

If no permissions are specified on the command line, the current file attributes are displayed.

You cannot examine or change the attributes of a file you do not own unless you are the super user. A super user can examine or change the attributes of any file in the system.

The file permission abbreviations are:

d	=	Directory file
s	=	Single user file. s denotes a non-sharable file.
r	=	Read permission to owner
w	=	Write permission to owner
e	=	Execute permission to owner
pr	=	Read permission to public
pw	=	Write permission to public
pe	=	Execute permission to public

NOTE: The ***owner*** is the creator of the file. Owner access is given to any user with the same ***group ID number*** as the owner. The ***public*** is any user with a different group ID number than the owner. You can determine file ownership with the dir -e command.

SPECIAL USE: You can use attr to change a directory file to a non-directory file if all entries have been deleted from it. You may also use the deldir utility to delete directory files. You cannot change a non-directory file to a directory file with this command. The directory attribute can only be turned on when a directory is created with the makdir utility.

OPTIONS:

-?	Displays the options, function, and command syntax of attr.
-a	Suppresses the printing of attributes.
-x	Searches for the specified file in the execution directory. The file must have execute permission to be found using -x.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES:

$ attr myfile	Displays the current attributes of myfile.
$ attr myfile -npr -npw	Turns off the public read and public write permissions.
$ attr myfile -rweprpwpe	Turns on both the public and owner read, write, and execute permissions.
$ attr -z	Displays the attributes of the file names read from standard input.
$ attr -z=file1	Displays the attributes of the file names read from file1.
$ attr -npwpr *	Turns off public write and turns on public read for all files in the directory.
$ attr *.lp	Lists the attributes of all files that have names ending in .lp.

backup — Make a Backup Copy of a Disk

SYNTAX: **backup [<opts>] [<srcpath> [<destpath>]]**

FUNCTION: backup physically copies all data from one device to another. A physical copy is performed sector by sector without regard to file structures. In most cases, the devices specified must have the same format and must not have defective sectors.

In the following discussions, the source disk is the disk you are backing up. The destination disk is the disk to which you are copying.

Single Drive Backup

A single drive backup requires exchanging disks in and out of the disk drive.

NOTE: Before backing up a disk, you should write protect the source disk with the appropriate write protect mechanism to prevent accidentally confusing the source disk and the destination disk during exchanges.

To begin the backup procedure, put the source disk in the drive and type backup. The system asks if you are ready to backup. Type y if you are ready.

Initially, backup reads a portion of the source disk into memory. backup then prompts you to exchange disks. Remove the source disk from the drive, and insert the destination disk. backup writes the previously stored data on to this disk. When the backup is finished, an exchange is again requested. This places the source disk back in the drive. This exchange process continues until all of the data on the disk is copied.

The -b option increases the amount of memory the backup procedure uses. This decreases the number of disk exchanges required.

Two Drive Backup

On a two drive system, the names /d0 and /d1 are assumed if both device names are omitted on the command line. If the second device name is omitted, a single unit back-up is performed on the drive specified.

To begin the backup procedure, put the source disk in the source drive and the destination disk in the destination drive. By default, the source drive is /d0 and the destination drive is /d1. Enter backup, the name of the source drive, and the name of the destination drive. The system asks if you are ready to backup. Enter y if you are ready. If no error occurs, the backup procedure is complete.

ERRORS: The backup procedure includes two passes. The first pass reads a portion of the source disk into a buffer in memory and then writes it to the destination disk. The second pass verifies that the data was copied correctly.

If an error occurs on the first pass, something is wrong with the source disk or its drive.

If an error occurs in the second pass, the problem is with the destination disk. If backup fails repeatedly on the second pass, re-format the destination disk and try to backup again.

OPTIONS:

-?	Displays the options, function, and command syntax of backup.
-b=<num>k	Allocates <num>k of memory for the backup buffer to use. backup uses a 4K buffer by default. backup runs faster if more memory is used.
-r	Causes the backup to continue if a read error occurs.
-v	Prevents backup from making a verification pass.

EXAMPLES: This example backs up the disk in /d2 to the disk in /d3:

```
$ backup /D2 /D3
```

This example backs up the disk in /d0 to the disk in /d1 without making a verification pass:

```
$ backup -v
```

This example allocates 40K of memory to use in backing up /d0 to /d2.

```
$ backup -b40 /d0 /d2
```

binex/exbin — Convert Binary Files to S-Record/S-Record to Binary

SYNTAX: **binex [<opts>] [<path1> [<path2>]]**
exbin [<path1> [<path2>]]

FUNCTION: binex converts binary files to S-record files. The exbin utility converts S-record files to binary.

S-record files are a type of text file containing records that represent binary data in hexadecimal form. This Motorola-standard format is often directly accepted by commercial PROM programmers, emulators, logic analyzers, and similar devices that use the RS-232 interface. It can be useful for transmitting files over data links that can only handle character type data. It can also be used for converting OS-9 assembler or compiler generated programs to load on non-OS-9 systems.

binex converts the OS-9 binary file specified by <path1> to a new file with S-record format. The new file is specified by <path2>. S-records have a header record to store the program name for informational purposes and each data record has an absolute memory address. This absolute memory address is meaningless to OS-9 because OS-9 uses position-independent code.

binex currently generates the following S-record types:

S1 records	Use a two byte address field
S2 records	Use a three byte address field
S3 records	Use a four byte address field
S7 records	Terminate blocks of S3 records
S8 records	Terminate blocks of S2 records
S9 records	Terminate blocks of S1 records

To specify the type of S-record file to generate, use the -s=<num> option. <num> = 1, 2, etc., corresponding to S1, S2, etc.

exbin is the inverse operation. <path1> is assumed to be an S-Record format text file which exbin converts to pure binary form in a new file, <path2>. The load addresses of each data record must describe contiguous data in ascending order. exbin does not generate or check for the proper OS-9 module headers or CRC check value required to actually load the binary file. You can use ident to check the validity of the modules if they are to be loaded or run. exbin converts any of the S-record types mentioned above.

Using either command, standard input and output are assumed if both paths are omitted. If the second path is omitted, standard output is assumed.

OPTIONS: -? Displays the options, function, and command syntax of binex/exbin.

-a=<num> Specifies the load address in hex. This is for binex only.

-s=<num> Specifies which type of S-record format is to generate. This is for binex only.

-x binex searches for <path1> in the execution directory. This is for binex only.

EXAMPLES: The following example downloads a program to T1. This type of command downloads programs to devices such as PROM programmers.

```
$ binex scanner.S1 >/T1
```

The next example generates prog.S1 in S1 format from the binary file, prog .

```
$ binex -s1 prog prog.S1
```

The following example generates CMDS/prog in OS-9 binary format from the S1 type file, program.S1 .

```
$ exbin prog.S1 cmds/prog
```

break — Invoke Sytem Level Debugger or Reset System

SYNTAX: **break**

FUNCTION: break executes an F$SysDbg system call. This call stops OS-9 and all user processes and returns control to the ROM debugger. The debugger g[o] command resumes execution of OS-9.

You should only call break from the system's console device, because the debugger only communicates with that device. If break is invoked from another terminal, you must still use the system's console device to communicate with the debugger.

Only super users can execute break.

NOTE: break is used only for system debugging. It should not be included with or run on a production system.

NOTE: If there is no debugger in ROM or if the debugger is disabled, break will reset the system.

CAVEAT: You must be aware of any open network paths when you use the break utility as all timesharing is stopped.

OPTION: -? Displays the function and command syntax of break.

build — Build a Text File from Standard Input

SYNTAX: **build <path>**

FUNCTION: build creates a file specified by a given pathlist.

To use the build utility, type build and a pathlist. A question mark prompt (?) is displayed. This requests an input line. Each line entered is written to the output file. Entering a line consisting of only a carriage return causes build to terminate. The build utility also terminates when you enter an end-of-file character at the beginning of an input line. The end-of-file character is typically <escape>.

OPTION: -? Displays the function and command syntax of build.

EXAMPLE:

```
$ build newfile
? Build should only be used
? in creating short text files.
? [RETURN]

$ list newfile
Build should only be used
in creating short text files.
```

cfp — Command File Processor

SYNTAX: **cfp [<opts>] [<path1>] {<path2>}**

FUNCTION: cfp creates a temporary procedure file in the current data directory and then invokes the shell to execute it.

To create a temporary procedure file, type cfp, the name of the procedure file (<path1>), and the file(s) (<path2>) to be executed by the procedure file.

All occurrences of an asterisk (*) in the procedure file (<path1>) are replaced by the given pathlists, <path2>, unless preceded by the tilde character (~). For example, ~* translates to *. The command procedure is not executed until all input files have been read.

For example, if you have a procedure file in your current data directory called copyit that consists of a single command line, copy *, all of your C programs from two directories, PROGMS and MISC.JUNK, are placed in your current data directory by typing:

```
$ cfp copyit ../progms/*.c ../misc.junk/*.c
```

If you use the "-s=<string>" option, you may omit the name of the procedure file, but you must enclose the option and its string in quotes. The -s option causes the cfp utility to use the string instead of a procedure file. For example:

```
$ cfp "-s=copy *" ../progms/*.c ../misc.junk/*.c
```

NOTE: You must use double quotes to force the shell to send the string -s=copy * as a single parameter to cfp. The quotes also prevent the shell from expanding the asterisk (*) to include all pathlists in the current data directory.

In the above examples, cfp creates a temporary procedure file to copy every file ending in .c in both PROGMS and MISC.JUNK to the current data directory. The procedure file created by cfp is deleted when all the files have been copied.

Using the -s option is convenient because you do not have to edit the procedure file to change the copy procedure. For example, if you are copying large C programs, you may want to increase the memory allocation to speed up the process.

You can allocate the additional memory on the cfp command line:

```
$ cfp "-s=copy -b100 *" ../progms/*.c ../misc.junk/*.c
```

You can use the -z and -z=<file> options to read the file names from either standard input or a file. Use the -z option to read the file names from standard input. For example, if you have a procedure file called count.em that contains the command count -l * and you want to count the lines in each program to see how large the programs are before you copy them, enter the following command line:

```
$ cfp -z count.em
```

The command line prompt does not appear because cfp is waiting for input. Enter the file names on separate command lines. For example

```
$ cfp -z count.em
../progms/*.c
../misc.junk/*.c
```

When you have finished entering the file names, press the carriage return a second time to get the shell prompt.

If you have a file containing a list of the files to copy, enter:

```
$ cfp -z=files "-s=copy *"
```

OPTIONS:

-?	Displays the options, function, and command syntax of cfp.
-d	Deletes the temporary file. This is the default.
-nd	Does not delete the temporary file.
-e	Executes the procedure file. This is the default.
-ne	Does not execute the procedure file. Instead, it will dump to standard output. This option causes -d and -nd to have no effect because the temporary procedure file is not created.
-s=<str>	Reads <str> instead of a procedure file. If the string contains characters interpreted by the shell, the entire option needs to be enclosed in quotes. It does not make sense to specify both a procedure file and this option.
-t=<path>	Creates the temporary file at <path> rather than in the current working directory.
-z	Reads the file names from standard input instead of <path2>.
-z=<file>	Reads the file names from <file> instead of <path2>.

EXAMPLE: In this example, test.p is a procedure file that contains the command line list * >/p2. The command cfp test.p file1 file2 file3 produces a procedure file containing the following commands:

```
list file1 >/p2
list file2 >/p2
list file3 >/p2
```

The following command accomplishes the same thing:

```
$ cfp "-s=list * >/p2" file1 file2 file3
```

chd/chx Change Current Data Directory/Current Execution Directory

SYNTAX: **chd [<path>]**
chx <path>

FUNCTION: chd and chx are built-in shell commands used to change OS-9's working data directory or working execution directory.

To change data directories, type chd and the pathlist to the new data directory. To change execution directories, type chx and the pathlist to the new execution directory. In both cases, a full or relative pathlist may be used. Relative pathlists used by chd and chx are relative to the current data and execution directory, respectively.

If the HOME environment variable is set, the chd command with no specified directory will change your data directory to the directory specified by HOME.

NOTE: These commands do not appear in the CMDS directory as they are built-in to the shell.

EXAMPLES:

```
$ chd /d1/PROGRAMS
$ chx ..
$ chx binary_files/test_programs
$ chx /D0/CMDS; chd /D1
```

cmp — Compare Two Binary Files

SYNTAX: **cmp [<opts>] <path1> <path2>**

FUNCTION: cmp opens two files and performs a comparison of the binary values of the corresponding data bytes of the files. If any differences are encountered, the file offset (address), the hexadecimal value, and the ASCII character for each byte are displayed.

The comparison ends when an end-of-file is encountered on either file. A summary of the number of bytes compared and the number of differences found is displayed.

To execute cmp, type cmp and the pathlists of the files to be compared.

OPTIONS:

-?	Displays the options, function, and command syntax of cmp.
-b=<num>[k]	Assigns <num>k of memory for cmp to use. cmp uses a 4K memory by default.
-s	Silent mode. Stops the comparison when the first mismatch occurs and prints an error message.
-x	Searches the current execution directory for both of the specified files.

EXAMPLES: The following example uses an 8K buffer to compare file1 with file2.

```
$ cmp file1 file2 -b=8k

Differences
        (hex)  (ascii)
byte     #1  #2  #1  #2
======== ==  ==  ==  ==
00000019 72  6e   r   n
0000001a 73  61   s   a
0000001b 74  6c   t   l

Bytes compared:  0000002d
Bytes different: 00000003

file1 is longer
```

The following example compares file1 with itself.

```
$ cmp file1 file1

Bytes compared:  0000002f
Bytes different: 00000000
```

code — Print Hex Value of Input Character

SYNTAX: **code**

FUNCTION: code prints the input character followed by the hex value of the input character. Unprintable characters print as a period (.). The keys specified by tmode quit and tmode abort terminate code. tmode quit is normally <control>E, and tmode abort is normally <control>C.

The most common usage of code is to discover the value of an unknown key on the keyboard or the hex value of an ASCII character.

OPTION: -? Displays the function and command syntax of code.

EXAMPLE:

```
$ code
ABORT or QUIT characters will terminate CODE
a -> 61
e -> 65
A -> 41
. -> 10
. -> 04
$
```

compress — Compress ASCII Files

SYNTAX: **compress [<opts>] {<path>}**

FUNCTION: compress reads the specified text file(s), converts it to compressed form, and writes the compressed text file to standard output or to an optional output file.

To use compress, type compress and the path of the text file to compress. If no files are given, standard input is used.

compress replaces multiple occurrences of a character with a three character coded sequence:

aaaaabbbbbccccccccc would be replaced with **~Ea~Eb~Jc**.

Each compressed input file name is appended with _comp. If a file with this name already exists, the old file is overwritten with the new file. Typical files compress about 30% smaller than the original file.

compress reduces the size of a file to save disk space. See the expand utility for details on how to expand a compressed file.

WARNING: Only use compress and expand on text files.

OPTIONS:

-?	Displays the options, function, and command syntax of compress.
-d	Deletes the original file. This is inappropriate when no pathlist is specified on the command line and standard input is used.
-n	Creates an output file.
-z	Reads file names from standard input.
-z=<file>	Reads file names from <file>.

EXAMPLES: In the first example, file1 is compressed, file1_comp is created, and file1 is deleted.

```
$ compress file1 -dn
```

In this example, file2 is compressed, file3 is created from the redirected standard output, and file2 is deleted.

```
$ compress file2 -d >file3
```

copy — Copy Data from One File to Another

SYNTAX: **copy [<opts>] <path1> [<path2>]**

FUNCTION: copy copies data from <path1> to <path2>. If <path2> already exists, the contents of <path1> overwrites the existing file. If <path2> does not exist, it is created. If no files are given on the command line and the -z option is not specified, an error is returned.

You can copy any type of file. It is not modified in any way as it is copied. The attributes of <path1> are also copied exactly.

NOTE: You must have permission to copy the file. You must be the owner of the file specified by <path1> or have public read permission in order to copy the file. You must also be able to write to the specified directory. In either case, if the copy procedure is successful, <path2> has your group.user number unless you are the super user. If you are the super user, <path2> has the same group.user number as <path1>.

If <path2> is omitted, the destination file has the same name as the source file. It is copied into the current data directory. Consequently, the following two copy commands have the same effect:

```
$ copy /h0/cmds/file1 file1
$ copy /h0/cmds/file1
```

copy is also capable of copying one or more files to the same directory by using the -w=<dir> option. The following command copies file1 and file2 into the BACKUP directory:

```
$ copy file1 file2 -w=backup
```

If used with wildcards, the -w=<dir> option becomes a selective dsave. The following command copies all files in the current data directory that have names ending with .lp into the LP directory:

```
$ copy *.lp -w=lp
```

Data is transferred using large block reads and writes until an end-of-file occurs on the input path. Because block transfers are used, normal output processing of data does not occur on character-oriented devices such as terminals, printers, etc. Therefore, the list utility is preferred over copy when a file consisting of text is sent to a terminal or printer.

NOTE: copy always runs faster if you specify additional memory with the -b option. This allows copy to transfer data with a minimum number of I/O requests.

OPTIONS:

-?	Displays the options, function, and command syntax of copy.
-a	Aborts the copy routine if an error occurs. This option effectively cancels the continue (y/n) ? prompt of the -w option.
-b=<num>k	Allocates <num>k memory to be used by copy. copy uses a 4K memory by default.
-f	Rewrites destination files with no write permission.
-p	Does not print a list of the files copied. This option is only for copying multiple files.
-r	Overwrites the existing file.
-v	Verifies the integrity of the new file.
-w=<dir>	Copies one or more files to <dir>. This option prints the file name after each successful copy. If an error such as no permission to copy occurs, the prompt continue (y/n) ? is displayed.
-x	Uses the current execution directory for <path1>.
-z	Reads file names from standard input.
-z=<file>	Reads file names from <file>.

EXAMPLES: The following example copies file1 to file2. If file2 already exists, error #218 is returned.

```
$ copy file1 file2
```

This example copies file1 to file2 using a 15K buffer.

```
$ copy file1 file2 -b=15k
```

This example copies all files in the current data directory to MYFILE.

```
$ copy * -w=MYFILE
```

This example copies all files in the current data directory that have names ending in .lp.

```
$ copy *.lp -w=MYFILE
```

This example copies /d1/joe and /d0/jim to FILE.

```
$ copy /d1/joe /d0/jim -w=FILE
```

This example writes file3 over file4.

```
$ copy file3 file4 -r
```

count — Count Characters, Words, and Lines in a File

SYNTAX: **count [<opts>] {<path>}**

FUNCTION: count counts the number of characters in a file and optionally prints a breakdown consisting of each unique character found and the number of times it occurred.

To count the number of characters in a file, enter count and the pathlist of the file to examine. If no pathlist is specified, count examines lines from standard input.

count recognizes the tab, line feed, and form feed characters as line delimiters.

By using the -w option, count counts the number of words in a file. A word is defined as a sequence of nonblank, non-carriage-return characters.

By using the -l option, the number of lines in a file is displayed. A line is defined by zero or more characters ending in a carriage-return.

OPTIONS:

-?	Displays the options, function, and command syntax of count.
-b	Counts characters and gives a breakdown of their occurrence.
-c	Counts characters.
-l	Counts lines.
-w	Counts words.
-z	Reads file names from standard input.
-z=<file>	Reads file names from <file>.

EXAMPLE:

```
$ list file1
first line
second line
third line

$ count -clw file1
"file1" contains 34 characters
"file1" contains 6 words
"file1" contains 3 lines
```

date — Display System Date and Time

SYNTAX: **date [<opts>]**

FUNCTION: date displays the current system date and system time. The system date and time are set by the setime utility.

OPTIONS:

-? Displays the options, function, and command syntax of date.

-j Displays the Julian date and time.

-m Displays the military time (24 hour clock) after the date.

EXAMPLES:

$ date

December 18, 1990 Tuesday 2:20:20 pm

$ date -m

December 18, 1990 Tuesday 14:20:24

The following example redirects the current date and time to the printer:

$ date >/p

dcheck — Check the Disk File Structure

SYNTAX: **dcheck [<opts>] <devname>**

FUNCTION: dcheck is a diagnostic tool used to detect the condition and the general integrity of the directory/file linkages of a disk device.

To use dcheck, type dcheck, the option(s) desired, and the name of the disk device to check.

dcheck first verifies and prints some of the vital file structure parameters. It moves down the tree file system to all directories and files on the disk. As it moves down the tree file system, the integrity of the file descriptor sectors (FDs) is verified. Any discrepancies in the directory/file linkages are reported.

From the segment list associated with each file, dcheck builds a sector allocation map. This map is created in memory.

If any FDs describe a segment with a cluster not within the file structure of the disk, a message is reported:

***** Bad FD segment (xxxxxx-yyyyyy)**

This indicates that a segment starting at sector xxxxxx (hexadecimal) and ending at sector yyyyyy cannot be used on this disk. The entire FD is probably bad if any of its segment descriptors are bad. Therefore, the allocation map is not updated for bad FDs.

While building the allocation map, dcheck ensures that each disk cluster appears only once in the file structure. If a cluster appears more than once, dcheck displays a message:

Sector xxxxxx (byte=nn bit=n) previously allocated

This message indicates the cluster at sector xxxxxx has been found at least once before in the file structure. byte=nn bit=n specifies in which byte of the bitmap this error occurred and in which bit in that byte. The first byte in the bitmap is numbered zero. For dcheck's purposes, bits are numbered zero through seven; the most significant bit is numbered zero. The message may be printed more than once if a cluster appears in a segment in more than one file.

Occasionally, sectors on a disk are marked as allocated even though they are not associated with a file or the disk's free space. This is most commonly caused by media defects discovered by format. These defective sectors are not included in the free space for the disk. This can also happen if a disk is removed from a drive while files are still open, or if a directory containing files is deleted by a means other than deldir.

If all the sectors of a cluster are not used in the file system, dcheck prints a message:

xxxxxx cluster only partially used

The allocation map created by dcheck is then compared to the allocation map stored on the disk. Any differences are reported in messages:

Sector xxxxxx (byte=nn bit=n) not in file structure
Sector xxxxxx (byte=nn bit=n) not in bit map

The first message indicates sector number xxxxxx was not found as part of the file system but is marked as allocated in the disk's allocation map. In addition to the causes previously mentioned, some sectors may have been excluded from the allocation map by the format program because they were defective. They could be the last sectors of the disk, whose sum is too small to comprise a cluster.

The second message indicates that the cluster starting at sector xxxxxx is part of the file structure but is not marked as allocated in the disk's allocation map. This type of disk error could cause problems later. It is possible that this cluster may later be allocated to another file. This would overwrite the current contents of the cluster with data from the newly allocated file. All current data located in this cluster would be lost. Any clusters reported as previously allocated by dcheck have this problem.

Repairing the Bitmap

dcheck is capable of repairing two types of disk problems using the -r and the -y options. If a cluster was found in the file structure but not in the bitmap, the bit may be turned on in the bitmap to include the cluster. If the cluster was marked in the bitmap but not in the file structure, the bit in the bitmap may be turned off.

WARNING: Do not use either of these options unless you thoroughly understand what you are doing. These errors could be caused by previously mentioned problems and perhaps should not be repaired.

Restrictions:

- ¿ Only the super user (user 0.n) may use this utility.
- ¡ dcheck should have exclusive access to the disk being checked. dcheck can be fooled if the disk allocation map changes while it is building its bitmap file from the changing file structure.

OPTIONS:

-?	Displays the options, function, and command syntax of dcheck.
-d=<num>	Prints the path to the directory <num> deep.
-r	Repair mode. Prompts to turn on or off bits in the bit map.
-y	Repair mode. Does not prompt for repair, but answers yes to all

prompts. This option must be used with the -r option.

