

UNIX™ TIME-SHARING SYSTEM:

UNIX PROGRAMMER'S MANUAL

*Seventh Edition, Volume 1*

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## PREFACE

Although this Seventh Edition no longer bears their byline, Ken Thompson and Dennis Ritchie remain the fathers and preceptors of the UNIX<sup>†</sup> time-sharing system. Many of the improvements here described bear their mark. Among many, many other people who have contributed to the further flowering of UNIX, we wish especially to acknowledge the contributions of A. V. Aho, S. R. Bourne, L. L. Cherry, G. L. Chesson, S. I. Feldman, C. B. Haley, R. C. Haight, S. C. Johnson, M. E. Lesk, T. L. Lyon, L. E. McMahon, R. Morris, R. Muha, D. A. Nowitz, L. Wehr, and P. J. Weinberger. We appreciate also the effective advice and criticism of T. A. Dolotta, A. G. Fraser, J. F. Maranzano, and J. R. Mashey; and we remember the important work of the late Joseph F. Ossanna.

B. W. Kernighan  
M. D. McIlroy

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## INTRODUCTION TO VOLUME 1

This volume gives descriptions of the publicly available features of the UNIX† system. It does not attempt to provide perspective or tutorial information upon the UNIX operating system, its facilities, or its implementation. Various documents on those topics are contained in Volume 2. In particular, for an overview see ‘The UNIX Time-Sharing System’ by Ritchie and Thompson; for a tutorial see ‘UNIX for Beginners’ by Kernighan.

Within the area it surveys, this volume attempts to be timely, complete and concise. Where the latter two objectives conflict, the obvious is often left unsaid in favor of brevity. It is intended that each program be described as it is, not as it should be. Inevitably, this means that various sections will soon be out of date.

The volume is divided into eight sections:

1. Commands
2. System calls
3. Subroutines
4. Special files
5. File formats and conventions
6. Games
7. Macro packages and language conventions
8. Maintenance

Commands are programs intended to be invoked directly by the user, in contradistinction to subroutines, which are intended to be called by the user’s programs. Commands generally reside in directory */bin* (for *bin* ary programs). Some programs also reside in */usr/bin*, to save space in */bin*. These directories are searched automatically by the command interpreter.

System calls are entries into the UNIX supervisor. Every system call has one or more C language interfaces described in section 2. The underlying assembly language interface, coded with opcode *sys*, a synonym for *trap*, is given as well.

An assortment of subroutines is available; they are described in section 3. The primary libraries in which they are kept are described in *intro*(3). The functions are described in terms of C, but most will work with Fortran as well.

The special files section 4 discusses the characteristics of each system ‘file’ that actually refers to an I/O device. The names in this section refer to the DEC device names for the hardware, instead of the names of the special files themselves.

The file formats and conventions section 5 documents the structure of particular kinds of files; for example, the form of the output of the loader and assembler is given. Excluded are files used by only one command, for example the assembler’s intermediate files.

Games have been relegated to section 6 to keep them from contaminating the more staid information of section 1.

Section 7 is a miscellaneous collection of information necessary to writing in various specialized languages: character codes, macro packages for typesetting, etc.

The maintenance section 8 discusses procedures not intended for use by the ordinary user. These procedures often involve use of commands of section 1, where an attempt has been made to single out

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peculiarly maintenance-flavored commands by marking them 1M.

Each section consists of a number of independent entries of a page or so each. The name of the entry is in the upper corners of its pages, together with the section number, and sometimes a letter characteristic of a subcategory, e.g. graphics is 1G, and the math library is 3M. Entries within each section are alphabetized. The page numbers of each entry start at 1; it is infeasible to number consecutively the pages of a document like this that is republished in many variant forms.

All entries are based on a common format, not all of whose subsections will always appear.

The *name* subsection lists the exact names of the commands and subroutines covered under the entry and gives a very short description of their purpose.

The *synopsis* summarizes the use of the program being described. A few conventions are used, particularly in the Commands subsection:

**Boldface** words are considered literals, and are typed just as they appear.

Square brackets [ ] around an argument indicate that the argument is optional. When an argument is given as 'name', it always refers to a file name.

Ellipses '...' are used to show that the previous argument-prototype may be repeated.

A final convention is used by the commands themselves. An argument beginning with a minus sign '-' is often taken to mean some sort of option-specifying argument even if it appears in a position where a file name could appear. Therefore, it is unwise to have files whose names begin with '-'.

The *description* subsection discusses in detail the subject at hand.

The *files* subsection gives the names of files which are built into the program.

A *see also* subsection gives pointers to related information.

A *diagnostics* subsection discusses the diagnostic indications which may be produced. Messages which are intended to be self-explanatory are not listed.

The *bugs* subsection gives known bugs and sometimes deficiencies. Occasionally also the suggested fix is described.

In section 2 an *assembler* subsection carries the assembly language system interface.

At the beginning of the volume is a table of contents, organized by section and alphabetically within each section. There is also a permuted index derived from the table of contents. Within each index entry, the title of the writeup to which it refers is followed by the appropriate section number in parentheses. This fact is important because there is considerable name duplication among the sections, arising principally from commands which exist only to exercise a particular system call.

## HOW TO GET STARTED

This section sketches the basic information you need to get started on .ie 1>0 UNIX : how to log in and log out, how to communicate through your terminal, and how to run a program. See 'UNIX for Beginners' in Volume 2 for a more complete introduction to the system.

*Logging in.* You must call UNIX from an appropriate terminal. UNIX terminals are typified by the TTY 43, the GE Terminet 300, the DASI 300S and 450, and most video terminals such as the Datamedia 5120 or HP 2640. You must also have a valid user name, which may be obtained, together with the telephone number, from the system administrators. The same telephone number serves terminals operating at all the standard speeds. After a data connection is established, the login procedure depends on what kind of terminal you are using.

*300-baud terminals:* Such terminals include the GE Terminet 300 and most display terminals run with popular modems. These terminals generally have a speed switch which should be set at '300' (or '30' for 30 characters per second) and a half/full duplex switch which should be set at full-duplex. (This switch will often have to be changed since many other systems require half-duplex). When a connection is established, the system types 'login:.'; you type your user name, followed by the 'return' key. If you have a password, the system asks for it and turns off the printer on the terminal so the password will not

appear. After you have logged in, the 'return', 'new line', or 'linefeed' keys will give exactly the same results.

*1200- and 150-baud terminals:* If there is a half/full duplex switch, set it at full-duplex. When you have established a data connection, the system types out a few garbage characters (the 'login:' message at the wrong speed). Depress the 'break' (or 'interrupt') key; this is a speed-independent signal to UNIX that a different speed terminal is in use. The system then will type 'login:,' this time at another speed. Continue depressing the break key until 'login:' appears in clear, then respond with your user name. From the TTY 37 terminal, and any other which has the 'newline' function (combined carriage return and linefeed), terminate each line you type with the 'new line' key, otherwise use the 'return' key.

*Hard-wired terminals.* Hard-wired terminals usually begin at the right speed, up to 9600 baud; otherwise the preceding instructions apply.

For all these terminals, it is important that you type your name in lower-case if possible; if you type upper-case letters, UNIX will assume that your terminal cannot generate lower-case letters and will translate all subsequent upper-case letters to lower case.

The evidence that you have successfully logged in is that the Shell program will type a '\$' to you. (The Shell is described below under 'How to run a program.')

For more information, consult *stty(1)*, which tells how to adjust terminal behavior, *getty(8)*, which discusses the login sequence in more detail, and *tty(4)*, which discusses terminal I/O.

*Logging out.* There are three ways to log out:

You can simply hang up the phone.

You can log out by typing an end-of-file indication (EOT character, control-d) to the Shell. The Shell will terminate and the 'login:' message will appear again.

You can also log in directly as another user by giving a *login(1)* command.

*How to communicate through your terminal.* When you type characters, a gnome deep in the system gathers your characters and saves them in a secret place. The characters will not be given to a program until you type a return (or newline), as described above in *Logging in*.

UNIX terminal I/O is full-duplex. It has full read-ahead, which means that you can type at any time, even while a program is typing at you. Of course, if you type during output, the printed output will have the input characters interspersed. However, whatever you type will be saved up and interpreted in correct sequence. There is a limit to the amount of read-ahead, but it is generous and not likely to be exceeded unless the system is in trouble. When the read-ahead limit is exceeded, the system throws away all the saved characters.

The character '@' in typed input kills all the preceding characters in the line, so typing mistakes can be repaired on a single line. Also, the character '#' erases the last character typed. Successive uses of '#' erase characters back to, but not beyond, the beginning of the line. '@' and '#' can be transmitted to a program by preceding them with '\'. (So, to erase '\', you need two '#'s). These conventions can be changed by the *stty(1)* command.

The 'break' or 'interrupt' key causes an *interrupt signal*, as does the The ASCII 'delete' (or 'rubout') character, which is not passed to programs. This signal generally causes whatever program you are running to terminate. It is typically used to stop a long printout that you don't want. However, programs can arrange either to ignore this signal altogether, or to be notified when it happens (instead of being terminated). The editor, for example, catches interrupts and stops what it is doing, instead of terminating, so that an interrupt can be used to halt an editor printout without losing the file being edited.

The *quit* signal is generated by typing the ASCII FS character. (FS appears many places on different terminals, most commonly as control-\  
or control- |.) It not only causes a running program to terminate but also generates a file with the core image of the terminated process. Quit is useful for debugging.

Besides adapting to the speed of the terminal, UNIX tries to be intelligent about whether you have a terminal with the newline function or whether it must be simulated with carriage-return and line-feed. In the latter case, all input carriage returns are turned to newline characters (the standard line delimiter) and both a carriage return and a line feed are echoed to the terminal. If you get into the wrong mode, the

*stty(1)* command will rescue you.

Tab characters are used freely in UNIX source programs. If your terminal does not have the tab function, you can arrange to have them turned into spaces during output, and echoed as spaces during input. The system assumes that tabs are set every eight columns. Again, the *stty(1)* command will set or reset this mode. Also, the command *tabs(1)* will set the tab stops automatically on many terminals.

*How to run a program; the Shell.* When you have successfully logged in, a program called the Shell is listening to your terminal. The Shell reads typed-in lines, splits them up into a command name and arguments, and executes the command. A command is simply an executable program. The Shell looks first in your current directory (see below) for a program with the given name, and if none is there, then in a system directory. There is nothing special about system-provided commands except that they are kept in a directory where the Shell can find them.

The command name is always the first word on an input line; it and its arguments are separated from one another by spaces.

When a program terminates, the Shell will ordinarily regain control and type a '\$' at you to indicate that it is ready for another command.

The Shell has many other capabilities, which are described in detail in section *sh(1)*.

*The current directory.* UNIX has a file system arranged in a hierarchy of directories. When the system administrator gave you a user name, he also created a directory for you (ordinarily with the same name as your user name). When you log in, any file name you type is by default in this directory. Since you are the owner of this directory, you have full permission to read, write, alter, or destroy its contents. Permissions to have your will with other directories and files will have been granted or denied to you by their owners. As a matter of observed fact, few UNIX users protect their files from destruction, let alone perusal, by other users.

To change the current directory (but not the set of permissions you were endowed with at login) use *cd(1)*.

*Path names.* To refer to files not in the current directory, you must use a path name. Full path names begin with '/', the name of the root directory of the whole file system. After the slash comes the name of each directory containing the next sub-directory (followed by a '/') until finally the file name is reached. For example, */usr/lem/flex* refers to the file *flex* in the directory *lem*; *lem* is itself a subdirectory of *usr*; *usr* springs directly from the root directory.

If your current directory has subdirectories, the path names of files therein begin with the name of the subdirectory with no prefixed '/'.

A path name may be used anywhere a file name is required.

Important commands which modify the contents of files are *cp(1)*, *mv(1)*, and *rm(1)*, which respectively copy, move (i.e. rename) and remove files. To find out the status of files or directories, use *ls(1)*. See *mkdir(1)* for making directories and *rmdir* (in *rm(1)*) for destroying them.

For a fuller discussion of the file system, see 'The UNIX Time-Sharing System,' by Ken Thompson and Dennis Ritchie. It may also be useful to glance through section 2 of this manual, which discusses system calls, even if you don't intend to deal with the system at that level.

*Writing a program.* To enter the text of a source program into a UNIX file, use the editor *ed(1)*. The three principal languages in UNIX are provided by the C compiler *cc(1)*, the Fortran compiler *f77(1)*, and the assembler *as(1)*. After the program text has been entered through the editor and written on a file, you can give the file to the appropriate language processor as an argument. The output of the language processor will be left on a file in the current directory named 'a.out'. (If the output is precious, use *mv* to move it to a less exposed name soon.) If you wrote in assembly language, you will probably need to load the program with library subroutines; see *ld(1)*. The other two language processors call the loader automatically.

When you have finally gone through this entire process without provoking any diagnostics, the resulting program can be run by giving its name to the Shell in response to the '\$' prompt.

Your programs can receive arguments from the command line just as system programs do, see *exec(2)*.

*Text processing.* Almost all text is entered through the editor *ed(1)*. The commands most often used to write text on a terminal are: *cat*, *pr*, *roff* and *nroff*, all in section 1.

The *cat* command simply dumps ASCII text on the terminal, with no processing at all. The *pr* command paginates the text, supplies headings, and has a facility for multi-column output. *Nroff* is an elaborate text formatting program. Used naked, it requires careful forethought, but for ordinary documents it has been tamed; see *ms(7)*. *Roff* is a simpler text formatting program, and requires somewhat less forethought.

*Troff* prepares documents for a Graphics Systems phototypesetter; it is very similar to *nroff*, and often works from exactly the same source text. It was used to produce this manual.

*Status inquiries.* Various commands exist to provide you with useful information. *Who(1)* prints a list of users presently logged in. *Date(1)* prints the current time and date. *Ls(1)* will list the files in your directory or give summary information about particular files.

*Surprises.* Certain commands provide inter-user communication. Even if you do not plan to use them, it would be well to learn something about them, because someone else may aim them at you.

To communicate with another user currently logged in, *write(1)* is used; *mail(1)* will leave a message whose presence will be announced to another user when he next logs in. The write-ups in the manual also suggest how to respond to the two commands if you are a target.

When you log in, a message-of-the-day may greet you before the first '\$'.

## CONVERTING FROM THE 6TH EDITION

There follows a catalogue of significant, mostly incompatible, changes that will affect old users converting to the 7th edition. No attempt is made to list all new facilities, or even all minor, but easily spotted changes, just the bare essentials without which it will be almost impossible to do anything.

*Addressing files.* Byte addresses in files are now long (32-bit) integers. Accordingly *seek* has been replaced by *lseek(2)*. Every program that contains a *seek* must be modified. *Stat* and *fstat(2)* have been affected similarly, since file lengths are now 32- rather than 24-bit quantities.

*Assembly language.* System entry points are no longer built in symbols. Their values must be obtained from */usr/include/sys.s*, see *intro(2)*. All system calls modify *r0*. This means that sequences like

```
mov    file,r0
sys    lseek,0,0,2
sys    write,buf,n
```

will no longer work. (In fact, *lseek* now modifies *r1* as well, so be doubly cautious.)

The *sleep(2)* entry point is gone; see the more general facility, *alarm*, plus *pause*.

Few library functions have assembly language entry points any more. You will have to simulate the C calling sequence.

*Stty and gtty.* These system calls have been extensively altered, see *ioctl(2)* and *tty(4)*.

*Archive files.* The format of files produced by *ar(1)* has been altered. To convert to the new style, use *arcv(1)*.

*C language, lint.* The official syntax for initialization requires an equal sign = before an initializer, and brackets { } around compound initial values; arrays and structures are now initialized honestly. Two-address operators, such as =+ and =-, are now written += and -= to avoid ambiguities, although the old style is still accepted. You will also certainly want to learn about

```
long integers
type definitions
casts (for type conversion)
unions (for more honest storage sharing)
#include <filename> (which searches in standard places)
```



The program *lint*(1) checks for obsolete syntax and does strong type checking of C programs, singly or in groups that are expected to be loaded together. It is indispensable for conversion work.

*Fortran.* The old *fc* is replaced by *f77*, a true compiler for Fortran 77, compatible with C. There are substantial changes in the language; see 'A Portable Fortran 77 Compiler' in Volume 2.

*Stream editor.* The program *sed*(1) is adapted to massive, repetitive editing jobs of the sort encountered in converting to the new system. It is well worth learning.

*Standard I/O.* The old *fopen*, *getc*, *putc* complex and the old *-lp* package are both dead, and even *getchar* has changed. All have been replaced by the clean, highly efficient, *stdio*(3) package. The first things to know are that *getchar*(3) returns the integer EOF (-1), which is not a possible byte value, on end of file, that 518-byte buffers are out, and that there is a defined FILE data type.

*Make.* The program *make*(1) handles the recompilation and loading of software in an orderly way from a 'makefile' recipe given for each piece of software. It remakes only as much as the modification dates of the input files show is necessary. The makefiles will guide you in building your new system.

*Shell, chdir.* F. L. Bauer once said Algol 68 is the Everest that must be climbed by every computer scientist because it is there. So it is with the shell for UNIX users. Everything beyond simple command invocation from a terminal is different. Even *chdir* is now spelled *cd*. You will want to study *sh*(1) long and hard.

*Debugging.* *Adb*(1) is a far more capable replacement for the debugger *db*. The first-time user should be especially careful about distinguishing / and ? in *adb* commands, and watching to make sure that the *x* whose value he asked for is the real *x*, and not just some absolute location equal to the stack offset of some automatic *x*. You can always use the 'true' name, *\_x*, to pin down a C external variable.

*Dsw.* This little-known, but indispensable facility has been taken over by *rm -ri*.

*Boot procedures.* Needless to say, these are all different. See section 8 of this volume, and 'Setting up UNIX' in Volume 2.





|   |   |           |
|---|---|-----------|
| sorted files . . . . .                            | clock daemon . . . . .                                | cron(8)   |
| system - issue a shell                            | close - close a file . . . . .                        | close(2)  |
| test - condition                                  | close or flush a stream . . . . .                     | fclose(3) |
| time - time a                                     | cli - clear i-node . . . . .                          | cli(1)    |
| nice, nohup - run a                               | cmp - compare two files . . . . .                     | cmp(1)    |
| uux - unix to unix                                | col - filter reverse line feeds . . . . .             | col(1)    |
| set, shift, times, trap, umask, wait -            | comm - select or reject lines common to two . . . . . | comm(1)   |
| intro - introduction to                           | command . . . . .                                     | system(3) |
| at - execute                                      | command . . . . .                                     | test(1)   |
| comm - select or reject lines                     | command . . . . .                                     | time(1)   |
| diff - differential file                          | command at low priority . . . . .                     | nice(1)   |
| cmp -   | command execution . . . . .                           | uux(1)    |
| diff3 - 3-way differential file                   | command language . . . . . /newgrp, read, readonly,   | sh(1)     |
| cc, pcc - C                                       | commands . . . . .                                    | intro(1)  |
| f77 - Fortran 77                                  | commands at a later time . . . . .                    | at(1)     |
| yacc - yet another compiler-                      | common to two sorted files . . . . .                  | comm(1)   |
| wait - await                                      | comparator . . . . .                                  | diff(1)   |
| test -  | compare two files . . . . .                           | cmp(1)    |
| mkconf - generate                                 | comparison . . . . .                                  | diff3(1)  |
| dcheck - file system directory                    | compiler . . . . .                                    | cc(1)     |
| icheck - file system storage                      | compiler . . . . .                                    | f77(1)    |
| mkfs -  | compiler . . . . .                                    | yacc(1)   |
| deroff - remove nroff, troff, tbl and eqn         | completion of process . . . . .                       | wait(1)   |
| ls - list   | condition command . . . . .                           | test(1)   |
| login/ . . . . . sh, for, case, if, while, break, | configuration tables . . . . .                        | mkconf(1) |
| ioctl, stty, gtty -                               | consistency check . . . . .                           | dcheck(1) |
| init, rc - process                                | consistency check . . . . .                           | icheck(1) |
| terminals-  | construct a file system . . . . .                     | mkfs(1)   |
| ecvt, fcvt, gcvt - output                         | constructs . . . . .                                  | deroff(1) |
| printf, fprintf, sprintf - formatted output       | contents of directory . . . . .                       | ls(1)     |
| scanf, fscanf, sscanf - formatted input           | continue, cd, eval, exec, exit, export, . . . . .     | sh(1)     |
| units -   | control device . . . . .                              | ioctl(2)  |
| dd -  | control initialization . . . . .                      | init(8)   |
| arcv -  | conventional names . . . . .                          | term(7)   |
| atof, atoi, atol -                                | conversion . . . . .                                  | ecvt(3)   |
| l3tol, ltol3 -                                    | conversion . . . . .                                  | printf(3) |
| localtime, gmtime, asctime, timezone -            | conversion . . . . .                                  | scanf(3)  |
| bcd, ppt -  | conversion program . . . . .                          | units(1)  |
| fortune - the book of changes and other           | convert and copy a file . . . . .                     | dd(1)     |
| cp -  | convert archives to new format . . . . .              | arcv(1)   |
| uucp, uulog - unix to unix                        | convert ASCII to numbers . . . . .                    | atof(3)   |
| dd - convert and                                  | convert between 3-byte integers and long . . . . .    | l3tol(3)  |
| brk, sbrk, break - change                         | convert date and time to ASCII . . . . . ctime,       | ctime(3)  |
| core - format of                                  | convert to antique media . . . . .                    | bcd(6)    |
| mem, kmem -                                       | cookies . . . . . ching,                              | ching(6)  |
| trigonometric functions . . . . . sin,            | copy . . . . .  | cp(1)     |
| sinh,   | copy . . . . .  | uucp(1)   |
| wc - word   | copy a file . . . . .                                 | dd(1)     |
| sum - sum and                                     | core - format of core image file . . . . .            | core(5)   |
|   | core allocation . . . . .                             | brk(2)    |
|   | core image file . . . . .                             | core(5)   |
|   | core memory . . . . .                                 | mem(4)    |
|   | cos, tan, asin, acos, atan, atan2 - . . . . .         | sin(3)    |
|   | cosh, tanh - hyperbolic functions . . . . .           | sinh(3)   |
|   | count . . . . .                                       | wc(1)     |
|   | count blocks in a file . . . . .                      | sum(1)    |
|   | cp - copy . . . . .                                   | cp(1)     |
|   | crash - what to do when the system crashes . . . . .  | crash(8)  |
|   | creat - create a new file . . . . .                   | creat(2)  |
|   | create an interprocess channel . . . . .              | pipe(2)   |
|   | creation mode mask . . . . .                          | umask(2)  |
|   | cron - clock daemon . . . . .                         | cron(8)   |
|   | crypt - encode/decode . . . . .                       | crypt(1)  |
|   | crypt, setkey, encrypt - DES encryption . . . . .     | crypt(3)  |
| - convert date and time to ASCII . . . . .        | ctime, localtime, gmtime, asctime, timezone . . . . . | ctime(3)  |
|   | cu - call UNIX . . . . .                              | cu(1)     |
|   | cubic - tic-tac-toe . . . . .                         | ttt(6)    |
|   | curve . . . . .                                       | spline(1) |
|   | daemon . . . . .                                      | cron(8)   |
|   | data . . . . .  | prof(1)   |
|   | data . . . . .  | ttys(5)   |
|   | data base subroutines . . . . . dbminit,              | dbm(3)    |

|  |  |               |
|--|--|---------------|
| null –   | data sink . . . . .                                  | null(4)       |
| types – primitive system                       | data types . . . . .                                 | types(5)      |
| join – relational                              | database operator . . . . .                          | join(1)       |
| du, dp – DU-11 201                             | data-phone interface . . . . .                       | du(4)         |
| date – print and set the                       | date . . . . .                                       | date(1)       |
| time, ftime – get                              | date and time . . . . .                              | time(2)       |
| gmtime, asctime, timezone – convert            | date and time to ASCII . . . . .                     | ctime(3)      |
| touch – update                                 | date last modified of a file . . . . .               | touch(1)      |
| nextkey – data base subroutines . . . . .      | dbminit, fetch, store, delete, firstkey, . . . . .   | dbm(3)        |
| check . . . . .                                | dc – desk calculator . . . . .                       | dc(1)         |
| dump,  | dcheck – file system directory consistency . . . . . | dcheck(1)     |
| adb –  | dd – convert and copy a file . . . . .               | dd(1)         |
| tp –   | ddate – incremental dump format . . . . .            | dump(5)       |
| crypt – encode/                                | debugger . . . . .                                   | adb(1)        |
| tc – TC-11/TU56                                | DEC/mag tape formats . . . . .                       | tp(5)         |
| chdir – change                                 | decode . . . . .                                     | crypt(1)      |
| eqnchar – special character                    | DECTape . . . . .                                    | tc(4)         |
| subroutines . . . . .                          | default directory . . . . .                          | chdir(2)      |
| dbminit, fetch, store,                         | definitions for eqn . . . . .                        | eqnchar(7)    |
| tail –   | delete, firstkey, nextkey – data base . . . . .      | dbm(3)        |
| msg – permit or                                | deliver the last part of a file . . . . .            | tail(1)       |
| constructs . . . . .                           | deny messages . . . . .                              | msg(1)        |
| crypt, setkey, encrypt –                       | deroff – remove nroff, troff, tbl and eqn . . . . .  | deroff(1)     |
| dup, dup2 – duplicate an open file             | DES encryption . . . . .                             | crypt(3)      |
| dc –   | descriptor . . . . .                                 | dup(2)        |
| access –                                       | desk calculator . . . . .                            | dc(1)         |
| file –   | determine accessibility of file . . . . .            | access(2)     |
| ioctl, stty, gtty – control                    | determine file type . . . . .                        | file(1)       |
| diff –   | device . . . . .                                     | ioctl(2)      |
| diff3 – 3-way                                  | df – disk free . . . . .                             | df(1)         |
| mv – move or rename files and                  | diff – differential file comparator . . . . .        | diff(1)       |
| cd – change working                            | diff3 – 3-way differential file comparison . . . . . | diff3(1)      |
| chdir – change default                         | differential file comparator . . . . .               | diff(1)       |
| ls – list contents of                          | differential file comparison . . . . .               | diff3(1)      |
| mkdir – make a                                 | dir – format of directories . . . . .                | dir(5)        |
| dcheck – file system                           | directories . . . . .                                | mv(1)         |
| unlink – remove                                | directory . . . . .                                  | cd(1)         |
| pwd – working                                  | directory . . . . .                                  | chdir(2)      |
| mknod – make a                                 | directory . . . . .                                  | ls(1)         |
| hp – RH-11/RP04, RP05, RP06 moving-head        | directory . . . . .                                  | mkdir(1)      |
| rk – RK-11/RK03 or RK05                        | directory consistency check . . . . .                | dcheck(1)     |
| rp – RP-11/RP03 moving-head                    | directory entry . . . . .                            | unlink(2)     |
| hs – RH11/RS03-RS04 fixed-head                 | directory name . . . . .                             | pwd(1)        |
| rf – RF11/RS11 fixed-head                      | directory or a special file . . . . .                | mknod(2)      |
| df –   | disk . . . . .                                       | hp(4)         |
| du – summarize                                 | disk . . . . .                                       | rk(4)         |
| mount, umount – mount and                      | disk . . . . .                                       | rp(4)         |
| prof –   | disk file . . . . .                                  | hs(4)         |
| hypot, cabs – euclidean                        | disk file . . . . .                                  | rf(4)         |
| – find and insert literature references in     | disk free . . . . .                                  | df(1)         |
| du,  | disk usage . . . . .                                 | du(1)         |
| reversi – a game of                            | dismount file system . . . . .                       | mount(1)      |
| graph –  | display profile data . . . . .                       | prof(1)       |
| arithmetic – provide                           | distance . . . . .                                   | hypot(3)      |
| pk – packet                                    | dn – DN-11 ACU interface . . . . .                   | dn(4)         |
| pkclose, pkread, pkwrite, pkfail – packet      | documents . . . . .                                  | refer(1)      |
| dump – incremental file system                 | dp – DU-11 201 data-phone interface . . . . .        | du(4)         |
| od – octal                                     | dramatic reversals . . . . .                         | reversi(6)    |
| dumppdir – print the names of files on a       | draw a graph . . . . .                               | graph(1)      |
| descriptor . . . . .                           | drill in number facts . . . . .                      | arithmetic(6) |
| echo – echo arguments . . . . .                | driver . . . . .                                     | pk(4)         |
| ecvt, fcvt, gcvt – output conversion . . . . . | driver simulator . . . . .                           | pkopen(3)     |
| echo – echo arguments . . . . .                | du – summarize disk usage . . . . .                  | du(1)         |
| ecvt, fcvt, gcvt – output conversion . . . . . | du, dp – DU-11 201 data-phone interface . . . . .    | du(4)         |
| echo – echo arguments . . . . .                | dump . . . . .                                       | dump(1)       |
| ecvt, fcvt, gcvt – output conversion . . . . . | dump . . . . .                                       | od(1)         |
| echo – echo arguments . . . . .                | dump – incremental file system dump . . . . .        | dump(1)       |
| ecvt, fcvt, gcvt – output conversion . . . . . | dump, ddate – incremental dump format . . . . .      | dump(5)       |
| echo – echo arguments . . . . .                | dump tape . . . . .                                  | dumppdir(1)   |
| ecvt, fcvt, gcvt – output conversion . . . . . | dup, dup2 – duplicate an open file . . . . .         | dup(2)        |
| echo – echo arguments . . . . .                | echo – echo arguments . . . . .                      | echo(1)       |
| ecvt, fcvt, gcvt – output conversion . . . . . | ecvt, fcvt, gcvt – output conversion . . . . .       | ecvt(3)       |

|   |             |
|---|-------------|
| ed – text editor . . . . .                                      | ed(1)       |
| end, etext, editor . . . . .                                    | end(3)      |
| ed – text editor . . . . .                                      | ed(1)       |
| sed – stream editor . . . . .                                   | sed(1)      |
| a.out – assembler and link editor output . . . . .              | a.out(5)    |
| grep, egrep, fgrep – search a file for a pattern . . . . .      | grep(1)     |
| crypt – encode/decode . . . . .                                 | crypt(1)    |
| crypt, setkey, encrypt – DES encryption . . . . .               | crypt(3)    |
| makekey – generate encryption key . . . . .                     | makekey(8)  |
| end, etext, edata – last locations in . . . . .                 | end(3)      |
| endgrent – get group file entry . . . . .                       | getgrent(3) |
| endpwent – get password file entry . . . . .                    | getpwent(3) |
| enroll – secret mail . . . . .                                  | xsend(1)    |
| entries from name list . . . . .                                | nlist(3)    |
| entry . . . . . getgrent, getgrgid, getgrnam, . . . . .         | getgrent(3) |
| entry . . . . . getpwent, getpwuid, getpwnam, . . . . .         | getpwent(3) |
| entry . . . . .   | unlink(2)   |
| environ – execute a file . . . . . execl, execv, . . . . .      | exec(2)     |
| environ – user environment . . . . .                            | environ(5)  |
| environment name . . . . .                                      | environ(3)  |
| eqn . . . . .   | eqnchar(7)  |
| eqn constructs . . . . .  | deroff(1)   |
| eqn, neqn, checkeq – typeset mathematics . . . . .              | eqn(1)      |
| eqnchar – special character definitions for . . . . .           | eqnchar(7)  |
| errno – introduction to system calls and . . . . .              | intro(2)    |
| error messages . . . . .  | perror(3)   |
| error numbers . . . . . intro, . . . . .                        | intro(2)    |
| errors . . . . .  | spell(1)    |
| establish packet protocol . . . . .                             | pkon(2)     |
| etext, edata – last locations in program . . . . .              | end(3)      |
| euclidean distance . . . . .                                    | hypot(3)    |
| eval, exec, exit, export, login, newgrp/. . . . . sh, . . . . . | sh(1)       |
| evaluate arguments as an expression . . . . .                   | expr(1)     |
| exec, exece, environ – execute a file . . . . .                 | exec(2)     |
| exec, exit, export, login, newgrp, read/. . . . .               | sh(1)       |
| exece, environ – execute a file . . . . . execl, . . . . .      | exec(2)     |
| execute commands at a later time . . . . .                      | at(1)       |
| execution . . . . .   | uux(1)      |
| execution accounting file . . . . .                             | acct(5)     |
| execution for an interval . . . . .                             | sleep(1)    |
| execution for interval . . . . .                                | sleep(3)    |
| execution profile . . . . .                                     | monitor(3)  |
| execution time profile . . . . .                                | profil(2)   |
| execv, execl, exece, execlp, execvp, exec, . . . . .            | exec(2)     |
| exit – terminate process . . . . .                              | exit(2)     |
| exit, export, login, newgrp, read, readonly/. . . . .           | sh(1)       |
| exp, log, log10, pow, sqrt – exponential, . . . . .             | exp(3)      |
| exponent . . . . .  | frexp(3)    |
| exponential, logarithm, power, square root . . . . .            | exp(3)      |
| export, login, newgrp, read, readonly, set/. . . . .            | sh(1)       |
| expr – evaluate arguments as an expression . . . . .            | expr(1)     |
| f77 – Fortran 77 compiler . . . . .                             | f77(1)      |
| fabs, floor, ceil – absolute value, floor, . . . . .            | floor(3)    |
| factor a number, generate large primes . . . . .                | factor(1)   |
| false – provide truth values . . . . .                          | true(1)     |
| fault . . . . .   | abort(3)    |
| fclose, fflush – close or flush a stream . . . . .              | fclose(3)   |
| fcvt, gcvt – output conversion . . . . .                        | ecvt(3)     |
| fdopen – open a stream . . . . .                                | fopen(3)    |
| feof, ferror, clearerr, fileno – stream . . . . .               | ferror(3)   |
| fetch, store, delete, firstkey, nextkey – . . . . .             | dbm(3)      |
| fflush – close or flush a stream . . . . .                      | fclose(3)   |
| fgetc, getw – get character or word from . . . . .              | getc(3)     |
| fgets – get a string from a stream . . . . .                    | gets(3)     |
| fgrep – search a file for a pattern . . . . .                   | grep(1)     |
| file . . . . .  | access(2)   |
| file . . . . .  | acct(5)     |
| file . . . . .  | chmod(2)    |
| file . . . . .  | chown(2)    |
| file . . . . .  | close(2)    |
| file . . . . .  | core(5)     |
| file . . . . .  | creat(2)    |

|   |                                |  |                                 |
|---|--------------------------------|--|---------------------------------|
| dd  | convert and copy a             | file   | dd(1)                           |
| execvp, exec, exece, environ                | execute a                      | file   | exec(2)                         |
| group                                       | group                          | file   | group(5)                        |
| hs  | RH11/RS03-RS04 fixed-head disk | file   | hs(4)                           |
| link  | link to a                      | file   | link(2)                         |
| mknod                                       | build special                  | file   | mknod(1)                        |
| mknod                                       | make a directory or a special  | file   | mknod(2)                        |
| passwd                                      | password                       | file   | passwd(5)                       |
| pr  | print                          | file   | pr(1)                           |
| read  | read from                      | file   | read(2)                         |
| rev   | reverse lines of a             | file   | rev(1)                          |
| rf  | RF11/RS11 fixed-head disk      | file   | rf(4)                           |
| size  | size of an object              | file   | size(1)                         |
| sum   | sum and count blocks in a      | file   | sum(1)                          |
| tail  | deliver the last part of a     | file   | tail(1)                         |
| touch                                       | update date last modified of a | file   | touch(1)                        |
| uniq  | report repeated lines in a     | file   | uniq(1)                         |
| write                                       | write on a                     | file   | write(2)                        |
|   |                                | file   | file(1)                         |
| diff  | differential                   | file comparator                              | diff(1)                         |
| diff3                                       | 3-way differential             | file comparison                              | diff3(1)                        |
| umask                                       | set                            | file creation mode mask                      | umask(2)                        |
| dup, dup2                                   | duplicate an open              | file descriptor                              | dup(2)                          |
| getgrnam, setgrent, endgrent                | get group                      | file entry                                   | getgrent, getgrgid, getpwent(3) |
| getpwnam, setpwent, endpwent                | get password                   | file entry                                   | getpwent, getpwuid, getpwent(3) |
| grep, egrep, fgrep                          | search a                       | file for a pattern                           | grep(1)                         |
| ar  | archive (library)              | file format                                  | ar(5)                           |
| split                                       | split a                        | file into pieces                             | split(1)                        |
| mktemp                                      | make a unique                  | file name                                    | mktemp(3)                       |
| stat, fstat                                 | get                            | file status                                  | stat(2)                         |
| mkfs  | construct a                    | file system                                  | mkfs(1)                         |
| mount, umount                               | mount and dismount             | file system                                  | mount(1)                        |
| mount, umount                               | mount or remove                | file system                                  | mount(2)                        |
| dcheck                                      |                                | file system directory consistency check      | dcheck(1)                       |
| dump  | incremental                    | file system dump                             | dump(1)                         |
| hier  |                                | file system hierarchy                        | hier(7)                         |
| quot  | summarize                      | file system ownership                        | quot(1)                         |
| restor                                      | incremental                    | file system restore                          | restor(1)                       |
| icheck                                      |                                | file system storage consistency check        | icheck(1)                       |
| mtab  | mounted                        | file system table                            | mtab(5)                         |
| filsys, flblk, ino                          | format of                      | file system volume                           | filsys(5)                       |
| utime                                       | set                            | file times                                   | utime(2)                        |
| file  | determine                      | file type                                    | file(1)                         |
| basename                                    | strip                          | filename affixes                             | basename(1)                     |
| feof, ferror, clearerr, cmp                 | compare two                    | fileno                                       | ferror(3)                       |
| select or reject lines common to two sorted |                                | files  | cmp(1)                          |
| find  | find                           | files  | comm(1)                         |
| rm, rmdir                                   | remove (unlink)                | files  | find(1)                         |
| sort  | sort or merge                  | files  | rm(1)                           |
| mv  | move or rename                 | files  | sort(1)                         |
| dumpdir                                     | print the names of             | files and directories                        | mv(1)                           |
| volume                                      |                                | files on a dump tape                         | dumpdir(1)                      |
| col   |                                | filsys, flblk, ino                           | filsys(5)                       |
| plot  | graphics                       | filter reverse line feeds                    | col(1)                          |
|   |                                | filters                                      | plot(1)                         |
| documents                                   | refer, lookbib                 | find   | find(1)                         |
|   | find                           | find and insert literature references in     | refer(1)                        |
|   | look                           | find files                                   | find(1)                         |
|   | look                           | find lines in a sorted list                  | look(1)                         |
|   | ttysname, isatty, ttyslot      | find name of a terminal                      | ttysname(3)                     |
|   | lorder                         | find ordering relation for an object library | lorder(1)                       |
|   | spell, spellin, spellout       | find spelling errors                         | spell(1)                        |
|   | dbminit, fetch, store, delete, | firstkey, nextkey                            | dbm(3)                          |
|   | hs                             | fixed-head disk file                         | hs(4)                           |
|   | rf                             | fixed-head disk file                         | rf(4)                           |
| functions                                   |                                | flblk, ino                                   | filsys(5)                       |
|   | fabs, fclose, fflush           | floor, ceil                                  | floor(3)                        |
|   | close or                       | flush a stream                               | fclose(3)                       |
|   |                                | fopen, freopen, fdopen                       | fopen(3)                        |
|   |                                | fork   | fork(2)                         |
|   | ar                             | format                                       | ar(5)                           |
|   | arcv                           | format                                       | arcv(1)                         |

|   |  |               |
|---|--|---------------|
| dump, ddate – incremental dump                | format . . . . .                                       | dump(5)       |
| core –  | format of core image file . . . . .                    | core(5)       |
| dir –   | format of directories . . . . .                        | dir(5)        |
| filsys, flblk, ino –                          | format of file system volume . . . . .                 | filsys(5)     |
| tbl –   | format tables for nroff or troff . . . . .             | tbl(1)        |
| roff –  | format text . . . . .                                  | roff(1)       |
| tp – DEC/mag tape                             | formats . . . . .                                      | tp(5)         |
| scanf, fscanf, sscanf –                       | formatted input conversion . . . . .                   | scanf(3)      |
| printf, fprintf, sprintf –                    | formatted output conversion . . . . .                  | printf(3)     |
| troff, nroff – text                           | formatting and typesetting . . . . .                   | troff(1)      |
| ms – macros for                               | formatting manuscripts . . . . .                       | ms(7)         |
| f77 –   | Fortran 77 compiler . . . . .                          | f77(1)        |
| ratfor – rational                             | Fortran dialect . . . . .                              | ratfor(1)     |
| struct – structure                            | Fortran programs . . . . .                             | struct(1)     |
| cookies . . . . .                             | fortune – the book of changes and other                | ching(6)      |
| conversion . . . . .                          | fprintf, sprintf – formatted output                    | printf(3)     |
| stream . . . . .                              | fprintf, putw – put character or word on a             | putc(3)       |
|   | fputs – put a string on a stream . . . . .             | puts(3)       |
|   | fread, fwrite – buffered binary input/output . . . . . | fread(3)      |
|   | free . . . . .   | df(1)         |
|   | free, realloc, calloc – main memory . . . . .          | malloc(3)     |
| allocator . . . . .                           | freopen, fdopen – open a stream . . . . .              | fopen(3)      |
|   | frexp, ldexp, modf – split into mantissa and           | frexp(3)      |
| exponent . . . . .                            | fscanf, sscanf – formatted input conversion . . . . .  | scanf(3)      |
|   | fseek, ftell, rewind – reposition a stream . . . . .   | fseek(3)      |
|   | fstat – get file status . . . . .                      | stat(2)       |
|   | ftell, rewind – reposition a stream . . . . .          | fseek(3)      |
|   | ftime – get date and time . . . . .                    | time(2)       |
|   | functions . . . . .                                    | floor(3)      |
| floor, ceil – absolute value, floor, ceiling  | functions . . . . .                                    | intro(3)      |
| intro – introduction to library               | functions . . . . .                                    | j0(3)         |
| j0, j1, jn, y0, y1, yn – bessel               | functions . . . . .                                    | sin(3)        |
| tan, asin, acos, atan, atan2 – trigonometric  | functions . . . . .                                    | sinh(3)       |
| sinh, cosh, tanh – hyperbolic                 | fwrite – buffered binary input/output . . . . .        | fread(3)      |
| fread,  | game . . . . .   | backgammon(6) |
| backgammon – the                              | game . . . . .   | checkers(6)   |
| checkers –                                    | game . . . . .   | moo(6)        |
| moo – guessing                                | game of black jack . . . . .                           | bj(6)         |
| bj – the                                      | game of chess . . . . .                                | chess(6)      |
| chess – the                                   | game of dramatic reversals . . . . .                   | reversi(6)    |
| reversi – a                                   | game of hunt-the-wumpus . . . . .                      | wump(6)       |
| wump – the                                    | games . . . . .  | words(6)      |
| hangman, words – word                         | gcd, rpow – multiple precision integer/                | mp(3)         |
| itom, madd, msub, mult, mdiv, min, mout, pow, | gcvt – output conversion . . . . .                     | ecvt(3)       |
| ecvt, fcvt,                                   | generate a maze problem . . . . .                      | maze(6)       |
| maze –  | generate configuration tables . . . . .                | mkconf(1)     |
| mkconf –                                      | generate encryption key . . . . .                      | makekey(8)    |
| makekey –                                     | generate IOT fault . . . . .                           | abort(3)      |
| abort –                                       | generate large primes . . . . .                        | factor(1)     |
| factor, primes – factor a number,             | generate names from i-numbers . . . . .                | ncheck(1)     |
| ncheck –                                      | generator . . . . .                                    | rand(3)       |
| rand, srand – random number                   | generator of lexical analysis programs . . . . .       | lex(1)        |
| lex –   | getc, getchar, fgetc, getw – get character             | getc(3)       |
| or word from stream . . . . .                 | getgid – get user and group identity . . . . .         | getuid(2)     |
| getuid, getgid, geteuid,                      | getenv – value for environment name . . . . .          | getenv(3)     |
|   | geteuid, getegid – get user and group                  | getuid(2)     |
| identity . . . . .                            | getgrent, getgrgid, getgrnam, setgrent,                | getgrent(3)   |
| endgrent – get group file entry . . . . .     | getlogin – get login name . . . . .                    | getlogin(3)   |
|   | getpass – read a password . . . . .                    | getpass(3)    |
|   | getpid – get process identification . . . . .          | getpid(2)     |
|   | getpw – get name from UID . . . . .                    | getpw(3)      |
| endpwent – get password file entry . . . . .  | getpwent, getpwuid, getpwnam, setpwent,                | getpwent(3)   |
|   | gets, fgets – get a string from a stream . . . . .     | gets(3)       |
|   | getty – set typewriter mode . . . . .                  | getty(8)      |
| and group identity . . . . .                  | getuid, getgid, geteuid, getegid – get user            | getuid(2)     |
|   | getw – get character or word from stream . . . . .     | getc(3)       |
| time to ASCII . . . . .                       | gmtime, asctime, timezone – convert date and           | ctime(3)      |
|   | goto . . . . .   | setjmp(3)     |
|   | graph . . . . .  | graph(1)      |
|   | graphics filters . . . . .                             | plot(1)       |
|   | graphics interface . . . . .                           | plot(3)       |
|   | graphics interface . . . . .                           | plot(5)       |



|  |  |             |
|--|--|-------------|
| pattern . . . . .                                      | grep, egrep, fgrep – search a file for a . . . . .     | grep(1)     |
| chown, chgrp – change owner or                         | group . . . . .  | chown(1)    |
| newgrp – log in to a new                               | group . . . . .  | newgrp(1)   |
| group . . . . .  | group – group file . . . . .                           | group(5)    |
| getgrgid, getgrnam, setgrent, endgrent – get           | group file entry . . . . .                             | getgrent(3) |
| setuid, setgid – set user and                          | group ID . . . . .                                     | setuid(2)   |
| getgid, geteuid, getegid – get user and                | group identity . . . . .                               | getuid(2)   |
| chown – change owner and                               | group of a file . . . . .                              | chown(2)    |
| make – maintain program                                | groups . . . . .                                       | make(1)     |
| ioctl, stty,   | gtty – control device . . . . .                        | ioctl(2)    |
| moo –  | guessing game . . . . .                                | moo(6)      |
| wump – the game of                                     | hangman, words – word games . . . . .                  | words(6)    |
| sinh, cosh, tanh –                                     | hier – file system hierarchy . . . . .                 | hier(7)     |
| hp – RH-11/RP04, RP05, RP06 moving-head disk . . . . . | hp – RH-11/RP04, RP05, RP06 moving-head disk . . . . . | hp(4)       |
| hs – RH11/RS03-RS04 fixed-head disk file . . . . .     | hs – RH11/RS03-RS04 fixed-head disk file . . . . .     | hs(4)       |
| ht – RH-11/TU-16 magtape interface . . . . .           | ht – RH-11/TU-16 magtape interface . . . . .           | ht(4)       |
| hunt-the-wumpus . . . . .                              | hunt-the-wumpus . . . . .                              | wump(6)     |
| hyperbolic functions . . . . .                         | hypot, cabs – euclidean distance . . . . .             | sinh(3)     |
| hypot, cabs – euclidean distance . . . . .             | hypot, cabs – euclidean distance . . . . .             | hypot(3)    |
| icheck – file system storage consistency . . . . .     | icheck – file system storage consistency . . . . .     | icheck(1)   |
| ID . . . . .   | ID . . . . .   | setuid(2)   |
| id temporarily . . . . .                               | id temporarily . . . . .                               | su(1)       |
| identification . . . . .                               | identification . . . . .                               | getpid(2)   |
| identity . . . . .                                     | identity . . . . .                                     | getuid(2)   |
| if, while, break, continue, cd, eval, exec,            | if, while, break, continue, cd, eval, exec,            | sh(1)       |
| ignore signals . . . . .                               | ignore signals . . . . .                               | signal(2)   |
| image file . . . . .                                   | image file . . . . .                                   | core(5)     |
| incremental dump format . . . . .                      | incremental dump format . . . . .                      | dump(5)     |
| incremental file system dump . . . . .                 | incremental file system dump . . . . .                 | dump(1)     |
| incremental file system restore . . . . .              | incremental file system restore . . . . .              | restor(1)   |
| index . . . . .  | index . . . . .  | ptx(1)      |
| index, rindex – string operations . . . . .            | index, rindex – string operations . . . . .            | string(3)   |
| indir – indirect system call . . . . .                 | indir – indirect system call . . . . .                 | indir(2)    |
| init, rc – process control initialization . . . . .    | init, rc – process control initialization . . . . .    | init(8)     |
| initialization data . . . . .                          | initialization data . . . . .                          | ttys(5)     |
| initiate I/O to/from a process . . . . .               | initiate I/O to/from a process . . . . .               | popen(3)    |
| ino – format of file system volume . . . . .           | ino – format of file system volume . . . . .           | filsys(5)   |
| i-node . . . . .                                       | i-node . . . . .                                       | clri(1)     |
| input conversion . . . . .                             | input conversion . . . . .                             | scanf(3)    |
| input stream . . . . .                                 | input stream . . . . .                                 | ungetc(3)   |
| input/output . . . . .                                 | input/output . . . . .                                 | fread(3)    |
| input/output package . . . . .                         | input/output package . . . . .                         | stdio(3)    |
| inquiries . . . . .                                    | inquiries . . . . .                                    | ferror(3)   |
| insert literature references in documents . . . . .    | insert literature references in documents . . . . .    | refer(1)    |
| interface . . . . .                                    | interface . . . . .                                    | cat(4)      |
| interface . . . . .                                    | interface . . . . .                                    | dn(4)       |
| interface . . . . .                                    | interface . . . . .                                    | du(4)       |
| interface . . . . .                                    | interface . . . . .                                    | ht(4)       |
| interface . . . . .                                    | interface . . . . .                                    | plot(3)     |
| interface . . . . .                                    | interface . . . . .                                    | plot(5)     |
| interface . . . . .                                    | interface . . . . .                                    | tm(4)       |
| interface . . . . .                                    | interface . . . . .                                    | tty(4)      |
| interpolate smooth curve . . . . .                     | interpolate smooth curve . . . . .                     | spline(1)   |
| interprocess channel . . . . .                         | interprocess channel . . . . .                         | pipe(2)     |
| introduction to commands . . . . .                     | introduction to commands . . . . .                     | intro(1)    |
| introduction to library functions . . . . .            | introduction to library functions . . . . .            | intro(3)    |
| introduction to system calls and error . . . . .       | introduction to system calls and error . . . . .       | intro(2)    |
| i-numbers . . . . .                                    | i-numbers . . . . .                                    | ncheck(1)   |
| I/O statistics . . . . .                               | I/O statistics . . . . .                               | iostat(1)   |
| I/O to/from a process . . . . .                        | I/O to/from a process . . . . .                        | popen(3)    |
| ioctl, stty, gtty – control device . . . . .           | ioctl, stty, gtty – control device . . . . .           | ioctl(2)    |
| iostat – report I/O statistics . . . . .               | iostat – report I/O statistics . . . . .               | iostat(1)   |
| IOT fault . . . . .                                    | IOT fault . . . . .                                    | abort(3)    |
| isalnum, isspace, ispunct, isprint, iscntrl,           | isalnum, isspace, ispunct, isprint, iscntrl,           | ctype(3)    |
| isatty, ttyslot – find name of a terminal . . . . .    | isatty, ttyslot – find name of a terminal . . . . .    | ttyslot(3)  |
| iscntrl, isascii – character classification . . . . .  | iscntrl, isascii – character classification . . . . .  | ctype(3)    |
| issue a shell command . . . . .                        | issue a shell command . . . . .                        | system(3)   |
| isupper, islower, isdigit, isalnum, isspace,           | isupper, islower, isdigit, isalnum, isspace,           | ctype(3)    |
| itom, madd, msub, mult, mdiv, min, mout, pow,          | itom, madd, msub, mult, mdiv, min, mout, pow,          | mp(3)       |
| j0, j1, jn, y0, y1, yn – bessel functions . . . . .    | j0, j1, jn, y0, y1, yn – bessel functions . . . . .    | j0(3)       |
| jack . . . . .   | jack . . . . .   | bj(6)       |
| jn, y0, y1, yn – bessel functions . . . . .            | jn, y0, y1, yn – bessel functions . . . . .            | j0(3)       |
| bj – the game of black                                 | bj – the game of black                                 |             |
| j0, j1,  | j0, j1,  |             |





|                                   |  |               |
|-----------------------------------|--|---------------|
|                                   | nm – print name list . . . . .   | nm(1)         |
|                                   | node . . . . .   | cli(1)        |
|                                   | nohup – run a command at low priority . . . . .                              | nice(1)       |
|                                   | non-local goto . . . . .   | setjmp(3)     |
|                                   | nroff – text formatting and typesetting . . . . .                            | troff(1)      |
|                                   | nroff or troff . . . . .   | tbl(1)        |
|                                   | nroff, troff, tbl and eqn constructs . . . . .                               | deroff(1)     |
|                                   | null – data sink . . . . .   | null(4)       |
|                                   | number facts . . . . .   | arithmetic(6) |
|                                   | number, generate large primes . . . . .                                      | factor(1)     |
|                                   | number generator . . . . .   | rand(3)       |
|                                   | numbers . . . . .  | atof(3)       |
|                                   | numbers . . . . . intro, errno   | intro(2)      |
|                                   | numbers . . . . .  | ncheck(1)     |
|                                   | object file . . . . .  | size(1)       |
|                                   | object library . . . . .   | order(1)      |
|                                   | octal dump . . . . .   | od(1)         |
|                                   | open – open for reading or writing . . . . .                                 | open(2)       |
|                                   | open a stream . . . . .  | fopen(3)      |
|                                   | open file descriptor . . . . .   | dup(2)        |
|                                   | open for reading or writing . . . . .  | open(2)       |
|                                   | openpl et al. – graphics interface . . . . .                                 | plot(3)       |
|                                   | operations . . . . . /strncat, strcmp, strncmp, strcpy,                      | string(3)     |
|                                   | operator . . . . .   | join(1)       |
|                                   | options . . . . .  | stty(1)       |
|                                   | ordering relation for an object library . . . . .                            | order(1)      |
|                                   | output . . . . .   | a.out(5)      |
|                                   | output . . . . .   | fread(3)      |
|                                   | output conversion . . . . .  | ecvt(3)       |
|                                   | output conversion . . . . .  | printf(3)     |
|                                   | output package . . . . .   | stdio(3)      |
|                                   | owner and group of a file . . . . .  | chown(2)      |
|                                   | owner or group . . . . .   | chown(1)      |
|                                   | ownership . . . . .  | quot(1)       |
|                                   | packet driver . . . . .  | pk(4)         |
|                                   | packet driver simulator . . . . .  | pkopen(3)     |
|                                   | packet protocol . . . . .  | pkon(2)       |
|                                   | paginator for the Tektronix 4014 . . . . .                                   | tk(1)         |
|                                   | passwd – change login password . . . . .                                     | passwd(1)     |
|                                   | passwd – passwd file . . . . .   | passwd(5)     |
|                                   | password . . . . .   | getpass(3)    |
|                                   | password . . . . .   | passwd(1)     |
|                                   | password file . . . . .  | passwd(5)     |
|                                   | password file entry . . . . . getpwent,                                      | getpwent(3)   |
|                                   | pattern . . . . .  | grep(1)       |
|                                   | pattern scanning and processing language . . . . .                           | awk(1)        |
|                                   | pause – stop until signal . . . . .  | pause(2)      |
|                                   | pcc – C compiler . . . . .   | cc(1)         |
|                                   | pclose – initiate I/O to/from a process . . . . .                            | popen(3)      |
|                                   | permit or deny messages . . . . .  | mesg(1)       |
|                                   | permuted index . . . . .   | ptx(1)        |
|                                   | perror, sys_errlist, sys_nerr – system error . . . . .                       | perror(3)     |
|                                   | phone interface . . . . .  | du(4)         |
|                                   | phototypesetter interface . . . . .  | cat(4)        |
|                                   | phototypesetter simulator . . . . .  | tc(1)         |
|                                   | phys – allow a process to access physical . . . . .                          | phys(2)       |
|                                   | pipe – create an interprocess channel . . . . .                              | pipe(2)       |
|                                   | pipe fitting . . . . .   | tee(1)        |
|                                   | pk – packet driver . . . . .   | pk(4)         |
|                                   | pkclose, pkread, pkwrite, pkfail – packet . . . . .                          | pkopen(3)     |
|                                   | pkoff – establish packet protocol . . . . .                                  | pkon(2)       |
|                                   | pkopen, pkclose, pkread, pkwrite, pkfail – . . . . .                         | pkopen(3)     |
|                                   | plot – graphics filters . . . . .  | plot(1)       |
|                                   | plot – graphics interface . . . . .  | plot(5)       |
|                                   | plot: openpl et al. – graphics interface . . . . .                           | plot(3)       |
|                                   | plotter . . . . .  | vp(4)         |
|                                   | pointer . . . . .  | lseek(2)      |
|                                   | popen, pclose – initiate I/O to/from a . . . . .                             | popen(3)      |
|                                   | posters . . . . .  | banner(6)     |
|                                   | pow, gcd, rpow – multiple precision integer/ . . . . .                       | mp(3)         |
|                                   | pow, sqrt – exponential, logarithm, power, . . . . .                         | exp(3)        |
|                                   | ppt – convert to antique media . . . . .                                     | bcd(6)        |
|                                   | cli – clear i-nice,  |               |
|                                   | setjmp, longjmp – troff,   |               |
|                                   | tbl – format tables for deroff – remove                                      |               |
|                                   | arithmetic – provide drill in factor, primes – factor a rand, srand – random |               |
|                                   | atof, atoi, atol – convert ASCII to  |               |
|                                   | – introduction to system calls and error                                     |               |
|                                   | ncheck – generate names from i-size – size of an                             |               |
|                                   | order – find ordering relation for an  |               |
|                                   | od –   |               |
|                                   | fopen, freopen, fdopen – dup, dup2 – duplicate an                            |               |
|                                   | open – plot:   |               |
|                                   | strncpy, strlen, index, rindex – string                                      |               |
|                                   | join – relational database   |               |
|                                   | stty – set terminal  |               |
|                                   | order – find   |               |
|                                   | a.out – assembler and link editor  |               |
|                                   | fread, fwrite – buffered binary input/                                       |               |
|                                   | ecvt, fcvt, gcvt –   |               |
|                                   | printf, fprintf, sprintf – formatted   |               |
|                                   | stdio – standard buffered input/   |               |
|                                   | chown – change   |               |
|                                   | chown, chgrp – change  |               |
|                                   | quot – summarize file system   |               |
|                                   | pk –   |               |
|                                   | pkopen, pkclose, pkread, pkwrite, pkfail –                                   |               |
|                                   | pkon, pkoff – establish  |               |
|                                   | tk –   |               |
|                                   | getpass – read a   |               |
|                                   | passwd – change login  |               |
|                                   | passwd –   |               |
|                                   | getpwuid, getpwnam, setpwent, endpwent – get                                 |               |
|                                   | grep, egrep, fgrep – search a file for a                                     |               |
|                                   | awk –  |               |
|                                   | cc,  |               |
|                                   | popen,   |               |
|                                   | mesg –   |               |
|                                   | ptx –  |               |
| messages . . . . .                | du, dp – DU-11 201 data-   |               |
|                                   | cat –  |               |
|                                   | tc –   |               |
| addresses . . . . .               | tee –  |               |
|                                   | pkopen,  |               |
|                                   | pkon,  |               |
| driver simulator . . . . .        | pkopen, pkclose, pkread, pkwrite, pkfail –                                   |               |
| packet driver simulator . . . . . | plot – graphics filters  |               |
|                                   | plot – graphics interface  |               |
|                                   | plot: openpl et al. – graphics interface                                     |               |
|                                   | plotter  |               |
|                                   | pointer  |               |
|                                   | popen, pclose – initiate I/O to/from a                                       |               |
|                                   | posters  |               |
|                                   | pow, gcd, rpow – multiple precision integer/                                 |               |
|                                   | pow, sqrt – exponential, logarithm, power,                                   |               |
|                                   | ppt – convert to antique media   |               |
|                                   | vp – Versatec printer-   |               |
|                                   | lseek, tell – move read/write  |               |
| process . . . . .                 | banner – make long   |               |
|                                   | itom, madd, msub, mult, mdiv, min, mout,                                     |               |
| square root . . . . .             | exp, log, log10,   |               |
|                                   | bcd,   |               |

|  |   |             |
|--|---|-------------|
|  | pr - print file . . . . .                             | pr(1)       |
|  | precision arithmetic language . . . . .               | bc(1)       |
| bc - arbitrary-precision integer arithmetic . . . . .                          | /msub, mult,  | mp(3)       |
| mdiv, min, mout, pow, gcd, rpow - multiple prepare execution profile . . . . . |   | monitor(3)  |
| monitor - lock - lock a process in . . . . .                                   | primary memory . . . . .                              | lock(2)     |
| primes - factor a number, generate large types - . . . . .                     | primes . . . . .                                      | factor(1)   |
| cat - catenate and primitive system data types . . . . .                       | print . . . . .                                       | types(5)    |
| date - print and set the date . . . . .  | print calendar . . . . .                              | cat(1)      |
| cal - print calendar . . . . .   | print file . . . . .                                  | date(1)     |
| pr - print name list . . . . .   | print name list . . . . .                             | cal(1)      |
| nm - print sections of this manual . . . . .                                   | print system facts . . . . .                          | pr(1)       |
| man - print the names of files on a dump tape . . . . .                        | printer-plotter . . . . .                             | nm(1)       |
| pstat - print system facts . . . . .   | printf, fprintf, sprintf - formatted output . . . . . | man(1)      |
| dumpdir - print the names of files on a dump tape . . . . .                    | priority . . . . .                                    | pstat(1)    |
| vp - Versatec printer-plotter . . . . .  | priority . . . . .                                    | dumpdir(1)  |
| conversion . . . . .   | procedures . . . . .                                  | vp(4)       |
| nice, nohup - run a command at low process . . . . .                           | process . . . . .                                     | printf(3)   |
| nice - set program process . . . . .   | process . . . . .                                     | nice(1)     |
| boot - startup process . . . . .   | process . . . . .                                     | nice(2)     |
| exit - terminate process . . . . .   | process . . . . .                                     | boot(8)     |
| fork - spawn new process . . . . .   | process . . . . .                                     | exit(2)     |
| kill - send signal to a process . . . . .                                      | process . . . . .                                     | fork(2)     |
| popen, pclose - initiate I/O to/from a process . . . . .                       | process control initialization . . . . .              | kill(2)     |
| wait - await completion of process identification . . . . .                    | process in primary memory . . . . .                   | popen(3)    |
| init, rc - process status . . . . .  | process times . . . . .                               | wait(1)     |
| getpid - get process to access physical addresses . . . . .                    | process to terminate . . . . .                        | init(8)     |
| lock - lock a process trace . . . . .  | process with extreme prejudice . . . . .              | getpid(2)   |
| ps - process times . . . . .   | processing language . . . . .                         | lock(2)     |
| times - get process to terminate . . . . .                                     | processor . . . . .                                   | ps(1)       |
| phys - allow a process to access physical addresses . . . . .                  | prof - display profile data . . . . .                 | times(2)    |
| wait - wait for process to terminate . . . . .                                 | profil - execution time profile . . . . .             | phys(2)     |
| ptrace - process trace . . . . .   | profile . . . . .                                     | wait(2)     |
| kill - terminate a process with extreme prejudice . . . . .                    | profile data . . . . .                                | ptrace(2)   |
| awk - pattern scanning and processing language . . . . .                       | program . . . . .                                     | kill(1)     |
| m4 - macro processor . . . . .   | program beautifier . . . . .                          | awk(1)      |
| prof - display profile data . . . . .  | program groups . . . . .                              | m4(1)       |
| profil - execution time profile . . . . .                                      | program priority . . . . .                            | prof(1)     |
| profile . . . . .  | program verification . . . . .                        | profil(2)   |
| profile data . . . . .   | program verifier . . . . .                            | profil(2)   |
| program . . . . .  | programs . . . . .                                    | prof(1)     |
| program . . . . .  | programs . . . . .                                    | end(3)      |
| program beautifier . . . . .   | protocol . . . . .                                    | units(1)    |
| program groups . . . . .   | provide drill in number facts . . . . .               | cb(1)       |
| program priority . . . . .   | provide truth values . . . . .                        | make(1)     |
| program verification . . . . .   | ps - process status . . . . .                         | nice(2)     |
| program verifier . . . . .   | pstat - print system facts . . . . .                  | assert(3)   |
| programs . . . . .   | ptrace - process trace . . . . .                      | lint(1)     |
| programs . . . . .   | ptx - permuted index . . . . .                        | lex(1)      |
| protocol . . . . .   | push character back into input stream . . . . .       | lex(1)      |
| provide drill in number facts . . . . .  | put a string on a stream . . . . .                    | struct(1)   |
| provide truth values . . . . .   | put character or word on a stream . . . . .           | pkon(2)     |
| ps - process status . . . . .  | puts, fputs - put a string on a stream . . . . .      | arithmic(6) |
| pstat - print system facts . . . . .   | putw - put character or word on a stream . . . . .    | true(1)     |
| ptrace - process trace . . . . .   | pwd - working directory name . . . . .                | ps(1)       |
| ptx - permuted index . . . . .   | qsort - quicker sort . . . . .                        | pstat(1)    |
| push character back into input stream . . . . .                                | quiz - test your knowledge . . . . .                  | ptrace(2)   |
| put a string on a stream . . . . .   | quot - summarize file system ownership . . . . .      | ptx(1)      |
| put character or word on a stream . . . . .                                    | rand, srand - random number generator . . . . .       | ungetc(3)   |
| puts, fputs - put a string on a stream . . . . .                               | ratfor - rational Fortran dialect . . . . .           | puts(3)     |
| putw - put character or word on a stream . . . . .                             | rc - process control initialization . . . . .         | putc(3)     |
| pwd - working directory name . . . . .   | read - read from file . . . . .                       | puts(3)     |
| qsort - quicker sort . . . . .   | read a password . . . . .                             | putc(3)     |
| quiz - test your knowledge . . . . .   | read . . . . .  | pwd(1)      |
| quot - summarize file system ownership . . . . .                               |   | qsort(3)    |
| rand, srand - random number generator . . . . .                                |   | quiz(6)     |
| ratfor - rational Fortran dialect . . . . .                                    |   | quot(1)     |
| rc - process control initialization . . . . .                                  |   | rand(3)     |
| read - read from file . . . . .  |   | ratfor(1)   |
| read a password . . . . .  |   | init(8)     |
| read . . . . .   |   | read(2)     |
|  |   | getpass(3)  |
|  |   | read(2)     |