EXAMPLE:

```
$ dcheck /d2
Volume - 'Ram Disk (Caution: Volatile)' on device /dd
$001000 total sectors on media, 256 bytes per sector
Sector $000001 is start of bitmap
$0200 bytes in allocation map, 1 sector(s) per cluster
Sector $000003 is start of root dir
Building allocation map...
$0003 sectors used for id sector and allocation map
Checking allocation map...

'Ram Disk (Caution: Volatile)' file structure is intact
5 directories, 60 files
580096 of 1048576 bytes (0.55 of 1.00 meg) used on media
```

deiniz — Detach a Device

SYNTAX: **deiniz [<opts>] {<modname>}**

FUNCTION: When a device is no longer needed, use deiniz to remove the device from the system device table. deiniz uses the I$Detach system call to accomplish this. Information concerning I$Detach is located in the ***OS-9 Technical Manual***.

To remove a device from the system device table, type deiniz, followed by the name of the module(s) to detach. <modname> may begin with a slash (/). The module names may be read from standard input or from a specified pathlist if the -z option is used.

WARNING: Do not deiniz a module unless you have explicitly iniz-ed it. If you do deiniz a device that you have not iniz-ed, you could cause problems for other users who may be using the module.

OPTIONS:

-?	Displays the options, function, and command syntax of deiniz.
-z	Reads the module names from standard input.
-z=<file>	Reads the module names from <file>.

EXAMPLE: **$ deiniz t1 t2 t3**

del — Delete a File

SYNTAX: **del [<opts>] {<path>}**

FUNCTION: del deletes the file(s) specified by the pathlist(s). You must have write permission for the file(s) to be deleted. You cannot delete directory files with this utility unless their attribute is changed to non-directory.

OPTIONS:

-?	Displays the options, function, and command syntax of del.
-e	Erases the disk space that the file occupied.
-f	Delete files with no write permission.
-p	Prompts for each file to be deleted with the following prompt: **delete <filename> ? (y,n,a,q)** y = yes. n = no. a = delete all specified files without further prompts. q = quit the deleting process.
-x	Looks for the file in the current execution directory.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES: These examples use the following directory structure:

```
$ dir
  Directory of /D1  14:29:46
junk          myfile        newfile       number_five
old_test_program            test_program
```

$ del newfile Deletes newfile.

$ del *_* Deletes all files in the current data directory with an underscore character in their name.

After executing the preceding two examples, the directory has the following files:

```
$ dir
  Directory of /D1  14:30:37
junk          myfile
```

To delete all files in the current directory, type:

```
$ dir -u ! del -z
```

SEE ALSO: The attr and deldir utility descriptions

deldir — Delete All Files in a Directory

SYNTAX: **deldir [<opts>] {<path>}**

FUNCTION: deldir deletes directories and the files they contain one file at a time. deldir is only used to delete all files in the directory.

When deldir is run, it prints a prompt message:

```
$ deldir OLDFILES

Deleting directory: OLDFILES
Delete, List, or Quit (d, l, or q) ?
```

A d response initiates the process of deleting files. An l response causes dir -e to run so you can have an opportunity to see the files in the directory before they are deleted. A q response aborts the command before action is taken. After listing the files, deldir prompts with:

```
delete ? (y,n)
```

The directory to be deleted may include directory files, which may themselves include directory files, etc. In this case, deldir operates recursively (that is, lower-level directories are also deleted). The lower-level directories are processed first.

You must have correct access permission to delete all files and directories encountered. If not, deldir aborts upon encountering the first file for which you do not have write permission.

deldir automatically calls dir and attr, so they must reside in the current execution directory. When deldir calls dir, it executes a dir -a command to show all files contained in the directory.

NOTE: You should never delete the current data directory (.).

OPTIONS:

-?	Displays the options, function, and command syntax of deldir.
-f	Deletes files regardless of whether write permission is set.
-q	Quiet mode. No questions are asked. The directory and its subdirectories are all deleted, if possible.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

devs — Display System's Device Table

SYNTAX: **devs**

FUNCTION: devs displays a list of the system's device table. The device table contains an entry for each active device known to OS-9. devs does not display information for uninitialized devices.

The devs display header lists the system name, the OS-9 version number, and the maximum number of devices allowed in the device table.

Each line in the devs display contains five fields:

Name	Description
Device	Name of the device descriptor
Driver	Name of the device driver
File Mgr	Name of the file manager
Data Ptr	Address of the device driver's static storage
Links	Device use count

NOTE: Each time a user executes a chd to an RBF device, the use count of that device is incremented by one. Consequently, the Links field may be artificially high.

OPTION: -? Displays the function and command syntax of devs.

EXAMPLE: The following example displays the device table for a system named Tazz:

```
$ devs
TAZZ_VME147  OS-9/68030 V2.4.x82  (128 devices max)

 Device    Driver    File Mgr   Data Ptr  Links
---------- ---------- ---------- --------- ------
term      sc8x30    scf       $007fda40     7
h0        rbsccs    rbf       $007fcbe0  31175
d0        rb320     rbf       $007e94a0     1
dd        rbsccs    rbf       $007fcbe0    23
t10       sc335     scf       $006d3a70     5
t11       sc335     scf       $006d3850     5
t12       sc335     scf       $006d3630     5
t13       sc335     scf       $006d3410     5
t20       sc335     scf       $006d31f0     5
t21       sc335     scf       $006d2fd0     5
t22       sc335     scf       $006d2db0     5
t23       sc335     scf       $006d2b90     5
5803      rb320     rbf       $007e94a0    20
3803      rb320     rbf       $007e94a0     1
mt2       sbgiga    sbf       $006d9640     1
n0        n9026     nfm       $006d63a0   372
nil       null      scf       $006d6340    10
socket    sockdvr   sockman   $006c0500     4
lo0       ifloop    ifman     $006c0380     4
le0       am7990    ifman     $006bed60     1
pipe      null      pipeman   $0068ecc0     3
pk        pkdvr     pkman     $0048dc90     1
pkm00     pkdvr     pkman     $00427b50     1
3807      rb320     rbf       $007e94a0    12
pcd0      rb320     pcf       $007e94a0     3
pks00     pkdvr     scf       $004279b0     2
```

SEE ALSO: The iniz and deiniz utilities

dir — Display Names of Files in a Directory

SYNTAX: **dir [<opts>] {<path>}**

FUNCTION: dir displays a formatted list of file names of the specified directory file on standard output.

To use the dir utility, type dir and the directory pathlist, if desired. If no parameters are specified, the current data directory is shown. If you use the -x option, the current execution directory is shown. If a pathlist of a directory file is specified, the files of the indicated directory are shown.

If the -e option is included, each file's entire description is displayed: size, address, owner, permissions, date, and time of last modification. Because the shell does not interpret the -x option, wildcards do not work as expected when this option is used.

Unless the -a option is used, file names that begin with a period (.) are not displayed.

Unformatted Directory Listing

You can print an unformatted directory listing using the -u option. This allows only the names of the entries of a directory to be displayed. No directory header is displayed. Entries are printed as follows:

```
$ dir -u
file1
file2
file3
DIR1
```

The output of a dir -u can be sent through a pipe to another utility or program that can use a pipe. For example:

```
$ dir -u ! attr -z
```

This displays the attributes of every entry in the current directory.

The -e option can be used to display an extended directory listing without the header by adding the -u option.

OPTIONS:

-?	Displays the options, function, and command syntax of dir.
-a	Displays all file names in the directory. This includes file names beginning with a period.
-d	Appends a slash (/) to all directory names listed. This does not affect the actual name of the directory.
-e	Displays an extended directory listing excluding file names beginning with a period.
-n	Displays directory names without displaying the file names they contain. This option is especially useful with wildcards.
-r	Recursively displays the directories. This does not include file names beginning with a period.
-r=<num>	Displays the directories recursively up to the <num> level below the current directory. This does not include file names beginning with a period.
-s	Displays an unsorted listing. This does not include file names beginning with a period.
-u	Displays an unformatted listing. This does not include file names beginning with a period.
-x	Displays the current execution directory. This does not include file names beginning with a period.
-z	Reads the directory names from standard input.
-z=<file>	Reads the directory names from <file>.

EXAMPLES: The first example displays the current data directory:

```
$ dir

                    Directory of . 12:12:54
BK          BKII        RELS        ed10.c      ed11.c
ed2.c
```

In the second example, the parent of the working data directory is displayed:

```
$ dir ..
```

This example displays the NEWSTUFF directory:

```
$ dir NEWSTUFF
```

The next example displays the entire description of the current data directory:

```
dir -e
                Directory of . 13:54:44
 Owner    Last modified Attributes Sector Bytecount Name
-------   ------------- ---------- ------ --------- ----
  1.78    90/11/28 0357  d-ewrewr   383C8       160 NOTES
  1.78    90/11/28 0357  d-ewrewr   383E8       608 PROGRAMS
  1.78    90/11/28 0357  d-ewrewr   383D8       160 TEXT
  1.78    90/11/14 0841  ------wr    F4058       438 arrayex.c
  1.78    90/11/12 0859  ------wr    F4068       538 arrayex.r
  1.78    90/11/09 0852  ------wr    F2AB0       312 asciiinfo
  0.0     90/04/27 1719  ----r-wr   71EC8      4626 atari.doc
  1.78    90/11/14 0911  ------wr    B4548       636 bobble.c
  1.78    90/11/14 0910  ------wr    B4AA8       815 bobble.r
  1.78    90/10/18 1259  ------wr    BD418       619 cd.order
  1.78    90/06/06 1009  ---wr-wr     82B8      5420 cdichanges
  1.78    90/11/28 1102  ------wr    E0C68      1478 checks.c
  1.78    90/11/28 1102  ------wr    E1D08      1075 checks.r
  1.78    90/09/07 0848  ------wr    708B8       274 datafile
  0.78    90/04/12 1206  ---wr-wr    70EE8      1065 drvr.a
  1.78    90/11/13 1544  ------wr    B1650       112 exloop
```

To display the execution directory, type:

```
$ dir -x
```

To display the entire description of the execution directory, type:

```
$ dir -xe
```

To display the contents of the current directory and all directories one level below this directory, type:

```
$ dir -r=1
```

The next example displays the entire description of all files within the current directory. This includes files within all subdirectories of the current directory.

```
$ dir -er
```

This example displays all directory and file names that begin with B.

```
$ Dir -n B*
```

diskcache — Enable, Disable, or Display Status of Cache

SYNTAX: **diskcache [<opts>] [<dev>]**

FUNCTION: diskcache enables, disables, or displays the status of the cache. Caching may be enabled for any type of RBF device, and more than one device may be cached at a time.

The total amount of system memory used for caching all enabled drives can be set by the utility's -t option. If not explicitly defined, the diskcache utility automatically selects a reasonable value based upon the amount of free system memory.

Caching may be dynamically enabled or disabled on a per drive basis while the system is running using the -e and -d options.

Statistical information regarding the hit/miss ratios, amount of memory allocated, etc. can be inspected on a drive by drive basis using the -l option. An example output of this information follows:

```
Current size =  1047552
  Size limit =  1048576

Device:  /h0:1:1
          Requests    Sectors      Hits      Zaps     >2 Xfr Hit Rate
    Reads:     47592      55436     21874       143       662  39.5%
   Writes:      7723       8065              7342        68
 Dir Reads:     54048      54048     34526     18387<-Sctr Zero  63.9%
Dir Writes:         0          0
 Hit compares =      63399 (         1/hit)
Miss compares =      92685 (         3/miss)
```

CAVEATS: Caching should only be invoked on devices that are known to the I/O system (that is, the devices should have been initialized with the iniz utility).

If caching is to be enabled on drives with different sector sizes, the device with the largest sector size should be included in the initial cache enabling. Attempting to add a drive (with a sector size larger than any currently cached drive) to the cache system after initial cache startup results in continuous "misses" for that drive, as the sector size is too large.

OPTIONS:

-?	Displays the options, function, and command syntax of diskcache.
-d	Disables cache for <dev>.
-e	Enables cache for <dev>.
-l	Displays the cache status for <dev>.
-t=<size>[k]	Specifies the size limit of the total cache.

dsave — Generate Procedure File to Copy Files

SYNTAX: **dsave [<opts>] [<path>]**

FUNCTION: dsave is used to backup or copy all files in one or more directories. It generates a procedure file, which is either executed later to actually do the work or is executed immediately using the -e option.

To use dsave, type dsave and the path of the new directory. When dsave is executed, it writes commands on standard output to copy files from the current data directory to the directory specified by <path>. If no <path> is specified, the copies are directed to the current data directory when the procedure file is executed.

dsave's standard output should be redirected to a procedure file that can be executed at a later time or the -e option should be used to execute dsave's output immediately.

If dsave encounters a directory file, it automatically includes makdir and chd commands in the output before generating copy commands for files in the subdirectory. The procedure file duplicates all levels of the file system connected downward from the current data directory.

If the current working directory happens to be the root directory of the disk, dsave creates a procedure file to backup the entire disk, file by file. This is useful when you need to copy many files from different format disks, or from a floppy disk or a hard disk.

If an error occurs, the following prompt is displayed:

continue (y,n,a,q)?

A y indicates you want to continue. An n indicates you do not want to continue. An a indicates you want to copy all possible files and you do not want dsave to display the prompt on error. A q indicates you want to quit the dsave procedure. If for any reason you do not wish to be bothered by this prompt, the -s option is available. This skips any file which cannot be copied and continues the dsave routine with no prompt.

dsave helps keep up-to-date directory backups. When the -d or -d=<date> options are used, dsave compares the date of the file to copy with a file of the same name in the directory it is to be copied to. The -d option copies any file with a more recent date. To copy a file with a date more recent than that specified, use the -d=<date> option.

A common error occurs when using dsave if the destination directory has files with the same name as the source directory. Because a file name must be unique within a directory, this produces an error. Use the -r option to prevent this error.

OPTIONS:

-? Displays the options, function, and command syntax of dsave.

-a	Does not copy any file that has a name beginning with a period.
-b[=]<n>k	Allocates <n>k bytes of memory for copy and cmp if needed.
-d	Compares dates with files of the same name and copies files with more recent dates.
-d=<date>	Compares the specified date with the date of files with the same name and copies any file with a more recent date than that specified.
-e	Executes the output immediately.
-f	Uses copy's -f option to force the writing of files.
-i	Indents for directory levels.
-l	Does not save directories below the current level.
-m	Does not include makdir commands in the procedure file.
-n	Does not load copy or cmp if -v is specified.
-o	Uses os9gen to create a bootfile on the specified destination device if a bootfile exists on the source device. The default name used for the bootfile is OS9Boot. This option is used to create a bootable disk. Merely copying OS9Boot to a new disk does not make it bootable.
-o=<name>	Uses os9gen to create a bootfile on a new device, using the specified name. This option is used to create a bootable disk. Merely copying OS9Boot to a new disk does not make it bootable.
-r	Writes any source file over a file with the same name in the destination directory. Effectively, this uses the copy utility with the -r option.
-s	Skips files on error. This effectively turns off the prompt to continue the dsave routine when an error occurs.
-v	Verifies files with the cmp utility.

EXAMPLES: The first three examples effectively accomplish the same goal: copying all files in /d0/MYFILES/STUFF to /d1/BACKUP/STUFF. Each example highlights a different method of using dsave.

In the first example, no path is specified in the dsave command and a procedure file is generated. Therefore, you must change data directories before executing the procedure file. If the directory is not changed, an error message occurs: #218--file already exists in this directory under the same name.

$ chd /d0/MYFILES/STUFF	*Selects the directory to be copied.*
$ dsave >/d0/makecopy	*Makes the procedure file* makecopy.
$ chd /d1/BACKUP/STUFF	*Select the destination directory for* makecopy.
$ /d0/makecopy	*Runs* makecopy.

The second example uses the path /d1/BACKUP/STUFF in the dsave command. Consequently, you do not need to change directories before executing the procedure file. This example also allocates 32K of memory for the copy procedure. Allocating more memory for the copy procedure usually saves time.

```
$ chd /d0/MYFILES/STUFF
$ dsave -ib=32  /d1/BACKUP/STUFF >saver
$ saver
```

The third example effectively accomplishes the same thing, but without using a procedure file.

```
$ chd /d0/MYFILES/STUFF
$ dsave -ieb32 /d1/BACKUP/STUFF
```

In the following example, dir -e shows the creation dates of the files. This shows the -d option of dsave.

```
$ chd /d0/BACKUP
$ dir -e
  Directory of . 14:14:32
 Owner    Last Modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 12.4     90/12/01 1417   ------wr    1A2B     11113 program.c
 12.4     90/06/05 1601   ------wr    8543      5744 prog.2
$ chd /d0/WORKFILES
$ dir -e
    Directory of . 14:14:32
 Owner    Last Modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 12.4     90/12/01 1417   ------wr    DODO     11113 program.c
 12.4     90/12/01 1601   ------wr    3458      5780 prog.2
directory of . 14:14:40
$ dsave -deb32 /d0/BACKUP
$ chd /d0/BACKUP
$ dir -e
 Directory of . 14:14:32
 Owner    Last Modified  Attributes Sector Bytecount Name
-------   -------------  ---------- ------ --------- ----
 12.4     90/12/01 1417   ------wr    DD33     11113 program.c
 12.4     90/12/01 1601   ------wr    4356      5780 prog.2
```

In this example only prog2 was copied because the date was more recent in the WORKFILE directory.

dump — Formatted File Data Dump in Hexadecimal and ASCII

SYNTAX: **dump [<opts>] [<path> [<addr>]]**

FUNCTION: dump produces a formatted display of the physical data contents of <path>. <path> may be a mass storage file or any other I/O device. dump is commonly used to examine the contents of non-text files.

To use this utility, type dump and the pathlist of the file to display. An address within a file may also be displayed. If <path> is omitted, standard input is used. The output is written to standard output. When <addr> is specified, the contents of the file are displayed starting with the appropriate address. <addr> is presumed to be a hexadecimal number.

The data is displayed 16 bytes per line in both hexadecimal and ASCII character format. Data bytes that have non-displayable values are represented by periods in the character area.

The addresses displayed on the dump are relative to the beginning of the file. Because memory modules are position-independent and stored in files exactly as they exist in memory, the addresses shown on the dump are relative to the load addresses of the memory modules.

OPTIONS:

-? Displays the options, function, and command syntax of dump.

-c Does not compress duplicate lines.

-m Dumps from a memory resident module.

-s Interprets the starting offset as a sector number. This is useful for RBF devices with a sector size not equal to 256.

-x Indicates that <path> is an execution directory. You must have execute permission for the pathlist.

EXAMPLES:

$ dump	Displays keyboard input in hex.
$ dump myfile >/P	Dumps myfile to printer.
$ dump shortfile	Dumps shortfile.

SAMPLE OUTPUT:

(starting address) **(data bytes in hexadecimal format)** **(data bytes in ASCII format)**

```
 Addr    0 1  2 3  4 5  6 7  8 9  A B  C D  E F 0 2 4 6 8 A C E
--------  ---- ---- ---- ---- ---- ---- ---- ---- ----------------
00000000  6d61 696e 2829 0d7b 0d09 696e 7420 783b main().{..int x;
00000010  0d09 0d09 6765 745f 7465 726d 5f64 6566 ....get_term_def
00000020  7328 293b 0d09 783d 6d65 6e75 2829 3b0d s();..x=menu();.
```

echo — Echo Text to Output Path

SYNTAX: **echo [<opts>] {<text>}**

FUNCTION: echo echoes its parameter to the standard output path. echo is typically used to generate messages in shell procedure files or to send an initialization character sequence to a terminal.

To use the echo utility, type echo and the text to output. echo reads the text until a carriage return is encountered. The input then echoes on the output path.

A hexadecimal number representing a character may be imbedded in a character string but you must precede it with a backslash (\). The shell removes all but one imbedded space from character strings passed to echo. Therefore, to allow for more than one blank between characters, you must enclose the string with double quotes. A single backslash (\) is echoed by entering two backslashes (\\).

NOTE: Do not include any of the punctuation characters used by the shell in the text unless you enclose the string with double quotes.

OPTIONS:

-?	Displays the options, function, and command syntax of echo.
-n	Separates the text with carriage returns.
-r	Does not send a carriage return after <text>.
-z	Reads the text from standard input.
-z=<file>	Reads the text from <file>.

EXAMPLES:

```
$ echo "Here is an important message!"
Here is an important message!
```

```
$ echo \1b >/p1
```
Sends an <escape> character to a printer (/p1).

```
$ echo column1      column2      column3
column1 column2 column3
```

```
$ echo "column1      column2      column3"
column1      column2      column3
```

edt — Line-Oriented Text Editor

SYNTAX: **edt [<opts>] <path>**

FUNCTION: edt is a line-oriented text editor that allows you to create and edit source files.

To use the line-oriented text editor, type edt and the pathlist desired. If the file is new or cannot be found, edt creates and opens it. edt then displays a question mark prompt (?) and waits for a command. If the file is found, edt opens it, displays the last line, and then displays the ? prompt.

The first character of a line must be a space if text is to be inserted. If any other character is typed in the first character position, edt tries to process the character as an edt command. edt command format is very similar to BASIC's editor.

edt determines the size of the file to edit and uses the returned size plus 2K as the edit buffer. If the file does not already exist, the edit buffer is initialized to 2K. When the end of the edit buffer is reached, a message is displayed.

OPTIONS:

-?	Displays the options, function, and command syntax for edt.
-b=<num>k	Allocates a buffer area equal to the size of the file plus <num>k bytes. If the file does not exist, a buffer of the indicated size is assigned for the new file.

EDT COMMANDS: All edt commands begin in the first character position of a line.

<num>	Moves the cursor to line number <num>.
<esc>	Closes the file and exits. q also does this.
<cr>	Moves the cursor down one line (carriage return).
+<num>	Moves the cursor down <num> lines. Default is one.
-<num>	Moves the cursor up <num> lines. Default is one.
<space>	Inserts lines.
d[<num>]	Deletes <num> lines. If <num> is not specified, the default value of <num> is one.
l<num>	Lists <num> lines. <num> may be positive or negative. The default value of <num> is one.
l*	Lists all lines in the entire file.
q	Quits the editing session. Command returns to the program that called the editor or the OS-9 shell.

NOTE: For the following search and replace commands, <delim> may be any character. The asterisk (*) option indicates that all occurrences of the pattern are searched for and replaced if specified.

s[*]<delim><search string><delim>

Search command: searches for the occurrences of a pattern. For example:

s/and/	Finds the first occurrence of and.
s*,Bob,	Finds all occurrences of Bob.

c[*]<delim><search string><delim><replace string><delim>

Replace command: finds and replaces a given string. For example:

c/Tuesday/Wednesday/	Replaces the first occurrence of Tuesday with Wednesday.
c*"employee"employees"	Replaces all occurrences of employee with employees.

events — Display Active System Events

SYNTAX: **events**

FUNCTION: events displays a list of the active events on the system and information about each event. The events header line lists the system name and the OS-9 version number.

Each line in the events display contains six fields:

event ID	Event ID number
name	Name of the event
value	Current contents of the event variable
W-inc	Wait increment. Assigned when the event is created and does not change.
S-inc	Signal increment. Assigned when the event is created and does not change.
links	Event use count. When the event is created, links is assigned the value one. links is incremented each time a process links to the event.

An event cannot be deleted unless the link count is zero.

If no active events are currently on the system, events displays the message "No active events."

OPTION: -? Displays the function and command syntax of events.

EXAMPLE: The following example displays the active system events for a system named Calvin:

```
Calvin    OS-9/68K V2.4

event ID      name        value     W-inc  S-inc  links
---------  ------------ ---------- ------ ------ ------
  10000   evtfffe4000          1     -1      1      1
  20001   irqfffe4000          0     -1      1      1
  30002   SysMbuf         121952      0      0      1
  40003   net_input            0     -1     -1      1
  50004   Sur00227750          0      0      0      1
  60005   Str002261f0          0      0      0      1
  70006   Stw002261f0          0      0      0      1
  80007   Str00227380          0      0      0      1
  90008   Stw00227380          0      0      0      1
  a0009   Str00232a50          0      0      0      1
  b000a   Stw00232a50          0      0      0      1
  c000b   Str0020ac30          0      0      0      1
  d000c   Stw0020ac30          0      0      0      1
  e000d   pkm00i               0      0      0      1
  f000e   pkm00o               0      0      0      1
 10000f   teln.1               0     -1     -1      1
 130012   Str0020adf0          0      0      0      1
 140013   Stw0020adf0          0      0      0      1
```

SEE ALSO: F$Event service request in the ***OS-9 Technical Manual***

ex — Execute Program as Overlay

SYNTAX: **ex <path> [<arglist>]**

FUNCTION: ex is a built-in shell command that causes the process executing the command to start executing another program. It permits a transition from the shell to another program without creating another process, thus conserving system memory.

ex is often used when the shell is called from another program to execute a specific program, after which the shell is not needed. For example, applications which use only BASIC need not waste memory space on shell.

ex should always be the last command on a shell input line because any command lines following it are never processed.