|   |  |             |
|---|--|-------------|
| /cd, eval, exec, exit, export, login, newgrp, | read, readonly, set, shift, times, trap, /   | sh(1)       |
| open - open for                               | reading or writing                           | open(2)     |
| /exec, exit, export, login, newgrp, read,     | readonly, set, shift, times, trap, umask, /  | sh(1)       |
| lseek, tell - move                            | read/write pointer                           | lseek(2)    |
| malloc, free,                                 | realloc, calloc - main memory allocator      | malloc(3)   |
| mail - send or                                | receive mail among users                     | mail(1)     |
| utmp, wtmp - login                            | records                                      | utmp(5)     |
| references in documents                       | refer, lookbib - find and insert literature  | refer(1)    |
| comm - select or                              | reject lines common to two sorted files      | comm(1)     |
| lorder - find ordering                        | relation for an object library               | lorder(1)   |
| join -  | relational database operator                 | join(1)     |
| strip - remove symbols and                    | relocation bits                              | strip(1)    |
| calendar -                                    | reminder service                             | calendar(1) |
| unlink -                                      | remove directory entry                       | unlink(2)   |
| mount, umount - mount or                      | remove file system                           | mount(2)    |
| deroff -                                      | remove nroff, troff, tbl and eqn constructs  | deroff(1)   |
| strip -                                       | remove symbols and relocation bits           | strip(1)    |
| rm, rmdir -                                   | remove (unlink) files                        | rm(1)       |
| mv - move or                                  | rename files and directories                 | mv(1)       |
| uniq - report                                 | repeated lines in a file                     | uniq(1)     |
| iostat -                                      | report I/O statistics                        | iostat(1)   |
| uniq -  | report repeated lines in a file              | uniq(1)     |
| fseek, ftell, rewind -                        | reposition a stream                          | fseek(3)    |
|   | restor - incremental file system restore     | restor(1)   |
|   | rev - reverse lines of a file                | rev(1)      |
| reversi - a game of dramatic                  | reversals                                    | reversi(6)  |
| col - filter                                  | reverse line feeds                           | col(1)      |
| rev -   | reverse lines of a file                      | rev(1)      |
|   | reversi - a game of dramatic reversals       | reversi(6)  |
| fseek, ftell,                                 | rewind - reposition a stream                 | fseek(3)    |
| hp -  | rf - RF11/RS11 fixed-head disk file          | rf(4)       |
| hs -  | RH-11/RP04, RP05, RP06 moving-head disk      | hp(4)       |
| ht -  | RH11/RS03-RS04 fixed-head disk file          | hs(4)       |
| strncmp, strcpy, strncpy, strlen, index,      | RH-11/TU-16 magtape interface                | ht(4)       |
|   | rindex - string operations                   | string(3)   |
|   | rk - RK-11/RK03 or RK05 disk                 | rk(4)       |
|   | rm, rmdir - remove (unlink) files            | rm(1)       |
|   | roff - format text                           | roff(1)     |
| sqrt - exponential, logarithm, power, square  | root   | exp(3)      |
|   | rp - RP-11/RP03 moving-head disk             | rp(4)       |
| hp - RH-11/                                   | RP04, RP05, RP06 moving-head disk            | hp(4)       |
| rp -  | RP-11/RP03 moving-head disk                  | rp(4)       |
| /madd, msub, mult, mdiv, min, mout, pow, gcd, | rpow - multiple precision integer arithmetic | mp(3)       |
| hs - RH11/                                    | RS03-RS04 fixed-head disk file               | hs(4)       |
| rf - RF11/                                    | RS11 fixed-head disk file                    | rf(4)       |
| nice, nohup -                                 | run a command at low priority                | nice(1)     |
|   | sa, accton - system accounting               | sa(1)       |
| brk,  | sbrk, break - change core allocation         | brk(2)      |
| conversion                                    | scanf, fscanf, sscanf - formatted input      | scanf(3)    |
|   | scanning and processing language             | awk(1)      |
| awk - pattern                                 | schedule signal after specified time         | alarm(2)    |
| alarm -                                       | search a file for a pattern                  | grep(1)     |
| grep, egrep, fgrep -                          | secret mail                                  | xsend(1)    |
| xsend, xget, enroll -                         | sections of this manual                      | man(1)      |
| man - print                                   | sed - stream editor                          | sed(1)      |
| files   | select or reject lines common to two sorted  | comm(1)     |
|   | send or receive mail among users             | mail(1)     |
|   | send signal to a process                     | kill(2)     |
| ascii - map of ASCII character                | set  | ascii(7)    |
| umask -                                       | set file creation mode mask                  | umask(2)    |
| utime -                                       | set file times                               | utime(2)    |
| nice -  | set program priority                         | nice(2)     |
| /exit, export, login, newgrp, read, readonly, | set, shift, times, trap, umask, wait - /     | sh(1)       |
| stty -  | set terminal options                         | stty(1)     |
| tabs -  | set terminal tabs                            | tabs(1)     |
| date - print and                              | set the date                                 | date(1)     |
| stime -                                       | set time                                     | stime(2)    |
| getty -                                       | set typewriter mode                          | getty(8)    |
| setuid, setgid -                              | set user and group ID                        | setuid(2)   |
|   | setbuf - assign buffering to a stream        | setbuf(3)   |
| setuid,                                       | setgid - set user and group ID               | setuid(2)   |
| getgrent, getgrgid, getgrnam,                 | setgrent, endgrent - get group file entry    | getgrent(3) |

|   |  |  |             |
|---|--|--|-------------|
|   | crypt,                                       | setjmp, longjmp – non-local goto . . . . .             | setjmp(3)   |
|   | getpwent, getpwuid, getpwnam,                | setkey, encrypt – DES encryption . . . . .             | crypt(3)    |
|   |  | setpwent, endpwent – get password file entry . . . . . | getpwent(3) |
| cd, eval, exec, exit, export, login, newgrp,/ . . . . . |  | setuid, setgid – set user and group ID . . . . .       | setuid(2)   |
|   | system – issue a                             | sh, for, case, if, while, break, continue, . . . . .   | sh(1)       |
|   | /export, login, newgrp, read, readonly, set, | shell command . . . . .                                | system(3)   |
|   | login –                                      | shift, times, trap, umask, wait – command/ . . . . .   | sh(1)       |
|   | pause – stop until                           | sign on . . . . .                                      | login(1)    |
|   |  | signal . . . . .                                       | pause(2)    |
|   | alarm – schedule                             | signal – catch or ignore signals . . . . .             | signal(2)   |
|   | kill – send                                  | signal after specified time . . . . .                  | alarm(2)    |
|   | signal – catch or ignore                     | signal to a process . . . . .                          | kill(2)     |
| pkread, pkwrite, pkfail – packet driver                 |  | signals . . . . .                                      | signal(2)   |
| tc – photypesetter                                      |  | simulator . . . . .                                    | pkopen(3)   |
| trigonometric functions . . . . .                       |  | simulator . . . . .                                    | tc(1)       |
|   | null – data                                  | sin, cos, tan, asin, acos, atan, atan2 – . . . . .     | sin(3)      |
|   |  | sinh, cosh, tanh – hyperbolic functions . . . . .      | sinh(3)     |
|   |  | sink . . . . .   | null(4)     |
|   |  | size – size of an object file . . . . .                | size(1)     |
|   |  | sleep – suspend execution for an interval . . . . .    | sleep(1)    |
|   |  | sleep – suspend execution for interval . . . . .       | sleep(3)    |
|   | spline – interpolate                         | smooth curve . . . . .                                 | spline(1)   |
|   | qsort – quicker                              | sort . . . . .   | qsort(3)    |
|   | tsort – topological                          | sort . . . . .   | tsort(1)    |
|   |  | sort – sort or merge files . . . . .                   | sort(1)     |
|   | comm – select or reject lines common to two  | sorted files . . . . .                                 | comm(1)     |
|   | look – find lines in a                       | sorted list . . . . .                                  | look(1)     |
|   | fork –                                       | spawn new process . . . . .                            | fork(2)     |
|   | alarm – schedule signal after                | specified time . . . . .                               | alarm(2)    |
| errors . . . . .  |  | spell, spellin, spellout – find spelling . . . . .     | spell(1)    |
|   |  | spline – interpolate smooth curve . . . . .            | spline(1)   |
|   |  | split – split a file into pieces . . . . .             | split(1)    |
|   | frexp, ldexp, modf –                         | split into mantissa and exponent . . . . .             | frexp(3)    |
|   | printf, fprintf,                             | sprintf – formatted output conversion . . . . .        | printf(3)   |
| root . . . . .  | exp, log, log10, pow,                        | sqrt – exponential, logarithm, power, square           | exp(3)      |
|   | rand,  | srand – random number generator . . . . .              | rand(3)     |
|   | scanf, fscanf,                               | sscanf – formatted input conversion . . . . .          | scanf(3)    |
|   | stdio –                                      | standard buffered input/output package . . . . .       | stdio(3)    |
|   | boot –                                       | startup procedures . . . . .                           | boot(8)     |
|   |  | stat, fstat – get file status . . . . .                | stat(2)     |
|   | iostat – report I/O                          | statistics . . . . .                                   | iostat(1)   |
|   | ps – process                                 | status . . . . .                                       | ps(1)       |
|   | stat, fstat – get file                       | status . . . . .                                       | stat(2)     |
|   | feof, ferror, clearerr, fileno – stream      | status inquiries . . . . .                             | ferror(3)   |
| package . . . . .                                       |  | stdio – standard buffered input/output                 | stdio(3)    |
|   |  | stime – set time . . . . .                             | stime(2)    |
|   | pause –                                      | stop until signal . . . . .                            | pause(2)    |
|   | icheck – file system                         | storage consistency check . . . . .                    | icheck(1)   |
| subroutines . . . . .                                   | dbminit, fetch,                              | store, delete, firstkey, nextkey – data base . . . . . | dbm(3)      |
| strncpy, strlen, index, rindex – string/ . . . . .      |  | strcat, strcat, strcmp, strncmp, strcpy, . . . . .     | string(3)   |
|   | fclose, fflush – close or flush a            | stream . . . . .                                       | fclose(3)   |
|   | stream, freopen, fdopen – open a             | stream . . . . .                                       | fopen(3)    |
|   | fseek, ftell, rewind – reposition a          | stream . . . . .                                       | fseek(3)    |
|   | fgetc, getw – get character or word from     | stream . . . . .                                       | getc(3)     |
|   | gets, fgets – get a string from a            | stream . . . . .                                       | gets(3)     |
|   | fputc, putw – put character or word on a     | stream . . . . .                                       | putc(3)     |
|   | puts, fputs – put a string on a              | stream . . . . .                                       | puts(3)     |
|   | setbuf – assign buffering to a               | stream . . . . .                                       | setbuf(3)   |
|   | ungetc – push character back into input      | stream . . . . .                                       | ungetc(3)   |
|   | sed –  | stream editor . . . . .                                | sed(1)      |
|   | feof, ferror, clearerr, fileno –             | stream status inquiries . . . . .                      | ferror(3)   |
|   | gets, fgets – get a                          | string from a stream . . . . .                         | gets(3)     |
|   | puts, fputs – put a                          | string on a stream . . . . .                           | puts(3)     |
|   | strcpy, strncpy, strlen, index, rindex –     | string operations . . . . .                            | string(3)   |
|   |  | strip – remove symbols and relocation bits . . . . .   | strip(1)    |
|   | basename –                                   | strip filename affixes . . . . .                       | basename(1) |
|   | /strncat, strcmp, strncmp, strcpy, strncpy,  | strlen, index, rindex – string operations . . . . .    | string(3)   |
|   |  | struct – structure Fortran programs . . . . .          | struct(1)   |
|   |  | stty – set terminal options . . . . .                  | stty(1)     |
|   | ioctl,                                       | stty, gtty – control device . . . . .                  | ioctl(2)    |
|   |  | su – substitute user id temporarily . . . . .          | su(1)       |
|   | store, delete, firstkey, nextkey – data base | subroutines . . . . .                                  | dbm(3)      |

|                                  |   |            |
|----------------------------------|---|------------|
|                                  | su – substitute user id temporarily . . . . .         | su(1)      |
|                                  | sum – sum and count blocks in a file . . . . .        | sum(1)     |
|                                  | du – summarize disk usage . . . . .                   | du(1)      |
|                                  | quot – summarize file system ownership . . . . .      | quot(1)    |
|                                  | sync – update the super block . . . . .               | sync(1)    |
| update – periodically update the | super block . . . . .                                 | update(8)  |
|                                  | sync – update super-block . . . . .                   | sync(2)    |
|                                  | sleep – suspend execution for an interval . . . . .   | sleep(1)   |
|                                  | sleep – suspend execution for interval . . . . .      | sleep(3)   |
|                                  | swab – swap bytes . . . . .                           | swab(3)    |
|                                  | strip – remove symbols and relocation bits . . . . .  | strip(1)   |
|                                  | sync – update super-block . . . . .                   | sync(2)    |
|                                  | sync – update the super block . . . . .               | sync(1)    |
| messages . . . . .               | sys_errlist, sys_nerr – system error . . . . .        | perror(3)  |
|                                  | table . . . . .                                       | mtab(5)    |
|                                  | mtab – mounted file system                            |            |
|                                  | mkconf – generate configuration                       | mkconf(1)  |
|                                  | tbl – format tables . . . . .                         | tbl(1)     |
|                                  | tbl – format tables for nroff or troff . . . . .      | tbl(1)     |
|                                  | tabs . . . . .  | tabs(1)    |
|                                  | tabs – set terminal                                   |            |
|                                  | tail – deliver the last part of a file . . . . .      | tail(1)    |
| functions . . . . .              | tan, asin, acos, atan, atan2 – trigonometric          | sin(3)     |
|                                  | sinh, cosh, tanh – hyperbolic functions . . . . .     | sinh(3)    |
|                                  | dumpdir – print the names of files on a dump          | dumpdir(1) |
|                                  | tape . . . . .  | tp(1)      |
|                                  | tp – manipulate tape archive . . . . .                | tar(1)     |
|                                  | tar – generate configuration                          |            |
|                                  | tbl – format tables for nroff or troff . . . . .      | tbl(1)     |
|                                  | tbl and eqn constructs . . . . .                      | deroff(1)  |
|                                  | tee – pipe fitting . . . . .                          | tee(1)     |
|                                  | tc – photypesetter simulator . . . . .                | tc(1)      |
|                                  | tc – TC-11/TU56 DEctape . . . . .                     | tc(4)      |
|                                  | tk – paginator for the Tektronix 4014                 | tk(1)      |
|                                  | tell – move read/write pointer . . . . .              | lseek(2)   |
|                                  | temporarily . . . . .                                 | su(1)      |
|                                  | terminal . . . . .                                    | ttyname(3) |
|                                  | terminal initialization data . . . . .                | ttys(5)    |
|                                  | terminal interface . . . . .                          | tty(4)     |
|                                  | terminal name . . . . .                               | tty(1)     |
|                                  | terminal options . . . . .                            | stty(1)    |
|                                  | terminal tabs . . . . .                               | tabs(1)    |
|                                  | terminals– conventional names . . . . .               | term(7)    |
|                                  | terminate . . . . .                                   | wait(2)    |
|                                  | terminate a process with extreme prejudice . . . . .  | kill(1)    |
|                                  | terminate process . . . . .                           | exit(2)    |
|                                  | test – condition command . . . . .                    | test(1)    |
|                                  | test your knowledge . . . . .                         | quiz(6)    |
|                                  | text . . . . .  | roff(1)    |
|                                  | text editor . . . . .                                 | ed(1)      |
|                                  | text formatting and typesetting . . . . .             | troff(1)   |
|                                  | tic-tac-toe . . . . .                                 | ttt(6)     |
|                                  | time . . . . .  | alarm(2)   |
|                                  | time . . . . .  | at(1)      |
|                                  | time . . . . .  | stime(2)   |
|                                  | time . . . . .  | time(2)    |
|                                  | time – time a command . . . . .                       | time(1)    |
|                                  | time, ftime – get date and time . . . . .             | time(2)    |
|                                  | time profile . . . . .                                | profil(2)  |
|                                  | time to ASCII . . . . .                               | ctime(3)   |
|                                  | times . . . . .                                       | times(2)   |
|                                  | times . . . . .                                       | utime(2)   |
|                                  | times – get process times . . . . .                   | times(2)   |
|                                  | times, trap, umask, wait – command language . . . . . | sh(1)      |
|                                  | timezone – convert date and time to ASCII . . . . .   | ctime(3)   |
|                                  | tk – paginator for the Tektronix 4014                 | tk(1)      |
|                                  | tm – TM-11/TU-10 magtape interface . . . . .          | tm(4)      |
|                                  | tsort – topological sort . . . . .                    | tsort(1)   |
|                                  | touch – update date last modified of a file . . . . . | touch(1)   |
|                                  | tp – DEC/mag tape formats . . . . .                   | tp(5)      |
|                                  | tp – manipulate tape archive . . . . .                | tp(1)      |
|                                  | tr – translate characters . . . . .                   | tr(1)      |
|                                  | ptrace – process trace . . . . .                      | ptrace(2)  |
|                                  | tr – translate characters . . . . .                   | tr(1)      |



|   |  |  |
|---|--|--|
| newgrp, read, readonly, set, shift, times,<br>sin, cos, tan, asin, acos, atan, atan2 –<br>tbl – format tables for nroff or<br>typesetting . . . . . | trap, umask, wait – command language . . . . . /login,<br>trigonometric functions . . . . .<br>troff . . . . .<br>troff, nroff – text formatting and . . . . .<br>troff, tbl and eqn constructs . . . . .<br>true, false – provide truth values . . . . .<br>tsort – topological sort . . . . .<br>tts, cubic – tic-tac-toe . . . . .<br>tty – general terminal interface . . . . .<br>tty – get terminal name . . . . .<br>ttyname, isatty, ttyslot – find name of a . . . . .<br>ttys – terminal initialization data . . . . .<br>ttyslot – find name of a terminal . . . . .<br>TU-10 magtape interface . . . . .<br>TU-16 magtape interface . . . . .<br>TU56 DECTape . . . . .<br>type . . . . .<br>types . . . . .<br>typeset manual . . . . .<br>typeset mathematics . . . . .<br>typesetting . . . . .<br>typewriter mode . . . . .<br>UID . . . . .<br>umask – set file creation mode mask . . . . .<br>umask, wait – command language . . . . . /newgrp,<br>umount – mount and dismount file system . . . . .<br>umount – mount or remove file system . . . . .<br>ungetc – push character back into input . . . . .<br>uniq – report repeated lines in a file . . . . .<br>unique file name . . . . .<br>units – conversion program . . . . .<br>UNIX . . . . .<br>unix command execution . . . . .<br>unix copy . . . . .<br>unix to unix command execution . . . . .<br>unix to unix copy . . . . .<br>unlink – remove directory entry . . . . .<br>unlink) files . . . . .<br>update – periodically update the super block . . . . .<br>update date last modified of a file . . . . .<br>update super-block . . . . .<br>update the super block . . . . .<br>update the super block . . . . .<br>usage . . . . .<br>user . . . . .<br>user and group ID . . . . .<br>user and group identity . . . . .<br>user environment . . . . .<br>user id temporarily . . . . .<br>users . . . . .<br>users . . . . .<br>utime – set file times . . . . .<br>utmp, wtmp – login records . . . . .<br>uucp, uulog – unix to unix copy . . . . .<br>uux – unix to unix command execution . . . . .<br>value . . . . .<br>value, floor, ceiling functions . . . . .<br>value for environment name . . . . .<br>values . . . . .<br>verification . . . . .<br>verifier . . . . .<br>Versatec printer-plotter . . . . .<br>volume . . . . .<br>vp – Versatec printer-plotter . . . . .<br>wait – await completion of process . . . . .<br>wait – command language . . . . . /newgrp, read,<br>wait – wait for process to terminate . . . . .<br>wall – write to all users . . . . .<br>wc – word count . . . . .<br>what to do when the system crashes . . . . .<br>while, break, continue, cd, eval, exec, exit, . . . . .<br>who – who is on the system . . . . . | sh(1)<br>sin(3)<br>tbl(1)<br>troff(1)<br>deroff(1)<br>true(1)<br>tsort(1)<br>tts(6)<br>tty(4)<br>tty(1)<br>ttyname(3)<br>ttys(5)<br>ttyname(3)<br>tm(4)<br>ht(4)<br>tc(4)<br>file(1)<br>types(5)<br>man(7)<br>eqn(1)<br>troff(1)<br>getty(8)<br>getpw(3)<br>umask(2)<br>sh(1)<br>mount(1)<br>mount(2)<br>ungetc(3)<br>uniq(1)<br>mktemp(3)<br>units(1)<br>cu(1)<br>uux(1)<br>uucp(1)<br>uux(1)<br>uucp(1)<br>unlink(2)<br>rm(1)<br>update(8)<br>touch(1)<br>sync(2)<br>sync(1)<br>update(8)<br>du(1)<br>write(1)<br>setuid(2)<br>getuid(2)<br>environ(5)<br>su(1)<br>mail(1)<br>wall(1)<br>utime(2)<br>utmp(5)<br>uucp(1)<br>uux(1)<br>abs(3)<br>floor(3)<br>getenv(3)<br>true(1)<br>assert(3)<br>lint(1)<br>vp(4)<br>filsys(5)<br>vp(4)<br>wait(1)<br>sh(1)<br>wait(2)<br>wall(1)<br>wc(1)<br>crash(8)<br>sh(1)<br>who(1) |
|---|--|--|

|   |  |          |
|---|--|----------|
| wc –                                    | word count . . . . .                           | wc(1)    |
| getchar, fgetc, getw – get character or | word from stream . . . . .                     | getc(3)  |
| hangman, words –                        | word games . . . . .                           | words(6) |
| putchar, fputc, putw – put character or | word on a stream . . . . .                     | putc(3)  |
| hangman,                                | words – word games . . . . .                   | words(6) |
| cd – change                             | working directory . . . . .                    | cd(1)    |
| pwd –                                   | working directory name . . . . .               | pwd(1)   |
|   | write – write on a file . . . . .              | write(2) |
|   | write – write to another user . . . . .        | write(1) |
| write –                                 | write on a file . . . . .                      | write(2) |
| lseek, tell – move read/                | write pointer . . . . .                        | lseek(2) |
| wall –                                  | write to all users . . . . .                   | wall(1)  |
| write –                                 | write to another user . . . . .                | write(1) |
| open – open for reading or              | writing . . . . .                              | open(2)  |
| utmp,                                   | wtmp – login records . . . . .                 | utmp(5)  |
|   | wump – the game of hunt-the-wumpus . . . . .   | wump(6)  |
| xsend,                                  | xget, enroll – secret mail . . . . .           | xsend(1) |
| j0, j1, jn,                             | y0, y1, yn – bessel functions . . . . .        | j0(3)    |
|   | yacc – yet another compiler-compiler . . . . . | yacc(1)  |

**NAME**

intro – introduction to commands

**DESCRIPTION**

This section describes publicly accessible commands in alphabetic order. Certain distinctions of purpose are made in the headings:

- (1) Commands of general utility.
- (1C) Commands for communication with other systems.
- (1G) Commands used primarily for graphics and computer-aided design.
- (1M) Commands used primarily for system maintenance.

The word 'local' at the foot of a page means that the command is not intended for general distribution.

**SEE ALSO****DIAGNOSTICS**

Section (6) for computer games.

*How to get started*, in the Introduction.

**DIAGNOSTICS**

Upon termination each command returns two bytes of status, one supplied by the system giving the cause for termination, and (in the case of 'normal' termination) one supplied by the program, see *wait* and *exit(2)*. The former byte is 0 for normal termination, the latter is customarily 0 for successful execution, nonzero to indicate troubles such as erroneous parameters, bad or inaccessible data, or other inability to cope with the task at hand. It is called variously 'exit code', 'exit status' or 'return code', and is described only where special conventions are involved.

**NAME**

ac – login accounting

**SYNOPSIS**

ac [ -w *wtmp* ] [ -p ] [ -d ] [ *people* ] ...

**DESCRIPTION**

*Ac* produces a printout giving connect time for each user who has logged in during the life of the current *wtmp* file. A total is also produced. -w is used to specify an alternate *wtmp* file. -p prints individual totals; without this option, only totals are printed. -d causes a printout for each midnight to midnight period. Any *people* will limit the printout to only the specified login names. If no *wtmp* file is given, */usr/adm/wtmp* is used.

The accounting file */usr/adm/wtmp* is maintained by *init* and *login*. Neither of these programs creates the file, so if it does not exist no connect-time accounting is done. To start accounting, it should be created with length 0. On the other hand if the file is left undisturbed it will grow without bound, so periodically any information desired should be collected and the file truncated.

**FILES**

*/usr/adm/wtmp*

**SEE ALSO**

*init*(8), *login*(1), *utmp*(5).

**NAME**

*adb* – debugger

**SYNOPSIS**

**adb** [-w] [ *objfil* [ *corfil* ] ]

**DESCRIPTION**

*Adb* is a general purpose debugging program. It may be used to examine files and to provide a controlled environment for the execution of UNIX programs.

*Objfil* is normally an executable program file, preferably containing a symbol table; if not then the symbolic features of *adb* cannot be used although the file can still be examined. The default for *objfil* is **a.out**. *Corfil* is assumed to be a core image file produced after executing *objfil*; the default for *corfil* is **core**.

Requests to *adb* are read from the standard input and responses are to the standard output. If the **-w** flag is present then both *objfil* and *corfil* are created if necessary and opened for reading and writing so that files can be modified using *adb*. *Adb* ignores QUIT; INTERRUPT causes return to the next *adb* command.

In general requests to *adb* are of the form

[ *address* ] [ , *count* ] [ *command* ] [ ; ]

If *address* is present then *dot* is set to *address*. Initially *dot* is set to 0. For most commands *count* specifies how many times the command will be executed. The default *count* is 1. *Address* and *count* are expressions.

The interpretation of an address depends on the context it is used in. If a subprocess is being debugged then addresses are interpreted in the usual way in the address space of the subprocess. For further details of address mapping see ADDRESSES.

**EXPRESSIONS**

. The value of *dot*.

+ The value of *dot* incremented by the current increment.

^ The value of *dot* decremented by the current increment.

" The last *address* typed.

*integer* An octal number if *integer* begins with a 0; a hexadecimal number if preceded by #; otherwise a decimal number.

*integer.fraction*

A 32 bit floating point number.

'*cccc*' The ASCII value of up to 4 characters. \ may be used to escape a '.

< *name* The value of *name*, which is either a variable name or a register name. *Adb* maintains a number of variables (see VARIABLES) named by single letters or digits. If *name* is a register name then the value of the register is obtained from the system header in *corfil*. The register names are **r0 ... r5 sp pc ps**.

*symbol* A *symbol* is a sequence of upper or lower case letters, underscores or digits, not starting with a digit. The value of the *symbol* is taken from the symbol table in *objfil*. An initial \_ or ~ will be prepended to *symbol* if needed.

\_ *symbol*

In C, the 'true name' of an external symbol begins with \_. It may be necessary to utter this name to distinguish it from internal or hidden variables of a program.

*routine.name*

The address of the variable *name* in the specified C routine. Both *routine* and *name* are

*symbols*. If *name* is omitted the value is the address of the most recently activated C stack frame corresponding to *routine*.

(*exp*) The value of the expression *exp*.

#### Monadic operators

\**exp* The contents of the location addressed by *exp* in *corfil*.

@*exp* The contents of the location addressed by *exp* in *objfil*.

-*exp* Integer negation.

~*exp* Bitwise complement.

**Dyadic operators** are left associative and are less binding than monadic operators.

*e1*+*e2* Integer addition.

*e1*-*e2* Integer subtraction.

*e1*\**e2* Integer multiplication.

*e1*%*e2* Integer division.

*e1*&*e2* Bitwise conjunction.

*e1*|*e2* Bitwise disjunction.

*e1*#*e2* *E1* rounded up to the next multiple of *e2*.

#### COMMANDS

Most commands consist of a verb followed by a modifier or list of modifiers. The following verbs are available. (The commands '?' and '/' may be followed by '\*'; see ADDRESSES for further details.)

?*f* Locations starting at *address* in *objfil* are printed according to the format *f*.

/*f* Locations starting at *address* in *corfil* are printed according to the format *f*.

=*f* The value of *address* itself is printed in the styles indicated by the format *f*. (For **i** format '?' is printed for the parts of the instruction that reference subsequent words.)

A *format* consists of one or more characters that specify a style of printing. Each format character may be preceded by a decimal integer that is a repeat count for the format character. While stepping through a format *dot* is incremented temporarily by the amount given for each format letter. If no format is given then the last format is used. The format letters available are as follows.

- o** 2 Print 2 bytes in octal. All octal numbers output by *adb* are preceded by 0.
- O** 4 Print 4 bytes in octal.
- q** 2 Print in signed octal.
- Q** 4 Print long signed octal.
- d** 2 Print in decimal.
- D** 4 Print long decimal.
- x** 2 Print 2 bytes in hexadecimal.
- X** 4 Print 4 bytes in hexadecimal.
- u** 2 Print as an unsigned decimal number.
- U** 4 Print long unsigned decimal.
- f** 4 Print the 32 bit value as a floating point number.
- F** 8 Print double floating point.
- b** 1 Print the addressed byte in octal.
- c** 1 Print the addressed character.
- C** 1 Print the addressed character using the following escape convention. Character values 000 to 040 are printed as @ followed by the corresponding character in the range 0100 to 0140. The character @ is printed as @@.

- s** *n* Print the addressed characters until a zero character is reached.
- S** *n* Print a string using the @ escape convention. *n* is the length of the string including its zero terminator.
- Y** 4 Print 4 bytes in date format (see *ctime(3)*).
- i** *n* Print as PDP11 instructions. *n* is the number of bytes occupied by the instruction. This style of printing causes variables 1 and 2 to be set to the offset parts of the source and destination respectively.
- a** 0 Print the value of *dot* in symbolic form. Symbols are checked to ensure that they have an appropriate type as indicated below.
- / local or global data symbol
  - ? local or global text symbol
  - = local or global absolute symbol
- p** 2 Print the addressed value in symbolic form using the same rules for symbol lookup as **a**.
- t** 0 When preceded by an integer tabs to the next appropriate tab stop. For example, **8t** moves to the next 8-space tab stop.
- r** 0 Print a space.
- n** 0 Print a newline.
- "..."** 0 Print the enclosed string.
- ^** *Dot* is decremented by the current increment. Nothing is printed.
- +** *Dot* is incremented by 1. Nothing is printed.
- *Dot* is decremented by 1. Nothing is printed.

newline If the previous command temporarily incremented *dot*, make the increment permanent. Repeat the previous command with a *count* of 1.

**[?/]l** *value mask*

Words starting at *dot* are masked with *mask* and compared with *value* until a match is found. If **L** is used then the match is for 4 bytes at a time instead of 2. If no match is found then *dot* is unchanged; otherwise *dot* is set to the matched location. If *mask* is omitted then -1 is used.

**[?/]w** *value ...*

Write the 2-byte *value* into the addressed location. If the command is **W**, write 4 bytes. Odd addresses are not allowed when writing to the subprocess address space.

**[?/]m** *b1 e1 f1[?/]*

New values for (*b1, e1, f1*) are recorded. If less than three expressions are given then the remaining map parameters are left unchanged. If the '?' or '/' is followed by '\*' then the second segment (*b2, e2, f2*) of the mapping is changed. If the list is terminated by '?' or '/' then the file (*objfil* or *corfil* respectively) is used for subsequent requests. (So that, for example, '/m?' will cause '/' to refer to *objfil*.)

**>name** *Dot* is assigned to the variable or register named.

**!** A shell is called to read the rest of the line following '!'.

**\$modifier**

Miscellaneous commands. The available *modifiers* are:

- <*f* Read commands from the file *f* and return.
- >*f* Send output to the file *f*, which is created if it does not exist.
- r** Print the general registers and the instruction addressed by **pc**. *Dot* is set to **pc**.
- f** Print the floating registers in single or double length. If the floating point status of **ps** is set to double (0200 bit) then double length is used anyway.
- b** Print all breakpoints and their associated counts and commands.
- a** ALGOL 68 stack backtrace. If *address* is given then it is taken to be the address of

the current frame (instead of **r4**). If *count* is given then only the first *count* frames are printed.

- c** C stack backtrace. If *address* is given then it is taken as the address of the current frame (instead of **r5**). If **C** is used then the names and (16 bit) values of all automatic and static variables are printed for each active function. If *count* is given then only the first *count* frames are printed.
- e** The names and values of external variables are printed.
- w** Set the page width for output to *address* (default 80).
- s** Set the limit for symbol matches to *address* (default 255).
- o** All integers input are regarded as octal.
- d** Reset integer input as described in EXPRESSIONS.
- q** Exit from *adb*.
- v** Print all non zero variables in octal.
- m** Print the address map.

#### *:modifier*

Manage a subprocess. Available modifiers are:

- bc** Set breakpoint at *address*. The breakpoint is executed *count*-1 times before causing a stop. Each time the breakpoint is encountered the command *c* is executed. If this command sets *dot* to zero then the breakpoint causes a stop.
- d** Delete breakpoint at *address*.
- r** Run *objfil* as a subprocess. If *address* is given explicitly then the program is entered at this point; otherwise the program is entered at its standard entry point. *count* specifies how many breakpoints are to be ignored before stopping. Arguments to the subprocess may be supplied on the same line as the command. An argument starting with < or > causes the standard input or output to be established for the command. All signals are turned on on entry to the subprocess.
- cs** The subprocess is continued with signal *s c s*, see *signal(2)*. If *address* is given then the subprocess is continued at this address. If no signal is specified then the signal that caused the subprocess to stop is sent. Breakpoint skipping is the same as for **r**.
- ss** As for **c** except that the subprocess is single stepped *count* times. If there is no current subprocess then *objfil* is run as a subprocess as for **r**. In this case no signal can be sent; the remainder of the line is treated as arguments to the subprocess.
- k** The current subprocess, if any, is terminated.

#### VARIABLES

*Adb* provides a number of variables. Named variables are set initially by *adb* but are not used subsequently. Numbered variables are reserved for communication as follows.

- 0 The last value printed.
- 1 The last offset part of an instruction source.
- 2 The previous value of variable 1.

On entry the following are set from the system header in the *corfil*. If *corfil* does not appear to be a **core** file then these values are set from *objfil*.

- b** The base address of the data segment.
- d** The data segment size.
- e** The entry point.
- m** The 'magic' number (0405, 0407, 0410 or 0411).
- s** The stack segment size.
- t** The text segment size.



## ADDRESSES

The address in a file associated with a written address is determined by a mapping associated with that file. Each mapping is represented by two triples ( $b1$ ,  $e1$ ,  $f1$ ) and ( $b2$ ,  $e2$ ,  $f2$ ) and the *file address* corresponding to a written *address* is calculated as follows.

$$b1 \leq \text{address} < e1 \Rightarrow \text{file address} = \text{address} + f1 - b1, \text{ otherwise,}$$
$$b2 \leq \text{address} < e2 \Rightarrow \text{file address} = \text{address} + f2 - b2,$$

otherwise, the requested *address* is not legal. In some cases (e.g. for programs with separated I and D space) the two segments for a file may overlap. If a `?` or `/` is followed by an `*` then only the second triple is used.

The initial setting of both mappings is suitable for normal **a.out** and **core** files. If either file is not of the kind expected then, for that file,  $b1$  is set to 0,  $e1$  is set to the maximum file size and  $f1$  is set to 0; in this way the whole file can be examined with no address translation.

So that *adb* may be used on large files all appropriate values are kept as signed 32 bit integers.

## FILES

/dev/mem  
/dev/swap  
a.out  
core

## SEE ALSO

ptrace(2), a.out(5), core(5)

## DIAGNOSTICS

'Adb' when there is no current command or format. Comments about inaccessible files, syntax errors, abnormal termination of commands, etc. Exit status is 0, unless last command failed or returned nonzero status.

## BUGS

A breakpoint set at the entry point is not effective on initial entry to the program.

When single stepping, system calls do not count as an executed instruction.

Local variables whose names are the same as an external variable may foul up the accessing of the external.

**NAME**

**ar** – archive and library maintainer

**SYNOPSIS**

**ar** key [ *posname* ] *afile* name ...

**DESCRIPTION**

*Ar* maintains groups of files combined into a single archive file. Its main use is to create and update library files as used by the loader. It can be used, though, for any similar purpose.

*Key* is one character from the set **drqtpmx**, optionally concatenated with one or more of **vuaibcl**. *Afile* is the archive file. The *names* are constituent files in the archive file. The meanings of the *key* characters are:

- d** Delete the named files from the archive file.
- r** Replace the named files in the archive file. If the optional character **u** is used with **r**, then only those files with modified dates later than the archive files are replaced. If an optional positioning character from the set **abi** is used, then the *posname* argument must be present and specifies that new files are to be placed after (**a**) or before (**b** or **i**) *posname*. Otherwise new files are placed at the end.
- q** Quickly append the named files to the end of the archive file. Optional positioning characters are invalid. The command does not check whether the added members are already in the archive. Useful only to avoid quadratic behavior when creating a large archive piece-by-piece.
- t** Print a table of contents of the archive file. If no names are given, all files in the archive are tabled. If names are given, only those files are tabled.
- p** Print the named files in the archive.
- m** Move the named files to the end of the archive. If a positioning character is present, then the *posname* argument must be present and, as in **r**, specifies where the files are to be moved.
- x** Extract the named files. If no names are given, all files in the archive are extracted. In neither case does **x** alter the archive file.
- v** Verbose. Under the verbose option, *ar* gives a file-by-file description of the making of a new archive file from the old archive and the constituent files. When used with **t**, it gives a long listing of all information about the files. When used with **p**, it precedes each file with a name.
- c** Create. Normally *ar* will create *afile* when it needs to. The create option suppresses the normal message that is produced when *afile* is created.
- l** Local. Normally *ar* places its temporary files in the directory */tmp*. This option causes them to be placed in the local directory.

**FILES**

*/tmp/v\** temporaries

**SEE ALSO**

*ld(1)*, *ar(5)*, *lorder(1)*

**BUGS**

If the same file is mentioned twice in an argument list, it may be put in the archive twice.

**NAME**

`arcv` – convert archives to new format

**SYNOPSIS**

`arcv` file ...

**DESCRIPTION**

*Arvcv* converts archive files (see *ar(1)*, *ar(5)*) from 6th edition to 7th edition format. The conversion is done in place, and the command refuses to alter a file not in old archive format.

Old archives are marked with a magic number of 0177555 at the start; new archives have 0177545.

**FILES**

/tmp/v\*, temporary copy

**SEE ALSO**

*ar(1)*, *ar(5)*

**NAME**

as – assembler

**SYNOPSIS**

as [ - ] [ -o objfile ] file ...

**DESCRIPTION**

As assembles the concatenation of the named files. If the optional first argument - is used, all undefined symbols in the assembly are treated as global.

The output of the assembly is left on the file *objfile*; if that is omitted, **a.out** is used. It is executable if no errors occurred during the assembly, and if there were no unresolved external references.

**FILES**

|                |                         |
|----------------|-------------------------|
| /lib/as2       | pass 2 of the assembler |
| /tmp/atm[1-3]? | temporary               |
| a.out          | object                  |

**SEE ALSO**

ld(1), nm(1), adb(1), a.out(5)  
*UNIX Assembler Manual* by D. M. Ritchie

**DIAGNOSTICS**

When an input file cannot be read, its name followed by a question mark is typed and assembly ceases. When syntactic or semantic errors occur, a single-character diagnostic is typed out together with the line number and the file name in which it occurred. Errors in pass 1 cause cancellation of pass 2. The possible errors are:

|          |  |
|----------|--|
| )        | Parentheses error                              |
| ]        | Parentheses error                              |
| <        | String not terminated properly                 |
| *        | Indirection used illegally                     |
| <b>a</b> | <b>Error in address</b>                        |
| <b>b</b> | <b>Branch instruction is odd or too remote</b> |
| <b>e</b> | <b>Error in expression</b>                     |
| <b>f</b> | <b>Error in local ('f' or 'b') type symbol</b> |
| <b>g</b> | <b>Garbage (unknown) character</b>             |
| <b>i</b> | <b>End of file inside an if</b>                |
| <b>m</b> | <b>Multiply defined symbol as label</b>        |
| <b>o</b> | <b>Word quantity assembled at odd address</b>  |
| <b>p</b> | <b>'.' different in pass 1 and 2</b>           |
| r        | Relocation error                               |
| u        | Undefined symbol                               |
| x        | Syntax error                                   |

**BUGS**

Syntax errors can cause incorrect line numbers in following diagnostics.

**NAME**

*at* – execute commands at a later time

**SYNOPSIS**

*at* time [ day ] [ file ]

**DESCRIPTION**

*At* squirrels away a copy of the named *file* (standard input default) to be used as input to *sh*(1) at a specified later time. A *cd*(1) command to the current directory is inserted at the beginning, followed by assignments to all environment variables. When the script is run, it uses the user and group ID of the creator of the copy file.

The *time* is 1 to 4 digits, with an optional following 'A', 'P', 'N' or 'M' for AM, PM, noon or midnight. One and two digit numbers are taken to be hours, three and four digits to be hours and minutes. If no letters follow the digits, a 24 hour clock time is understood.

The optional *day* is either (1) a month name followed by a day number, or (2) a day of the week; if the word 'week' follows invocation is moved seven days further off. Names of months and days may be recognizably truncated. Examples of legitimate commands are

```
at 8am jan 24
at 1530 fr week
```

*At* programs are executed by periodic execution of the command */usr/lib/atrun* from *cron*(8). The granularity of *at* depends upon how often *atrun* is executed.

Standard output or error output is lost unless redirected.

**FILES**

*/usr/spool/at/yy.ddd.hhhh.uu*  
activity to be performed at hour *hhhh* of year day *ddd* of year *yy*. *uu* is a unique number.  
*/usr/spool/at/lasttimedone* contains *hhhh* for last hour of activity.  
*/usr/spool/at/past* directory of activities now in progress  
*/usr/lib/atrun* program that executes activities that are due  
*pwd*(1)

**SEE ALSO**

*calendar*(1), *cron*(8)

**DIAGNOSTICS**

Complains about various syntax errors and times out of range.

**BUGS**

Due to the granularity of the execution of */usr/lib/atrun*, there may be bugs in scheduling things almost exactly 24 hours into the future.

**NAME**

`awk` – pattern scanning and processing language

**SYNOPSIS**

`awk [ -Fc ] [ prog ] [ file ] ...`

**DESCRIPTION**

*Awk* scans each input *file* for lines that match any of a set of patterns specified in *prog*. With each pattern in *prog* there can be an associated action that will be performed when a line of a *file* matches the pattern. The set of patterns may appear literally as *prog*, or in a file specified as `-f file`.

Files are read in order; if there are no files, the standard input is read. The file name `-` means the standard input. Each line is matched against the pattern portion of every pattern-action statement; the associated action is performed for each matched pattern.

An input line is made up of fields separated by white space. (This default can be changed by using `FS`, *vide infra*.) The fields are denoted `$1`, `$2`, ... ; `$0` refers to the entire line.

A pattern-action statement has the form

```
pattern { action }
```

A missing `{ action }` means print the line; a missing pattern always matches.

An action is a sequence of statements. A statement can be one of the following:

```
if ( conditional ) statement [ else statement ]
while ( conditional ) statement
for ( expression ; conditional ; expression ) statement
break
continue
{ [ statement ] ... }
variable = expression
print [ expression-list ] [ >expression ]
printf format [ , expression-list ] [ >expression ]
next      # skip remaining patterns on this input line
exit      # skip the rest of the input
```

Statements are terminated by semicolons, newlines or right braces. An empty expression-list stands for the whole line. Expressions take on string or numeric values as appropriate, and are built using the operators `+`, `-`, `*`, `/`, `%`, and concatenation (indicated by a blank). The C operators `++`, `--`, `+=`, `-=`, `*=`, `/=`, and `%=` are also available in expressions. Variables may be scalars, array elements (denoted `x[i]`) or fields. Variables are initialized to the null string. Array subscripts may be any string, not necessarily numeric; this allows for a form of associative memory. String constants are quoted `"..."`.

The *print* statement prints its arguments on the standard output (or on a file if `>file` is present), separated by the current output field separator, and terminated by the output record separator. The *printf* statement formats its expression list according to the format (see *printf(3)*).

The built-in function *length* returns the length of its argument taken as a string, or of the whole line if no argument. There are also built-in functions *exp*, *log*, *sqrt*, and *int*. The last truncates its argument to an integer. *substr*(*s*, *m*, *n*) returns the *n*-character substring of *s* that begins at position *m*. The function *sprintf*(*fmt*, *expr*, *expr*, ...) formats the expressions according to the *printf(3)* format given by *fmt* and returns the resulting string.

Patterns are arbitrary Boolean combinations (`!`, `||`, `&&`, and parentheses) of regular expressions and relational expressions. Regular expressions must be surrounded by slashes and are as in *egrep*. Isolated regular expressions in a pattern apply to the entire line. Regular expressions may also occur in relational expressions.

A pattern may consist of two patterns separated by a comma; in this case, the action is performed for all lines between an occurrence of the first pattern and the next occurrence of the second.

A relational expression is one of the following:

```
expression matchop regular-expression
expression relop expression
```

where a relop is any of the six relational operators in C, and a matchop is either `~` (for contains) or `!~` (for does not contain). A conditional is an arithmetic expression, a relational expression, or a Boolean combination of these.

The special patterns BEGIN and END may be used to capture control before the first input line is read and after the last. BEGIN must be the first pattern, END the last.

A single character *c* may be used to separate the fields by starting the program with

```
BEGIN { FS = "c" }
```

or by using the `-Fc` option.

Other variable names with special meanings include NF, the number of fields in the current record; NR, the ordinal number of the current record; FILENAME, the name of the current input file; OFS, the output field separator (default blank); ORS, the output record separator (default newline); and OFMT, the output format for numbers (default "%.6g").

#### EXAMPLES

Print lines longer than 72 characters:

```
length > 72
```

Print first two fields in opposite order:

```
{ print $2, $1 }
```

Add up first column, print sum and average:

```
{ s += $1 }
END { print "sum is", s, " average is", s/NR }
```

Print fields in reverse order:

```
{ for (i = NF; i > 0; --i) print $i }
```

Print all lines between start/stop pairs:

```
/start/, /stop/
```

Print all lines whose first field is different from previous one:

```
$1 != prev { print; prev = $1 }
```

#### SEE ALSO

lex(1), sed(1)

A. V. Aho, B. W. Kernighan, P. J. Weinberger, *Awk – a pattern scanning and processing language*

#### BUGS

There are no explicit conversions between numbers and strings. To force an expression to be treated as a number add 0 to it; to force it to be treated as a string concatenate "" to it.

**NAME**

bas – basic

**SYNOPSIS**

**bas** [ file ]

**DESCRIPTION**

*Bas* is a dialect of Basic. If a file argument is provided, the file is used for input before the terminal is read. *Bas* accepts lines of the form:

```
statement
integer statement
```

Integer numbered statements (known as internal statements) are stored for later execution. They are stored in sorted ascending order. Non-numbered statements are immediately executed. The result of an immediate expression statement (that does not have '=' as its highest operator) is printed. Interrupts suspend computation.

Statements have the following syntax:

**expression**

The expression is executed for its side effects (assignment or function call) or for printing as described above.

**comment**

This statement is ignored. It is used to interject commentary in a program.

**done**

Return to system level.

**dump**

The name and current value of every variable is printed.

**edit**

The UNIX editor, *ed*, is invoked with the *file* argument. After the editor exits, this file is recompiled.

**for** name = expression expression statement

**for** name = expression expression

**next**

The *for* statement repetitively executes a statement (first form) or a group of statements (second form) under control of a named variable. The variable takes on the value of the first expression, then is incremented by one on each loop, not to exceed the value of the second expression.

**goto** expression

The expression is evaluated, truncated to an integer and execution goes to the corresponding integer numbered statement. If executed from immediate mode, the internal statements are compiled first.

**if** expression statement

**if** expression

[ **else**

**fi**

The statement (first form) or group of statements (second form) is executed if the expression evaluates to non-zero. In the second form, an optional **else** allows for a group of statements to be executed when the first group is not.

**list** [expression [expression]]

is used to print out the stored internal statements. If no arguments are given, all internal statements are printed. If one argument is given, only that internal statement is listed. If two arguments are given, all internal statements inclusively between the arguments are printed.



**print** list

The list of expressions and strings are concatenated and printed. (A string is delimited by " characters.)

**prompt** list

*Prompt* is the same as *print* except that no newline character is printed.

**return** [expression]

The expression is evaluated and the result is passed back as the value of a function call. If no expression is given, zero is returned.

**run**

The internal statements are compiled. The symbol table is re-initialized. The random number generator is reset. Control is passed to the lowest numbered internal statement.

**save** [expression [expression]]

*Save* is like *list* except that the output is written on the *file* argument. If no argument is given on the command, **b.out** is used.

Expressions have the following syntax:

## name

A name is used to specify a variable. Names are composed of a letter followed by letters and digits. The first four characters of a name are significant.

## number

A number is used to represent a constant value. A number is written in Fortran style, and contains digits, an optional decimal point, and possibly a scale factor consisting of an **e** followed by a possibly signed exponent.

## ( expression )

Parentheses are used to alter normal order of evaluation.

## \_ expression

The result is the negation of the expression.

## expression operator expression

Common functions of two arguments are abbreviated by the two arguments separated by an operator denoting the function. A complete list of operators is given below.

## expression ( [expression [ , expression] ... ] )

Functions of an arbitrary number of arguments can be called by an expression followed by the arguments in parentheses separated by commas. The expression evaluates to the line number of the entry of the function in the internally stored statements. This causes the internal statements to be compiled. If the expression evaluates negative, a builtin function is called. The list of builtin functions appears below.

## name [ expression [ , expression ] ... ]

Each expression is truncated to an integer and used as a specifier for the name. The result is syntactically identical to a name. **a[1,2]** is the same as **a[1][2]**. The truncated expressions are restricted to values between 0 and 32767.

The following is the list of operators:

=        = is the assignment operator. The left operand must be a name or an array element. The result is the right operand. Assignment binds right to left,

& |      & (logical and) has result zero if either of its arguments are zero. It has result one if both its arguments are non-zero. | (logical or) has result zero if both of its arguments are zero. It has result one if either of its arguments are non-zero.

< <= > >= == <>

The relational operators (< less than, <= less than or equal, > greater than, >= greater than or equal, == equal to, <> not equal to) return one if their arguments are in the specified relation. They return zero otherwise. Relational operators at the same level extend as follows:  $a > b > c$  is the same as  $a > b \& b > c$ .

+ -    Add and subtract.  
 \* /    Multiply and divide.  
 ^      Exponentiation.

The following is a list of builtin functions:

**arg(i)** is the value of the  $i$ -th actual parameter on the current level of function call.

**exp(x)** is the exponential function of  $x$ .

**log(x)** is the natural logarithm of  $x$ .

**sqr(x)** is the square root of  $x$ .

**sin(x)** is the sine of  $x$  (radians).

**cos(x)** is the cosine of  $x$  (radians).

**atn(x)** is the arctangent of  $x$ . Its value is between  $-\pi/2$  and  $\pi/2$ .

**rnd()** is a uniformly distributed random number between zero and one.

**expr()** is the only form of program input. A line is read from the input and evaluated as an expression. The resultant value is returned.

**abs(x)** is the absolute value of  $x$ .

**int(x)** returns  $x$  truncated (towards 0) to an integer.

#### FILES

/tmp/btm?      temporary  
 b.out          save file  
 /bin/ed      for **edit**

#### DIAGNOSTICS

Syntax errors cause the incorrect line to be typed with an underscore where the parse failed. All other diagnostics are self explanatory.

#### BUGS

Has been known to give core images.  
 Catches interrupts even when they are turned off.

**NAME**

basename – strip filename affixes

**SYNOPSIS**

**basename** string [ suffix ]

**DESCRIPTION**

*Basename* deletes any prefix ending in '/' and the *suffix*, if present in *string*, from *string*, and prints the result on the standard output. It is normally used inside substitution marks `` in shell procedures.

This shell procedure invoked with the argument */usr/src/cmd/cat.c* compiles the named file and moves the output to *cat* in the current directory:

```
cc $1
mv a.out `basename $1 .c`
```

**SEE ALSO**

sh(1)

**NAME**

bc – arbitrary-precision arithmetic language

**SYNOPSIS**

**bc** [ -c ] [ -l ] [ file ... ]

**DESCRIPTION**

*Bc* is an interactive processor for a language which resembles C but provides unlimited precision arithmetic. It takes input from any files given, then reads the standard input. The **-l** argument stands for the name of an arbitrary precision math library. The syntax for *bc* programs is as follows; L means letter a-z, E means expression, S means statement.

**Comments**

are enclosed in /\* and \*/.

**Names**

simple variables: L

array elements: L [ E ]

The words 'ibase', 'obase', and 'scale'

**Other operands**

arbitrarily long numbers with optional sign and decimal point.

( E )

sqrt ( E )

length ( E )      number of significant decimal digits

scale ( E )      number of digits right of decimal point

L ( E , ... , E )

**Operators**

+ - \* / % ^ (% is remainder; ^ is power)

++ --      (prefix and postfix; apply to names)

== <= >= != < >

= += -= \*= /= %= ^=

**Statements**

E

{ S ; ... ; S }

if ( E ) S

while ( E ) S

for ( E ; E ; E ) S

null statement

break

quit

**Function definitions**

define L ( L , ..., L ) {

    auto L, ... , L

    S; ... S

    return ( E )

}

**Functions in -l math library**

s(x)      sine

c(x)      cosine

e(x)      exponential

l(x)      log

a(x)      arctangent

j(n,x)    Bessel function

All function arguments are passed by value.

The value of a statement that is an expression is printed unless the main operator is an assignment. Either semicolons or newlines may separate statements. Assignment to *scale* influences the number of digits to be retained on arithmetic operations in the manner of *dc(1)*. Assignments to *ibase* or *obase* set the input and output number radix respectively.

The same letter may be used as an array, a function, and a simple variable simultaneously. All variables are global to the program. 'Auto' variables are pushed down during function calls. When using arrays as function arguments or defining them as automatic variables empty square brackets must follow the array name.

For example

```
scale = 20
define e(x){
    auto a, b, c, i, s
    a = 1
    b = 1
    s = 1
    for(i=1; 1==1; i++){
        a = a*x
        b = b*i
        c = a/b
        if(c == 0) return(s)
        s = s+c
    }
}
```

defines a function to compute an approximate value of the exponential function and

```
for(i=1; i<=10; i++) e(i)
```

prints approximate values of the exponential function of the first ten integers.

*Bc* is actually a preprocessor for *dc(1)*, which it invokes automatically, unless the *-c* (compile only) option is present. In this case the *dc* input is sent to the standard output instead.

#### FILES

```
/usr/lib/lib.b mathematical library
dc(1) desk calculator proper
```

#### SEE ALSO

```
dc(1)
L. L. Cherry and R. Morris, BC – An arbitrary precision desk-calculator language
```

#### BUGS

No *&&*, *|*, or *!* operators.  
*For* statement must have all three E's.  
*Quit* is interpreted when read, not when executed.

**NAME**

cal – print calendar

**SYNOPSIS**

**cal** [ month ] year

**DESCRIPTION**

*Cal* prints a calendar for the specified year. If a month is also specified, a calendar just for that month is printed. *Year* can be between 1 and 9999. The *month* is a number between 1 and 12. The calendar produced is that for England and her colonies.

Try September 1752.

**BUGS**

The year is always considered to start in January even though this is historically naive. Beware that 'cal 78' refers to the early Christian era, not the 20th century.

**NAME**

calendar – reminder service

**SYNOPSIS**

**calendar** [ - ]

**DESCRIPTION**

*Calendar* consults the file 'calendar' in the current directory and prints out lines that contain today's or tomorrow's date anywhere in the line. Most reasonable month-day dates such as 'Dec. 7,' 'december 7,' '12/7,' etc., are recognized, but not '7 December' or '7/12'. On weekends 'tomorrow' extends through Monday.

When an argument is present, *calendar* does its job for every user who has a file 'calendar' in his login directory and sends him any positive results by *mail*(1). Normally this is done daily in the wee hours under control of *cron*(8).

**FILES**

calendar  
/usr/lib/calendar to figure out today's and tomorrow's dates  
/etc/passwd  
/tmp/cal\*  
egrep, sed, mail subprocesses

**SEE ALSO**

at(1), cron(8), mail(1)

**BUGS**

Your calendar must be public information for you to get reminder service.  
*Calendar's* extended idea of 'tomorrow' doesn't account for holidays.

**NAME**

cat – concatenate and print

**SYNOPSIS**

**cat** [ **-u** ] file ...

**DESCRIPTION**

*Cat* reads each *file* in sequence and writes it on the standard output. Thus

```
cat file
```

prints the file and

```
cat file1 file2 >file3
```

concatenates the first two files and places the result on the third.

If no *file* is given, or if the argument `'-'` is encountered, *cat* reads from the standard input. Output is buffered in 512-byte blocks unless the standard output is a terminal or the `-u` option is present.

**SEE ALSO**

pr(1), cp(1)

**BUGS**

Beware of `'cat a b >a'` and `'cat a b >b'`, which destroy input files before reading them.



**NAME**

`cb` – C program beautifier

**SYNOPSIS**

`cb`

**DESCRIPTION**

*Cb* places a copy of the C program from the standard input on the standard output with spacing and indentation that displays the structure of the program.

**BUGS**

**NAME**

`cc`, `pcc` – C compiler

**SYNOPSIS**

`cc` [ option ] ... file ...

`pcc` [ option ] ... file ...

**DESCRIPTION**

`Cc` is the UNIX C compiler. It accepts several types of arguments:

Arguments whose names end with `.c` are taken to be C source programs; they are compiled, and each object program is left on the file whose name is that of the source with `.o` substituted for `.c`. The `.o` file is normally deleted, however, if a single C program is compiled and loaded all at one go.

In the same way, arguments whose names end with `.s` are taken to be assembly source programs and are assembled, producing a `.o` file.

The following options are interpreted by `cc`. See `ld(1)` for load-time options.

- c** Suppress the loading phase of the compilation, and force an object file to be produced even if only one program is compiled.
- p** Arrange for the compiler to produce code which counts the number of times each routine is called; also, if loading takes place, replace the standard startup routine by one which automatically calls `monitor(3)` at the start and arranges to write out a `mon.out` file at normal termination of execution of the object program. An execution profile can then be generated by use of `prof(1)`.
- f** In systems without hardware floating-point, use a version of the C compiler which handles floating-point constants and loads the object program with the floating-point interpreter. Do not use if the hardware is present.
- O** Invoke an object-code optimizer.
- S** Compile the named C programs, and leave the assembler-language output on corresponding files suffixed `.s`.
- P** Run only the macro preprocessor and place the result for each `.c` file in a corresponding `.i` file and has no `#` lines in it.
- E** Run only the macro preprocessor and send the result to the standard output. The output is intended for compiler debugging; it is unacceptable as input to `cc`.
- o output**  
Name the final output file `output`. If this option is used the file `a.out` will be left undisturbed.
- Dname=def**
- Dname** Define the `name` to the preprocessor, as if by `#define`. If no definition is given, the name is defined as 1.
- Uname** Remove any initial definition of `name`.
- Idir** `#include` files whose names do not begin with `'/'` are always sought first in the directory of the `file` argument, then in directories named in **-I** options, then in directories on a standard list.
- Bstring** Find substitute compiler passes in the files named `string` with the suffixes `cpp`, `c0`, `c1` and `c2`. If `string` is empty, use a standard backup version.
- t[p012]**  
Find only the designated compiler passes in the files whose names are constructed by a **-B** option. In the absence of a **-B** option, the `string` is taken to be `/usr/c/`.

Other arguments are taken to be either loader option arguments, or C-compatible object programs, typically produced by an earlier *cc* run, or perhaps libraries of C-compatible routines. These programs, together with the results of any compilations specified, are loaded (in the order given) to produce an executable program with name **a.out**.

The major purpose of the 'portable C compiler', *pcc*, is to serve as a model on which to base other compilers. *Pcc* does not support options **-f**, **-E**, **-B**, and **-t**. It provides, in addition to the language of *cc*, unsigned char type data and initialized bit fields.

## FILES

|                |  |
|----------------|--|
| file.c         | input file                                 |
| file.o         | object file                                |
| a.out          | loaded output                              |
| /tmp/ctm?      | temporaries for <i>cc</i>                  |
| /lib/cpp       | preprocessor                               |
| /lib/c[01]     | compiler for <i>cc</i>                     |
| /usr/c/oc[012] | backup compiler for <i>cc</i>              |
| /usr/c/ocpp    | backup preprocessor                        |
| /lib/fc[01]    | floating-point compiler                    |
| /lib/c2        | optional optimizer                         |
| /lib/crt0.o    | runtime startoff                           |
| /lib/mcrt0.o   | startoff for profiling                     |
| /lib/fcrt0.o   | startoff for floating-point interpretation |
| /lib/libc.a    | standard library, see <i>intro(3)</i>      |
| /usr/include   | standard directory for '#include' files    |
| /tmp/pc*       | temporaries for <i>pcc</i>                 |
| /usr/lib/ccom  | compiler for <i>pcc</i>                    |

## SEE ALSO

B. W. Kernighan and D. M. Ritchie, *The C Programming Language*, Prentice-Hall, 1978  
 D. M. Ritchie, *C Reference Manual*  
 monitor(3), prof(1), adb(1), ld(1)

## DIAGNOSTICS

The diagnostics produced by C itself are intended to be self-explanatory. Occasional messages may be produced by the assembler or loader. Of these, the most mystifying are from the assembler, *as(1)*, in particular 'm', which means a multiply-defined external symbol (function or data).

## BUGS

*Pcc* is little tried on the PDP11; specialized code generated for that machine has not been well shaken down. The **-O** optimizer was designed to work with *cc*; its use with *pcc* is suspect.

**NAME**

cd – change working directory

**SYNOPSIS**

**cd** directory

**DESCRIPTION**

*Directory* becomes the new working directory. The process must have execute (search) permission in *directory*.

Because a new process is created to execute each command, *cd* would be ineffective if it were written as a normal command. It is therefore recognized and executed by the Shell.

**SEE ALSO**

sh(1), pwd(1), chdir(2)

**NAME**

chmod – change mode

**SYNOPSIS**

**chmod** mode file ...

**DESCRIPTION**

The mode of each named file is changed according to *mode*, which may be absolute or symbolic. An absolute *mode* is an octal number constructed from the OR of the following modes:

|      |   |
|------|---|
| 4000 | set user ID on execution                |
| 2000 | set group ID on execution               |
| 1000 | sticky bit, see <i>chmod(2)</i>         |
| 0400 | read by owner                           |
| 0200 | write by owner                          |
| 0100 | execute (search in directory) by owner  |
| 0070 | read, write, execute (search) by group  |
| 0007 | read, write, execute (search) by others |

A symbolic *mode* has the form:

[*who*] *op permission* [*op permission*] ...

The *who* part is a combination of the letters **u** (for user's permissions), **g** (group) and **o** (other). The letter **a** stands for **ugo**. If *who* is omitted, the default is *a* but the setting of the file creation mask (see *umask(2)*) is taken into account.

*Op* can be + to add *permission* to the file's mode, – to take away *permission* and = to assign *permission* absolutely (all other bits will be reset).

*Permission* is any combination of the letters **r** (read), **w** (write), **x** (execute), **s** (set owner or group id) and **t** (save text – sticky). Letters **u**, **g** or **o** indicate that *permission* is to be taken from the current mode. Omitting *permission* is only useful with = to take away all permissions.

The first example denies write permission to others, the second makes a file executable:

```
chmod o-w file
chmod +x file
```

Multiple symbolic modes separated by commas may be given. Operations are performed in the order specified. The letter **s** is only useful with **u** or **g**.

Only the owner of a file (or the super-user) may change its mode.

**SEE ALSO**

ls(1), chmod(2), chown(1), stat(2), umask(2)

**NAME**

chown, chgrp – change owner or group

**SYNOPSIS**

**chown** owner file ...

**chgrp** group file ...

**DESCRIPTION**

*Chown* changes the owner of the *files* to *owner*. The owner may be either a decimal UID or a login name found in the password file.

*Chgrp* changes the group-ID of the *files* to *group*. The group may be either a decimal GID or a group name found in the group-ID file.

Only the super-user can change owner or group, in order to simplify as yet unimplemented accounting procedures.

**FILES**

/etc/passwd

/etc/group

**SEE ALSO**

chown(2), passwd(5), group(5)

**NAME**

*clri* – clear i-node

**SYNOPSIS**

**clri** filesystem i-number ...

**DESCRIPTION**

*Clri* writes zeros on the i-nodes with the decimal *i-numbers* on the *filesystem*. After *clri*, any blocks in the affected file will show up as ‘missing’ in an *icheck(1)* of the *filesystem*.

Read and write permission is required on the specified file system device. The i-node becomes allocatable.

The primary purpose of this routine is to remove a file which for some reason appears in no directory. If it is used to zap an i-node which does appear in a directory, care should be taken to track down the entry and remove it. Otherwise, when the i-node is reallocated to some new file, the old entry will still point to that file. At that point removing the old entry will destroy the new file. The new entry will again point to an unallocated i-node, so the whole cycle is likely to be repeated again and again.

**SEE ALSO**

*icheck(1)*

**BUGS**

If the file is open, *clri* is likely to be ineffective.

**NAME**

cmp – compare two files

**SYNOPSIS**

**cmp** [ **-l** ] [ **-s** ] file1 file2

**DESCRIPTION**

The two files are compared. (If *file1* is '-', the standard input is used.) Under default options, *cmp* makes no comment if the files are the same; if they differ, it announces the byte and line number at which the difference occurred. If one file is an initial subsequence of the other, that fact is noted.

Options:

- l** Print the byte number (decimal) and the differing bytes (octal) for each difference.
- s** Print nothing for differing files; return codes only.

**SEE ALSO**

diff(1), comm(1)

**DIAGNOSTICS**

Exit code 0 is returned for identical files, 1 for different files, and 2 for an inaccessible or missing argument.



**NAME**

`col` – filter reverse line feeds

**SYNOPSIS**

`col [-bfx]`

**DESCRIPTION**

*Col* reads the standard input and writes the standard output. It performs the line overlays implied by reverse line feeds (ESC-7 in ASCII) and by forward and reverse half line feeds (ESC-9 and ESC-8). *Col* is particularly useful for filtering multicolumn output made with the `.rt` command of *nroff* and output resulting from use of the *tbl(1)* preprocessor.

Although *col* accepts half line motions in its input, it normally does not emit them on output. Instead, text that would appear between lines is moved to the next lower full line boundary. This treatment can be suppressed by the `-f` (fine) option; in this case the output from *col* may contain forward half line feeds (ESC-9), but will still never contain either kind of reverse line motion.

If the `-b` option is given, *col* assumes that the output device in use is not capable of backspacing. In this case, if several characters are to appear in the same place, only the last one read will be taken.

The control characters SO (ASCII code 017), and SI (016) are assumed to start and end text in an alternate character set. The character set (primary or alternate) associated with each printing character read is remembered; on output, SO and SI characters are generated where necessary to maintain the correct treatment of each character.

*Col* normally converts white space to tabs to shorten printing time. If the `-x` option is given, this conversion is suppressed.

All control characters are removed from the input except space, backspace, tab, return, newline, ESC (033) followed by one of 789, SI, SO, and VT (013). This last character is an alternate form of full reverse line feed, for compatibility with some other hardware conventions. All other non-printing characters are ignored.

**SEE ALSO**

*troff(1)*, *tbl(1)*, *greek(1)*

**BUGS**

Can't back up more than 128 lines.

No more than 800 characters, including backspaces, on a line.

**NAME**

`comm` – select or reject lines common to two sorted files

**SYNOPSIS**

**comm** [ - [ **123** ] ] file1 file2

**DESCRIPTION**

*Comm* reads *file1* and *file2*, which should be ordered in ASCII collating sequence, and produces a three column output: lines only in *file1*; lines only in *file2*; and lines in both files. The filename '-' means the standard input.

Flags 1, 2, or 3 suppress printing of the corresponding column. Thus **comm -12** prints only the lines common to the two files; **comm -23** prints only lines in the first file but not in the second; **comm -123** is a no-op.

**SEE ALSO**

`cmp(1)`, `diff(1)`, `uniq(1)`

**NAME**

`cp` – copy

**SYNOPSIS**

`cp` *file1* *file2*

`cp` *file* ... *directory*

**DESCRIPTION**

*File1* is copied onto *file2*. The mode and owner of *file2* are preserved if it already existed; the mode of the source file is used otherwise.

In the second form, one or more *files* are copied into the *directory* with their original file-names.

*Cp* refuses to copy a file onto itself.

**SEE ALSO**

`cat(1)`, `pr(1)`, `mv(1)`

**NAME**

`crypt` – encode/decode

**SYNOPSIS**

`crypt` [ *password* ]

**DESCRIPTION**

*Crypt* reads from the standard input and writes on the standard output. The *password* is a key that selects a particular transformation. If no *password* is given, *crypt* demands a key from the terminal and turns off printing while the key is being typed in. *Crypt* encrypts and decrypts with the same key:

```
crypt key <clear >cypher
crypt key <cypher | pr
```

will print the clear.

Files encrypted by *crypt* are compatible with those treated by the editor *ed* in encryption mode.

The security of encrypted files depends on three factors: the fundamental method must be hard to solve; direct search of the key space must be infeasible; ‘sneak paths’ by which keys or cleartext can become visible must be minimized.

*Crypt* implements a one-rotor machine designed along the lines of the German Enigma, but with a 256-element rotor. Methods of attack on such machines are known, but not widely; moreover the amount of work required is likely to be large.

The transformation of a key into the internal settings of the machine is deliberately designed to be expensive, i.e. to take a substantial fraction of a second to compute. However, if keys are restricted to (say) three lower-case letters, then encrypted files can be read by expending only a substantial fraction of five minutes of machine time.

Since the key is an argument to the *crypt* command, it is potentially visible to users executing *ps*(1) or a derivative. To minimize this possibility, *crypt* takes care to destroy any record of the key immediately upon entry. No doubt the choice of keys and key security are the most vulnerable aspect of *crypt*.

**FILES**

/dev/tty for typed key

**SEE ALSO**

*ed*(1), *makekey*(8)

**BUGS**

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**NAME**

cu – call UNIX

**SYNOPSIS**

**cu** telno [ **-t** ] [ **-s** speed ] [ **-a** acu ] [ **-l** line ]

**DESCRIPTION**

*Cu* calls up another UNIX system, a terminal, or possibly a non-UNIX system. It manages an interactive conversation with possible transfers of text files. *Telno* is the telephone number, with minus signs at appropriate places for delays. The **-t** flag is used to dial out to a terminal. *Speed* gives the transmission speed (110, 134, 150, 300, 1200); 300 is the default value.

The **-a** and **-l** values may be used to specify pathnames for the ACU and communications line devices. They can be used to override the following built-in choices:

**-a** /dev/cua0 **-l** /dev/cul0

After making the connection, *cu* runs as two processes: the *send* process reads the standard input and passes most of it to the remote system; the *receive* process reads from the remote system and passes most data to the standard output. Lines beginning with “~” have special meanings.

The *send* process interprets the following:

|                  |  |
|------------------|--|
| ~.               | terminate the conversation.  |
| ~EOT             | terminate the conversation   |
| ~<file           | send the contents of <i>file</i> to the remote system, as though typed at the terminal.  |
| ~!               | invoke an interactive shell on the local system.   |
| ~!cmd ...        | run the command on the local system (via <b>sh -c</b> ).   |
| ~\$cmd ...       | run the command locally and send its output to the remote system.  |
| ~%take from [to] | copy file ‘from’ (on the remote system) to file ‘to’ on the local system. If ‘to’ is omitted, the ‘from’ name is used both places. |
| ~%put from [to]  | copy file ‘from’ (on local system) to file ‘to’ on remote system. If ‘to’ is omitted, the ‘from’ name is used both places.         |
| ~...             | send the line ‘~...’.  |

The *receive* process handles output diversions of the following form:

```
~>[>][:]file
zero or more lines to be written to file
~>
```

In any case, output is diverted (or appended, if ‘>>’ used) to the file. If ‘:’ is used, the diversion is *silent*, i.e., it is written only to the file. If ‘:’ is omitted, output is written both to the file and to the standard output. The trailing ‘~>’ terminates the diversion.

The use of **~%put** requires *stty* and *cat* on the remote side. It also requires that the current erase and kill characters on the remote system be identical to the current ones on the local system. Backslashes are inserted at appropriate places.

The use of **~%take** requires the existence of *echo* and *tee* on the remote system. Also, **stty tabs** mode is required on the remote system if tabs are to be copied without expansion.

**FILES**

/dev/cua0  
/dev/cul0  
/dev/null

**SEE ALSO**

dn(4), tty(4)

**DIAGNOSTICS**

Exit code is zero for normal exit, nonzero (various values) otherwise.

**BUGS**

The syntax is unique.

**NAME**

date – print and set the date

**SYNOPSIS**

**date** [ *yymmddhhmm* [ *.ss* ] ]

**DESCRIPTION**

If no argument is given, the current date and time are printed. If an argument is given, the current date is set. *yy* is the last two digits of the year; the first *mm* is the month number; *dd* is the day number in the month; *hh* is the hour number (24 hour system); the second *mm* is the minute number; *.ss* is optional and is the seconds. For example:

```
date 10080045
```

sets the date to Oct 8, 12:45 AM. The year, month and day may be omitted, the current values being the defaults. The system operates in GMT. *Date* takes care of the conversion to and from local standard and daylight time.

**FILES**

/usr/adm/wtmp to record time-setting

**SEE ALSO**

utmp(5)

**DIAGNOSTICS**

'No permission' if you aren't the super-user and you try to change the date; 'bad conversion' if the date set is syntactically incorrect.

**NAME**

dc – desk calculator

**SYNOPSIS**

**dc** [ file ]

**DESCRIPTION**

*Dc* is an arbitrary precision arithmetic package. Ordinarily it operates on decimal integers, but one may specify an input base, output base, and a number of fractional digits to be maintained. The overall structure of *dc* is a stacking (reverse Polish) calculator. If an argument is given, input is taken from that file until its end, then from the standard input. The following constructions are recognized:

**number**

The value of the number is pushed on the stack. A number is an unbroken string of the digits 0-9. It may be preceded by an underscore `_` to input a negative number. Numbers may contain decimal points.

**+ - / \* % ^**

The top two values on the stack are added (+), subtracted (-), multiplied (\*), divided (/), remaindered (%), or exponentiated (^). The two entries are popped off the stack; the result is pushed on the stack in their place. Any fractional part of an exponent is ignored.

**sx** The top of the stack is popped and stored into a register named *x*, where *x* may be any character. If the **s** is capitalized, *x* is treated as a stack and the value is pushed on it.

**lx** The value in register *x* is pushed on the stack. The register *x* is not altered. All registers start with zero value. If the **l** is capitalized, register *x* is treated as a stack and its top value is popped onto the main stack.

**d** The top value on the stack is duplicated.

**p** The top value on the stack is printed. The top value remains unchanged. **P** interprets the top of the stack as an ascii string, removes it, and prints it.

**f** All values on the stack and in registers are printed.

**q** exits the program. If executing a string, the recursion level is popped by two. If **q** is capitalized, the top value on the stack is popped and the string execution level is popped by that value.

**x** treats the top element of the stack as a character string and executes it as a string of *dc* commands.

**X** replaces the number on the top of the stack with its scale factor.

**[ ... ]** puts the bracketed ascii string onto the top of the stack.

**<x >x =x**

The top two elements of the stack are popped and compared. Register *x* is executed if they obey the stated relation.

**v** replaces the top element on the stack by its square root. Any existing fractional part of the argument is taken into account, but otherwise the scale factor is ignored.

**!** interprets the rest of the line as a UNIX command.

**c** All values on the stack are popped.

**i** The top value on the stack is popped and used as the number radix for further input. **I** pushes the input base on the top of the stack.

**o** The top value on the stack is popped and used as the number radix for further output.

**O** pushes the output base on the top of the stack.

**k** the top of the stack is popped, and that value is used as a non-negative scale factor: the



appropriate number of places are printed on output, and maintained during multiplication, division, and exponentiation. The interaction of scale factor, input base, and output base will be reasonable if all are changed together.

- z** The stack level is pushed onto the stack.
- Z** replaces the number on the top of the stack with its length.
- ?** A line of input is taken from the input source (usually the terminal) and executed.
- ;** **:** are used by *bc* for array operations.

An example which prints the first ten values of  $n!$  is

```
[la1+dsa*pla10>y]sy
0sa1
lyx
```

#### SEE ALSO

*bc(1)*, which is a preprocessor for *dc* providing infix notation and a C-like syntax which implements functions and reasonable control structures for programs.

#### DIAGNOSTICS

- 'x is unimplemented' where x is an octal number.
- 'stack empty' for not enough elements on the stack to do what was asked.
- 'Out of space' when the free list is exhausted (too many digits).
- 'Out of headers' for too many numbers being kept around.
- 'Out of pushdown' for too many items on the stack.
- 'Nesting Depth' for too many levels of nested execution.

**NAME**

`dcheck` – file system directory consistency check

**SYNOPSIS**

`dcheck` [ `-i` numbers ] [ filesystem ]

**DESCRIPTION**

*Dcheck* reads the directories in a file system and compares the link-count in each i-node with the number of directory entries by which it is referenced. If the file system is not specified, a set of default file systems is checked.

The `-i` flag is followed by a list of i-numbers; when one of those i-numbers turns up in a directory, the number, the i-number of the directory, and the name of the entry are reported.

The program is fastest if the raw version of the special file is used, since the i-list is read in large chunks.

**FILES**

Default file systems vary with installation.

**SEE ALSO**

`icheck(1)`, `filsys(5)`, `clri(1)`, `ncheck(1)`

**DIAGNOSTICS**

When a file turns up for which the link-count and the number of directory entries disagree, the relevant facts are reported. Allocated files which have 0 link-count and no entries are also listed. The only dangerous situation occurs when there are more entries than links; if entries are removed, so the link-count drops to 0, the remaining entries point to thin air. They should be removed. When there are more links than entries, or there is an allocated file with neither links nor entries, some disk space may be lost but the situation will not degenerate.

**BUGS**

Since *dcheck* is inherently two-pass in nature, extraneous diagnostics may be produced if applied to active file systems.

**NAME**

`dd` – convert and copy a file

**SYNOPSIS**

`dd` [option=value] ...

**DESCRIPTION**

*Dd* copies the specified input file to the specified output with possible conversions. The standard input and output are used by default. The input and output block size may be specified to take advantage of raw physical I/O.

| <i>option</i>               | <i>values</i>  |
|-----------------------------|--|
| <code>if=</code>            | input file name; standard input is default   |
| <code>of=</code>            | output file name; standard output is default   |
| <code>ibs=<i>n</i></code>   | input block size <i>n</i> bytes (default 512)  |
| <code>obs=<i>n</i></code>   | output block size (default 512)  |
| <code>bs=<i>n</i></code>    | set both input and output block size, superseding <i>ibs</i> and <i>obs</i> ; also, if no conversion is specified, it is particularly efficient since no copy need be done |
| <code>cbs=<i>n</i></code>   | conversion buffer size   |
| <code>skip=<i>n</i></code>  | skip <i>n</i> input records before starting copy   |
| <code>files=<i>n</i></code> | copy <i>n</i> files from (tape) input  |
| <code>seek=<i>n</i></code>  | seek <i>n</i> records from beginning of output file before copying   |
| <code>count=<i>n</i></code> | copy only <i>n</i> input records   |
| <code>conv=ascii</code>     | convert EBCDIC to ASCII  |
| <code>ebcdic</code>         | convert ASCII to EBCDIC  |
| <code>ibm</code>            | slightly different map of ASCII to EBCDIC  |
| <code>lcase</code>          | map alphabetic to lower case   |
| <code>ucase</code>          | map alphabetic to upper case   |
| <code>swab</code>           | swap every pair of bytes   |
| <code>noerror</code>        | do not stop processing on an error   |
| <code>sync</code>           | pad every input record to <i>ibs</i>   |
| <code>... , ...</code>      | several comma-separated conversions  |

Where sizes are specified, a number of bytes is expected. A number may end with **k**, **b** or **w** to specify multiplication by 1024, 512, or 2 respectively; a pair of numbers may be separated by **x** to indicate a product.

*Cbs* is used only if *ascii* or *ebcdic* conversion is specified. In the former case *cbs* characters are placed into the conversion buffer, converted to ASCII, and trailing blanks trimmed and new-line added before sending the line to the output. In the latter case ASCII characters are read into the conversion buffer, converted to EBCDIC, and blanks added to make up an output record of size *cbs*.

After completion, *dd* reports the number of whole and partial input and output blocks.

For example, to read an EBCDIC tape blocked ten 80-byte EBCDIC card images per record into the ASCII file *x*:

```
dd if=/dev/rmt0 of=x ibs=800 cbs=80 conv=ascii,lcase
```

Note the use of raw magtape. *Dd* is especially suited to I/O on the raw physical devices because it allows reading and writing in arbitrary record sizes.

To skip over a file before copying from magnetic tape do

```
(dd of=/dev/null; dd of=x) </dev/rmt0
```

**SEE ALSO**

`cp(1)`, `tr(1)`

**DIAGNOSTICS**

f+p records in(out): numbers of full and partial records read(written)

**BUGS**

The ASCII/EBCDIC conversion tables are taken from the 256 character standard in the CACM Nov, 1968. The 'ibm' conversion, while less blessed as a standard, corresponds better to certain IBM print train conventions. There is no universal solution.

Newlines are inserted only on conversion to ASCII; padding is done only on conversion to EBCDIC. These should be separate options.

**NAME**

`deroff` – remove *nroff*, *troff*, *tbl* and *eqn* constructs

**SYNOPSIS**

`deroff` [ `-w` ] file ...

**DESCRIPTION**

*Deroff* reads each file in sequence and removes all *nroff* and *troff* command lines, backslash constructions, macro definitions, *eqn* constructs (between `.EQ` and `.EN` lines or between delimiters), and table descriptions and writes the remainder on the standard output. *Deroff* follows chains of included files (`.so` and `.nx` commands); if a file has already been included, a `.so` is ignored and a `.nx` terminates execution. If no input file is given, *deroff* reads from the standard input file.

If the `-w` flag is given, the output is a word list, one ‘word’ (string of letters, digits, and apostrophes, beginning with a letter; apostrophes are removed) per line, and all other characters ignored. Otherwise, the output follows the original, with the deletions mentioned above.

**SEE ALSO**

`troff(1)`, `eqn(1)`, `tbl(1)`

**BUGS**

*Deroff* is not a complete *troff* interpreter, so it can be confused by subtle constructs. Most errors result in too much rather than too little output.

**NAME**

df – disk free

**SYNOPSIS**

**df** [ filesystem ] ...

**DESCRIPTION**

*Df* prints out the number of free blocks available on the *filesystems*. If no file system is specified, the free space on all of the normally mounted file systems is printed.

**FILES**

Default file systems vary with installation.

**SEE ALSO**

icheck(1)

**NAME**

diff – differential file comparator

**SYNOPSIS**

**diff** [ **-efbh** ] file1 file2

**DESCRIPTION**

*Diff* tells what lines must be changed in two files to bring them into agreement. If *file1* (*file2*) is '-', the standard input is used. If *file1* (*file2*) is a directory, then a file in that directory whose file-name is the same as the file-name of *file2* (*file1*) is used. The normal output contains lines of these forms:

```
n1 a n3,n4
n1,n2 d n3
n1,n2 c n3,n4
```

These lines resemble *ed* commands to convert *file1* into *file2*. The numbers after the letters pertain to *file2*. In fact, by exchanging 'a' for 'd' and reading backward one may ascertain equally how to convert *file2* into *file1*. As in *ed*, identical pairs where  $n1 = n2$  or  $n3 = n4$  are abbreviated as a single number.

Following each of these lines come all the lines that are affected in the first file flagged by '<', then all the lines that are affected in the second file flagged by '>'.

The **-b** option causes trailing blanks (spaces and tabs) to be ignored and other strings of blanks to compare equal.

The **-e** option produces a script of *a*, *c* and *d* commands for the editor *ed*, which will recreate *file2* from *file1*. The **-f** option produces a similar script, not useful with *ed*, in the opposite order. In connection with **-e**, the following shell program may help maintain multiple versions of a file. Only an ancestral file (\$1) and a chain of version-to-version *ed* scripts (\$2,\$3,...) made by *diff* need be on hand. A 'latest version' appears on the standard output.

```
(shift; cat $*; echo `1,$p`) | ed - $1
```

Except in rare circumstances, *diff* finds a smallest sufficient set of file differences.

Option **-h** does a fast, half-hearted job. It works only when changed stretches are short and well separated, but does work on files of unlimited length. Options **-e** and **-f** are unavailable with **-h**.

**FILES**

```
/tmp/d????
/usr/lib/diffh for -h
```

**SEE ALSO**

cmp(1), comm(1), ed(1)

**DIAGNOSTICS**

Exit status is 0 for no differences, 1 for some, 2 for trouble.

**BUGS**

Editing scripts produced under the **-e** or **-f** option are naive about creating lines consisting of a single '·'.

**NAME**

diff3 – 3-way differential file comparison

**SYNOPSIS**

**diff3** [ **-ex3** ] file1 file2 file3

**DESCRIPTION**

*Diff3* compares three versions of a file, and publishes disagreeing ranges of text flagged with these codes:

```
====          all three files differ
====1        file1 is different
====2        file2 is different
====3        file3 is different
```

The type of change suffered in converting a given range of a given file to some other is indicated in one of these ways:

```
f : n1 a      Text is to be appended after line number n1 in file f, where f = 1, 2, or 3.
f : n1 , n2 c  Text is to be changed in the range line n1 to line n2. If n1 = n2, the range may be
                abbreviated to n1.
```

The original contents of the range follows immediately after a **c** indication. When the contents of two files are identical, the contents of the lower-numbered file is suppressed.

Under the **-e** option, *diff3* publishes a script for the editor *ed* that will incorporate into *file1* all changes between *file2* and *file3*, *i.e.* the changes that normally would be flagged **====** and **====3**. Option **-x** (**-3**) produces a script to incorporate only changes flagged **====** (**====3**). The following command will apply the resulting script to 'file1'.

```
(cat script; echo '1,$p') | ed - file1
```

**FILES**

```
/tmp/d3?????
/usr/lib/diff3
```

**SEE ALSO**

diff(1)

**BUGS**

Text lines that consist of a single '.' will defeat **-e**.  
Files longer than 64K bytes won't work.



**NAME**

du - summarize disk usage

**SYNOPSIS**

**du** [ **-s** ] [ **-a** ] [ name ... ]

**DESCRIPTION**

*Du* gives the number of blocks contained in all files and (recursively) directories within each specified directory or file *name*. If *name* is missing, '.' is used.

The optional argument **-s** causes only the grand total to be given. The optional argument **-a** causes an entry to be generated for each file. Absence of either causes an entry to be generated for each directory only.

A file which has two links to it is only counted once.

**BUGS**

Non-directories given as arguments (not under **-a** option) are not listed.

If there are too many distinct linked files, *du* counts the excess files multiply.

**NAME**

dump – incremental file system dump

**SYNOPSIS**

**dump** [ key [ argument ... ] filesystem ]

**DESCRIPTION**

*Dump* copies to magnetic tape all files changed after a certain date in the *filesystem*. The *key* specifies the date and other options about the dump. *Key* consists of characters from the set **0123456789fusd**.

- f** Place the dump on the next *argument* file instead of the tape.
- u** If the dump completes successfully, write the date of the beginning of the dump on file */etc/ddate*. This file records a separate date for each filesystem and each dump level.
- 0–9** This number is the ‘dump level’. All files modified since the last date stored in the file */etc/ddate* for the same filesystem at lesser levels will be dumped. If no date is determined by the level, the beginning of time is assumed; thus the option **0** causes the entire filesystem to be dumped.
- s** The size of the dump tape is specified in feet. The number of feet is taken from the next *argument*. When the specified size is reached, the dump will wait for reels to be changed. The default size is 2300 feet.
- d** The density of the tape, expressed in BPI, is taken from the next *argument*. This is used in calculating the amount of tape used per write. The default is 1600.

If no arguments are given, the *key* is assumed to be **9u** and a default file system is dumped to the default tape.

Now a short suggestion on how perform dumps. Start with a full level 0 dump

```
dump 0u
```

Next, periodic level 9 dumps should be made on an exponential progression of tapes. (Sometimes called Tower of Hanoi – 1 2 1 3 1 2 1 4 ... tape 1 used every other time, tape 2 used every fourth, tape 3 used every eighth, etc.)

```
dump 9u
```

When the level 9 incremental approaches a full tape (about 78000 blocks at 1600 BPI blocked 20), a level 1 dump should be made.

```
dump 1u
```

After this, the exponential series should progress as uninterrupted. These level 9 dumps are based on the level 1 dump which is based on the level 0 full dump. This progression of levels of dump can be carried as far as desired.

**FILES**

default filesystem and tape vary with installation.  
*/etc/ddate*: record dump dates of filesystem/level.

**SEE ALSO**

restor(1), dump(5), dumpdir(1)

**DIAGNOSTICS**

If the dump requires more than one tape, it will ask you to change tapes. Reply with a new-line when this has been done.

**BUGS**

Sizes are based on 1600 BPI blocked tape. The raw magtape device has to be used to approach these densities. Read errors on the filesystem are ignored. Write errors on the magtape are usually fatal.

**NAME**

`dumpdir` – print the names of files on a dump tape

**SYNOPSIS**

*dumpdir* [ **f** filename ]

**DESCRIPTION**

*Dumpdir* is used to read magtapes dumped with the *dump* command and list the names and inode numbers of all the files and directories on the tape.

The **f** option causes *filename* as the name of the tape instead of the default.

**FILES**

default tape unit varies with installation  
rst\*

**SEE ALSO**

`dump(1)`, `restor(1)`

**DIAGNOSTICS**

If the dump extends over more than one tape, it may ask you to change tapes. Reply with a new-line when the next tape has been mounted.

**BUGS**

There is redundant information on the tape that could be used in case of tape reading problems. Unfortunately, *dumpdir* doesn't use it.

**NAME**

echo – echo arguments

**SYNOPSIS**

**echo** [ **-n** ] [ arg ] ...

**DESCRIPTION**

*Echo* writes its arguments separated by blanks and terminated by a newline on the standard output. If the flag **-n** is used, no newline is added to the output.

*Echo* is useful for producing diagnostics in shell programs and for writing constant data on pipes. To send diagnostics to the standard error file, do 'echo ... 1>&2'.

**NAME**

ed – text editor

**SYNOPSIS**

ed [ - ] [ -x ] [ name ]

**DESCRIPTION**

*Ed* is the standard text editor.

If a *name* argument is given, *ed* simulates an *e* command (see below) on the named file; that is to say, the file is read into *ed*'s buffer so that it can be edited. If *-x* is present, an *x* command is simulated first to handle an encrypted file. The optional *-* suppresses the printing of character counts by *e*, *r*, and *w* commands.

*Ed* operates on a copy of any file it is editing; changes made in the copy have no effect on the file until a *w* (write) command is given. The copy of the text being edited resides in a temporary file called the *buffer*.

Commands to *ed* have a simple and regular structure: zero or more *addresses* followed by a single character *command*, possibly followed by parameters to the command. These addresses specify one or more lines in the buffer. Missing addresses are supplied by default.

In general, only one command may appear on a line. Certain commands allow the addition of text to the buffer. While *ed* is accepting text, it is said to be in *input mode*. In this mode, no commands are recognized; all input is merely collected. Input mode is left by typing a period '.' alone at the beginning of a line.

*Ed* supports a limited form of *regular expression* notation. A regular expression specifies a set of strings of characters. A member of this set of strings is said to be *matched* by the regular expression. In the following specification for regular expressions the word 'character' means any character but new-line.

1. Any character except a special character matches itself. Special characters are the regular expression delimiter plus \[. and sometimes ^\*\$.
2. A . matches any character.
3. A \ followed by any character except a digit or () matches that character.
4. A nonempty string *s* bracketed [*s*] (or [*^s*]) matches any character in (or not in) *s*. In *s*, \ has no special meaning, and ] may only appear as the first letter. A substring *a-b*, with *a* and *b* in ascending ASCII order, stands for the inclusive range of ASCII characters.
5. A regular expression of form 1-4 followed by \* matches a sequence of 0 or more matches of the regular expression.
6. A regular expression, *x*, of form 1-8, bracketed \(*x*\) matches what *x* matches.
7. A \ followed by a digit *n* matches a copy of the string that the bracketed regular expression beginning with the *n*th \(\) matched.
8. A regular expression of form 1-8, *x*, followed by a regular expression of form 1-7, *y* matches a match for *x* followed by a match for *y*, with the *x* match being as long as possible while still permitting a *y* match.
9. A regular expression of form 1-8 preceded by ^ (or followed by \$), is constrained to matches that begin at the left (or end at the right) end of a line.
10. A regular expression of form 1-9 picks out the longest among the leftmost matches in a line.
11. An empty regular expression stands for a copy of the last regular expression encountered.

Regular expressions are used in addresses to specify lines and in one command (see *s* below) to specify a portion of a line which is to be replaced. If it is desired to use one of the regular expression meta-characters as an ordinary character, that character may be preceded by '\'. This also applies to the character bounding the regular expression (often '/') and to '\' itself.

To understand addressing in *ed* it is necessary to know that at any time there is a *current line*. Generally speaking, the current line is the last line affected by a command; however, the exact effect on the current line is discussed under the description of the command. Addresses are constructed as follows.

1. The character '.' addresses the current line.
2. The character '\$' addresses the last line of the buffer.
3. A decimal number *n* addresses the *n*-th line of the buffer.
4. '*x*' addresses the line marked with the name *x*, which must be a lower-case letter. Lines are marked with the *k* command described below.
5. A regular expression enclosed in slashes '/' addresses the line found by searching forward from the current line and stopping at the first line containing a string that matches the regular expression. If necessary the search wraps around to the beginning of the buffer.
6. A regular expression enclosed in queries '?' addresses the line found by searching backward from the current line and stopping at the first line containing a string that matches the regular expression. If necessary the search wraps around to the end of the buffer.
7. An address followed by a plus sign '+' or a minus sign '-' followed by a decimal number specifies that address plus (resp. minus) the indicated number of lines. The plus sign may be omitted.
8. If an address begins with '+' or '-' the addition or subtraction is taken with respect to the current line; e.g. '-5' is understood to mean '.-5'.
9. If an address ends with '+' or '-', then 1 is added (resp. subtracted). As a consequence of this rule and rule 8, the address '-' refers to the line before the current line. Moreover, trailing '+' and '-' characters have cumulative effect, so '--' refers to the current line less 2.
10. To maintain compatibility with earlier versions of the editor, the character '^' in addresses is equivalent to '-'.

Commands may require zero, one, or two addresses. Commands which require no addresses regard the presence of an address as an error. Commands which accept one or two addresses assume default addresses when insufficient are given. If more addresses are given than such a command requires, the last one or two (depending on what is accepted) are used.

Addresses are separated from each other typically by a comma ','. They may also be separated by a semicolon ';'. In this case the current line '.' is set to the previous address before the next address is interpreted. This feature can be used to determine the starting line for forward and backward searches ('/', '?'). The second address of any two-address sequence must correspond to a line following the line corresponding to the first address.

In the following list of *ed* commands, the default addresses are shown in parentheses. The parentheses are not part of the address, but are used to show that the given addresses are the default.

As mentioned, it is generally illegal for more than one command to appear on a line. However, most commands may be suffixed by 'p' or by 'l', in which case the current line is either printed or listed respectively in the way discussed below.

```
(.)a
<text>
```

.

The append command reads the given text and appends it after the addressed line. '.' is left on

the last line input, if there were any, otherwise at the addressed line. Address '0' is legal for this command; text is placed at the beginning of the buffer.

(.,.)c

<text>

.

The change command deletes the addressed lines, then accepts input text which replaces these lines. '.' is left at the last line input; if there were none, it is left at the line preceding the deleted lines.

(.,.)d

The delete command deletes the addressed lines from the buffer. The line originally after the last line deleted becomes the current line; if the lines deleted were originally at the end, the new last line becomes the current line.

e filename

The edit command causes the entire contents of the buffer to be deleted, and then the named file to be read in. '.' is set to the last line of the buffer. The number of characters read is typed. 'filename' is remembered for possible use as a default file name in a subsequent *r* or *w* command. If 'filename' is missing, the remembered name is used.

E filename

This command is the same as *e*, except that no diagnostic results when no *w* has been given since the last buffer alteration.

f filename

The filename command prints the currently remembered file name. If 'filename' is given, the currently remembered file name is changed to 'filename'.

(1,\$)g/regular expression/command list

In the global command, the first step is to mark every line which matches the given regular expression. Then for every such line, the given command list is executed with '.' initially set to that line. A single command or the first of multiple commands appears on the same line with the global command. All lines of a multi-line list except the last line must be ended with '\'. *A*, *i*, and *c* commands and associated input are permitted; the '.' terminating input mode may be omitted if it would be on the last line of the command list. The commands *g* and *v* are not permitted in the command list.

(.)i

<text>

.

This command inserts the given text before the addressed line. '.' is left at the last line input, or, if there were none, at the line before the addressed line. This command differs from the *a* command only in the placement of the text.

(.,.+1)j

This command joins the addressed lines into a single line; intermediate newlines simply disappear. '.' is left at the resulting line.

(.)kx

The mark command marks the addressed line with name *x*, which must be a lower-case letter. The address form '*x*' then addresses this line.

(.,.)l

The list command prints the addressed lines in an unambiguous way: non-graphic characters are printed in two-digit octal, and long lines are folded. The *l* command may be placed on the same line after any non-i/o command.

(.,.)ma

The move command repositions the addressed lines after the line addressed by *a*. The last of the moved lines becomes the current line.

(.,.)p

The print command prints the addressed lines. '.' is left at the last line printed. The *p* command may be placed on the same line after any non-i/o command.

(.,.)P

This command is a synonym for *p*.

q

The quit command causes *ed* to exit. No automatic write of a file is done.

Q

This command is the same as *q*, except that no diagnostic results when no *w* has been given since the last buffer alteration.

(\$)r filename

The read command reads in the given file after the addressed line. If no file name is given, the remembered file name, if any, is used (see *e* and *f* commands). The file name is remembered if there was no remembered file name already. Address '0' is legal for *r* and causes the file to be read at the beginning of the buffer. If the read is successful, the number of characters read is typed. '.' is left at the last line read in from the file.

(.,.)s/regular expression/replacement/ or,

(.,.)s/regular expression/replacement/g

The substitute command searches each addressed line for an occurrence of the specified regular expression. On each line in which a match is found, all matched strings are replaced by the replacement specified, if the global replacement indicator 'g' appears after the command. If the global indicator does not appear, only the first occurrence of the matched string is replaced. It is an error for the substitution to fail on all addressed lines. Any character other than space or new-line may be used instead of '/' to delimit the regular expression and the replacement. '.' is left at the last line substituted.

An ampersand '&' appearing in the replacement is replaced by the string matching the regular expression. The special meaning of '&' in this context may be suppressed by preceding it by '\'. The characters '\n' where *n* is a digit, are replaced by the text matched by the *n*-th regular subexpression enclosed between '(' and ')'. When nested, parenthesized subexpressions are present, *n* is determined by counting occurrences of '(' starting from the left.

Lines may be split by substituting new-line characters into them. The new-line in the replacement string must be escaped by preceding it by '\'.

(.,.)ta

This command acts just like the *m* command, except that a copy of the addressed lines is placed after address *a* (which may be 0). '.' is left on the last line of the copy.

(.,.)u

The undo command restores the preceding contents of the current line, which must be the last line in which a substitution was made.

(1,\$)v/regular expression/command list

This command is the same as the global command *g* except that the command list is executed *g* with '.' initially set to every line *except* those matching the regular expression.

(1,\$)w filename

The write command writes the addressed lines onto the given file. If the file does not exist, it is created mode 666 (readable and writable by everyone). The file name is remembered if there was no remembered file name already. If no file name is given, the remembered file name, if any, is used (see *e* and *f* commands). '.' is unchanged. If the command is successful, the number of characters written is printed.



(1,\$)W filename

This command is the same as *w*, except that the addressed lines are appended to the file.

x A key string is demanded from the standard input. Later *r*, *e* and *w* commands will encrypt and decrypt the text with this key by the algorithm of *crypt(1)*. An explicitly empty key turns off encryption.

(\$)= The line number of the addressed line is typed. '.' is unchanged by this command.

!<shell command>

The remainder of the line after the '!' is sent to *sh(1)* to be interpreted as a command. '.' is unchanged.

(.+1)<newline>

An address alone on a line causes the addressed line to be printed. A blank line alone is equivalent to '.+1p'; it is useful for stepping through text.

If an interrupt signal (ASCII DEL) is sent, *ed* prints a '?' and returns to its command level.

Some size limitations: 512 characters per line, 256 characters per global command list, 64 characters per file name, and 128K characters in the temporary file. The limit on the number of lines depends on the amount of core: each line takes 1 word.

When reading a file, *ed* discards ASCII NUL characters and all characters after the last newline. It refuses to read files containing non-ASCII characters.

## FILES

/tmp/e\*

ed.hup: work is saved here if terminal hangs up

## SEE ALSO

B. W. Kernighan, *A Tutorial Introduction to the ED Text Editor*

B. W. Kernighan, *Advanced editing on UNIX*

*sed(1)*, *crypt(1)*

## DIAGNOSTICS

'?name' for inaccessible file; '?' for errors in commands; '?TMP' for temporary file overflow.

To protect against throwing away valuable work, a *q* or *e* command is considered to be in error, unless a *w* has occurred since the last buffer change. A second *q* or *e* will be obeyed regardless.

## BUGS

The *l* command mishandles DEL.

A *!* command cannot be subject to a *g* command.

Because 0 is an illegal address for a *w* command, it is not possible to create an empty file with *ed*.

**NAME**

eqn, neqn, checkeq — typeset mathematics

**SYNOPSIS**

**eqn** [ -dxy ] [ -pn ] [ -sn ] [ -fn ] [ file ] ...  
**checkeq** [ file ] ...

**DESCRIPTION**

*Eqn* is a troff(1) preprocessor for typesetting mathematics on a Graphic Systems phototypesetter, *neqn* on terminals. Usage is almost always

```
eqn file ... | troff
neqn file ... | nroff
```

If no files are specified, these programs reads from the standard input. A line beginning with '.EQ' marks the start of an equation; the end of an equation is marked by a line beginning with '.EN'. Neither of these lines is altered, so they may be defined in macro packages to get centering, numbering, etc. It is also possible to set two characters as 'delimiters'; subsequent text between delimiters is also treated as *eqn* input. Delimiters may be set to characters *x* and *y* with the command-line argument -dxy or (more commonly) with 'delim xy' between .EQ and .EN. The left and right delimiters may be identical. Delimiters are turned off by 'delim off'. All text that is neither between delimiters nor between .EQ and .EN is passed through untouched.

The program *checkeq* reports missing or unbalanced delimiters and .EQ/.EN pairs.

Tokens within *eqn* are separated by spaces, tabs, newlines, braces, double quotes, tildes or circumflexes. Braces {} are used for grouping; generally speaking, anywhere a single character like *x* could appear, a complicated construction enclosed in braces may be used instead. Tilde ~ represents a full space in the output, circumflex ^ half as much.

Subscripts and superscripts are produced with the keywords **sub** and **sup**. Thus *x sub i* makes  $x_i$ , *a sub i sup 2* produces  $a_i^2$ , and *e sup {x sup 2 + y sup 2}* gives  $e^{x^2+y^2}$ .

Fractions are made with **over**: *a over b* yields  $\frac{a}{b}$ .

**sqrt** makes square roots: *1 over sqrt {ax sup 2 +bx+c}* results in  $\frac{1}{\sqrt{ax^2+bx+c}}$ .

The keywords **from** and **to** introduce lower and upper limits on arbitrary things:  $\lim_{n \rightarrow \infty} \sum_0^n x_i$  is made with *lim from {n-> inf } sum from 0 to n x sub i*.

Left and right brackets, braces, etc., of the right height are made with **left** and **right**: *left [ x sup 2 + y sup 2 over alpha right ] ~ = ~ 1* produces  $\left[ x^2 + \frac{y^2}{\alpha} \right] = 1$ . The **right** clause is optional. Legal characters after **left** and **right** are braces, brackets, bars, **c** and **f** for ceiling and floor, and "" for nothing at all (useful for a right-side-only bracket).

Vertical piles of things are made with **pile**, **lpile**, **cpile**, and **rpile**: *pile {a above b above c}* produces  $\begin{matrix} a \\ b \\ c \end{matrix}$ .

There can be an arbitrary number of elements in a pile. **lpile** left-justifies, **pile** and **cpile** center, with different vertical spacing, and **rpile** right justifies.

Matrices are made with **matrix**: *matrix { lcol { x sub i above y sub 2 } ccol { 1 above 2 } }* produces  $\begin{matrix} x_i & 1 \\ y_2 & 2 \end{matrix}$ . In addition, there is **rcol** for a right-justified column.

Diacritical marks are made with **dot**, **dotdot**, **hat**, **tilde**, **bar**, **vec**, **dyad**, and **under**:  $x \text{ dot} = f(t)$  bar is  $\overline{x=f(t)}$ ,  $y \text{ dotdot bar } \tilde{\sim} = \tilde{\sim} n$  under is  $\underline{\tilde{\sim} = n}$ , and  $x \text{ vec } \sim = \sim y \text{ dyad}$  is  $\vec{x} = \vec{y}$ .

Sizes and font can be changed with **size**  $n$  or **size**  $\pm n$ , **roman**, **italic**, **bold**, and **font**  $n$ . Size and fonts can be changed globally in a document by **gsize**  $n$  and **gfont**  $n$ , or by the command-line arguments **-sn** and **-fn**.

Normally subscripts and superscripts are reduced by 3 point sizes from the previous size; this may be changed by the command-line argument **-pn**.

Successive display arguments can be lined up. Place **mark** before the desired lineup point in the first equation; place **lineup** at the place that is to line up vertically in subsequent equations.

Shorthands may be defined or existing keywords redefined with **define**: *define thing % replacement %* defines a new token called *thing* which will be replaced by *replacement* whenever it appears thereafter. The % may be any character that does not occur in *replacement*.

Keywords like *sum* ( $\Sigma$ ) *int* ( $\int$ ) *inf* ( $\infty$ ) and shorthands like  $\geq$  ( $\geq$ )  $\rightarrow$  ( $\rightarrow$ ), and  $\neq$  ( $\neq$ ) are recognized. Greek letters are spelled out in the desired case, as in *alpha* or *GAMMA*. Mathematical words like *sin*, *cos*, *log* are made Roman automatically. *Troff*(1) four-character escapes like  $\backslash$ (bs ( $\text{\textcircled{A}}$ ) can be used anywhere. Strings enclosed in double quotes "..." are passed through untouched; this permits keywords to be entered as text, and can be used to communicate with *troff* when all else fails.

#### SEE ALSO

*troff*(1), *tbl*(1), *ms*(7), *eqnchar*(7)

B. W. Kernighan and L. L. Cherry, *Typesetting Mathematics—User's Guide*

J. F. Ossanna, *NROFF/TROFF User's Manual*

#### BUGS

To embolden digits, parens, etc., it is necessary to quote them, as in "bold "12.3"".

**NAME**

*expr* – evaluate arguments as an expression

**SYNOPSIS**

**expr** arg ...

**DESCRIPTION**

The arguments are taken as an expression. After evaluation, the result is written on the standard output. Each token of the expression is a separate argument.

The operators and keywords are listed below. The list is in order of increasing precedence, with equal precedence operators grouped.

*expr* | *expr*

yields the first *expr* if it is neither null nor '0', otherwise yields the second *expr*.

*expr* & *expr*

yields the first *expr* if neither *expr* is null or '0', otherwise yields '0'.

*expr* *relop* *expr*

where *relop* is one of < <= != >= >, yields '1' if the indicated comparison is true, '0' if false. The comparison is numeric if both *expr* are integers, otherwise lexicographic.

*expr* + *expr*

*expr* - *expr*

addition or subtraction of the arguments.

*expr* \* *expr*

*expr* / *expr*

*expr* % *expr*

multiplication, division, or remainder of the arguments.

*expr* : *expr*

The matching operator compares the string first argument with the regular expression second argument; regular expression syntax is the same as that of *ed*(1). The *(...)* pattern symbols can be used to select a portion of the first argument. Otherwise, the matching operator yields the number of characters matched ('0' on failure).

( *expr* ) parentheses for grouping.

Examples:

To add 1 to the Shell variable *a*:

```
a=`expr $a + 1`
```

To find the filename part (least significant part) of the pathname stored in variable *a*, which may or may not contain '/':

```
expr $a : '.*^(.*)' | ` $a
```

Note the quoted Shell metacharacters.

**SEE ALSO**

*ed*(1), *sh*(1), *test*(1)

**DIAGNOSTICS**

*Expr* returns the following exit codes:

- |   |  |
|---|--|
| 0 | if the expression is neither null nor '0', |
| 1 | if the expression is null or '0',          |
| 2 | for invalid expressions.                   |

**NAME**

*f77* – Fortran 77 compiler

**SYNOPSIS**

**f77** [ option ] ... file ...

**DESCRIPTION**

*F77* is the UNIX Fortran 77 compiler. It accepts several types of arguments:

Arguments whose names end with *‘.f’* are taken to be Fortran 77 source programs; they are compiled, and each object program is left on the file in the current directory whose name is that of the source with *‘.o’* substituted for *‘.f’*.

Arguments whose names end with *‘.r’* or *‘.e’* are taken to be Ratfor or EFL source programs, respectively; these are first transformed by the appropriate preprocessor, then compiled by *f77*.

In the same way, arguments whose names end with *‘.c’* or *‘.s’* are taken to be C or assembly source programs and are compiled or assembled, producing a *‘.o’* file.

The following options have the same meaning as in *cc(1)*. See *ld(1)* for load-time options.

- c** Suppress loading and produce *‘.o’* files for each source file.
- p** Prepare object files for profiling, see *prof(1)*.
- O** Invoke an object-code optimizer.
- S** Compile the named programs, and leave the assembler-language output on corresponding files suffixed *‘.s’*. (No *‘.o’* is created.)
- f** Use a floating point interpreter (for PDP11's that lack 11/70-style floating point).
- o output**  
Name the final output file *output* instead of *‘a.out’*.

The following options are peculiar to *f77*.

- onetrip**  
Compile DO loops that are performed at least once if reached. (Fortran 77 DO loops are not performed at all if the upper limit is smaller than the lower limit.)
- u** Make the default type of a variable *‘undefined’* rather than using the default Fortran rules.
- C** Compile code to check that subscripts are within declared array bounds.
- w** Suppress all warning messages. If the option is *‘-w66’*, only Fortran 66 compatibility warnings are suppressed.
- F** Apply EFL and Ratfor preprocessor to relevant files, put the result in the file with the suffix changed to *‘.f’*, but do not compile.
- m** Apply the M4 preprocessor to each *‘.r’* or *‘.e’* file before transforming it with the Ratfor or EFL preprocessor.
- Ex** Use the string *x* as an EFL option in processing *‘.e’* files.
- Rx** Use the string *x* as a Ratfor option in processing *‘.r’* files.

Other arguments are taken to be either loader option arguments, or *F77*-compatible object programs, typically produced by an earlier run, or perhaps libraries of *F77*-compatible routines. These programs, together with the results of any compilations specified, are loaded (in the order given) to produce an executable program with name *‘a.out’*.

**FILES**

|              |             |
|--------------|-------------|
| file.[fresc] | input file  |
| file.o       | object file |

a.out           loaded output  
/usr/lib/f77pass1compiler  
/lib/c1          pass 2  
/lib/c2          optional optimizer  
/usr/lib/libF77.a intrinsic function library  
/usr/lib/libI77.a Fortran I/O library  
/lib/libc.a      C library, see section 3

**SEE ALSO**

S. I. Feldman, P. J. Weinberger, *A Portable Fortran 77 Compiler*  
prof(1), cc(1), ld(1)

**DIAGNOSTICS**

The diagnostics produced by *f77* itself are intended to be self-explanatory. Occasional messages may be produced by the loader.

**BUGS**

The Fortran 66 subset of the language has been exercised extensively; the newer features have not.

**NAME**

*factor*, *primes* – factor a number, generate large primes

**SYNOPSIS**

**factor** [ number ]

**primes**

**DESCRIPTION**

When *factor* is invoked without an argument, it waits for a number to be typed in. If you type in a positive number less than  $2^{56}$  (about  $7.2 \times 10^{16}$ ) it will factor the number and print its prime factors; each one is printed the proper number of times. Then it waits for another number. It exits if it encounters a zero or any non-numeric character.

If *factor* is invoked with an argument, it factors the number as above and then exits.

Maximum time to factor is proportional to  $\sqrt{n}$  and occurs when  $n$  is prime or the square of a prime. It takes 1 minute to factor a prime near  $10^{14}$  on a PDP11.

When *primes* is invoked, it waits for a number to be typed in. If you type in a positive number less than  $2^{56}$  it will print all primes greater than or equal to this number.

**DIAGNOSTICS**

'Ouch.' for input out of range or for garbage input.

**NAME**

file – determine file type

**SYNOPSIS**

**file** file ...

**DESCRIPTION**

*File* performs a series of tests on each argument in an attempt to classify it. If an argument appears to be ascii, *file* examines the first 512 bytes and tries to guess its language.

**BUGS**

It often makes mistakes. In particular it often suggests that command files are C programs.



**NAME**

find – find files

**SYNOPSIS**

**find** pathname-list expression

**DESCRIPTION**

*Find* recursively descends the directory hierarchy for each pathname in the *pathname-list* (i.e., one or more pathnames) seeking files that match a boolean *expression* written in the primaries given below. In the descriptions, the argument *n* is used as a decimal integer where *+n* means more than *n*, *-n* means less than *n* and *n* means exactly *n*.

**-name** filename

True if the *filename* argument matches the current file name. Normal Shell argument syntax may be used if escaped (watch out for '[', '?' and '\*').

**-perm** onum

True if the file permission flags exactly match the octal number *onum* (see *chmod(1)*). If *onum* is prefixed by a minus sign, more flag bits (01777, see *stat(2)*) become significant and the flags are compared:  $(flags \& onum) == onum$ .

**-type** c

True if the type of the file is *c*, where *c* is **b**, **c**, **d** or **f** for block special file, character special file, directory or plain file.

**-links** n

True if the file has *n* links.

**-user** uname

True if the file belongs to the user *uname* (login name or numeric user ID).

**-group** gname

True if the file belongs to group *gname* (group name or numeric group ID).

**-size** n

True if the file is *n* blocks long (512 bytes per block).

**-inum** n

True if the file has inode number *n*.

**-atime** n

True if the file has been accessed in *n* days.

**-mtime** n

True if the file has been modified in *n* days.

**-exec** command

True if the executed command returns a zero value as exit status. The end of the command must be punctuated by an escaped semicolon. A command argument '{}' is replaced by the current pathname.

**-ok** command

Like **-exec** except that the generated command is written on the standard output, then the standard input is read and the command executed only upon response **y**.

**-print**

Always true; causes the current pathname to be printed.

**-newer** file

True if the current file has been modified more recently than the argument *file*.

The primaries may be combined using the following operators (in order of decreasing precedence):

- 1) A parenthesized group of primaries and operators (parentheses are special to the Shell and must be escaped).
- 2) The negation of a primary ('!' is the unary *not* operator).
- 3) Concatenation of primaries (the *and* operation is implied by the juxtaposition of two primaries).
- 4) Alternation of primaries ('-o' is the *or* operator).

**EXAMPLE**

To remove all files named 'a.out' or '\*.o' that have not been accessed for a week:

```
find / \( -name a.out -o -name '*.o' \) -atime +7 -exec rm {} \;
```

**FILES**

/etc/passwd

/etc/group

**SEE ALSO**

sh(1), test(1), filsys(5)

**BUGS**

The syntax is painful.

**NAME**

graph – draw a graph

**SYNOPSIS**

**graph** [ option ] ...

**DESCRIPTION**

*Graph* with no options takes pairs of numbers from the standard input as abscissas and ordinates of a graph. Successive points are connected by straight lines. The graph is encoded on the standard output for display by the *plot(1)* filters.

If the coordinates of a point are followed by a nonnumeric string, that string is printed as a label beginning on the point. Labels may be surrounded with quotes "...", in which case they may be empty or contain blanks and numbers; labels never contain newlines.

The following options are recognized, each as a separate argument.

- a** Supply abscissas automatically (they are missing from the input); spacing is given by the next argument (default 1). A second optional argument is the starting point for automatic abscissas (default 0 or lower limit given by –**x**).
- b** Break (disconnect) the graph after each label in the input.
- c** Character string given by next argument is default label for each point.
- g** Next argument is grid style, 0 no grid, 1 frame with ticks, 2 full grid (default).
- l** Next argument is label for graph.
- m** Next argument is mode (style) of connecting lines: 0 disconnected, 1 connected (default). Some devices give distinguishable line styles for other small integers.
- s** Save screen, don't erase before plotting.
- x** [ **l** ] If **l** is present, x axis is logarithmic. Next 1 (or 2) arguments are lower (and upper) *x* limits. Third argument, if present, is grid spacing on *x* axis. Normally these quantities are determined automatically.
- y** [ **l** ] Similarly for *y*.
- h** Next argument is fraction of space for height.
- w** Similarly for width.
- r** Next argument is fraction of space to move right before plotting.
- u** Similarly to move up before plotting.
- t** Transpose horizontal and vertical axes. (Option –**x** now applies to the vertical axis.)

A legend indicating grid range is produced with a grid unless the –**s** option is present.

If a specified lower limit exceeds the upper limit, the axis is reversed.

**SEE ALSO**

spline(1), plot(1)

**BUGS**

*Graph* stores all points internally and drops those for which there isn't room. Segments that run out of bounds are dropped, not windowed. Logarithmic axes may not be reversed.

**NAME**

`grep`, `egrep`, `fgrep` – search a file for a pattern

**SYNOPSIS**

**grep** [ option ] ... expression [ file ] ...

**egrep** [ option ] ... [ expression ] [ file ] ...

**fgrep** [ option ] ... [ strings ] [ file ]

**DESCRIPTION**

Commands of the *grep* family search the input *files* (standard input default) for lines matching a pattern. Normally, each line found is copied to the standard output; unless the `-h` flag is used, the file name is shown if there is more than one input file.

*Grep* patterns are limited regular expressions in the style of *ed(1)*; it uses a compact nondeterministic algorithm. *Egrep* patterns are full regular expressions; it uses a fast deterministic algorithm that sometimes needs exponential space. *Fgrep* patterns are fixed strings; it is fast and compact.

The following options are recognized.

- `-v` All lines but those matching are printed.
- `-c` Only a count of matching lines is printed.
- `-l` The names of files with matching lines are listed (once) separated by newlines.
- `-n` Each line is preceded by its line number in the file.
- `-b` Each line is preceded by the block number on which it was found. This is sometimes useful in locating disk block numbers by context.
- `-s` No output is produced, only status.
- `-h` Do not print filename headers with output lines.
- `-y` Lower case letters in the pattern will also match upper case letters in the input (*grep* only).
- `-e expression`  
Same as a simple *expression* argument, but useful when the *expression* begins with a `-`.
- `-f file` The regular expression (*egrep*) or string list (*fgrep*) is taken from the *file*.
- `-x` (Exact) only lines matched in their entirety are printed (*fgrep* only).

Care should be taken when using the characters `$ * [ ^ | ? " ( )` and `\` in the *expression* as they are also meaningful to the Shell. It is safest to enclose the entire *expression* argument in single quotes `' '`.

*Fgrep* searches for lines that contain one of the (newline-separated) *strings*.

*Egrep* accepts extended regular expressions. In the following description ‘character’ excludes newline:

A `\` followed by a single character matches that character.

The character `^` (\$) matches the beginning (end) of a line.

A `.` matches any character.

A single character not otherwise endowed with special meaning matches that character.

A string enclosed in brackets `[]` matches any single character from the string. Ranges of ASCII character codes may be abbreviated as in `'a-z0-9'`. A `]` may occur only as the first character of the string. A literal `-` must be placed where it can't be mistaken as a range indicator.

A regular expression followed by `*` (+, ?) matches a sequence of 0 or more (1 or more, 0 or 1) matches of the regular expression.

Two regular expressions concatenated match a match of the first followed by a match of the second.

Two regular expressions separated by `|` or newline match either a match for the first or a match for the second.

A regular expression enclosed in parentheses matches a match for the regular expression.

The order of precedence of operators at the same parenthesis level is `[]` then `*+?` then concatenation then `|` and newline.

**SEE ALSO**

`ed(1)`, `sed(1)`, `sh(1)`

**DIAGNOSTICS**

Exit status is 0 if any matches are found, 1 if none, 2 for syntax errors or inaccessible files.

**BUGS**

Ideally there should be only one *grep*, but we don't know a single algorithm that spans a wide enough range of space-time tradeoffs.

Lines are limited to 256 characters; longer lines are truncated.

**NAME**

`icheck` – file system storage consistency check

**SYNOPSIS**

`icheck` [ `-s` ] [ `-b` numbers ] [ filesystem ]

**DESCRIPTION**

*Icheck* examines a file system, builds a bit map of used blocks, and compares this bit map against the free list maintained on the file system. If the file system is not specified, a set of default file systems is checked. The normal output of *icheck* includes a report of

The total number of files and the numbers of regular, directory, block special and character special files.

The total number of blocks in use and the numbers of single-, double-, and triple-indirect blocks and directory blocks.

The number of free blocks.

The number of blocks missing; i.e. not in any file nor in the free list.

The `-s` option causes *icheck* to ignore the actual free list and reconstruct a new one by rewriting the super-block of the file system. The file system should be dismounted while this is done; if this is not possible (for example if the root file system has to be salvaged) care should be taken that the system is quiescent and that it is rebooted immediately afterwards so that the old, bad in-core copy of the super-block will not continue to be used. Notice also that the words in the super-block which indicate the size of the free list and of the i-list are believed. If the super-block has been curdled these words will have to be patched. The `-s` option causes the normal output reports to be suppressed.

Following the `-b` option is a list of block numbers; whenever any of the named blocks turns up in a file, a diagnostic is produced.

*Icheck* is faster if the raw version of the special file is used, since it reads the i-list many blocks at a time.

**FILES**

Default file systems vary with installation.

**SEE ALSO**

`dcheck(1)`, `ncheck(1)`, `filsys(5)`, `clri(1)`

**DIAGNOSTICS**

For duplicate blocks and bad blocks (which lie outside the file system) *icheck* announces the difficulty, the i-number, and the kind of block involved. If a read error is encountered, the block number of the bad block is printed and *icheck* considers it to contain 0. 'Bad freeblock' means that a block number outside the available space was encountered in the free list. '*n* dups in free' means that *n* blocks were found in the free list which duplicate blocks either in some file or in the earlier part of the free list.

**BUGS**

Since *icheck* is inherently two-pass in nature, extraneous diagnostics may be produced if applied to active file systems.

It believes even preposterous super-blocks and consequently can get core images.

**NAME**

`iostat` – report I/O statistics

**SYNOPSIS**

`iostat` [ option ] ... [ interval [ count ] ]

**DESCRIPTION**

*Iostat* delves into the system and reports certain statistics kept about input-output activity. Information is kept about up to three different disks (RF, RK, RP) and about typewriters. For each disk, IO completions and number of words transferred are counted; for typewriters collectively, the number of input and output characters are counted. Also, each sixtieth of a second, the state of each disk is examined and a tally is made if the disk is active. The tally goes into one of four categories, depending on whether the system is executing in user mode, in 'nice' (background) user mode, in system mode, or idle. From all these numbers and from the known transfer rates of the devices it is possible to determine information such as the degree of IO overlap and average seek times for each device.

The optional *interval* argument causes *iostat* to report once each *interval* seconds. The first report is for all time since a reboot and each subsequent report is for the last interval only.

The optional *count* argument restricts the number of reports.

With no option argument *iostat* reports for each disk the number of transfers per minute, the milliseconds per average seek, and the milliseconds per data transfer exclusive of seek time. It also gives the percentage of time the system has spend in each of the four categories mentioned above.

The following options are available:

- t** Report the number of characters of terminal IO per second as well.
- i** Report the percentage of time spend in each of the four categories mentioned above, the percentage of time each disk was active (seeking or transferring), the percentage of time any disk was active, and the percentage of time spent in 'IO wait:' idle, but with a disk active.
- s** Report the raw timing information: 32 numbers indicating the percentage of time spent in each of the possible configurations of 4 system states and 8 IO states (3 disks each active or not).
- b** Report on the usage of IO buffers.

**FILES**

/dev/mem, /unix

**NAME**

join – relational database operator

**SYNOPSIS**

**join** [ options ] file1 file2

**DESCRIPTION**

*Join* forms, on the standard output, a join of the two relations specified by the lines of *file1* and *file2*. If *file1* is '-', the standard input is used.

*File1* and *file2* must be sorted in increasing ASCII collating sequence on the fields on which they are to be joined, normally the first in each line.

There is one line in the output for each pair of lines in *file1* and *file2* that have identical join fields. The output line normally consists of the common field, then the rest of the line from *file1*, then the rest of the line from *file2*.

Fields are normally separated by blank, tab or newline. In this case, multiple separators count as one, and leading separators are discarded.

These options are recognized:

- an** In addition to the normal output, produce a line for each unpairable line in file *n*, where *n* is 1 or 2.
- es** Replace empty output fields by string *s*.
- jn m** Join on the *m*th field of file *n*. If *n* is missing, use the *m*th field in each file.
- o list** Each output line comprises the fields specified in *list*, each element of which has the form *n.m*, where *n* is a file number and *m* is a field number.
- tc** Use character *c* as a separator (tab character). Every appearance of *c* in a line is significant.

**SEE ALSO**

sort(1), comm(1), awk(1)

**BUGS**

With default field separation, the collating sequence is that of *sort -b*; with **-t**, the sequence is that of a plain sort.

The conventions of *join*, *sort*, *comm*, *uniq*, *look* and *awk(1)* are wildly incongruous.



**NAME**

kill – terminate a process with extreme prejudice

**SYNOPSIS**

**kill** [ -signo ] processid ...

**DESCRIPTION**

*Kill* sends signal 15 (terminate) to the specified processes. If a signal number preceded by ‘-’ is given as first argument, that signal is sent instead of terminate (see *signal(2)*). This will kill processes that do not catch the signal; in particular ‘kill -9 ...’ is a sure kill.

By convention, if process number 0 is specified, all members in the process group (i.e. processes resulting from the current login) are signaled.

The killed processes must belong to the current user unless he is the super-user. To shut the system down and bring it up single user the super-user may use ‘kill -1 1’; see *init(8)*.

The process number of an asynchronous process started with ‘&’ is reported by the shell. Process numbers can also be found by using *ps(1)*.

**SEE ALSO**

*ps(1)*, *kill(2)*, *signal(2)*

**NAME**

`ld` – loader

**SYNOPSIS**

`ld` [ option ] file ...

**DESCRIPTION**

*Ld* combines several object programs into one, resolves external references, and searches libraries. In the simplest case several object *files* are given, and *ld* combines them, producing an object module which can be either executed or become the input for a further *ld* run. (In the latter case, the `-r` option must be given to preserve the relocation bits.) The output of *ld* is left on **a.out**. This file is made executable only if no errors occurred during the load.

The argument routines are concatenated in the order specified. The entry point of the output is the beginning of the first routine.

If any argument is a library, it is searched exactly once at the point it is encountered in the argument list. Only those routines defining an unresolved external reference are loaded. If a routine from a library references another routine in the library, and the library has not been processed by *ranlib*(1), the referenced routine must appear after the referencing routine in the library. Thus the order of programs within libraries may be important. If the first member of a library is named `'_SYMDEF'`, then it is understood to be a dictionary for the library such as produced by *ranlib*; the dictionary is searched iteratively to satisfy as many references as possible.

The symbols `'_etext'`, `'_edata'` and `'_end'` (`'etext'`, `'edata'` and `'end'` in C) are reserved, and if referred to, are set to the first location above the program, the first location above initialized data, and the first location above all data respectively. It is erroneous to define these symbols.