NOTE: Because this is a built-in shell command, it does not appear in the CMDS directory.

EXAMPLES:

```
$ ex BASIC
$ tsmon /t1& tsmon /t2& ex tsmon /term
```

expand — Expand a Compressed File

SYNTAX: **expand [<opts>] {<path>}**

FUNCTION: expand restores compressed files to their original form. It is the complement command of the compress utility.

To expand a compressed file, type expand and the name of the file to expand. If no file names are given on the command line, standard input is assumed.

OPTIONS:

-?	Displays the options, function, and command syntax of expand.
-d	Deletes the old version of the file. This option is not appropriate when no pathlist is specified on the command line and standard input is used.
-n	Sends output to a file instead of the standard output. The file has _exp appended to it, unless the file name already has a _comp suffix. In this case, the _comp is removed.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES:

$ expand data.a -nd	Expands and then deletes data.a, creating data.a_exp.
$ expand file1_comp	Expands file1_comp and displays output on standard output.
$ expand -nd file2_comp	file2_comp is expanded and then deleted, creating file2 with the expanded output.

fixmod — Fix Module CRC and Parity

SYNTAX: **fixmod [<opts>] {<modname>}**

FUNCTION: fixmod verifies and updates module parity and module CRC (cyclic redundancy check). You can also use it to set the access permissions and the group.user number of the owner of the module.

Use fixmod to update the CRC and parity of a module every time a module is ***patched*** or modified in any way. OS-9 cannot recognize a module with an incorrect CRC.

You must have write access to the file in order to use fixmod.

Use the -u option to recalculate and update the CRC and parity. Without the -u option, fixmod only verifies the CRC and parity of the module.

The -up=<perm> option sets the module access permissions to <perm>. <perm> must be specified in hexadecimal. You must be the owner of the module or a super user to set the access permissions. The permission field of the module header is divided into four sections from right to left:

owner permissions
group permissions
public permissions
reserved for future use

Each of these sections are divided into four fields from right to left:

read attribute
write attribute
execute attribute
reserved for future use

The entire module access permissions field is given as a four digit hexadecimal value. For example, the command fixmod -up=555 specifies the following module access permissions field:

-----e-r-e-r-e-r

The -uo<g>.<u> option allows the super user to change the ownership of a module by setting the module owner's group.user number.

OPTIONS:	-?	Displays the options, function, and command syntax of fixmod.
	-u	Updates an invalid module CRC or parity.
	-ua[=]<att.rev>	Changes the module's attribute/revision level.
	-ub	Fixes the sys/rev field in BASIC packed subroutine modules.
	-up=<perm>	Sets the module access permissions to <perm>. <perm> must be specified in hexadecimal.
	-uo<g>.<u>	Sets the module owner's group.user number to <g>.<u>. Only the super user is allowed to use this option.
	-x	Looks for the module in the execution directory.
	-z	Reads the module names from standard input.
	-z=<file>	Reads the module names from <file>.
EXAMPLES:	**$ fixmod dt**	Checks parity and CRC for module dt.
	$ fixmod dt -u	Checks parity and CRC for module dt and updates them if necessary.

SEE ALSO: Refer to the ***OS-9 Technical Manual*** for more information concerning CRC and parity. For a full explanation of module header fields, see the ident utility.

format — Initialize Disk Media

SYNTAX: **format [<opts>] <devname>**

FUNCTION: format is used to physically initialize, verify, and establish an initial file structure on a disk. You must format all disks before using them on an OS-9 system. format can format almost any type of disk, including hard disks.

To use the format utility, type format, the name of the device to format, and any options. format will determine whether the device is autosize (for example, devices such as SCSI CCS drives) or non-autosize (such as standard floppy disks and many hard disks). An autosize device is one which can be queried to determine the capacity of the device. format checks a bit in PD_Ctrl to determine whether or not a device is autosize. If this bit is zero, the device is non-autosize. If one, the media is autosize.

Format on Non-Autosize Devices

If format determines that your device is non-autosize, format reads a description of the disk from the device descriptor module. The default values for the number of sides, number of tracks, sector size, and density are determined by the values in the descriptor. At this time, the default cluster size is set at one. format determines the media capacity by multiplying together the number of cylinders (PD_CYL), tracks (PD_TKS), and sectors per track (PD_SCT, PD_T0S). Because format calculates the device capacity in this way, the -t=<num> and -ss/-ds options can be used to affect the capacity of the device.

The following information is displayed before formatting begins:

```
            Disk Formatter
OS-9/68K V2.4   Delta MVME147 - 68030
------------  Format Data  ------------

Fixed values:
   Physical floppy size: 5 1/4"
                    (Universal Format)
          Sector size: 256
        Sectors/track: 16
    Track zero sect/trk: 16
         Sector offset: 1
          Track offset: 1
           LSN offset: $000000
Total physical cylinders: 80
 Minimum sect allocation: 8

Variables:
       Recording format: MFM all tracks
   Track density in TPI: 96
Number of log. cylinders: 79
     Number of surfaces: 2
Sector interleave offset: 1

Formatting device:  /d0
proceed?
```

You can change the values in the variables section when formatting floppy disks by command line options or by answering n to the prompt. format asks for any required options not given on the command line.

When formatting hard disks, answering n to the prompt returns control to the shell. You can change hard disk parameters only by command line options or by changing the device descriptor.

The values in the Fixed values section can only be changed by altering the device descriptor module of the specific unit.

Format on Autosize Devices

If format determines that the device has the autosize feature, format performs an SS_DSize SetStat call to the drive to request the capacity of the device. Typically, the driver then queries the actual drive. The value returned to format is the capacity of the device. Because format performs no calculations when determining the capacity, the -t and -ss/-ds options do not affect the capacity of the device.

The following information is displayed before formatting commences:

```
          Disk Formatter
OS-9/68K V2.4   Delta MVME147 - 68030
------------  Format Data  ------------

Fixed values:
          Disk type: hard
         Sector size: 512
       Disk capacity: 208936 sectors
                (106975232 bytes)
       Sector offset: 0
        Track offset: 0
          LSN offset: $000000
Minimum sect allocation: 8

Variables:
Sector interleave offset: 1

Formatting device:  /h1
proceed?
```

When formatting hard disks, answering n to the prompt returns control to the shell. You can only change the sector interleave offset. The other values cannot be changed by the format utility.

The values in the Fixed values section can only be changed by altering the device descriptor module of the specific unit.

Continuing the Format Procedure

The formatting process works as follows:

- ¿ The disk surface is physically initialized and sectored.
- ¡ Each sector is read back and verified. If the sector fails to verify after several attempts, the offending sector is excluded from the initial free space on the disk. As the verification is performed, track numbers are displayed on the standard output device for non-autosize devices; logical sector numbers are displayed for autosize devices.
- ¬ The disk allocation map, root directory, and identification sector are written to the first few sectors of track zero. These sectors cannot be defective.

NOTE: format uses a ***fast verify*** mode. This means that format reads a minimum of 32 sectors. If the cluster size is greater than 32 sectors, then one cluster worth of sectors is read. If the cluster size is less than 32 sectors, 32 sectors are read. If you want format to use the cluster size regardless of the number of sectors per cluster, you must use the -nf option. For example, if your cluster size has one sector, 32 sectors are read by default, while only one sector would be read if you specify -nf.

NOTE: You must run os9gen to create the bootstrap after the disk has been formatted if you use the disk as a system disk,

OPTIONS:

-?	Displays the options, function, and command syntax of format.
-c=<num>	Specifies the number of sectors per cluster. <num> must be decimal and must be a power of 2. The default is 1.
-dd	Double density (floppy) disk
-ds	Double sided (floppy) disk
-e	Displays elapsed verify time. This is useful for checking the sector interleave values.
-i=<num>	Specifies the number for sector interleave offset value. <num> is decimal.
-nf	Specifies no fast verify mode.
-np	Specifies no physical format.
-nv	Specifies no physical verification.
-r	Inhibits the ready prompt. This option is ignored if the device is a hard disk. This makes it necessary to explicitly state that you want to format a hard disk.
-sd	Single density (floppy) disk
-ss	Single sided (floppy) disk
-t=<num>	Specifies the number of cylinders given in decimal.
-v=<name>	Volume name. This name can be 32 characters maximum. **NOTE:** If the name contains blanks, enclose the option and name with quotation marks. For example, "-v=Name of disk".

EXAMPLES:

```
$ format /D1 -dsdd -v="database" -t=77

$ format /D1 -sssd -r
```

free — Display Free Space Remaining on a Mass-Storage Device

SYNTAX: **free [<opts>] {<devname>}**

FUNCTION: free displays the number of unused 256-byte sectors on a device available for new files or for expanding existing files. free also displays the disk's name, creation date, cluster size, and largest free block in bytes.

To use the free utility, type free followed by the name of the device to examine. The device name must be the name of a mass-storage, multi-file device.

Data sectors are allocated in groups called ***clusters***. The number of sectors per cluster depends on the storage capacity and physical characteristics of the specific device. This means that small amounts of free space, given in sectors, may not be divisible into the same number of files.

For example, a given disk system uses 8 sectors per cluster. A free command shows the disk has 32 sectors free. Because memory is allocated in clusters, a maximum of four new files could be created even if each had only one sector.

OPTIONS:

-?	Displays the option, function, and command syntax of free.
-b=<num>	Uses the specified buffer size.

EXAMPLE:

```
$ free
"Tazz: /H0 Wren V" created on: Oct 6, 1990
Capacity: 2347860 sectors (256-byte sectors, 8-sector clusters)
1508424 free sectors, largest block 1380120 sectors
386156544 of 601052160 bytes (368.26 of 573.20 Mb) free on media (64%)
353310720 bytes (336.94 Mb) in largest free block
```

frestore — Directory Backup Restoration

SYNTAX: **frestore [<opts>] [<path>]**

FUNCTION: frestore restores a directory structure from multiple volumes of tape or disk media.

Typing frestore by itself on the command line attempts to restore a directory structure from the device /mt0 to the current directory. Specifying the pathlist of a directory on the command line causes the files to be restored in the specified directory. fsave creates the directory structure and an index of the directory structure.

If more than one tape/disk is involved in the fsave backup, each tape/disk is considered a different volume. The volume count begins at one (1). When you begin a frestore operation, you must use the last volume of the backup first. The last volume of the backup contains the index of the entire backup.

frestore first attempts to locate and read in the index of the directory structure from the source device. The device you are restoring from is the source device. It then begins an interactive session with you to determine which files and directories in the backup should be restored to the current directory. The -s option forces frestore to restore all files/directories of the backup from the source device without the interactive shell.

The -d option allows you to specify a source device other than /mt0.

The -v option causes frestore to identify the name and volume number of the backup mounted on the source device. It also displays the date the backup was made and the group.user number of the person who made the backup. This option does not restore any files. After displaying the appropriate information, frestore terminates. This is helpful for locating the last volume of the backup if a mix-up has occurred. The -i option duplicates the -v option and also checks to see if the index is on the volume being checked.

The -e option echoes each file pathlist as the index is read off the source device.

CAVEATS: frestore cannot restore a file that requires more than four disks.

If the backup index requires more than a single volume, frestore fails with a header block corrupt error.

NOTE: For a full description of the fsave, frestore, and tape utilities, read the chapter on making backups. The information in the chapter on making backups includes work-through examples and backup strategies for disk and tape.

OPTIONS: -? Displays the options, function, and command syntax of frestore.

-a	Forces access permission for overwriting an existing file. You must be the owner of the file or a super user (0.n) to use this option.
-b[=]<int>	Specifies the buffer size used to restore the files.
-c	Checks the validity of files without the interactive shell.
-d[=]<path>	Specifies the source device. The default source device is /mt0.
-e	Displays the pathlists of all files in the index as the index is read from the source device.
-f[=]<path>	Restores from a file.
-i	Displays the backup name, creation date, group.user number of the owner of the backup, volume number of the disk or tape, and whether the index is on the volume. This option will not restore any files. The information is displayed, and frestore is terminated.
-j[=]<int>	Sets the minimum system memory request.
-p	Suppresses the prompt for the first volume.
-q	Overwrites already existing files when used with the -s option.
-s	Forces frestore to restore all files from the source device without an interactive shell.
-t[=]<dirpath>	Specifies an alternate location for the temporary index file.
-v	Displays the backup name, creation date, group.user number of the owner of the backup, and volume number of the disk or tape. This option will not restore any files. The information is displayed, and frestore is terminated.
-x[=]<int>	Pre-extends a temporary file. <int> is specified in kilobytes.

EXAMPLES: The following command restores files and directories from the source device /mt0 to the current directory by way of an interactive shell.

```
$ frestore
```

The next command restores files and directories from the source device /d0 to the current directory using a 32K buffer. As each file is read from the index, the file's pathlist is echoed to the terminal.

```
$ frestore -eb=32 -d=/d0
```

The next command restores all files/directories found on the source device /mt1 to the directory BACKUP without using the interactive shell.

```
$ frestore -d=/mt1 -s BACKUP
```

The following command displays the backup and the volume number:

```
$ frestore -v

Backup: DOCUMENTATION
Made:   11/30/90 10:10
By:     0.0
Volume: 0
```

This command does not restore the backup.

fsave — Incremental Directory Backup

SYNTAX: **fsave [<opts>] [<dir>]**

FUNCTION: fsave performs an incremental backup of a directory structure to tape(s) or disk(s).

Typing fsave by itself on the command line makes a level 0 backup of the current directory onto the target device /mt0.

Use the -l option to specify different backup levels. A higher level backup only saves files changed since the most recent backup with the next lower number. For example, a level 1 backup saves all files changed since the last level 0 backup.

The backup log file, /h0/sys/backup_dates, is updated each time an fsave is executed. The backup log keeps track of the name of the backup and the date it was created. More importantly, it keeps track of the level of the backup. When fsave is executed, this backup log is examined for the specified level of the current backup and the previous backups with the same name. Once the backup is finished, a new entry is entered in the file indicating the date, name, level, etc. of the current backup.

fsave does not accept a device name as a directory. For example, if fsave /ho is entered, error #216 is returned.

The Fsave Procedure

Upon starting an fsave procedure, fsave first builds the directory structure. You are then prompted to mount the first volume to use:

```
fsave: please mount volume.
(press return when mounted).
```

If a disk is used as the backup medium, fsave verifies the disk and displays the following information:

```
verifying disk

Bytes held on this disk: 546816
Total data bytes left:   62431
Number of Disks needed:  1
```

NOTE: The numbers above are used as an example. If a tape is used as the backup medium, the backup begins at this point.

As each file is saved to the backup device, its pathlist is echoed to the terminal. If this is a long backup, use the -e option to turn off the echoing of pathlists.

If fsave receives an error when trying to backup a file, it displays a message and continues the fsave operation.

If the backup requires more than one volume, fsave prompts you to mount the next volume before continuing.

At the end of the backup, fsave prints the following information:

```
fsave: Saving the index structure

Logical backup name:
Date of backup:
Backup made by:
Data bytes written:
Number of files:
Number of volumes:
Index is on volume:
```

By specifying one or more directories on the command line, fsave performs recursive backups for each specified pathlist. You can specify a maximum of 32 directories on the command line.

Use the -d option to specify an alternative target device. The default device is /mt0.

Use the -m option to specify an alternative backup log file. The default pathlist is /h0/sys/backup_dates.

WARNING: When using disks for backup purposes, be aware that fsave does not use an RBF file structure to save the files on the target disk. It creates its own file structure. This makes the backup disk unusable for purposes other than fsave and frestore without reformatting. Any data on the disk before using fsave is destroyed by the backup.

NOTE: For a full description of the fsave, frestore, and tape utilities, read the chapter on backups in this manual. The information in the chapter on backups includes work through examples and backup strategies for disk and tape.

OPTIONS:

-?	Displays the options, function, and command syntax of fsave.
-b[=]<int>	Allocates <int>k buffer size to read files from source disk.
-d[=]<dev>	Specifies the target device to store the backup. The default target device is /mt0.
-e	Does not echo the file pathlist as it is saved to the target device.
-f[=]<path>	Saves to a file.
-g[=]<int>	Specifies a backup of files owned by group number <int> only.
-j[=]<num>	Specifies the minimum system memory request.
-l[=]<int>	Specifies the level of backup to be performed.
-m[=]<path>	Specifies the pathlist of the date backup log file to be used. The default is /h0/sys/backup_dates.
-p	Turns off the ***mount volume*** prompt for the first volume.
-s	Displays the pathlists of all files needing to be saved and the size of the entire backup without actually executing the backup procedure.
-t[=]<dirpath>	Specifies an alternate location for the temporary index file.
-u[=]<int>	Specifies a backup of files owned by user number <int> only.
-v	Does not verify the disk volume when mounted.
-x[=]<int>	Pre-extends the temporary file. <int> is specified in kilobytes.

EXAMPLES: The following command specifies a level 0 backup of the current directory. It assumes the device /mt0 is to be used. /h0/SYS/backup_dates is used as the backup log file.

```
$ fsave
```

This command specifies a level 2 backup of the current directory. The device /mt1 is used. /h0/misc/my_dates is used as the backup log file.

```
$ fsave -l=2 -d=/mt1 -m=/h0/misc/my_dates
```

The next command specifies a level 0 backup of all files owned by the super user in the CMDS directory, assuming CMDS is in your current directory. /d2 is the target device used for this backup. The backup log file used is /h0/sys/backup_dates. The mount volume prompt is not generated for the first volume, and a 32K buffer is used to read the files from the CMDS directory.

```
$ fsave -pb=32 -g=0 -u=0 -d=/d2 CMDS
```

grep — Search a File for a Pattern

SYNTAX: **grep [<opts>] [<expression>] {[<path>]}**

FUNCTION: grep searches the input pathlist(s) for lines matching <expression>.

To use the grep utility, type grep, the expression to search for, and the pathlist of the file to search. If no <path> is specified, grep searches standard input.

If grep finds a line that matches <expression>, the line is written to the standard output with an optional line number of where it is located within the file. When multiple files are searched, the output has the name of the file preceding the occurrence of the matched expression.

Expressions

An <expression> is used to specify a set of characters. A string which is a member of this set is said to match the expression. To facilitate the creation of expressions, some metacharacters are defined to create complex sets of characters. These special characters are:

Char	Name/Description
.	**ANY**. The period (.) is defined to match any ASCII character except new line.
~	**BOL** or **NEGATE**. The tilde (~) is defined to modify a character class as described above when located between square brackets ([ ]). At the beginning of an entire expression, it requires the expression to compare and match the string at only the beginning of the line. The **NEGATE** character modifies the character class so it matches any ASCII character *not* in the given class or newline.
[ ]	**CHARACTER CLASS**. The square brackets ([ ]) define a group of characters which match any single character in the compare string. grep recognizes certain abbreviations to aid the entry of ranges of strings: [a-z] Equivalent to the string abcdefghijklmnopqrstuvwxyz [m-pa-f] Equivalent to the string mnopabcdef [0-7] Equivalent to the string 01234567

Char	Name/Description
*	**CLOSURE**. The asterisk (*) modifies the preceding single character expression, so it matches zero or more occurrences of the single character. If a choice is available, the longest such group is chosen.
$	**EOL**. The dollar sign ($) requires the expression to compare and match the string only when located at the end of line.
\	**ESCAPE**. The backslash (\) removes special significance from special characters. It is followed by a base and a numeric value or a special character. If no base is specified, the base for the numeric value defaults to hexadecimal. An explicit base of decimal or hexadecimal can be specified by preceding the numeric value with a qualifier of d or x, respectively. It also allows entry of some non-printing characters such as: \t = Tab character \n = New-line character \l = Line feed character \b = Backspace character \f = Form feed character

Example Expressions

You can combine any metacharacters and normal characters to create an expression:

Expression	Same as
abcd	abcd
ab.d	abcd, abxd, ab?d, etc.
"ab *d"	“abd”, “ab d”, “ab d”, “ab d”, etc.
~abcd	abcd (only if very first characters on a line)
abcd$	abcd (only if very last characters on a line)
~abcd$	abcd (only if abcd is the complete line)
[Aa]bcd	abcd, Abcd
abcd[0-9a-zA-z]	abcd followed by any alphanumeric character
bcd[~a-d]	bcd followed by any ASCII char except a, b, c, d, or new line

OPTIONS:

-?	Displays the options, function, and command syntax of grep.
-c	Counts the number of matching lines.
-e=<expr>	Searches for <expr>. This is the same as <expression> in the command line.
-f=<path>	Reads the list of expressions from <path>.
-l	Prints only the names of the files with matching lines.
-n	Prints the relative line number within the file followed by the matched expression.
-s	Silent Mode. Does not display matching lines.
-v	Prints all lines except for those that match.
-z	Reads the file names from standard input.
-z=<path>	Reads the file names from <path>.

NOTES: -l and -n cannot be used at the same time. -n and -s cannot be used at the same time.

EXAMPLES: To write all lines of myfile that contain occurrences of xyz to standard output, enter:

```
$ grep xyz myfile
```

This example searches myfile for expressions input from words, counts the number of matches, and gives the line number found with each occurrence:

```
$ grep -f=words myfile -nc
```

help On-Line Utility Reference

SYNTAX: **help [<utility name>]**

FUNCTION: help displays information about a specific utility.

For information about a specific utility, type help and the name of the desired utility. help displays the function, syntax, and options of the utility. After the information is displayed, control returns to the shell.

For information about the help utility, type help by itself. help lists the syntax and function of the help utility.

NOTE: Built-in shell commands do not have help information.

EXAMPLES: **$ help build**

$ help attr

ident — Print OS-9 Module Identification

SYNTAX: **ident [<opts>] {<modname>}**

FUNCTION: ident displays module header information and the additional information that follows the header from OS-9 memory modules. ident also checks for incomplete module headers.

ident displays the following information in this order:

module size
owner
CRC bytes (with verification)
header parity (with verification)
edition
type/language, and attributes/revision
access permission

For program modules it also includes:

execution offset
data size
stack size
initialized data offset
offset to the data reference lists

ident prints the interpretation of the type/language and attribute/revision bytes at the bottom of the display.

With the exception of the access permission data, all of the above fields are self-explanatory. The access permissions are divided into four sections from right to left:

owner permissions
group permissions
public permissions
reserved for future use

Each of these sections are divided into four fields from right to left:

read attribute
write attribute
execute attribute
reserved for future use

If the attribute is turned on, the first letter of the attribute (r, w, e) is displayed.

All reserved fields are displayed as dashes unless the fields are turned on. In that case, the fields are represented with question marks. In any case, the kernel ignores these fields as they are reserved for future use.

Owner permissions allow the owner to access the module. Group permissions allow anyone with the same group number as the owner to access the module. Public permissions allow access to the module regardless of the group.user number. The following example allows the owner and the group to read and execute the module, but bars access to the public:

Permission: $55 ---------e-r-e-r

OPTIONS:

-?	Displays the options, function, and command syntax of ident.
-m	Searches for modules in memory.
-q	Quick mode. Only one line per module.
-s	Silent mode. Quick, but only displays bad CRCs.
-x	Searches for modules in the execution directory.
-z	Reads the module names from standard input.
-z=<file>	Reads the module names from <file>.