*Ld* understands several options. Except for `-I`, they should appear before the file names.

- `-s` 'Strip' the output, that is, remove the symbol table and relocation bits to save space (but impair the usefulness of the debugger). This information can also be removed by *strip*(1).
- `-u` Take the following argument as a symbol and enter it as undefined in the symbol table. This is useful for loading wholly from a library, since initially the symbol table is empty and an unresolved reference is needed to force the loading of the first routine.
- `-Lx` This option is an abbreviation for the library name `'/lib/libx.a'`, where *x* is a string. If that does not exist, *ld* tries `'/usr/lib/libx.a'`. A library is searched when its name is encountered, so the placement of a `-I` is significant.
- `-x` Do not preserve local (non-`globl`) symbols in the output symbol table; only enter external symbols. This option saves some space in the output file.
- `-X` Save local symbols except for those whose names begin with `'L'`. This option is used by *cc*(1) to discard internally generated labels while retaining symbols local to routines.
- `-r` Generate relocation bits in the output file so that it can be the subject of another *ld* run. This flag also prevents final definitions from being given to common symbols, and suppresses the 'undefined symbol' diagnostics.
- `-d` Force definition of common storage even if the `-r` flag is present.
- `-n` Arrange that when the output file is executed, the text portion will be read-only and shared among all users executing the file. This involves moving the data areas up to the first possible 4K word boundary following the end of the text.
- `-i` When the output file is executed, the program text and data areas will live in separate address spaces. The only difference between this option and `-n` is that here the data starts at location 0.
- `-o` The *name* argument after `-o` is used as the name of the *ld* output file, instead of **a.out**.

- e The following argument is taken to be the name of the entry point of the loaded program; location 0 is the default.
- O This is an overlay file, only the text segment will be replaced by *exec(2)*. Shared data must have the same layout as in the program overlaid.
- D The next argument is a decimal number that sets the size of the data segment.

**FILES**

/lib/lib\*.a libraries  
/usr/lib/lib\*.a more libraries  
a.out output file

**SEE ALSO**

as(1), ar(1), cc(1), ranlib(1)

**BUGS**

**NAME**

lex – generator of lexical analysis programs

**SYNOPSIS**

**lex** [ **-tvfn** ] [ file ] ...

**DESCRIPTION**

*Lex* generates programs to be used in simple lexical analysis of text. The input *files* (standard input default) contain regular expressions to be searched for, and actions written in C to be executed when expressions are found.

A C source program, 'lex.yy.c' is generated, to be compiled thus:

```
cc lex.yy.c -ll
```

This program, when run, copies unrecognized portions of the input to the output, and executes the associated C action for each regular expression that is recognized.

The following *lex* program converts upper case to lower, removes blanks at the end of lines, and replaces multiple blanks by single blanks.

```
%%  
[A-Z] putchar(yytext[0]+'a'-'A');  
[ ]+$  
[ ]+  putchar(' ');
```

The options have the following meanings.

- t** Place the result on the standard output instead of in file 'lex.yy.c'.
- v** Print a one-line summary of statistics of the generated analyzer.
- n** Opposite of **-v**; **-n** is default.
- f** 'Faster' compilation: don't bother to pack the resulting tables; limited to small programs.

**SEE ALSO**

yacc(1)

M. E. Lesk and E. Schmidt, *LEX – Lexical Analyzer Generator*

**NAME**

lint – a C program verifier

**SYNOPSIS**

**lint** [ **-abchnpuvx** ] file ...

**DESCRIPTION**

*Lint* attempts to detect features of the C program *files* which are likely to be bugs, or non-portable, or wasteful. It also checks the type usage of the program more strictly than the compilers. Among the things which are currently found are unreachable statements, loops not entered at the top, automatic variables declared and not used, and logical expressions whose value is constant. Moreover, the usage of functions is checked to find functions which return values in some places and not in others, functions called with varying numbers of arguments, and functions whose values are not used.

By default, it is assumed that all the *files* are to be loaded together; they are checked for mutual compatibility. Function definitions for certain libraries are available to *lint*; these libraries are referred to by a conventional name, such as *-lm*, in the style of *ld(1)*.

Any number of the options in the following list may be used. The **-D**, **-U**, and **-I** options of *cc(1)* are also recognized as separate arguments.

- p** Attempt to check portability to the *IBM* and *GCOS* dialects of C.
- h** Apply a number of heuristic tests to attempt to intuit bugs, improve style, and reduce waste.
- b** Report *break* statements that cannot be reached. (This is not the default because, unfortunately, most *lex* and many *yacc* outputs produce dozens of such comments.)
- v** Suppress complaints about unused arguments in functions.
- x** Report variables referred to by extern declarations, but never used.
- a** Report assignments of long values to int variables.
- c** Complain about casts which have questionable portability.
- u** Do not complain about functions and variables used and not defined, or defined and not used (this is suitable for running *lint* on a subset of files out of a larger program).
- n** Do not check compatibility against the standard library.

*Exit(2)* and other functions which do not return are not understood; this causes various lies.

Certain conventional comments in the C source will change the behavior of *lint*:

*/\*NOTREACHED\*/*

at appropriate points stops comments about unreachable code.

*/\*VARARGS*n*\*/*

suppresses the usual checking for variable numbers of arguments in the following function declaration. The data types of the first *n* arguments are checked; a missing *n* is taken to be 0.

*/\*NOSTRICT\*/*

shuts off strict type checking in the next expression.

*/\*ARGSUSED\*/*

turns on the **-v** option for the next function.

*/\*LINTLIBRARY\*/*

at the beginning of a file shuts off complaints about unused functions in this file.

**FILES**

*/usr/lib/lint[12]* programs

*/usr/lib/lib-lc* declarations for standard functions

*/usr/lib/lib-port* declarations for portable functions

**SEE ALSO**

cc(1)

S. C. Johnson, *Lint, a C Program Checker*

**NAME**

ln - make a link

**SYNOPSIS**

**ln** name1 [ name2 ]

**DESCRIPTION**

A link is a directory entry referring to a file; the same file (together with its size, all its protection information, etc.) may have several links to it. There is no way to distinguish a link to a file from its original directory entry; any changes in the file are effective independently of the name by which the file is known.

*Ln* creates a link to an existing file *name1*. If *name2* is given, the link has that name; otherwise it is placed in the current directory and its name is the last component of *name1*.

It is forbidden to link to a directory or to link across file systems.

**SEE ALSO**

rm(1)

**NAME**

login – sign on

**SYNOPSIS**

**login** [ username ]

**DESCRIPTION**

The *login* command is used when a user initially signs on, or it may be used at any time to change from one user to another. The latter case is the one summarized above and described here. See 'How to Get Started' for how to dial up initially.

If *login* is invoked without an argument, it asks for a user name, and, if appropriate, a password. Echoing is turned off (if possible) during the typing of the password, so it will not appear on the written record of the session.

After a successful login, accounting files are updated and the user is informed of the existence of *.mail* and message-of-the-day files. *Login* initializes the user and group IDs and the working directory, then executes a command interpreter (usually *sh*(1)) according to specifications found in a password file. Argument 0 of the command interpreter is *'-sh'*.

Login is recognized by *sh*(1) and executed directly (without forking).

**FILES**

|               |                    |
|---------------|--------------------|
| /etc/utmp     | accounting         |
| /usr/adm/wtmp | accounting         |
| /usr/mail/*   | mail               |
| /etc/motd     | message-of-the-day |
| /etc/passwd   | password file      |

**SEE ALSO**

init(8), newgrp(1), getty(8), mail(1), passwd(1), passwd(5)

**DIAGNOSTICS**

'Login incorrect,' if the name or the password is bad.

'No Shell', 'cannot open password file', 'no directory': consult a programming counselor.



**NAME**

look – find lines in a sorted list

**SYNOPSIS**

**look** [ **-df** ] string [ file ]

**DESCRIPTION**

*Look* consults a sorted *file* and prints all lines that begin with *string*. It uses binary search.

The options **d** and **f** affect comparisons as in *sort*(1):

**d** ‘Dictionary’ order: only letters, digits, tabs and blanks participate in comparisons.

**f** Fold. Upper case letters compare equal to lower case.

If no *file* is specified, */usr/dict/words* is assumed with collating sequence **-df**.

**FILES**

*/usr/dict/words*

**SEE ALSO**

*sort*(1), *grep*(1)

**NAME**

lookall – look through all text files on UNIX

**SYNOPSIS**

**lookall** [ -C*n* ]

**DESCRIPTION**

*Lookall* accepts keywords from the standard input, performs a search similar to that of *refer*(1), and writes the result on the standard output. *Lookall* consults, however, an index to all the text files on the system rather than just bibliographies. Only the first 50 words of each file (roughly) were used to make the indexes. Blank lines are taken as delimiters between queries.

The -C*n* option specifies a coordination level search: up to *n* keywords may be missing from the answers, and the answers are listed with those containing the most keywords first.

The command sequence in */usr/dict/lookall/makindex* regenerates the index.

**FILES**

The directory */usr/dict/lookall* contains the index files.

**DIAGNOSTICS**

‘Warning: index precedes file ...’ means that a file has been changed since the index was made and it may be retrieved (or not retrieved) erroneously.

**BUGS**

Coordination level searching doesn’t work as described: only those acceptable items with the smallest number of missing keywords are retrieved.

**NAME**

`lorder` – find ordering relation for an object library

**SYNOPSIS**

`lorder` file ...

**DESCRIPTION**

The input is one or more object or library archive (see *ar(1)*) files. The standard output is a list of pairs of object file names, meaning that the first file of the pair refers to external identifiers defined in the second. The output may be processed by *tsort(1)* to find an ordering of a library suitable for one-pass access by *ld(1)*.

This brash one-liner intends to build a new library from existing '.o' files.

```
ar cr library `lorder *.o | tsort`
```

**FILES**

\*symref, \*symdef  
nm(1), sed(1), sort(1), join(1)

**SEE ALSO**

*tsort(1)*, *ld(1)*, *ar(1)*

**BUGS**

The names of object files, in and out of libraries, must end with '.o'; nonsense results otherwise.

**NAME**

`ls` - list contents of directory

**SYNOPSIS**

`ls [ -ltasdrucifg ] name ...`

**DESCRIPTION**

For each directory argument, `ls` lists the contents of the directory; for each file argument, `ls` repeats its name and any other information requested. The output is sorted alphabetically by default. When no argument is given, the current directory is listed. When several arguments are given, the arguments are first sorted appropriately, but file arguments appear before directories and their contents. There are several options:

- l** List in long format, giving mode, number of links, owner, size in bytes, and time of last modification for each file. (See below.) If the file is a special file the size field will instead contain the major and minor device numbers.
- t** Sort by time modified (latest first) instead of by name, as is normal.
- a** List all entries; usually `.'` and `..` are suppressed.
- s** Give size in blocks, including indirect blocks, for each entry.
- d** If argument is a directory, list only its name, not its contents (mostly used with **-l** to get status on directory).
- r** Reverse the order of sort to get reverse alphabetic or oldest first as appropriate.
- u** Use time of last access instead of last modification for sorting (**-t**) or printing (**-l**).
- c** Use time of last modification to inode (mode, etc.) instead of last modification to file for sorting (**-t**) or printing (**-l**).
- i** Print i-number in first column of the report for each file listed.
- f** Force each argument to be interpreted as a directory and list the name found in each slot. This option turns off **-l**, **-t**, **-s**, and **-r**, and turns on **-a**; the order is the order in which entries appear in the directory.
- g** Give group ID instead of owner ID in long listing.

The mode printed under the **-l** option contains 11 characters which are interpreted as follows: the first character is

- d** if the entry is a directory;
- b** if the entry is a block-type special file;
- c** if the entry is a character-type special file;
- if the entry is a plain file.

The next 9 characters are interpreted as three sets of three bits each. The first set refers to owner permissions; the next to permissions to others in the same user-group; and the last to all others. Within each set the three characters indicate permission respectively to read, to write, or to execute the file as a program. For a directory, 'execute' permission is interpreted to mean permission to search the directory for a specified file. The permissions are indicated as follows:

- r** if the file is readable;
- w** if the file is writable;
- x** if the file is executable;
- if the indicated permission is not granted.

The group-execute permission character is given as **s** if the file has set-group-ID mode; likewise the user-execute permission character is given as **S** if the file has set-user-ID mode.

The last character of the mode (normally 'x' or '-') is **t** if the 1000 bit of the mode is on. See *chmod(1)* for the meaning of this mode.

When the sizes of the files in a directory are listed, a total count of blocks, including indirect blocks is printed.

**FILES**

/etc/passwd to get user ID's for 'ls -l'.

/etc/group to get group ID's for 'ls -g'.

**NAME**

m4 – macro processor

**SYNOPSIS**

**m4** [ files ]

**DESCRIPTION**

*M4* is a macro processor intended as a front end for Ratfor, C, and other languages. Each of the argument files is processed in order; if there are no arguments, or if an argument is '-', the standard input is read. The processed text is written on the standard output.

Macro calls have the form

```
name(arg1,arg2, . . . , argn)
```

The '(' must immediately follow the name of the macro. If a defined macro name is not followed by a '(', it is deemed to have no arguments. Leading unquoted blanks, tabs, and newlines are ignored while collecting arguments. Potential macro names consist of alphabetic letters, digits, and underscore '\_', where the first character is not a digit.

Left and right single quotes (`) are used to quote strings. The value of a quoted string is the string stripped of the quotes.

When a macro name is recognized, its arguments are collected by searching for a matching right parenthesis. Macro evaluation proceeds normally during the collection of the arguments, and any commas or right parentheses which happen to turn up within the value of a nested call are as effective as those in the original input text. After argument collection, the value of the macro is pushed back onto the input stream and rescanned.

*M4* makes available the following built-in macros. They may be redefined, but once this is done the original meaning is lost. Their values are null unless otherwise stated.

- |             |  |
|-------------|--|
| define      | The second argument is installed as the value of the macro whose name is the first argument. Each occurrence of \$ <i>n</i> in the replacement text, where <i>n</i> is a digit, is replaced by the <i>n</i> -th argument. Argument 0 is the name of the macro; missing arguments are replaced by the null string.                  |
| undefine    | removes the definition of the macro named in its argument.   |
| ifdef       | If the first argument is defined, the value is the second argument, otherwise the third. If there is no third argument, the value is null. The word <i>unix</i> is predefined on UNIX versions of <i>m4</i> .  |
| changequote | Change quote characters to the first and second arguments. <i>Changequote</i> without arguments restores the original values (i.e., ` `).  |
| divert      | <i>M4</i> maintains 10 output streams, numbered 0-9. The final output is the concatenation of the streams in numerical order; initially stream 0 is the current stream. The <i>divert</i> macro changes the current output stream to its (digit-string) argument. Output diverted to a stream other than 0 through 9 is discarded. |
| undivert    | causes immediate output of text from diversions named as arguments, or all diversions if no argument. Text may be undiverted into another diversion. Undiverting discards the diverted text.   |
| divnum      | returns the value of the current output stream.  |
| dnl         | reads and discards characters up to and including the next newline.  |
| ifelse      | has three or more arguments. If the first argument is the same string as the second, then the value is the third argument. If not, and if there are more than four arguments, the process is repeated with arguments 4, 5, 6 and 7. Otherwise, the value is either the fourth string, or, if                                       |

|          |  |
|----------|--|
|          | it is not present, null.   |
| incr     | returns the value of its argument incremented by 1. The value of the argument is calculated by interpreting an initial digit-string as a decimal number.   |
| eval     | evaluates its argument as an arithmetic expression, using 32-bit arithmetic. Operators include +, -, *, /, %, ^ (exponentiation); relationals; parentheses.  |
| len      | returns the number of characters in its argument.  |
| index    | returns the position in its first argument where the second argument begins (zero origin), or -1 if the second argument does not occur.  |
| substr   | returns a substring of its first argument. The second argument is a zero origin number selecting the first character; the third argument indicates the length of the substring. A missing third argument is taken to be large enough to extend to the end of the first string. |
| translit | transliterates the characters in its first argument from the set given by the second argument to the set given by the third. No abbreviations are permitted.   |
| include  | returns the contents of the file named in the argument.  |
| sinclude | is identical to <i>include</i> , except that it says nothing if the file is inaccessible.  |
| syscmd   | executes the UNIX command given in the first argument. No value is returned.   |
| maketemp | fills in a string of XXXXXX in its argument with the current process id.   |
| errprint | prints its argument on the diagnostic output file.   |
| dumpdef  | prints current names and definitions, for the named items, or for all if no arguments are given.   |

**SEE ALSO**

B. W. Kernighan and D. M. Ritchie, *The M4 Macro Processor*

**NAME**

mail – send or receive mail among users

**SYNOPSIS**

**mail** person ...  
**mail** [ **-r** ] [ **-q** ] [ **-p** ] [ **-f** file ]

**DESCRIPTION**

*Mail* with no argument prints a user's mail, message-by-message, in last-in, first-out order; the optional argument **-r** causes first-in, first-out order. If the **-p** flag is given, the mail is printed with no questions asked; otherwise, for each message, *mail* reads a line from the standard input to direct disposition of the message.

newline Go on to next message.

d Delete message and go on to the next.

p Print message again.

– Go back to previous message.

s [ *file* ] ...  
 Save the message in the named *files* ('mbox' default).

w [ *file* ] ...  
 Save the message, without a header, in the named *files* ('mbox' default).

m [ *person* ] ...  
 Mail the message to the named *persons* (yourself is default).

EOT (control-D)  
 Put unexamined mail back in the mailbox and stop.

q Same as EOT.

x Exit, without changing the mailbox file.

!command  
 Escape to the Shell to do command.

? Print a command summary.

An interrupt stops the printing of the current letter. The optional argument **-q** causes *mail* to exit after interrupts without changing the mailbox.

When *persons* are named, *mail* takes the standard input up to an end-of-file (or a line with just '.') and adds it to each *person's* 'mail' file. The message is preceded by the sender's name and a postmark. Lines that look like postmarks are prepended with '>'. A *person* is usually a user name recognized by *login*(1). To denote a recipient on a remote system, prefix *person* by the system name and exclamation mark (see *uucp*(1)).

The **-f** option causes the named file, e.g. 'mbox', to be printed as if it were the mail file.

Each user owns his own mailbox, which is by default generally readable but not writable. The command does not delete an empty mailbox nor change its mode, so a user may make it unreadable if desired.

When a user logs in he is informed of the presence of mail.

**FILES**

|                   |                                       |
|-------------------|---------------------------------------|
| /usr/spool/mail/* | mailboxes                             |
| /etc/passwd       | to identify sender and locate persons |
| mbox              | saved mail                            |
| /tmp/ma*          | temp file                             |



dead.letter      unmailable text  
uux(1)

**SEE ALSO**

xsend(1), write(1), uucp(1)

**BUGS**

There is a locking mechanism intended to prevent two senders from accessing the same mailbox, but it is not perfect and races are possible.

**NAME**

make – maintain program groups

**SYNOPSIS**

**make** [ **-f** *makefile* ] [ *option* ] ... *file* ...

**DESCRIPTION**

*Make* executes commands in *makefile* to update one or more target *names*. *Name* is typically a program. If no **-f** option is present, 'makefile' and 'Makefile' are tried in order. If *makefile* is '-', the standard input is taken. More than one **-f** option may appear

*Make* updates a target if it depends on prerequisite files that have been modified since the target was last modified, or if the target does not exist.

*Makefile* contains a sequence of entries that specify dependencies. The first line of an entry is a blank-separated list of targets, then a colon, then a list of prerequisite files. Text following a semicolon, and all following lines that begin with a tab, are shell commands to be executed to update the target.

Sharp and newline surround comments.

The following makefile says that 'pgm' depends on two files 'a.o' and 'b.o', and that they in turn depend on '.c' files and a common file 'incl'.

```
pgm: a.o b.o
    cc a.o b.o -lm -o pgm
a.o: incl a.c
    cc -c a.c
b.o: incl b.c
    cc -c b.c
```

*Makefile* entries of the form

```
string1 = string2
```

are macro definitions. Subsequent appearances of  $\$(string1)$  are replaced by *string2*. If *string1* is a single character, the parentheses are optional.

*Make* infers prerequisites for files for which *makefile* gives no construction commands. For example, a '.c' file may be inferred as prerequisite for a '.o' file and be compiled to produce the '.o' file. Thus the preceding example can be done more briefly:

```
pgm: a.o b.o
    cc a.o b.o -lm -o pgm
a.o b.o: incl
```

Prerequisites are inferred according to selected suffixes listed as the 'prerequisites' for the special name '.SUFFIXES'; multiple lists accumulate; an empty list clears what came before. Order is significant; the first possible name for which both a file and a rule as described in the next paragraph exist is inferred. The default list is

```
.SUFFIXES: .out .o .c .e .r .f .y .l .s
```

The rule to create a file with suffix *s2* that depends on a similarly named file with suffix *s1* is specified as an entry for the 'target' *s1s2*. In such an entry, the special macro  $\$*$  stands for the target name with suffix deleted,  $\$@$  for the full target name,  $\$<$  for the complete list of prerequisites, and  $\$?$  for the list of prerequisites that are out of date. For example, a rule for making optimized '.o' files from '.c' files is

```
.c.o: ; cc -c -O -o  $\$@$   $\$*.c$ 
```

Certain macros are used by the default inference rules to communicate optional arguments to any result-ing compilations. In particular, 'CFLAGS' is used for *cc* and *f77(1)* options, 'LFLAGS' and 'YFLAGS' for *lex* and *yacc(1)* options.

Command lines are executed one at a time, each by its own shell. A line is printed when it is executed unless the special target `‘.SILENT’` is in *makefile*, or the first character of the command is `‘@’`.

Commands returning nonzero status (see *intro(1)*) cause *make* to terminate unless the special target `‘.IGNORE’` is in *makefile* or the command begins with `<tab><hyphen>`.

Interrupt and quit cause the target to be deleted unless the target depends on the special name `‘.PRECIOUS’`.

Other options:

- `-i` Equivalent to the special entry `‘.IGNORE:’`.
- `-k` When a command returns nonzero status, abandon work on the current entry, but continue on branches that do not depend on the current entry.
- `-n` Trace and print, but do not execute the commands needed to update the targets.
- `-t` Touch, i.e. update the modified date of targets, without executing any commands.
- `-r` Equivalent to an initial special entry `‘.SUFFIXES:’` with no list.
- `-s` Equivalent to the special entry `‘.SILENT:’`.

#### FILES

*makefile*, *Makefile*

#### SEE ALSO

*sh(1)*, *touch(1)*

S. I. Feldman *Make – A Program for Maintaining Computer Programs*

#### BUGS

Some commands return nonzero status inappropriately. Use `-i` to overcome the difficulty.

Commands that are directly executed by the shell, notably *cd(1)*, are ineffectual across newlines in *make*.

**NAME**

`man` – print sections of this manual

**SYNOPSIS**

`man` [ option ... ] [ chapter ] title ...

**DESCRIPTION**

*Man* locates and prints the section of this manual named *title* in the specified *chapter*. (In this context, the word ‘page’ is often used as a synonym for ‘section’.) The *title* is entered in lower case. The *chapter* number does not need a letter suffix. If no *chapter* is specified, the whole manual is searched for *title* and all occurrences of it are printed.

*Options* and their meanings are:

- t** Phototypeset the section using *troff*(1).
- n** Print the section on the standard output using *nroff*(1).
- k** Display the output on a Tektronix 4014 terminal using *troff*(1) and *tc*(1).
- e** Appended or prefixed to any of the above causes the manual section to be preprocessed by *neqn* or *eqn*(1); –**e** alone means –**te**.
- w** Print the path names of the manual sections, but do not print the sections themselves.

(default)

Copy an already formatted manual section to the terminal, or, if none is available, act as –**n**. It may be necessary to use a filter to adapt the output to the particular terminal’s characteristics.

Further *options*, e.g. to specify the kind of terminal you have, are passed on to *troff*(1) or *nroff*. *Options* and *chapter* may be changed before each *title*.

For example:

```
man man
```

would reproduce this section, as well as any other sections named *man* that may exist in other chapters of the manual, e.g. *man*(7).

**FILES**

```
/usr/man/man?/*  
/usr/man/cat?/*
```

**SEE ALSO**

*nroff*(1), *eqn*(1), *tc*(1), *man*(7)

**BUGS**

The manual is supposed to be reproducible either on a phototypesetter or on a terminal. However, on a terminal some information is necessarily lost.

**NAME**

mesg - permit or deny messages

**SYNOPSIS**

**mesg** [ **n** ] [ **y** ]

**DESCRIPTION**

*Mesg* with argument **n** forbids messages via *write*(1) by revoking non-user write permission on the user's terminal. *Mesg* with argument **y** reinstates permission. All by itself, *mesg* reports the current state without changing it.

**FILES**

/dev/tty\*  
/dev

**SEE ALSO**

write(1)

**DIAGNOSTICS**

Exit status is 0 if messages are receivable, 1 if not, 2 on error.

**NAME**

mkconf – generate configuration tables

**SYNOPSIS**

mkconf

**DESCRIPTION**

*Mkconf* examines a machine configuration table on its standard input. Its output is a pair of files *l.s* and *c.c*. The first is an assembler program that represents the interrupt vectors located in low memory addresses; the second contains initialized block and character device switch tables.

Input to *mkconf* is a sequence of lines. The following describe devices on the machine:

|       |                 |
|-------|-----------------|
| pc    | (PC11)          |
| lp    | (LP11)          |
| rf    | (RS11)          |
| hs    | (RS03/RS04)     |
| tc    | (TU56)          |
| rk    | (RK03/RK05)     |
| tm    | (TU10)          |
| rp    | (RP03)          |
| hp    | (RP04/5/6)      |
| ht    | (TU16)          |
| dc*   | (DC11)          |
| kl*   | (KL11/DL11-ABC) |
| dl*   | (DL11-E)        |
| dp*   | (DP11)          |
| dn*   | (DN11)          |
| dh*   | (DH11)          |
| dhdm* | (DM11-BB)       |
| du*   | (DU11)          |

The devices marked with \* may be preceded by a number telling how many are to be included. The console typewrite is automatically included; don't count it as part of the KL or DL specification. Count DN's in units of 4 (1 system unit).

The following lines are also accepted.

**root dev minor**

The specified block device (e.g. **hp**) is used for the root. *minor* is a decimal number giving the minor device. This line must appear exactly once.

**swap dev minor**

The specified block device is used for swapping. If not given the root is used.

**pipe dev minor**

The specified block device is used to store pipes. If not given the root is used.

**swplo number****nswap number**

Sets the origin (block number) and size of the area used for swapping. By default, the not very useful numbers 4000 and 872.

**pack** Include the packet driver. By default it is left out.

**mpx** Include the multiplexor driver. By default it is left out.

**FILES**

*l.s*, *c.c* output files

**SEE ALSO**

'Setting up Unix', in Volume 2.

**BUGS**

The set of devices it knows about, the set of drivers included, and the set of devices on the machine are mutually incomparable. Some handwork is certain to be necessary. Because of floating vectors that may have been missed, It is mandatory to check the *l.s* file to make sure it corresponds with reality.

**NAME**

`mkdir` – make a directory

**SYNOPSIS**

**mkdir** dirname ...

**DESCRIPTION**

*Mkdir* creates specified directories in mode 777. Standard entries, '.', for the directory itself, and '..' for its parent, are made automatically.

*Mkdir* requires write permission in the parent directory.

**SEE ALSO**

`rm(1)`

**DIAGNOSTICS**

*Mkdir* returns exit code 0 if all directories were successfully made. Otherwise it prints a diagnostic and returns nonzero.



**NAME**

mkfs – construct a file system

**SYNOPSIS**

*/etc/mkfs* special proto

**DESCRIPTION**

*Mkfs* constructs a file system by writing on the special file *special* according to the directions found in the prototype file *proto*. The prototype file contains tokens separated by spaces or new lines. The first token is the name of a file to be copied onto block zero as the bootstrap program, see *bproc*(8). The second token is a number specifying the size of the created file system. Typically it will be the number of blocks on the device, perhaps diminished by space for swapping. The next token is the number of i-nodes in the i-list. The next set of tokens comprise the specification for the root file. File specifications consist of tokens giving the mode, the user-id, the group id, and the initial contents of the file. The syntax of the contents field depends on the mode.

The mode token for a file is a 6 character string. The first character specifies the type of the file. (The characters **-bcd** specify regular, block special, character special and directory files respectively.) The second character of the type is either **u** or **-** to specify set-user-id mode or not. The third is **g** or **-** for the set-group-id mode. The rest of the mode is a three digit octal number giving the owner, group, and other read, write, execute permissions, see *chmod*(1).

Two decimal number tokens come after the mode; they specify the user and group ID's of the owner of the file.

If the file is a regular file, the next token is a pathname whence the contents and size are copied.

If the file is a block or character special file, two decimal number tokens follow which give the major and minor device numbers.

If the file is a directory, *mkfs* makes the entries **.** and **..** and then reads a list of names and (recursively) file specifications for the entries in the directory. The scan is terminated with the token **\$**.

If the prototype file cannot be opened and its name consists of a string of digits, *mkfs* builds a file system with a single empty directory on it. The size of the file system is the value of *proto* interpreted as a decimal number. The number of i-nodes is calculated as a function of the filesystem size. The boot program is left uninitialized.

A sample prototype specification follows:

```

/usr/mdec/uboot
4872 55
d--777 3 1
usr    d--777 3 1
      sh    ---755 3 1 /bin/sh
      ken   d--755 6 1
      $
      b0    b--644 3 1 0 0
      c0    c--644 3 1 0 0
      $
$

```

**SEE ALSO**

*filsys*(5), *dir*(5), *bproc*(8)

**BUGS**

There should be some way to specify links.

**NAME**

mknod – build special file

**SYNOPSIS**

**/etc/mknod** name [ **c** ] [ **b** ] major minor

**DESCRIPTION**

*Mknod* makes a special file. The first argument is the *name* of the entry. The second is **b** if the special file is block-type (disks, tape) or **c** if it is character-type (other devices). The last two arguments are numbers specifying the *major* device type and the *minor* device (e.g. unit, drive, or line number).

The assignment of major device numbers is specific to each system. They have to be dug out of the system source file *conf.c*.

**SEE ALSO**

mknod(2)

**NAME**

mount, umount – mount and dismount file system

**SYNOPSIS**

**/etc/mount** [ special name [ -r ] ]

**/etc/umount** special

**DESCRIPTION**

*Mount* announces to the system that a removable file system is present on the device *special*. The file *name* must exist already; it must be a directory (unless the root of the mounted file system is not a directory). It becomes the name of the newly mounted root. The optional last argument indicates that the file system is to be mounted read-only.

*Umount* announces to the system that the removable file system previously mounted on device *special* is to be removed.

These commands maintain a table of mounted devices. If invoked without an argument, *mount* prints the table.

Physically write-protected and magnetic tape file systems must be mounted read-only or errors will occur when access times are updated, whether or not any explicit write is attempted.

**FILES**

/etc/mtab: mount table

**SEE ALSO**

mount(2), mtab(5)

**BUGS**

Mounting file systems full of garbage will crash the system.

Mounting a root directory on a non-directory makes some apparently good pathnames invalid.

**NAME**

`mv` – move or rename files and directories

**SYNOPSIS**

`mv file1 file2`

`mv file ... directory`

**DESCRIPTION**

*Mv* moves (changes the name of) *file1* to *file2*.

If *file2* already exists, it is removed before *file1* is moved. If *file2* has a mode which forbids writing, *mv* prints the mode (see *chmod(2)*) and reads the standard input to obtain a line; if the line begins with **y**, the move takes place; if not, *mv* exits.

In the second form, one or more *files* are moved to the *directory* with their original file-names.

*Mv* refuses to move a file onto itself.

**SEE ALSO**

*cp(1)*, *chmod(2)*

**BUGS**

If *file1* and *file2* lie on different file systems, *mv* must copy the file and delete the original. In this case the owner name becomes that of the copying process and any linking relationship with other files is lost.

*Mv* should take **-f** flag, like *rm*, to suppress the question if the target exists and is not writable.

**NAME**

ncheck - generate names from i-numbers

**SYNOPSIS**

**ncheck** [ **-i** numbers ] [ **-a** ] [ **-s** ] [ filesystem ]

**DESCRIPTION**

*Ncheck* with no argument generates a pathname vs. i-number list of all files on a set of default file systems. Names of directory files are followed by './'. The **-i** option reduces the report to only those files whose i-numbers follow. The **-a** option allows printing of the names '.' and '..', which are ordinarily suppressed. The **-s** option reduces the report to special files and files with set-user-ID mode; it is intended to discover concealed violations of security policy.

A file system may be specified.

The report is in no useful order, and probably should be sorted.

**SEE ALSO**

dcheck(1), ickcheck(1), sort(1)

**DIAGNOSTICS**

When the filesystem structure is improper, '??' denotes the 'parent' of a parentless file and a pathname beginning with '...' denotes a loop.

**NAME**

`newgrp` – log in to a new group

**SYNOPSIS**

**newgrp** group

**DESCRIPTION**

*Newgrp* changes the group identification of its caller, analogously to *login*(1). The same person remains logged in, and the current directory is unchanged, but calculations of access permissions to files are performed with respect to the new group ID.

A password is demanded if the group has a password and the user himself does not.

When most users log in, they are members of the group named 'other.' *Newgrp* is known to the shell, which executes it directly without a fork.

**FILES**

`/etc/group`, `/etc/passwd`

**SEE ALSO**

`login`(1), `group`(5)

**NAME**

`nice`, `nohup` – run a command at low priority

**SYNOPSIS**

**nice** [ *-number* ] *command* [ *arguments* ]

**nohup** *command* [ *arguments* ]

**DESCRIPTION**

*Nice* executes *command* with low scheduling priority. If the *number* argument is present, the priority is incremented (higher numbers mean lower priorities) by that amount up to a limit of 20. The default *number* is 10.

The super-user may run commands with priority higher than normal by using a negative priority, e.g. `--10`.

*Nohup* executes *command* immune to hangup and terminate signals from the controlling terminal. The priority is incremented by 5. *Nohup* should be invoked from the shell with `&` in order to prevent it from responding to interrupts by or stealing the input from the next person who logs in on the same terminal.

**FILES**

`nohup.out` standard output and standard error file under *nohup*

**SEE ALSO**

`nice(2)`

**DIAGNOSTICS**

*Nice* returns the exit status of the subject command.

**NAME**

**nm** - print name list

**SYNOPSIS**

**nm** [ **-gnopru** ] [ file ... ]

**DESCRIPTION**

*Nm* prints the name list (symbol table) of each object *file* in the argument list. If an argument is an archive, a listing for each object file in the archive will be produced. If no *file* is given, the symbols in 'a.out' are listed.

Each symbol name is preceded by its value (blanks if undefined) and one of the letters **U** (undefined), **A** (absolute), **T** (text segment symbol), **D** (data segment symbol), **B** (bss segment symbol), or **C** (common symbol). If the symbol is local (non-external) the type letter is in lower case. The output is sorted alphabetically.

Options are:

- g** Print only global (external) symbols.
- n** Sort numerically rather than alphabetically.
- o** Prepend file or archive element name to each output line rather than only once.
- p** Don't sort; print in symbol-table order.
- r** Sort in reverse order.
- u** Print only undefined symbols.

**SEE ALSO**

ar(1), ar(5), a.out(5)



**NAME**

`od` - octal dump

**SYNOPSIS**

`od` [ `-bcdox` ] [ `file` ] [ [ `+` ]offset[ `.` ] [ `b` ] ]

**DESCRIPTION**

`Od` dumps *file* in one or more formats as selected by the first argument. If the first argument is missing, `-o` is default. The meanings of the format argument characters are:

- b** Interpret bytes in octal.
- c** Interpret bytes in ASCII. Certain non-graphic characters appear as C escapes: null=`\0`, backspace=`\b`, formfeed=`\f`, newline=`\n`, return=`\r`, tab=`\t`; others appear as 3-digit octal numbers.
- d** Interpret words in decimal.
- o** Interpret words in octal.
- x** Interpret words in hex.

The *file* argument specifies which file is to be dumped. If no file argument is specified, the standard input is used.

The offset argument specifies the offset in the file where dumping is to commence. This argument is normally interpreted as octal bytes. If `.` is appended, the offset is interpreted in decimal. If `b` is appended, the offset is interpreted in blocks of 512 bytes. If the file argument is omitted, the offset argument must be preceded `+`.

Dumping continues until end-of-file.

**SEE ALSO**

`adb(1)`

**NAME**

passwd – change login password

**SYNOPSIS**

**passwd** [ name ]

**DESCRIPTION**

This command changes (or installs) a password associated with the user *name* (your own name by default).

The program prompts for the old password and then for the new one. The caller must supply both. The new password must be typed twice, to forestall mistakes.

New passwords must be at least four characters long if they use a sufficiently rich alphabet and at least six characters long if monospace. These rules are relaxed if you are insistent enough.

Only the owner of the name or the super-user may change a password; the owner must prove he knows the old password.

**FILES**

/etc/passwd

**SEE ALSO**

login(1), passwd(5), crypt(3)

Robert Morris and Ken Thompson, *Password Security: A Case History*

**NAME**

plot – graphics filters

**SYNOPSIS**

**plot** [ -Tterminal [ raster ] ]

**DESCRIPTION**

These commands read plotting instructions (see *plot(5)*) from the standard input, and in general produce plotting instructions suitable for a particular *terminal* on the standard output.

If no *terminal* type is specified, the environment parameter \$TERM (see *environ(5)*) is used. Known *terminals* are:

4014 Tektronix 4014 storage scope.

450 DASI Hyterm 450 terminal (Diablo mechanism).

300 DASI 300 or GSI terminal (Diablo mechanism).

300S DASI 300S terminal (Diablo mechanism).

ver Versatec D1200A printer-plotter. This version of *plot* places a scan-converted image in '/usr/tmp/raster' and sends the result directly to the plotter device rather than to the standard output. The optional argument causes a previously scan-converted file *raster* to be sent to the plotter.

**FILES**

/usr/bin/tek

/usr/bin/t450

/usr/bin/t300

/usr/bin/t300s

/usr/bin/vplot

/usr/tmp/raster

**SEE ALSO**

plot(3), plot(5)

**BUGS**

There is no lockout protection for /usr/tmp/raster.

**NAME**

`pr` - print file

**SYNOPSIS**

`pr` [ option ] ... [ file ] ...

**DESCRIPTION**

*Pr* produces a printed listing of one or more *files*. The output is separated into pages headed by a date, the name of the file or a specified header, and the page number. If there are no file arguments, *pr* prints its standard input.

Options apply to all following files but may be reset between files:

- `-n` Produce *n*-column output.
- `+n` Begin printing with page *n*.
- `-h` Take the next argument as a page header.
- `-wn` For purposes of multi-column output, take the width of the page to be *n* characters instead of the default 72.
- `-ln` Take the length of the page to be *n* lines instead of the default 66.
- `-t` Do not print the 5-line header or the 5-line trailer normally supplied for each page.
- `-sc` Separate columns by the single character *c* instead of by the appropriate amount of white space. A missing *c* is taken to be a tab.
- `-m` Print all *files* simultaneously, each in one column,

Inter-terminal messages via *write*(1) are forbidden during a *pr*.

**FILES**

/dev/tty? to suspend messages.

**SEE ALSO**

`cat`(1)

**DIAGNOSTICS**

There are no diagnostics when *pr* is printing on a terminal.

**NAME**

prep – prepare text for statistical processing

**SYNOPSIS**

**prep** [ **-dio** ] file ...

**DESCRIPTION**

*Prep* reads each *file* in sequence and writes it on the standard output, one ‘word’ to a line. A word is a string of alphabetic characters and imbedded apostrophes, delimited by space or punctuation. Hyphented words are broken apart; hyphens at the end of lines are removed and the hyphenated parts are joined. Strings of digits are discarded.

The following option letters may appear in any order:

- d** Print the word number (in the input stream) with each word.
- i** Take the next *file* as an ‘ignore’ file. These words will not appear in the output. (They will be counted, for purposes of the **-d** count.)
- o** Take the next *file* as an ‘only’ file. Only these words will appear in the output. (All other words will also be counted for the **-d** count.)
- p** Include punctuation marks (single nonalphanumeric characters) as separate output lines. The punctuation marks are not counted for the **-d** count.

Ignore and only files contain words, one per line.

**SEE ALSO**

deroff(1)

**NAME**

prof – display profile data

**SYNOPSIS**

**prof** [ **-v** ] [ **-a** ] [ **-l** ] [ **-low** [ **-high** ] ] [ file ]

**DESCRIPTION**

*Prof* interprets the file *mon.out* produced by the *monitor* subroutine. Under default modes, the symbol table in the named object file (*a.out* default) is read and correlated with the *mon.out* profile file. For each external symbol, the percentage of time spent executing between that symbol and the next is printed (in decreasing order), together with the number of times that routine was called and the number of milliseconds per call.

If the **-a** option is used, all symbols are reported rather than just external symbols. If the **-l** option is used, the output is listed by symbol value rather than decreasing percentage.

If the **-v** option is used, all printing is suppressed and a graphic version of the profile is produced on the standard output for display by the *plot(1)* filters. The numbers *low* and *high*, by default 0 and 100, cause a selected percentage of the profile to be plotted with accordingly higher resolution.

In order for the number of calls to a routine to be tallied, the **-p** option of *cc* must have been given when the file containing the routine was compiled. This option also arranges for the *mon.out* file to be produced automatically.

**FILES**

mon.out for profile  
a.out for namelist

**SEE ALSO**

monitor(3), profil(2), cc(1), plot(1)

**BUGS**

Beware of quantization errors.

**NAME**

ps – process status

**SYNOPSIS**

**ps** [ **aklx** ] [ namelist ]

**DESCRIPTION**

*Ps* prints certain indicia about active processes. The **a** option asks for information about all processes with terminals (ordinarily only one's own processes are displayed); **x** asks even about processes with no terminal; **l** asks for a long listing. The short listing contains the process ID, tty letter, the cumulative execution time of the process and an approximation to the command line.

The long listing is columnar and contains

- F**      Flags associated with the process. 01: in core; 02: system process; 04: locked in core (e.g. for physical I/O); 10: being swapped; 20: being traced by another process.
- S**      The state of the process. 0: nonexistent; S: sleeping; W: waiting; R: running; I: intermediate; Z: terminated; T: stopped.
- UID**    The user ID of the process owner.
- PID**    The process ID of the process; as in certain cults it is possible to kill a process if you know its true name.
- PPID**   The process ID of the parent process.
- CPU**    Processor utilization for scheduling.
- PRI**    The priority of the process; high numbers mean low priority.
- NICE**   Used in priority computation.
- ADDR**   The core address of the process if resident, otherwise the disk address.
- SZ**     The size in blocks of the core image of the process.
- WCHAN**    The event for which the process is waiting or sleeping; if blank, the process is running.
- TTY**    The controlling tty for the process.
- TIME**    The cumulative execution time for the process.

The command and its arguments.

A process that has exited and has a parent, but has not yet been waited for by the parent is marked <defunct>. *Ps* makes an educated guess as to the file name and arguments given when the process was created by examining core memory or the swap area. The method is inherently somewhat unreliable and in any event a process is entitled to destroy this information, so the names cannot be counted on too much.

If the **k** option is specified, the file */usr/sys/core* is used in place of */dev/mem*. This is used for postmortem system debugging. If a second argument is given, it is taken to be the file containing the system's namelist.

**FILES**

- /unix*      system namelist
- /dev/mem*    core memory
- /usr/sys/core* alternate core file
- /dev*        searched to find swap device and tty names

**SEE ALSO**

kill(1)

**BUGS**

Things can change while *ps* is running; the picture it gives is only a close approximation to reality. Some data printed for defunct processes is irrelevant



**NAME**

pstat – print system facts

**SYNOPSIS**

**pstat** [ **-aixptuf** ] [ suboptions ] [ file ]

**DESCRIPTION**

*Pstat* interprets the contents of certain system tables. If *file* is given, the tables are sought there, otherwise in */dev/mem*. The required namelist is taken from */unix*. Options are

**-a** Under **-p**, describe all process slots rather than just active ones.

**-i** Print the inode table with the these headings:

LOC The core location of this table entry.

FLAGS Miscellaneous state variables encoded thus:

L locked  
 U update time *filsys(5)* must be corrected  
 A access time must be corrected  
 M file system is mounted here  
 W wanted by another process (L flag is on)  
 T contains a text file  
 C changed time must be corrected

CNT Number of open file table entries for this inode.

DEV Major and minor device number of file system in which this inode resides.

INO I-number within the device.

MODE Mode bits, see *chmod(2)*.

NLK Number of links to this inode.

UID User ID of owner.

SIZ/DEV

Number of bytes in an ordinary file, or major and minor device of special file.

**-x** Print the text table with these headings:

LOC The core location of this table entry.

FLAGS Miscellaneous state variables encoded thus:

T *ptrace(2)* in effect  
 W text not yet written on swap device  
 L loading in progress  
 K locked  
 w wanted (L flag is on)

DADDR Disk address in swap, measured in multiples of 512 bytes.

CADDR Core address, measured in multiples of 64 bytes.

SIZE Size of text segment, measured in multiples of 64 bytes.

IPTR Core location of corresponding inode.

CNT Number of processes using this text segment.

CCNT Number of processes in core using this text segment.

**-p** Print process table for active processes with these headings:

LOC The core location of this table entry.

S Run state encoded thus:

0 no process  
 1 waiting for some event  
 3 runnable

4       being created  
 5       being terminated  
 6       stopped under trace  
**F**      Miscellaneous state variables, or-ed together:  
     01     loaded  
     02     the scheduler process  
     04     locked  
     010    swapped out  
     020    traced  
     040    used in tracing  
     0100   locked in by *lock(2)*.  
**PRI**     Scheduling priority, see *nice(2)*.  
**SIGNAL**   Signals received (signals 1-16 coded in bits 0-15),  
**UID**     Real user ID.  
**TIM**     Time resident in seconds; times over 127 coded as 127.  
**CPU**     Weighted integral of CPU time, for scheduler.  
**NI**      Nice level, see *nice(2)*.  
**PGRP**    Process number of root of process group (the opener of the controlling terminal).  
**PID**     The process ID number.  
**PPID**    The process ID of parent process.  
**ADDR**    If in core, the physical address of the 'u-area' of the process measured in multiples of 64 bytes. If swapped out, the position in the swap area measured in multiples of 512 bytes.  
**SIZE**    Size of process image in multiples of 64 bytes.  
**WCHAN**   Wait channel number of a waiting process.  
**LINK**    Link pointer in list of runnable processes.  
**TEXTP**   If text is pure, pointer to location of text table entry.  
**CLKT**    Countdown for *alarm(2)* measured in seconds.  
**-t**      Print table for terminals (only DH11 and DL11 handled) with these headings:  
**RAW**     Number of characters in raw input queue.  
**CAN**     Number of characters in canonicalized input queue.  
**OUT**     Number of characters in putput queue.  
**MODE**    See *tty(4)*.  
**ADDR**    Physical device address.  
**DEL**     Number of delimiters (newlines) in canonicalized input queue.  
**COL**     Calculated column position of terminal.  
**STATE**   Miscellaneous state variables encoded thus:  
     **W**     waiting for open to complete  
     **O**     open  
     **S**     has special (output) start routine  
     **C**     carrier is on  
     **B**     busy doing output  
     **A**     process is awaiting output  
     **X**     open for exclusive use  
     **H**     hangup on close  
**PGRP**    Process group for which this is controlling terminal.  
**-u**      print information about a user process; the next argument is its address as given by *ps(1)*. The process must be in main memory, or the file used can be a core image and the address 0.  
**-f**      Print the open file table with these headings:  
**LOC**     The core location of this table entry.  
**FLG**     Miscellaneous state variables encoded thus:

R      open for reading  
W      open for writing  
P      pipe  
CNT    Number of processes that know this open file.  
INO    The location of the inode table entry for this file.  
OFFS   The file offset, see *lseek(2)*.

**FILES**

/unix     namelist  
/dev/mem  default source of tables

**SEE ALSO**

ps(1), stat(2), filsys(5)  
K. Thompson, *UNIX Implementation*

**NAME**

`ptx` – permuted index

**SYNOPSIS**

`ptx` [ option ] ... [ input [ output ] ]

**DESCRIPTION**

*Ptx* generates a permuted index to file *input* on file *output* (standard input and output default). It has three phases: the first does the permutation, generating one line for each keyword in an input line. The keyword is rotated to the front. The permuted file is then sorted. Finally, the sorted lines are rotated so the keyword comes at the middle of the page. *Ptx* produces output in the form:

```
.xx "tail" "before keyword" "keyword and after" "head"
```

where *.xx* may be an *nroff* or *troff*(1) macro for user-defined formatting. The *before keyword* and *keyword and after* fields incorporate as much of the line as will fit around the keyword when it is printed at the middle of the page. *Tail* and *head*, at least one of which is an empty string "", are wrapped-around pieces small enough to fit in the unused space at the opposite end of the line. When original text must be discarded, *'* marks the spot.

The following options can be applied:

- f** Fold upper and lower case letters for sorting.
- t** Prepare the output for the phototypesetter; the default line length is 100 characters.
- w n** Use the next argument, *n*, as the width of the output line. The default line length is 72 characters.
- g n** Use the next argument, *n*, as the number of characters to allow for each gap among the four parts of the line as finally printed. The default gap is 3 characters.
- o only** Use as keywords only the words given in the *only* file.
- i ignore**  
Do not use as keywords any words given in the *ignore* file. If the *-i* and *-o* options are missing, use */usr/lib/eign* as the *ignore* file.
- b break**  
Use the characters in the *break* file to separate words. In any case, tab, newline, and space characters are always used as break characters.
- r** Take any leading nonblank characters of each input line to be a reference identifier (as to a page or chapter) separate from the text of the line. Attach that identifier as a 5th field on each output line.

The index for this manual was generated using *ptx*.

**FILES**

*/bin/sort*  
*/usr/lib/eign*

**BUGS**

Line length counts do not account for overstriking or proportional spacing.

**NAME**

pubindex – make inverted bibliographic index

**SYNOPSIS**

**pubindex** [ file ] ...

**DESCRIPTION**

*Pubindex* makes a hashed inverted index to the named *files* for use by *refer(1)*. The *files* contain bibliographic references separated by blank lines. A bibliographic reference is a set of lines that contain bibliographic information fields. Each field starts on a line beginning with a '%', followed by a key-letter, followed by a blank, and followed by the contents of the field, which continues until the next line starting with '%'. The most common key-letters and the corresponding fields are:

|   |  |
|---|--|
| A | Author name  |
| B | Title of book containing article referenced        |
| C | City   |
| D | Date   |
| d | Alternate date                                     |
| E | Editor of book containing article referenced       |
| G | Government (CFSTI) order number                    |
| I | Issuer (publisher)                                 |
| J | Journal  |
| K | Other keywords to use in locating reference        |
| M | Technical memorandum number                        |
| N | Issue number within volume                         |
| O | Other commentary to be printed at end of reference |
| P | Page numbers                                       |
| R | Report number                                      |
| r | Alternate report number                            |
| T | Title of article, book, etc.                       |
| V | Volume number                                      |
| X | Commentary unused by <i>pubindex</i>               |

Except for 'A', each field should only be given once. Only relevant fields should be supplied. An example is:

```
%T 5-by-5 Palindromic Word Squares
%A M. D. McIlroy
%J Word Ways
%V 9
%P 199-202
%D 1976
```

**FILES**

*x.ia*, *x.ib*, *x.ic* where *x* is the first argument.

**SEE ALSO**

*refer(1)*

**NAME**

`pwd` – working directory name

**SYNOPSIS**

`pwd`

**DESCRIPTION**

*Pwd* prints the pathname of the working (current) directory.

**SEE ALSO**

`cd(1)`

**NAME**

quot – summarize file system ownership

**SYNOPSIS**

**quot** [ option ] ... [ filesystem ]

**DESCRIPTION**

*Quot* prints the number of blocks in the named *filesystem* currently owned by each user. If no *filesystem* is named, a default name is assumed. The following options are available:

- n** Cause the pipeline **ncheck filesystem | sort +0n | quot -n filesystem** to produce a list of all files and their owners.
- c** Print three columns giving file size in blocks, number of files of that size, and cumulative total of blocks in that size or smaller file.
- f** Print count of number of files as well as space owned by each user.

**FILES**

Default file system varies with system.  
/etc/passwd to get user names

**SEE ALSO**

ls(1), du(1)

**BUGS**

Holes in files are counted as if they actually occupied space.

**NAME**

`ranlib` – convert archives to random libraries

**SYNOPSIS**

**ranlib** archive ...

**DESCRIPTION**

*Ranlib* converts each *archive* to a form which can be loaded more rapidly by the loader, by adding a table of contents named **\_\_SYMDEF** to the beginning of the archive. It uses *ar(1)* to reconstruct the archive, so that sufficient temporary file space must be available in the file system containing the current directory.

**SEE ALSO**

*ld(1)*, *ar(1)*

**BUGS**

Because generation of a library by *ar* and randomization by *ranlib* are separate, phase errors are possible. The loader *ld* warns when the modification date of a library is more recent than the creation of its dictionary; but this means you get the warning even if you only copy the library.



**NAME**

ratfor – rational Fortran dialect

**SYNOPSIS**

**ratfor** [ option ... ] [ filename ... ]

**DESCRIPTION**

*Ratfor* converts a rational dialect of Fortran into ordinary irrational Fortran. *Ratfor* provides control flow constructs essentially identical to those in C:

statement grouping:

```
{ statement; statement; statement }
```

decision-making:

```
if (condition) statement [ else statement ]
```

```
switch (integer value) {
    case integer:    statement
    ...
    [ default: ]    statement
}
```

loops: while (condition) statement  
 for (expression; condition; expression) statement  
 do limits statement  
 repeat statement [ until (condition) ]  
 break [n]  
 next [n]

and some syntactic sugar to make programs easier to read and write:

free form input:

multiple statements/line; automatic continuation

comments:

```
# this is a comment
```

translation of relationals:

>, >=, etc., become .GT., .GE., etc.

return (expression)

returns expression to caller from function

define: define name replacement

include: include filename

The option **-h** causes quoted strings to be turned into 27H constructs. **-C** copies comments to the output, and attempts to format it neatly. Normally, continuation lines are marked with a & in column 1; the option **-6x** makes the continuation character **x** and places it in column 6.

*Ratfor* is best used with *f77(1)*.

**SEE ALSO**

*f77(1)*

B. W. Kernighan and P. J. Plauger, *Software Tools*, Addison-Wesley, 1976.

**NAME**

refer, lookbib – find and insert literature references in documents

**SYNOPSIS**

**refer** [ option ] ...

**lookbib** [ file ] ...

**DESCRIPTION**

*Lookbib* accepts keywords from the standard input and searches a bibliographic data base for references that contain those keywords anywhere in title, author, journal name, etc. Matching references are printed on the standard output. Blank lines are taken as delimiters between queries.

*Refer* is a preprocessor for *nroff* or *troff*(1) that finds and formats references. The input files (standard input default) are copied to the standard output, except for lines between `.[` and `.]` command lines, which are assumed to contain keywords as for *lookbib*, and are replaced by information from the bibliographic data base. The user may avoid the search, override fields from it, or add new fields. The reference data, from whatever source, are assigned to a set of *troff* strings. Macro packages such as *ms*(7) print the finished reference text from these strings. A flag is placed in the text at the point of reference; by default the references are indicated by numbers.

The following options are available:

- ar** Reverse the first *r* author names (Jones, J. A. instead of J. A. Jones). If *r* is omitted all author names are reversed.
- b** Bare mode: do not put any flags in text (neither numbers nor labels).
- cstring**  
Capitalize (with CAPS SMALL CAPS) the fields whose key-letters are in *string*.
- e** Instead of leaving the references where encountered, accumulate them until a sequence of the form
 

```
.[
  $LIST$
.]
```

 is encountered, and then write out all references collected so far. Collapse references to the same source.
- kx** Instead of numbering references, use labels as specified in a reference data line beginning `%x`; by default *x* is **L**.
- lm,n** Instead of numbering references, use labels made from the senior author's last name and the year of publication. Only the first *m* letters of the last name and the last *n* digits of the date are used. If either *m* or *n* is omitted the entire name or date respectively is used.
- p** Take the next argument as a file of references to be searched. The default file is searched last.
- n** Do not search the default file.
- keys**  
Sort references by fields whose key-letters are in the *keys* string; permute reference numbers in text accordingly. Implies **–e**. The key-letters in *keys* may be followed by a number to indicate how many such fields are used, with **+** taken as a very large number. The default is **AD** which sorts on the senior author and then date; to sort, for example, on all authors and then title use **–sA+T**.

To use your own references, put them in the format described in *pubindex*(1) They can be searched more rapidly by running *pubindex*(1) on them before using *refer*; failure to index results in a linear search.

When *refer* is used with *eqn*, *neqn* or *tbl*, *refer* should be first, to minimize the volume of data passed through pipes.

**FILES**

*/usr/dict/papers* directory of default publication lists and indexes

*/usr/lib/refer* directory of programs

**SEE ALSO**

**NAME**

restor – incremental file system restore

**SYNOPSIS**

*restor* key [ argument ... ]

**DESCRIPTION**

*Restor* is used to read magtapes dumped with the *dump* command. The *key* specifies what is to be done. *Key* is one of the characters **rRxt** optionally combined with **f**.

- f** Use the first *argument* as the name of the tape instead of the default.
- r or R** The tape is read and loaded into the file system specified in *argument*. This should not be done lightly (see below). If the key is **R** *restor* asks which tape of a multi volume set to start on. This allows *restor* to be interrupted and then restarted (an *icheck -s* must be done before
- x** Each file on the tape named by an *argument* is extracted. The file name has all 'mount' prefixes removed; for example, /usr/bin/lpr is named /bin/lpr on the tape. The file extracted is placed in a file with a numeric name supplied by *restor* (actually the inode number). In order to keep the amount of tape read to a minimum, the following procedure is recommended:

Mount volume 1 of the set of dump tapes.

Type the *restor* command.

*Restor* will announce whether or not it found the files, give the number it will name the file, and rewind the tape.

It then asks you to 'mount the desired tape volume'. Type the number of the volume you choose. On a multivolume dump the recommended procedure is to mount the last through the first volume in that order. *Restor* checks to see if any of the files requested are on the mounted tape (or a later tape, thus the reverse order) and doesn't read through the tape if no files are. If you are working with a single volume dump or the number of files being restored is large, respond to the query with '1' and *restor* will read the tapes in sequential order.

If you have a hierarchy to restore you can use *dumpdir(1)* to produce the list of names and a shell script to move the resulting files to their homes.

- t** Print the date the tape was written and the date the filesystem was dumped from.

The **r** option should only be used to restore a complete dump tape onto a clear file system or to restore an incremental dump tape onto this. Thus

```
/etc/mkfs /dev/rp0 40600
restor r /dev/rp0
```

is a typical sequence to restore a complete dump. Another *restor* can be done to get an incremental dump in on top of this.

A *dump* followed by a *mkfs* and a *restor* is used to change the size of a file system.

**FILES**

default tape unit varies with installation  
rst\*

**SEE ALSO**

*dump(1)*, *mkfs(1)*, *dumpdir(1)*

**DIAGNOSTICS**

There are various diagnostics involved with reading the tape and writing the disk. There are also diagnostics if the i-list or the free list of the file system is not large enough to hold the dump.

If the dump extends over more than one tape, it may ask you to change tapes. Reply with a new-line when the next tape has been mounted.

**BUGS**

There is redundant information on the tape that could be used in case of tape reading problems. Unfortunately, *restor* doesn't use it.

**NAME**

rev – reverse lines of a file

**SYNOPSIS**

rev [ file ] ...

**DESCRIPTION**

*Rev* copies the named files to the standard output, reversing the order of characters in every line. If no file is specified, the standard input is copied.

**NAME**

**rm**, **rmdir** – remove (unlink) files

**SYNOPSIS**

**rm** [ **-fri** ] file ...

**rmdir** dir ...

**DESCRIPTION**

*Rm* removes the entries for one or more files from a directory. If an entry was the last link to the file, the file is destroyed. Removal of a file requires write permission in its directory, but neither read nor write permission on the file itself.

If a file has no write permission and the standard input is a terminal, its permissions are printed and a line is read from the standard input. If that line begins with 'y' the file is deleted, otherwise the file remains. No questions are asked when the **-f** (force) option is given.

If a designated file is a directory, an error comment is printed unless the optional argument **-r** has been used. In that case, *rm* recursively deletes the entire contents of the specified directory, and the directory itself.

If the **-i** (interactive) option is in effect, *rm* asks whether to delete each file, and, under **-r**, whether to examine each directory.

*Rmdir* removes entries for the named directories, which must be empty.

**SEE ALSO**

unlink(2)

**DIAGNOSTICS**

Generally self-explanatory. It is forbidden to remove the file '..' merely to avoid the antisocial consequences of inadvertently doing something like **'rm -r .'**.

**NAME**

roff - format text

**SYNOPSIS**

**roff** [ *+n* ] [ *-n* ] [ *-s* ] [ *-h* ] file ...

**nroff** -**mr** [ option ] ... file ...

**troff** -**mr** [ option ] ... file ...

**DESCRIPTION**

*Roff* formats text according to control lines embedded in the text in the given files. Encountering a nonexistent file terminates printing. Incoming inter-terminal messages are turned off during printing. The optional flag arguments mean:

- +n* Start printing at the first page with number *n*.
- n* Stop printing at the first page numbered higher than *n*.
- s* Stop before each page (including the first) to allow paper manipulation; resume on receipt of an interrupt signal.
- h* Insert tabs in the output stream to replace spaces whenever appropriate.

Input consists of intermixed *text lines*, which contain information to be formatted, and *request lines*, which contain instructions about how to format it. Request lines begin with a distinguished *control character*, normally a period.

Output lines may be *filled* as nearly as possible with words without regard to input lineation. Line *breaks* may be caused at specified places by certain commands, or by the appearance of an empty input line or an input line beginning with a space.

The capabilities of *roff* are specified in the attached Request Summary. Numerical values are denoted there by *n* or *+n*, titles by *t*, and single characters by *c*. Numbers denoted *+n* may be signed *+* or *-*, in which case they signify relative changes to a quantity, otherwise they signify an absolute resetting. Missing *n* fields are ordinarily taken to be 1, missing *t* fields to be empty, and *c* fields to shut off the appropriate special interpretation.

Running titles usually appear at top and bottom of every page. They are set by requests like

```
.he 'part1'part2'part3'
```

Part1 is left justified, part2 is centered, and part3 is right justified on the page. Any % sign in a title is replaced by the current page number. Any nonblank may serve as a quote.

ASCII tab characters are replaced in the input by a *replacement character*, normally a space, according to the column settings given by a *.ta* command. (See *.tr* for how to convert this character on output.)

Automatic hyphenation of filled output is done under control of *.hy*. When a word contains a designated *hyphenation character*, that character disappears from the output and hyphens can be introduced into the word at the marked places only.

The *-mr* option of *nroff* or *troff(1)* simulates *roff* to the greatest extent possible.

**FILES**

/usr/lib/suftab    suffix hyphenation tables  
/tmp/rtm?        temporary

**BUGS**

*Roff* is the simplest of the text formatting programs, and is utterly frozen.



## REQUEST SUMMARY

| Request    | Break | Initial | Meaning   |
|------------|-------|---------|---|
| .ad        | yes   | yes     | Begin adjusting right margins.  |
| .ar        | no    | arabic  | Arabic page numbers.  |
| .br        | yes   | –       | Causes a line break the filling of the current line is stopped.                                     |
| .bl n      | yes   | –       | Insert of n blank lines, on new page if necessary.  |
| .bp +n     | yes   | n=1     | Begin new page and number it n; no n means '+1'.  |
| .cc c      | no    | c=.     | Control character becomes 'c'.  |
| .ce n      | yes   | –       | Center the next n input lines, without filling.   |
| .de xx     | no    | –       | Define parameterless macro to be invoked by request '.xx' (definition ends on line beginning '..'). |
| .ds        | yes   | no      | Double space; same as '.ls 2'.  |
| .ef t      | no    | t=      | Even foot title becomes t.  |
| .eh t      | no    | t=      | Even head title becomes t.  |
| .fi        | yes   | yes     | Begin filling output lines.   |
| .fo        | no    | t=      | All foot titles are t.  |
| .hc c      | no    | none    | Hyphenation character becomes 'c'.  |
| .he t      | no    | t=      | All head titles are t.  |
| .hx        | no    | –       | Title lines are suppressed.   |
| .hy n      | no    | n=1     | Hyphenation is done, if n=1; and is not done, if n=0.   |
| .ig        | no    | –       | Ignore input lines through a line beginning with '..'.  |
| .in +n     | yes   | –       | Indent n spaces from left margin.   |
| .ix +n     | no    | –       | Same as '.in' but without break.  |
| .li n      | no    | –       | Literal, treat next n lines as text.  |
| .ll +n     | no    | n=65    | Line length including indent is n characters.   |
| .ls +n     | yes   | n=1     | Line spacing set to n lines per output line.  |
| .m1 n      | no    | n=2     | Put n blank lines between the top of page and head title.   |
| .m2 n      | no    | n=2     | n blank lines put between head title and beginning of text on page.                                 |
| .m3 n      | no    | n=1     | n blank lines put between end of text and foot title.   |
| .m4 n      | no    | n=3     | n blank lines put between the foot title and the bottom of page.                                    |
| .na        | yes   | no      | Stop adjusting the right margin.  |
| .ne n      | no    | –       | Begin new page, if n output lines cannot fit on present page.                                       |
| .nn +n     | no    | –       | The next n output lines are not numbered.   |
| .n1        | no    | no      | Add 5 to page offset; number lines in margin from 1 on each page.                                   |
| .n2 n      | no    | no      | Add 5 to page offset; number lines from n; stop if n=0.   |
| .ni +n     | no    | n=0     | Line numbers are indented n.  |
| .nf        | yes   | no      | Stop filling output lines.  |
| .nx file   | –     | –       | Switch input to 'file'.   |
| .of t      | no    | t=      | Odd foot title becomes t.   |
| .oh t      | no    | t=      | Odd head title becomes t.   |
| .pa +n     | yes   | n=1     | Same as '.bp'.  |
| .pl +n     | no    | n=66    | Total paper length taken to be n lines.   |
| .po +n     | no    | n=0     | Page offset. All lines are preceded by n spaces.  |
| .ro        | no    | arabic  | Roman page numbers.   |
| .sk n      | no    | –       | Produce n blank pages starting next page.   |
| .sp n      | yes   | –       | Insert block of n blank lines, except at top of page.   |
| .ss        | yes   | yes     | Single space output lines, equivalent to '.ls 1'.   |
| .ta n n..  | –     | –       | Pseudotab settings. Initial tab settings are columns 9 17 25 ...                                    |
| .tc c      | no    | space   | Tab replacement character becomes 'c'.  |
| .ti +n     | yes   | –       | Temporarily indent next output line n spaces.   |
| .tr cdef.. | no    | –       | Translate c into d, e into f, etc.  |
| .ul n      | no    | –       | Underline the letters and numbers in the next n input lines.  |

**NAME**

sa, accton – system accounting

**SYNOPSIS**

```
sa [ -abcjlnrstuv ] [ file ]  
/etc/accton [ file ]
```

**DESCRIPTION**

With an argument naming an existing *file*, *accton* causes system accounting information for every process executed to be placed at the end of the file. If no argument is given, accounting is turned off.

*Sa* reports on, cleans up, and generally maintains accounting files.

*Sa* is able to condense the information in */usr/adm/acct* into a summary file */usr/adm/savacct* which contains a count of the number of times each command was called and the time resources consumed. This condensation is desirable because on a large system *acct* can grow by 100 blocks per day. The summary file is read before the accounting file, so the reports include all available information.

If a file name is given as the last argument, that file will be treated as the accounting file; *sha* is the default. There are zillions of options:

- a Place all command names containing unprintable characters and those used only once under the name '\*\*\*other.'
- b Sort output by sum of user and system time divided by number of calls. Default sort is by sum of user and system times.
- c Besides total user, system, and real time for each command print percentage of total time over all commands.
- j Instead of total minutes time for each category, give seconds per call.
- l Separate system and user time; normally they are combined.
- m Print number of processes and number of CPU minutes for each user.
- n Sort by number of calls.
- r Reverse order of sort.
- s Merge accounting file into summary file */usr/adm/savacct* when done.
- t For each command report ratio of real time to the sum of user and system times.
- u Superseding all other flags, print for each command in the accounting file the user ID and command name.
- v If the next character is a digit *n*, then type the name of each command used *n* times or fewer. Await a reply from the typewriter; if it begins with 'y', add the command to the category '\*\*\*junk\*\*.' This is used to strip out garbage.

**FILES**

```
/usr/adm/acct    raw accounting  
/usr/adm/savacct summary  
/usr/adm/usracct per-user summary
```

**SEE ALSO**

ac(1), acct(2)

**NAME**

sed – stream editor

**SYNOPSIS**

**sed** [ **-n** ] [ **-e** script ] [ **-f** sfile ] [ file ] ...

**DESCRIPTION**

*Sed* copies the named *files* (standard input default) to the standard output, edited according to a script of commands. The **-f** option causes the script to be taken from file *sfile*; these options accumulate. If there is just one **-e** option and no **-f**'s, the flag **-e** may be omitted. The **-n** option suppresses the default output.

A script consists of editing commands, one per line, of the following form:

[address [, address] ] function [arguments]

In normal operation *sed* cyclically copies a line of input into a *pattern space* (unless there is something left after a 'D' command), applies in sequence all commands whose *addresses* select that pattern space, and at the end of the script copies the pattern space to the standard output (except under **-n**) and deletes the pattern space.

An *address* is either a decimal number that counts input lines cumulatively across files, a '\$' that addresses the last line of input, or a context address, 'regular expression', in the style of *ed*(1) modified thus:

The escape sequence '\n' matches a newline embedded in the pattern space.

A command line with no addresses selects every pattern space.

A command line with one address selects each pattern space that matches the address.

A command line with two addresses selects the inclusive range from the first pattern space that matches the first address through the next pattern space that matches the second. (If the second address is a number less than or equal to the line number first selected, only one line is selected.) Thereafter the process is repeated, looking again for the first address.

Editing commands can be applied only to non-selected pattern spaces by use of the negation function '!' (below).

In the following list of functions the maximum number of permissible addresses for each function is indicated in parentheses.

An argument denoted *text* consists of one or more lines, all but the last of which end with '\n' to hide the newline. Backslashes in *text* are treated like backslashes in the replacement string of an 's' command, and may be used to protect initial blanks and tabs against the stripping that is done on every script line.

An argument denoted *rfile* or *wfile* must terminate the command line and must be preceded by exactly one blank. Each *wfile* is created before processing begins. There can be at most 10 distinct *wfile* arguments.

(1) a\  
*text*

Append. Place *text* on the output before reading the next input line.

(2) b *label*

Branch to the ':' command bearing the *label*. If *label* is empty, branch to the end of the script.

(2) c\  
*text*

Change. Delete the pattern space. With 0 or 1 address or at the end of a 2-address range, place *text* on the output. Start the next cycle.

(2) d Delete the pattern space. Start the next cycle.

- (2)D Delete the initial segment of the pattern space through the first newline. Start the next cycle.
- (2)g Replace the contents of the pattern space by the contents of the hold space.
- (2)G Append the contents of the hold space to the pattern space.
- (2)h Replace the contents of the hold space by the contents of the pattern space.
- (2)H Append the contents of the pattern space to the hold space.
- (1)i\  
*text* Insert. Place *text* on the standard output.
- (2)l List the pattern space on the standard output in an unambiguous form. Non-printing characters are spelled in two digit ascii, and long lines are folded.
- (2)n Copy the pattern space to the standard output. Replace the pattern space with the next line of input.
- (2)N Append the next line of input to the pattern space with an embedded newline. (The current line number changes.)
- (2)p Print. Copy the pattern space to the standard output.
- (2)P Copy the initial segment of the pattern space through the first newline to the standard output.
- (1)q Quit. Branch to the end of the script. Do not start a new cycle.
- (2)r *rfile*  
Read the contents of *rfile*. Place them on the output before reading the next input line.
- (2)s/*regular expression/replacement/flags*  
Substitute the *replacement* string for instances of the *regular expression* in the pattern space. Any character may be used instead of '/'. For a fuller description see *ed(1)*. *Flags* is zero or more of
  - g Global. Substitute for all nonoverlapping instances of the *regular expression* rather than just the first one.
  - p Print the pattern space if a replacement was made.
  - w *wfile* Write. Append the pattern space to *wfile* if a replacement was made.
- (2)t *label*  
Test. Branch to the ':' command bearing the *label* if any substitutions have been made since the most recent reading of an input line or execution of a 't'. If *label* is empty, branch to the end of the script.
- (2)w *wfile*  
Write. Append the pattern space to *wfile*.
- (2)x Exchange the contents of the pattern and hold spaces.
- (2)y/*string1/string2/*  
Transform. Replace all occurrences of characters in *string1* with the corresponding character in *string2*. The lengths of *string1* and *string2* must be equal.
- (2)! *function*  
Don't. Apply the *function* (or group, if *function* is '{') only to lines *not* selected by the address(es).
- (0): *label*  
This command does nothing; it bears a *label* for 'b' and 't' commands to branch to.
- (1)= Place the current line number on the standard output as a line.
- (2){ Execute the following commands through a matching '}' only when the pattern space is

selected.

(0) An empty command is ignored.

**SEE ALSO**

ed(1), grep(1), awk(1)

**NAME**

sh, for, case, if, while, :, ., break, continue, cd, eval, exec, exit, export, login, newgrp, read, readonly, set, shift, times, trap, umask, wait – command language

**SYNOPSIS**

**sh** [ **-ceiknrstuvx** ] [ **arg** ] ...

**DESCRIPTION**

*Sh* is a command programming language that executes commands read from a terminal or a file. See **invocation** for the meaning of arguments to the shell.

**Commands.**

A *simple-command* is a sequence of non blank *words* separated by blanks (a blank is a **tab** or a **space**). The first word specifies the name of the command to be executed. Except as specified below the remaining words are passed as arguments to the invoked command. The command name is passed as argument 0 (see *exec(2)*). The *value* of a simple-command is its exit status if it terminates normally or 200+*status* if it terminates abnormally (see *signal(2)* for a list of status values).

A *pipeline* is a sequence of one or more *commands* separated by |. The standard output of each command but the last is connected by a *pipe(2)* to the standard input of the next command. Each command is run as a separate process; the shell waits for the last command to terminate.

A *list* is a sequence of one or more *pipelines* separated by **;**, **&**, **&&** or **||** and optionally terminated by **;** or **&**. **;** and **&** have equal precedence which is lower than that of **&&** and **||**, **&&** and **||** also have equal precedence. A semicolon causes sequential execution; an ampersand causes the preceding *pipeline* to be executed without waiting for it to finish. The symbol **&&** (**|**) causes the *list* following to be executed only if the preceding *pipeline* returns a zero (non zero) value. Newlines may appear in a *list*, instead of semicolons, to delimit commands.

A *command* is either a simple-command or one of the following. The value returned by a command is that of the last simple-command executed in the command.

**for name [in word ...] do list done**

Each time a **for** command is executed *name* is set to the next word in the **for** word list. If **in word ...** is omitted then **in "\$@"** is assumed. Execution ends when there are no more words in the list.

**case word in [pattern [ | pattern ] ... ) list ;;] ... esac**

A **case** command executes the *list* associated with the first pattern that matches *word*. The form of the patterns is the same as that used for file name generation.

**if list then list [elif list then list] ... [else list] fi**

The *list* following **if** is executed and if it returns zero the *list* following **then** is executed. Otherwise, the *list* following **elif** is executed and if its value is zero the *list* following **then** is executed. Failing that the **else list** is executed.

**while list [do list] done**

A **while** command repeatedly executes the *while list* and if its value is zero executes the **do list**; otherwise the loop terminates. The value returned by a **while** command is that of the last executed command in the **do list**. **until** may be used in place of **while** to negate the loop termination test.

( *list* ) Execute *list* in a subshell.

{ *list* } *list* is simply executed.

The following words are only recognized as the first word of a command and when not quoted.

**if then else elif fi case in esac for while until do done { }**

**Command substitution.**

The standard output from a command enclosed in a pair of grave accents (` `) may be used as part or all of a word; trailing newlines are removed.

**Parameter substitution.**

The character **\$** is used to introduce substitutable parameters. Positional parameters may be assigned values by **set**. Variables may be set by writing

```
name=value [ name=value ] ...
```

**\${parameter}**

A *parameter* is a sequence of letters, digits or underscores (a *name*), a digit, or any of the characters **\* @ # ? - \$ !**. The value, if any, of the parameter is substituted. The braces are required only when *parameter* is followed by a letter, digit, or underscore that is not to be interpreted as part of its name. If *parameter* is a digit then it is a positional parameter. If *parameter* is **\*** or **@** then all the positional parameters, starting with **\$1**, are substituted separated by spaces. **\$0** is set from argument zero when the shell is invoked.

**\${parameter-word}**

If *parameter* is set then substitute its value; otherwise substitute *word*.

**\${parameter=word}**

If *parameter* is not set then set it to *word*; the value of the parameter is then substituted. Positional parameters may not be assigned to in this way.

**\${parameter?word}**

If *parameter* is set then substitute its value; otherwise, print *word* and exit from the shell. If *word* is omitted then a standard message is printed.

**\${parameter+word}**

If *parameter* is set then substitute *word*; otherwise substitute nothing.

In the above *word* is not evaluated unless it is to be used as the substituted string. (So that, for example, `echo ${d-`pwd`}` will only execute `pwd` if `d` is unset.)

The following *parameters* are automatically set by the shell.

|           |  |
|-----------|--|
| <b>#</b>  | The number of positional parameters in decimal.                |
| <b>-</b>  | Options supplied to the shell on invocation or by <b>set</b> . |
| <b>?</b>  | The value returned by the last executed command in decimal.    |
| <b>\$</b> | The process number of this shell.                              |
| <b>!</b>  | The process number of the last background command invoked.     |

The following *parameters* are used but not set by the shell.

|             |  |
|-------------|--|
| <b>HOME</b> | The default argument (home directory) for the <b>cd</b> command.   |
| <b>PATH</b> | The search path for commands (see <b>execution</b> ).  |
| <b>MAIL</b> | If this variable is set to the name of a mail file then the shell informs the user of the arrival of mail in the specified file. |
| <b>PS1</b>  | Primary prompt string, by default '\$ '.   |
| <b>PS2</b>  | Secondary prompt string, by default '> '.  |
| <b>IFS</b>  | Internal field separators, normally <b>space</b> , <b>tab</b> , and <b>newline</b> .   |

**Blank interpretation.**

After parameter and command substitution, any results of substitution are scanned for internal field separator characters (those found in **\$IFS**) and split into distinct arguments where such characters are found. Explicit null arguments (" or `) are retained. Implicit null arguments (those resulting from *parameters* that have no values) are removed.

**File name generation.**

Following substitution, each command word is scanned for the characters \*, ? and [. If one of these characters appears then the word is regarded as a pattern. The word is replaced with alphabetically sorted file names that match the pattern. If no file name is found that matches the pattern then the word is left unchanged. The character . at the start of a file name or immediately following a /, and the character /, must be matched explicitly.

- \* Matches any string, including the null string.
- ? Matches any single character.
- [...] Matches any one of the characters enclosed. A pair of characters separated by – matches any character lexically between the pair.

**Quoting.**

The following characters have a special meaning to the shell and cause termination of a word unless quoted.

; & ( ) | < > **newline space tab**

A character may be *quoted* by preceding it with a \. **\newline** is ignored. All characters enclosed between a pair of quote marks (``), except a single quote, are quoted. Inside double quotes ("") parameter and command substitution occurs and \ quotes the characters \ ` " and \$.

"\$\*" is equivalent to "\$1 \$2 ..." whereas

"\$@" is equivalent to "\$1" "\$2" ... .

**Prompting.**

When used interactively, the shell prompts with the value of PS1 before reading a command. If at any time a newline is typed and further input is needed to complete a command then the secondary prompt (\$PS2) is issued.

**Input output.**

Before a command is executed its input and output may be redirected using a special notation interpreted by the shell. The following may appear anywhere in a simple-command or may precede or follow a *command* and are not passed on to the invoked command. Substitution occurs before *word* or *digit* is used.

<*word* Use file *word* as standard input (file descriptor 0).

>*word* Use file *word* as standard output (file descriptor 1). If the file does not exist then it is created; otherwise it is truncated to zero length.

>>*word* Use file *word* as standard output. If the file exists then output is appended (by seeking to the end); otherwise the file is created.

<<*word* The shell input is read up to a line the same as *word*, or end of file. The resulting document becomes the standard input. If any character of *word* is quoted then no interpretation is placed upon the characters of the document; otherwise, parameter and command substitution occurs, **\newline** is ignored, and \ is used to quote the characters \ \$ ` and the first character of *word*.

<&*digit*

The standard input is duplicated from file descriptor *digit*; see *dup(2)*. Similarly for the standard output using >.

<&– The standard input is closed. Similarly for the standard output using >.

If one of the above is preceded by a digit then the file descriptor created is that specified by the digit (instead of the default 0 or 1). For example,

... 2>&1



creates file descriptor 2 to be a duplicate of file descriptor 1.

If a command is followed by **&** then the default standard input for the command is the empty file (/dev/null). Otherwise, the environment for the execution of a command contains the file descriptors of the invoking shell as modified by input output specifications.

### Environment.

The environment is a list of name-value pairs that is passed to an executed program in the same way as a normal argument list; see *exec(2)* and *environ(5)*. The shell interacts with the environment in several ways. On invocation, the shell scans the environment and creates a *parameter* for each name found, giving it the corresponding value. Executed commands inherit the same environment. If the user modifies the values of these *parameters* or creates new ones, none of these affects the environment unless the **export** command is used to bind the shell's *parameter* to the environment. The environment seen by any executed command is thus composed of any unmodified name-value pairs originally inherited by the shell, plus any modifications or additions, all of which must be noted in **export** commands.

The environment for any *simple-command* may be augmented by prefixing it with one or more assignments to *parameters*. Thus these two lines are equivalent

```
TERM=450 cmd args
(export TERM; TERM=450; cmd args)
```

If the **-k** flag is set, *all* keyword arguments are placed in the environment, even if they occur after the command name. The following prints 'a=b c' and 'c':

```
echo a=b c
set -k
echo a=b c
```

### Signals.

The INTERRUPT and QUIT signals for an invoked command are ignored if the command is followed by **&**; otherwise signals have the values inherited by the shell from its parent. (But see also **trap**.)

### Execution.

Each time a command is executed the above substitutions are carried out. Except for the 'special commands' listed below a new process is created and an attempt is made to execute the command via an *exec(2)*.

The shell parameter **\$PATH** defines the search path for the directory containing the command. Each alternative directory name is separated by a colon (:). The default path is **:/bin:/usr/bin**. If the command name contains a / then the search path is not used. Otherwise, each directory in the path is searched for an executable file. If the file has execute permission but is not an *a.out* file, it is assumed to be a file containing shell commands. A subshell (i.e., a separate process) is spawned to read it. A parenthesized command is also executed in a subshell.

### Special commands.

The following commands are executed in the shell process and except where specified no input output redirection is permitted for such commands.

```
:      No effect; the command does nothing.
. file Read and execute commands from file and return. The search path $PATH is used to find the
        directory containing file.
```

**break** [*n*]

Exit from the enclosing **for** or **while** loop, if any. If *n* is specified then break *n* levels.

**continue** [*n*]

Resume the next iteration of the enclosing **for** or **while** loop. If *n* is specified then resume at the *n*-th enclosing loop.

**cd** [*arg*]

Change the current directory to *arg*. The shell parameter **\$HOME** is the default *arg*.

**eval** [*arg ...*]

The arguments are read as input to the shell and the resulting command(s) executed.

**exec** [*arg ...*]

The command specified by the arguments is executed in place of this shell without creating a new process. Input output arguments may appear and if no other arguments are given cause the shell input output to be modified.

**exit** [*n*]

Causes a non interactive shell to exit with the exit status specified by *n*. If *n* is omitted then the exit status is that of the last command executed. (An end of file will also exit from the shell.)

**export** [*name ...*]

The given names are marked for automatic export to the *environment* of subsequently-executed commands. If no arguments are given then a list of exportable names is printed.

**login** [*arg ...*]

Equivalent to 'exec login arg ...'.

**newgrp** [*arg ...*]

Equivalent to 'exec newgrp arg ...'.

**read** *name ...*

One line is read from the standard input; successive words of the input are assigned to the variables *name* in order, with leftover words to the last variable. The return code is 0 unless the end-of-file is encountered.

**readonly** [*name ...*]

The given names are marked readonly and the values of the these names may not be changed by subsequent assignment. If no arguments are given then a list of all readonly names is printed.

**set** [**-eknptuvx** [*arg ...*]]

- e** If non interactive then exit immediately if a command fails.
- k** All keyword arguments are placed in the environment for a command, not just those that precede the command name.
- n** Read commands but do not execute them.
- t** Exit after reading and executing one command.
- u** Treat unset variables as an error when substituting.
- v** Print shell input lines as they are read.
- x** Print commands and their arguments as they are executed.
- Turn off the **-x** and **-v** options.

These flags can also be used upon invocation of the shell. The current set of flags may be found in \$-.

Remaining arguments are positional parameters and are assigned, in order, to **\$1**, **\$2**, etc. If no arguments are given then the values of all names are printed.

**shift** The positional parameters from **\$2...** are renamed **\$1...**

**times** Print the accumulated user and system times for processes run from the shell.

**trap** [*arg*] [*n*] ...

*Arg* is a command to be read and executed when the shell receives signal(s) *n*. (Note that *arg* is scanned once when the trap is set and once when the trap is taken.) Trap commands are executed in order of signal number. If *arg* is absent then all trap(s) *n* are reset to their original values. If *arg* is the null string then this signal is ignored by the shell and by invoked commands. If *n* is 0 then the command *arg* is executed on exit from the shell, otherwise upon receipt of signal *n* as numbered in *signal(2)*. *Trap* with no arguments prints a list of commands associated with each signal number.

**umask** [*nnn*]

The user file creation mask is set to the octal value *nnn* (see *umask(2)*). If *nnn* is omitted, the

current value of the mask is printed.

**wait** [*n*]

Wait for the specified process and report its termination status. If *n* is not given then all currently active child processes are waited for. The return code from this command is that of the process waited for.

**Invocation.**

If the first character of argument zero is `-`, commands are read from `$HOME/.profile`, if such a file exists. Commands are then read as described below. The following flags are interpreted by the shell when it is invoked.

- `-c string` If the `-c` flag is present then commands are read from *string*.
- `-s` If the `-s` flag is present or if no arguments remain then commands are read from the standard input. Shell output is written to file descriptor 2.
- `-i` If the `-i` flag is present or if the shell input and output are attached to a terminal (as told by *gty*) then this shell is *interactive*. In this case the terminate signal SIGTERM (see *signal(2)*) is ignored (so that 'kill 0' does not kill an interactive shell) and the interrupt signal SIGINT is caught and ignored (so that **wait** is interruptable). In all cases SIGQUIT is ignored by the shell.

The remaining flags and arguments are described under the **set** command.

**FILES**

`$HOME/.profile`  
`/tmp/sh*`  
`/dev/null`

**SEE ALSO**

`test(1)`, `exec(2)`,

**DIAGNOSTICS**

Errors detected by the shell, such as syntax errors cause the shell to return a non zero exit status. If the shell is being used non interactively then execution of the shell file is abandoned. Otherwise, the shell returns the exit status of the last command executed (see also **exit**).

**BUGS**

If `<<` is used to provide standard input to an asynchronous process invoked by `&`, the shell gets mixed up about naming the input document. A garbage file `/tmp/sh*` is created, and the shell complains about not being able to find the file by another name.

**NAME**

size – size of an object file

**SYNOPSIS**

**size** [ object ... ]

**DESCRIPTION**

*Size* prints the (decimal) number of bytes required by the text, data, and bss portions, and their sum in octal and decimal, of each object-file argument. If no file is specified, **a.out** is used.

**SEE ALSO**

a.out(5)

**NAME**

sleep – suspend execution for an interval

**SYNOPSIS**

**sleep** time

**DESCRIPTION**

*Sleep* suspends execution for *time* seconds. It is used to execute a command after a certain amount of time as in:

```
(sleep 105; command)&
```

or to execute a command every so often, as in:

```
while true
do
    command
    sleep 37
done
```

**SEE ALSO**

alarm(2), sleep(3)

**BUGS**

*Time* must be less than 65536 seconds.

**NAME**

sort – sort or merge files

**SYNOPSIS**

**sort** [ **-mubdfinrtx** ] [ *+pos1* [ *-pos2* ] ] ... [ **-o** name ] [ **-T** directory ] [ name ] ...

**DESCRIPTION**

*Sort* sorts lines of all the named files together and writes the result on the standard output. The name ‘-’ means the standard input. If no input files are named, the standard input is sorted.

The default sort key is an entire line. Default ordering is lexicographic by bytes in machine collating sequence. The ordering is affected globally by the following options, one or more of which may appear.

- b** Ignore leading blanks (spaces and tabs) in field comparisons.
- d** ‘Dictionary’ order: only letters, digits and blanks are significant in comparisons.
- f** Fold upper case letters onto lower case.
- i** Ignore characters outside the ASCII range 040-0176 in nonnumeric comparisons.
- n** An initial numeric string, consisting of optional blanks, optional minus sign, and zero or more digits with optional decimal point, is sorted by arithmetic value. Option **n** implies option **b**.
- r** Reverse the sense of comparisons.
- tx** ‘Tab character’ separating fields is *x*.

The notation *+pos1 -pos2* restricts a sort key to a field beginning at *pos1* and ending just before *pos2*. *Pos1* and *pos2* each have the form *m.n*, optionally followed by one or more of the flags **bdfinr**, where *m* tells a number of fields to skip from the beginning of the line and *n* tells a number of characters to skip further. If any flags are present they override all the global ordering options for this key. If the **b** option is in effect *n* is counted from the first nonblank in the field; **b** is attached independently to *pos2*. A missing *.n* means *.0*; a missing *-pos2* means the end of the line. Under the **-tx** option, fields are strings separated by *x*; otherwise fields are nonempty nonblank strings separated by blanks.

When there are multiple sort keys, later keys are compared only after all earlier keys compare equal. Lines that otherwise compare equal are ordered with all bytes significant.

These option arguments are also understood:

- c** Check that the input file is sorted according to the ordering rules; give no output unless the file is out of sort.
- m** Merge only, the input files are already sorted.
- o** The next argument is the name of an output file to use instead of the standard output. This file may be the same as one of the inputs.
- T** The next argument is the name of a directory in which temporary files should be made.
- u** Suppress all but one in each set of equal lines. Ignored bytes and bytes outside keys do not participate in this comparison.

**Examples.** Print in alphabetical order all the unique spellings in a list of words. Capitalized words differ from uncapitalized.

```
sort -u +0f +0 list
```

Print the password file (*passwd(5)*) sorted by user id number (the 3rd colon-separated field).

```
sort -t: +2n /etc/passwd
```

Print the first instance of each month in an already sorted file of (month day) entries. The options **-um** with just one input file make the choice of a unique representative from a set of equal lines predictable.

```
sort -um +0 -1 dates
```

**FILES**

/usr/tmp/stm\*, /tmp/\*: first and second tries for temporary files

**SEE ALSO**

uniq(1), comm(1), rev(1), join(1)

**DIAGNOSTICS**

Comments and exits with nonzero status for various trouble conditions and for disorder discovered under option **-c**.

**BUGS**

Very long lines are silently truncated.

**NAME**

`spell`, `spellin`, `spellout` – find spelling errors

**SYNOPSIS**

`spell` [ option ] ... [ file ] ...

`/usr/src/cmd/spell/spellin` [ list ]

`/usr/src/cmd/spell/spellout` [ -d ] list

**DESCRIPTION**

*Spell* collects words from the named documents, and looks them up in a spelling list. Words that neither occur among nor are derivable (by applying certain inflections, prefixes or suffixes) from words in the spelling list are printed on the standard output. If no files are named, words are collected from the standard input.

*Spell* ignores most *troff*, *tbl* and *eqn(1)* constructions.

Under the `-v` option, all words not literally in the spelling list are printed, and plausible derivations from spelling list words are indicated.

Under the `-b` option, British spelling is checked. Besides preferring *centre*, *colour*, *speciality*, *travelled*, etc., this option insists upon *-ise* in words like *standardise*, Fowler and the OED to the contrary notwithstanding.

Under the `-x` option, every plausible stem is printed with '=' for each word.

The spelling list is based on many sources, and while more haphazard than an ordinary dictionary, is also more effective in respect to proper names and popular technical words. Coverage of the specialized vocabularies of biology, medicine and chemistry is light.

Pertinent auxiliary files may be specified by name arguments, indicated below with their default settings. Copies of all output are accumulated in the history file. The stop list filters out misspellings (e.g. *thier=thy-y+ier*) that would otherwise pass.

Two routines help maintain the hash lists used by *spell*. Both expect a list of words, one per line, from the standard input. *Spellin* adds the words on the standard input to the preexisting *list* and places a new list on the standard output. If no *list* is specified, the new list is created from scratch. *Spellout* looks up each word in the standard input and prints on the standard output those that are missing from (or present on, with option `-d`) the hash list.

**FILES**

D=/usr/dict/hlist[ab]: hashed spelling lists, American & British

S=/usr/dict/hstop: hashed stop list

H=/usr/dict/spellhist: history file

/usr/lib/spell

*deroff(1)*, *sort(1)*, *tee(1)*, *sed(1)*

**BUGS**

The spelling list's coverage is uneven; new installations will probably wish to monitor the output for several months to gather local additions.

British spelling was done by an American.



**NAME**

spline – interpolate smooth curve

**SYNOPSIS**

**spline** [ option ] ...

**DESCRIPTION**

*Spline* takes pairs of numbers from the standard input as abscissas and ordinates of a function. It produces a similar set, which is approximately equally spaced and includes the input set, on the standard output. The cubic spline output (R. W. Hamming, *Numerical Methods for Scientists and Engineers*, 2nd ed., 349ff) has two continuous derivatives, and sufficiently many points to look smooth when plotted, for example by *graph*(1).

The following options are recognized, each as a separate argument.

- a** Supply abscissas automatically (they are missing from the input); spacing is given by the next argument, or is assumed to be 1 if next argument is not a number.
- k** The constant  $k$  used in the boundary value computation

$$y''_0 = ky''_1, \quad y''_n = ky''_{n-1}$$

is set by the next argument. By default  $k = 0$ .

- n** Space output points so that approximately  $n$  intervals occur between the lower and upper  $x$  limits. (Default  $n = 100$ .)
- p** Make output periodic, i.e. match derivatives at ends. First and last input values should normally agree.
- x** Next 1 (or 2) arguments are lower (and upper)  $x$  limits. Normally these limits are calculated from the data. Automatic abscissas start at lower limit (default 0).

**SEE ALSO**

*graph*(1)

**DIAGNOSTICS**

When data is not strictly monotone in  $x$ , *spline* reproduces the input without interpolating extra points.

**BUGS**

A limit of 1000 input points is enforced silently.

**NAME**

split – split a file into pieces

**SYNOPSIS**

**split** [ *-n* ] [ file [ name ] ]

**DESCRIPTION**

*Split* reads *file* and writes it in *n*-line pieces (default 1000), as many as necessary, onto a set of output files. The name of the first output file is *name* with **aa** appended, and so on lexicographically. If no output name is given, **x** is default.

If no input file is given, or if **-** is given in its stead, then the standard input file is used.

**NAME**

strip – remove symbols and relocation bits

**SYNOPSIS**

**strip** name ...

**DESCRIPTION**

*Strip* removes the symbol table and relocation bits ordinarily attached to the output of the assembler and loader. This is useful to save space after a program has been debugged.

The effect of *strip* is the same as use of the *-s* option of *ld*.

**FILES**

/tmp/stm?          temporary file

**SEE ALSO**

ld(1)

**NAME**

struct – structure Fortran programs

**SYNOPSIS**

**struct** [ option ] ... file

**DESCRIPTION**

*Struct* translates the Fortran program specified by *file* (standard input default) into a Ratfor program. Wherever possible, Ratfor control constructs replace the original Fortran. Statement numbers appear only where still necessary. Cosmetic changes are made, including changing Hollerith strings into quoted strings and relational operators into symbols (.e.g. '.GT.' into '>'). The output is appropriately indented.

The following options may occur in any order.

- s Input is accepted in standard format, i.e. comments are specified by a c, C, or \* in column 1, and continuation lines are specified by a nonzero, nonblank character in column 6. Normally, a statement whose first nonblank character is not alphanumeric is treated as a continuation.
- i Do not turn computed goto statements into switches. (Ratfor does not turn switches back into computed goto statements.)
- a Turn sequences of else ifs into a non-Ratfor switch of the form

```

switch {
    case pred1: code
    case pred2: code
    case pred3: code
    default: code
}

```

The case predicates are tested in order; the code appropriate to only one case is executed. This generalized form of switch statement does not occur in Ratfor.

- b Generate goto's instead of multilevel break statements.
- n Generate goto's instead of multilevel next statements.
- en If *n* is 0 (default), place code within a loop only if it can lead to an iteration of the loop. If *n* is nonzero, admit code segments with fewer than *n* statements to a loop if otherwise the loop would have exits to several places including the segment, and the segment can be reached only from the loop.

**FILES**

/tmp/struct\*  
/usr/lib/struct/\*

**SEE ALSO**

f77(1)

**BUGS**

Struct knows Fortran 66 syntax, but not full Fortran 77 (alternate returns, IF...THEN...ELSE, etc.) If an input Fortran program contains identifiers which are reserved words in Ratfor, the structured version of the program will not be a valid Ratfor program. Extended range DO's generate cryptic errors. Columns 73-80 are not special even when –s is in effect. Will not generate Ratfor FOR statements.

**NAME**

stty – set terminal options

**SYNOPSIS**

**stty** [ option ... ]

**DESCRIPTION**

*Stty* sets certain I/O options on the current output terminal. With no argument, it reports the current settings of the options. The option strings are selected from the following set:

**even** allow even parity  
**–even** disallow even parity  
**odd** allow odd parity  
**–odd** disallow odd parity  
**raw** raw mode input (no erase, kill, interrupt, quit, EOT; parity bit passed back)  
**–raw** negate raw mode  
**cooked** same as ‘–raw’  
**cbreak** make each character available to *read(2)* as received; no erase and kill  
**–cbreak** make characters available to *read* only when newline is received  
**–nl** allow carriage return for new-line, and output CR-LF for carriage return or new-line  
**nl** accept only new-line to end lines  
**echo** echo back every character typed  
**–echo** do not echo characters  
**lcase** map upper case to lower case  
**–lcase** do not map case  
**–tabs** replace tabs by spaces when printing  
**tabs** preserve tabs  
**ek** reset erase and kill characters back to normal # and @  
**erase c** set erase character to *c*. *C* can be of the form ‘^X’ which is interpreted as a ‘control X’.  
**kill c** set kill character to *c*. ‘^X’ works here also.  
**cr0 cr1 cr2 cr3**  
select style of delay for carriage return (see *ioctl(2)*)  
**nl0 nl1 nl2 nl3**  
select style of delay for linefeed  
**tab0 tab1 tab2 tab3**  
select style of delay for tab  
**ff0 ff1** select style of delay for form feed  
**bs0 bs1** select style of delay for backspace  
**tty33** set all modes suitable for the Teletype Corporation Model 33 terminal.  
**tty37** set all modes suitable for the Teletype Corporation Model 37 terminal.  
**vt05** set all modes suitable for Digital Equipment Corp. VT05 terminal  
**tn300** set all modes suitable for a General Electric TermiNet 300  
**ti700** set all modes suitable for Texas Instruments 700 series terminal  
**tek** set all modes suitable for Tektronix 4014 terminal  
**hup** hang up dataphone on last close.  
**–hup** do not hang up dataphone on last close.  
**0** hang up phone line immediately  
**50 75 110 134 150 200 300 600 1200 1800 2400 4800 9600 exta extb**  
Set terminal baud rate to the number given, if possible. (These are the speeds supported by the DH-11 interface).

**SEE ALSO**

*ioctl(2)*, *tabs(1)*

**NAME**

su – substitute user id temporarily

**SYNOPSIS**

**su** [ *userid* ]

**DESCRIPTION**

*Su* demands the password of the specified *userid*, and if it is given, changes to that *userid* and invokes the Shell *sh*(1) without changing the current directory or the user environment (see *environ*(5)). The new user ID stays in force until the Shell exits.

If no *userid* is specified, 'root' is assumed. To remind the super-user of his responsibilities, the Shell substitutes '#' for its usual prompt.

**SEE ALSO**

*sh*(1)

**NAME**

sum – sum and count blocks in a file

**SYNOPSIS**

**sum** file

**DESCRIPTION**

*Sum* calculates and prints a 16-bit checksum for the named file, and also prints the number of blocks in the file. It is typically used to look for bad spots, or to validate a file communicated over some transmission line.

**SEE ALSO**

wc(1)

**DIAGNOSTICS**

'Read error' is indistinguishable from end of file on most devices; check the block count.

**NAME**

`sync` – update the super block

**SYNOPSIS**

`sync`

**DESCRIPTION**

*Sync* executes the *sync* system primitive. If the system is to be stopped, *sync* must be called to insure file system integrity. See *sync(2)* for details.

**SEE ALSO**

*sync(2)*, *update(8)*



**NAME**

tabs – set terminal tabs

**SYNOPSIS**

**tabs** [ **-n** ] [ terminal ]

**DESCRIPTION**

*Tabs* sets the tabs on a variety of terminals. Various of the terminal names given in *term(7)* are recognized; the default is, however, suitable for most 300 baud terminals. If the **-n** flag is present then the left margin is not indented as is normal.

**SEE ALSO**

stty(1), term(7)

**NAME**

tail – deliver the last part of a file

**SYNOPSIS**

**tail** [  $\pm$ number[**lbc**] ] [ file ]

**DESCRIPTION**

*Tail* copies the named file to the standard output beginning at a designated place. If no file is named, the standard input is used.

Copying begins at distance *+number* from the beginning, or *-number* from the end of the input. *Number* is counted in units of lines, blocks or characters, according to the appended option **l**, **b** or **c**. When no units are specified, counting is by lines.

**SEE ALSO**

dd(1)

**BUGS**

Tails relative to the end of the file are treasured up in a buffer, and thus are limited in length. Various kinds of anomalous behavior may happen with character special files.

**NAME**

**tar** - tape archiver

**SYNOPSIS**

**tar** [ key ] [ name ... ]

**DESCRIPTION**

*Tar* saves and restores files on magtape. Its actions are controlled by the *key* argument. The *key* is a string of characters containing at most one function letter and possibly one or more function modifiers. Other arguments to the command are file or directory names specifying which files are to be dumped or restored. In all cases, appearance of a directory name refers to the files and (recursively) subdirectories of that directory.

The function portion of the key is specified by one of the following letters:

- r** The named files are written on the end of the tape. The **c** function implies this.
- x** The named files are extracted from the tape. If the named file matches a directory whose contents had been written onto the tape, this directory is (recursively) extracted. The owner, modification time, and mode are restored (if possible). If no file argument is given, the entire content of the tape is extracted. Note that if multiple entries specifying the same file are on the tape, the last one overwrites all earlier.
- t** The names of the specified files are listed each time they occur on the tape. If no file argument is given, all of the names on the tape are listed.
- u** The named files are added to the tape if either they are not already there or have been modified since last put on the tape.
- c** Create a new tape; writing begins on the beginning of the tape instead of after the last file. This command implies **r**.

The following characters may be used in addition to the letter which selects the function desired.

- 0,...,7** This modifier selects the drive on which the tape is mounted. The default is **1**.
- v** Normally *tar* does its work silently. The **v** (verbose) option causes it to type the name of each file it treats preceded by the function letter. With the **t** function, **v** gives more information about the tape entries than just the name.
- w** causes *tar* to print the action to be taken followed by file name, then wait for user confirmation. If a word beginning with 'y' is given, the action is performed. Any other input means don't do it.
- f** causes *tar* to use the next argument as the name of the archive instead of /dev/mt?. If the name of the file is '-', *tar* writes to standard output or reads from standard input, whichever is appropriate. Thus, *tar* can be used as the head or tail of a filter chain *Tar* can also be used to move hierarchies with the command
 

```
cd fromdir; tar cf - . | (cd todir; tar xf -)
```
- b** causes *tar* to use the next argument as the blocking factor for tape records. The default is 1, the maximum is 20. This option should only be used with raw magnetic tape archives (See **f** above). The block size is determined automatically when reading tapes (key letters 'x' and 't').
- l** tells *tar* to complain if it cannot resolve all of the links to the files dumped. If this is not specified, no error messages are printed.
- m** tells *tar* to not restore the modification times. The mod time will be the time of extraction.

**FILES**

/dev/mt?  
/tmp/tar\*

**DIAGNOSTICS**

Complaints about bad key characters and tape read/write errors.

Complaints if enough memory is not available to hold the link tables.

**BUGS**

There is no way to ask for the  $n$ -th occurrence of a file.

Tape errors are handled ungracefully.

The **u** option can be slow.

The **b** option should not be used with archives that are going to be updated. The current magtape driver cannot backspace raw magtape. If the archive is on a disk file the **b** option should not be used at all, as updating an archive stored in this manner can destroy it.

The current limit on file name length is 100 characters.

**NAME**

*tbl* – format tables for *nroff* or *troff*

**SYNOPSIS**

**tbl** [ files ] ...

**DESCRIPTION**

*Tbl* is a preprocessor for formatting tables for *nroff* or *troff*(1). The input files are copied to the standard output, except for lines between *.TS* and *.TE* command lines, which are assumed to describe tables and reformatted. Details are given in the reference manual.

As an example, letting *\t* represent a tab (which should be typed as a genuine tab) the input

```
.TS
c s s
c c s
c c c
l n n.
Household Population
Town\tHouseholds
\tNumber\tSize
Bedminster\t789\t3.26
Bernards Twp.\t3087\t3.74
Bernardsville\t2018\t3.30
Bound Brook\t3425\t3.04
Branchburg\t1644\t3.49
Bridgewater\t7897\t3.81
Far Hills\t240\t3.19
.TE
```

yields

| Household Population |            |      |
|----------------------|------------|------|
| Town                 | Households |      |
|                      | Number     | Size |
| Bedminster           | 789        | 3.26 |
| Bernards Twp.        | 3087       | 3.74 |
| Bernardsville        | 2018       | 3.30 |
| Bound Brook          | 3425       | 3.04 |
| Branchburg           | 1644       | 3.49 |
| Bridgewater          | 7897       | 3.81 |
| Far Hills            | 240        | 3.19 |

If no arguments are given, *tbl* reads the standard input, so it may be used as a filter. When it is used with *eqn* or *neqn* the *tbl* command should be first, to minimize the volume of data passed through pipes.

**SEE ALSO**

*troff*(1), *eqn*(1)  
M. E. Lesk, *TBL*.

**NAME**

`tc` – phototypesetter simulator

**SYNOPSIS**

`tc` [ `-t` ] [ `-sN` ] [ `-pL` ] [ `file` ]

**DESCRIPTION**

`Tc` interprets its input (standard input default) as device codes for a Graphic Systems phototypesetter (`cat`). The standard output of `tc` is intended for a Tektronix 4015 (a 4014 terminal with ASCII and APL character sets). The sixteen typesetter sizes are mapped into the 4014's four sizes; the entire TROFF character set is drawn using the 4014's character generator, using overstruck combinations where necessary. Typical usage:

```
troff -t file | tc
```

At the end of each page `tc` waits for a newline (empty line) from the keyboard before continuing on to the next page. In this wait state, the command `e` will suppress the screen erase before the next page; `sN` will cause the next `N` pages to be skipped; and `!line` will send line to the shell.

The command line options are:

- `-t` Don't wait between pages; for directing output into a file.
- `-sN` Skip the first `N` pages.
- `-pL` Set page length to `L`. `L` may include the scale factors `p` (points), `i` (inches), `c` (centimeters), and `P` (picas); default is picas.
- `'-l w'` Multiply the default aspect ratio, 1.5, of a displayed page by `l/w`.

**SEE ALSO**

`troff(1)`, `plot(1)`

**BUGS**

Font distinctions are lost.  
The aspect ratio option is unbelievable.

**NAME**

tee – pipe fitting

**SYNOPSIS**

**tee** [ **-i** ] [ **-a** ] [ file ] ...

**DESCRIPTION**

*Tee* transcribes the standard input to the standard output and makes copies in the *files*. Option **-i** ignores interrupts; option **-a** causes the output to be appended to the *files* rather than overwriting them.

**NAME**

test – condition command

**SYNOPSIS**

**test** *expr*

**DESCRIPTION**

*test* evaluates the expression *expr*, and if its value is true then returns zero exit status; otherwise, a non zero exit status is returned. *test* returns a non zero exit if there are no arguments.

The following primitives are used to construct *expr*.

- r** *file* true if the file exists and is readable.
- w** *file* true if the file exists and is writable.
- f** *file* true if the file exists and is not a directory.
- d** *file* true if the file exists and is a directory.
- s** *file* true if the file exists and has a size greater than zero.
- t** [*files* ]  
true if the open file whose file descriptor number is *files* (1 by default) is associated with a terminal device.
- z** *s1* true if the length of string *s1* is zero.
- n** *s1* true if the length of the string *s1* is nonzero.
- s1* = *s2* true if the strings *s1* and *s2* are equal.
- s1* != *s2* true if the strings *s1* and *s2* are not equal.
- s1* true if *s1* is not the null string.
- n1* **-eq** *n2*  
true if the integers *n1* and *n2* are algebraically equal. Any of the comparisons **-ne**, **-gt**, **-ge**, **-lt**, or **-le** may be used in place of **-eq**.

These primaries may be combined with the following operators:

- !** unary negation operator
- a** binary *and* operator
- o** binary *or* operator
- ( *expr* ) parentheses for grouping.
- a** has higher precedence than **-o**. Notice that all the operators and flags are separate arguments to *test*. Notice also that parentheses are meaningful to the Shell and must be escaped.

**SEE ALSO**

sh(1), find(1)



**NAME**

`time` – time a command

**SYNOPSIS**

**`time`** command

**DESCRIPTION**

The given command is executed; after it is complete, *time* prints the elapsed time during the command, the time spent in the system, and the time spent in execution of the command. Times are reported in seconds.

The execution time can depend on what kind of memory the program happens to land in; the user time in MOS is often half what it is in core.

The times are printed on the diagnostic output stream.

**BUGS**

Elapsed time is accurate to the second, while the CPU times are measured to the 60th second. Thus the sum of the CPU times can be up to a second larger than the elapsed time.

**NAME**

tk – paginator for the Tektronix 4014

**SYNOPSIS**

**tk** [ **-t** ] [ **-N** ] [ **-pL** ] [ file ]

**DESCRIPTION**

The output of *tk* is intended for a Tektronix 4014 terminal. *Tk* arranges for 66 lines to fit on the screen, divides the screen into *N* columns, and contributes an eight space page offset in the (default) single-column case. Tabs, spaces, and backspaces are collected and plotted when necessary. Teletype Model 37 half- and reverse-line sequences are interpreted and plotted. At the end of each page *tk* waits for a newline (empty line) from the keyboard before continuing on to the next page. In this wait state, the command *!command* will send the *command* to the shell.

The command line options are:

- t**     Don't wait between pages; for directing output into a file.
- N**     Divide the screen into *N* columns and wait after the last column.
- pL**    Set page length to *L* lines.

**SEE ALSO**

pr(1)

**NAME**

touch – update date last modified of a file

**SYNOPSIS**

**touch** [ **-c** ] file ...

**DESCRIPTION**

*Touch* attempts to set the modified date of each *file*. This is done by reading a character from the file and writing it back.

If a *file* does not exist, an attempt will be made to create it unless the **-c** option is specified.

**NAME**

**tp** – manipulate tape archive

**SYNOPSIS**

**tp** [ *key* ] [ *name ...* ]

**DESCRIPTION**

*tp* saves and restores files on DECTape or magtape. Its actions are controlled by the *key* argument. The *key* is a string of characters containing at most one function letter and possibly one or more function modifiers. Other arguments to the command are file or directory names specifying which files are to be dumped, restored, or listed. In all cases, appearance of a directory name refers to the files and (recursively) subdirectories of that directory.

The function portion of the *key* is specified by one of the following letters:

- r** The named files are written on the tape. If files with the same names already exist, they are replaced. ‘Same’ is determined by string comparison, so ‘./abc’ can never be the same as ‘/usr/dmr/abc’ even if ‘/usr/dmr’ is the current directory. If no file argument is given, ‘.’ is the default.
- u** updates the tape. **u** is like **r**, but a file is replaced only if its modification date is later than the date stored on the tape; that is to say, if it has changed since it was dumped. **u** is the default command if none is given.
- d** deletes the named files from the tape. At least one name argument must be given. This function is not permitted on magtapes.
- x** extracts the named files from the tape to the file system. The owner and mode are restored. If no file argument is given, the entire contents of the tape are extracted.
- t** lists the names of the specified files. If no file argument is given, the entire contents of the tape is listed.

The following characters may be used in addition to the letter which selects the function desired.

- m** Specifies magtape as opposed to DECTape.
- 0,...,7** This modifier selects the drive on which the tape is mounted. For DECTape, **x** is default; for magtape ‘0’ is the default.
- v** Normally *tp* does its work silently. The **v** (verbose) option causes it to type the name of each file it treats preceded by the function letter. With the **t** function, **v** gives more information about the tape entries than just the name.
- c** means a fresh dump is being created; the tape directory is cleared before beginning. Usable only with **r** and **u**. This option is assumed with magtape since it is impossible to selectively overwrite magtape.
- i** Errors reading and writing the tape are noted, but no action is taken. Normally, errors cause a return to the command level.
- f** Use the first named file, rather than a tape, as the archive. This option is known to work only with **x**.
- w** causes *tp* to pause before treating each file, type the indicative letter and the file name (as with **v**) and await the user’s response. Response **y** means ‘yes’, so the file is treated. Null response means ‘no’, and the file does not take part in whatever is being done. Response **x** means ‘exit’; the *tp* command terminates immediately. In the **x** function, files previously asked about have been extracted already. With **r**, **u**, and **d** no change has been made to the tape.

**FILES**

/dev/tap?

/dev/mt?

**SEE ALSO**

ar(1), tar(1)

**DIAGNOSTICS**

Several; the non-obvious one is 'Phase error', which means the file changed after it was selected for dumping but before it was dumped.

**BUGS**

A single file with several links to it is treated like several files.

Binary-coded control information makes magnetic tapes written by *tp* difficult to carry to other machines; *tar(1)* avoids the problem.

**NAME**

tr – translate characters

**SYNOPSIS**

```
tr [ -cds ] [ string1 [ string2 ] ]
```

**DESCRIPTION**

*Tr* copies the standard input to the standard output with substitution or deletion of selected characters. Input characters found in *string1* are mapped into the corresponding characters of *string2*. When *string2* is short it is padded to the length of *string1* by duplicating its last character. Any combination of the options **-cds** may be used: **-c** complements the set of characters in *string1* with respect to the universe of characters whose ASCII codes are 01 through 0377 octal; **-d** deletes all input characters in *string1*; **-s** squeezes all strings of repeated output characters that are in *string2* to single characters.

In either string the notation *a–b* means a range of characters from *a* to *b* in increasing ASCII order. The character **\** followed by 1, 2 or 3 octal digits stands for the character whose ASCII code is given by those digits. A **\** followed by any other character stands for that character.

The following example creates a list of all the words in ‘file1’ one per line in ‘file2’, where a word is taken to be a maximal string of alphabetic. The second string is quoted to protect **\** from the Shell. 012 is the ASCII code for newline.

```
tr -cs A-Za-z '\012' <file1 >file2
```

**SEE ALSO**

ed(1), ascii(7)

**BUGS**

Won't handle ASCII NUL in *string1* or *string2*; always deletes NUL from input.

**NAME**

troff, nroff – text formatting and typesetting

**SYNOPSIS**

**troff** [ option ] ... [ file ] ...

**nroff** [ option ] ... [ file ] ...

**DESCRIPTION**

*Troff* formats text in the named *files* for printing on a Graphic Systems C/A/T phototypesetter; *nroff* for typewriter-like devices. Their capabilities are described in the *Nroff/Troff user's manual*.

If no *file* argument is present, the standard input is read. An argument consisting of a single minus (-) is taken to be a file name corresponding to the standard input. The options, which may appear in any order so long as they appear before the files, are:

- olist Print only pages whose page numbers appear in the comma-separated *list* of numbers and ranges. A range *N-M* means pages *N* through *M*; an initial *-N* means from the beginning to page *N*; and a final *N-* means from *N* to the end.
- nN Number first generated page *N*.
- sN Stop every *N* pages. *Nroff* will halt prior to every *N* pages (default *N=1*) to allow paper loading or changing, and will resume upon receipt of a newline. *Troff* will stop the phototypesetter every *N* pages, produce a trailer to allow changing cassettes, and resume when the typesetter's start button is pressed.
- mname Prepend the macro file */usr/lib/tmac/tmac.name* to the input *files*.
- raN Set register *a* (one-character) to *N*.
- i Read standard input after the input files are exhausted.
- q Invoke the simultaneous input-output mode of the **rd** request.

*Nroff only*

- Tname Prepare output for specified terminal. Known *names* are **37** for the (default) Teletype Corporation Model 37 terminal, **tn300** for the GE TerminiNet 300 (or any terminal without half-line capability), **300S** for the DASI-300S, **300** for the DASI-300, and **450** for the DASI-450 (Diablo Hyterm).
- e Produce equally-spaced words in adjusted lines, using full terminal resolution.
- h Use output tabs during horizontal spacing to speed output and reduce output character count. Tab settings are assumed to be every 8 nominal character widths.

*Troff only*

- t Direct output to the standard output instead of the phototypesetter.
- f Refrain from feeding out paper and stopping phototypesetter at the end of the run.
- w Wait until phototypesetter is available, if currently busy.
- b Report whether the phototypesetter is busy or available. No text processing is done.
- a Send a printable ASCII approximation of the results to the standard output.
- pN Print all characters in point size *N* while retaining all prescribed spacings and motions, to reduce phototypesetter elapsed time.
- g Prepare output for a GCOS phototypesetter and direct it to the standard output (see *gcat(1)*).

If the file */usr/adm/tracct* is writable, *troff* keeps phototypesetter accounting records there. The integrity of that file may be secured by making *troff* a 'set user-id' program.

**FILES**

|                      |  |
|----------------------|--|
| /usr/lib/suftab      | suffix hyphenation tables                |
| /tmp/ta*             | temporary file                           |
| /usr/lib/tmac/tmac.* | standard macro files                     |
| /usr/lib/term/*      | terminal driving tables for <i>nroff</i> |
| /usr/lib/font/*      | font width tables for <i>troff</i>       |
| /dev/cat             | phototypesetter                          |
| /usr/adm/tracct      | accounting statistics for /dev/cat       |

**SEE ALSO**

J. F. Ossanna, *Nroff/Troff user's manual*

B. W. Kernighan, *A TROFF Tutorial*

eqn(1), tbl(1)

col(1), tk(1) (*nroff* only)

tc(1), gcat(1) (*troff* only)



**NAME**

true, false – provide truth values

**SYNOPSIS**

**true**

**false**

**DESCRIPTION**

*True* does nothing, successfully. *False* does nothing, unsuccessfully. They are typically used in input to *sh*(1) such as:

```
while true
do
    command
done
```

**SEE ALSO**

*sh*(1)

**DIAGNOSTICS**

*True* has exit status zero, *false* nonzero.

**NAME**

tsort – topological sort

**SYNOPSIS**

**tsort** [ file ]

**DESCRIPTION**

*Tsort* produces on the standard output a totally ordered list of items consistent with a partial ordering of items mentioned in the input *file*. If no *file* is specified, the standard input is understood.

The input consists of pairs of items (nonempty strings) separated by blanks. Pairs of different items indicate ordering. Pairs of identical items indicate presence, but not ordering.

**SEE ALSO**

lorder(1)

**DIAGNOSTICS**

Odd data: there is an odd number of fields in the input file.

**BUGS**

Uses a quadratic algorithm; not worth fixing for the typical use of ordering a library archive file.

**NAME**

`tty` – get terminal name

**SYNOPSIS**

`tty`

**DESCRIPTION**

*Tty* prints the pathname of the user's terminal.

**DIAGNOSTICS**

'not a tty' if the standard input file is not a terminal.

**NAME**

uniq – report repeated lines in a file

**SYNOPSIS**

**uniq** [ **-udc** [ **+n** ] [ **-n** ] ] [ input [ output ] ]

**DESCRIPTION**

*Uniq* reads the input file comparing adjacent lines. In the normal case, the second and succeeding copies of repeated lines are removed; the remainder is written on the output file. Note that repeated lines must be adjacent in order to be found; see *sort*(1). If the **-u** flag is used, just the lines that are not repeated in the original file are output. The **-d** option specifies that one copy of just the repeated lines is to be written. The normal mode output is the union of the **-u** and **-d** mode outputs.

The **-c** option supersedes **-u** and **-d** and generates an output report in default style but with each line preceded by a count of the number of times it occurred.

The *n* arguments specify skipping an initial portion of each line in the comparison:

- n**      The first *n* fields together with any blanks before each are ignored. A field is defined as a string of non-space, non-tab characters separated by tabs and spaces from its neighbors.
- +n**      The first *n* characters are ignored. Fields are skipped before characters.

**SEE ALSO**

sort(1), comm(1)

**NAME**

units – conversion program

**SYNOPSIS**

**units**

**DESCRIPTION**

*Units* converts quantities expressed in various standard scales to their equivalents in other scales. It works interactively in this fashion:

```
You have: inch
You want: cm
          * 2.54000e+00
          / 3.93701e-01
```

A quantity is specified as a multiplicative combination of units optionally preceded by a numeric multiplier. Powers are indicated by suffixed positive integers, division by the usual sign:

```
You have: 15 pounds force/in2
You want: atm
          * 1.02069e+00
          / 9.79730e-01
```

*Units* only does multiplicative scale changes. Thus it can convert Kelvin to Rankine, but not Centigrade to Fahrenheit. Most familiar units, abbreviations, and metric prefixes are recognized, together with a generous leavening of exotica and a few constants of nature including:

|       |  |
|-------|--|
| pi    | ratio of circumference to diameter     |
| c     | speed of light                         |
| e     | charge on an electron                  |
| g     | acceleration of gravity                |
| force | same as g                              |
| mole  | Avogadro's number                      |
| water | pressure head per unit height of water |
| au    | astronomical unit                      |

'Pound' is a unit of mass. Compound names are run together, e.g. 'lightyear'. British units that differ from their US counterparts are prefixed thus: 'brgallon'. Currency is denoted 'belgiumfranc', 'britain-pound', ...

For a complete list of units, 'cat /usr/lib/units'.

**FILES**

/usr/lib/units

**BUGS**

Don't base your financial plans on the currency conversions.

**NAME**

uucp, uulog – unix to unix copy

**SYNOPSIS**

**uucp** [ option ] ... source-file ... destination-file

**uulog** [ option ] ...

**DESCRIPTION**

*Uucp* copies files named by the source-file arguments to the destination-file argument. A file name may be a path name on your machine, or may have the form

system-name!pathname

where 'system-name' is taken from a list of system names which *uucp* knows about. Shell metacharacters `?*[]` appearing in the pathname part will be expanded on the appropriate system.

Pathnames may be one of

- (1) a full pathname;
- (2) a pathname preceded by `~user`; where *user* is a userid on the specified system and is replaced by that user's login directory;
- (3) anything else is prefixed by the current directory.

If the result is an erroneous pathname for the remote system the copy will fail. If the destination-file is a directory, the last part of the source-file name is used.

*Uucp* preserves execute permissions across the transmission and gives 0666 read and write permissions (see *chmod(2)*).

The following options are interpreted by *uucp*.

- d** Make all necessary directories for the file copy.
- c** Use the source file when copying out rather than copying the file to the spool directory.
- m** Send mail to the requester when the copy is complete.

*Uulog* maintains a summary log of *uucp* and *uux(1)* transactions in the file `/usr/spool/uucp/LOGFILE` by gathering information from partial log files named `/usr/spool/uucp/LOG.*.?`. It removes the partial log files.

The options cause *uulog* to print logging information:

- sys** Print information about work involving system *sys*.
- user** Print information about work done for the specified *user*.

**FILES**

`/usr/spool/uucp` - spool directory  
`/usr/lib/uucp/*` - other data and program files

**SEE ALSO**

*uux(1)*, *mail(1)*  
 D. A. Nowitz, *Uucp Implementation Description*

**WARNING**

The domain of remotely accessible files can (and for obvious security reasons, usually should) be severely restricted. You will very likely not be able to fetch files by pathname; ask a responsible person on the remote system to send them to you. For the same reasons you will probably not be able to send files to arbitrary pathnames.

**BUGS**

All files received by *uucp* will be owned by *uucp*.

The `-m` option will only work sending files or receiving a single file. (Receiving multiple files specified by special shell characters `?*[]` will not activate the `-m` option.)

**NAME**

`uux` – unix to unix command execution

**SYNOPSIS**

`uux` [ - ] command-string

**DESCRIPTION**

`Uux` will gather 0 or more files from various systems, execute a command on a specified system and send standard output to a file on a specified system.

The command-string is made up of one or more arguments that look like a shell command line, except that the command and file names may be prefixed by system-name!. A null system-name is interpreted as the local system.

File names may be one of

- (1) a full pathname;
- (2) a pathname preceded by `~xxx`; where `xxx` is a userid on the specified system and is replaced by that user's login directory;
- (3) anything else is prefixed by the current directory.

The `'-'` option will cause the standard input to the `uux` command to be the standard input to the command-string.

For example, the command

```
uux "!diff usg!/usr/dan/f1 pwba!/a4/dan/f1 > !fi.diff"
```

will get the `f1` files from the `usg` and `pwba` machines, execute a `diff` command and put the results in `f1.diff` in the local directory.

Any special shell characters such as `<>`; `|` should be quoted either by quoting the entire command-string, or quoting the special characters as individual arguments.

**FILES**

`/usr/uucp/spool` - spool directory  
`/usr/uucp/*` - other data and programs

**SEE ALSO**

`uucp(1)`  
D. A. Nowitz, *Uucp implementation description*

**WARNING**

An installation may, and for security reasons generally will, limit the list of commands executable on behalf of an incoming request from `uux`. Typically, a restricted site will permit little other than the receipt of mail via `uux`.

**BUGS**

Only the first command of a shell pipeline may have a system-name!. All other commands are executed on the system of the first command.

The use of the shell metacharacter `*` will probably not do what you want it to do.

The shell tokens `<<` and `>>` are not implemented.

There is no notification of denial of execution on the remote machine.



**NAME**

wait – await completion of process

**SYNOPSIS**

**wait**

**DESCRIPTION**

Wait until all processes started with **&** have completed, and report on abnormal terminations.

Because the *wait(2)* system call must be executed in the parent process, the Shell itself executes *wait*, without creating a new process.

**SEE ALSO**

sh(1)

**BUGS**

Not all the processes of a 3- or more-stage pipeline are children of the Shell, and thus can't be waited for.

**NAME**

wall – write to all users

**SYNOPSIS**

**/etc/wall**

**DESCRIPTION**

*Wall* reads its standard input until an end-of-file. It then sends this message, preceded by 'Broadcast Message ...', to all logged in users.

The sender should be super-user to override any protections the users may have invoked.

**FILES**

/dev/tty?

/etc/utmp

**SEE ALSO**

mesg(1), write(1)

**DIAGNOSTICS**

'Cannot send to ...' when the open on a user's tty file fails.

**NAME**

`wc` – word count

**SYNOPSIS**

`wc` [ **-lwc** ] [ name ... ]

**DESCRIPTION**

*Wc* counts lines, words and characters in the named files, or in the standard input if no name appears. A word is a maximal string of characters delimited by spaces, tabs or newlines.

If the optional argument is present, just the specified counts (lines, words or characters) are selected by the letters **l**, **w**, or **c**.

**NAME**

*who* – who is on the system

**SYNOPSIS**

**who** [ *who-file* ] [ **am I** ]

**DESCRIPTION**

*Who*, without an argument, lists the login name, terminal name, and login time for each current UNIX user.

Without an argument, *who* examines the */etc/utmp* file to obtain its information. If a file is given, that file is examined. Typically the given file will be */usr/adm/wtmp*, which contains a record of all the logins since it was created. Then *who* lists logins, logouts, and crashes since the creation of the *wtmp* file. Each login is listed with user name, terminal name (with *'/dev/'* suppressed), and date and time. When an argument is given, logouts produce a similar line without a user name. Reboots produce a line with *'x'* in the place of the device name, and a fossil time indicative of when the system went down.

With two arguments, as in *'who am I'* (and also *'who are you'*), *who* tells who you are logged in as.

**FILES**

*/etc/utmp*

**SEE ALSO**

*getuid(2)*, *utmp(5)*

**NAME**

write - write to another user

**SYNOPSIS**

**write** user [ ttyname ]

**DESCRIPTION**

*Write* copies lines from your terminal to that of another user. When first called, it sends the message

Message from yourname yourttyname...

The recipient of the message should write back at this point. Communication continues until an end of file is read from the terminal or an interrupt is sent. At that point *write* writes 'EOT' on the other terminal and exits.

If you want to write to a user who is logged in more than once, the *ttyname* argument may be used to indicate the appropriate terminal name.

Permission to write may be denied or granted by use of the *mesg* command. At the outset writing is allowed. Certain commands, in particular *nroff* and *pr(1)* disallow messages in order to prevent messy output.

If the character '!' is found at the beginning of a line, *write* calls the shell to execute the rest of the line as a command.