EXAMPLE:

```
$ ident -m ident
Header for:     ident
Module size:    $1562      #5474
Owner:          0.0
Module CRC:     $FA8ECA    Good CRC
Header parity:  $2471      Good parity
Edition:        $C         #12
Ty/La At/Rev:   $101       $8001
Permission:     $555       -----e-r-e-r-e-r
Exec. off:      $4E        #78
Data size:      $15EC      #5612
Stack size:     $C00       #3072
Init. data off: $1482      #4250
Data ref. off:  $151A      #5402
Prog mod, 68000 obj, Sharable
```

iniz — Attach Devices

SYNTAX: **iniz [<opts>] {<devname>}**

FUNCTION: iniz performs an I$Attach system call on each device name passed to it. This initializes and links the device to the system.

To attach a device to the system, type iniz and the name(s) of the device(s) to be ***attached*** to the system. OS-9 searches the system module directory using the name of the device to see if the device is already attached.

If the device is not already attached, an initialization routine is called to link the device to the system.

If the device is already attached, it is not re-initialized, but the link count is incremented.

The device names may be listed on the command line, read from standard input or read from a specified pathlist.

NOTE: Do not iniz non-sharable device modules as they become "busy" forever.

OPTIONS:

-?	Displays the options, function, and command syntax of iniz.
-z	Reads the device names from standard input.
-z=<file>	Reads the device names from <file>.

EXAMPLES:

$ iniz h0 term	Increments the link counts of modules h0 and term.
$ iniz -z	Increments the link count of any modules with names read from standard input.
$ iniz -z=/h0/file	Increments the link count of all modules whose names are supplied in /h0/file.

irqs — Display System's IRQ Polling Table

SYNTAX: **irqs**

FUNCTION: irqs displays a list of the system's IRQ polling table. The IRQ polling table contains a list of the service routines for each interrupt handler known by the system.

The irqs display header lists the system name, the OS-9 version number, the maximum number of devices allowed in the device table, and the maximum number of entries in the IRQ table.

Each line in the irqs display contains seven fields:

vector	Exception vector number used by the device. A second number, the hardware interrupt level, is displayed for auto-vectored interrupts.
prior	Software polling priority.
port addr	Base address of the interrupt generating hardware. The operating system does not use this value, but passes it to the interrupt service routine.
data addr	Address of the device driver's static storage.
irq svc	Interrupt service routine's entry point.
driver	Name of the module which contains the interrupt service routine, usually a device driver.
device	Name of the device descriptor. **NOTE:** If no device name is displayed, the entries relate to IRQ handlers that support "anonymous" devices (for example, the clock ticker, DMA devices associated with other peripherals).

OPTION: -? Displays the function and command syntax of irqs.

EXAMPLE: The following example displays the IRQ polling table for a system named Calvin:

```
$ irqs

Calvin    OS-9/68K V2.4    (max devs: 32, max irqs: 32)

 vector prior port addr data addr  irq svc    driver   device
------- ----- --------- --------- ---------  --------- ------
 68        0  $fffe1800 $00230b90 $00215084  am7990
 69        5  $fffe4000 $003bd560 $00012ad2  scsi147
 70        5  $fffe4000 $003bd560 $00012ad2  scsi147
 72        0  $fffe1000 $00000000 $0000ccda  tk147
 88        5  $fffe3002 $003be3f0 $0000dacc  sc8x30    term
 88        5  $fffe3000 $003bd300 $0000dacc  sc8x30    t1
 89        5  $fffe3800 $002044a0 $0000dacc  sc8x30    t3
 89        5  $fffe3802 $003bbeb0 $0000dacc  sc8x30    t2
 90        5  $ffff1001 $003bc560 $0000e6b6  sc68560   t4
 91        5  $ffff1041 $003bc120 $0000e6b6  sc68560   t5
255        5  $ffff8800 $00245a50 $002458e0  n9026     n0
```

SEE ALSO: F$IRQ system state service request in the ***OS-9 Technical Manual***

kill — Abort a Process

SYNTAX: **kill {<procID>}**

FUNCTION: kill is a built-in shell command. It sends a signal to ***kill*** the process having the specified process ID number. This unconditionally terminates the process.

To terminate a process, type kill and the ID number(s) of the process(es) to abort. The process must have the same user ID as the user executing the command. Use procs to obtain the process ID numbers.

If a process is waiting for I/O, it cannot die until it completes the current I/O operation. Therefore, if you kill a process and procs shows it still exists, the process is probably waiting for the output buffer to be flushed before it can die.

The command kill 0 kills all processes owned by the user.

NOTE: Because kill is a built-in shell command, it does not appear in the CMDS directory.

EXAMPLES:

```
$ kill 6 7
$ procs
 Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
  2   1  0.0   128   0.25k   0 w      0.01   ??? sysgo <>>>term
  3   2  0.0   128   4.75k   0 w      4.11 01:13 shell <>>>term
  4   3  0.0     5   4.00k   0 a   12:42.06 00:14 xhog <>>>term
  5   3  0.0   128   8.50k   0 *      0.08 00:00 procs <>>term
  6   0  0.0   128   4.00k   0 s      0.02 01:12 tsmon <>>>t1
  7   0  0.0   128   4.00k   0 s      0.01 01:12 tsmon <>>>t2
$ kill 4
$ procs
 Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
  2   1  0.0   128   0.25k   0 w      0.01   ??? sysgo <>>>term
  3   2  0.0   128   4.75k   0 w      4.11 01:13 shell <>>>term
  4   3  0.0   128   8.50k   0 *      0.08 00:00 procs <>>term
```

link — Link a Previously Loaded Module into Memory

SYNTAX: **link [<opts>] {<modname>}**

FUNCTION: link is used to ***link*** a previously loaded module into memory. To use this utility, type link and the name(s) of the module(s) to lock into memory. The link count of the module specified is incremented by one each time it is linked. Use unlink to unlink the module when it is no longer needed.

OPTIONS:

-?	Displays the options, function, and command syntax of link.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES:

$ link prog1 prog2 prog3

$ link -z=linkfile	Links modules from linkfile.
$ link -z	Links modules from standard input.

list — List the Contents of a Text File

SYNTAX: **list [<opts>] {<path>}**

FUNCTION: list displays text lines from the specified path(s) to standard output.

To use the list utility, type list and the pathlist. list terminates upon reaching the end-of-file of the last input path. If more than one path is specified, the first path is copied to standard output, the second path is copied next, etc. Each path is copied to standard output in the order specified on the command line.

list is most commonly used to examine or print text files.

OPTIONS:

-?	Displays the options, function, and command syntax of list.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES: To redirect the startup listing to the printer and place the entire command in the background, enter:

```
$ list /d0/startup >/P&
```

The following example lists text from files to standard output in the same order as the command line:

```
$ list /D1/user5/document /d0/myfile /d0/Bob/text
```

To list all files in the current data directory, enter:

```
$ list *
```

The following example reads the name(s) of the file(s) to list from namefile and lists their contents.

```
$ list -z=namefile
```

load — Load Module(s) from File into Memory

SYNTAX: **load [<opts>] {<path>}**

FUNCTION: load loads one or more modules specified by <path> into memory.

Unless a full pathlist is specified, <path> is relative to your current execution directory. Consequently, if the module to load is in your execution directory, you only need to enter its name:

load <file>

If <file> is not in your execution directory and if the shell environment variable PATH is defined, load searches each directory specified by PATH until <file> is successfully loaded from a directory. This corresponds to the shell execution search method using the PATH environment variable. By using the -l option, load prints the pathlist of the successfully loaded file.

The names of the modules are added to the module directory. If a module is loaded with the same name as a module already in memory, the module having the highest revision level is kept.

File Security

The OS-9 file security mechanism enforces certain requirements regarding owner and access permissions when loading modules into the module directory.

You must have file access permission to the file to be loaded. If the file is loaded from an execution directory, the execute permission (e) must be set. If the file is loaded from a directory other than the execution directory and the -d option is specified, only the read permission (r) is required.

NOTE: Unless the file has public execute and/or public read permission, only the owner of the file or a super user can load the file. Use the dir -e command to examine a file's owner and access permissions.

You must have module access permission to the file being loaded. This is not to be confused with the file access permission. The module owner and access permissions are stored in the module header; use ident to examine them. To prevent ordinary users from loading super user programs, OS-9 enforces the following restriction: if the module group ID is zero (super group), then the module can be loaded only if the process' group ID and the file's group ID is also zero.

If you are not the owner of a module and not a super user, the public execute and/or read access permissions must be set. The module access permissions are divided into three

groups: the owner, the group, and the public. Only the owner of the module or a super user can set the module access permissions.

OPTIONS:

-?	Displays the options, function, and command syntax of load.
-d	Loads the file from your current data directory, instead of your current execution directory.
-l	Prints the pathlist of the file to be loaded.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLE:

```
$ mdir
   Module Directory at 14:44:35
kernel    init     p32clk    rbf      p32hd
h0        p32fd    d0        d1       ram
r0        dd       mdir

$ load edit

$ mdir
   Module Directory at 14:44:35
kernel    init     p32clk    rbf      p32hd
h0        p32fd    d0        d1       ram
r0        dd       edit      mdir
```

login — Timesharing System Login

SYNTAX: **login [<name>] [,] [<password>]**

FUNCTION: login is used in timesharing systems to provide login security. It is automatically called by the timesharing monitor tsmon, or you can explicitly invoke it after the initial login to change a terminal's user.

login requests a user name and password, which is checked against a validation, or password file. If the information is correct, the user's system priority, user ID, and working directories are set up according to information stored in the file. The initial program specified in the password file is also executed. This initial program is usually the shell. The date, time, and process number are also displayed.

If you cannot supply a correct user name and password after three attempts, the login attempt is aborted.

NOTE: If the shell from which you called login is not needed again, you may discard it using the ex utility to start the login command: ex login.

To log off the system, you must terminate the initial program specified in the password file. For most programs, including shell, you can do this by typing an end-of-file character (escape) as the first character on a line.

If the file SYS/motd exists, a successful login displays the contents of motd on your terminal screen.

The Password File

The password file must be present in the SYS directory being used: /h0/SYS, /d0/SYS, etc. The file contains one or more variable-length text entries; one for each user name. These entries are not shell command lines. Each entry has seven fields. Each field is delimited by a comma. The fields are:

- ¿ **User name.** This field may be up to 32 characters long. It cannot include spaces. The user name may not begin with a number, a period, or an underscore, but these characters may be used elsewhere in the name. If this field is empty, any name matches.

- ¡ **Password.** This field may contain up to 32 characters including spaces. If this field is omitted, no password is required for the specified user.

- ¬ **Group.User ID number.** This field allows 0 to 65535 groups and 0 to 65535 users. 0.n is the super user. The file security system uses this number as the system-wide user ID to identify all processes initiated by the user. The system manager should assign a unique ID to each potential user.

- Ð **Initial process priority:** The initial process priority can be from 1 to 65535.

- *f* **Initial execution directory pathlist**. The initial execution directory is usually /d0/CMDS. Specifying a period (.) for this field defaults the initial execution directory to the CMDS file located in the current directory, usually /h0 or /d0.

- Ý **Initial data directory pathlist**. This is the specific user directory. Specifying a period (.) for this field defaults to the current directory.

- ý **Initial Program.** The name and parameters of the program to initially execute. This is usually shell.

Sample Password File:

```
superuser,secret,0.0,255,.,.,shell -p="@howdy"
brian,open sesame,3.7,128,../d1/STEVE,shell
sara,jane,3.10,100,/d0/BUSINESS,/d1/LETTERS,wordprocessor
robert,,4.0,128,./d1/ROBERT,Basic
mean_joe,midori,12.97,100,Joe,Joe,shell
```

Using password file entries, login sets the following shell environment variables. Programs can examine these environment variables to determine various characteristics of the user's environment:

Name	Description

HOME	Initial data directory pathlist
SHELL	Name of the initial program executed
USER	User name
PATH	Login process' initial execution directory. If a period (.) is specified, PATH is not set.

NOTE: Environment variables are case sensitive.

To show how login uses the password file to set up environment variables, examine the previous sample password file. Assume login's data and execution directories are /h0 and /h0/CMDS, respectively, logging in as mean_joe executes a shell with the data directory of /h0/Joe and the execution directory of /h0/CMDS/Joe. The environment variables passed to the shell are set as follows:

```
HOME=/h0/Joe
SHELL=shell
USER=mean_joe
PATH=/H0/Cmds
```

OPTION: -? Displays the function and command syntax of login.

logout — Timesharing System Logout

SYNTAX: logout

FUNCTION: logout terminates the current shell. If the shell to terminate is the login shell, logout executes the .logout procedure file before terminating the shell.

To terminate the current shell, type logout and a carriage return. This terminates the current shell in the same manner as an end-of-file character, with one exception. If the shell to be terminated is the login shell, logout executes the procedure file .logout. The login shell is the initial shell created by the login utility when you log on the system. In order for logout to execute the .logout file, .logout must be located in the directory specified by the HOME environment variable.

EXAMPLE:

```
3.lac list .logout
procs
wait
date
echo "see you later. . ."
3.lac logout
2.lac logout
1.lac logout
 Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
  2   1   0.0   128    0.25k   0 w       0.01   ??? sysgo <>>>term
  3   2   0.0   128    4.75k   0 w       4.11 01:13 shell <>>>term
  4   3   0.0   128    8.50k   0 *       0.08 00:00 procs <>>term
  5   0   0.0   128    4.00k   0 s       0.02 01:12 tsmon <>>>t1
July 7, 1989 11:59 pm
see you later . . .
```

makdir — Create a Directory File

SYNTAX: **makdir [<opts>] {<path>}**

FUNCTION: makdir creates a new directory file specified by the given pathlist.

To create a new directory, type makdir and the pathlist specifying the new directory. You must have write permission for the new directory's parent directory. The new directory is initialized and does not initially contain files except for the pointers to itself (.) and its parent directory (.). All access permissions are enabled except single use, or non-sharable.

It is an OS-9 convention to capitalize directory names to distinguish them from lower case file names. This is not required; it is just a convention.

OPTIONS:

-?	Displays the options, function, and command syntax of makdir.
-x	Creates the directory in the execution directory.
-z	Reads the directory names from standard input.
-z=<file>	Reads the directory names from <file>.

EXAMPLES:

```
$ makdir /d1/STEVE/PROJECT
$ makdir DATAFILES
$ makdir ../SAVEFILES
$ makdir RED GREEN BLUE ../PURPLE
```

make — Maintain, Update, and Regenerate Groups of Programs

SYNTAX: **make [<opts>] [<target>] {[<target>]} [<macros>]**

FUNCTION: make determines whether a file needs to be updated. It examines the dates of the target file and the files used to create the target file. If make determines that the file must be updated, it executes specified commands to re-create the file. make has several built-in assumptions specifically designed for compiling high-level language programs; however, you may use make to maintain any files dependent on updated files.

make executes commands from a special type of procedure file called a ***makefile***. The makefile describes the dependent relationships between files used to create the <target> file(s). A makefile may describe the commands to create many files. If make is invoked without a target file on the command line, make attempts to make the first target file described in the makefile. If one or more target file's are entered on the command line, make reads and processes the entire makefile and only attempts to make the appropriate file(s).

A makefile contains three types of entries:

¿ ***Dependency Entry:*** This specifies the relationship of a target file and the file(s) used to build the target file. The entry has the following syntax:

<target>:[[<file>],<file>]

The list of files following the target file is known as the ***dependency list***.

¡ ***Command Entry:*** This specifies the command that you must execute to update a particular target file, if the target file needs to be updated. make updates a target file only if it depends on files newer than itself.

If no instructions for update are provided, make attempts to create a command entry to perform the operation. make recognizes a command entry by a line beginning with one or more spaces or tabs. Any legal OS-9 command line is acceptable. You can list more than one command entry for any dependency. Each command is forked separately unless continued from the previous command with a backslash (\). Do not intersperse comments with commands. For example:

```
<target>:[[<file>],<file>]
    <OS-9 command line>
    <OS-9 command line>
```

- ***Comment Entry:*** This consists of any line beginning with an asterisk (*). All characters following a pound sign (#) are also ignored as comments with one exception: a digit following a pound sign is considered part of a command entry. All blank lines are ignored. For example:

  <target>:[[<file>],<file>]

  *** the following command will be executed if the dependent**
  *** files are newer than the target file**
  <OS-9 command line> # this is also a comment line

You may continue entries on the next line by placing a space followed by a backslash (\) at the end of each line to continue. If a command line is continued, a space or tab must be the first character in the continued line. With non-command lines, leading spaces and tabs are ignored on continuation lines. Entries longer than 256 characters must be continued on the next line. For example:

**FILES = aaa.r bbb.r ccc.r ddd.r eee.r fff.r ggg.r **
hhh.r iii.r jjj.r

make starts by reading the entire makefile and setting up a table of dependencies exactly as listed in the makefile. When make encounters a name on the left side of a colon, it first checks to see if it has encountered the name before. If it has, make connects the lists and continues.

After reading the makefile, make determines the target file(s). The target file is the main file to be made on the list. It then makes a second pass through the dependency table. During the second pass, make looks for object files with no relocatable files in their dependency lists and for relocatable files with no source files in their dependency lists. This facilitates program compilation. If make needs to find any source files or relocatable files to complete the dependency lists, it looks for them in the specified data directory, unless a macro is specified.

make does a third pass through the list to get the file dates and compare them. When make finds a file in a dependency list that is newer than its target file, it executes the specified command(s). If no command entry is specified, a command is generated based on the assumptions given in the next section. Because OS-9 only stores the time down to the closest minute, make remakes a file if its date matches one of its dependents.

When a command is executed, it is echoed to standard output unless the -s, or silent, option is used or the command line starts with an "at" sign (@). When the -n option is used, the command is echoed to standard output but is not actually executed.

If your system runs out of memory while executing a command, you can redirect the output of make into a procedure file and execute the procedure file.

make normally stops if an error code is returned when a command line is executed. Errors are ignored if the -i option is used or a command line begins with a hyphen.

Sometimes, it is helpful to see the file dependencies and the dates associated with each of the files in the list. The -d option turns on the make debugger and gives a complete listing of the macro definitions, a listing of the files as it checks the dependency list, and all the file modification dates. If it cannot find a file to examine its date, it assumes a date of -1/00/00 00:00, indicating the necessity to update the file.

To update the date on a file without remaking it, use the -t option. make merely opens the file for update and then closes it, thus making the date current.

If you are quite explicit about your makefile dependencies and do not want make to assume anything, use the -b option to turn off the built-in rules governing implicit file dependencies.

Implicit Rules, Definitions, and Assumptions

Any time a command line is generated, make assumes the target file is a program to compile. Therefore, if the target file is not a program to compile, make sure the command entries are included for each dependency list. make uses the following definitions and rules when forced to create a command line.

Object Files: Files with no suffixes. An object file is made from a relocatable file and is linked when it needs to be made.

Relocatable Files: Files appended by the suffix .r. Relocatable files are made from source files and are assembled or compiled if they need to be made.

Source Files: Files having one of the following suffixes: .a, .c, .f, or .p.

Default Compiler: cc

Default Assembler: r68

Default Linker: cc

Default Directory for All Files: current data directory (.)

NOTE: Only use the default linker with programs that use Cstart.

Macro Recognition

make recognizes a macro by the dollar sign ($) character in front of the name. If a macro name is longer than a single character, the entire name must be surrounded by parentheses. For example, $R refers to the macro R, $(PFLAGS) refers to the macro PFLAGS, $(B) and $B refer to the macro B, and $BR is interpreted as the value for the macro B followed by the character R.

Macros may be placed in the makefile for convenience or on the command line for flexibility. Everywhere the macro name appears, the expansion is substituted for it. Macros are allowed in the form of <macro name> = <expansion>.

NOTE: If a macro is defined in your makefile and then redefined on the command line, the command line definition overrides the definition in the makefile. This feature is useful for compiling with special options.

In order for make to be more flexible, you can define special macros in the makefile. make uses these macros when assumptions must be made in generating command lines or searching for unspecified files. For example, if no source file is specified for program.r, make searches the specified directory, SDIR, or ".", for program.a (or .c, .p, .f).

make recognizes the following special macros:

Macro	Definition
ODIR=<path>	make searches the directory specified by <path> for all files that have no suffix or relative pathlist. If ODIR is not defined in the makefile, make searches the current directory by default.
SDIR=<path>	make searches the directory specified by <path> for all source files not specified by a full pathlist. If SDIR is not defined in the makefile, make searches the current directory by default.
RDIR=<path>	make searches the directory specified by <path> for all relocatable files not specified by a full pathlist. If RDIR is not defined, make searches the current directory by default.
CFLAGS=<opts>	These compiler options are used in any necessary compiler command lines.
RFLAGS=<opts>	These assembler options are used in any necessary assembler command lines.
LFLAGS=<opts>	These linker options are used in any necessary linker command lines.
CC=<comp>	make uses this compiler when generating command lines. The default compiler is cc.
RC=<asm>	make uses this assembler when generating command lines. The default assembler is r68.
LC=<link>	make uses this linker when generating command lines. The default linker is cc.

Some reserved macros are expanded when a command line associated with a particular file dependency is forked. These macros may only be used on a command line. They are useful when you need to be explicit about a command line but have a target program with several dependencies.

In practice, these reserved macros are wildcards with the following meanings:

Macro	Definition
$@	Expands to the name of the file made by the command.
$*	Expands to the prefix of the file made.
$?	Expands to the list of files found to be newer than the target on a given dependency line.

Make Generated Command Lines

make is capable of generating three types of command lines:

¿ Compiler Command Lines: These are generated if a source file with a suffix of .c, .f, or .p needs to be recompiled. The compiler command line generated by make has the following syntax:

$(CC) $(CFLAGS) -r=$(RDIR) $(SDIR)/<file>[.c, .f, or .p]

¡ Assembler Command Lines: These are generated if an assembly language source file needs to be re-assembled. The assembler command line generated by make has the following syntax:

$(RC) $(RFLAGS) $(SDIR)/<file>.a -o=$(RDIR)/<file>.r

¬ Linker Command Lines: These are generated if an object file needs to be relinked in order to re-make the program module. The linker command line generated by make has the following syntax:

$(LC) $(LFLAGS) $(RDIR)/<file>.r -f=$(ODIR)/<file>

WARNING: When make is generating a command line for the linker, it looks at its list and uses the first relocatable file it finds, but only the first one. For example:

prog: x.r y.r z.r

would generate

cc x.r, not **cc x.r y.r z.r** or **cc prog.r**

OPTIONS:

-?	Displays the options, function, and command syntax of make.
-b	Does not use built-in rules.
-bo	Does not use built-in rules for object files.
-d	Debug Mode. Prints the dates of the files in the makefile.
-dd	Double debug mode, very verbose.
-f-	Reads the makefile from standard input.
-f=<path>	Specifies <path> as the makefile. If <path> is specified as a hyphen (-), make commands are read from standard input.
-i	Ignores errors.
-n	Does not execute commands, but does display them.
-s	Silent Mode. Executes commands without echo.
-t	Updates the dates without executing commands.
-u	Does the make regardless of the dates on files.
-x	Uses the cross-compiler/assembler.
-z	Reads a list of make targets from standard input.
-z=<path>	Reads a list of make targets from <path>.

Options may be included on the command line when running make, or they may be included in the makefile for convenience.

CAVEAT: The make language is highly specific. Therefore, use caution when using dummy files with names like print.

CAVEAT: make is always case-dependent with respect to directory names and file names.

Unless a file is specifically an object file or the -b option is used to turn off the implicit rules, use a suffix for your dummy files. For example, use print.file and xxx.h for your header files.

mdir — Display Module Directory

SYNTAX: **mdir [<opts>] [<modname>]**

FUNCTION: mdir displays the present module names in the system module directory. The system module directory contains all modules currently resident in memory. By specifying individual module names, only specified modules are displayed if resident in memory.

If you use the -e option, an extended listing of the physical address, size, owner, revision level, user count, and the type of each module is displayed.