The following protocol is suggested for using *write*: when you first write to another user, wait for him to write back before starting to send. Each party should end each message with a distinctive signal—(o) for 'over' is conventional—that the other may reply. (oo) for 'over and out' is suggested when conversation is about to be terminated.

**FILES**

|           |                |
|-----------|----------------|
| /etc/utmp | to find user   |
| /bin/sh   | to execute '!' |

**SEE ALSO**

mesg(1), who(1), mail(1)

**NAME**

xsend, xget, enroll – secret mail

**SYNOPSIS**

**xsend** person

**xget**

**enroll**

**DESCRIPTION**

These commands implement a secure communication channel; it is like *mail(1)*, but no one can read the messages except the intended recipient. The method embodies a public-key cryptosystem using knapsacks.

To receive messages, use *enroll*; it asks you for a password that you must subsequently quote in order to receive secret mail.

To receive secret mail, use *xget*. It asks for your password, then gives you the messages.

To send secret mail, use *xsend* in the same manner as the ordinary mail command. (However, it will accept only one target). A message announcing the receipt of secret mail is also sent by ordinary mail.

**FILES**

/usr/spool/secretmail/\*.key: keys /usr/spool/secretmail/\*.[0-9]: messages

**SEE ALSO**

mail (1)

**BUGS**

It should be integrated with ordinary mail. The announcement of secret mail makes traffic analysis possible.

**NAME**

yacc – yet another compiler-compiler

**SYNOPSIS**

**yacc** [ **-vd** ] grammar

**DESCRIPTION**

*Yacc* converts a context-free grammar into a set of tables for a simple automaton which executes an LR(1) parsing algorithm. The grammar may be ambiguous; specified precedence rules are used to break ambiguities.

The output file, *y.tab.c*, must be compiled by the C compiler to produce a program *yyparse*. This program must be loaded with the lexical analyzer program, *yylex*, as well as *main* and *yyerror*, an error handling routine. These routines must be supplied by the user; *Lex(1)* is useful for creating lexical analyzers usable by *yacc*.

If the **-v** flag is given, the file *y.output* is prepared, which contains a description of the parsing tables and a report on conflicts generated by ambiguities in the grammar.

If the **-d** flag is used, the file *y.tab.h* is generated with the *define* statements that associate the *yacc*-assigned ‘token codes’ with the user-declared ‘token names’. This allows source files other than *y.tab.c* to access the token codes.

**FILES**

|                                    |   |
|------------------------------------|---|
| <i>y.output</i>                    |   |
| <i>y.tab.c</i>                     |   |
| <i>y.tab.h</i>                     | defines for token names                   |
| <i>yacc.tmp</i> , <i>yacc.acts</i> | temporary files                           |
| <i>/usr/lib/yaccpar</i>            | parser prototype for C programs           |
| <i>/lib/liby.a</i>                 | library with default ‘main’ and ‘yyerror’ |

**SEE ALSO**

*lex(1)*

*LR Parsing* by A. V. Aho and S. C. Johnson, Computing Surveys, June, 1974.

*YACC – Yet Another Compiler Compiler* by S. C. Johnson.

**DIAGNOSTICS**

The number of reduce-reduce and shift-reduce conflicts is reported on the standard output; a more detailed report is found in the *y.output* file. Similarly, if some rules are not reachable from the start symbol, this is also reported.

**BUGS**

Because file names are fixed, at most one *yacc* process can be active in a given directory at a time.





**NAME**

intro, errno – introduction to system calls and error numbers

**SYNOPSIS**

```
#include <errno.h>
```

**DESCRIPTION**

Section 2 of this manual lists all the entries into the system. Most of these calls have an error return. An error condition is indicated by an otherwise impossible returned value. Almost always this is `-1`; the individual sections specify the details. An error number is also made available in the external variable *errno*. *Errno* is not cleared on successful calls, so it should be tested only after an error has occurred.

There is a table of messages associated with each error, and a routine for printing the message; See  *perror*(3). The possible error numbers are not recited with each writeup in section 2, since many errors are possible for most of the calls. Here is a list of the error numbers, their names as defined in `<errno.h>`, and the messages available using *perror*.

- 0 Error 0  
Unused.
- 1 EPERM Not owner  
Typically this error indicates an attempt to modify a file in some way forbidden except to its owner or super-user. It is also returned for attempts by ordinary users to do things allowed only to the super-user.
- 2 ENOENT No such file or directory  
This error occurs when a file name is specified and the file should exist but doesn't, or when one of the directories in a path name does not exist.
- 3 ESRCH No such process  
The process whose number was given to *signal* and *ptrace* does not exist, or is already dead.
- 4 EINTR Interrupted system call  
An asynchronous signal (such as interrupt or quit), which the user has elected to catch, occurred during a system call. If execution is resumed after processing the signal, it will appear as if the interrupted system call returned this error condition.
- 5 EIO I/O error  
Some physical I/O error occurred during a *read* or *write*. This error may in some cases occur on a call following the one to which it actually applies.
- 6 ENXIO No such device or address  
I/O on a special file refers to a subdevice that does not exist, or beyond the limits of the device. It may also occur when, for example, a tape drive is not dialled in or no disk pack is loaded on a drive.
- 7 E2BIG Arg list too long  
An argument list longer than 5120 bytes is presented to *exec*.
- 8 ENOEXEC Exec format error  
A request is made to execute a file which, although it has the appropriate permissions, does not start with a valid magic number, see *a.out*(5).
- 9 EBADF Bad file number  
Either a file descriptor refers to no open file, or a read (resp. write) request is made to a file that is open only for writing (resp. reading).
- 10 ECHILD No children  
*Wait* and the process has no living or unwaited-for children.

- 11 EAGAIN No more processes  
In a *fork*, the system's process table is full or the user is not allowed to create any more processes.
- 12 ENOMEM Not enough core  
During an *exec* or *break*, a program asks for more core than the system is able to supply. This is not a temporary condition; the maximum core size is a system parameter. The error may also occur if the arrangement of text, data, and stack segments requires too many segmentation registers.
- 13 EACCES Permission denied  
An attempt was made to access a file in a way forbidden by the protection system.
- 14 EFAULT Bad address  
The system encountered a hardware fault in attempting to access the arguments of a system call.
- 15 ENOTBLK Block device required  
A plain file was mentioned where a block device was required, e.g. in *mount*.
- 16 EBUSY Mount device busy  
An attempt to mount a device that was already mounted or an attempt was made to dismount a device on which there is an active file (open file, current directory, mounted-on file, active text segment).
- 17 EEXIST File exists  
An existing file was mentioned in an inappropriate context, e.g. *link*.
- 18 EXDEV Cross-device link  
A link to a file on another device was attempted.
- 19 ENODEV No such device  
An attempt was made to apply an inappropriate system call to a device; e.g. read a write-only device.
- 20 ENOTDIR Not a directory  
A non-directory was specified where a directory is required, for example in a path name or as an argument to *chdir*.
- 21 EISDIR Is a directory  
An attempt to write on a directory.
- 22 EINVAL Invalid argument  
Some invalid argument: dismounting a non-mounted device, mentioning an unknown signal in *signal*, reading or writing a file for which *seek* has generated a negative pointer. Also set by math functions, see *intro(3)*.
- 23 ENFILE File table overflow  
The system's table of open files is full, and temporarily no more *opens* can be accepted.
- 24 EMFILE Too many open files  
Customary configuration limit is 20 per process.
- 25 ENOTTY Not a typewriter  
The file mentioned in *stty* or *gtty* is not a terminal or one of the other devices to which these calls apply.
- 26 ETXTBSY Text file busy  
An attempt to execute a pure-procedure program that is currently open for writing (or reading!). Also an attempt to open for writing a pure-procedure program that is being executed.

- 27 **EFBIG** File too large  
The size of a file exceeded the maximum (about  $10^9$  bytes).
- 28 **ENOSPC** No space left on device  
During a *write* to an ordinary file, there is no free space left on the device.
- 29 **ESPIPE** Illegal seek  
An *lseek* was issued to a pipe. This error should also be issued for other non-seekable devices.
- 30 **EROFS** Read-only file system  
An attempt to modify a file or directory was made on a device mounted read-only.
- 31 **EMLINK** Too many links  
An attempt to make more than 32767 links to a file.
- 32 **EPIPE** Broken pipe  
A write on a pipe for which there is no process to read the data. This condition normally generates a signal; the error is returned if the signal is ignored.
- 33 **EDOM** Math argument  
The argument of a function in the math package (3M) is out of the domain of the function.
- 34 **ERANGE** Result too large  
The value of a function in the math package (3M) is unrepresentable within machine precision.

**SEE ALSO**

intro(3)

**ASSEMBLER****as /usr/include/sys.s file ...**

The PDP11 assembly language interface is given for each system call. The assembler symbols are defined in `'/usr/include/sys.s'`.

Return values appear in registers r0 and r1; it is unwise to count on these registers being preserved when no value is expected. An erroneous call is always indicated by turning on the c-bit of the condition codes. The error number is returned in r0. The presence of an error is most easily tested by the instructions *bes* and *bec* ('branch on error set (or clear)'). These are synonyms for the *bcs* and *bcc* instructions.

On the Interdata 8/32, the system call arguments correspond well to the arguments of the C routines. The sequence is:

```
la      %2,errno
l       %0,&callno
svc     0,args
```

Thus register 2 points to a word into which the error number will be stored as needed; it is cleared if no error occurs. Register 0 contains the system call number; the nomenclature is identical to that on the PDP11. The argument of the *svc* is the address of the arguments, laid out in storage as in the C calling sequence. The return value is in register 2 (possibly 3 also, as in *pipe*) and is  $-1$  in case of error. The overflow bit in the program status word is also set when errors occur.

**NAME**

access – determine accessibility of file

**SYNOPSIS**

```
access(name, mode)
char *name;
```

**DESCRIPTION**

*Access* checks the given file *name* for accessibility according to *mode*, which is 4 (read), 2 (write) or 1 (execute) or a combination thereof. Specifying mode 0 tests whether the directories leading to the file can be searched and the file exists.

An appropriate error indication is returned if *name* cannot be found or if any of the desired access modes would not be granted. On disallowed accesses `-1` is returned and the error code is in *errno*. `0` is returned from successful tests.

The user and group IDs with respect to which permission is checked are the real UID and GID of the process, so this call is useful to set-UID programs.

Notice that it is only access bits that are checked. A directory may be announced as writable by *access*, but an attempt to open it for writing will fail (although files may be created there); a file may look executable, but *exec* will fail unless it is in proper format.

**SEE ALSO**

stat(2)

**ASSEMBLER**

(access = 33.)

```
sys access; name; mode
```

**NAME**

acct – turn accounting on or off

**SYNOPSIS**

```
acct(file)
char *file;
```

**DESCRIPTION**

The system is prepared to write a record in an accounting *file* for each process as it terminates. This call, with a null-terminated string naming an existing file as argument, turns on accounting; records for each terminating process are appended to *file*. An argument of 0 causes accounting to be turned off.

The accounting file format is given in *acct(5)*.

**SEE ALSO**

acct(5), sa(1)

**DIAGNOSTICS**

On error –1 is returned. The file must exist and the call may be exercised only by the super-user. It is erroneous to try to turn on accounting when it is already on.

**BUGS**

No accounting is produced for programs running when a crash occurs. In particular nonterminating programs are never accounted for.

**ASSEMBLER**

```
(acct = 51.)
sys acct; file
```

**NAME**

alarm – schedule signal after specified time

**SYNOPSIS**

**alarm(seconds)**  
**unsigned seconds;**

**DESCRIPTION**

*Alarm* causes signal SIGALRM, see *signal(2)*, to be sent to the invoking process in a number of seconds given by the argument. Unless caught or ignored, the signal terminates the process.

Alarm requests are not stacked; successive calls reset the alarm clock. If the argument is 0, any alarm request is cancelled. Because the clock has a 1-second resolution, the signal may occur up to one second early; because of scheduling delays, resumption of execution of when the signal is caught may be delayed an arbitrary amount. The longest specifiable delay time is 65535 seconds.

The return value is the amount of time previously remaining in the alarm clock.

**SEE ALSO**

pause(2), signal(2), sleep(3)

**ASSEMBLER**

(alarm = 27.)

(seconds in r0)

**sys alarm**

(previous amount in r0)

**NAME**

*brk*, *sbrk*, *break* – change core allocation

**SYNOPSIS**

**char \*brk(addr)**

**char \*sbrk(incr)**

**DESCRIPTION**

*Brk* sets the system's idea of the lowest location not used by the program (called the break) to *addr* (rounded up to the next multiple of 64 bytes on the PDP11, 256 bytes on the Interdata 8/32, 512 bytes on the VAX-11/780). Locations not less than *addr* and below the stack pointer are not in the address space and will thus cause a memory violation if accessed.

In the alternate function *sbrk*, *incr* more bytes are added to the program's data space and a pointer to the start of the new area is returned.

When a program begins execution via *exec* the break is set at the highest location defined by the program and data storage areas. Ordinarily, therefore, only programs with growing data areas need to use *break*.

**SEE ALSO**

*exec*(2), *malloc*(3), *end*(3)

**DIAGNOSTICS**

Zero is returned if the break could be set; -1 if the program requests more memory than the system limit or if too many segmentation registers would be required to implement the break.

**BUGS**

Setting the break in the range 0177701 to 0177777 (on the PDP11) is the same as setting it to zero.

**ASSEMBLER**

(break = 17.)

**sys break; addr**

*Break* performs the function of *brk*. The name of the routine differs from that in C for historical reasons.

**NAME**

chdir, chroot – change default directory

**SYNOPSIS**

**chdir(dirname)**

**char \*dirname;**

**chroot(dirname)**

**char \*dirname;**

**DESCRIPTION**

*Dirname* is the address of the pathname of a directory, terminated by a null byte. *Chdir* causes this directory to become the current working directory, the starting point for path names not beginning with '/'.

*Chroot* sets the root directory, the starting point for path names beginning with '/'. The call is restricted to the super-user.

**SEE ALSO**

cd(1)

**DIAGNOSTICS**

Zero is returned if the directory is changed; -1 is returned if the given name is not that of a directory or is not searchable.

**ASSEMBLER**

(chdir = 12.)

**sys chdir; dirname**

(chroot = 61.)

**sys chroot; dirname**



**NAME**

chmod – change mode of file

**SYNOPSIS**

```
chmod(name, mode)
char *name;
```

**DESCRIPTION**

The file whose name is given as the null-terminated string pointed to by *name* has its mode changed to *mode*. Modes are constructed by ORing together some combination of the following:

- 04000 set user ID on execution
- 02000 set group ID on execution
- 01000 save text image after execution
- 00400 read by owner
- 00200 write by owner
- 00100 execute (search on directory) by owner
- 00070 read, write, execute (search) by group
- 00007 read, write, execute (search) by others

If an executable file is set up for sharing (`-n` or `-i` option of *ld(1)*) then mode 1000 prevents the system from abandoning the swap-space image of the program-text portion of the file when its last user terminates. Thus when the next user of the file executes it, the text need not be read from the file system but can simply be swapped in, saving time. Ability to set this bit is restricted to the super-user since swap space is consumed by the images; it is only worth while for heavily used commands.

Only the owner of a file (or the super-user) may change the mode. Only the super-user can set the 1000 mode.

**SEE ALSO**

chmod(1)

**DIAGNOSTIC**

Zero is returned if the mode is changed; `-1` is returned if *name* cannot be found or if current user is neither the owner of the file nor the super-user.

**ASSEMBLER**

(chmod = 15.)

```
sys chmod; name; mode
```

**NAME**

chown – change owner and group of a file

**SYNOPSIS**

```
chown(name, owner, group)  
char *name;
```

**DESCRIPTION**

The file whose name is given by the null-terminated string pointed to by *name* has its *owner* and *group* changed as specified. Only the super-user may execute this call, because if users were able to give files away, they could defeat the (nonexistent) file-space accounting procedures.

**SEE ALSO**

chown(1), passwd(5)

**DIAGNOSTICS**

Zero is returned if the owner is changed; -1 is returned on illegal owner changes.

**ASSEMBLER**

(chown = 16.)

```
sys chown; name; owner; group
```

**NAME**

close – close a file

**SYNOPSIS**

**close(fildes)**

**DESCRIPTION**

Given a file descriptor such as returned from an *open*, *creat*, *dup* or *pipe(2)* call, *close* closes the associated file. A close of all files is automatic on *exit*, but since there is a limit on the number of open files per process, *close* is necessary for programs which deal with many files.

Files are closed upon termination of a process, and certain file descriptors may be closed by *exec(2)* (see *ioctl(2)*).

**SEE ALSO**

*creat(2)*, *open(2)*, *pipe(2)*, *exec(2)*, *ioctl(2)*

**DIAGNOSTICS**

Zero is returned if a file is closed; -1 is returned for an unknown file descriptor.

**ASSEMBLER**

(close = 6.)

(file descriptor in r0)

**sys close**

**NAME**

`creat` – create a new file

**SYNOPSIS**

```
creat(name, mode)  
char *name;
```

**DESCRIPTION**

*Creat* creates a new file or prepares to rewrite an existing file called *name*, given as the address of a null-terminated string. If the file did not exist, it is given mode *mode*, as modified by the process's mode mask (see *umask(2)*). Also see *chmod(2)* for the construction of the *mode* argument.

If the file did exist, its mode and owner remain unchanged but it is truncated to 0 length.

The file is also opened for writing, and its file descriptor is returned.

The *mode* given is arbitrary; it need not allow writing. This feature is used by programs which deal with temporary files of fixed names. The creation is done with a mode that forbids writing. Then if a second instance of the program attempts a *creat*, an error is returned and the program knows that the name is unusable for the moment.

**SEE ALSO**

*write(2)*, *close(2)*, *chmod(2)*, *umask(2)*

**DIAGNOSTICS**

The value `-1` is returned if: a needed directory is not searchable; the file does not exist and the directory in which it is to be created is not writable; the file does exist and is unwritable; the file is a directory; there are already too many files open.

**ASSEMBLER**

(`creat = 8.`)

```
sys creat; name; mode
```

(file descriptor in `r0`)

**NAME**

`dup`, `dup2` – duplicate an open file descriptor

**SYNOPSIS**

**dup**(*fildes*)

**int** *fildes*;

**dup2**(*fildes*, *fildes2*)

**int** *fildes*, *fildes2*;

**DESCRIPTION**

Given a file descriptor returned from an *open*, *pipe*, or *creat* call, *dup* allocates another file descriptor synonymous with the original. The new file descriptor is returned.

In the second form of the call, *fildes* is a file descriptor referring to an open file, and *fildes2* is a non-negative integer less than the maximum value allowed for file descriptors (approximately 19). *Dup2* causes *fildes2* to refer to the same file as *fildes*. If *fildes2* already referred to an open file, it is closed first.

**SEE ALSO**

`creat(2)`, `open(2)`, `close(2)`, `pipe(2)`

**DIAGNOSTICS**

The value `-1` is returned if: the given file descriptor is invalid; there are already too many open files.

**ASSEMBLER**

(`dup = 41.`)

(file descriptor in `r0`)

(new file descriptor in `r1`)

**sys dup**

(file descriptor in `r0`)

The *dup2* entry is implemented by adding 0100 to *fildes*.

**NAME**

execl, execv, execl, execve, execlp, execvp, exec, exece, environ – execute a file

**SYNOPSIS**

```
execl(name, arg0, arg1, ..., argn, 0)
char *name, *arg0, *arg1, ..., *argn;

execv(name, argv)
char *name, *argv[ ];

execl(name, arg0, arg1, ..., argn, 0, envp)
char *name, *arg0, *arg1, ..., *argn, *envp[ ];

execve(name, argv, envp);
char *name, *argv[ ], *envp[ ];

extern char **environ;
```

**DESCRIPTION**

*Exec* in all its forms overlays the calling process with the named file, then transfers to the entry point of the core image of the file. There can be no return from a successful *exec*; the calling core image is lost.

Files remain open across *exec* unless explicit arrangement has been made; see *ioctl(2)*. Ignored signals remain ignored across these calls, but signals that are caught (see *signal(2)*) are reset to their default values.

Each user has a *real* user ID and group ID and an *effective* user ID and group ID. The real ID identifies the person using the system; the effective ID determines his access privileges. *Exec* changes the effective user and group ID to the owner of the executed file if the file has the 'set-user-ID' or 'set-group-ID' modes. The real user ID is not affected.

The *name* argument is a pointer to the name of the file to be executed. The pointers *arg[0]*, *arg[1]* ... address null-terminated strings. Conventionally *arg[0]* is the name of the file.

From C, two interfaces are available. *Execl* is useful when a known file with known arguments is being called; the arguments to *execl* are the character strings constituting the file and the arguments; the first argument is conventionally the same as the file name (or its last component). A 0 argument must end the argument list.

The *execv* version is useful when the number of arguments is unknown in advance; the arguments to *execv* are the name of the file to be executed and a vector of strings containing the arguments. The last argument string must be followed by a 0 pointer.

When a C program is executed, it is called as follows:

```
main(argc, argv, envp)
int argc;
char **argv, **envp;
```

where *argc* is the argument count and *argv* is an array of character pointers to the arguments themselves. As indicated, *argc* is conventionally at least one and the first member of the array points to a string containing the name of the file.

*Argv* is directly usable in another *execv* because *argv[argc]* is 0.

*Envp* is a pointer to an array of strings that constitute the *environment* of the process. Each string consists of a name, an "=", and a null-terminated value. The array of pointers is terminated by a null pointer. The shell *sh(1)* passes an environment entry for each global shell variable defined when the program is called. See *environ(5)* for some conventionally used names. The C run-time start-off routine places a copy of *envp* in the global cell *environ*, which is used by *execv* and *execl* to pass the environment to any subprograms executed by the current program. The *exec* routines use lower-level routines as follows to pass an environment explicitly:

```

execle(file, arg0, arg1, . . . , argn, 0, environ);
execve(file, argv, environ);

```

*execlp* and *execvp* are called with the same arguments as *execl* and *execv*, but duplicate the shell's actions in searching for an executable file in a list of directories. The directory list is obtained from the environment.

#### FILES

/bin/sh shell, invoked if command file found by *execlp* or *execvp*

#### SEE ALSO

fork(2), environ(5)

#### DIAGNOSTICS

If the file cannot be found, if it is not executable, if it does not start with a valid magic number (see *a.out*(5)), if maximum memory is exceeded, or if the arguments require too much space, a return constitutes the diagnostic; the return value is  $-1$ . Even for the super-user, at least one of the execute-permission bits must be set for a file to be executed.

#### BUGS

If *execvp* is called to execute a file that turns out to be a shell command file, and if it is impossible to execute the shell, the values of *argv[0]* and *argv[-1]* will be modified before return.

#### ASSEMBLER

(exec = 11.)

**sys exec; name; argv**

(exece = 59.)

**sys exece; name; argv; envp**

Plain *exec* is obsoleted by *exece*, but remains for historical reasons.

When the called file starts execution on the PDP11, the stack pointer points to a word containing the number of arguments. Just above this number is a list of pointers to the argument strings, followed by a null pointer, followed by the pointers to the environment strings and then another null pointer. The strings themselves follow; a 0 word is left at the very top of memory.

```

sp→  nargs
      arg0
      ...
      argn
      0
      env0
      ...
      envm
      0
arg0: <arg0\0>
      ...
env0: <env0\0>
      0

```

On the Interdata 8/32, the stack begins at a conventional place (currently 0xD0000) and grows upwards. After *exec*, the layout of data on the stack is as follows.

```

      int    0
arg0:  byte  ...
      ...
argp0: int    arg0
      ...

```

```
    int    0
envp0: int  env0
    ...
    int    0
%2→ space 40
    int    nargs
    int    argp0
    int    envp0
%3→
```

This arrangement happens to conform well to C calling conventions.



**NAME**

exit – terminate process

**SYNOPSIS**

**exit(status)**

**int status;**

**\_exit(status)**

**int status;**

**DESCRIPTION**

*Exit* is the normal means of terminating a process. *Exit* closes all the process's files and notifies the parent process if it is executing a *wait*. The low-order 8 bits of *status* are available to the parent process.

This call can never return.

The C function *exit* may cause cleanup actions before the final 'sys exit'. The function *\_exit* circumvents all cleanup.

**SEE ALSO**

wait(2)

**ASSEMBLER**

(exit = 1.)

(status in r0)

**sys exit**

**NAME**

fork – spawn new process

**SYNOPSIS**

**fork()**

**DESCRIPTION**

*Fork* is the only way new processes are created. The new process's core image is a copy of that of the caller of *fork*. The only distinction is the fact that the value returned in the old (parent) process contains the process ID of the new (child) process, while the value returned in the child is 0. Process ID's range from 1 to 30,000. This process ID is used by *wait(2)*.

Files open before the fork are shared, and have a common read-write pointer. In particular, this is the way that standard input and output files are passed and also how pipes are set up.

**SEE ALSO**

*wait(2)*, *exec(2)*

**DIAGNOSTICS**

Returns -1 and fails to create a process if: there is inadequate swap space, the user is not super-user and has too many processes, or the system's process table is full. Only the super-user can take the last process-table slot.

**ASSEMBLER**

(fork = 2.)

**sys fork**

(new process return)

(old process return, new process ID in r0)

The return locations in the old and new process differ by one word. The C-bit is set in the old process if a new process could not be created.

**NAME**

getpid – get process identification

**SYNOPSIS**

**getpid()**

**DESCRIPTION**

*Getpid* returns the process ID of the current process. Most often it is used to generate uniquely-named temporary files.

**SEE ALSO**

mktemp(3)

**ASSEMBLER**

(getpid = 20.)

**sys getpid**

(pid in r0)

**NAME**

getuid, getgid, geteuid, getegid – get user and group identity

**SYNOPSIS**

**getuid( )**

**geteuid( )**

**getgid( )**

**getegid( )**

**DESCRIPTION**

*Getuid* returns the real user ID of the current process, *geteuid* the effective user ID. The real user ID identifies the person who is logged in, in contradistinction to the effective user ID, which determines his access permission at the moment. It is thus useful to programs which operate using the 'set user ID' mode, to find out who invoked them.

*Getgid* returns the real group ID, *getegid* the effective group ID.

**SEE ALSO**

setuid(2)

**ASSEMBLER**

(getuid = 24.)

**sys getuid**

(real user ID in r0, effective user ID in r1)

(getgid = 47.)

**sys getgid**

(real group ID in r0, effective group ID in r1)

**NAME**

*indir* – indirect system call

**ASSEMBLER**

(*indir* = 0.)

**sys *indir*; call**

The system call at the location *call* is executed. Execution resumes after the *indir* call.

The main purpose of *indir* is to allow a program to store arguments in system calls and execute them out of line in the data segment. This preserves the purity of the text segment.

If *indir* is executed indirectly, it is a no-op. If the instruction at the indirect location is not a system call, *indir* returns error code EINVAL; see *intro(2)*.

**NAME**

*ioctl*, *stty*, *gtty* – control device

**SYNOPSIS**

```
#include <sgtty.h>

ioctl(fildes, request, argp)
struct sgttyb *argp;

stty(fildes, argp)
struct sgttyb *argp;

gtty(fildes, argp)
struct sgttyb *argp;
```

**DESCRIPTION**

*ioctl* performs a variety of functions on character special files (devices). The writeups of various devices in section 4 discuss how *ioctl* applies to them.

For certain status setting and status inquiries about terminal devices, the functions *stty* and *gtty* are equivalent to

```
ioctl(fildes, TIOCSETP, argp)
ioctl(fildes, TIOCGETP, argp)
```

respectively; see *tty*(4).

The following two calls, however, apply to any open file:

```
ioctl(fildes, FIOCLEX, NULL);
ioctl(fildes, FIONCLEX, NULL);
```

The first causes the file to be closed automatically during a successful *exec* operation; the second reverses the effect of the first.

**SEE ALSO**

*stty*(1), *tty*(4), *exec*(2)

**DIAGNOSTICS**

Zero is returned if the call was successful; -1 if the file descriptor does not refer to the kind of file for which it was intended.

**BUGS**

Strictly speaking, since *ioctl* may be extended in different ways to devices with different properties, *argp* should have an open-ended declaration like

```
union { struct sgttyb ...; ... } *argp;
```

The important thing is that the size is fixed by 'struct sgttyb'.

**ASSEMBLER**

```
(ioctl = 54.)
sys ioctl; fildes; request; argp

(stty = 31.)
(file descriptor in r0)
stty; argp

(gtty = 32.)
(file descriptor in r0)
sys gtty; argp
```

**NAME**

kill – send signal to a process

**SYNOPSIS**

**kill(pid, sig);**

**DESCRIPTION**

*Kill* sends the signal *sig* to the process specified by the process number in *r0*. See *signal(2)* for a list of signals.

The sending and receiving processes must have the same effective user ID, otherwise this call is restricted to the super-user.

If the process number is 0, the signal is sent to all other processes in the sender's process group; see *tty(4)*.

If the process number is -1, and the user is the super-user, the signal is broadcast universally except to processes 0 and 1, the scheduler and initialization processes, see *init(8)*.

Processes may send signals to themselves.

**SEE ALSO**

signal(2), kill(1)

**DIAGNOSTICS**

Zero is returned if the process is killed; -1 is returned if the process does not have the same effective user ID and the user is not super-user, or if the process does not exist.

**ASSEMBLER**

(kill = 37.)

(process number in *r0*)

**sys kill; sig**

**NAME**

link – link to a file

**SYNOPSIS**

```
link(name1, name2)
char *name1, *name2;
```

**DESCRIPTION**

A link to *name1* is created; the link has the name *name2*. Either name may be an arbitrary path name.

**SEE ALSO**

ln(1), unlink(2)

**DIAGNOSTICS**

Zero is returned when a link is made; -1 is returned when *name1* cannot be found; when *name2* already exists; when the directory of *name2* cannot be written; when an attempt is made to link to a directory by a user other than the super-user; when an attempt is made to link to a file on another file system; when a file has too many links.

**ASSEMBLER**

(link = 9.)

```
sys link; name1; name2
```



**NAME**

lock – lock a process in primary memory

**SYNOPSIS**

**lock(flag)**

**DESCRIPTION**

If the *flag* argument is non-zero, the process executing this call will not be swapped except if it is required to grow. If the argument is zero, the process is *unlocked*. This call may only be executed by the super-user.

**BUGS**

*Locked* processes interfere with the compaction of primary memory and can cause deadlock. This system call is not considered a permanent part of the system.

**ASSEMBLER**

(lock = 53.)

**sys lock; flag**

**NAME**

`lseek`, `tell` – move read/write pointer

**SYNOPSIS**

**long lseek(*fildev*, *offset*, *whence*)**

**long offset;**

**long tell(*fildev*)**

**DESCRIPTION**

The file descriptor refers to a file open for reading or writing. The read (resp. write) pointer for the file is set as follows:

If *whence* is 0, the pointer is set to *offset* bytes.

If *whence* is 1, the pointer is set to its current location plus *offset*.

If *whence* is 2, the pointer is set to the size of the file plus *offset*.

The returned value is the resulting pointer location.

The obsolete function `tell(fildev)` is identical to `lseek(fildev, 0L, 1)`.

Seeking far beyond the end of a file, then writing, creates a gap or 'hole', which occupies no physical space and reads as zeros.

**SEE ALSO**

`open(2)`, `creat(2)`, `fseek(3)`

**DIAGNOSTICS**

-1 is returned for an undefined file descriptor, seek on a pipe, or seek to a position before the beginning of file.

**BUGS**

`Lseek` is a no-op on character special files.

**ASSEMBLER**

(`lseek` = 19.)

(file descriptor in `r0`)

**sys `lseek`; `offset1`; `offset2`; `whence`**

*Offset1* and *offset2* are the high and low words of *offset*; `r0` and `r1` contain the pointer upon return.

**NAME**

`mknod` – make a directory or a special file

**SYNOPSIS**

```
mknod(name, mode, addr)  
char *name;
```

**DESCRIPTION**

*Mknod* creates a new file whose name is the null-terminated string pointed to by *name*. The mode of the new file (including directory and special file bits) is initialized from *mode*. (The protection part of the mode is modified by the process's mode mask; see *umask(2)*). The first block pointer of the i-node is initialized from *addr*. For ordinary files and directories *addr* is normally zero. In the case of a special file, *addr* specifies which special file.

*Mknod* may be invoked only by the super-user.

**SEE ALSO**

`mkdir(1)`, `mknod(1)`, `filsys(5)`

**DIAGNOSTICS**

Zero is returned if the file has been made; `-1` if the file already exists or if the user is not the super-user.

**ASSEMBLER**

(`mknod = 14`.)

```
sys mknod; name; mode; addr
```

**NAME**

mount, umount – mount or remove file system

**SYNOPSIS**

**mount(special, name, rwflag)**

**char \*special, \*name;**

**umount(special)**

**char \*special;**

**DESCRIPTION**

*Mount* announces to the system that a removable file system has been mounted on the block-structured special file *special*; from now on, references to file *name* will refer to the root file on the newly mounted file system. *Special* and *name* are pointers to null-terminated strings containing the appropriate path names.

*Name* must exist already. *Name* must be a directory (unless the root of the mounted file system is not a directory). Its old contents are inaccessible while the file system is mounted.

The *rwflag* argument determines whether the file system can be written on; if it is 0 writing is allowed, if non-zero no writing is done. Physically write-protected and magnetic tape file systems must be mounted read-only or errors will occur when access times are updated, whether or not any explicit write is attempted.

*Umount* announces to the system that the *special* file is no longer to contain a removable file system. The associated file reverts to its ordinary interpretation.

**SEE ALSO**

mount(1)

**DIAGNOSTICS**

*Mount* returns 0 if the action occurred; -1 if *special* is inaccessible or not an appropriate file; if *name* does not exist; if *special* is already mounted; if *name* is in use; or if there are already too many file systems mounted.

*Umount* returns 0 if the action occurred; -1 if if the special file is inaccessible or does not have a mounted file system, or if there are active files in the mounted file system.

**ASSEMBLER**

(mount = 21.)

**sys mount; special; name; rwflag**

(umount = 22.)

**sys umount; special**

**NAME**

`mpx` – create and manipulate multiplexed files

**SYNOPSIS**

```
mpx(name, access) char *name;
join(fd, xd)
chan(xd)
extract(i, xd)
attach(i, xd)
detach(i, xd)
connect(fd, cd, end)
npgrp(i, xd, pgrp)
ckill(i, xd, signal)
#include <sys/mx.h>
mpxcall(cmd, vec)
int *vec;
```

**DESCRIPTION**

**mpxcall(cmd, vec)** is the system call shared by the library routines described below. *Cmd* selects a command using values defined in *<sys/mx.h>*. *Vec* is the address of a structure containing the arguments for the command.

**mpx(name, access)**

*Mpx* creates and opens the file *name* with access permission *access* (see *creat(2)*) and returns a file descriptor available for reading and writing. A *-1* is returned if the file cannot be created, if *name* already exists, or if the file table or other operating system data structures are full. The file descriptor is required for use with other routines.

If *name* designates a null string, a file descriptor is returned as described but no entry is created in the file system.

Once created an *mpx* file may be opened (see *open(2)*) by any process. This provides a form of inter-process communication whereby a process B can ‘call’ process A by opening an *mpx* file created by A. To B, the file is ordinary with one exception: the *connect* primitive could be applied to it. Otherwise the functions described below are used only in process A and descendants that inherit the open *mpx* file.

When a process opens an *mpx* file, the owner of the file receives a control message when the file is next read. The method for ‘answering’ this kind of call involves using *attach* and *detach* as described in more detail below.

Once B has opened A’s *mpx* file it is said to have a *channel* to A. A channel is a pair of data streams: in this case, one from B to A and the other from A to B. Several processes may open the same *mpx* file yielding multiple channels within the one *mpx* file. By accessing the appropriate channel, A can communicate with B and any others. When A reads (see *read(2)*) from the *mpx* file data written to A by the other processes appears in A’s buffer using a record format described in *mpxio(5)*. When A writes (see *write(2)*) on its *mpx* file the data must be formatted in a similar way.

The following commands are used to manipulate *mpx* files and channels.

*join*– adds a new channel on an *mpx* file to an open file F. I/O on the new channel is I/O on F.

*chan*– creates a new channel.

*extract*– file descriptor maintenance.

*connect*– similar to *join* except that the open file F is connected to an existing channel.

*attach* and *detach*— used with call protocol.

*npgrp*— manipulates process group numbers so that a channel can act as a control terminal (see *tty(4)*).

*ckill*— send signal (see *signal(2)*) to process group through channel.

A maximum of 15 channels may be connected to an mpx file. They are numbered 0 through 14. *Join* may be used to make one mpx file appear as a channel on another mpx file. A hierarchy or tree of mpx files may be set up in this way. In this case one of the mpx files must be the root of a tree where the other mpx files are interior nodes. The maximum depth of such a tree is 4.

An *index* is a 16-bit value that denotes a location in an mpx tree other than the root: the path through mpx 'nodes' from the root to the location is expressed as a sequence of 4-bit nibbles. The branch taken at the root is represented by the low-order 4-bits of an index. Each succeeding branch is specified by the next higher-order nibble. If the length of a path to be expressed is less than 4, then the illegal channel number, 15, must be used to terminate the sequence. This is not strictly necessary for the simple case of a tree consisting of only a root node: its channels can be expressed by the numbers 0 through 14. An index *i* and file descriptor *xd* for the root of an mpx tree are required as arguments to most of the commands described below. Indices also serve as channel identifiers in the record formats given in *mpxio(5)*. Since -1 is not a valid index, it can be returned as a error indication by subroutines that normally return indices.

The operating system informs the process managing an mpx file of changes in the status of channels attached to the file by generating messages that are read along with data from the channels. The form and content of these messages is described in *mpxio(5)*.

**join(*fd*, *xd*)** establishes a connection (channel) between an mpx file and another object. *Fd* is an open file descriptor for a character device or an mpx file and *xd* is the file descriptor of an mpx file. *Join* returns the index for the new channel if the operation succeeds and -1 if it does not.

Following *join*, *fd* may still be used in any system call that would have been meaningful before the join operation. Thus a process can read and write directly to *fd* as well as access it via *xd*. If the number of channels required for a tree of mpx files exceeds the number of open files permitted a process by the operating system, some of the file descriptors can be released using the standard *close(2)* call. Following a close on an active file descriptor for a channel or internal mpx node, that object may still be accessed through the root of the tree.

**chan(*xd*)** allocates a channel and connects one end of it to the mpx file represented by file descriptor *xd*. *Chan* returns the index of the new channel or a -1 indicating failure. The *extract* primitive can be used to get a non-multiplexed file descriptor for the free end of a channel created by *chan*.

Both *chan* and *join* operate on the mpx file specified by *xd*. File descriptors for interior nodes of an mpx tree must be preserved or reconstructed with *extract* for use with *join* or *chan*. For the remaining commands described here, *xd* denotes the file descriptor for the root of an mpx tree.

**Extract(*i*, *xd*)** returns a file descriptor for the object with index *i* on the mpx tree with root file descriptor *xd*. A -1 is returned by *extract* if a file descriptor is not available or if the arguments do not refer to an existing channel and mpx file.

**attach(*i*, *xd*)**

**detach(*i*, *xd*)**. If a process A has created an mpx file represented by file descriptor *xd*, then a process B can open (see *open(2)*) the mpx file. The purpose is to establish a channel between A and B through the mpx file. *Attach* and *Detach* are used by A to respond to such opens.

An open request by B fails immediately if a new channel cannot be allocated on the mpx file, if the mpx file does not exist, or if it does exist but there is no process (A) with a multiplexed file descriptor for the mpx file (i.e. *xd* as returned by *mpx(2)*). Otherwise a channel with index number *i* is allocated. The next time A reads on file descriptor *xd*, the WATCH control message (see *mpxio(5)*) will be delivered on channel *i*. A responds to this message with *attach* or *detach*. The former causes the open to

complete and return a file descriptor to B. The latter deallocates channel *i* and causes the open to fail.

One mpx file may be placed in 'listener' mode. This is done by writing `ioctl(xd, MXLSTN, 0)` where *xd* is an mpx file descriptor and MXLSTN is defined in `/usr/include/sgtty.h`. The semantics of listener mode are that all file names discovered by `open(2)` to have the syntax `system!pathname` (see `uucp(1)`) are treated as opens on the mpx file. The operating system sends the listener process an OPEN message (see `mpxio(5)`) which includes the file name being opened. `Attach` and `detach` then apply as described above.

`Detach` has two other uses: it closes and releases the resources of any active channel it is applied to, and should be used to respond to a CLOSE message (see `mpxio(5)`) on a channel so the channel may be reused.

**connect(*fd*, *cd*, *end*).** *Fd* is a character file descriptor and *cd* is a file descriptor for a channel, such as might be obtained via `extract( chan(xd), xd)` or by `open(2)` followed by `attach`. `Connect` splices the two streams together. If *end* is negative, only the output of *fd* is spliced to the input of *cd*. If *end* is positive, the output of *cd* is spliced to the input of *fd*. If *end* is zero, then both splices are made.

**npgrp(*i*, *xd*, *pgrp*).** If *xd* is negative `npgrp` applies to the process executing it, otherwise *i* and *xd* are interpreted as a channel index and mpx file descriptor and `npgrp` is applied to the process on the non-multiplexed end of the channel. If *pgrp* is zero, the process group number of the indicated process is set to the process number of that process, otherwise the value of *pgrp* is used as the process group number.

`Npgrp` normally returns the new process group number. If *i* and *xd* specify a nonexistent channel, `npgrp` returns `-1`.

**ckill(*i*, *xd*, *signal*).** `ckill` sends the specified signal (see `signal(2)`) through the channel specified by *i* and *xd*. If the channel is connected to anything other than a process, `ckill` is a null operation. If there is a process at the other end of the channel, the process group will be interrupted (see `signal(2)`, `kill(2)`). `Ckill` normally returns `signal`. If *ch* and *xd* specify a nonexistent channel, `ckill` returns `-1`.

#### FILES

`/usr/include/sys/mx.h`  
`/usr/include/sgtty.h`

#### SEE ALSO

`mpxio(5)`

#### BUGS

Mpx files are an experimental part of the operating system more subject to change and prone to bugs than other parts. Maintenance programs, e.g. `icheck(1)`, diagnose mpx files as an illegal mode. Channels may only be connected to objects in the operating system that are accessible through the line discipline mechanism. Higher performance line disciplines are needed. The maximum tree depth restriction is not really checked. A non-destructive `disconnect` primitive (inverse of `connect`) is not provided. A non-blocking flow control strategy based on messages defined in `mpxio(5)` should not be attempted by novices; the enabling `ioctl` command should be protected. The `join` operation could be subsumed by `connect`. A mechanism is needed for moving a channel from one location in an mpx tree to another.

**NAME**

mpxcall – multiplexor and channel interface

**SYNOPSIS**

**mpxcall(arg1, arg2, arg3, cmd)**

**DESCRIPTION**

*Mpxcall* supplies a primitive interface to the kernel used by the routines listed below. Each routine that uses *mpxcall* passes an integer *cmd* as the fourth argument. These are defined in */usr/include/mx.h*. *Mpxcall* always returns an integer which is to be interpreted in accordance with the definition of *cmd*.

**SEE ALSO**

group(2), join(2), extract(2), connect(2), chan(2), attach(2), detach(2)

**DIAGNOSTICS**

The value -1 is returned on error.



**NAME**

nice – set program priority

**SYNOPSIS**

**nice(incr)**

**DESCRIPTION**

The scheduling priority of the process is augmented by *incr*. Positive priorities get less service than normal. Priority 10 is recommended to users who wish to execute long-running programs without flak from the administration.

Negative increments are ignored except on behalf of the super-user. The priority is limited to the range –20 (most urgent) to 20 (least).

The priority of a process is passed to a child process by *fork(2)*. For a privileged process to return to normal priority from an unknown state, *nice* should be called successively with arguments –40 (goes to priority –20 because of truncation), 20 (to get to 0), then 0 (to maintain compatibility with previous versions of this call).

**SEE ALSO**

nice(1)

**ASSEMBLER**

(nice = 34.)

(priority in r0)

**sys nice**

**NAME**

open – open for reading or writing

**SYNOPSIS**

```
open(name, mode)
char *name;
```

**DESCRIPTION**

*Open* opens the file *name* for reading (if *mode* is 0), writing (if *mode* is 1) or for both reading and writing (if *mode* is 2). *Name* is the address of a string of ASCII characters representing a path name, terminated by a null character.

The file is positioned at the beginning (byte 0). The returned file descriptor must be used for subsequent calls for other input-output functions on the file.

**SEE ALSO**

creat(2), read(2), write(2), dup(2), close(2)

**DIAGNOSTICS**

The value  $-1$  is returned if the file does not exist, if one of the necessary directories does not exist or is unreadable, if the file is not readable (resp. writable), or if too many files are open.

**ASSEMBLER**

(open = 5.)

**sys open; name; mode**

(file descriptor in r0)

**NAME**

pause – stop until signal

**SYNOPSIS**

**pause( )**

**DESCRIPTION**

*Pause* never returns normally. It is used to give up control while waiting for a signal from *kill(2)* or *alarm(2)*.

**SEE ALSO**

kill(1), kill(2), alarm(2), signal(2), setjmp(3)

**ASSEMBLER**

(pause = 29.)

**sys pause**

**NAME**

`phys` – allow a process to access physical addresses

**SYNOPSIS**

`phys(segreg, size, physadr)`

**DESCRIPTION**

The argument *segreg* specifies a process virtual (data-space) address range of 8K bytes starting at virtual address *segreg*×8K bytes. This address range is mapped into physical address *physadr*×64 bytes. Only the first *size*×64 bytes of this mapping is addressable. If *size* is zero, any previous mapping of this virtual address range is nullified. For example, the call

```
phys(6, 1, 0177775);
```

will map virtual addresses 0160000-0160077 into physical addresses 017777500-017777577. In particular, virtual address 0160060 is the PDP-11 console located at physical address 017777560.

This call may only be executed by the super-user.

**SEE ALSO**

PDP-11 segmentation hardware

**DIAGNOSTICS**

The function value zero is returned if the physical mapping is in effect. The value -1 is returned if not super-user, if *segreg* is not in the range 0-7, if *size* is not in the range 0-127, or if the specified *segreg* is already used for other than a previous call to *phys*.

**BUGS**

This system call is obviously very machine dependent and very dangerous. This system call is not considered a permanent part of the system.

**ASSEMBLER**

(`phys = 52.`)

`sys phys; segreg; size; physadr`

**NAME**

pipe – create an interprocess channel

**SYNOPSIS**

```
pipe(fildes)  
int fildes[2];
```

**DESCRIPTION**

The *pipe* system call creates an I/O mechanism called a pipe. The file descriptors returned can be used in read and write operations. When the pipe is written using the descriptor *fildes*[1] up to 4096 bytes of data are buffered before the writing process is suspended. A read using the descriptor *fildes*[0] will pick up the data. Writes with a count of 4096 bytes or less are atomic; no other process can intersperse data.

It is assumed that after the pipe has been set up, two (or more) cooperating processes (created by subsequent *fork* calls) will pass data through the pipe with *read* and *write* calls.

The Shell has a syntax to set up a linear array of processes connected by pipes.

Read calls on an empty pipe (no buffered data) with only one end (all write file descriptors closed) returns an end-of-file.

**SEE ALSO**

sh(1), read(2), write(2), fork(2)

**DIAGNOSTICS**

The function value zero is returned if the pipe was created; -1 if too many files are already open. A signal is generated if a write on a pipe with only one end is attempted.

**BUGS**

Should more than 4096 bytes be necessary in any pipe among a loop of processes, deadlock will occur.

**ASSEMBLER**

(pipe = 42.)

**sys pipe**

(read file descriptor in r0)

(write file descriptor in r1)

**NAME**

*pkon*, *pkoff* – establish packet protocol

**SYNOPSIS**

***pkon*(*fd*, *size*)**

***pkoff*(*fd*)**

**DESCRIPTION**

*Pkon* establishes packet protocol (see *pk*(4)) on the open character special file whose file descriptor is *fd*. *Size* is a desired packet size, a power of 2 in the range  $32 \leq \textit{size} \leq 4096$ . The size is negotiated with a remote packet driver, and a possibly smaller actual packet size is returned.

An asynchronous line used for packet communication should be in raw mode; see *tty*(4).

*Pkoff* turns off the packet driver on the channel whose file descriptor is *fd*.

**SEE ALSO**

*pk*(4), *pkopen*(3), *tty*(4), *signal*(2)

**DIAGNOSTICS**

*Pkon* returns -1 if *fd* does not describe an open file, or if packet communication cannot be established.

*Pkoff* returns -1 for an unknown file descriptor.

Writing on a packet driver link that has been shut down by *close* or *pkoff* at the other end raises signal SIGPIPE in the writing process.

**NAME**

profil – execution time profile

**SYNOPSIS**

```
profil(buff, bufsiz, offset, scale)  
char *buff;  
int bufsiz, offset, scale;
```

**DESCRIPTION**

*Buff* points to an area of core whose length (in bytes) is given by *bufsiz*. After this call, the user's program counter (pc) is examined each clock tick (60th second); *offset* is subtracted from it, and the result multiplied by *scale*. If the resulting number corresponds to a word inside *buff*, that word is incremented.

The scale is interpreted as an unsigned, fixed-point fraction with binary point at the left: 0177777(8) gives a 1-1 mapping of pc's to words in *buff*; 077777(8) maps each pair of instruction words together. 02(8) maps all instructions onto the beginning of *buff* (producing a non-interrupting core clock).

Profiling is turned off by giving a *scale* of 0 or 1. It is rendered ineffective by giving a *bufsiz* of 0. Profiling is turned off when an *exec* is executed, but remains on in child and parent both after a *fork*. Profiling may be turned off if an update in *buff* would cause a memory fault.

**SEE ALSO**

monitor(3), prof(1)

**ASSEMBLER**

(profil = 44.)

```
sys profil; buff; bufsiz; offset; scale
```

**NAME**

ptrace – process trace

**SYNOPSIS**

```
#include <signal.h>
```

```
ptrace(request, pid, addr, data)  
int *addr;
```

**DESCRIPTION**

*Ptrace* provides a means by which a parent process may control the execution of a child process, and examine and change its core image. Its primary use is for the implementation of breakpoint debugging. There are four arguments whose interpretation depends on a *request* argument. Generally, *pid* is the process ID of the traced process, which must be a child (no more distant descendant) of the tracing process. A process being traced behaves normally until it encounters some signal whether internally generated like ‘illegal instruction’ or externally generated like ‘interrupt.’ See *signal(2)* for the list. Then the traced process enters a stopped state and its parent is notified via *wait(2)*. When the child is in the stopped state, its core image can be examined and modified using *ptrace*. If desired, another *ptrace* request can then cause the child either to terminate or to continue, possibly ignoring the signal.

The value of the *request* argument determines the precise action of the call:

- 0 This request is the only one used by the child process; it declares that the process is to be traced by its parent. All the other arguments are ignored. Peculiar results will ensue if the parent does not expect to trace the child.
- 1,2 The word in the child process’s address space at *addr* is returned. If I and D space are separated, request 1 indicates I space, 2 D space. *Addr* must be even. The child must be stopped. The input *data* is ignored.
- 3 The word of the system’s per-process data area corresponding to *addr* is returned. *Addr* must be even and less than 512. This space contains the registers and other information about the process; its layout corresponds to the *user* structure in the system.
- 4,5 The given *data* is written at the word in the process’s address space corresponding to *addr*, which must be even. No useful value is returned. If I and D space are separated, request 4 indicates I space, 5 D space. Attempts to write in pure procedure fail if another process is executing the same file.
- 6 The process’s system data is written, as it is read with request 3. Only a few locations can be written in this way: the general registers, the floating point status and registers, and certain bits of the processor status word.
- 7 The *data* argument is taken as a signal number and the child’s execution continues at location *addr* as if it had incurred that signal. Normally the signal number will be either 0 to indicate that the signal that caused the stop should be ignored, or that value fetched out of the process’s image indicating which signal caused the stop. If *addr* is (int \*)1 then execution continues from where it stopped.
- 8 The traced process terminates.
- 9 Execution continues as in request 7; however, as soon as possible after execution of at least one instruction, execution stops again. The signal number from the stop is SIGTRAP. (On the PDP-11 the T-bit is used and just one instruction is executed; on the Interdata the stop does not take place until a store instruction is executed.) This is part of the mechanism for implementing breakpoints.

As indicated, these calls (except for request 0) can be used only when the subject process has stopped. The *wait* call is used to determine when a process stops; in such a case the ‘termination’ status returned by *wait* has the value 0177 to indicate stoppage rather than genuine termination.



To forestall possible fraud, *ptrace* inhibits the set-user-id facility on subsequent *exec(2)* calls. If a traced process calls *exec*, it will stop before executing the first instruction of the new image showing signal SIGTRAP.

On the Interdata 8/32, 'word' means a 32-bit word and 'even' means 0 mod 4.

**SEE ALSO**

*wait(2)*, *signal(2)*, *adb(1)*

**DIAGNOSTICS**

The value  $-1$  is returned if *request* is invalid, *pid* is not a traceable process, *addr* is out of bounds, or *data* specifies an illegal signal number.

**BUGS**

On the Interdata 8/32, 'as soon as possible' (request 7) means 'as soon as a store instruction has been executed.'

The request 0 call should be able to specify signals which are to be treated normally and not cause a stop. In this way, for example, programs with simulated floating point (which use 'illegal instruction' signals at a very high rate) could be efficiently debugged.

The error indication,  $-1$ , is a legitimate function value; *errno*, see *intro(2)*, can be used to disambiguate.

It should be possible to stop a process on occurrence of a system call; in this way a completely controlled environment could be provided.

**ASSEMBLER**

(ptrace = 26.)

(data in r0)

**sys ptrace; pid; addr; request**

(value in r0)

**NAME**

read – read from file

**SYNOPSIS**

```
read(fildes, buffer, nbytes)
char *buffer;
```

**DESCRIPTION**

A file descriptor is a word returned from a successful *open*, *creat*, *dup*, or *pipe* call. *Buffer* is the location of *nbytes* contiguous bytes into which the input will be placed. It is not guaranteed that all *nbytes* bytes will be read; for example if the file refers to a typewriter at most one line will be returned. In any event the number of characters read is returned.

If the returned value is 0, then end-of-file has been reached.

**SEE ALSO**

open(2), creat(2), dup(2), pipe(2)

**DIAGNOSTICS**

As mentioned, 0 is returned when the end of the file has been reached. If the read was otherwise unsuccessful the return value is -1. Many conditions can generate an error: physical I/O errors, bad buffer address, preposterous *nbytes*, file descriptor not that of an input file.

**ASSEMBLER**

```
(read = 3.)
(file descriptor in r0)
sys read; buffer; nbytes
(byte count in r0)
```

**NAME**

setuid, setgid – set user and group ID

**SYNOPSIS**

**setuid(uid)**

**setgid(gid)**

**DESCRIPTION**

The user ID (group ID) of the current process is set to the argument. Both the effective and the real ID are set. These calls are only permitted to the super-user or if the argument is the real ID.

**SEE ALSO**

getuid(2)

**DIAGNOSTICS**

Zero is returned if the user (group) ID is set; -1 is returned otherwise.

**ASSEMBLER**

(setuid = 23.)

(user ID in r0)

**sys setuid**

(setgid = 46.)

(group ID in r0)

**sys setgid**

**NAME**

signal – catch or ignore signals

**SYNOPSIS**

```
#include <signal.h>

(*signal(sig, func))()
(*func());
```

**DESCRIPTION**

A signal is generated by some abnormal event, initiated either by user at a typewriter (quit, interrupt), by a program error (bus error, etc.), or by request of another program (kill). Normally all signals cause termination of the receiving process, but a *signal* call allows them either to be ignored or to cause an interrupt to a specified location. Here is the list of signals with names as in the include file.

|         |     |  |
|---------|-----|--|
| SIGHUP  | 1   | hangup   |
| SIGINT  | 2   | interrupt                                      |
| SIGQUIT | 3*  | quit   |
| SIGILL  | 4*  | illegal instruction (not reset when caught)    |
| SIGTRAP | 5*  | trace trap (not reset when caught)             |
| SIGIOT  | 6*  | IOT instruction                                |
| SIGEMT  | 7*  | EMT instruction                                |
| SIGFPE  | 8*  | floating point exception                       |
| SIGKILL | 9   | kill (cannot be caught or ignored)             |
| SIGBUS  | 10* | bus error                                      |
| SIGSEGV | 11* | segmentation violation                         |
| SIGSYS  | 12* | bad argument to system call                    |
| SIGPIPE | 13  | write on a pipe or link with no one to read it |
| SIGALRM | 14  | alarm clock                                    |
| SIGTERM | 15  | software termination signal                    |
|         | 16  | unassigned                                     |

The starred signals in the list above cause a core image if not caught or ignored.

If *func* is SIG\_DFL, the default action for signal *sig* is reinstated; this default is termination, sometimes with a core image. If *func* is SIG\_IGN the signal is ignored. Otherwise when the signal occurs *func* will be called with the signal number as argument. A return from the function will continue the process at the point it was interrupted. Except as indicated, a signal is reset to SIG\_DFL after being caught. Thus if it is desired to catch every such signal, the catching routine must issue another *signal* call.

When a caught signal occurs during certain system calls, the call terminates prematurely. In particular this can occur during a *read* or *write(2)* on a slow device (like a typewriter; but not a file); and during *pause* or *wait(2)*. When such a signal occurs, the saved user status is arranged in such a way that when return from the signal-catching takes place, it will appear that the system call returned an error status. The user's program may then, if it wishes, re-execute the call.

The value of *signal* is the previous (or initial) value of *func* for the particular signal.

After a *fork(2)* the child inherits all signals. *Exec(2)* resets all caught signals to default action.

**SEE ALSO**

kill(1), kill(2), ptrace(2), setjmp(3)

**DIAGNOSTICS**

The value (int)-1 is returned if the given signal is out of range.

**BUGS**

If a repeated signal arrives before the last one can be reset, there is no chance to catch it.

The type specification of the routine and its *func* argument are problematical.

**ASSEMBLER**

(signal = 48.)

**sys signal; sig; label**

(old label in r0)

If *label* is 0, default action is reinstated. If *label* is odd, the signal is ignored. Any other even *label* specifies an address in the process where an interrupt is simulated. An RTI or RTT instruction will return from the interrupt.

**NAME**

stat, fstat – get file status

**SYNOPSIS**

```
#include <sys/types.h>
```

```
#include <sys/stat.h>
```

```
stat(name, buf)
```

```
char *name;
```

```
struct stat *buf;
```

```
fstat(fildev, buf)
```

```
struct stat *buf;
```

**DESCRIPTION**

*Stat* obtains detailed information about a named file. *Fstat* obtains the same information about an open file known by the file descriptor from a successful *open*, *creat*, *dup* or *pipe(2)* call.

*Name* points to a null-terminated string naming a file; *buf* is the address of a buffer into which information is placed concerning the file. It is unnecessary to have any permissions at all with respect to the file, but all directories leading to the file must be searchable. The layout of the structure pointed to by *buf* as defined in *<stat.h>* is given below. *St\_mode* is encoded according to the ‘#define’ statements.

```
struct stat
{
    dev_t    st_dev;
    ino_t    st_ino;
    unsigned short  st_mode;
    short    st_nlink;
    short    st_uid;
    short    st_gid;
    dev_t    st_rdev;
    off_t    st_size;
    time_t   st_atime;
    time_t   st_mtime;
    time_t   st_ctime;
};

#define S_IFMT 0170000 /* type of file */
#define S_IFDIR 0040000 /* directory */
#define S_IFCHR 0020000 /* character special */
#define S_IFBLK 0060000 /* block special */
#define S_IFREG 0100000 /* regular */
#define S_IFIFO 0010000 /* fifo */
#define S_ISUID 04000 /* set user id on execution */
#define S_ISGID 02000 /* set group id on execution */
#define S_ISVTX 01000 /* save swapped text even after use */
#define S_IREAD 00400 /* read permission, owner */
#define S_IWRITE 00200 /* write permission, owner */
#define S_IEXEC 00100 /* execute/search permission, owner */
```

The mode bits 0000070 and 0000007 encode group and others permissions (see *chmod(2)*). The defined types, *ino\_t*, *off\_t*, *time\_t*, name various width integer values; *dev\_t* encodes major and minor device numbers; their exact definitions are in the include file *<sys/types.h>* (see *types(5)*).

When *fildev* is associated with a pipe, *fstat* reports an ordinary file with restricted permissions. The size is the number of bytes queued in the pipe.

*st\_atime* is the file was last read. For reasons of efficiency, it is not set when a directory is searched, although this would be more logical. *st\_mtime* is the time the file was last written or created. It is not set by changes of owner, group, link count, or mode. *st\_ctime* is set both both by writing and changing the i-node.

**SEE ALSO**

ls(1), filsys(5)

**DIAGNOSTICS**

Zero is returned if a status is available; -1 if the file cannot be found.

**ASSEMBLER**

(stat = 18.)

**sys stat; name; buf**

(fstat = 28.)

(file descriptor in r0)

**sys fstat; buf**

**NAME**

stime – set time

**SYNOPSIS**

```
stime(tp)  
long *tp;
```

**DESCRIPTION**

*Stime* sets the system's idea of the time and date. Time, pointed to by *tp*, is measured in seconds from 0000 GMT Jan 1, 1970. Only the super-user may use this call.

**SEE ALSO**

date(1), time(2), ctime(3)

**DIAGNOSTICS**

Zero is returned if the time was set; -1 if user is not the super-user.

**ASSEMBLER**

```
(stime = 25.)  
(time in r0-r1)  
sys stime
```



**NAME**

sync – update super-block

**SYNOPSIS**

**sync()**

**DESCRIPTION**

*Sync* causes all information in core memory that should be on disk to be written out. This includes modified super blocks, modified i-nodes, and delayed block I/O.

It should be used by programs which examine a file system, for example *icheck*, *df*, etc. It is mandatory before a boot.

**SEE ALSO**

sync(1), update(8)

**BUGS**

The writing, although scheduled, is not necessarily complete upon return from *sync*.

**ASSEMBLER**

(sync = 36.)

**sys sync**

**NAME**

time, ftime – get date and time

**SYNOPSIS**

**long time(0)**

**long time(tloc)**

**long \*tloc;**

**#include <sys/types.h>**

**#include <sys/timeb.h>**

**ftime(tp)**

**struct timeb \*tp;**

**DESCRIPTION**

*Time* returns the time since 00:00:00 GMT, Jan. 1, 1970, measured in seconds.

If *tloc* is nonnull, the return value is also stored in the place to which *tloc* points.

The *ftime* entry fills in a structure pointed to by its argument, as defined by *<sys/timeb.h>*:

```
/*
 * Structure returned by ftime system call
 */
struct timeb
{
    time_t    time;
    unsigned short millitm;
    short     timezone;
    short     dstflag;
};
```

The structure contains the time since the epoch in seconds, up to 1000 milliseconds of more-precise interval, the local timezone (measured in minutes of time westward from Greenwich), and a flag that, if nonzero, indicates that Daylight Saving time applies locally during the appropriate part of the year.

**SEE ALSO**

date(1), stime(2), ctime(3)

**ASSEMBLER**

(ftime = 35.)

**sys ftime; bufptr**

(time = 13.; obsolete call)

**sys time**

(time since 1970 in r0-r1)

**NAME**

times – get process times

**SYNOPSIS**

```
times(buffer)  
struct tbuffer *buffer;
```

**DESCRIPTION**

*Times* returns time-accounting information for the current process and for the terminated child processes of the current process. All times are in 1/HZ seconds, where HZ=60 in North America.

After the call, the buffer will appear as follows:

```
struct tbuffer {  
    long    proc_user_time;  
    long    proc_system_time;  
    long    child_user_time;  
    long    child_system_time;  
};
```

The children times are the sum of the children's process times and their children's times.

**SEE ALSO**

time(1), time(2)

**ASSEMBLER**

```
(times = 43.)  
sys times; buffer
```

**NAME**

umask – set file creation mode mask

**SYNOPSIS**

**umask(complmode)**

**DESCRIPTION**

*Umask* sets a mask used whenever a file is created by *creat(2)* or *mknod(2)*: the actual mode (see *chmod(2)*) of the newly-created file is the logical **and** of the given mode and the complement of the argument. Only the low-order 9 bits of the mask (the protection bits) participate. In other words, the mask shows the bits to be turned off when files are created.

The previous value of the mask is returned by the call. The value is initially 0 (no restrictions). The mask is inherited by child processes.

**SEE ALSO**

*creat(2)*, *mknod(2)*, *chmod(2)*

**ASSEMBLER**

(umask = 60.)

**sys umask; complmode**

**NAME**

unlink – remove directory entry

**SYNOPSIS**

```
unlink(name)  
char *name;
```

**DESCRIPTION**

*Name* points to a null-terminated string. *Unlink* removes the entry for the file pointed to by *name* from its directory. If this entry was the last link to the file, the contents of the file are freed and the file is destroyed. If, however, the file was open in any process, the actual destruction is delayed until it is closed, even though the directory entry has disappeared.