The module type is listed using the following mnemonics:

Mnemonic	Type of Module
Prog	Program Module
Subr	Subroutine Module
Mult	Multi Module
Data	Data Module
Trap	Trap Handler Module
Sys	System Module
FMan	File Manager
Driv	Device Driver Module
Desc	Device Descriptor Module

NOTE: User-defined modules not corresponding with this list are displayed by their number.

By using the -a option, the language of each module is displayed instead of the type in an extended listing. The language field uses the following mnemonics:

Mnemonic	Module Language
Obj	68000 Machine Code
Bas	Basic09 I Code
Pasc	Pascal I Code
C	C I Code
Cobl	Cobol I Code
Fort	Fortran I Code

NOTE: If the language field is inappropriate for the module, a blank field is displayed. For example, d0, t1, or init.

WARNING: Not all modules listed by mdir are executable as processes; always check the module type code to make sure it is executable before executing an unfamiliar module.

OPTIONS:

-?	Displays the options, function, and command syntax of mdir.
-a	Displays the language field instead of the type field in an extended listing.
-e	Displays the extended module directory.
-t=<type>	Displays only the modules of the specified type.
-u	Displays an unformatted listing used for piping the output etc.

EXAMPLES: To save space, the following examples are fairly incomplete. Module directories are generally much larger.

```
$ mdir
   Module Directory at 15:32:38

kernel    syscache   ssm       init      tk147
rtclock   rbf

$ mdir -e
 Addr     Size     Owner    Perm Type Revs  Ed #  Lnk  Module name
-------- -------- ----------- ---- ---- ---- ----- ----- --------------
00006f00    27562     0.0     0555 Sys  a000    83     2 kernel
0000daaa      368     0.0     0555 Sys  a000    10     1 syscache
0000dc1a     1682     0.0     0555 Sys  a000    29     1 ssm
0000e2ac      622     0.0     0555 Sys  8000    20     0 init
0000e51a      322     0.0     0555 Sys  a000     7     1 tk147
0000e65c      494     0.0     0555 Subr a000     8     0 rtclock
0000e84a     8952     0.0     0555 Fman e000    79    26 rbf

$ mdir -ea
 Addr     Size     Owner    Perm Lang Revs  Ed #  Lnk  Module name
-------- -------- ----------- ---- ---- ---- ----- ----- --------------
00006f00    27562     0.0     0555 Obj  a000    83     2 kernel
0000daaa      368     0.0     0555 Obj  a000    10     1 syscache
0000dc1a     1682     0.0     0555 Obj  a000    29     1 ssm
0000e2ac      622     0.0     0555      8000    20     0 init
0000e51a      322     0.0     0555 Obj  a000     7     1 tk147
0000e65c      494     0.0     0555 Obj  a000     8     0 rtclock
0000e84a     8952     0.0     0555 Obj  e000    79    26 rbf
```

merge — Copy and Combine Files to Standard Output

SYNTAX: **merge [<opts>] {<path>}**

FUNCTION: merge copies multiple input files specified by <path> to standard output. merge is commonly used to combine several files into a single output file.

Data is copied in the order the pathlists are specified on the command line. merge does no output line editing such as automatic line feed. The standard output is generally redirected to a file or device.

OPTIONS:

-?	Displays the options, function, and command syntax of merge.
-b=<num>	Allocates a <num>k buffer size for use by merge. The default memory size is 4K.
-x	Searches the current execution directory for files to be merged.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES:

```
$ merge compile.list asm.list >/p

$ merge file1 file2 file3 file4 >combined.file -b=32k

$ merge -x load link copy >Utils1

$ merge -z=/h0/PROGS/file1 >merged_files
```

mfree — Display Free System RAM

SYNTAX: **mfree [<opts>]**

FUNCTION: mfree displays a list of areas in memory not presently in use and available for assignment. The address and size of each free memory block are displayed.

OPTIONS:

-? Displays the option, function, and command syntax of mfree.

-e Displays an extended free memory list.

EXAMPLES:

```
$ mfree
Current total free RAM: 1392.00 K-bytes

mfree -e
Minimum allocation size:      4.00 K-bytes
Number of memory segments:  25
Total RAM at startup:      4095.00 K-bytes
Current total free RAM:    1392.00 K-bytes

Free memory map:

  Segment Address       Size of Segment
 ----------------  --------------------------
    $55000         $7000        28.00 K-bytes
    $6A000         $B000        44.00 K-bytes
    $80000         $8A000      552.00 K-bytes
    $10E000        $1A000      104.00 K-bytes
    $12F000        $1E000      120.00 K-bytes
    $151000        $60000      384.00 K-bytes
    $1B5000        $2000         8.00 K-bytes
    $1B8000        $E000        56.00 K-bytes
    $1DE000        $1000         4.00 K-bytes
    $208000        $4000        16.00 K-bytes
    $21C000        $5000        20.00 K-bytes
    $245000        $1000         4.00 K-bytes
    $249000        $1000         4.00 K-bytes
```

moded — Edit OS-9 Modules

SYNTAX: **moded [<opts>] [<path>]**

FUNCTION: moded is used to edit individual fields of certain types of OS-9 modules. Currently, you can use moded to change the Init module and any OS-9 device descriptor module. moded can edit modules which exist in their own files and modules which exist among other modules in a single file such as a bootstrap file. moded updates the module's CRC and header parity if changes are made.

Regardless of how you invoke moded, you always enter the editor's command mode. This is designated by the moded: prompt.

If no parameters are specified on the moded command line, no current module is loaded in memory.

If a file is specified on the command line, it is assumed to contain a module of the same name. This module is loaded into the editor's buffer and becomes the ***current*** module.

If the -f option is used, the specified file is loaded into the editor's memory. If a module of the same name exists in the file, it becomes the current module. If no such module exists, there is no current module.

If the -f option is used and a module name is specified on the command line, the specified module becomes the current module.

The following commands may be executed from command mode:

Command	Description
e(dit)	Edits the current module.
f(ile)	Opens a file of modules.
l(ist)	Lists the contents of the current module.
m(odule)	Finds a module in a file.
w(rite)	Updates the module CRC and writes to the file.
q(uit)	Returns to the shell.
$	Calls the OS-9 shell.
?	Prints this help message.

Once moded is invoked, it attempts to read the moded.fields file. This file contains module field information for each type of module to edit. Without this file, moded cannot function.

moded searches for moded.fields in the following directories in this order:

- Search device /dd first.
- Search the default system device, as specified in the Init module (M$SysDev). If the Init module cannot be linked to, the SYS directory is searched for on the current device.

If this file cannot be found, an error is returned.

Selecting the Current Module

If you do not specify a module or file on the command line, you may open a module or file from command mode using the e or f commands, respectively. The e command prompts for a file name and a module name if different from the file name. This module then becomes the current module.

The f command prompts for the name of a file containing one or more modules. If a module in the file has the same name as the file, it becomes the current module by default. Use the m command to change the current module.

Edit Mode

To edit the current module, use the e command. If there is no current module, the editor prompts for the module name to edit. The editor prints the name of a field, its current value, and prompts for a new value. At this point, you can enter any of the following edit commands:

Command	Description
<expr>	A new value for the field.
-	Re-displays the last field.
.	Leaves the edit mode.
?	Prints the edit mode commands.
??	Prints a description of the current field.
<cr>	Leaves the current value unchanged.

If the definition of any field is unfamiliar, use the ?? command for a short description of the current field.

Once you have made all necessary changes to the module, exit edit mode by reaching the end of the module or by typing a period. At this point, the changes made to the module exist only in memory. To write the changes to the actual file, use the w command. This also updates the module header parity and CRC.

Listing Module Fields

To examine the field values of the current module, use the l command. This displays a formatted list of the field names and their values.

The Moded.fields File

The moded.fields file consists of descriptions of specific types of modules. Each module description consists of three parts: the module type, the field descriptor, and the description lines. Comments may be interspersed throughout the file by preceding the comment line with an asterisk. For example:

```
* this is a comment line
* it may appear anywhere in the moded.fields file
```

¿ ***The Module Type:*** This is a single line consisting of the module type as specified in M$Type in the module header and the device type as specified in PD_DTP in the device descriptor. Both values are specified as decimals and are separated from each other by a comma. The module type line is the only line which begins with a pound sign (#). The following example line describes an RBF device descriptor module:

```
#15,1
```

Two module type values are accepted:

Value	Description
12	System Module (Init module only)
15	Device Descriptor Module

The device type value is only used when a device descriptor module is being described. The following device type values are accepted:

Value	Description
0	SCF
1	RBF
2	PIPE
3	SBF
4	NET
6	UCM
11	GFM

¡ ***The Field Descriptor:*** This consists of two lines. The first is a textual description of the module field; the baud rate, parity. and descriptor name. moded uses this description as a prompt to change this field's value.

The second line has the following format:

<type>,<offset>,<base>,<value>[,<name>]

<type> specifies the field size in bytes. This is a decimal value. The following values are accepted:

1	byte
2	word
3	3 byte value
4	long word
5	long word offset to a string
6	word offset to a string

<offset> specifies the offset of the field from the beginning of the module. This is a hexadecimal value. **NOTE:** For device-specific fields (see <name> below), this offset is the offset of the field within the DevCon section of the descriptor (and not the module start).

<base> specifies the numeric base in which the field value is displayed in moded. The following bases are supported:

0	ASCII
8	Octal
10	Decimal
16	Hexadecimal

<value> specifies the default value of the field. This is currently unused; set it to zero.

<name> specifies the driver name for this and each field description that follows until a new <name> is specified or a module type line is encountered. This field is optional. For example, <name> allows descriptors with DevCon sections specific to certain drivers to be edited.

The following lines describe a "descriptor name" field:

descriptor name
5,c,0,0

The field consists of a long-word offset to a string. It is offset 12 bytes from the beginning of the module. The display base is in ASCII.

- ***Description Lines:*** After the Field Descriptor lines, you can use any number of lines to describe the field. This description is displayed when the edit mode command, ??, is used. Each description line must begin with an exclamation point (!) to differentiate it from a Field Descriptor. These lines are optional, but they are useful when editing uncertain module fields. The following lines might be used to describe the example used for the Field Descriptor:

```
! This field contains the name that the descriptor
! will be known by when in memory.
```

Example Module Description in Moded.fields:

The following example shows how you could set up a module description:

```
*************************************************************
*the following section describes an RBF device descriptor *
*************************************************************
#15,1
descriptor name
5,c,0,0
! This field contains the name that the descriptor will
! be known by when in memory.
port address
4,30,16,0
! This is the absolute physical address of the hardware
! controller.
irq vector
1,34,10,0
! This is the irq vector that the device will assert.
! Auto-vectored interrupt devices will use vectors 25-31.
! Vectored interrupt devices will use vectors 64-255.
```

The Provided Moded.fields File:

The provided moded.fields file comes with module descriptions for standard RBF, SBF, SCF, PIPE, NETWORK, UCM, and GFM module descriptors. It also includes a description for the Init module.

OPTIONS:

-?	Displays the help message.
-d=<path>	Use <path> for the field descriptions (moded.fields).
-e=<path>	Use <path> for the error message file.
-f=<path>	Specifies a file consisting of one or more modules to be loaded into the moded buffer.

os9gen — Build and Link a Bootstrap File

SYNTAX: **os9gen [<opts>] <devname> {<path>}**

FUNCTION: os9gen creates and links the OS9Boot file required on any disk from which OS-9 is to be bootstrapped. You can use os9gen to make a copy of an existing boot file, add modules to an existing boot file, or create an entirely new boot file for a different system. These are just a few examples.

To use the os9gen utility, type os9gen and the name of the device on which the OS9Boot file is to be installed. os9gen creates a working file called TempBoot on the device specified. Each file specified on the command line is opened and copied to the TempBoot file.

NOTE: Only super users (0.n) may use this utility. os9gen can also only be used on format-enabled devices.

After all input files are copied to TempBoot, any existing OS9Boot file on the target device is renamed OldBoot. If an OldBoot file is already present, it is deleted before OS9Boot is renamed.

TempBoot is then renamed OS9Boot. Its starting address and size are linked in the disk's Identification Sector (LSN 0) for use by the OS-9 bootstrap firmware.

If your boot file is non-contiguous or larger than 64K, use the -e option. **NOTE:** Your bootstrap ROMs must support this feature. If they do not, you should not use this option.

If the -z option is used, os9gen first uses the files specified on the command line and then the file names from its standard input, or from the specified pathlist, one pathlist per line. If the names are entered manually, no prompts are given and the end-of-file key (usually <escape>) or a blank line is entered after the line containing the last pathlist.

To determine what modules are necessary for your boot file, use the ident utility with the OS9Boot file that came with your system.

The -q option updates information in the disk's Identification Sector by directing it to point to a file already contained in the root directory of the specified device.

The -q option is useful when restoring the OldBoot file as the valid boot on the disk. os9gen renames the specified file to be OS9Boot and saves the current boot as described previously.

The -r option removes the pointer to the boot file but does not delete the file. This is useful if you delete the bootfile from your disk (using the del command). Deleting the bootfile from the file structure *does not* remove the bootfile pointers from the disk's Identification Sector. It can also be used to make a disk non-bootable without deleting the actual bootfile.

OPTIONS:

-?	Displays the options, function, and command syntax of os9gen.
-b=<num>	Assigns <num>k of memory for os9gen. Default memory size is 4K.
-e	Extended Boot. Allows you to use large (greater than 64K) and/or non-contiguous files. **NOTE:** Bootstrap ROMs must support this feature.
-q=<file>	Quick Boot. Sets sector zero pointing to <file>.
-r	Removes the pointer to the boot file. This file is not deleted.
-x	Searches the execution directory for pathlists.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES: This command manually installs a boot file on device /d1 which is an exact copy of the OS9Boot file on device /d0.

```
$ os9gen /d1 /d0/os9boot
```

The following three methods manually install a boot file on device /d1. The boot file on /d1 is a copy of the OS9Boot file on device /d0 with the addition of modules stored in the files /d0/tape.driver and /d2/video.driver:

Method 1:

```
$ os9gen /d1 /d0/os9boot /d0/tape.driver /d2/video.driver
```

Method 2:

```
$ os9gen /d1 /d0/os9boot -z
/d0/tape.driver
/d2/video.driver
[ESCAPE]
```

Method 3:

```
$ os9gen /d1 -z
/d0/os9boot
/d0/tape.driver
/d2/video.driver
[ESCAPE]
```

You can automatically install a boot file by building a ***bootlist*** file and using the -z option to either redirect os9gen standard input or use the specified file as input:

$ build /d0/bootlist	*Create file* bootlist
? /d0/os9boot	*Enter first file name*
? /d0/tape.driver	*Enter second file name*
? /d2/video.driver	*Enter third file name*
? * V1.2 of video driver	*Comment line*
? [RETURN]	*Terminate* build
$ os9gen /d1 -z </d0/bootlist	*Redirects standard input*
$ os9gen /d1 -z=/d0/bootlist	*Reads input from pathlist*

NOTE: os9gen treats any input line preceded by an asterisk (*) as a comment.

The following command makes the OldBoot file the current boot and saves the current OS9BOOT file as OldBoot:

```
$ os9gen /d1 -q=oldboot
```

pd — Print the Working Directory

SYNTAX: **pd [<opts>]**

FUNCTION: pd displays a pathlist showing the path from the root directory to your current data directory. Programs can use pd to discover the actual physical location of files or by users to find their whereabouts in the file system. pd -x displays the pathlist from the root directory to the current execution directory.

OPTIONS:

-? Displays the option, function, and command syntax of pd.

-x Displays the path to the current execution directory.

EXAMPLES:

```
$ chd /D1/STEVE/TEXTFILES/MANUALS
$ pd
/d1/STEVE/TEXTFILES/MANUALS

$ chd ..
$ pd
/d1/STEVE/TEXTFILES

$ chd ..
$ pd
/d1/STEVE

$ pd -x
/d0/CMDS
```

pr Print Files

SYNTAX: **pr [<opts>] {<path>}**

FUNCTION: pr produces a formatted listing of one or more files to the standard output.

To use the pr utility, type pr and the pathlist(s) of the files to list. The listing is separated into pages. Each page has the page number, the name of the listing, and the date and time printed at the top.

pr can produce multi-column output. When printing multiple output columns with the -m option, if an output line exceeds the column width, the output line is truncated. pr can also print files simultaneously, one per column.

If no files are specified on the command line and the -z option is used, standard input is assumed to be a list of file names, one file name per input line, to print out. If no files are specified on the command line and the -z option is not used, standard input is displayed on standard output.

Files and options may be intermixed.

A typical page of output consists of 66 lines of output. Consequently, pr uses the following default parameters: 61 lines of output with 5 blank lines as a trailer. The 61 lines of output contain one line for the title, 5 blank lines for a header, and 55 lines of text. The trailer can be reduced or eliminated by expanding the number of lines per page.

OPTIONS: An equal sign (=) in an option specification is optional.

-?	Displays the options, function, and command syntax of pr.
-c=<char>	Uses <char> as the specified column separator. A <space> is the default column separator.
-d	Specifies the actual page depth.
-f	Pads the page using a series of \n (new line), instead of a \f (form feed).
-h=<num>	Sets the number of blank lines after title line. The default is 5.
-k=<num>	Sets the <num> columns that the output file will be listed in for multi-column output.
-l=<num>	Sets the left margin to <num>. The default is 0.
-m	Prints files simultaneously, one file per column. If three files are given on the command line, each file is printed in its own column on the page.
-n=<num>	Specifies the line numbering increment: <num>. The default is 1.

-o	Truncates lines longer than the right margin. By default, long lines are wrapped around to the next line.
-p=<num>	Specifies the number of lines per page: <num>. The default is 61.
-r=<num>	Sets the right margin to <num>. The default is 79.
-t	Does not print title.
-u=<title>	Uses specified title instead of file name. <title> may not be longer than 48 characters.
-x=<num>	Sets the starting page number to <num>. The default is 1.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES: The following example prints file1 using the default values of 55 lines of text per page, one line for the title, and 5 lines each for the header and trailer:

```
$ pr file1 >/p1
```

The following example prints file1 with no title. This uses 56 lines of text per page:

```
$ pr file1 -t >/p1
```

The following example prints file1 using 90 lines per page. Pagination begins with page 10:

```
$ pr file1 -x=10 p=90 >/p1
```

To display a numbered, unformatted listing of the data directory, type:

```
$ dir -u ! pr -n
```

printenv — Print Environment Variables

SYNTAX: **printenv**

FUNCTION: printenv prints any defined environment variables to standard output.

EXAMPLE: **$ printenv**

```
NAME=andy
TERM=abm85
LIST=/p1
As_long_as_you_want=long_value
```

SEE ALSO: setenv and unsetenv utility descriptions and the discussion of the shell environment in the chapter on the shell

procs — Display Processes

SYNTAX: **procs [<opts>]**

FUNCTION: procs displays a list of processes running on the system owned by the user invoking the routine. Processes can switch states rapidly, usually many times per second. Consequently, the display is a snapshot taken at the instant the command is executed and shows only those processes running at that exact moment.

procs with no options displays ten pieces of information for each process:

Id	Process ID
PId	Parent process ID
Grp.usr	Owner of the process (group and user)
Prior	Initial priority of the process
MemSiz	Amount of memory the process is using
Sig	Number of any pending signals for the process
S	Process status: w Waiting s Sleeping a Active * Currently executing
CPU Time	Amount of CPU time the process has used
Age	Elapsed time since the process started
Module & I/O	Process name and standard I/O paths: < Standard input > Standard output >> Standard error output If several of the paths point to the same pathlist, the identifiers for the paths are merged.

procs -a displays nine pieces of information: the process ID, the parent process ID, the process name, and standard I/O paths and six new pieces of information:

Aging	Age of the process based on the initial priority and how long it has waited for processing
F$calls	Number of service request calls made
I$calls	Number of I/O requests made
Last	Last system call made
Read	Number of bytes read
Written	Number of bytes written

The -b option displays both sets of information. The -e option displays information for all processes in the system. Detailed explanation of all information displayed by procs is available in the ***OS-9 Technical Manual***.

OPTIONS:

-? Displays the options, function, and command syntax of procs.

-a Displays alternate information.

-b Displays regular and alternate procs information.

-e Displays all processes of all users.

EXAMPLES:

```
$ procs
Id PId Grp.Usr Prior MemSiz Sig S   CPU Time   Age Module & I/O
 2   1   0.0   128   0.25k   0 w      0.01   ??? sysgo <>>>term
 3   2   0.0   128   4.75k   0 w      4.11 01:13 shell <>>>term
 4   3   0.0     5   4.00k   0 a   12:42.06 00:14 xhog <>>>term
 5   3   0.0   128   8.50k   0 *      0.08 00:00 procs <>>term
 6   0   0.0   128   4.00k   0 s      0.02 01:12 tsmon <>>>t1
 7   0   0.0   128   4.00k   0 s      0.01 01:12 tsmon <>>>t2

$ procs -a
Id PId  Aging  F$calls I$calls Last     Read Written Module & I/O
 2   1   129        5       1 Wait        0       0 sysgo <>>>term
 3   2   132      116     127 Wait      282     129 shell <>>>term
 4   3    11        1       0 TLink       0       0 xhog  <>>>term
 5   3   128        7       4 GPrDsc      0       0 procs <>>>term
 6   0   130        2       7 ReadLn      0       0 tsmon <>>>t1
 7   0   129        2       7 ReadLn      0       0 tsmon <>>>t2
```

profile — Read Commands from File and Return

SYNTAX: **profile <path>**

FUNCTION: profile causes the current shell to read its input from the named file and then return to its original input source which is usually the keyboard.

The file specified in <path> may contain any utility or shell commands, including those to set or unset environment variables or to change directories. These changes remain in effect after the command executes. This is in contrast to calling a normal procedure file by name only, which would then be executed by a child shell. This would not affect the environment of the calling shell.

You can nest profile commands. That is, the file itself may contain a profile command for another file. When the latter profile command is completed, the first one will resume.

A particularly useful application for profile files is within the .login and .logout files of a system's users. For example, if each user includes the following line in their .login file, system-wide commands (common environments, news bulletins, etc.) can be included in the file /dd/SYS/login_sys:

```
profile /dd/SYS/login_sys
```

A similar technique can be used for .logout files.

qsort — In-Memory Quick Sort

SYNTAX: **qsort [<opts>] {<path>}**

FUNCTION: qsort is a quick sort algorithm that sorts any number of lines up to the maximum capacity of memory.

To use qsort, type qsort and the pathlist(s) of the file(s) to sort. qsort sorts the file(s) by a user-specified field or field one by default. The field separation character defaults to a space if no separation character is specified. If no file names are given on the command line, standard input is assumed.

CAVEAT: Multiple separation characters in a row are counted as a single field separator. For example, if a comma is specified as the field separation character, three commas in a row (,,,) signify only one field separator. If the intent is to create two null fields, a space must be inserted between each comma (, , ,).

OPTIONS:

-?	Displays the options, function, and command syntax of qsort.
-c=<char>	Specifies the field separation character. If an asterisk (*), question mark (?), or comma (,) are used as field separation characters, the option and the character must be enclosed by quotation marks.
-f=<num>	Specifies the sort field. **NOTE:** Only one -f field is allowed on a command line.
-z	Reads the file names from standard input.
-z=<file>	Reads the file names from <file>.

EXAMPLES:

$ qsort file1 file2 file3	Sorts files and displays.
$ dir -ue ! qsort -f=7	Sorts extended directory listing by entry name, field 7.
$ qsort file -f=2 "-c=*"	Sorts file by field 2 using an asterisk (*) as the field separation character.
$ qsort file -f=2 "-c=,"	Sorts file by field 2 using a comma (,) as the field separation character.
$ qsort -z	Reads file names from standard input.

rename — Change File Name

SYNTAX: **rename [<opts>] <path> <new name>**

FUNCTION: rename assigns a new name to the mass storage file specified in the pathlist.

To rename a file, type rename, followed by the name of the file to rename, followed by the new name. You must have write permission for the file to change its name. You cannot use the names "." or ".." for <path>.

OPTIONS:

-? Displays the option, function, and command syntax of rename.

-x Indicates that <path> starts at the current execution directory. You must have execute permission for the specified file.

EXAMPLES:

```
$ dir
  Directory of .  16:22:53
blue          myfile
$ rename blue purple
$ dir
  Directory of .  16:23:22
myfile        purple

$ rename /h0/HARRY/test1 test2

$ rename -x screenclear clearscreen
```

romsplit — Split File

SYNTAX: **romsplit {<opts>} {<path>}**

FUNCTION: romsplit splits the input file specified by <path> into two or four files.

romsplit converts a ROM object image into an 8-bit wide file. This is useful when a PROM programmer cannot burn more than one PROM at a time and the system has the ROMs addressed as 16-bit or 32-bit wide memory.

If the -q option is not specified, romsplit copies the even bytes of data to a new file with the same name with a .0 extension. The odd bytes are copied to a new file with the same name with a .1 extension.

If the -q option is specified, the following copying scheme is used:

Byte Number	Destination File
0, 4, 8, 12 etc.	<path>.0
1, 5, 9, 13 etc.	<path>.1
2, 6, 10, 14 etc.	<path>.2
3, 7, 11, 15 etc.	<path>.3

OPTIONS:

-? Displays the options, function, and command syntax of romsplit.

-q Splits the input file into four files.

-x Reads the input file from execution directory.

save — Save Memory Module(s) to a File

SYNTAX: **save [<opts>] {<modname>}**

FUNCTION: save copies the specified module(s) from memory into your current data directory. The file(s) created in your directory have the same name(s) as the specified module(s).

To save a specified module, type save, followed by the name(s) of the module(s) to save. <modname> must exist in the module directory when saved. The new file is given access permissions for all modes except public write.

If you specify more than one module, each module is stored in a separate file, unless you use the -f option. In that case, all modules listed are saved in the specified file.

NOTE: To save a module, the module must have read access permission for either your group or user ID.

NOTE: save uses the current execution directory as the default directory. Executable modules should generally be saved in the default execution directory.

OPTIONS:

-?	Displays the options, function, and command syntax of save.
-f=<path>	Saves all specified modules to <path>.
-r	Rewrites existing files.
-x	Changes the default directory to the current execution directory.
-z	Reads the module names from standard input.
-z=<file>	Reads the module names from <file>.

EXAMPLES:

```
$ save -x dir copy
$ save -f=/d1/math_pack add sub mul div
```

set — Set Shell Options

SYNTAX: **set [<opts>]**

FUNCTION: set changes shell options for the individual shell in which they are declared.

To change the options for your current shell, enter set and the desired shell options. This command is the equivalent of typing the options directly after the shell prompt on the command line. This is a preferred method of changing shell parameters within procedure files because of its clarity.

The hyphen that usually proceeds declared options is unnecessary when using the set command.

The options specified by set change the shell parameters only in the shell in which they are declared. All descendant shells have the default parameters unless changed within the new shell.

NOTE: set is a built-in shell command. Therefore, it is not in the CMDS directory.

OPTIONS:

?	Displays the options, function, and command syntax of set.
e=<file>	Prints error messages from <file>. If no file is specified, the default file used is /dd/sys/errmsg. Without the -e option, shell prints only error numbers with no message description.
ne	Prints no error messages. This is the default.
l	Must log off system with logout.
nl	Must log off system with <esc>.
p	Displays prompt. The default prompt is $.
np	Does not display prompt.
p=<string>	Sets current shell prompt equal to <string>.
t	Echoes input lines.
nt	Does not echo input lines. This is the default.
v	Verbose mode. Displays a message for each directory searched when executing a command.
nv	Turns off verbose mode.

x	Aborts process upon error. Default.
nx	Does not abort on error.

EXAMPLES: All commands on the same line have the same effect:

$ set x	**$ set -x**	**$ -x**
$ set xp="JOE"	**$ set -xp="JOE"**	**$ -xp="JOE"**

setenv — Set Environment Variables

SYNTAX: **setenv <eparam> <evalue>**

FUNCTION: setenv sets environment variables within a shell for use by the individual shell's child processes.

<eparam> and <evalue> are strings stored in the environment list by shell. These variables are known to the shell in which they are defined and are passed on to descendent processes from that shell.

NOTE: setenv should not be confused with the shell's set command. It has a completely different function. setenv is a built-in shell command. Therefore, it is not in the CMDS directory.

EXAMPLES:

```
$ setenv PATH ../h0/cmds:/d0/cmds:/dd/cmds

$ setenv TERM abm85

$ setenv _sh 0

$ setenv As_long_as_you_want long_value
```

setime — Activate and Set the System Clock

SYNTAX: **setime [<opts>] [y m d h m s [am/pm]]**

FUNCTION: setime sets the system date and time. Once set, it activates the system interrupt clock.

To set the system date and time, type setime, and enter the year, month, day, hour, minute, second, and am or pm as parameters on the command line.

setime does not require field delimiters, but allows you to use the following delimiters between the year, month, day, etc.:

colon (:), semicolon (;), slash (/), comma (,), or space ( )

If semicolons are used as field delimiters, the date and time string must be enclosed by quotes. For example:

```
$ setime "91;1;15;1;25;30;pm"
```

If no parameters are given, setime issues the prompt:

```
$ setime
yy/mm/dd hh:mm:ss [am/pm]
Time:
```

When no am/pm field is specified, OS-9 system time uses the 24 hour clock. For example, 15:20 is 3:20 pm. Midnight is specified as 00:00. Noon is specified as 12:00. Using the am/pm field allows you to use the 12 hour clock. If a conflict exists between the time and the am/pm field (such as 15:20 pm) the system ignores the am/pm designation.

Entering setime echoes the date and time when set.

IMPORTANT NOTE: You must execute this command before OS-9 can perform time-sharing operations. If the system does not have a real-time clock, you should still use this command to set the date for the file system.

Systems with Battery Backed Up Clocks:

setime should still be run to start time-slicing, but you only need to give the -s. The date and time are read from the clock.

OPTIONS:

-?	Displays the options, function, and command syntax of setime.
-d	Does not echo date/time when set.
-s	Reads time from battery backed up clock.

EXAMPLES:

$ setime 91 01 13 15 45	Set to: January 13, 1991, 3:45 PM
$ setime 910113 154500	Same as above
$ setime 91/01/13/3/45/pm	Same as above
$ setime -s	For systems with a battery-backup clock
$ setime **yy/mm/dd hh:mm:ss [am/pm]** **Time:**	No parameters are specified, therefore a prompt is given.

setpr — Set Process CPU Priority

SYNTAX: **setpr <procID> <number>**

FUNCTION: setpr changes the CPU priority of a process.

To use setpr, type setpr, the process ID, and the new priority number of the process to change. setpr may only be used with a process having your ID. The priority number is a decimal number in the range of 1 (lowest) to 65535 (hex FFFF).

Use procs to obtain the ID number and present priority of any current process.

NOTE: This command does not appear in the CMDS directory as it is a built-in shell command.

EXAMPLE: **$ setpr 8 250** Changes the priority of process number 8 to 250.

shell — OS-9 Command Interpreter

SYNTAX: **shell [[set] <arglist>]**

FUNCTION: shell is OS-9's command interpreter program. It reads data from its standard input which is usually the keyboard or a file and interprets the data as a sequence of commands. The basic function of shell is to initiate and control execution of other OS-9 programs.

Usually you enter the shell automatically upon logging into OS-9. The shell displays a dollar sign ($) prompt to show that it is ready and waiting for a command line. You can create a new shell by typing shell optionally followed by a command line.

The shell reads and interprets one text line at a time from standard input. After interpreting each line, the shell reads another line until an end-of-file condition occurs, at which time it terminates itself.

An exception occurs when the shell is called from another program. In this case, the shell processes the specified command as if it was typed on a shell command line. Control returns to the calling program after the single command line is processed. If no command is specified (shell<cr>) or the command is a shell option or built-in command (chd, chx, etc.), more lines are read from standard input and processed as normal. This continues until an end-of-file condition or the logout command is executed.

CAVEAT: The shell's ex command does not recognize utility options unless they are separated from the utility name with a space. For example, ex procs -e works properly, but ex procs-e does not.

The shell uses special characters for various purposes. Special characters consist of the following:

Modifiers:	#	Memory allocation
	^	Process priority modification
	>	Standard output redirection
	<	Standard input redirection
	>>	Standard error output redirection
Separators:	;	Sequential execution
	&	Concurrent execution
	!	Pipe: interprocess communication

Wildcards: * Stands for any string of characters
? Stands for any single character

To send one of these characters to a utility program, you must use a method called ***quoting*** to prevent the shell from interpreting the special character. Quoting consists of enclosing the sequence of characters to be passed to a routine in single or double quotes. For example, '<char>' or "<char>".

The following command line prints the indicated string:

```
$ echo "Hello; goodbye"
Hello; goodbye
```

However, the following command displays the string Hello on your terminal screen and then attempts to execute a program called goodbye.

```
$ echo Hello; goodbye
```

The shell expands the two wildcards to build pathlists. The question mark (?) wildcard matches any single character. The asterisk (*) wildcard matches any string of characters.

dir ???? displays the names of files in the current directory that are four characters long. dir s* displays all names of files in the current directory that begin with s.

Any command that uses a pathlist on the command line accepts a pathlist specified with wildcards. When shell expands the wildcards, if no explicit directory is given, the files in the current data directory are searched for the matched expansion. If an explicit directory name is given in the pathlist, the specified directory is searched.

NOTE: If a command uses an option to search for a file in the current execution directory, wildcards may produce unexpected results. The shell simply reads the current directory or the given relative pathlist containing a wildcard and passes these file names to the command. If the command then tries to find the files relative to the execution directory, the search will most likely fail.

Setting Shell Options

There are two methods of setting shell options. The first method is to type the option on the command line or after the command, shell. For example:

$ -np	Turns off the shell prompt.
$ shell -np	Creates a new shell that does not prompt.

The second method uses the special shell command, set. To set shell options, type set, followed by the options desired. When using set, a hyphen (-) is unnecessary before the letter option. For example:

$ set np	Turns off the shell prompt.
$ shell set np	Creates a new shell that does not prompt.

As you can see, the two methods accomplish the same function. They are both provided for your convenience. Use the method that is clearer for you.

The Shell Environment

For each user on an OS-9 system, the shell maintains a unique list of ***environment*** variables. These variables affect the operation of the shell or other programs subsequently executed. They are ***programmable defaults*** that you can set to your liking.

All environment variables can be accessed by any process called by the environment's shell or descendent shells. This essentially allows you to use the environment variables as ***global*** variables.

NOTE: If a subsequent shell redefines an environment variable, the variable is only redefined for that shell and its descendents.

NOTE: Environment variables are case sensitive.

Several special environment variables are automatically set up when you log on a time-sharing system:

PORT	This specifies the name of the terminal. This is automatically set up by tsmon. /t1 is an example of a legal PORT name.

HOME This specifies your ***home*** directory. The home directory is the directory specified in your password file entry. This is also the directory used when the command chd with no parameters is executed.

SHELL This is the process that is first executed upon logging on to the system.

USER This is the user name you type when prompted by login.

Four other important environment variables are available:

PATH This specifies any number of directories. Each directory must be separated by a colon (:). The shell uses this as a list of commands directories to search when executing a command. If the default commands directory does not include the file/module to execute, each directory specified by PATH is searched until the file/module is found or until the list is exhausted.

PROMPT This specifies the current prompt. By specifying an "at" sign (@) as part of your prompt, you may easily keep track of how many shells you personally have running under each other. The @ is used as a replaceable macro for the shell level number. The environment variable _sh sets the base level.

_sh This specifies the base level for counting the number of shell levels. For example, set the shell prompt to "@howdy: " and _sh to 0:

```
$ setenv _sh 0
$ -p="@howdy: "
howdy: shell
1.howdy: shell
2.howdy: eof
1.howdy: eof
howdy:
```

TERM This specifies the specific terminal being used. This allows word processors, screen editors, and other screen dependent programs to know what type of terminal configuration to use.

The Environment Utilities

Three utilities are available to manipulate environment variables:

- setenv declares the variable and sets its value. The variable is placed in an environment storage area accessed by the shell. For example:

```
$ setenv PATH ..:/h0/cmds:/d0/cmds:/dd/cmds
```

```
$ setenv _sh 0
```

- unsetenv clears the value of the variable and removes it from storage. For example:

```
$ unsetenv PATH
$ unsetenv _sh
```

- printenv prints the variables and their values to standard output. For example:

```
$ printenv
PATH ..:/h0/cmds:/d0/cmds:/dd/cmds
PROMPT howdy
_sh 0
```

The Profile Command

The profile built-in shell command can be used to cause the current shell to read its input from the named file and then return to its original input source, which is usually the keyboard. To use the profile command, enter profile and the name of a file:

```
profile setmyenviron
```

The specified file (in this case, setmyenviron) may contain any utility or shell commands, including commands to set or unset environment variables or to change directories. These changes will remain in effect after the command has finished executing. This is in contrast to calling a normal procedure file by name only. If you call a normal procedure file without using the profile command, the changes would not affect the environment of the calling shell.

Profile commands may be nested. That is, the file itself may contain a profile command for another file. When the latter profile command is completed, the first one will resume.

A particularly useful application for profile files is within a user's .login and .logout files. For example, if each user includes the following line in the .login file, then system-wide commands (common environments, news bulletins, etc.) can be included in the file /dd/SYS/login_sys.

```
profile /dd/SYS/login_sys
```

A similar technique can be used for .logout files.

The Login Shell, .login, and .logout

The ***login shell*** is the initial shell created by the ***login*** program to process the user input commands after logging in. Two special procedure files are extremely useful for personalizing the shell environment:

- .login
- .logout.

To make use of these files, they must be located in your home directory. The .login and .logout files provide a way to execute desired commands when logging on to and leaving the system.

The login shell processes .login as a command file immediately after successful login. This allows you to run a number of initializing commands without remembering each and every command. After processing all commands in the .login file, the shell prompts you for more commands. The main difference in handling the .login file is that the login shell itself actually executes the commands rather than creating another shell to execute the commands. You can issue such commands as set and setenv within the .login file and have them affect the login shell. This is especially useful for setting up the environment variables PATH, PROMPT, TERM, and _sh.

The following is an example .login file:

```
setenv PATH ..:/h0/cmds:/d0/cmds:/dd/cmds:/h0/doc/spex
setenv PROMPT "@what next: "
setenv _sh 0
setenv TERM abm85h
querymail
date
dir
```

.logout is executed when logout is executed to exit the login shell and leave the system. The .logout file is executed before the login shell terminates. Use this to execute any cleaning up procedures that are done on a regular schedule. This might be anything from instigating a backup procedure of some sort to printing a reminder of things to do.

The following is an example .logout file:

```
procs
wait
echo "all processes terminated"
* basic program to instigate backup if necessary *
disk_backup
echo "backup complete"
```

Shell Command Line Syntax

The shell command line consists of a ***keyword*** and optionally any of the parts listed below. The keyword must appear first on a command line. The order of the optional parts depends on the nature of the command and the desired effect. The command line consists of:

Command Line Unit	Description
Keyword	A name of a program or procedure file, a pathlist, or built-in shell command. The shell's built-in commands are:
	ex — Executes a process as overlay.
	chd — Changes your data directory.
	chx — Changes your execution directory.
	kill — Aborts a specified process.
	logout — Terminates the current shell and executes the .logout procedure file if the login shell is terminated.
	profile — Causes the current shell to read its input from the named file and returns to the original input source.
	set — Sets shell options.
	setenv — Sets environment variables.
	setpr — Sets process priority.
	unsetenv — Clears environment variables.
	w — Waits for any one process to finish.
	wait — Waits for all immediate child processes to finish.
Parameter	File or directory names, values, variables, constants, options, etc. to be passed to the program. Wildcards may be used to identify parameter names. The recognized wildcards are:
	* — Matches any character.
	? — Matches any single character.

Execution Modifiers

These modify a program's execution by redirecting I/O or changing the priority or memory allocation of a process:

#<mem size>	Allocates specified memory to a process.
^<priority>	Sets the priority of the process.
<	Redirects standard input.
>[- or +]	Redirects standard output.
>>[- or +]	Redirects standard error output.

The hyphen (-) following the modifiers above signify to write over a specified file. The plus (+) appends the file with the redirected output.

Separators

Separators connect command lines together in the same command line. They specify to the shell how they are to be executed. The separators are:

;	Indicates sequential execution.
&	Indicates concurrent execution.
!	Creates a communication ***pipe*** between processes. Pipes connect the standard output of one process to the standard input of another.

Command Line Execution

The shell command line syntax indicates that a keyword may be a program name, procedure file name, a pathlist, or built-in shell command. Built-in commands are executed immediately by the shell; no directory searching is required, nor is a process created to execute the command. If the specified command is not a built-in command, the shell must locate the program to execute from a number of possible locations. The following procedure describes the actions of the shell when processing a command:

¿ Get command line.

¡ Prepare command:

a. Validate syntax
b. Isolate keyword, parameters, and execution modifiers
c. Expand wildcard names if given

¬ If the keyword is a built-in command, execute the command. Otherwise, search the following directories until the command is found or the directory search is exhausted:

a. The module directory
b. The execution directory
c. Each directory specified by the PATH environment variable

Ð If the command could not be found in the above directories, return error: can't find command.

ƒ If the command is found, load the command into the module directory.

Ý If the load fails, execute shell command (command is assumed to be a procedure file for the shell)

ý If the load succeeds and the module is executable object code, execute command.

« If the load succeeds and the module is BASIC I-code, execute Runb command. Command is an argument for RunB.

» If either of the above command execution fails, return error: can't execute command.

Commands and procedure files in the current execution directory must have the e and/or pe file attribute set or the file will not be found.

If the PATH environment variable is set, its value is interpreted as a list of directories to search if the initial search of the execution directory fails. If an absolute pathlist, a path beginning with a slash (/) is given as the command, the shell does not perform the PATH directory search. The following are examples of setting up the PATH variable:

```
setenv PATH /d0
setenv PATH /h0/cmds:/n0/jack/h0/cmds:/n0/jill/h0/cmds
setenv PATH kim:../kim:.../cmds
```

Each directory name is separated by a colon (:). Shell isolates the directory name and appends it to the command name and uses this pathlist to load the command. If the load fails, the next directory given is used until the command is successfully loaded or all directories are tried. Regardless of the error encountered, the shell continues with the next directory. If a directory given is a relative pathlist, the pathlist is relative to the execution directory.

To assist in determining the directory from which a command was loaded or not loaded, turn on the -v option to display the shell's progress while searching the directories.

The login program automatically sets the PATH variable to the execution directory from which login itself was loaded if the password entry gives an execution directory

other than ".". The period (.) tells the shell to use the login's execution directory.

Example Command Lines

The following example displays a numbered listing of the data directory. dir is a keyword indicating the dir utility. -u is a parameter for dir. The exclamation point (!) is a pipe that redirects the unformatted output of dir to the standard input of pr. pr is a keyword indicating the pr utility. -n is a parameter for pr.

```
dir -u ! pr -n
```

The following command line lists all files in the current data directory that have names beginning with s. list is the keyword. s* identifies the parameters.

```
list s*
```

update uses master as standard input in this next example. The output from update is used as input for sort. The output from sort is redirected to the printer.

```
update <master ! sort >/p1
```

OPTIONS:

-?	Displays the options, function, and command syntax of shell.
-e=<file>	Prints error messages from <file>. If no file is specified, the default file used is /dd/sys/errmsg. Without the -e option, shell prints only error numbers with no message description.
-ne	Prints no error messages. This is the default.
-l	The logout built-in command is required to terminate the login shell. <eof> does not terminate the shell.
-nl	<eof> terminates the login shell. The <Esc> key normally sends an <eof> to the shell.
-p	Displays prompt. The default prompt is $.
-np	Does not display prompt.

-p=<string>	Sets current shell prompt equal to <string>.
-t	Echoes input lines.
-nt	Does not echo input lines. This is the default.
-v	Verbose mode. Displays a message for each directory searched when executing a command.
-nv	Turns off verbose mode.
-x	Aborts process upon error. This is the default.
-nx	Does not abort on error.

sleep — Suspend a Process for a Period of Time

SYNTAX: **sleep [<opts>] <num>**

FUNCTION: sleep puts your process to sleep for a number of ticks. It is generally used to generate time delays in procedure files.

To use the sleep utility, type sleep, followed by the number of ticks you want the process to sleep. A tick count of one causes the process to give up its current time slice and return immediately. A tick count of zero causes the process to sleep indefinitely, usually until awakened by a signal. The duration of a tick is system-dependent.

sleep is generally used to generate time delays in procedure files.

OPTIONS:

-? Displays the option and command syntax of sleep.

-s Changes count representation to seconds.

NOTE: Only one option may be used on the command line. If not specified, <num> defaults to zero.

EXAMPLES:

$ sleep 25	Sleep for 25 ticks.
$ sleep -s 1000	Sleep for 1000 seconds.

tape — Tape Controller Manipulation

SYNTAX: **tape {<opts>} [<dev>]**

FUNCTION: tape provides a means to access a tape controller from a terminal. tape can rewind, erase, skip forwards and backwards, and write tapemarks to a tape.

If the tape device <dev> is not specified on the command line and the -z option is not used, tape uses the default device /mt0.

OPTIONS:

-?	Displays options, function, and command syntax of tape.
-b[=<num>]	Skips the specified number of blocks. The default is one block. If <num> is negative, the tape skips backward.
-e=<num>	Erases a specified number of blocks of tape.
-f[=<num>]	Skips the specified number of tapemarks. The default is one tapemark. If <num> is negative, the tape skips backward.
-o	Puts tape off-line.
-r	Rewinds the tape.
-s	Determines the block size of the device.
-t	Retensions the tape.
-w[=<num>]	Writes a specified number of tapemarks. The default is one tapemark.
-z	Reads a list of device names from standard input. The default device is /mt0.
-z=<file>	Reads a list of device names from <file>.

If you specify more than one option, tape executes each option function in a specific order. Therefore, you can skip ahead a specified number of blocks, erase, and then rewind the tape all with the same command.

The order of option execution is as follows:

- ¿ Gets device name(s) from the -z option.
- ¡ Skips the number of tapemarks specified by the -f option.
- ¬ Skips the number of blocks specified by the -b option.
- Ð Writes a specified number of tapemarks.
- *f* Erases a specified number of blocks of tape.
- Ý Rewinds the tape.
- ý Puts the tape off-line.

EXAMPLES:

$ tape /mt0 -r	Rewinds tape on device /mt0.
$ tape -f=5 -e=2 -r	Skips forward five files on device /mt0, erases the next two blocks, and then rewinds the tape.

tapegen — Put Files on a Tape

SYNTAX: **tapegen [<opts>] <filename> <filename>**

FUNCTION: tapegen creates the "bootable" tape. tapegen is a standard utility that performs a function similar to the os9gen utility. Both utilities place the bootstrap file on the media and mark the media identification block with information regarding the bootstrap file. In addition, tapegen can optionally place initialized data on the tape, for application-specific purposes.

To use the tapegen utility, type tapegen followed by any desired options.

OPTION:

-?	Displays the options, function, and command syntax of tapegen.
-b=<bootfile>	Installs an OS-9 boot file.
-bz	Reads boot module names from standard input.
-bz=<bootlist>	Reads boot module names from the specified bootlist file.
-c	Checks and displays header information.
-d=<dev>	Specifies the tape device name. The default is /mt0.
-o	Takes the tape drive off-line when finished.
-t=<target>	Specifies the name of the target system.
-i=<file>	Installs an initialized data file on the tape. This is usually a RAM disk image.
-v=<volume>	Specifies the name of the tape volume.
-z	Reads filenames from standard input.
-z=<file>	Reads filenames from the specified file.