**SEE ALSO**

rm(1), link(2)

**DIAGNOSTICS**

Zero is normally returned; -1 indicates that the file does not exist, that its directory cannot be written, or that the file contains pure procedure text that is currently in use. Write permission is not required on the file itself. It is also illegal to unlink a directory (except for the super-user).

**ASSEMBLER**

(unlink = 10.)

```
sys unlink; name
```

**NAME**

utime – set file times

**SYNOPSIS**

```
#include <sys/types.h>
utime(file, timep)
char *file;
time_t timep[2];
```

**DESCRIPTION**

The *utime* call uses the ‘accessed’ and ‘updated’ times in that order from the *timep* vector to set the corresponding recorded times for *file*.

The caller must be the owner of the file or the super-user. The ‘inode-changed’ time of the file is set to the current time.

**SEE ALSO**

stat (2)

**ASSEMBLER**

(utime = 30.)

**sys utime; file; timep**

**NAME**

wait – wait for process to terminate

**SYNOPSIS**

**wait(status)**

**int \*status;**

**wait(0)**

**DESCRIPTION**

*Wait* causes its caller to delay until a signal is received or one of its child processes terminates. If any child has died since the last *wait*, return is immediate; if there are no children, return is immediate with the error bit set (resp. with a value of  $-1$  returned). The normal return yields the process ID of the terminated child. In the case of several children several *wait* calls are needed to learn of all the deaths.

If (int)*status* is nonzero, the high byte of the word pointed to receives the low byte of the argument of *exit* when the child terminated. The low byte receives the termination status of the process. See *signal(2)* for a list of termination statuses (signals); 0 status indicates normal termination. A special status (0177) is returned for a stopped process which has not terminated and can be restarted. See *ptrace(2)*. If the 0200 bit of the termination status is set, a core image of the process was produced by the system.

If the parent process terminates without waiting on its children, the initialization process (process ID = 1) inherits the children.

**SEE ALSO**

*exit(2)*, *fork(2)*, *signal(2)*

**DIAGNOSTICS**

Returns  $-1$  if there are no children not previously waited for.

**ASSEMBLER**

(wait = 7.)

**sys wait**

(process ID in r0)

(status in r1)

The high byte of the status is the low byte of r0 in the child at termination.

**NAME**

write – write on a file

**SYNOPSIS**

```
write(fildes, buffer, nbytes)  
char *buffer;
```

**DESCRIPTION**

A file descriptor is a word returned from a successful *open*, *creat*, *dup*, or *pipe(2)* call.

*Buffer* is the address of *nbytes* contiguous bytes which are written on the output file. The number of characters actually written is returned. It should be regarded as an error if this is not the same as requested.

Writes which are multiples of 512 characters long and begin on a 512-byte boundary in the file are more efficient than any others.

**SEE ALSO**

creat(2), open(2), pipe(2)

**DIAGNOSTICS**

Returns -1 on error: bad descriptor, buffer address, or count; physical I/O errors.

**ASSEMBLER**

```
(write = 4.)  
(file descriptor in r0)  
sys write; buffer; nbytes  
(byte count in r0)
```



**NAME**

intro – introduction to library functions

**SYNOPSIS**

```
#include <stdio.h>
```

```
#include <math.h>
```

**DESCRIPTION**

This section describes functions that may be found in various libraries, other than those functions that directly invoke UNIX system primitives, which are described in section 2. Functions are divided into various libraries distinguished by the section number at the top of the page:

- (3) These functions, together with those of section 2 and those marked (3S), constitute library *libc*, which is automatically loaded by the C compiler *cc*(1) and the Fortran compiler *f77*(1). The link editor *ld*(1) searches this library under the ‘-lc’ option. Declarations for some of these functions may be obtained from include files indicated on the appropriate pages.
- (3M) These functions constitute the math library, *libm*. They are automatically loaded as needed by the Fortran compiler *f77*(1). The link editor searches this library under the ‘-lm’ option. Declarations for these functions may be obtained from the include file <math.h>.
- (3S) These functions constitute the ‘standard I/O package’, see *stdio*(3). These functions are in the library *libc* already mentioned. Declarations for these functions may be obtained from the include file <stdio.h>.
- (3X) Various specialized libraries have not been given distinctive captions. The files in which these libraries are found are named on the appropriate pages.

**FILES**

/lib/libc.a

/lib/libm.a, /usr/lib/libm.a (one or the other)

**SEE ALSO**

*stdio*(3), *nm*(1), *ld*(1), *cc*(1), *f77*(1), *intro*(2)

**DIAGNOSTICS**

Functions in the math library (3M) may return conventional values when the function is undefined for the given arguments or when the value is not representable. In these cases the external variable *errno* (see *intro*(2)) is set to the value EDOM or ERANGE. The values of EDOM and ERANGE are defined in the include file <math.h>.

**ASSEMBLER**

In assembly language these functions may be accessed by simulating the C calling sequence. For example, *ecvt*(3) might be called this way:

```
setd
mov    $sign,-(sp)
mov    $decpt,-(sp)
mov    ndigit,-(sp)
movf   value,-(sp)
jsr    pc,_ecvt
add    $14.,sp
```

**NAME**

abort – generate IOT fault

**DESCRIPTION**

*Abort* executes the PDP11 IOT instruction. This causes a signal that normally terminates the process with a core dump, which may be used for debugging.

**SEE ALSO**

adb(1), signal(2), exit(2)

**DIAGNOSTICS**

Usually 'IOT trap – core dumped' from the shell.

**NAME**

`abs` – integer absolute value

**SYNOPSIS**

**`abs(i)`**

**DESCRIPTION**

*Abs* returns the absolute value of its integer operand.

**SEE ALSO**

`floor(3)` for *fabs*

**BUGS**

You get what the hardware gives on the largest negative integer.

**NAME**

assert – program verification

**SYNOPSIS**

```
#include <assert.h>
```

```
assert (expression)
```

**DESCRIPTION**

*Assert* is a macro that indicates *expression* is expected to be true at this point in the program. It causes an *exit(2)* with a diagnostic comment on the standard output when *expression* is false (0). Compiling with the *cc(1)* option **-DNDEBUG** effectively deletes *assert* from the program.

**DIAGNOSTICS**

'Assertion failed: file *f* line *n*.' *F* is the source file and *n* the source line number of the *assert* statement.

**NAME**

*atof*, *atoi*, *atol* – convert ASCII to numbers

**SYNOPSIS**

**double** *atof*(*nptr*)

**char** \**nptr*;

**atoi**(*nptr*)

**char** \**nptr*;

**long** *atol*(*nptr*)

**char** \**nptr*;

**DESCRIPTION**

These functions convert a string pointed to by *nptr* to floating, integer, and long integer representation respectively. The first unrecognized character ends the string.

*Atof* recognizes an optional string of tabs and spaces, then an optional sign, then a string of digits optionally containing a decimal point, then an optional 'e' or 'E' followed by an optionally signed integer.

*Atoi* and *atol* recognize an optional string of tabs and spaces, then an optional sign, then a string of digits.

**SEE ALSO**

*scanf*(3)

**BUGS**

There are no provisions for overflow.

**NAME**

`crypt`, `setkey`, `encrypt` – DES encryption

**SYNOPSIS**

```
char *crypt(key, salt)
```

```
char *key, *salt;
```

```
setkey(key)
```

```
char *key;
```

```
encrypt(block, edflag)
```

```
char *block;
```

**DESCRIPTION**

*Crypt* is the password encryption routine. It is based on the NBS Data Encryption Standard, with variations intended (among other things) to frustrate use of hardware implementations of the DES for key search.

The first argument to *crypt* is a user's typed password. The second is a 2-character string chosen from the set [a-zA-Z0-9./]. The *salt* string is used to perturb the DES algorithm in one of 4096 different ways, after which the password is used as the key to encrypt repeatedly a constant string. The returned value points to the encrypted password, in the same alphabet as the salt. The first two characters are the salt itself.

The other entries provide (rather primitive) access to the actual DES algorithm. The argument of *setkey* is a character array of length 64 containing only the characters with numerical value 0 and 1. If this string is divided into groups of 8, the low-order bit in each group is ignored, leading to a 56-bit key which is set into the machine.

The argument to the *encrypt* entry is likewise a character array of length 64 containing 0's and 1's. The argument array is modified in place to a similar array representing the bits of the argument after having been subjected to the DES algorithm using the key set by *setkey*. If *edflag* is 0, the argument is encrypted; if non-zero, it is decrypted.

**SEE ALSO**

`passwd(1)`, `passwd(5)`, `login(1)`, `getpass(3)`

**BUGS**

The return value points to static data whose content is overwritten by each call.

**NAME**

ctime, localtime, gmtime, asctime, timezone – convert date and time to ASCII

**SYNOPSIS**

```
char *ctime(clock)
long *clock;

#include <time.h>

struct tm *localtime(clock)
long *clock;

struct tm *gmtime(clock)
long *clock;

char *asctime(tm)
struct tm *tm;

char *timezone(zone, dst)
```

**DESCRIPTION**

*Ctime* converts a time pointed to by *clock* such as returned by *time(2)* into ASCII and returns a pointer to a 26-character string in the following form. All the fields have constant width.

```
Sun Sep 16 01:03:52 1973\n\0
```

*Localtime* and *gmtime* return pointers to structures containing the broken-down time. *Localtime* corrects for the time zone and possible daylight savings time; *gmtime* converts directly to GMT, which is the time UNIX uses. *Asctime* converts a broken-down time to ASCII and returns a pointer to a 26-character string.

The structure declaration from the include file is:

```
struct tm { /* see ctime(3) */
    int tm_sec;
    int tm_min;
    int tm_hour;
    int tm_mday;
    int tm_mon;
    int tm_year;
    int tm_wday;
    int tm_yday;
    int tm_isdst;
};
```

These quantities give the time on a 24-hour clock, day of month (1-31), month of year (0-11), day of week (Sunday = 0), year – 1900, day of year (0-365), and a flag that is nonzero if daylight saving time is in effect.

When local time is called for, the program consults the system to determine the time zone and whether the standard U.S.A. daylight saving time adjustment is appropriate. The program knows about the peculiarities of this conversion in 1974 and 1975; if necessary, a table for these years can be extended.

*Timezone* returns the name of the time zone associated with its first argument, which is measured in minutes westward from Greenwich. If the second argument is 0, the standard name is used, otherwise the Daylight Saving version. If the required name does not appear in a table built into the routine, the difference from GMT is produced; e.g. in Afghanistan *timezone*(-60\*4+30, 0) is appropriate because it is 4:30 ahead of GMT and the string **GMT+4:30** is produced.

**SEE ALSO**

time(2)

**BUGS**

The return values point to static data whose content is overwritten by each call.



**NAME**

`isalpha`, `isupper`, `islower`, `isdigit`, `isalnum`, `isspace`, `ispunct`, `isprint`, `isctrl`, `isascii` – character classification

**SYNOPSIS**

```
#include <ctype.h>
```

```
isalpha(c)
```

```
...
```

**DESCRIPTION**

These macros classify ASCII-coded integer values by table lookup. Each is a predicate returning nonzero for true, zero for false. `isascii` is defined on all integer values; the rest are defined only where `isascii` is true and on the single non-ASCII value EOF (see `stdio(3)`).

*isalpha*            *c* is a letter

*isupper*           *c* is an upper case letter

*islower*           *c* is a lower case letter

*isdigit*            *c* is a digit

*isalnum*            *c* is an alphanumeric character

*isspace*            *c* is a space, tab, carriage return, newline, or formfeed

*ispunct*            *c* is a punctuation character (neither control nor alphanumeric)

*isprint*            *c* is a printing character, code 040(8) (space) through 0176 (tilde)

*isctrl*             *c* is a delete character (0177) or ordinary control character (less than 040).

*isascii*            *c* is an ASCII character, code less than 0200

**SEE ALSO**

`ascii(7)`

**NAME**

dbminit, fetch, store, delete, firstkey, nextkey – data base subroutines

**SYNOPSIS**

```
typedef struct { char *dptr; int dsize; } datum;
```

```
dbminit(file)
```

```
char *file;
```

```
datum fetch(key)
```

```
datum key;
```

```
store(key, content)
```

```
datum key, content;
```

```
delete(key)
```

```
datum key;
```

```
datum firstkey();
```

```
datum nextkey(key);
```

```
datum key;
```

**DESCRIPTION**

These functions maintain key/content pairs in a data base. The functions will handle very large (a billion blocks) databases and will access a keyed item in one or two filesystem accesses. The functions are obtained with the loader option **-ldbm**.

*Keys* and *contents* are described by the *datum* typedef. A *datum* specifies a string of *dsize* bytes pointed to by *dptr*. Arbitrary binary data, as well as normal ASCII strings, are allowed. The data base is stored in two files. One file is a directory containing a bit map and has *.dir* as its suffix. The second file contains all data and has *.pag* as its suffix.

Before a database can be accessed, it must be opened by *dbminit*. At the time of this call, the files *file.dir* and *file.pag* must exist. (An empty database is created by creating zero-length *.dir* and *.pag* files.)

Once open, the data stored under a key is accessed by *fetch* and data is placed under a key by *store*. A key (and its associated contents) is deleted by *delete*. A linear pass through all keys in a database may be made, in an (apparently) random order, by use of *firstkey* and *nextkey*. *Firstkey* will return the first key in the database. With any key *nextkey* will return the next key in the database. This code will traverse the data base:

```
for(key=firstkey(); key.dptr!=NULL; key=nextkey(key))
```

**DIAGNOSTICS**

All functions that return an *int* indicate errors with negative values. A zero return indicates ok. Routines that return a *datum* indicate errors with a null (0) *dptr*.

**BUGS**

The *.pag* file will contain holes so that its apparent size is about four times its actual content. Older UNIX systems may create real file blocks for these holes when touched. These files cannot be copied by normal means (cp, cat, tp, tar, ar) without filling in the holes.

*Dptr* pointers returned by these subroutines point into static storage that is changed by subsequent calls.

The sum of the sizes of a key/content pair must not exceed the internal block size (currently 512 bytes). Moreover all key/content pairs that hash together must fit on a single block. *Store* will return an error in the event that a disk block fills with inseparable data.

*Delete* does not physically reclaim file space, although it does make it available for reuse.

The order of keys presented by *firstkey* and *nextkey* depends on a hashing function, not on anything interesting.

**NAME**

*ecvt*, *fcvt*, *gcvt* – output conversion

**SYNOPSIS**

```
char *ecvt(value, ndigit, decpt, sign)
double value;
int ndigit, *decpt, *sign;

char *fcvt(value, ndigit, decpt, sign)
double value;
int ndigit, *decpt, *sign;

char *gcvt(value, ndigit, buf)
double value;
char *buf;
```

**DESCRIPTION**

*Ecvt* converts the *value* to a null-terminated string of *ndigit* ASCII digits and returns a pointer thereto. The position of the decimal point relative to the beginning of the string is stored indirectly through *decpt* (negative means to the left of the returned digits). If the sign of the result is negative, the word pointed to by *sign* is non-zero, otherwise it is zero. The low-order digit is rounded.

*Fcvt* is identical to *ecvt*, except that the correct digit has been rounded for Fortran F-format output of the number of digits specified by *ndigits*.

*Gcvt* converts the *value* to a null-terminated ASCII string in *buf* and returns a pointer to *buf*. It attempts to produce *ndigit* significant digits in Fortran F format if possible, otherwise E format, ready for printing. Trailing zeros may be suppressed.

**SEE ALSO**

`printf(3)`

**BUGS**

The return values point to static data whose content is overwritten by each call.

**NAME**

*end*, *etext*, *edata* – last locations in program

**SYNOPSIS**

```
extern end;  
extern etext;  
extern edata;
```

**DESCRIPTION**

These names refer neither to routines nor to locations with interesting contents. The address of *etext* is the first address above the program text, *edata* above the initialized data region, and *end* above the uninitialized data region.

When execution begins, the program break coincides with *end*, but many functions reset the program break, among them the routines of *brk(2)*, *malloc(3)*, standard input/output (*stdio(3)*), the profile (`-p`) option of *cc(1)*, etc. The current value of the program break is reliably returned by `'sbrk(0)'`, see *brk(2)*.

**SEE ALSO**

*brk(2)*, *malloc(3)*

**NAME**

*exp*, *log*, *log10*, *pow*, *sqrt* – exponential, logarithm, power, square root

**SYNOPSIS**

```
#include <math.h>
```

```
double exp(x)
```

```
double x;
```

```
double log(x)
```

```
double x;
```

```
double log10(x)
```

```
double x;
```

```
double pow(x, y)
```

```
double x, y;
```

```
double sqrt(x)
```

```
double x;
```

**DESCRIPTION**

*Exp* returns the exponential function of *x*.

*Log* returns the natural logarithm of *x*; *log10* returns the base 10 logarithm.

*Pow* returns  $x^y$ .

*Sqrt* returns the square root of *x*.

**SEE ALSO**

*hypot*(3), *sinh*(3), *intro*(2)

**DIAGNOSTICS**

*Exp* and *pow* return a huge value when the correct value would overflow; *errno* is set to ERANGE.

*Pow* returns 0 and sets *errno* to EDOM when the second argument is negative and non-integral and when both arguments are 0.

*Log* returns 0 when *x* is zero or negative; *errno* is set to EDOM.

*Sqrt* returns 0 when *x* is negative; *errno* is set to EDOM.

**NAME**

`fclose`, `fflush` – close or flush a stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
fclose(stream)
```

```
FILE *stream;
```

```
fflush(stream)
```

```
FILE *stream;
```

**DESCRIPTION**

*Fclose* causes any buffers for the named *stream* to be emptied, and the file to be closed. Buffers allocated by the standard input/output system are freed.

*Fclose* is performed automatically upon calling *exit*(2).

*Fflush* causes any buffered data for the named output *stream* to be written to that file. The stream remains open.

**SEE ALSO**

`close`(2), `fopen`(3), `setbuf`(3)

**DIAGNOSTICS**

These routines return **EOF** if *stream* is not associated with an output file, or if buffered data cannot be transferred to that file.

**NAME**

feof, ferror, clearerr, fileno – stream status inquiries

**SYNOPSIS**

```
#include <stdio.h>
```

```
feof(stream)
```

```
FILE *stream;
```

```
ferror(stream)
```

```
FILE *stream
```

```
clearerr(stream)
```

```
FILE *stream
```

```
fileno(stream)
```

```
FILE *stream;
```

**DESCRIPTION**

*Feof* returns non-zero when end of file is read on the named input *stream*, otherwise zero.

*Ferror* returns non-zero when an error has occurred reading or writing the named *stream*, otherwise zero. Unless cleared by *clearerr*, the error indication lasts until the stream is closed.

*Clrerr* resets the error indication on the named *stream*.

*Fileno* returns the integer file descriptor associated with the *stream*, see *open(2)*.

These functions are implemented as macros; they cannot be redeclared.

**SEE ALSO**

fopen(3), open(2)



**NAME**

*fabs*, *floor*, *ceil* – absolute value, floor, ceiling functions

**SYNOPSIS**

```
#include <math.h>
```

```
double floor(x)
```

```
double x;
```

```
double ceil(x)
```

```
double x;
```

```
double fabs(x)
```

```
double(x);
```

**DESCRIPTION**

*Fabs* returns the absolute value  $|x|$ .

*Floor* returns the largest integer not greater than  $x$ .

*Ceil* returns the smallest integer not less than  $x$ .

**SEE ALSO**

*abs*(3)

**NAME**

`fopen`, `freopen`, `fdopen` – open a stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
FILE *fopen(filename, type)
```

```
char *filename, *type;
```

```
FILE *freopen(filename, type, stream)
```

```
char *filename, *type;
```

```
FILE *stream;
```

```
FILE *fdopen(fildes, type)
```

```
char *type;
```

**DESCRIPTION**

*Fopen* opens the file named by *filename* and associates a stream with it. *Fopen* returns a pointer to be used to identify the stream in subsequent operations.

*Type* is a character string having one of the following values:

"r" open for reading

"w" create for writing

"a" append: open for writing at end of file, or create for writing

*Freopen* substitutes the named file in place of the open *stream*. It returns the original value of *stream*. The original stream is closed.

*Freopen* is typically used to attach the preopened constant names, **stdin**, **stdout**, **stderr**, to specified files.

*Fdopen* associates a stream with a file descriptor obtained from *open*, *dup*, *creat*, or *pipe(2)*. The *type* of the stream must agree with the mode of the open file.

**SEE ALSO**

`open(2)`, `fclose(3)`

**DIAGNOSTICS**

*Fopen* and *freopen* return the pointer **NULL** if *filename* cannot be accessed.

**BUGS**

*Fdopen* is not portable to systems other than UNIX.

**NAME**

*fread*, *fwrite* – buffered binary input/output

**SYNOPSIS**

```
#include <stdio.h>
```

```
fread(ptr, sizeof(*ptr), nitems, stream)
```

```
FILE *stream;
```

```
fwrite(ptr, sizeof(*ptr), nitems, stream)
```

```
FILE *stream;
```

**DESCRIPTION**

*Fread* reads, into a block beginning at *ptr*, *nitems* of data of the type of *\*ptr* from the named input *stream*. It returns the number of items actually read.

*Fwrite* appends at most *nitems* of data of the type of *\*ptr* beginning at *ptr* to the named output *stream*. It returns the number of items actually written.

**SEE ALSO**

*read*(2), *write*(2), *fopen*(3), *getc*(3), *putc*(3), *gets*(3), *puts*(3), *printf*(3), *scanf*(3)

**DIAGNOSTICS**

*Fread* and *fwrite* return 0 upon end of file or error.

**NAME**

*frexp*, *ldexp*, *modf* – split into mantissa and exponent

**SYNOPSIS**

**double frexp(value, eptr)**

**double value;**

**int \*eptr;**

**double ldexp(value, exp)**

**double value;**

**double modf(value, iptr)**

**double value, \*iptr;**

**DESCRIPTION**

*Frexp* returns the mantissa of a double *value* as a double quantity, *x*, of magnitude less than 1 and stores an integer *n* such that  $value = x * 2^{**n}$  indirectly through *eptr*.

*Ldexp* returns the quantity  $value * 2^{**exp}$ .

*Modf* returns the positive fractional part of *value* and stores the integer part indirectly through *iptr*.

**NAME**

`fseek`, `ftell`, `rewind` – reposition a stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
fseek(stream, offset, ptrname)
```

```
FILE *stream;
```

```
long offset;
```

```
long ftell(stream)
```

```
FILE *stream;
```

```
rewind(stream)
```

**DESCRIPTION**

*Fseek* sets the position of the next input or output operation on the *stream*. The new position is at the signed distance *offset* bytes from the beginning, the current position, or the end of the file, according as *ptrname* has the value 0, 1, or 2.

*Fseek* undoes any effects of *ungetc*(3).

*Ftell* returns the current value of the offset relative to the beginning of the file associated with the named *stream*. It is measured in bytes on UNIX; on some other systems it is a magic cookie, and the only foolproof way to obtain an *offset* for *fseek*.

*Rewind*(*stream*) is equivalent to *fseek*(*stream*, *OL*, 0).

**SEE ALSO**

`lseek`(2), `fopen`(3)

**DIAGNOSTICS**

*Fseek* returns -1 for improper seeks.

**NAME**

`getc`, `getchar`, `fgetc`, `getw` – get character or word from stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
int getc(stream)
```

```
FILE *stream;
```

```
int getchar()
```

```
int fgetc(stream)
```

```
FILE *stream;
```

```
int getw(stream)
```

```
FILE *stream;
```

**DESCRIPTION**

*Getc* returns the next character from the named input *stream*.

*Getchar()* is identical to *getc(stdin)*.

*Fgetc* behaves like *getc*, but is a genuine function, not a macro; it may be used to save object text.

*Getw* returns the next word from the named input *stream*. It returns the constant **EOF** upon end of file or error, but since that is a good integer value, *feof* and *ferror(3)* should be used to check the success of *getw*. *Getw* assumes no special alignment in the file.

**SEE ALSO**

`fopen(3)`, `putc(3)`, `gets(3)`, `scanf(3)`, `fread(3)`, `ungetc(3)`

**DIAGNOSTICS**

These functions return the integer constant **EOF** at end of file or upon read error.

A stop with message, 'Reading bad file', means an attempt has been made to read from a stream that has not been opened for reading by *fopen*.

**BUGS**

The end-of-file return from *getchar* is incompatible with that in UNIX editions 1-6.

Because it is implemented as a macro, *getc* treats a *stream* argument with side effects incorrectly. In particular, '`getc(*f++);`' doesn't work sensibly.

**NAME**

getenv – value for environment name

**SYNOPSIS**

```
char *getenv(name)
char *name;
```

**DESCRIPTION**

*Getenv* searches the environment list (see *environ(5)*) for a string of the form *name=value* and returns *value* if such a string is present, otherwise 0 (NULL).

**SEE ALSO**

*environ(5)*, *exec(2)*

**NAME**

getgrent, getgrgid, getgrnam, setgrent, endgrent – get group file entry

**SYNOPSIS**

```
#include <grp.h>

struct group *getgrent();
struct group *getgrgid(gid) int gid;
struct group *getgrnam(name) char *name;
int setgrent();
int endgrent();
```

**DESCRIPTION**

*Getgrent*, *getgrgid* and *getgrnam* each return pointers to an object with the following structure containing the broken-out fields of a line in the group file.

```
struct group { /* see getgrent(3) */
    char *gr_name;
    char *gr_passwd;
    int gr_gid;
    char **gr_mem;
};
```

The members of this structure are:

*gr\_name*

The name of the group.

*gr\_passwd*

The encrypted password of the group.

*gr\_gid* The numerical group-ID.

*gr\_mem*

Null-terminated vector of pointers to the individual member names.

*Getgrent* simply reads the next line while *getgrgid* and *getgrnam* search until a matching *gid* or *name* is found (or until EOF is encountered). Each routine picks up where the others leave off so successive calls may be used to search the entire file.

A call to *setgrent* has the effect of rewinding the group file to allow repeated searches. *Endgrent* may be called to close the group file when processing is complete.

**FILES**

/etc/group

**SEE ALSO**

getlogin(3), getpwent(3), group(5)

**DIAGNOSTICS**

A null pointer (0) is returned on EOF or error.

**BUGS**

All information is contained in a static area so it must be copied if it is to be saved.



**NAME**

getlogin – get login name

**SYNOPSIS**

```
char *getlogin();
```

**DESCRIPTION**

*Getlogin* returns a pointer to the login name as found in */etc/utmp*. It may be used in conjunction with *getpwnam* to locate the correct password file entry when the same userid is shared by several login names.

If *getlogin* is called within a process that is not attached to a typewriter, it returns NULL. The correct procedure for determining the login name is to first call *getlogin* and if it fails, to call *getpwuid*.

**FILES**

*/etc/utmp*

**SEE ALSO**

*getpwent(3)*, *getgrent(3)*, *utmp(5)*

**DIAGNOSTICS**

Returns NULL (0) if name not found.

**BUGS**

The return values point to static data whose content is overwritten by each call.

**NAME**

getpass – read a password

**SYNOPSIS**

```
char *getpass(prompt)
char *prompt;
```

**DESCRIPTION**

*Getpass* reads a password from the file */dev/tty*, or if that cannot be opened, from the standard input, after prompting with the null-terminated string *prompt* and disabling echoing. A pointer is returned to a null-terminated string of at most 8 characters.

**FILES**

*/dev/tty*

**SEE ALSO**

crypt(3)

**BUGS**

The return value points to static data whose content is overwritten by each call.

**NAME**

getpw – get name from UID

**SYNOPSIS**

```
getpw(uid, buf)
char *buf;
```

**DESCRIPTION**

*Getpw* searches the password file for the (numerical) *uid*, and fills in *buf* with the corresponding line; it returns non-zero if *uid* could not be found. The line is null-terminated.

**FILES**

/etc/passwd

**SEE ALSO**

getpwent(3), passwd(5)

**DIAGNOSTICS**

Non-zero return on error.

**NAME**

getpwent, getpwuid, getpwnam, setpwent, endpwent – get password file entry

**SYNOPSIS**

```
#include <pwd.h>

struct passwd *getpwent();
struct passwd *getpwuid(uid) int uid;
struct passwd *getpwnam(name) char *name;
int setpwent();
int endpwent();
```

**DESCRIPTION**

*Getpwent*, *getpwuid* and *getpwnam* each return a pointer to an object with the following structure containing the broken-out fields of a line in the password file.

```
struct passwd { /* see getpwent(3) */
    char *pw_name;
    char *pw_passwd;
    int pw_uid;
    int pw_gid;
    int pw_quota;
    char *pw_age;
    char *pw_comment;
    char *pw_gecos;
    char *pw_dir;
    char *pw_shell;
};
```

The fields *pw\_quota* and *pw\_comment* are unused; the others have meanings described in *passwd(5)*.

*Getpwent* reads the next line (opening the file if necessary); *setpwent* rewinds the file; *endpwent* closes it.

*Getpwuid* and *getpwnam* search from the beginning until a matching *uid* or *name* is found (or until EOF is encountered).

**FILES**

/etc/passwd

**SEE ALSO**

getlogin(3), getgrent(3), passwd(5)

**DIAGNOSTICS**

Null pointer (0) returned on EOF or error.

**BUGS**

All information is contained in a static area so it must be copied if it is to be saved.

**NAME**

gets, fgets – get a string from a stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
char *gets(s)
```

```
char *s;
```

```
char *fgets(s, n, stream)
```

```
char *s;
```

```
FILE *stream;
```

**DESCRIPTION**

*Gets* reads a string into *s* from the standard input stream **stdin**. The string is terminated by a newline character, which is replaced in *s* by a null character. *Gets* returns its argument.

*Fgets* reads *n*–1 characters, or up to a newline character, whichever comes first, from the *stream* into the string *s*. The last character read into *s* is followed by a null character. *Fgets* returns its first argument.

**SEE ALSO**

puts(3), getc(3), scanf(3), fread(3), ferror(3)

**DIAGNOSTICS**

*Gets* and *fgets* return the constant pointer **NULL** upon end of file or error.

**BUGS**

*Gets* deletes a newline, *fgets* keeps it, all in the name of backward compatibility.

**NAME**

hypot, cabs – euclidean distance

**SYNOPSIS**

```
#include <math.h>
```

```
double hypot(x, y)
```

```
double x, y;
```

```
double cabs(z)
```

```
struct { double x, y; } z;
```

**DESCRIPTION**

*Hypot* and *cabs* return

$\sqrt{x*x + y*y}$ ,

taking precautions against unwarranted overflows.

**SEE ALSO**

exp(3) for *sqrt*

**NAME**

`j0`, `j1`, `jn`, `y0`, `y1`, `yn` – Bessel functions

**SYNOPSIS**

```
#include <math.h>
```

```
double j0(x)
```

```
double x;
```

```
double j1(x)
```

```
double x;
```

```
double jn(n, x);
```

```
double x;
```

```
double y0(x)
```

```
double x;
```

```
double y1(x)
```

```
double x;
```

```
double yn(n, x)
```

```
double x;
```

**DESCRIPTION**

These functions calculate Bessel functions of the first and second kinds for real arguments and integer orders.

**DIAGNOSTICS**

Negative arguments cause `y0`, `y1`, and `yn` to return a huge negative value and set `errno` to `EDOM`.

**NAME**

*l3tol*, *l3tol3* – convert between 3-byte integers and long integers

**SYNOPSIS**

***l3tol*(*lp*, *cp*, *n*)**

**long \**lp*;**

**char \**cp*;**

***l3tol3*(*cp*, *lp*, *n*)**

**char \**cp*;**

**long \**lp*;**

**DESCRIPTION**

*L3tol* converts a list of *n* three-byte integers packed into a character string pointed to by *cp* into a list of long integers pointed to by *lp*.

*L3tol3* performs the reverse conversion from long integers (*lp*) to three-byte integers (*cp*).

These functions are useful for file-system maintenance; disk addresses are three bytes long.

**SEE ALSO**

*filsys*(5)



**NAME**

malloc, free, realloc, calloc – main memory allocator

**SYNOPSIS**

**char \*malloc(size)**

**unsigned size;**

**free(ptr)**

**char \*ptr;**

**char \*realloc(ptr, size)**

**char \*ptr;**

**unsigned size;**

**char \*calloc(nelem, elsize)**

**unsigned nelem, elsize;**

**DESCRIPTION**

*Malloc* and *free* provide a simple general-purpose memory allocation package. *Malloc* returns a pointer to a block of at least *size* bytes beginning on a word boundary.

The argument to *free* is a pointer to a block previously allocated by *malloc*; this space is made available for further allocation, but its contents are left undisturbed.

Needless to say, grave disorder will result if the space assigned by *malloc* is overrun or if some random number is handed to *free*.

*Malloc* allocates the first big enough contiguous reach of free space found in a circular search from the last block allocated or freed, coalescing adjacent free blocks as it searches. It calls *sbrk* (see *break(2)*) to get more memory from the system when there is no suitable space already free.

*Realloc* changes the size of the block pointed to by *ptr* to *size* bytes and returns a pointer to the (possibly moved) block. The contents will be unchanged up to the lesser of the new and old sizes.

*Realloc* also works if *ptr* points to a block freed since the last call of *malloc*, *realloc* or *calloc*; thus sequences of *free*, *malloc* and *realloc* can exploit the search strategy of *malloc* to do storage compaction.

*Calloc* allocates space for an array of *nelem* elements of size *elsize*. The space is initialized to zeros.

Each of the allocation routines returns a pointer to space suitably aligned (after possible pointer coercion) for storage of any type of object.

**DIAGNOSTICS**

*Malloc*, *realloc* and *calloc* return a null pointer (0) if there is no available memory or if the arena has been detectably corrupted by storing outside the bounds of a block. *Malloc* may be recompiled to check the arena very stringently on every transaction; see the source code.

**BUGS**

When *realloc* returns 0, the block pointed to by *ptr* may be destroyed.

**NAME**

mktemp – make a unique file name

**SYNOPSIS**

```
char *mktemp(template)
char *template;
```

**DESCRIPTION**

*Mktemp* replaces *template* by a unique file name, and returns the address of the template. The template should look like a file name with six trailing X's, which will be replaced with the current process id and a unique letter.

**SEE ALSO**

getpid(2)

**NAME**

monitor – prepare execution profile

**SYNOPSIS**

```
monitor(lowpc, highpc, buffer, bufsize, nfunc)  
int (*lowpc)( ), (*highpc)( );  
short buffer[ ];
```

**DESCRIPTION**

An executable program created by 'cc -p' automatically includes calls for *monitor* with default parameters; *monitor* needn't be called explicitly except to gain fine control over profiling.

*Monitor* is an interface to *profil(2)*. *Lowpc* and *highpc* are the addresses of two functions; *buffer* is the address of a (user supplied) array of *bufsize* short integers. *Monitor* arranges to record a histogram of periodically sampled values of the program counter, and of counts of calls of certain functions, in the buffer. The lowest address sampled is that of *lowpc* and the highest is just below *highpc*. At most *nfunc* call counts can be kept; only calls of functions compiled with the profiling option **-p** of *cc(1)* are recorded. For the results to be significant, especially where there are small, heavily used routines, it is suggested that the buffer be no more than a few times smaller than the range of locations sampled.

To profile the entire program, it is sufficient to use

```
extern etext();  
...  
monitor((int)2, etext, buf, bufsize, nfunc);
```

*Etext* lies just above all the program text, see *end(3)*.

To stop execution monitoring and write the results on the file *mon.out*, use

```
monitor(0);
```

then *prof(1)* can be used to examine the results.

**FILES**

mon.out

**SEE ALSO**

prof(1), profil(2), cc(1)

**NAME**

*itom*, *madd*, *msub*, *mult*, *mdiv*, *min*, *mout*, *pow*, *gcd*, *rpow* – multiple precision integer arithmetic

**SYNOPSIS**

```
typedef struct { int len; short *val; } mint;
```

```
madd(a, b, c)
```

```
msub(a, b, c)
```

```
mult(a, b, c)
```

```
mdiv(a, b, q, r)
```

```
min(a)
```

```
mout(a)
```

```
pow(a, b, m, c)
```

```
gcd(a, b, c)
```

```
rpow(a, b, c)
```

```
msqrt(a, b, r)
```

```
mint *a, *b, *c, *m, *q, *r;
```

```
sdiv(a, n, q, r)
```

```
mint *a, *q;
```

```
short *r;
```

```
mint *itom(n)
```

**DESCRIPTION**

These routines perform arithmetic on integers of arbitrary length. The integers are stored using the defined type *mint*. Pointers to a *mint* should be initialized using the function *itom*, which sets the initial value to *n*. After that space is managed automatically by the routines.

*madd*, *msub*, *mult*, assign to their third arguments the sum, difference, and product, respectively, of their first two arguments. *mdiv* assigns the quotient and remainder, respectively, to its third and fourth arguments. *sdiv* is like *mdiv* except that the divisor is an ordinary integer. *msqrt* produces the square root and remainder of its first argument. *rpow* calculates *a* raised to the power *b*, while *pow* calculates this reduced modulo *m*. *min* and *mout* do decimal input and output.

The functions are obtained with the loader option *-lmp*.

**DIAGNOSTICS**

Illegal operations and running out of memory produce messages and core images.

**NAME**

nlist – get entries from name list

**SYNOPSIS**

```
#include <a.out.h>
nlist(filename, nl)
char *filename;
struct nlist nl[ ];
```

**DESCRIPTION**

*Nlist* examines the name list in the given executable output file and selectively extracts a list of values. The name list consists of an array of structures containing names, types and values. The list is terminated with a null name. Each name is looked up in the name list of the file. If the name is found, the type and value of the name are inserted in the next two fields. If the name is not found, both entries are set to 0. See *a.out(5)* for the structure declaration.

This subroutine is useful for examining the system name list kept in the file **/unix**. In this way programs can obtain system addresses that are up to date.

**SEE ALSO**

a.out(5)

**DIAGNOSTICS**

All type entries are set to 0 if the file cannot be found or if it is not a valid namelist.

**NAME**

`perror`, `sys_errlist`, `sys_nerr` – system error messages

**SYNOPSIS**

```
perror(s)  
char *s;  
  
int sys_nerr;  
char *sys_errlist[];
```

**DESCRIPTION**

*Perror* produces a short error message on the standard error file describing the last error encountered during a call to the system from a C program. First the argument string *s* is printed, then a colon, then the message and a new-line. Most usefully, the argument string is the name of the program which incurred the error. The error number is taken from the external variable *errno* (see *intro(2)*), which is set when errors occur but not cleared when non-erroneous calls are made.

To simplify variant formatting of messages, the vector of message strings *sys\_errlist* is provided; *errno* can be used as an index in this table to get the message string without the newline. *sys\_nerr* is the number of messages provided for in the table; it should be checked because new error codes may be added to the system before they are added to the table.

**SEE ALSO**

*intro(2)*

**NAME**

pkopen, pkclose, pkread, pkwrite, pkfail – packet driver simulator

**SYNOPSIS**

**char \*pkopen(fd)**

**pkclose(ptr)**

**char \*ptr;**

**pkread(ptr, buffer, count)**

**char \*ptr, \*buffer;**

**pkwrite(ptr, buffer, count)**

**char \*ptr, \*buffer;**

**pkfail()**

**DESCRIPTION**

These routines are a user-level implementation of the full-duplex end-to-end communication protocol described in *pk(4)*. If *fd* is a file descriptor open for reading and writing, *pkopen* carries out the initial synchronization and returns an identifying pointer. The pointer is used as the first parameter to *pkread*, *pkwrite*, and *pkclose*.

*Pkread*, *pkwrite* and *pkclose* behave analogously to *read*, *write* and *close(2)*. However, a write of zero bytes is meaningful and will produce a corresponding read of zero bytes.

**SEE ALSO**

pk(4), pkon(2)

**DIAGNOSTICS**

*Pkfail* is called upon persistent breakdown of communication. *Pkfail* must be supplied by the user.

*Pkopen* returns a null (0) pointer if packet protocol can not be established.

*Pkread* returns -1 on end of file, 0 in correspondence with a 0-length write.

**BUGS**

This simulation of *pk(4)* leaves something to be desired in needing special read and write routines, and in not being inheritable across calls of *exec(2)*. Its prime use is on systems that lack *pk*.

These functions use *alarm(2)*; simultaneous use of *alarm* for other purposes may cause trouble.

**NAME**

plot: openpl et al. – graphics interface

**SYNOPSIS**

**openpl**( )  
**erase**( )  
**label**(s) char s[ ];  
**line**(x1, y1, x2, y2)  
**circle**(x, y, r)  
**arc**(x, y, x0, y0, x1, y1)  
**move**(x, y)  
**cont**(x, y)  
**point**(x, y)  
**linemod**(s) char s[ ];  
**space**(x0, y0, x1, y1)  
**closepl**( )

**DESCRIPTION**

These subroutines generate graphic output in a relatively device-independent manner. See *plot(5)* for a description of their effect. *Openpl* must be used before any of the others to open the device for writing. *Closepl* flushes the output.

String arguments to *label* and *linemod* are null-terminated, and do not contain newlines.

Various flavors of these functions exist for different output devices. They are obtained by the following *ld(1)* options:

- lplot** device-independent graphics stream on standard output for *plot(1)* filters
- l300** GSI 300 terminal
- l300s** GSI 300S terminal
- l450** DASI 450 terminal
- l4014** Tektronix 4014 terminal

**SEE ALSO**

plot(5), plot(1), graph(1)



**NAME**

`popen`, `pclose` – initiate I/O to/from a process

**SYNOPSIS**

```
#include <stdio.h>
```

```
FILE *popen(command, type)
```

```
char *command, *type;
```

```
pclose(stream)
```

```
FILE *stream;
```

**DESCRIPTION**

The arguments to *popen* are pointers to null-terminated strings containing respectively a shell command line and an I/O mode, either "r" for reading or "w" for writing. It creates a pipe between the calling process and the command to be executed. The value returned is a stream pointer that can be used (as appropriate) to write to the standard input of the command or read from its standard output.

A stream opened by *popen* should be closed by *pclose*, which waits for the associated process to terminate and returns the exit status of the command.

Because open files are shared, a type "r" command may be used as an input filter, and a type "w" as an output filter.

**SEE ALSO**

`pipe(2)`, `fopen(3)`, `fclose(3)`, `system(3)`, `wait(2)`

**DIAGNOSTICS**

*Popen* returns a null pointer if files or processes cannot be created, or the Shell cannot be accessed.

*Pclose* returns -1 if *stream* is not associated with a 'popened' command.

**BUGS**

Buffered reading before opening an input filter may leave the standard input of that filter mispositioned. Similar problems with an output filter may be forestalled by careful buffer flushing, e.g. with *fflush*, see *fclose(3)*.

**NAME**

printf, fprintf, sprintf – formatted output conversion

**SYNOPSIS**

```
#include <stdio.h>
```

```
printf(format [, arg ] ... )
char *format;
```

```
fprintf(stream, format [, arg ] ... )
FILE *stream;
char *format;
```

```
sprintf(s, format [, arg ] ... )
char *s, format;
```

**DESCRIPTION**

*Printf* places output on the standard output stream *stdout*. *Fprintf* places output on the named output stream. *Sprintf* places ‘output’ in the string *s*, followed by the character ‘\0’.

Each of these functions converts, formats, and prints its arguments after the first under control of the first argument. The first argument is a character string which contains two types of objects: plain characters, which are simply copied to the output stream, and conversion specifications, each of which causes conversion and printing of the next successive *arg printf*.

Each conversion specification is introduced by the character **%**. Following the **%**, there may be

- an optional minus sign ‘-’ which specifies *left adjustment* of the converted value in the indicated field;
- an optional digit string specifying a *field width*; if the converted value has fewer characters than the field width it will be blank-padded on the left (or right, if the left-adjustment indicator has been given) to make up the field width; if the field width begins with a zero, zero-padding will be done instead of blank-padding;
- an optional period ‘.’ which serves to separate the field width from the next digit string;
- an optional digit string specifying a *precision* which specifies the number of digits to appear after the decimal point, for e- and f-conversion, or the maximum number of characters to be printed from a string;
- the character **l** specifying that a following **d**, **o**, **x**, or **u** corresponds to a long integer *arg*. (A capitalized conversion code accomplishes the same thing.)
- a character which indicates the type of conversion to be applied.

A field width or precision may be ‘\*’ instead of a digit string. In this case an integer *arg* supplies the field width or precision.

The conversion characters and their meanings are

- dox** The integer *arg* is converted to decimal, octal, or hexadecimal notation respectively.
- f** The float or double *arg* is converted to decimal notation in the style ‘[-]ddd.ddd’ where the number of d’s after the decimal point is equal to the precision specification for the argument. If the precision is missing, 6 digits are given; if the precision is explicitly 0, no digits and no decimal point are printed.
- e** The float or double *arg* is converted in the style ‘[-]d.ddde±dd’ where there is one digit before the decimal point and the number after is equal to the precision specification for the argument; when the precision is missing, 6 digits are produced.
- g** The float or double *arg* is printed in style **d**, in style **f**, or in style **e**, whichever gives full precision in minimum space.

- c** The character *arg* is printed. Null characters are ignored.
- s** *Arg* is taken to be a string (character pointer) and characters from the string are printed until a null character or until the number of characters indicated by the precision specification is reached; however if the precision is 0 or missing all characters up to a null are printed.
- u** The unsigned integer *arg* is converted to decimal and printed (the result will be in the range 0 to 65535).
- %** Print a '%'; no argument is converted.

In no case does a non-existent or small field width cause truncation of a field; padding takes place only if the specified field width exceeds the actual width. Characters generated by *printf* are printed by *putc(3)*.

**Examples**

To print a date and time in the form 'Sunday, July 3, 10:02', where *weekday* and *month* are pointers to null-terminated strings:

```
printf("%s, %s %d, %02d:%02d", weekday, month, day, hour, min);
```

To print  $\pi$  to 5 decimals:

```
printf("pi = %.5f", 4*atan(1.0));
```

**SEE ALSO**

*putc(3)*, *scanf(3)*, *ecvt(3)*

**BUGS**

Very wide fields (>128 characters) fail.

**NAME**

putc, putchar, fputc, putw – put character or word on a stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
int putc(c, stream)
```

```
char c;
```

```
FILE *stream;
```

```
putchar(c)
```

```
fputc(c, stream)
```

```
FILE *stream;
```

```
putw(w, stream)
```

```
FILE *stream;
```

**DESCRIPTION**

*Putc* appends the character *c* to the named output *stream*. It returns the character written.

*Putchar(c)* is defined as *putc(c, stdout)*.

*Fputc* behaves like *putc*, but is a genuine function rather than a macro. It may be used to save on object text.

*Putw* appends word (i.e. **int**) *w* to the output *stream*. It returns the word written. *Putw* neither assumes nor causes special alignment in the file.

The standard stream *stdout* is normally buffered if and only if the output does not refer to a terminal; this default may be changed by *setbuf(3)*. The standard stream *stderr* is by default unbuffered unconditionally, but use of *freopen* (see *fopen(3)*) will cause it to become buffered; *setbuf*, again, will set the state to whatever is desired. When an output stream is unbuffered information appears on the destination file or terminal as soon as written; when it is buffered many characters are saved up and written as a block. *Flush* (see *fclose(3)*) may be used to force the block out early.

**SEE ALSO**

*fopen(3)*, *fclose(3)*, *getc(3)*, *puts(3)*, *printf(3)*, *fread(3)*

**DIAGNOSTICS**

These functions return the constant **EOF** upon error. Since this is a good integer, *ferror(3)* should be used to detect *putw* errors.

**BUGS**

Because it is implemented as a macro, *putc* treats a *stream* argument with side effects improperly. In particular 'putc(c, \*f++);' doesn't work sensibly.

**NAME**

puts, fputs – put a string on a stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
puts(s)
```

```
char *s;
```

```
fputs(s, stream)
```

```
char *s;
```

```
FILE *stream;
```

**DESCRIPTION**

*Puts* copies the null-terminated string *s* to the standard output stream *stdout* and appends a newline character.

*Fputs* copies the null-terminated string *s* to the named output *stream*.

Neither routine copies the terminal null character.

**SEE ALSO**

fopen(3), gets(3), putc(3), printf(3), perror(3)

fread(3) for *fwrite*

**BUGS**

*Puts* appends a newline, *fputs* does not, all in the name of backward compatibility.

**NAME**

qsort – quicker sort

**SYNOPSIS**

```
qsort(base, nel, width, compar)  
char *base;  
int (*compar)( );
```

**DESCRIPTION**

*Qsort* is an implementation of the quicker-sort algorithm. The first argument is a pointer to the base of the data; the second is the number of elements; the third is the width of an element in bytes; the last is the name of the comparison routine to be called with two arguments which are pointers to the elements being compared. The routine must return an integer less than, equal to, or greater than 0 according as the first argument is to be considered less than, equal to, or greater than the second.

**SEE ALSO**

sort(1)

**NAME**

rand, srand – random number generator

**SYNOPSIS**

**srand(seed)**

**int seed;**

**rand( )**

**DESCRIPTION**

*Rand* uses a multiplicative congruential random number generator with period  $2^{32}$  to return successive pseudo-random numbers in the range from 0 to  $2^{15}-1$ .

The generator is reinitialized by calling *srand* with 1 as argument. It can be set to a random starting point by calling *srand* with whatever you like as argument.

**NAME**

scanf, fscanf, sscanf – formatted input conversion

**SYNOPSIS**

```
#include <stdio.h>

scanf(format [ , pointer ] . . . )
char *format;

fscanf(stream, format [ , pointer ] . . . )
FILE *stream;
char *format;

sscanf(s, format [ , pointer ] . . . )
char *s, *format;
```

**DESCRIPTION**

*Scanf* reads from the standard input stream *stdin*. *Fscanf* reads from the named input *stream*. *Sscanf* reads from the character string *s*. Each function reads characters, interprets them according to a format, and stores the results in its arguments. Each expects as arguments a control string *format*, described below, and a set of *pointer* arguments indicating where the converted input should be stored.

The control string usually contains conversion specifications, which are used to direct interpretation of input sequences. The control string may contain:

1. Blanks, tabs or newlines, which match optional white space in the input.
2. An ordinary character (not %) which must match the next character of the input stream.
3. Conversion specifications, consisting of the character %, an optional assignment suppressing character \*, an optional numerical maximum field width, and a conversion character.

A conversion specification directs the conversion of the next input field; the result is placed in the variable pointed to by the corresponding argument, unless assignment suppression was indicated by \*. An input field is defined as a string of non-space characters; it extends to the next inappropriate character or until the field width, if specified, is exhausted.

The conversion character indicates the interpretation of the input field; the corresponding pointer argument must usually be of a restricted type. The following conversion characters are legal:

- %** a single '%' is expected in the input at this point; no assignment is done.
- d** a decimal integer is expected; the corresponding argument should be an integer pointer.
- o** an octal integer is expected; the corresponding argument should be a integer pointer.
- x** a hexadecimal integer is expected; the corresponding argument should be an integer pointer.
- s** a character string is expected; the corresponding argument should be a character pointer pointing to an array of characters large enough to accept the string and a terminating '\0', which will be added. The input field is terminated by a space character or a newline.
- c** a character is expected; the corresponding argument should be a character pointer. The normal skip over space characters is suppressed in this case; to read the next non-space character, try '%1s'. If a field width is given, the corresponding argument should refer to a character array, and the indicated number of characters is read.
- e** a floating point number is expected; the next field is converted accordingly and stored through the corresponding argument, which should be a pointer to a *float*. The input format for floating point numbers is an optionally signed string of digits possibly containing a decimal point, followed by an optional exponent field consisting of an E or e followed by an optionally signed integer.
- [** indicates a string not to be delimited by space characters. The left bracket is followed by a set of characters and a right bracket; the characters between the brackets define a set of characters making



up the string. If the first character is not circumflex (^), the input field is all characters until the first character not in the set between the brackets; if the first character after the left bracket is ^, the input field is all characters until the first character which is in the remaining set of characters between the brackets. The corresponding argument must point to a character array.

The conversion characters **d**, **o** and **x** may be capitalized or preceded by **l** to indicate that a pointer to **long** rather than to **int** is in the argument list. Similarly, the conversion characters **e** or **f** may be capitalized or preceded by **l** to indicate a pointer to **double** rather than to **float**. The conversion characters **d**, **o** and **x** may be preceded by **h** to indicate a pointer to **short** rather than to **int**.

The *scanf* functions return the number of successfully matched and assigned input items. This can be used to decide how many input items were found. The constant **EOF** is returned upon end of input; note that this is different from 0, which means that no conversion was done; if conversion was intended, it was frustrated by an inappropriate character in the input.

For example, the call

```
int i; float x; char name[50];
scanf( "%d%f%s", &i, &x, name);
```

with the input line

```
25 54.32E-1 thompson
```

will assign to *i* the value 25, *x* the value 5.432, and *name* will contain 'thompson\0'. Or,

```
int i; float x; char name[50];
scanf("%2d%f%*d[1234567890]", &i, &x, name);
```

with input

```
56789 0123 56a72
```

will assign 56 to *i*, 789.0 to *x*, skip '0123', and place the string '56\0' in *name*. The next call to *getchar* will return 'a'.

#### SEE ALSO

atof(3), getc(3), printf(3)

#### DIAGNOSTICS

The *scanf* functions return **EOF** on end of input, and a short count for missing or illegal data items.

#### BUGS

The success of literal matches and suppressed assignments is not directly determinable.

**NAME**

setbuf – assign buffering to a stream

**SYNOPSIS**

```
#include <stdio.h>

setbuf(stream, buf)
FILE *stream;
char *buf;
```

**DESCRIPTION**

*Setbuf* is used after a stream has been opened but before it is read or written. It causes the character array *buf* to be used instead of an automatically allocated buffer. If *buf* is the constant pointer **NULL**, input/output will be completely unbuffered.

A manifest constant **BUFSIZ** tells how big an array is needed:

```
char buf[BUFSIZ];
```

A buffer is normally obtained from *malloc*(3) upon the first *getc* or *putc*(3) on the file, except that output streams directed to terminals, and the standard error stream *stderr* are normally not buffered.

**SEE ALSO**

fopen(3), getc(3), putc(3), malloc(3)

**NAME**

setjmp, longjmp – non-local goto

**SYNOPSIS**

```
#include <setjmp.h>
```

```
setjmp(env)
```

```
jmp_buf env;
```

```
longjmp(env, val)
```

```
jmp_buf env;
```

**DESCRIPTION**

These routines are useful for dealing with errors and interrupts encountered in a low-level subroutine of a program.

*Setjmp* saves its stack environment in *env* for later use by *longjmp*. It returns value 0.

*Longjmp* restores the environment saved by the last call of *setjmp*. It then returns in such a way that execution continues as if the call of *setjmp* had just returned the value *val* to the function that invoked *setjmp*, which must not itself have returned in the interim. All accessible data have values as of the time *longjmp* was called.

**SEE ALSO**

signal(2)

**NAME**

`sin`, `cos`, `tan`, `asin`, `acos`, `atan`, `atan2` – trigonometric functions

**SYNOPSIS**

```
#include <math.h>
```

```
double sin(x)
```

```
double x;
```

```
double cos(x)
```

```
double x;
```

```
double asin(x)
```

```
double x;
```

```
double acos(x)
```

```
double x;
```

```
double atan(x)
```

```
double x;
```

```
double atan2(x, y)
```

```
double x, y;
```

**DESCRIPTION**

*Sin*, *cos* and *tan* return trigonometric functions of radian arguments. The magnitude of the argument should be checked by the caller to make sure the result is meaningful.

*Asin* returns the arc sin in the range  $-\pi/2$  to  $\pi/2$ .

*Acos* returns the arc cosine in the range 0 to  $\pi$ .

*Atan* returns the arc tangent of  $x$  in the range  $-\pi/2$  to  $\pi/2$ .

*Atan2* returns the arc tangent of  $x/y$  in the range  $-\pi$  to  $\pi$ .

**DIAGNOSTICS**

Arguments of magnitude greater than 1 cause *asin* and *acos* to return value 0; *errno* is set to EDOM. The value of *tan* at its singular points is a huge number, and *errno* is set to ERANGE.

**BUGS**

The value of *tan* for arguments greater than about  $2^{31}$  is garbage.

**NAME**

sinh, cosh, tanh – hyperbolic functions

**SYNOPSIS**

```
#include <math.h>
```

```
double sinh(x)
```

```
double x;
```

```
double cosh(x)
```

```
double x;
```

```
double tanh(x)
```

```
double x;
```

**DESCRIPTION**

These functions compute the designated hyperbolic functions for real arguments.

**DIAGNOSTICS**

*Sinh* and *cosh* return a huge value of appropriate sign when the correct value would overflow.

**NAME**

sleep – suspend execution for interval

**SYNOPSIS**

**sleep(seconds)**  
**unsigned seconds;**

**DESCRIPTION**

The current process is suspended from execution for the number of seconds specified by the argument. The actual suspension time may be up to 1 second less than that requested, because scheduled wakeups occur at fixed 1-second intervals, and an arbitrary amount longer because of other activity in the system.

The routine is implemented by setting an alarm clock signal and pausing until it occurs. The previous state of this signal is saved and restored. If the sleep time exceeds the time to the alarm signal, the process sleeps only until the signal would have occurred, and the signal is sent 1 second later.

**SEE ALSO**

alarm(2), pause(2)

**NAME**

stdio – standard buffered input/output package

**SYNOPSIS**

```
#include <stdio.h>
```

```
FILE *stdin;
```

```
FILE *stdout;
```

```
FILE *stderr;
```

**DESCRIPTION**

The functions described in Sections 3S constitute an efficient user-level buffering scheme. The in-line macros *getc* and *putc(3)* handle characters quickly. The higher level routines *gets*, *fgets*, *scanf*, *fscanf*, *fread*, *puts*, *fputs*, *printf*, *fprintf*, *fwrite* all use *getc* and *putc*; they can be freely intermixed.

A file with associated buffering is called a *stream*, and is declared to be a pointer to a defined type **FILE**. *Fopen(3)* creates certain descriptive data for a stream and returns a pointer to designate the stream in all further transactions. There are three normally open streams with constant pointers declared in the include file and associated with the standard open files:

|               |                      |
|---------------|----------------------|
| <b>stdin</b>  | standard input file  |
| <b>stdout</b> | standard output file |
| <b>stderr</b> | standard error file  |

A constant 'pointer' **NULL** (0) designates no stream at all.

An integer constant **EOF** (–1) is returned upon end of file or error by integer functions that deal with streams.

Any routine that uses the standard input/output package must include the header file <stdio.h> of pertinent macro definitions. The functions and constants mentioned in sections labeled 3S are declared in the include file and need no further declaration. The constants, and the following 'functions' are implemented as macros; redeclaration of these names is perilous: *getc*, *getchar*, *putc*, *putchar*, *feof*, *ferror*, *fileno*.

**SEE ALSO**

open(2), close(2), read(2), write(2)

**DIAGNOSTICS**

The value **EOF** is returned uniformly to indicate that a **FILE** pointer has not been initialized with *fopen*, input (output) has been attempted on an output (input) stream, or a **FILE** pointer designates corrupt or otherwise unintelligible **FILE** data.

**NAME**

strcat, strncat, strcmp, strncmp, strcpy, strncpy, strlen, index, rindex – string operations

**SYNOPSIS**

**char \*strcat(s1, s2)**

**char \*s1, \*s2;**

**char \*strncat(s1, s2, n)**

**char \*s1, \*s2;**

**strcmp(s1, s2)**

**char \*s1, \*s2;**

**strncmp(s1, s2, n)**

**char \*s1, \*s2;**

**char \*strcpy(s1, s2)**

**char \*s1, \*s2;**

**char \*strncpy(s1, s2, n)**

**char \*s1, \*s2;**

**strlen(s)**

**char \*s;**

**char \*index(s, c)**

**char \*s, c;**

**char \*rindex(s, c)**

**char \*s;**

**DESCRIPTION**

These functions operate on null-terminated strings. They do not check for overflow of any receiving string.

*Strcat* appends a copy of string *s2* to the end of string *s1*. *Strncat* copies at most *n* characters. Both return a pointer to the null-terminated result.

*Strcmp* compares its arguments and returns an integer greater than, equal to, or less than 0, according as *s1* is lexicographically greater than, equal to, or less than *s2*. *Strncmp* makes the same comparison but looks at at most *n* characters.

*Strcpy* copies string *s2* to *s1*, stopping after the null character has been moved. *Strncpy* copies exactly *n* characters, truncating or null-padding *s2*; the target may not be null-terminated if the length of *s2* is *n* or more. Both return *s1*.

*Strlen* returns the number of non-null characters in *s*.

*Index* (*rindex*) returns a pointer to the first (last) occurrence of character *c* in string *s*, or zero if *c* does not occur in the string.

**BUGS**

*Strcmp* uses native character comparison, which is signed on PDP11's, unsigned on other machines.



**NAME**

swab – swap bytes

**SYNOPSIS**

```
swab(from, to, nbytes)  
char *from, *to;
```

**DESCRIPTION**

*Swab* copies *nbytes* bytes pointed to by *from* to the position pointed to by *to*, exchanging adjacent even and odd bytes. It is useful for carrying binary data between PDP11's and other machines. *Nbytes* should be even.

**NAME**

system – issue a shell command

**SYNOPSIS**

```
system(string)
char *string;
```

**DESCRIPTION**

*System* causes the *string* to be given to *sh*(1) as input as if the string had been typed as a command at a terminal. The current process waits until the shell has completed, then returns the exit status of the shell.

**SEE ALSO**

popen(3), exec(2), wait(2)

**DIAGNOSTICS**

Exit status 127 indicates the shell couldn't be executed.

**NAME**

`ttyname`, `isatty`, `ttyslot` – find name of a terminal

**SYNOPSIS**

**char \*`ttyname`(`fildes`)**

**isatty(`fildes`)**

**ttyslot()**

**DESCRIPTION**

*Ttyname* returns a pointer to the null-terminated path name of the terminal device associated with file descriptor *fildes*.

*Isatty* returns 1 if *fildes* is associated with a terminal device, 0 otherwise.

*Ttyslot* returns the number of the entry in the *ttys*(5) file for the control terminal of the current process.

**FILES**

/dev/\*

/etc/ttys

**SEE ALSO**

`ioctl`(2), `ttys`(5)

**DIAGNOSTICS**

*Ttyname* returns a null pointer (0) if *fildes* does not describe a terminal device in directory '/dev'.

*Ttyslot* returns 0 if '/etc/ttys' is inaccessible or if it cannot determine the control terminal.

**BUGS**

The return value points to static data whose content is overwritten by each call.

**NAME**

ungetc – push character back into input stream

**SYNOPSIS**