EXAMPLES: The following example makes a bootable tape. The disk image is derived from the /dd device.

```
$ tapegen -b=OS9Boot.tape -i=/dd@ "-v=OS-9/68K Boot Tape" -t=MySystem
```

This example makes a bootable tape with no initialized data file. The "header" information is displayed after writing the tape.

```
$ tapegen -b=OS9Boot.h0 -c
```

tee — Copy Standard Input to Multiple Output Paths

SYNTAX: **tee {<path>}**

FUNCTION: tee is a filter that copies all text lines from its standard input to its standard output and any other additional pathlists given as parameters.

To use the tee utility, type tee and the pathlist(s) to which standard input is to be redirected. This utility is generally used with input redirected through a pipe.

OPTION: -? Displays the function and command syntax of tee.

EXAMPLES: The example below uses a pipeline and tee to simultaneously send the output listing of dir to the terminal, printer, and a disk file:

```
$ dir -e ! tee /printer /d0/dir.listing
```

This example sends the output of an assembler listing to a disk file and the printer:

```
$ asm pgm.src l ! tee pgm.list >/printer
```

This example broadcasts a message to three terminals:

```
$ echo WARNING System down in 10 minutes ! tee /t1 /t2 /t3
```

tmode — Change Terminal Operating Mode

SYNTAX: **tmode [<opts>] [<arglist>]**

FUNCTION: tmode displays or changes the operating parameters of your terminal.

NOTE: tmode can only be used for SCF or GFM devices.

To change the operating parameters of your terminal, type tmode and any parameters you want changed. If no parameters are given, the present values for each parameter are displayed. Otherwise, the parameter(s) given in the parameter list are processed. You can give any number of parameters, separated by spaces or commas.

If a parameter is set to zero, OS-9 no longer uses the parameter until it is re-set to a recognizable code. For example, to set xon and xoff to zero, type:

```
tmode xon=0 xoff=0
```

Consequently, OS-9 does not recognize xon and xoff until the values are re-set.

To re-set the value of a parameter to its default, type tmode and specify the parameter with no value. This re-sets the parameter to the default value given in this manual.

Use the -w=<path#> option to specify the path number to be affected. If none is given, standard input is affected.

NOTE: If you use tmode in a shell procedure file, you must use the option -w=<path#> to specify one of the standard paths (0, 1, or 2) to change the terminal's operating characteristics. The change remains in effect until the path is closed. For a permanent change to a device characteristic, you must change the device descriptor. You may alter the device descriptor to set a device's initial operating parameters using xmode. See the xmode utility for more information.

You cannot change the following five parameters by tmode: type, par, cs, stop, and baud. These are included in tmode for informational purposes only. You can only change these by altering the device descriptor and using iniz. See xmode for more information.

tmode can work only if a path to the file/device has already been opened. The ***OS-9 Technical Manual*** contains full information on device descriptors.

Tmode Parameter Names

Name	Function
upc	Upper case only. Lower case characters are converted automatically to

upper case.

noupc	Upper and lower case characters permitted. Default.
bsb	Erase on backspace. Backspace characters are echoed as a backspace-space-backspace sequence. Default.
nobsb	No erase on backspace. Echoes single backspace only.
bsl	Backspace over line. Lines are deleted by sending backspace-space-backspace sequences to erase the same line for video terminals. Default.
nobsl	No backspace over line. Lines are deleted by printing a new line sequence for hard-copy terminals.
echo	Input characters echoed back to terminal. Default.
noecho	No echo
lf	Auto line feed on. Line feeds are automatically echoed to terminal on input and output carriage returns. Default.
nolf	Auto line feed off
null=n	Set null count. Number of null ($00) characters transmitted after carriage returns for return delay. The number is decimal. The default null count is 0.
pause	Screen pause on. Output suspended upon full screen. See pag parameter for definition of screen size. Output can be resumed by typing any key.
nopause	Screen pause mode off
pag=n	Set video display page length to n lines, where n is in decimal. Used for pause mode, see above.
bsp=h	Set input backspace character (normally <control>H, default = 08). Numeric value of character in hexadecimal.
del=h	Set input delete line character (normally <control>X, default = 18). Numeric value of character in hexadecimal.

Name	**Function**
eor=h	Set end-of-record input character (normally <cr>, default = 0D). Numeric value of character in hexadecimal.

eof=h Set end-of-file input character (normally <esc>, default = 1B). Numeric value of character in hexadecimal.

reprint=h Set reprint line character (normally <control>D, default = 04). Numeric value of character in hexadecimal.

dup=h Sets the duplicate last input line character (normally <control>A, default = 01). Numeric value of character in hexadecimal.

psc=h Set pause character (normally <control>W, default = 17). Numeric value of character in hexadecimal.

abort=h Abort character (normally <control>C, default = 03). Numeric value of character in hexadecimal.

quit=h Quit character (normally <control>E, default = 05). Numeric value of character in hexadecimal.

bse=h Set output backspace character (default = 08). Numeric value of character in hexadecimal.

bell=h Set bell (alert) output character (default = 07). Numeric value of character in hexadecimal.

type=h ACIA initialization value: shows parity, character size, and number of stop bits. Value in hexadecimal. This value is affected by changing the individual par(ity), cs (character length), and stop (stop bits) values. This value cannot be changed by tmode.

par=s Shows parity using one of the following strings: odd, even, or none. Changing parity will affect the type value. Parity cannot be changed by tmode.

cs=n Shows character length using one of the following values:

n = 8, 7, 6 or 5 (bits)

Changing character length will change the type value. Character length cannot be changed by tmode.

Name	Function

stop=n Shows number of stop bits used:

n = 1, 1.5 or 2 (stop bits)

Changing the stop bit value affects the type value. The number of stop bits used cannot be changed by tmode.

baud=n — Baud rate: The baud rate may currently be set to the following values:

n = **50**	**134.5**	**600**	**2000**	**4800**	**19200**
75	**150**	**1200**	**2400**	**7200**	**38400**
110	**300**	**1800**	**3600**	**9600**	**extern**

The baud rate cannot be changed by tmode.

xon=h — DC1 resume output character (normally <control>Q, default = 11). Numeric value of character in hexadecimal.

xoff=h — DC2 suspend output character (normally <control>S, default = 13). Numeric value of character in hexadecimal.

tabc=h — Tab character (normally <control>I, default = 09). Numeric value of character in hexadecimal.

tabs=n — Number of characters between tab stops. The number is in decimal. The default is 4 characters between tab stops.

normal — Set the terminal back to its default characteristics. This will not affect the following values: type, baud rate, parity, character length, and stop bits.

OPTIONS:

-? — Displays the option, function, and command syntax of tmode.

-w=<path#> — Changes the path number <path#> affected.

EXAMPLES:

```
$ tmode noupc lf null=4 bse=1F pause

$ tmode pag=24 pause bsl noecho bsp=8 bsl=C

$ tmode xon xoff quit=5
```

touch — Update the Last Modification Date of a File

SYNTAX: **touch [<opts>] {<path>}**

FUNCTION: touch updates the last modification date of a file. Usually, this command is used with a make command's ***makefile***. Associated with every file is the date the file was last modified. touch simply opens a file and closes it to update the time the file was last modified to the current date.

To update the last modification date of a file, type touch and the pathlist of the file to update. touch searches the current data directory for the file to update if another directory or the -x option is not specified.

NOTE: If the specified file is not found, touch creates a file with a current modification date.

OPTIONS:

-?	Displays the options, function, and command syntax of touch.
-c	Does not create a file if not found.
-q	Does not quit if an error occurs.
-x	Searches the execution directory for the file.
-z	Reads the file names from standard input.
-z=<path>	Reads the file names from <path>.

EXAMPLES:

```
$ touch -c /h0/doc/program

$ touch -cz

$ dir -u ! touch
```

tr — Transliterate Characters

SYNTAX: **tr [<opts>] <str1> [<str2>] [<path1>] [<path2>]**

FUNCTION: tr transliterates characters from <str1> into a corresponding character from <str2>. If <str1> contains more characters than <str2>, the final character in <str2> is used for each excess character in <str1>.

To use the tr utility, type tr and the characters to search for (<str1>), and optionally, the replacement characters (<str2>), the input file's pathlist (<path2>) and the output file's pathlist (<path2>).

<str1> is required. If <str2> is missing, all characters in <str1> are deleted from the output. If <path1> and <path2> are missing, standard input and output are assumed. If only one path is specified, it is used as the input file pathlist.

<str1> and <str2> are interpreted as character classes. To facilitate creating character classes, use the following metacharacters:

Char	Name/Description
-	**RANGE**. The hyphen (-) is defined as representing all characters lexicographically greater than the preceding character and less than the following character. For example: [a-z] is equivalent to the string abcdefghijklmnopqrstuvwxyz. [m-pa-f] is equivalent to the string mnopabcdef. [0-7] is equivalent to the string 01234567. See the ASCII chart in Appendix A for character values.

Char	Name/Description
\	**ESCAPE**. The backslash (\) removes special significance from special characters. It is followed by a base and a numeric value or a special character. If no base is specified, the base for the numeric value defaults to hexadecimal. An explicit base of decimal or hexadecimal can be specified by preceding the numeric value with a qualifier of d or x, respectively. It also allows entry of some non-printing characters such as: \t = Tab character \n = New-line character \l = Line feed character \b = Backspace character \f = Form feed character

NOTE: Do not confuse <str1> and <str2> with the ***character class*** regular expression. <str1> and <str2> do not need surrounding brackets. Brackets are merely treated as characters in the character class.

OPTIONS:

-?	Displays the options, function, and command syntax of tr.
-c	Transliterates all ASCII characters (1 through $7F) to <str2>, except for the set of characters in <str1>.
-d	Deletes all matching input characters and expressions.
-s	Squeezes all repeated output characters or expressions in <str2> to single characters or expressions.
-v	Same as -c.
-z	Reads standard input for list of file names.
-z=<path>	Reads the file names from <path>.

You can generally give options anywhere on the command line. If you wish to use the pathlists but not <str2>, you must specify the -d option prior to the pathlists. Similarly, if you use the -z option to read pathlists from standard input, the -z must precede <path2>.

The -s option does not differentiate between characters originally in <str2> and transliterated characters. It always returns a string with no consecutively repeated characters. For example, the command tr -s abcde x transliterates the string exasperate into xspxrxtx.

The -s and -d options are mutually exclusive.

If you use the -c option to change all but a certain sequence of characters, it also changes carriage returns and newlines unless they are specified in the sequence of characters.

WARNING: tr always deletes ASCII nul ($00).

EXAMPLES: The following examples use standard input for the input to tr. The output is sent to standard output. Thus, the first line following each command line is the standard input, and the second line is the standard output.

```
$ tr abcd jklm
aabdc_efg
jjkml_efg
```

Transliterates standard input, converting a to j, b to k, c to l, and d to m.

```
$ tr abcd j
abcd_efgh
jjjj_efgh
```

Transliterates standard input, converting each a, b, c, and d to j.

```
$ tr a-d k
abc_abcd-efgh
kkk_kkkk-efgh
```

Transliterates standard input, converting each character contained in the expression abcd to k.

```
$ tr abcd
abcd_efgh
_efgh
```

Transliterates standard input, deleting each a, b, c, and d.

```
$ tr -d abcd
abcdefg
efg
```

Transliterates standard input, deleting each a, b, c, and d.

```
$ tr -s dcba eocd
edenbcada
encoded
```

Transliterates standard input converting d to e, c to o, b to c, and a to d. Consecutively repeated output characters, the matching eocd, are squeezed into a single character

```
$ tr -c a-zA-Z \n
one word per line
one
word
per
line
```

Transliterates standard input, converting all non-alphabetic characters to newline characters.

tsmon Supervise Idle Terminals and Initiate the Login Command

SYNTAX: **tsmon [<opts>] {/<dev>}**

FUNCTION: tsmon supervises idle terminals and starts the login utility in a timesharing application. Typically, tsmon is executed as part of the start-up procedure when the system is first brought up and remains active until the system shuts down.

The parameter /<dev> specifies a terminal to monitor. This is generally an SCF device.

You can specify up to 28 device name pathlists for tsmon to monitor. When you type a carriage return on any of the specified paths, tsmon automatically forks login, with standard I/O paths opened to the device. If login fails because you could not supply a valid user name or password, control returns to tsmon.

Most programs terminate when an end-of-file character (normally <escape>) is entered as the first character on a command line. This logs you off the system and returns control to tsmon.

tsmon prints a message when you log off:

Logout after 11 minutes, 30 seconds. Total time 3:57:46.

The Total time figure is the total amount of time that the terminal has accumulated on-line since the tsmon was started.

tsmon is normally used to monitor I/O devices capable of bi-directional communication, such as CRT terminals. However, you may use tsmon to monitor a named pipe. If this is done, tsmon creates the named pipe, and then waits for data to be written to it by some other process.

When data arrives, tsmon starts a shell with its input redirected to the pipe file. This is useful for starting remote processes in a networked environment.

You can run several tsmon processes concurrently, each one watching a different group of devices. This must be done when more than 28 terminals are to be monitored, but is sometimes useful for other reasons. For example, you may want to keep modems or terminals suspected of hardware trouble isolated from other devices in the system.

tsmon forks login with the PORT environment variable set to the SCF device name and all other environment variables cleared.

OPTIONS:

-? Displays the options, function, and command syntax of tsmon.

-d Displays statistics when a ^\ character (control-backslash or hex $1C) is typed on a monitored terminal.

-l=<prog>	Forks <prog>, an alternate login program.
-p	Displays an "online" prompt to each timesharing terminal being monitored by tsmon.
-r=<prog>	Forks an alternate shell program.
-z	Reads the device names from standard input.
-z=<path>	Reads the device names from <path>.

EXAMPLES: This command starts timesharing on term and t1, printing a welcome message to each. A similar command might be used as the last line of a system startup file.

```
tsmon -dp /term /t1&
2 devices online                (confirmation by tsmon)
```

The -d option causes tsmon to print various statistics about the devices being monitored whenever control-backslash (^\) is typed on either terminal. The statistics might look something like this:

```
tsmon started 12-11-90 20:38:15 with 2 devices     0:36:06
 /term     quiet at  0:08:07   cumulative time  3:29:30   logins: 1/9
*/t1       quiet at  0:36:03   cumulative time  3:57:46   logins: 2/4
```

NOTE: The standard input device shown for tsmon by the procs utility always indicates the last device to gain tsmon's attention.

You must implement the SS_SSig I$SetStat function (send signal on data ready) on any device to be monitored by tsmon. Because this function is used (for example, instead of I$ReadLn), it is possible to output data to a terminal that is *not* logged in without having to wait for someone to press a key.

unlink — Unlink Memory Module

SYNTAX: **unlink [<opts>] {<modname>}**

FUNCTION: unlink tells OS-9 that you no longer need the memory module(s) named

To unlink an attached module, type unlink and the name(s) of the module(s) to unlink. The link count is then be decremented by one. If the link count becomes zero, the module directory entry is deleted and the memory is de-allocated. It is good practice to unlink modules whenever possible to make most efficient use of available memory resources.

WARNING: Never unlink a module you did not link to or load. Unlinking a module more than once may prematurely lower its link count and possibly destroy the module while it is still in use.

OPTIONS:

-?	Displays the options, function, and command syntax of unlink.
-z	Reads the module names from standard input.
-z=<file>	Reads the module names from <file>.

EXAMPLES:

$ unlink pgm pm5 pgm9

Unlinks pgm, pgm5, and pgm9 and lowers the link count of each module by one.

$ dir -u ! unlink -z

Pipes an unsorted listing of the current data directory to unlink. This unlinks all modules contained in the directory and lowers the link count of each module by one.

$ unlink -z=namefile

Unlinks each module listed in namefile and lowers the link count of each module by one.

```
$ mdir
  Module Directory at 14:44:35
kernel    init     p32clk    rbf      p32hd
h0        d0       r0        edit     mdir
$ unlink edit
$ mdir
  Module Directory at 14:44:35
kernel    init     p32clk    rbf      p32hd
h0        d0       r0        mdir
```

unsetenv — Clear Environment Parameter

SYNTAX: **unsetenv <eparam>**

FUNCTION: unsetenv deletes the specified environment variable from the environment list.

To use setenv, type unsetenv, followed by the environment parameter to delete. This removes the variable from the environment list.

NOTE: If the specified variable has not been previously defined, unsetenv has no effect and it gives you no message.

EXAMPLES:

```
$ unsetenv _sh
$ unsetenv TERM
```

SEE ALSO: setenv and printenv utility descriptions

w/wait — Wait for One/All Child Process(es) to Terminate

SYNTAX:

```
w
wait
```

FUNCTION: w causes the shell to wait for the termination of one child process before returning with a prompt. wait causes the shell to wait for all child processes to terminate before returning with a prompt.

Type w or wait and a carriage return. When the shell prompt is displayed, the child process(es) have terminated.

EXAMPLES:

```
$ list file1 >/p1&
$ list file2.temp ! filter >file2&
$ wait
$ list file2 >/p1
```

In this example, the prompt returns when the first of these three processes (one, two, or three) terminates:

```
$ one&
$ two&
$ three$
$ w
$
```

xmode — Examine or Change Device Initialization Mode

SYNTAX: **xmode [<opts>] <devname> [<arglist>] {<devname>}**

FUNCTION: xmode displays or changes the initialization parameters of any SCF-type device such as a video display, printer, RS-232 port, etc. Some common uses are to change the baud rates and control key definitions.

NOTE: xmode can only be used for SCF or GFM devices.

To use the xmode utility, type xmode and any parameters to change. If no parameters are given, the present values for each parameter are displayed. Otherwise, the parameter(s) given in the parameter list are processed. You can give any number of parameters, separated by spaces or commas. You must specify a device name to process the parameter(s) given in the parameter list.

If a parameter is set to zero, the device no longer uses the parameter until it is re-set to a recognizable code. For example, set xon and xoff to zero:

```
xmode /term xon=0 xoff=0
```

/term will not recognize xon and xoff until the values are re-set.

To re-set the values of a parameter to its default, type xmode and specify the parameter with no value. This re-sets the parameter to the default value given in this manual.

xmode is similar to the tmode utility. tmode only operates on open paths so it has a temporary effect. xmode actually updates the device descriptor. The change persists as long as the computer is running, even if paths to the device are repetitively opened and closed.

Five parameters need further explanation: type, par, cs, stop, and baud. These parameters are changed by xmode only if the device is iniz-ed directly after the xmode changes are made. This is usually done in the startup file or by first deiniz-ing a file. For example, the following command sequence changes the baud rate of /t1 to 9600:

```
$ deiniz t1
$ xmode baud=9600
$ iniz t1
```

This type of command sequence changes the device descriptor and initializes it on the system. Only the five parameters mentioned above need this special sequence changed. All other xmode parameters are changed immediately.

OPTIONS: -? Display the options, function, and command syntax of xmode.

-z Reads device names from standard input.

-z=<file> Reads device names from <file>.

Xmode Parameter Names

Name	Function
upc	Upper case only. Lower case characters are converted automatically to upper case.
noupc	Upper and lower case characters are permitted. Default.
bsb	Erase on backspace. Backspace characters are echoed as a backspace-space-backspace sequence. Default.
nobsb	No erase on backspace. Echoes single backspace only.
bsl	Backspace over line. Lines are deleted by sending backspace-space-backspace sequences to erase the same line for video terminals. Default.
nobsl	No backspace over line. Lines are deleted by printing a new line sequence for hard-copy terminals.
echo	Input characters echoed back to terminal. Default.
noecho	No echo
lf	Auto line feed on. Line feeds are automatically echoed to terminal on input and output carriage returns. Default.
nolf	Auto line feed off
null=n	Set null count. Number of null ($00) characters transmitted after carriage returns for return delay. The number is decimal. By default, the null count is set to zero.
pause	Screen pause on. Output suspended upon full screen. See pag parameter for definition of screen size. Output can be resumed by typing any key.
nopause	Screen pause mode off
pag=n	Set video display page length to n lines. n is a decimal number. Used for pause mode, see above.

Name	Function
bsp=h	Set input backspace character (normally <control>H, default = 08).

Numeric value of character in hexadecimal.

del=h	Set input delete line character (normally <control>X, default = 18). Numeric value of character in hexadecimal.
eor=h	Set end-of-record input character (normally <cr>, default = 0D). Numeric value of character in hexadecimal.
eof=h	Set end-of-file input character (normally <esc>, default = 1B). Numeric value of character in hexadecimal.
reprint=h	Set reprint line character (normally <control>D, default = 04). Numeric value of character in hexadecimal.
dup=h	Set duplicate last input line character (normally <control>A, default = 01). Numeric value of character in hexadecimal.
psc=h	Set pause character (normally <control>W, default = 17). Numeric value of character in hexadecimal.
abort=h	Abort character (normally <control>C, default = 03). Numeric value of character in hexadecimal.
quit=h	Quit character (normally <control>E, default = 05). Numeric value of character in hexadecimal.
bse=h	Set output backspace character (default = 08). Numeric value of character in hexadecimal.
bell=h	Set bell (alert) output character (default = 07). Numeric value of character in hexadecimal.
type=h	ACIA initialization value. Sets parity, character size, and number of stop bits. Value in hexadecimal. This value is affected by changing the individual par(ity), cs (character length), and stop (stop bits) values. This value is not affected by the xmode normal command. This value is not changed until the specified device is iniz-ed.
par=s	Sets parity using one of the following strings: odd, even, or none. Setting parity affects the type value. This value is not affected by xmode normal. This value is not changed until the specified device is iniz-ed.

Name	Function
cs=n	Sets character length using one of the following values:

n = 8, 7, 6 or 5 (bits)

Setting character length changes the type value. This value is not affected by xmode normal. This value is not changed until the specified device is iniz-ed.

stop=n Sets the number of stop bits used:

n = 1, 1.5 or 2 (stop bits)

Setting the stop bit value affects the type value. This value is not affected by xmode normal. This value is not changed until the specified device is iniz-ed.

baud=n Baud rate. The baud rate may currently be set to the following values:

n = 50 134.5 600 2000 4800 19200
75 150 1200 2400 7200 38400
110 300 1800 3600 9600 extern

This value is not affected by xmode normal and is not changed until the specified device is iniz-ed.

xon=h DC1 resume output character (normally <control>Q, default = 11). Numeric value of character in hexadecimal.

xoff=h DC2 suspend output character (normally <control>S, default = 13). Numeric value of character in hexadecimal.

tabc=h Tab character (normally <control>I, default = 09). Numeric value of character in hexadecimal.

tabs=n Number of characters between tab stops. The number is in decimal. By default, there are four characters between tab stops.

normal Set the terminal back to its default characteristics. This does not affect the following values: type, baud rate, parity, character length, and stop bits.

EXAMPLES: **$ xmode /term noupc lf null=4 bse=1F pause**

$ xmode /t1 pag=24 pause bsl noecho bsp=8 bsl=C

NOTES

End of Chapter

A

ASCII Conversion Chart

ASCII is an acronym for American Standard Code for Information Interchange. It consists of 96 printable and 32 unprintable characters. The following conversion table includes Binary, Decimal, Octal, Hexadecimal, and ASCII. The unprintable characters are defined below:

ASCII Symbol Definitions

Symbol	Definition	Symbol	Definition
ACK	acknowledge	FS	file separator
BEL	bell	GS	group separator
BS	backspace	HT	horizontal tabulation
CAN	cancel	LF	line feed
CR	carriage return	NAK	negative acknowledgement
DC	device control	NUL	null
DEL	delete	RS	record shipment
DLE	data link escape	SI	shift in
EM	end of medium	SO	shift out
ENQ	enquiry	SOH	start of heading
EOT	end of transmission	SP	space
ESC	escape	STX	start of text
ETB	end of transmission	SUB	substitute
ETX	end of text	SYN	synchronous idle
FF	form feed	US	unit separator
		VT	vertical tabulation

Binary	Decimal	Octal	Hex	ASCII
0000000	0	0	0	NUL
0000001	1	1	1	SOH
0000010	2	2	2	STX
0000011	3	3	3	ETX
0000100	4	4	4	EOT
0000101	5	5	5	ENQ
0000110	6	6	6	ACK
0000111	7	7	7	BEL
0001000	8	10	8	BS
0001001	9	11	9	HT
0001010	10	12	A	LF
0001011	11	13	B	VT
0001100	12	14	C	FF
0001101	13	15	D	CR
0001110	14	16	E	SO
0001111	15	17	F	SI
0010000	16	20	10	DLE
0010001	17	21	11	DC1
0010010	18	22	12	DC2
0010011	19	23	13	DC3
0010100	20	24	14	DC4
0010101	21	25	15	NAK
0010110	22	26	16	SYN
0010111	23	27	17	ETB
0011000	24	30	18	CAN
0011001	25	31	19	EM
0011010	26	32	1A	SUB
0011011	27	33	1B	ESC
0011100	28	34	1C	FS
0011101	29	35	1D	GS
0011110	30	36	1E	RS
0011111	31	37	1F	US
0100000	32	40	20	SP
0100001	33	41	21	!
0100010	34	42	22	"
0100011	35	43	23	#
0100100	36	44	24	$
0100101	37	45	25	%
0100110	38	46	26	&
0100111	39	47	27	’
0101000	40	50	28	(
0101001	41	51	29	)
0101010	42	52	2A	*

Binary	Decimal	Octal	Hex	ASCII
0101011	43	53	2B	+
0101100	44	54	2C	,
0101101	45	55	2D	-
0101110	46	56	2E	.
0101111	47	57	2F	/
0110000	48	60	30	0
0110001	49	61	31	1
0110010	50	62	32	2
0110011	51	63	33	3
0110100	52	64	34	4
0110101	53	65	35	5
0110110	54	66	36	6
0110111	55	67	37	7
0111000	56	70	38	8
0111001	57	71	39	9
0111010	58	72	3A	:
0111011	59	73	3B	;
0111100	60	74	3C	<
0111101	61	75	3D	=
0111110	62	76	3E	>
0111111	63	77	3F	?
1000000	64	100	40	@
1000001	65	101	41	A
1000010	66	102	42	B
1000011	67	103	43	C
1000100	68	104	44	D
1000101	69	105	45	E
1000110	70	106	46	F
1000111	71	107	47	G
1001000	72	110	48	H
1001001	73	111	49	I
1001010	74	112	4A	J
1001011	75	113	4B	K
1001100	76	114	4C	L
1001101	77	115	4D	M
1001110	78	116	4E	N
1001111	79	117	4F	O
1010000	80	120	50	P
1010001	81	121	51	Q
1010010	82	122	52	R
1010011	83	123	53	S
1010100	84	124	54	T
1010101	85	125	55	U

Binary	Decimal	Octal	Hex	ASCII
1010110	86	126	56	V
1010111	87	127	57	W
1011000	88	130	58	X
1011001	89	131	59	Y
1011010	90	132	5A	Z
1011011	91	133	5B	[
1011100	92	134	5C	\
1011101	93	135	5D	]
1011110	94	136	5E	^
1011111	95	137	5F	_
1100000	96	140	60	‘
1100001	97	141	61	a
1100010	98	142	62	b
1100011	99	143	63	c
1100100	100	144	64	d
1100101	101	145	65	e
1100110	102	146	66	f
1100111	103	147	67	g
1101000	104	150	68	h
1101001	105	151	69	i
1101010	106	152	6A	j
1101011	107	153	6B	k
1101100	108	154	6C	l
1101101	109	155	6D	m
1101110	110	156	6E	n
1101111	111	157	6F	o
1110000	112	160	70	p
1110001	113	161	71	q
1110010	114	162	72	r
1110011	115	163	73	s
1110100	116	164	74	t
1110101	117	165	75	u
1110110	118	166	76	v
1110111	119	167	77	w
1111000	120	170	78	x
1111001	121	171	79	y
1111010	122	172	7A	z
1111011	123	173	7B	{
1111100	124	174	7C	|
1111101	125	175	7D	}
1111110	126	176	7E	~
1111111	127	177	7F	DEL

B

The ROM Debugger

This appendix documents the debug version of the ROM debugger. A new ROM debugger, RomBug, is also available. RomBug is documented in the ***OS-9 ROM Debugger's User's Manual***.

The ROM Debugger

The ROM debugger is an optional part of the Professional OS-9 package. The ROM debugger is not a conventional program because you cannot invoke it from the command line. Assuming the ROM debugger is present and enabled, it is invoked in the following situations:

- When the machine is turned on and the UseDebug routine in the sysinit.a file returns the Zero flag of the CCR as false.
- When the abort signal (auto vector level 7) is encountered.
- When a bus error, address error, illegal instruction error, or trace exception is encountered.

Overview of Debugger Functions

The ROM debugger loads and tests OS-9 and I/O drivers. The debugger's command set allows you to analyze programs by tracing, single instruction stepping, and breakpointing. It can disassemble instructions as the instructions are traced or stepped, or as a block. Commands can also examine or alter memory or CPU registers.

Depending on the type of debugger options selected, you can communicate with the host system as a terminal and download programs into RAM for testing via the communications link.

The debugger accepts command lines from the console. The command lines consist of a command code followed by a return key. Use the backspace (<control>H) and line delete (<control>X) keys to correct errors. If the system's ioxxx.a files resemble the standard Microware versions, you can use xoff (<control>S) and xon (<control>Q) to suspend and resume output, respectively.

Expressions and Register Names

In some commands, the debugger can accept number expressions, shown as <num> or <len>, and address expressions, shown as <addr>. Both types of expressions have the same syntax. Expressions can be numbers or a combination of numbers, operators, and register names. Expressions are evaluated from left to right without priority, unless parentheses are used.

All numbers are assumed to be hexadecimal unless preceded with a pound sign character (#). For example, 200 is interpreted as a hex number but #200 is interpreted as a decimal number.

Register names consist of a period (.) followed by the usual assembly language name. For example, .a3 refers to register A3. Register names can be used freely in expressions.

The operators recognized by the debugger are:

One-Operand Operators:	-	negative
	~	bit-by-bit NOT
Two-Operand Operators:	+	add
	-	subtract
	*	multiply
	/	divide
	>	shift right; A>B shifts A right B bits
	<	shift left; A<B shifts A left B bits
	&	bit-by-bit AND
	|	bit-by-bit OR
	^	bit-by-bit XOR (exclusive OR)

The debugger has a special internal register called the ***relocation register***. This is used to add a constant offset to addresses. You can change the value of the relocation register at any time using the .r command.

NOTE: The display mode and change memory mode commands for the debugger are not affected by the relocation register offset.

It is often convenient to set the relocation register to the beginning physical address of a program code section or data area. Subsequent address commands can use the same offsets printed on assembler listings. Any address expression consisting of only a number (no operator) automatically has the relocation value added. The value of the relocation register can also be used in expressions or changed by referring to the register as ".r".

The Debugger and Traps

Many of the debugger functions are implemented using traps. In particular, breakpoints cannot be used in ROM because breakpoints work by transparently replacing the existing instruction opcodes with opcodes that cause an "illegal instruction" trap. Obviously, instructions in ROM cannot be replaced in this manner.

The e command alternately enables and disables the debugger. When the debugger is enabled, it handles all address errors, bus errors, illegal instructions, and trace traps. The level 7 autovector trap is also reserved for use with an optional abort switch. Before the OS-9 kernel is started, traps not deliberately set by the debugger cause appropriate diagnostic messages to be displayed on the console.

When the debugger is disabled, all traps are passed to OS-9. To run the OS-9 user debug utility after the system is up, the ROM debugger must be disabled.

Breakpoints and Caching

The debugger uses traps to set up breakpoints. Consequently, systems such as 68020 systems that contain instruction caches may have occasional problems with missed breakpoints. This occurs when a breakpoint is set at an instruction location that is currently cached. The debugger sets an "illegal instruction" trap in the code location specified, but the CPU executes the cached version of the instruction, causing the breakpoint to be missed.

To avoid this problem, Microware recommends that *all* cache resources for the system be disabled while using the ROM debugger, if possible.

The Talk-Through Command

The second communications port on the target system is used for communications with the host system to provide download and talk-through functions. You can make versions of the debugger that omit the download or both download and talk-through functions in order to save ROM space.

Talk-through mode makes the debugger transparently pass data between the target system's terminal and the communications port to the host system. This effectively makes the target system terminal act as a host system terminal. The target system's terminal can be used to edit, assemble, etc., on the host system. This eliminates the need for two terminals. Use the following command to enter talk-through mode:

tm <EscChar>

This mode is exited when the specified escape character is typed.

Obviously, you should select the escape character carefully so it will not be the same as one used in normal communications with the host. Infrequently used characters such as the tilde (~) are recommended.

The Download Command

The download command passes a command to the host system which causes it to send program data to the target system via the communications link. The program is loaded into RAM memory.

The program must be in the industry-standard Motorola S-record format. Only S1, S2, S3, S7, S8, and S9 record formats are recognized. The binex utility must be used to convert the OS-9 linker output from its normal binary format to S-record format. binex is a standard utility on professional OS-9 systems, licensed OS-9 distribution packages, and Port Paks. A Unix version is included in the distribution packages for VAX systems.

NOTE: Refer to the ***OS-9 Utilities*** section for more information on the binex utility.

The S-record format has data records that include a ***load address*** that specifies where to load the program in memory. OS-9 programs are position-independent, so the load address always starts at address zero. As S-records are received, the load addresses are added to the debugger's relocation register value to determine the actual address in RAM where the program is stored.

NOTE: You must download all program modules before OS-9 is executed for the first time. Otherwise, the modules will not be found by the search.

The relocation register to the area of RAM reserved for downloaded code in the boot.a special search table must be set. The two versions of the download command are:

Name	Description

l <HostCmd> Downloads data in Motorola S-record format. <HostCmd> is sent to the host as a command line to trigger the download. I/O delay must be set in register .d0 before the download. The load addresses are displayed every 512 bytes.

le <HostCmd> Same as l <HostCmd> except received S-records are also displayed on the console instead of load addresses.

The <HostCmd> sent to the host is the command required to dump the S-record file. For OS-9 hosts, the screen pause must be turned off using the tmode nopause command. A sample download command for an OS-9 host system is:

```
.r f1000 l binex objs/boot320
```

A sample download command for a Unix host system is:

```
l cat s.rec.file
```

The debugger transmits the command string to the host and then expects the host to begin transmitting S-records. The download ends when an S9 type record is received.

Sometimes the target system cannot keep up with a sustained high data rate when downloading. Therefore, the debugger sends xon and xoff to the host for flow control. If the host system does not respond immediately to xoff, you must set up a buffering delay count in register .d0 before using the download commands. A value of 20 works well in most cases with a data link running at 9600 baud, but you may have to experiment with this value as it is dependent on a combination of characteristics of the host system:

- xoff response lag time
- The target system CPU speed
- The baud rate

If the download command seems to hang up, a <control>E character aborts the download and also sends an abort signal to the host system. This may happen if the I/O buffer delay is not large enough or if the OS-9 host's screen pause is on.

Downloading using these commands should only be attempted after a hardware reset or after a debugger rst command. Otherwise, stack/data conflicts may occur within OS-9 and may produce strange results.

If you are debugging only one module, the module should be kept in a different file than the main OS-9 download file. This allows the main OS-9 code already in memory to be used and only the new version of the module will have to be downloaded. This will save a considerable amount of time. The rst command must be used first.

Basic Debugger Commands

Command	Description
b	Display addresses of all breakpoints.
b <addr>	Set breakpoint at <addr>. <addr> is relative to the default relocation register.
c <mod> <addr>	Enter change memory mode starting at <addr>. <mod> applies until change mode is exited. The default data length is one byte (8 bits). The <mod> options are: w R/W words (16 bits) l R/W long words (32 bits) n No read for match or print m No reread for match test o R/W odd addresses, bytes only v R/W even addresses, bytes only Change mode commands are: <CR> Move to next location <num> Store new value, reread, verify match, move to next location - Move to previous location + Move to next location . Exit mode Commands may be strung together. For example, the following command changes one location and then exits change mode: **c .a5+3c FF .**
d <addr> [<len>]	Enter memory display mode beginning at <addr>. Contents of memory are displayed in hex and ASCII. If <len> is not specified, 256 bytes are displayed. Display mode commands are: <CR> Display next <len> bytes . Exit mode other Exit mode, interpret as command **NOTE**: The display mode and change memory mode commands for the debugger are not affected by the relocation register offset.

Command	Description
di <addr> [<len>]	Disassemble and display <len> instructions beginning at <addr>. If <len> is not specified, 20 instructions are displayed. Disassemble mode commands are: <CR> Display next <len> bytes . Exit mode other Exit mode, interpret as command
e	Enable/disable debugger.
g	Execute program starting at <PC>.
g <addr>	Execute program starting at <addr>. **NOTE:** If the program is stopped at a breakpoint, it is necessary to trace one instruction before using the g command.
k <addr>	Kill (remove) breakpoint located at <addr>. <addr> is relative to the default relocation register.
k*	Kill all breakpoints.
l<hostcmd>	Download data in Motorola S-record format. <hostcmd> is sent to the host as a command line to trigger the download. I/O delay must be set in .d0 before the download. The load addresses are displayed every 512 bytes.
le<hostcmd>	Same as l<hostcmd>, except received S-records are displayed instead of load addresses.
rst	Reset system; PC = Initial PC, SSP = Initial SSP, and SR = Supervisor state interrupts masked are set to level 7. This allows a g command to restart the system.
t <num>	Enter trace mode and trace <num> instructions. Trace mode commands are: <CR> Trace <num> more instructions . Exit trace mode other Exit trace mode, interpret as command
tm <EscChar>	Enter talk-through mode. This mode is exited when the specified escape character is typed.

Command	Description
.	Display all registers.
.<reg> <num>	Set register <reg> to value <num>.
.pc <addr>	Set program counter to <addr>.

.r <num>	Set relocation register to <num>.

End of Appendix B

C

Glossary

application program:

A program that needs an operating system environment to execute. For example, word processing, accounting, or spreadsheet programs.

ASCII:

The standard code of symbols, including alphanumerics, used in a computer environment. ASCII stands for American Standard Code for Information Interchange.

attributes:

A set of status codes that control access to a file for security. Also indicates if a file is a directory or not.

bit:

An abbreviation for binary digit. This is the most basic unit of information used by a computer. It is capable of two values: one and zero.

bit map:

A binary table in which each bit represents a specific location of memory accessable to the central processing unit (CPU).

backup:

A utility provided with OS-9 that allows you to create a duplicate copy of an existing disk. Also, the copied disk.

boot (bootstrap or cold start):

A startup function that initially loads the operating system into memory and starts it after the computer is first turned on or after it is reset.

byte:
Unit of memory consisting of 8 binary on/off switches (bits).

cold start:
see boot.

command:
A request made from the keyboard for the execution of a specific operation. Also, sometimes refers to one of the utilities provided with OS-9.

command interpreter:
Software that translates input commands into machine language commands causing the computer to perform the requested actions. The name of OS-9's command interpreter program is shell.

command line:
A single line of input including a keyword that the operating system can understand and act upon. A command line may also include an object and the parameters of the command.

concurrent execution:
The act of deliberately running a program at the same time as another program; also the effect multitasking has on programs. See also: multi-tasking, sequential execution.

cross-development:
This refers to programs developed on one computer for the purpose of translating instructions for/to another computer.

data directory:
A directory used by OS-9 to locate data files used by programs. You can change which directory is the current data directory. See also: directory.

data module:
A type of module used for shared variable storage by two or more tasks. See also: memory module.

default system device:
This refers to the system device (disk, RAM, etc.) used for information and program storage used by a computer. The OS-9 mnemonic for this device is /dd.

device descriptor module:
A type of module which contains the identification and initialization values for a specific I/O device. The name of the device descriptor module is also the logical name by which the device is referred to by the software.

device driver module:
A program module that contains the software necessary to interface OS-9 to a particular type of I/O device. A single driver module is often shared by many identical types of I/O ports (such as for terminals).

directory:

A special file used by OS-9 which contains the names of other files or directories. A directory allows you to organize your files by placing all files to be grouped together in one place.

DMA:

Abbreviation for Direct Memory Access. This is a procedure or method used to gain direct access to the computer's main storage without involving the central processing unit (CPU).

environment:

The shell environment is a list a variables that may be accessed by the shell and any user applications to be used as ***global*** variables. Each user's shell maintains a unique environment.

exception:

A special control signal that diverts the attention of the computer from the main program because of a particular event, signal, or set of circumstances.

execution directory:

A directory used by OS-9 to locate files containing programs (utilities). You can change which directory is your current execution directory at will, but usually the system-wide commands directory (CMDS) is used. See also: directory.

execution modifier:

A character in a command line recognized by the shell that changes the default execution of the command. Modifiers are used to change the memory size (#), process priority (^), and standard I/O paths (>, <, >>).

FPCP:

An abbreviation for a Floating Point Co-Processor (for example, 68881, 68882).

file:

An ordered sequence of bytes used for mass storage. A file may contain a program, text, a list of commands, etc.

file pointer:

An indicator of where the next access in a file will occur.

file system:

The logical organization of mass storage and all other I/O devices into a common and compatible system based on paths, files, and directories.

filter:

A special type of utility command program specially designed for use with pipes. A filter typically performs some useful function on the data flowing through it such as sorting, editing, etc. See also: pipe.

format:

A utility provided in OS-9 to initialize a disk before it is used. New disks must be formatted prior to being used. Also refers to the physical division of a disk into sectors, clusters, etc.

group.user ID:

This number is used for file system security purposes. Files have owner and public access permissions. If no public access permissions are set, only the owner of a file may access it. There are two types of file ownership: by the ***group*** and by the ***user***. Each file is stored with a ***group.user*** ID. Any user with the same user ID as the file is considered an owner. Any user with the same group ID as the file is also considered an owner. This allows people who work on the same project to be able to access the same files via their group number.

interrupt:

A control signal caused by an event, signal, or set of circumstances that cause a break in the normal flow of a system or routine such that the flow can be resumed from that point at a later time.

keyword:

A program, procedure file, or built-in command that the shell recognizes in a command line.

link:

An OS-9 function used to request the location of a memory module of a given name prior to its use. Causes the user count of the module to be increased by one. unlink is the opposite function. See also: memory module and module directory.

memory module:

A named block of program code or data that is or can be loaded into memory. Memory modules use a special standardized format. See also: data module, module directory, and program module.

MMU:

Abbreviation for Memory Management Unit. MMU is special hardware used to provide logical to physical address translation and to protect system memory from accidental modification. Some MMU hardware also provides virtual memory capabilities. MMU is a super-set of SPU. See SPU.

module directory:

A list automatically maintained by OS-9 of the name, location, and user count of each memory module which is present in memory. See also: link and memory module.

multi-tasking:

A feature of the operating system which allows multiple programs to be run at the same time.

multi-user:

A function of the operating system which allows multiple users to use the system at the same time; provides security for the system and each user's files. Sometimes referred to as timesharing.

NFM:

The Network File Manager is the OS-9 network file manager module that supports networking. NFM is responsible for maintaining accurate communication between device drivers across a network.

operating system:

The master control program that manages the operation of the computer and provides commonly-used functions such as I/O for other programs.

owner attributes:

Owner read, owner write, and owner execute. An owner of a file is a user with the same group number or user ID associated with the file. If set, the owner attributes allow access to the file by the owner. See public attributes.

parameters:

A character or symbol recognized by the shell in a command line that specifies additional conditions for the execution of the command.

password:

A user-unique code word used to log on to a timesharing system that validates identity for security.

password file:

A file that contains a list of all valid user names and passwords for users on the system.

path:

The routing of input or output between a program and a file or I/O device.

path descriptor:

A data structure used by file managers and device drivers to perform I/O functions. A path descriptor contains information specific to an open path. Every open path is represented by a path descriptor. Path descriptors are allocated and deallocated as paths are opened and closed.

pathlist:

A list of names that specifies the location of the file or I/O device to be associated with a path. It may in various combinations include a device name, one or more directory names, and a file name.

permission:

Term used to indicate that a certain attribute is set for a file. For example, owner read permission. Also sometimes used for the term attribute.

pipe:

A special type of I/O path that connects and synchronizes the standard output of a program to the standard input of another simultaneously running program. Chains of piped programs are called ***pipelines***. See also: filter and standard I/O paths.

pipeline:

See pipe.

position independent code:

Code that does not reference absolute addresses. All OS-9 code must be position independent.

procedure file:

A file that contains a list of commands to be performed by the shell as if they were typed in from a keyboard.

process:

An individual running program; synonymous with task.

process ID:

A unique code number assigned by OS-9 when a new process is created. It identifies the process in subsequent commands or system calls.

program module:

A memory module which contains executable code. All OS-9 programs must be kept in memory module format. See also: memory module.

public attributes:

Public read, public write, public execute. The public is defined as any user not having the same user ID or group number as the file. If set, these attributes allow anyone access to the file. See owner attributes.

RAM disk:

A special device driver module that allows the part of the system's main memory to behave as a disk drive. This permits high speed, but non-permanent, storage for small, commonly used files.

RBF:

The Random Block File manager is the OS-9 file manager module that supports random access, block oriented mass storage devices (disk systems, etc.). RBF can handle any number or type of such systems simultaneously. It is responsible for maintaining the logical and physical file structure for OS-9.

record locking:

A special function built into OS-9's file management system which eliminates problems caused by two or more users trying to update the same part of a file at the same time.

redirection:

A method of changing the normal input and/or output of a program to alternate files or I/O devices. This is done at the time the program is run through the use of modifiers in the command line, as opposed to at the time it is written. See also: standard I/O paths.

re-entrant code:

Code shared by two or more programs. This saves program memory space that would be duplicated in each program. Re-entrant code must not alter itself in any way.

root directory:

The directory entered when the user first logs on to the system. This directory is specified in the password file.

SBF:

The Sequential Block File manager is the OS-9 file manager module that supports sequential access, block oriented mass storage devices (tape systems). SBF can handle any number or type of such systems simultaneously.

SCF:

The Sequential Character File manager is the OS-9 manager module that supports sequential access, character oriented devices (terminals, printers). SCF can handle any number or type of such systems simultaneously.

self-modifying code:

Code that alters itself during execution. OS-9 code must not be self-modifying.

separator:

A special character recognized by shell in the command line that specifies the sequential or concurrent execution of more than one process. The special characters are: a semicolon (;) for sequential execution and an ampersand (&) for concurrent execution.

sequential execution:

The act of deliberately running programs one at a time in the order specified as opposed to concurrently. This is done when it is necessary for one program to be completed before the next one in a sequence is begun. See also: multi-tasking, concurrent execution, and separator.

shell:

OS-9's command interpreter program. This program acts as an interface between your and the operating system. See also: command interpreter.

signal:

A software interrupt that can be sent from one process to another or from OS-9 to a process. For example, the <control>E abort key causes an abort signal to be sent to a program.

single user:

A mode of operation where only one user utilizes the computer. Also, a file attribute that allows only one user at a time to access the file.

SPU:

Abbreviation for System Protection Unit. SPU is special hardware used to protect system memory from accidental modification. If a process tries to access any part of system memory or any other process' memory, the SPU hardware causes a bus error and the system aborts the process.

standard I/O path:

The default I/O path used by a program for routine input and output. Every process has three standard I/O paths: input, output, and error output. See also: path and redirection.

system call:

A request from a programming language that causes OS-9 to perform a specific function such as input/output.

system disk:

A disk which contains the system boot file plus other common system-wide files such as the utility command set.

task:

See process.

timesharing:

See multi-user.

UNIX:

An operating system similar to OS-9.

user name:

A name used externally to identify each user when logging on to the system. Based on the contents of the password file, the system converts this name to the corresponding user ID number for subsequent internal use. See also: user ID and password file.

user ID:

A unique code number used to identify the user's files and processes. See also: user name and password file.

utility:

One of the set of programs supplied with OS-9 that is used to perform housekeeping, maintenance, customization, and convenience functions.

End of Appendix C

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