```
#include <stdio.h>
```

```
ungetc(c, stream)
```

```
FILE *stream;
```

**DESCRIPTION**

*Ungetc* pushes the character *c* back on an input stream. That character will be returned by the next *getc* call on that stream. *Ungetc* returns *c*.

One character of pushback is guaranteed provided something has been read from the stream and the stream is actually buffered. Attempts to push EOF are rejected.

*Fseek*(3) erases all memory of pushed back characters.

**SEE ALSO**

*getc*(3), *setbuf*(3), *fseek*(3)

**DIAGNOSTICS**

*Ungetc* returns **EOF** if it can't push a character back.

**NAME**

cat – phototypesetter interface

**DESCRIPTION**

*Cat* provides the interface to a Graphic Systems C/A/T phototypesetter. Bytes written on the file specify font, size, and other control information as well as the characters to be flashed. The coding will not be described here.

Only one process may have this file open at a time. It is write-only.

**FILES**

/dev/cat

**SEE ALSO**

troff(1)

Phototypesetter interface specification

**NAME**

dn – DN-11 ACU interface

**DESCRIPTION**

The *dn?* files are write-only. The permissible codes are:

|     |                                     |
|-----|-------------------------------------|
| 0-9 | dial 0-9                            |
| :   | dial *                              |
| ;   | dial #                              |
| –   | 4 second delay for second dial tone |
| <   | end-of-number                       |

The entire telephone number must be presented in a single *write* system call.

It is recommended that an end-of-number code be given even though not all ACU's actually require it.

**FILES**

/dev/dn0 connected to 801 with dp0  
/dev/dn1 not currently connected  
/dev/dn2 not currently connected

**SEE ALSO**

dp(4)

**NAME**

du, dp – DU-11 201 data-phone interface

**DESCRIPTION**

The *dp0* file is a 201 data-phone interface. *Read* and *write* calls to *dp0* are limited to a maximum of 512 bytes. Each write call is sent as a single record. Seven bits from each byte are written along with an eighth odd parity bit. The sync must be user supplied. Each read call returns characters received from a single record. Seven bits are returned unaltered; the eighth bit is set if the byte was not received in odd parity. A 10 second time out is set and a zero-byte record is returned if nothing is received in that time.

**FILES**

/dev/dp0

**SEE ALSO**

dn(4)

**BUGS**

The name *dp0* is a historical dreg.

**NAME**

hp – RH-11/RP04, RP05, RP06 moving-head disk

**DESCRIPTION**

The octal representation of the minor device number is encoded *idp*, where *i* is an interleave flag, *d* is a physical drive number, and *p* is a pseudodrive (subsection) within a physical unit. If *i* is 0, the origins and sizes of the pseudodisks on each drive, counted in cylinders of 418 512-byte blocks, are:

| disk | start | length |
|------|-------|--------|
| 0    | 0     | 23     |
| 1    | 23    | 21     |
| 2    | 0     | 0      |
| 3    | 0     | 0      |
| 4    | 44    | 386    |
| 5    | 430   | 385    |
| 6    | 44    | 367    |
| 7    | 44    | 771    |

If *i* is 1, the minor device consists of the specified pseudodisk on drives numbered 0 through the designated drive number. Successively numbered blocks are distributed across the drives in rotation.

Systems distributed for these devices use disk 0 for the root, disk 1 for swapping, and disk 4 (RP04/5) or disk 7 (RP06) for a mounted user file system.

The block files access the disk via the system's normal buffering mechanism and may be read and written without regard to physical disk records.

A 'raw' interface provides for direct transmission between the disk and the user's read or write buffer. A single read or write call results in exactly one I/O operation and therefore raw I/O is considerably more efficient when many words are transmitted. The names of the raw files conventionally begin with an extra 'r.' In raw I/O the buffer must begin on a word boundary, and raw I/O to an interleaved device is likely to have disappointing results.

**FILES**

/dev/rp?, /dev/rrp?

**SEE ALSO**

rp(4)

**BUGS**

In raw I/O *read* and *write(2)* truncate file offsets to 512-byte block boundaries, and *write* scribbles on the tail of incomplete blocks. Thus, in programs that are likely to access raw devices, *read*, *write* and *lseek(2)* should always deal in 512-byte multiples.

Raw device drivers don't work on interleaved devices.



**NAME**

hs – RH11/RS03-RS04 fixed-head disk file

**DESCRIPTION**

The files *hs0* ... *hs7* refer to RJS03 disk drives 0 through 7. The files *hs8* ... *hs15* refer to RJS04 disk drives 0 through 7. The RJS03 drives are each 1024 blocks long and the RJS04 drives are 2048 blocks long.

The *hs* files access the disk via the system's normal buffering mechanism and may be read and written without regard to physical disk records. There is also a 'raw' interface which provides for direct transmission between the disk and the user's read or write buffer. A single read or write call results in exactly one I/O operation and therefore raw I/O is considerably more efficient when many words are transmitted. The names of the raw HS files begin with *rhs*. The same minor device considerations hold for the raw interface as for the normal interface.

In raw I/O the buffer must begin on a word boundary, and counts should be a multiple of 512 bytes (a disk block). Likewise *lseek* calls should specify a multiple of 512 bytes.

**FILES**

/dev/hs?, /dev/rhs?

**NAME**

ht – RH-11/TU-16 magtape interface

**DESCRIPTION**

The files *mt0*, *mt1*, ... refer to the DEC RH/TM/TU16 magtape. When opened for reading or writing, the tape is not rewound. When closed, it is rewound (unless the 0200 bit is on, see below). If the tape was open for writing, a double end-of-file is written. If the tape is not to be rewound the tape is backspaced to just between the two tapemarks.

A standard tape consists of a series of 512 byte records terminated by a double end-of-file. To the extent possible, the system makes it possible, if inefficient, to treat the tape like any other file. Seeks have their usual meaning and it is possible to read or write a byte at a time. Writing in very small units is inadvisable, however, because it tends to create monstrous record gaps.

The last octal digit of the minor device number selects the drive. The middle digit selects a controller. The initial digit is even to select 800 BPI, odd to select 1600 BPI. If the 0200 bit is on (initial digit 2 or 3), the tape is not rewound on close. Note that the minor device number has no necessary connection with the file name, and in fact *tp(1)* turns the short name *x* into *'/dev/mtx'*.

The *mt* files discussed above are useful when it is desired to access the tape in a way compatible with ordinary files. When foreign tapes are to be dealt with, and especially when long records are to be read or written, the 'raw' interface is appropriate. The associated files may be named *rmt0*, ..., *rmt7*, but the same minor-device considerations as for the regular files still apply.

Each *read* or *write* call reads or writes the next record on the tape. In the write case the record has the same length as the buffer given. During a read, the record size is passed back as the number of bytes read, provided it is no greater than the buffer size; if the record is long, an error is indicated. In raw tape I/O, the buffer must begin on a word boundary and the count must be even. Seeks are ignored. A zero count is returned when a tape mark is read; another read will fetch the first record of the next tape file.

**FILES**

*/dev/mt?*, */dev/rmt?*

**SEE ALSO**

*tp(1)*

**BUGS**

The magtape system is supposed to be able to take 64 drives. Such addressing has never been tried.

Taking a drive off line, or running off the end of tape, while writing have been known to hang the system.

If any non-data error is encountered, it refuses to do anything more until closed. In raw I/O, there should be a way to perform forward and backward record and file spacing and to write an EOF mark explicitly.

**NAME**

mem, kmem – core memory

**DESCRIPTION**

*Mem* is a special file that is an image of the core memory of the computer. It may be used, for example, to examine, and even to patch the system. *Kmem* is the same as *mem* except that kernel virtual memory rather than physical memory is accessed.

Byte addresses are interpreted as memory addresses. References to non-existent locations return errors.

Examining and patching device registers is likely to lead to unexpected results when read-only or write-only bits are present.

On PDP11's, the I/O page begins at location 0160000 of *kmem* and per-process data for the current process begins at 0140000.

**FILES**

/dev/mem, /dev/kmem

**BUGS**

On PDP11's, memory files are accessed one byte at a time, an inappropriate method for some device registers.

**NAME**

null – data sink

**DESCRIPTION**

Data written on a null special file is discarded.

Reads from a null special file always return 0 bytes.

**FILES**

/dev/null

**NAME**

pk – packet driver

**DESCRIPTION**

The packet driver implements a full-duplex end-to-end flow control strategy for machine-to-machine communication. Packet driver protocol is established by calling *pkon(2)* with a character device file descriptor and a desired packet size in bytes. The packet size must be a power of 2,  $32 \leq size \leq 4096$ . The file descriptor must represent an 8-bit data path. This is normally obtained by setting the device in raw mode (see *ioctl(2)*).

The actual packet size, which may be smaller than the desired packet size, is arrived at by negotiation with the packet driver at the remote end of the data link.

The packet driver maintains two data areas for incoming and outgoing packets. The output area is needed to implement retransmission on errors, and arriving packets are queued in the input area. Data arriving for a file not open for reading is discarded. Initially the size of both areas is set to two packets.

It is not necessary that reads and writes be multiples of the packet size although there is less system overhead if they are. Read operations return the maximum amount of data available from the input area up to the number of bytes specified in the system call. The buffer sizes in write operations are not normally transmitted across the link. However, writes of zero length are treated specially and are reflected at the remote end as a zero-length read. This facilitates marking the serial byte stream, usually for delimiting files.

When one side of a packet driver link is shut down by *close(2)* or *pkoff* (see *pkon(2)*), *read(2)* on the other side will return 0, and *write* on the other side will raise a SIGPIPE signal.

**SEE ALSO**

*pkon(2)*, *pkopen(3)*

**NAME**

rf – RF11/RS11 fixed-head disk file

**DESCRIPTION**

This file refers to the concatenation of all RS-11 disks.

Each disk contains 1024 256-word blocks. The length of the combined RF file is  $1024 \times (\text{minor} + 1)$  blocks. That is minor device zero is taken to be 1024 blocks long; minor device one is 2048, etc.

The *rf0* file accesses the disk via the system's normal buffering mechanism and may be read and written without regard to physical disk records. There is also a 'raw' interface which provides for direct transmission between the disk and the user's read or write buffer. A single read or write call results in exactly one I/O operation and therefore raw I/O is considerably more efficient when many words are transmitted. The name of the raw RF file is *rrf0*. The same minor device considerations hold for the raw interface as for the normal interface.

In raw I/O the buffer must begin on a word boundary, and counts should be a multiple of 512 bytes (a disk block). Likewise *seek* calls should specify a multiple of 512 bytes.

**FILES**

/dev/rf0, /dev/rrf0

**BUGS**

The 512-byte restrictions on the raw device are not physically necessary, but are still imposed.

**NAME**

rk – RK-11/RK03 or RK05 disk

**DESCRIPTION**

*Rk?* refers to an entire disk as a single sequentially-addressed file. Its 256-word blocks are numbered 0 to 4871. Minor device numbers are drive numbers on one controller.

The *rk* files discussed above access the disk via the system's normal buffering mechanism and may be read and written without regard to physical disk records. There is also a 'raw' interface which provides for direct transmission between the disk and the user's read or write buffer. A single read or write call results in exactly one I/O operation and therefore raw I/O is considerably more efficient when many words are transmitted. The names of the raw RK files begin with *rrk* and end with a number which selects the same disk as the corresponding *rk* file.

In raw I/O the buffer must begin on a word boundary, and counts should be a multiple of 512 bytes (a disk block). Likewise *seek* calls should specify a multiple of 512 bytes.

**FILES**

/dev/rk?, /dev/rrk?

**BUGS**

In raw I/O *read* and *write(2)* truncate file offsets to 512-byte block boundaries, and *write* scribbles on the tail of incomplete blocks. Thus, in programs that are likely to access raw devices, *read*, *write* and *lseek(2)* should always deal in 512-byte multiples.

**NAME**

rp – RP-11/RP03 moving-head disk

**DESCRIPTION**

The files *rp0* ... *rp7* refer to sections of RP disk drive 0. The files *rp8* ... *rp15* refer to drive 1 etc. This allows a large disk to be broken up into more manageable pieces.

The origin and size of the pseudo-disks on each drive are as follows:

| disk | start      | length |
|------|------------|--------|
| 0    | 0          | 81000  |
| 1    | 0          | 5000   |
| 2    | 5000       | 2000   |
| 3    | 7000       | 74000  |
| 4-7  | unassigned |        |

Thus *rp0* covers the whole drive, while *rp1*, *rp2*, *rp3* can serve usefully as a root, swap, and mounted user file system respectively.

The *rp* files access the disk via the system's normal buffering mechanism and may be read and written without regard to physical disk records. There is also a 'raw' interface which provides for direct transmission between the disk and the user's read or write buffer. A single read or write call results in exactly one I/O operation and therefore raw I/O is considerably more efficient when many words are transmitted. The names of the raw RP files begin with *rrp* and end with a number which selects the same disk section as the corresponding *rp* file.

In raw I/O the buffer must begin on a word boundary.

**FILES**

/dev/rp?, /dev/rrp?

**SEE ALSO**

hp(4)

**BUGS**

In raw I/O *read* and *write(2)* truncate file offsets to 512-byte block boundaries, and *write* scribbles on the tail of incomplete blocks. Thus, in programs that are likely to access raw devices, *read*, *write* and *lseek(2)* should always deal in 512-byte multiples.



**NAME**

tc – TC-11/TU56 DECTape

**DESCRIPTION**

The files *tap0* ... *tap7* refer to the TC-11/TU56 DECTape drives 0 to 7.

The 256-word blocks on a standard DECTape are numbered 0 to 577.

**FILES**

/dev/tap?

**SEE ALSO**

tp(1)

**NAME**

tm – TM-11/TU-10 magtape interface

**DESCRIPTION**

The files *mt0*, ..., *mt7* refer to the DEC TU10/TM11 magtape. When closed it can be rewound or not, see below. If it was open for writing, two end-of-files are written. If the tape is not to be rewound it is positioned with the head between the two tapemarks.

If the 0200 bit is on in the minor device number the tape is not rewound when closed.

A standard tape consists of a series of 512 byte records terminated by an end-of-file. To the extent possible, the system makes it possible, if inefficient, to treat the tape like any other file. Seeks have their usual meaning and it is possible to read or write a byte at a time. Writing in very small units is inadvisable, however, because it tends to create monstrous record gaps.

The *mt* files discussed above are useful when it is desired to access the tape in a way compatible with ordinary files. When foreign tapes are to be dealt with, and especially when long records are to be read or written, the 'raw' interface is appropriate. The associated files are named *rmt0*, ..., *rmt7*. Each *read* or *write* call reads or writes the next record on the tape. In the write case the record has the same length as the buffer given. During a read, the record size is passed back as the number of bytes read, provided it is no greater than the buffer size; if the record is long, an error is indicated. In raw tape I/O, the buffer must begin on a word boundary and the count must be even. Seeks are ignored. A zero byte count is returned when a tape mark is read, but another read will fetch the first record of the new tape file.

**FILES**

/dev/mt?, /dev/rmt?

**SEE ALSO**

tp(1)

**BUGS**

If any non-data error is encountered, it refuses to do anything more until closed. In raw I/O, there should be a way to perform forward and backward record and file spacing and to write an EOF mark.

**NAME**

tty – general terminal interface

**DESCRIPTION**

This section describes both a particular special file, and the general nature of the terminal interface.

The file `/dev/tty` is, in each process, a synonym for the control terminal associated with that process. It is useful for programs that wish to be sure of writing messages on the terminal no matter how output has been redirected. It can also be used for programs that demand a file name for output, when typed output is desired and it is tiresome to find out which terminal is currently in use.

As for terminals in general: all of the low-speed asynchronous communications ports use the same general interface, no matter what hardware is involved. The remainder of this section discusses the common features of the interface.

When a terminal file is opened, it causes the process to wait until a connection is established. In practice user's programs seldom open these files; they are opened by *init* and become a user's input and output file. The very first terminal file open in a process becomes the *control terminal* for that process. The control terminal plays a special role in handling quit or interrupt signals, as discussed below. The control terminal is inherited by a child process during a *fork*, even if the control terminal is closed. The set of processes that thus share a control terminal is called a *process group*; all members of a process group receive certain signals together, see `DEL` below and *kill(2)*.

A terminal associated with one of these files ordinarily operates in full-duplex mode. Characters may be typed at any time, even while output is occurring, and are only lost when the system's character input buffers become completely choked, which is rare, or when the user has accumulated the maximum allowed number of input characters that have not yet been read by some program. Currently this limit is 256 characters. When the input limit is reached all the saved characters are thrown away without notice.

Normally, terminal input is processed in units of lines. This means that a program attempting to read will be suspended until an entire line has been typed. Also, no matter how many characters are requested in the read call, at most one line will be returned. It is not however necessary to read a whole line at once; any number of characters may be requested in a read, even one, without losing information. There are special modes, discussed below, that permit the program to read each character as typed without waiting for a full line.

During input, erase and kill processing is normally done. By default, the character '#' erases the last character typed, except that it will not erase beyond the beginning of a line or an EOT. By default, the character '@' kills the entire line up to the point where it was typed, but not beyond an EOT. Both these characters operate on a keystroke basis independently of any backspacing or tabbing that may have been done. Either '@' or '#' may be entered literally by preceding it by '\'; the erase or kill character remains, but the '\' disappears. These two characters may be changed to others.

When desired, all upper-case letters are mapped into the corresponding lower-case letter. The upper-case letter may be generated by preceding it by '\'. In addition, the following escape sequences can be generated on output and accepted on input:

| for | use |
|-----|-----|
| \   | \\  |
|     | \\! |
| ~   | \\~ |
| {   | \\{ |
| }   | \\} |

Certain ASCII control characters have special meaning. These characters are not passed to a reading program except in raw mode where they lose their special character. Also, it is possible to change these characters from the default; see below.

EOT (Control-D) may be used to generate an end of file from a terminal. When an EOT is received,

all the characters waiting to be read are immediately passed to the program, without waiting for a new-line, and the EOT is discarded. Thus if there are no characters waiting, which is to say the EOT occurred at the beginning of a line, zero characters will be passed back, and this is the standard end-of-file indication.

- DEL (Rubout) is not passed to a program but generates an *interrupt* signal which is sent to all processes with the associated control terminal. Normally each such process is forced to terminate, but arrangements may be made either to ignore the signal or to receive a trap to an agreed-upon location. See *signal(2)*.
- FS (Control-\ or control-shift-L) generates the *quit* signal. Its treatment is identical to the interrupt signal except that unless a receiving process has made other arrangements it will not only be terminated but a core image file will be generated.
- DC3 (Control-S) delays all printing on the terminal until something is typed in.
- DC1 (Control-Q) restarts printing after DC3 without generating any input to a program.

When the carrier signal from the dataset drops (usually because the user has hung up his terminal) a *hangup* signal is sent to all processes with the terminal as control terminal. Unless other arrangements have been made, this signal causes the processes to terminate. If the hangup signal is ignored, any read returns with an end-of-file indication. Thus programs that read a terminal and test for end-of-file on their input can terminate appropriately when hung up on.

When one or more characters are written, they are actually transmitted to the terminal as soon as previously-written characters have finished typing. Input characters are echoed by putting them in the output queue as they arrive. When a process produces characters more rapidly than they can be typed, it will be suspended when its output queue exceeds some limit. When the queue has drained down to some threshold the program is resumed. Even parity is always generated on output. The EOT character is not transmitted (except in raw mode) to prevent terminals that respond to it from hanging up.

Several *ioctl(2)* calls apply to terminals. Most of them use the following structure, defined in *<sgtty.h>*:

```
struct sgttyb {
    char    sg_ispeed;
    char    sg_ospeed;
    char    sg_erase;
    char    sg_kill;
    int     sg_flags;
};
```

The *sg\_ispeed* and *sg\_ospeed* fields describe the input and output speeds of the device according to the following table, which corresponds to the DEC DH-11 interface. If other hardware is used, impossible speed changes are ignored. Symbolic values in the table are as defined in *<sgtty.h>*.

|       |    |                     |
|-------|----|---------------------|
| B0    | 0  | (hang up dataphone) |
| B50   | 1  | 50 baud             |
| B75   | 2  | 75 baud             |
| B110  | 3  | 110 baud            |
| B134  | 4  | 134.5 baud          |
| B150  | 5  | 150 baud            |
| B200  | 6  | 200 baud            |
| B300  | 7  | 300 baud            |
| B600  | 8  | 600 baud            |
| B1200 | 9  | 1200 baud           |
| B1800 | 10 | 1800 baud           |
| B2400 | 11 | 2400 baud           |
| B4800 | 12 | 4800 baud           |

```

B9600 13 9600 baud
EXTA 14 External A
EXTB 15 External B

```

In the current configuration, only 110, 150, 300 and 1200 baud are really supported on dial-up lines. Code conversion and line control required for IBM 2741's (134.5 baud) must be implemented by the user's program. The half-duplex line discipline required for the 202 dataset (1200 baud) is not supplied; full-duplex 212 datasets work fine.

The *sg\_erase* and *sg\_kill* fields of the argument structure specify the erase and kill characters respectively. (Defaults are # and @.)

The *sg\_flags* field of the argument structure contains several bits that determine the system's treatment of the terminal:

```

ALLDELAY 0177400 Delay algorithm selection
BSDELAY 0100000 Select backspace delays (not implemented):
BS0      0
BS1      0100000
VTDELAY 0040000 Select form-feed and vertical-tab delays:
FF0      0
FF1      0100000
CRDELAY 0030000 Select carriage-return delays:
CR0      0
CR1      0010000
CR2      0020000
CR3      0030000
TBDELAY 0006000 Select tab delays:
TAB0     0
TAB1     0001000
TAB2     0004000
XTABS    0006000
NLDELAY 0001400 Select new-line delays:
NL0      0
NL1      0000400
NL2      0001000
NL3      0001400
EVENP    0000200 Even parity allowed on input (most terminals)
ODDP     0000100 Odd parity allowed on input
RAW      0000040 Raw mode: wake up on all characters, 8-bit interface
CRMOD    0000020 Map CR into LF; echo LF or CR as CR-LF
ECHO     0000010 Echo (full duplex)
LCASE    0000004 Map upper case to lower on input
CBREAK   0000002 Return each character as soon as typed
TANDEM   0000001 Automatic flow control

```

The delay bits specify how long transmission stops to allow for mechanical or other movement when certain characters are sent to the terminal. In all cases a value of 0 indicates no delay.

Backspace delays are currently ignored but might be used for Terminet 300's.

If a form-feed/vertical tab delay is specified, it lasts for about 2 seconds.

Carriage-return delay type 1 lasts about .08 seconds and is suitable for the Terminet 300. Delay type 2 lasts about .16 seconds and is suitable for the VT05 and the TI 700. Delay type 3 is unimplemented and is 0.

New-line delay type 1 is dependent on the current column and is tuned for Teletype model 37's. Type 2 is useful for the VT05 and is about .10 seconds. Type 3 is unimplemented and is 0.

Tab delay type 1 is dependent on the amount of movement and is tuned to the Teletype model 37. Type 3, called XTABS, is not a delay at all but causes tabs to be replaced by the appropriate number of spaces on output.

Characters with the wrong parity, as determined by bits 200 and 100, are ignored.

In raw mode, every character is passed immediately to the program without waiting until a full line has been typed. No erase or kill processing is done; the end-of-file indicator (EOT), the interrupt character (DEL) and the quit character (FS) are not treated specially. There are no delays and no echoing, and no replacement of one character for another; characters are a full 8 bits for both input and output (parity is up to the program).

Mode 020 causes input carriage returns to be turned into new-lines; input of either CR or LF causes LF-CR both to be echoed (for terminals with a new-line function).

CBREAK is a sort of half-cooked (rare?) mode. Programs can read each character as soon as typed, instead of waiting for a full line, but quit and interrupt work, and output delays, case-translation, CRMOD, XTABS, ECHO, and parity work normally. On the other hand there is no erase or kill, and no special treatment of \ or EOT.

TANDEM mode causes the system to produce a stop character (default DC3) whenever the input queue is in danger of overflowing, and a start character (default DC1) when the input queue has drained sufficiently. It is useful for flow control when the 'terminal' is actually another machine that obeys the conventions.

Several *ioctl* calls have the form:

```
#include <sgtty.h>
```

```
ioctl(fildes, code, arg)
```

```
struct sgttyb *arg;
```

The applicable codes are:

TIOCGETP

Fetch the parameters associated with the terminal, and store in the pointed-to structure.

TIOCSETP

Set the parameters according to the pointed-to structure. The interface delays until output is quiescent, then throws away any unread characters, before changing the modes.

TIOCSETN

Set the parameters but do not delay or flush input. Switching out of RAW or CBREAK mode may cause some garbage input.

With the following codes the *arg* is ignored.

TIOCEXCL

Set "exclusive-use" mode: no further opens are permitted until the file has been closed.

TIOCNXCL

Turn off "exclusive-use" mode.

TIOCHPCL

When the file is closed for the last time, hang up the terminal. This is useful when the line is associated with an ACU used to place outgoing calls.

TIOCFLUSH

All characters waiting in input or output queues are flushed.

The following codes affect characters that are special to the terminal interface. The argument is a pointer to the following structure, defined in `<sgtty.h>`:

```

struct tchars {
    char    t_intrc;        /* interrupt */
    char    t_quitc;       /* quit */
    char    t_startc;     /* start output */
    char    t_stopc;     /* stop output */
    char    t_eofc;       /* end-of-file */
    char    t_brkc;      /* input delimiter (like nl) */
};

```

The default values for these characters are DEL, FS, DC1, DC3, EOT, and -1. A character value of -1 eliminates the effect of that character. The `t_brkc` character, by default -1, acts like a new-line in that it terminates a 'line,' is echoed, and is passed to the program. The 'stop' and 'start' characters may be the same, to produce a toggle effect. It is probably counterproductive to make other special characters (including erase and kill) identical.

The calls are:

#### TIOCSETC

Change the various special characters to those given in the structure.

#### TIOCSETP

Set the special characters to those given in the structure.

#### FILES

/dev/tty  
 /dev/tty\*  
 /dev/console

#### SEE ALSO

getty(8), stty(1), signal(2), ioctl(2)

#### BUGS

Half-duplex terminals are not supported.

The terminal handler has clearly entered the race for ever-greater complexity and generality. It's still not complex and general enough for TENEX fans.

**NAME**

vp – Versatec printer-plotter

**DESCRIPTION**

*Vp0* is the interface to a Versatec D1200A printer-plotter with a Versatec C-PDP11(DMA) controller. Ordinarily bytes written on it are interpreted as ASCII characters and printed. As a printer, it writes 64 lines of 132 characters each on 11 by 8.5 inch paper. Only some of the ASCII control characters are interpreted.

NL performs the usual new-line function, i.e. spaces up the paper and resets to the left margin. It is ignored however following a CR which ends a non-empty line.

CR is ignored if the current line is empty but is otherwise like NL.

FF resets to the left margin and then to the top of the next page.

EOT resets to the left margin, advances 8 inches, and then performs a FF.

The *ioctl(2)* system call may be used to change the mode of the device. Only the first word of the 3-word argument structure is used. The bits mean:

0400 Enter simultaneous print/plot mode.

0200 Enter plot mode.

0100 Enter print mode (default on open).

040 Send remote terminate.

020 Send remote form-feed.

010 Send remote EOT.

04 Send remote clear.

02 Send remote reset.

On open a reset, clear, and form-feed are performed automatically. Notice that the mode bits are not encoded, so that it is required that exactly one be set.

In plot mode each byte is interpreted as 8 bits of which the high-order is plotted to the left; a '1' leaves a visible dot. A full line of dots is produced by 264 bytes; lines are terminated only by count or by a remote terminate function. There are 200 dots per inch both vertically and horizontally.

When simultaneous print-plot mode is entered exactly one line of characters, terminated by NL, CR, or the remote terminate function, should be written. Then the device enters plot mode and at least 20 lines of plotting bytes should be sent. As the line of characters (which is 20 dots high) is printed, the plotting bytes overlay the characters. Notice that it is impossible to print characters on baselines that differ by fewer than 20 dot-lines.

In print mode lines may be terminated either with an appropriate ASCII character or by using the remote terminate function.

**FILES**

/dev/vp0

**SEE ALSO**

opr(1)



**NAME**

a.out – assembler and link editor output

**SYNOPSIS**

```
#include <a.out.h>
```

**DESCRIPTION**

*A.out* is the output file of the assembler *as*(1) and the link editor *ld*(1). Both programs make *a.out* executable if there were no errors and no unresolved external references. Layout information as given in the include file for the PDP11 is:

```
struct    exec {      /* a.out header */
    short      a_magic; /* magic number */
    unsigned   a_text;  /* size of text segment */
    unsigned   a_data;  /* size of initialized data */
    unsigned   a_bss;   /* size of uninitialized data */
    unsigned   a_syms;  /* size of symbol table */
    unsigned   a_entry; /* entry point */
    unsigned   a_unused; /* not used */
    unsigned   a_flag;  /* relocation info stripped */
};

#define  A_MAGIC1      0407 /* normal */
#define  A_MAGIC2      0410 /* read-only text */
#define  A_MAGIC3      0411 /* separated I&D */
#define  A_MAGIC4      0405 /* overlay */

struct    nlist { /* symbol table entry */
    char      n_name[8]; /* symbol name */
    int       n_type;    /* type flag */
    unsigned  n_value;   /* value */
};

/* values for type flag */
#define  N_UNDF  0      /* undefined */
#define  N_ABS   01     /* absolute */
#define  N_TEXT  02     /* text symbol */
#define  N_DATA  03     /* data symbol */
#define  N_BSS   04     /* bss symbol */
#define  N_TYPE  037
#define  N_REG   024    /* register name */
#define  N_FN    037    /* file name symbol */
#define  N_EXT   040    /* external bit, or'ed in */
#define  FORMAT "% .6o" /* to print a value */
```

The file has four sections: a header, the program and data text, relocation information, and a symbol table (in that order). The last two may be empty if the program was loaded with the ‘-s’ option of *ld* or if the symbols and relocation have been removed by *strip*(1).

In the header the sizes of each section are given in bytes, but are even. The size of the header is not included in any of the other sizes.

When an *a.out* file is loaded into core for execution, three logical segments are set up: the text segment, the data segment (with uninitialized data, which starts off as all 0, following initialized), and a stack. The text segment begins at 0 in the core image; the header is not loaded. If the magic number in the header is 0407(8), it indicates that the text segment is not to be write-protected and shared, so the data

segment is immediately contiguous with the text segment. If the magic number is 0410, the data segment begins at the first 0 mod 8K byte boundary following the text segment, and the text segment is not writable by the program; if other processes are executing the same file, they will share the text segment. If the magic number is 411, the text segment is again pure, write-protected, and shared, and moreover instruction and data space are separated; the text and data segment both begin at location 0. If the magic number is 0405, the text segment is overlaid on an existing (0411 or 0405) text segment and the existing data segment is preserved.

The stack will occupy the highest possible locations in the core image: from 0177776(8) and growing downwards. The stack is automatically extended as required. The data segment is only extended as requested by *brk*(2).

The start of the text segment in the file is 020(8); the start of the data segment is  $020+S_t$  (the size of the text) the start of the relocation information is  $020+S_t+S_d$ ; the start of the symbol table is  $020+2(S_t+S_d)$  if the relocation information is present,  $020+S_t+S_d$  if not.

The layout of a symbol table entry and the principal flag values that distinguish symbol types are given in the include file. Other flag values may occur if an assembly language program defines machine instructions.

If a symbol's type is undefined external, and the value field is non-zero, the symbol is interpreted by the loader *ld* as the name of a common region whose size is indicated by the value of the symbol.

The value of a word in the text or data portions which is not a reference to an undefined external symbol is exactly that value which will appear in core when the file is executed. If a word in the text or data portion involves a reference to an undefined external symbol, as indicated by the relocation information for that word, then the value of the word as stored in the file is an offset from the associated external symbol. When the file is processed by the link editor and the external symbol becomes defined, the value of the symbol will be added into the word in the file.

If relocation information is present, it amounts to one word per word of program text or initialized data. There is no relocation information if the 'relocation info stripped' flag in the header is on.

Bits 3-1 of a relocation word indicate the segment referred to by the text or data word associated with the relocation word:

|     |  |
|-----|--|
| 000 | absolute number                        |
| 002 | reference to text segment              |
| 004 | reference to initialized data          |
| 006 | reference to uninitialized data (bss)  |
| 010 | reference to undefined external symbol |

Bit 0 of the relocation word indicates, if 1, that the reference is relative to the pc (e.g. 'clr x'); if 0, that the reference is to the actual symbol (e.g., 'clr \*\$x').

The remainder of the relocation word (bits 15-4) contains a symbol number in the case of external references, and is unused otherwise. The first symbol is numbered 0, the second 1, etc.

**SEE ALSO**

as(1), ld(1), nm(1)

**NAME**

acct – execution accounting file

**SYNOPSIS**

```
#include <sys/acct.h>
```

**DESCRIPTION**

*Acct(2)* causes entries to be made into an accounting file for each process that terminates. The accounting file is a sequence of entries whose layout, as defined by the include file is:

```
typedef unsigned short comp_t;
    /* "floating point": 3 bits base 8 exp, 13-bits fraction */

struct acct
{
    char    ac_comm[10]; /* command name */
    comp_t  ac_untime;   /* user time */
    comp_t  ac_stime;    /* system time */
    comp_t  ac_etime;    /* elapsed time */
    time_t  ac_btime;    /* beginning time */
    short   ac_uid;      /* user ID */
    short   ac_gid;      /* group ID */
    short   ac_mem;      /* average memory usage */
    comp_t  ac_io;       /* number of disk IO blocks */
    dev_t   ac_tty;      /* control typewriter */
    comp_t  ac_rw;       /* blocks read or written */
    char    ac_flag;     /* accounting flag */
};
    /* flag bits */
#define AFORK 01          /* has executed fork, but no exec */
#define ASU   02          /* used super-user privileges */
```

If the process does an *exec(2)*, the first 10 characters of the filename appear in *ac\_comm*. The accounting flag contains bits indicating whether *exec(2)* was ever accomplished, and whether the process ever had super-user privileges.

**SEE ALSO**

acct(2), sa(1)

**NAME**

ar – archive (library) file format

**SYNOPSIS**

```
#include <ar.h>
```

**DESCRIPTION**

The archive command *ar* is used to combine several files into one. Archives are used mainly as libraries to be searched by the link-editor *ld*.

A file produced by *ar* has a magic number at the start, followed by the constituent files, each preceded by a file header. The magic number and header layout as described in the include file are:

```
#define ARMAG 0177545
struct ar_hdr {
    char    ar_name[14];
    long    ar_date;
    char    ar_uid;
    char    ar_gid;
    int     ar_mode;
    long    ar_size;
};
```

The name is a null-terminated string; the date is in the form of *time(2)*; the user ID and group ID are numbers; the mode is a bit pattern per *chmod(2)*; the size is counted in bytes.

Each file begins on a word boundary; a null byte is inserted between files if necessary. Nevertheless the size given reflects the actual size of the file exclusive of padding.

Notice there is no provision for empty areas in an archive file.

**SEE ALSO**

ar(1), ld(1), nm(1)

**BUGS**

Coding user and group IDs as characters is a botch.

**NAME**

core – format of core image file

**DESCRIPTION**

UNIX writes out a core image of a terminated process when any of various errors occur. See *signal(2)* for the list of reasons; the most common are memory violations, illegal instructions, bus errors, and user-generated quit signals. The core image is called 'core' and is written in the process's working directory (provided it can be; normal access controls apply).

The first 1024 bytes of the core image are a copy of the system's per-user data for the process, including the registers as they were at the time of the fault; see the system listings for the format of this area. The remainder represents the actual contents of the user's core area when the core image was written. If the text segment is write-protected and shared, it is not dumped; otherwise the entire address space is dumped.

In general the debugger *adb(1)* is sufficient to deal with core images.

**SEE ALSO**

*adb(1)*, *signal(2)*

**NAME**

dir – format of directories

**SYNOPSIS**

```
#include <sys/dir.h>
```

**DESCRIPTION**

A directory behaves exactly like an ordinary file, save that no user may write into a directory. The fact that a file is a directory is indicated by a bit in the flag word of its i-node entry see, *filsys(5)*. The structure of a directory entry as given in the include file is:

```
#ifndef  DIRSIZ
#define  DIRSIZ14
#endif
struct  direct
{
        ino_t  d_ino;
        char   d_name[DIRSIZ];
};
```

By convention, the first two entries in each directory are for '.' and '..'. The first is an entry for the directory itself. The second is for the parent directory. The meaning of '..' is modified for the root directory of the master file system and for the root directories of removable file systems. In the first case, there is no parent, and in the second, the system does not permit off-device references. Therefore in both cases '..' has the same meaning as '.'.

**SEE ALSO**

filsys(5)

**NAME**

dump, ddate – incremental dump format

**SYNOPSIS**

```
#include <sys/types.h>
#include <sys/ino.h>
# include <dumprestor.h>
```

**DESCRIPTION**

Tapes used by *dump* and *restor*(1) contain:

- a header record
- two groups of bit map records
- a group of records describing directories
- a group of records describing files

The format of the header record and of the first record of each description as given in the include file *<dumprestor.h>* is:

```
#define NTREC    20
#define MLEN     16
#define MSIZ     4096

#define TS_TAPE  1
#define TS_INODE 2
#define TS_BITS   3
#define TS_ADDR  4
#define TS_END   5
#define TS_CLRI  6
#define MAGIC    (int)60011
#define CHECKSUM(int)84446
struct  spcl
{
    int      c_type;
    time_t   c_date;
    time_t   c_ddate;
    int      c_volume;
    daddr_t  c_tapea;
    ino_t     c_inumber;
    int      c_magic;
    int      c_checksum;
    struct   dinodec_dinode;
    int      c_count;
    char     c_addr[BSIZE];
} spcl;

struct  idates
{
    char     id_name[16];
    char     id_incno;
    time_t   id_ddate;
};
```

*NTREC* is the number of 512 byte records in a physical tape block. *MLEN* is the number of bits in a bit map word. *MSIZ* is the number of bit map words.

The *TS\_* entries are used in the *c\_type* field to indicate what sort of header this is. The types and their meanings are as follows:

*TS\_TAPE* Tape volume label  
*TS\_INODE* A file or directory follows. The *c\_dinode* field is a copy of the disk inode and contains bits telling what sort of file this is.  
*TS\_BITS* A bit map follows. This bit map has a one bit for each inode that was dumped.  
*TS\_ADDR* A subrecord of a file description. See *c\_addr* below.  
*TS\_END* End of tape record.  
*TS\_CLRI* A bit map follows. This bit map contains a zero bit for all inodes that were empty on the file system when dumped.  
*MAGIC* All header records have this number in *c\_magic*.  
*CHECKSUM*  
Header records checksum to this value.

The fields of the header structure are as follows:

*c\_type* The type of the header.  
*c\_date* The date the dump was taken.  
*c\_ddate* The date the file system was dumped from.  
*c\_volume* The current volume number of the dump.  
*c\_tapea* The current number of this (512-byte) record.  
*c\_inumber* The number of the inode being dumped if this is of type *TS\_INODE*.  
*c\_magic* This contains the value *MAGIC* above, truncated as needed.  
*c\_checksum*  
This contains whatever value is needed to make the record sum to *CHECKSUM*.  
*c\_dinode* This is a copy of the inode as it appears on the file system; see *filsys(5)*.  
*c\_count* The count of characters in *c\_addr*.  
*c\_addr* An array of characters describing the blocks of the dumped file. A character is zero if the block associated with that character was not present on the file system, otherwise the character is non-zero. If the block was not present on the file system, no block was dumped; the block will be restored as a hole in the file. If there is not sufficient space in this record to describe all of the blocks in a file, *TS\_ADDR* records will be scattered through the file, each one picking up where the last left off.

Each volume except the last ends with a tapemark (read as an end of file). The last volume ends with a *TS\_END* record and then the tapemark.

The structure *idates* describes an entry of the file */etc/ddate* where dump history is kept. The fields of the structure are:

*id\_name* The dumped filesystem is *'/dev/id\_nam'*.  
*id\_incno* The level number of the dump tape; see *dump(1)*.  
*id\_ddate* The date of the incremental dump in system format see *types(5)*.

## FILES

*/etc/ddate*

## SEE ALSO

*dump(1)*, *dumpdir(1)*, *restor(1)*, *filsys(5)*, *types(5)*



**NAME**

environ – user environment

**SYNOPSIS**

```
extern char **environ;
```

**DESCRIPTION**

An array of strings called the ‘environment’ is made available by *exec(2)* when a process begins. By convention these strings have the form ‘name=value’. The following names are used by various commands:

**PATH** The sequence of directory prefixes that *sh*, *time*, *nice(1)*, etc., apply in searching for a file known by an incomplete path name. The prefixes are separated by ‘:’. *Login(1)* sets `PATH=/bin:/usr/bin`.

**HOME** A user’s login directory, set by *login(1)* from the password file *passwd(5)*.

**TERM** The kind of terminal for which output is to be prepared. This information is used by commands, such as *nroff* or *plot(1)*, which may exploit special terminal capabilities. See *term(7)* for a list of terminal types.

Further names may be placed in the environment by the *export* command and ‘name=value’ arguments in *sh(1)*, or by *exec(2)*. It is unwise to conflict with certain Shell variables that are frequently exported by ‘.profile’ files: MAIL, PS1, PS2, IFS.

**SEE ALSO**

*exec(2)*, *sh(1)*, *term(7)*, *login(1)*

**NAME**

filsys, fblk, ino – format of file system volume

**SYNOPSIS**

```
#include <sys/types.h>
#include <sys/fblk.h>
#include <sys/filsys.h>
#include <sys/ino.h>
```

**DESCRIPTION**

Every file system storage volume (e.g. RF disk, RK disk, RP disk, DECtape reel) has a common format for certain vital information. Every such volume is divided into a certain number of 512-byte blocks. Block 0 is unused and is available to contain a bootstrap program, pack label, or other information.

Block 1 is the *super block*. The layout of the super block as defined by the include file `<sys/filsys.h>` is:

```
/* Structure of the super-block */
struct filsys
{
    unsigned short    s_iseize; /* size in blocks of i-list */
    daddr_t  s_fsize;  /* size in blocks of entire volume */
    short      s_nfree; /* number of addresses in s_free */
    daddr_t  s_free[NICFREE]; /* free block list */
    short      s_ninode; /* number of i-nodes in s_inode */
    ino_t     s_inode[NICINOD]; /* free i-node list */
    char      s_flock;  /* lock during free list manipulation */
    char      s_ilock;  /* lock during i-list manipulation */
    char      s_fmod;   /* super block modified flag */
    char      s_ronly;  /* mounted read-only flag */
    time_t    s_time;   /* last super block update */
    /* remainder not maintained by this version of the system */
    daddr_t  s_tfrees;  /* total free blocks */
    ino_t    s_tinode;  /* total free inodes */
    short    s_m;       /* interleave factor */
    short    s_n;       /* " " */
    char     s_fname[6]; /* file system name */
    char     s_fpack[6]; /* file system pack name */
};
```

$S\_iseize$  is the address of the first block after the i-list, which starts just after the super-block, in block 2. Thus the i-list is  $s\_iseize - 2$  blocks long.  $S\_fsize$  is the address of the first block not potentially available for allocation to a file. These numbers are used by the system to check for bad block addresses; if an 'impossible' block address is allocated from the free list or is freed, a diagnostic is written on the on-line console. Moreover, the free array is cleared, so as to prevent further allocation from a presumably corrupted free list.

The free list for each volume is maintained as follows. The  $s\_free$  array contains, in  $s\_free[1]$ , ... ,  $s\_free[s\_nfree - 1]$ , up to NICFREE free block numbers. NICFREE is a configuration constant.  $S\_free[0]$  is the block address of the head of a chain of blocks constituting the free list. The layout of each block of the free chain as defined in the include file `<sys/fblk.h>` is:

```
struct fblk
{
    int      df_nfree;
    daddr_t  df_free[NICFREE];
};
```

The fields *df\_nfree* and *df\_free* in a free block are used exactly like *s\_nfree* and *s\_free* in the super block. To allocate a block: decrement *s\_nfree*, and the new block number is *s\_free[s\_nfree]*. If the new block address is 0, there are no blocks left, so give an error. If *s\_nfree* became 0, read the new block into *s\_nfree* and *s\_free*. To free a block, check if *s\_nfree* is NICFREE; if so, copy *s\_nfree* and the *s\_free* array into it, write it out, and set *s\_nfree* to 0. In any event set *s\_free[s\_nfree]* to the freed block's address and increment *s\_nfree*.

*S\_ninode* is the number of free i-numbers in the *s\_inode* array. To allocate an i-node: if *s\_ninode* is greater than 0, decrement it and return *s\_inode[s\_ninode]*. If it was 0, read the i-list and place the numbers of all free inodes (up to NICINOD) into the *s\_inode* array, then try again. To free an i-node, provided *s\_ninode* is less than NICINODE, place its number into *s\_inode[s\_ninode]* and increment *s\_ninode*. If *s\_ninode* is already NICINODE, don't bother to enter the freed i-node into any table. This list of i-nodes is only to speed up the allocation process; the information as to whether the inode is really free or not is maintained in the inode itself.

*S\_flock* and *s\_iloc* are flags maintained in the core copy of the file system while it is mounted and their values on disk are immaterial. The value of *s\_fmod* on disk is likewise immaterial; it is used as a flag to indicate that the super-block has changed and should be copied to the disk during the next periodic update of file system information. *S\_ronly* is a write-protection indicator; its disk value is also immaterial.

*S\_time* is the last time the super-block of the file system was changed. During a reboot, *s\_time* of the super-block for the root file system is used to set the system's idea of the time.

The fields *s\_tfree*, *s\_tinode*, *s\_fname* and *s\_fpack* are not currently maintained.

I-numbers begin at 1, and the storage for i-nodes begins in block 2. I-nodes are 64 bytes long, so 8 of them fit into a block. I-node 2 is reserved for the root directory of the file system, but no other i-number has a built-in meaning. Each i-node represents one file. The format of an i-node as given in the include file `<sys/ino.h>` is:

```

    /* Inode structure as it appears on a disk block. */
struct dinode
{
    unsigned short di_mode; /* mode and type of file */
    short di_nlink; /* number of links to file */
    short di_uid; /* owner's user id */
    short di_gid; /* owner's group id */
    off_t di_size; /* number of bytes in file */
    char di_addr[40]; /* disk block addresses */
    time_t di_atime; /* time last accessed */
    time_t di_mtime; /* time last modified */
    time_t di_ctime; /* time created */
};
#define INOPB 8 /* 8 inodes per block */
/*
 * the 40 address bytes:
 * 39 used; 13 addresses
 * of 3 bytes each.
 */

```

*Di\_mode* tells the kind of file; it is encoded identically to the *st\_mode* field of *stat(2)*. *Di\_nlink* is the number of directory entries (links) that refer to this i-node. *Di\_uid* and *di\_gid* are the owner's user and group IDs. *Size* is the number of bytes in the file. *Di\_atime* and *di\_mtime* are the times of last access and modification of the file contents (read, write or create) (see *times(2)*); *Di\_ctime* records the time of last modification to the inode or to the file, and is used to determine whether it should be dumped.

Special files are recognized by their modes and not by i-number. A block-type special file is one which can potentially be mounted as a file system; a character-type special file cannot, though it is not necessarily character-oriented. For special files, the *di\_addr* field is occupied by the device code (see *types(5)*). The device codes of block and character special files overlap.

Disk addresses of plain files and directories are kept in the array *di\_addr* packed into 3 bytes each. The first 10 addresses specify device blocks directly. The last 3 addresses are singly, doubly, and triply indirect and point to blocks of 128 block pointers. Pointers in indirect blocks have the type *daddr\_t* (see *types(5)*).

For block *b* in a file to exist, it is not necessary that all blocks less than *b* exist. A zero block number either in the address words of the i-node or in an indirect block indicates that the corresponding block has never been allocated. Such a missing block reads as if it contained all zero words.

**SEE ALSO**

icheck(1), dcheck(1), dir(5), mount(1), stat(2), types(5)

**NAME**

group – group file

**DESCRIPTION**

*Group* contains for each group the following information:

- group name
- encrypted password
- numerical group ID
- a comma separated list of all users allowed in the group

This is an ASCII file. The fields are separated by colons; Each group is separated from the next by a new-line. If the password field is null, no password is demanded.

This file resides in directory /etc. Because of the encrypted passwords, it can and does have general read permission and can be used, for example, to map numerical group ID's to names.

**FILES**

/etc/group

**SEE ALSO**

newgrp(1), crypt(3), passwd(1), passwd(5)

**NAME**

mpxio – multiplexed i/o

**SYNOPSIS**

```
#include <sys/mx.h>
```

```
#include <sgtty.h>
```

**DESCRIPTION**

Data transfers on mpx files (see *mpx(2)*) are multiplexed by imposing a record structure on the io stream. Each record represents data from/to a particular channel or a control or status message associated with a particular channel.

The prototypical data record read from an mpx file is as follows

```
struct input_record {
    short    index;
    short    count;
    short    ccount;
    char     data[];
};
```

where *index* identifies the channel, and *count* specifies the number of characters in *data*. If *count* is zero, *ccount* gives the size of *data*, and the record is a control or status message. Although *count* or *ccount* might be odd, the operating system aligns records on short (i.e. 16-bit) boundaries by skipping bytes when necessary.

Data written to an mpx file must be formatted as an array of record structures defined as follows

```
struct output_record {
    short    index;
    short    count;
    short    ccount;
    char     *data;
};
```

where the data portion of the record is referred to indirectly and the other cells have the same interpretation as in *input\_record*.

The control messages listed below may be read from a multiplexed file descriptor. They are presented as two 16-bit integers: the first number is the message code (defined in *<sys/mx.h>*), the second is an optional parameter meaningful only with M\_WATCH and M\_BLK.

M\_WATCH – a process ‘wants to attach’ on this channel. The second parameter is the 16-bit user-id of the process that executed the open.

M\_CLOSE – the channel is closed. This message is generated when the last file descriptor referencing a channel is closed. The *detach* command (see *mpx(2)*) should be used in response to this message.

M\_EOT – indicates logical end of file on a channel. If the channel is joined to a typewriter, EOT (control-d) will cause the M\_EOT message under the conditions specified in *tty(4)* for end of file. If the channel is attached to a process, M\_EOT will be generated whenever the process writes zero bytes on the channel.

M\_BLK – if non-blocking mode has been enabled on an mpx file descriptor *xd* by executing *ioctl(xd, MXNBLK, 0)*, write operations on the file are truncated in the kernel when internal queues become full. This is done on a per-channel basis: the parameter is a count of the number of characters not transferred to the channel on which M\_BLK is received.

M\_UBLK – is generated for a channel after M\_BLK when the internal queues have drained below a threshold.

Two other messages may be generated by the kernel. As with other messages, the first 16-bit quantity is the message code.

**M\_OPEN** – is generated in conjunction with ‘listener’ mode (see *mpx(2)*). The uid of the calling process follows the message code as with **M\_WATCH**. This is followed by a null-terminated string which is the name of the file being opened.

**M\_IOCTL** – is generated for a channel connected to a process when that process executes the *ioctl(fd, cmd, &vec)* call on the channel file descriptor. The **M\_IOCTL** code is followed by the *cmd* argument given to *ioctl* followed by the contents of the structure *vec*. It is assumed, not needing a better compromise at this time, that the length of *vec* is determined by *sizeof(struct sgtyb)* as declared in *<sgtty.h>*.

Two control messages are understood by the operating system. **M\_EOT** may be sent through an *mpx* file to a channel. It is equivalent to propagating a zero-length record through the channel; i.e. the channel is allowed to drain and the process or device at the other end receives a zero-length transfer before data starts flowing through the channel again. **M\_IOCTL** can also be sent through a channel. The format is identical to that described above.

**NAME**

mtab – mounted file system table

**DESCRIPTION**

*Mtab* resides in directory */etc* and contains a table of devices mounted by the *mount* command. *Umount* removes entries.

Each entry is 64 bytes long; the first 32 are the null-padded name of the place where the special file is mounted; the second 32 are the null-padded name of the special file. The special file has all its directories stripped away; that is, everything through the last '/' is thrown away.

This table is present only so people can look at it. It does not matter to *mount* if there are duplicated entries nor to *umount* if a name cannot be found.

**FILES**

*/etc/mtab*

**SEE ALSO**

*mount*(1)



**NAME**

passwd – password file

**DESCRIPTION**

*Passwd* contains for each user the following information:

name (login name, contains no upper case)

encrypted password

numerical user ID

numerical group ID

GCOS job number, box number, optional GCOS user-id

initial working directory

program to use as Shell

This is an ASCII file. Each field within each user's entry is separated from the next by a colon. The GCOS field is used only when communicating with that system, and in other installations can contain any desired information. Each user is separated from the next by a new-line. If the password field is null, no password is demanded; if the Shell field is null, the Shell itself is used.

This file resides in directory /etc. Because of the encrypted passwords, it can and does have general read permission and can be used, for example, to map numerical user ID's to names.

**FILES**

/etc/passwd

**SEE ALSO**

getpwent(3), login(1), crypt(3), passwd(1), group(5)

**NAME**

plot – graphics interface

**DESCRIPTION**

Files of this format are produced by routines described in *plot(3)*, and are interpreted for various devices by commands described in *plot(1)*. A graphics file is a stream of plotting instructions. Each instruction consists of an ASCII letter usually followed by bytes of binary information. The instructions are executed in order. A point is designated by four bytes representing the x and y values; each value is a signed integer. The last designated point in an **l**, **m**, **n**, or **p** instruction becomes the ‘current point’ for the next instruction.

Each of the following descriptions begins with the name of the corresponding routine in *plot(3)*.

**m** move: The next four bytes give a new current point.

**n** cont: Draw a line from the current point to the point given by the next four bytes. See *plot(1)*.

**p** point: Plot the point given by the next four bytes.

**l** line: Draw a line from the point given by the next four bytes to the point given by the following four bytes.

**t** label: Place the following ASCII string so that its first character falls on the current point. The string is terminated by a newline.

**a** arc: The first four bytes give the center, the next four give the starting point, and the last four give the end point of a circular arc. The least significant coordinate of the end point is used only to determine the quadrant. The arc is drawn counter-clockwise.

**c** circle: The first four bytes give the center of the circle, the next two the radius.

**e** erase: Start another frame of output.

**f** linemod: Take the following string, up to a newline, as the style for drawing further lines. The styles are ‘dotted,’ ‘solid,’ ‘longdashed,’ ‘shortdashed,’ and ‘dotdashed.’ Effective only in *plot 4014* and *plot ver*.

**s** space: The next four bytes give the lower left corner of the plotting area; the following four give the upper right corner. The plot will be magnified or reduced to fit the device as closely as possible.

Space settings that exactly fill the plotting area with unity scaling appear below for devices supported by the filters of *plot(1)*. The upper limit is just outside the plotting area. In every case the plotting area is taken to be square; points outside may be displayable on devices whose face isn't square.

```
4014      space(0, 0, 3120, 3120);
ver       space(0, 0, 2048, 2048);
300, 300s space(0, 0, 4096, 4096);
450      space(0, 0, 4096, 4096);
```

**SEE ALSO**

plot(1), plot(3), graph(1)

**NAME**

tp – DEC/mag tape formats

**DESCRIPTION**

The command *tp* dumps files to and extracts files from DECtape and magtape. The formats of these tapes are the same except that magtapes have larger directories.

Block zero contains a copy of a stand-alone bootstrap program. See *bproc*(8).

Blocks 1 through 24 for DECtape (1 through 62 for magtape) contain a directory of the tape. There are 192 (resp. 496) entries in the directory; 8 entries per block; 64 bytes per entry. Each entry has the following format:

```
struct {
    char    pathname[32];
    int     mode;
    char    uid;
    char    gid;
    char    unused1;
    char    size[3];
    long    modtime;
    int     tapeaddr;
    char    unused2[16];
    int     checksum;
};
```

The path name entry is the path name of the file when put on the tape. If the pathname starts with a zero word, the entry is empty. It is at most 32 bytes long and ends in a null byte. Mode, uid, gid, size and time modified are the same as described under i-nodes (see file system *filsys*(5)). The tape address is the tape block number of the start of the contents of the file. Every file starts on a block boundary. The file occupies  $(\text{size}+511)/512$  blocks of continuous tape. The checksum entry has a value such that the sum of the 32 words of the directory entry is zero.

Blocks above 25 (resp. 63) are available for file storage.

A fake entry has a size of zero.

**SEE ALSO**

*filsys*(5), *tp*(1)

**BUGS**

The *pathname*, *uid*, *gid*, and *size* fields are too small.

**NAME**

ttys – terminal initialization data

**DESCRIPTION**

The *ttys* file is read by the *init* program and specifies which terminal special files are to have a process created for them which will allow people to log in. It contains one line per special file.

The first character of a line is either '0' or '1'; the former causes the line to be ignored, the latter causes it to be effective. The second character is used as an argument to *getty*(8), which performs such tasks as baud-rate recognition, reading the login name, and calling *login*. For normal lines, the character is '0'; other characters can be used, for example, with hard-wired terminals where speed recognition is unnecessary or which have special characteristics. (*Getty* will have to be fixed in such cases.) The remainder of the line is the terminal's entry in the device directory, */dev*.

**FILES**

*/etc/ttys*

**SEE ALSO**

*init*(8), *getty*(8), *login*(1)

**NAME**

types – primitive system data types

**SYNOPSIS**

```
#include <sys/types.h>
```

**DESCRIPTION**

The data types defined in the include file are used in UNIX system code; some data of these types are accessible to user code:

```
typedef struct { int r[1]; } *    physadr;
typedef long      daddr_t;
typedef char *    caddr_t;
typedef unsigned short ino_t;
typedef char      cnt_t;
typedef long      time_t;
typedef int       label_t[6];
typedef short     dev_t;
typedef long      off_t;
typedef long      paddr_t;
```

The form *daddr\_t* is used for disk addresses except in an i-node on disk, see *filsys(5)*. Times are encoded in seconds since 00:00:00 GMT, January 1, 1970. The major and minor parts of a device code specify kind and unit number of a device and are installation-dependent. Offsets are measured in bytes from the beginning of a file. The *label\_t* variables are used to save the processor state while another process is running.

**SEE ALSO**

*filsys(5)*, *time(2)*, *lseek(2)*, *adb(1)*

**NAME**

utmp, wtmp – login records

**SYNOPSIS**

```
#include <utmp.h>
```

**DESCRIPTION**

The *utmp* file allows one to discover information about who is currently using UNIX. The file is a sequence of entries with the following structure declared in the include file:

```
struct utmp {
    char    ut_line[8];           /* tty name */
    char    ut_name[8];          /* user id */
    long    ut_time;             /* time on */
};
```

This structure gives the name of the special file associated with the user's terminal, the user's login name, and the time of the login in the form of *time(2)*.

The *wtmp* file records all logins and logouts. Its format is exactly like *utmp* except that a null user name indicates a logout on the associated terminal. Furthermore, the terminal name “~” indicates that the system was rebooted at the indicated time; the adjacent pair of entries with terminal names ‘|’ and ‘}’ indicate the system-maintained time just before and just after a *date* command has changed the system's idea of the time.

*Wtmp* is maintained by *login(1)* and *init(8)*. Neither of these programs creates the file, so if it is removed record-keeping is turned off. It is summarized by *ac(1)*.

**FILES**

/etc/utmp  
/usr/adm/wtmp

**SEE ALSO**

login(1), init(8), who(1), ac(1)

**NAME**

arithmetic – provide drill in number facts

**SYNOPSIS**

`/usr/games/arithmetic [ +-x/ ] [ range ]`

**DESCRIPTION**

*Arithmetic* types out simple arithmetic problems, and waits for an answer to be typed in. If the answer is correct, it types back "Right!", and a new problem. If the answer is wrong, it replies "What?", and waits for another answer. Every twenty problems, it publishes statistics on correctness and the time required to answer.

To quit the program, type an interrupt (delete).

The first optional argument determines the kind of problem to be generated; +-x/ respectively cause addition, subtraction, multiplication, and division problems to be generated. One or more characters can be given; if more than one is given, the different types of problems will be mixed in random order; default is +-.

*Range* is a decimal number; all addends, subtrahends, differences, multiplicands, divisors, and quotients will be less than or equal to the value of *range*. Default *range* is 10.

At the start, all numbers less than or equal to *range* are equally likely to appear. If the respondent makes a mistake, the numbers in the problem which was missed become more likely to reappear.

As a matter of educational philosophy, the program will not give correct answers, since the learner should, in principle, be able to calculate them. Thus the program is intended to provide drill for someone just past the first learning stage, not to teach number facts *de novo*. For almost all users, the relevant statistic should be time per problem, not percent correct.

**NAME**

backgammon – the game

**SYNOPSIS**

**/usr/games/backgammon**

**DESCRIPTION**

This program does what you expect. It will ask whether you need instructions.



**NAME**

banner – make long posters

**SYNOPSIS**

**/usr/games/banner**

**DESCRIPTION**

*Banner* reads the standard input and prints it sideways in huge built-up letters on the standard output.

**NAME**

`bcd`, `ppt` – convert to antique media

**SYNOPSIS**

`/usr/games/bcd` *text*

`/usr/games/ppt`

**DESCRIPTION**

*Bcd* converts the literal *text* into a form familiar to old-timers.

*Ppt* converts the standard input into yet another form.

**SEE ALSO**

`dd(1)`

**NAME**

bj – the game of black jack

**SYNOPSIS**

**/usr/games/bj**

**DESCRIPTION**

*Bj* is a serious attempt at simulating the dealer in the game of black jack (or twenty-one) as might be found in Reno. The following rules apply:

The bet is \$2 every hand.

A player 'natural' (black jack) pays \$3. A dealer natural loses \$2. Both dealer and player naturals is a 'push' (no money exchange).

If the dealer has an ace up, the player is allowed to make an 'insurance' bet against the chance of a dealer natural. If this bet is not taken, play resumes as normal. If the bet is taken, it is a side bet where the player wins \$2 if the dealer has a natural and loses \$1 if the dealer does not.

If the player is dealt two cards of the same value, he is allowed to 'double'. He is allowed to play two hands, each with one of these cards. (The bet is doubled also; \$2 on each hand.)

If a dealt hand has a total of ten or eleven, the player may 'double down'. He may double the bet (\$2 to \$4) and receive exactly one more card on that hand.

Under normal play, the player may 'hit' (draw a card) as long as his total is not over twenty-one. If the player 'busts' (goes over twenty-one), the dealer wins the bet.

When the player 'stands' (decides not to hit), the dealer hits until he attains a total of seventeen or more. If the dealer busts, the player wins the bet.

If both player and dealer stand, the one with the largest total wins. A tie is a push.

The machine deals and keeps score. The following questions will be asked at appropriate times. Each question is answered by **y** followed by a new line for 'yes', or just new line for 'no'.

? (means, 'do you want a hit?')

Insurance?

Double down?

Every time the deck is shuffled, the dealer so states and the 'action' (total bet) and 'standing' (total won or lost) is printed. To exit, hit the interrupt key (DEL) and the action and standing will be printed.

**NAME**

checkers – game

**SYNOPSIS**`/usr/games/checkers`**DESCRIPTION***Checkers* uses standard notation for the board:

| BLACK |     |     |     |     |     |     |     |
|-------|-----|-----|-----|-----|-----|-----|-----|
| ///   | 1   | /// | 2   | /// | 3   | /// | 4   |
| ///   |     | /// |     | /// |     | /// |     |
| 5     | /// | 6   | /// | 7   | /// | 8   | /// |
| ///   |     | /// |     | /// |     | /// |     |
| ///   | 9   | /// | 10  | /// | 11  | /// | 12  |
| ///   |     | /// |     | /// |     | /// |     |
| 13    | /// | 14  | /// | 15  | /// | 16  | /// |
| ///   |     | /// |     | /// |     | /// |     |
| ///   | 17  | /// | 18  | /// | 19  | /// | 20  |
| ///   |     | /// |     | /// |     | /// |     |
| 21    | /// | 22  | /// | 23  | /// | 24  | /// |
| ///   |     | /// |     | /// |     | /// |     |
| ///   | 25  | /// | 26  | /// | 27  | /// | 28  |
| ///   |     | /// |     | /// |     | /// |     |
| 29    | /// | 30  | /// | 31  | /// | 32  | /// |
| ///   |     | /// |     | /// |     | /// |     |

WHITE

Black plays first. The program normally plays white. To specify a move, name the square moved from and the square moved to. For multiple jumps name all the squares touched.

Certain commands may be given instead of moves:

`reverse` Reverse roles; the program takes over your pieces.

`backup` Undo the last move for each player.

`list` Print the record of the game.

`move` Let the program select a move for you.

`print` Print a map of the present position.

**NAME**

chess – the game of chess

**SYNOPSIS**

**/usr/games/chess**

**DESCRIPTION**

*Chess* is a computer program that plays class D chess. Moves may be given either in standard (descriptive) notation or in algebraic notation. The symbol '+' is used to specify check; 'o-o' and 'o-o-o' specify castling. To play black, type 'first'; to print the board, type an empty line.

Each move is echoed in the appropriate notation followed by the program's reply.

**FILES**

/usr/lib/book                    opening 'book'

**DIAGNOSTICS**

The most cryptic diagnostic is 'eh?' which means that the input was syntactically incorrect.

**WARNING**

Over-use of this program will cause it to go away.

**BUGS**

Pawns may be promoted only to queens.

**NAME**

ching, fortune – the book of changes and other cookies

**SYNOPSIS**

**/usr/games/ching** [ hexagram ]

**/usr/games/fortune**

**DESCRIPTION**

The *I Ching* or *Book of Changes* is an ancient Chinese oracle that has been in use for centuries as a source of wisdom and advice.

The text of the *oracle* (as it is sometimes known) consists of sixty-four *hexagrams*, each symbolized by a particular arrangement of six straight (---) and broken ( - - ) lines. These lines have values ranging from six through nine, with the even values indicating the broken lines.

Each hexagram consists of two major sections. The **Judgement** relates specifically to the matter at hand (E.g., "It furthers one to have somewhere to go.") while the **Image** describes the general attributes of the hexagram and how they apply to one's own life ("Thus the superior man makes himself strong and untiring.").

When any of the lines have the values six or nine, they are moving lines; for each there is an appended judgement which becomes significant. Furthermore, the moving lines are inherently unstable and change into their opposites; a second hexagram (and thus an additional judgement) is formed.

Normally, one consults the oracle by fixing the desired question firmly in mind and then casting a set of changes (lines) using yarrow-stalks or tossed coins. The resulting hexagram will be the answer to the question.

Using an algorithm suggested by S. C. Johnson, the Unix *oracle* simply reads a question from the standard input (up to an EOF) and hashes the individual characters in combination with the time of day, process id and any other magic numbers which happen to be lying around the system. The resulting value is used as the seed of a random number generator which drives a simulated coin-toss divination. The answer is then piped through **nroff** for formatting and will appear on the standard output.

For those who wish to remain steadfast in the old traditions, the oracle will also accept the results of a personal divination using, for example, coins. To do this, cast the change and then type the resulting line values as an argument.

The impatient modern may prefer to settle for Chinese cookies; try *fortune*.

**SEE ALSO**

It furthers one to see the great man.

**DIAGNOSTICS**

The great prince issues commands,  
Founds states, vests families with fiefs.  
Inferior people should not be employed.

**BUGS**

Waiting in the mud  
Brings about the arrival of the enemy.  
  
If one is not extremely careful,  
Somebody may come up from behind and strike him.  
Misfortune.

**NAME**

maze – generate a maze problem

**SYNOPSIS**

*/usr/games/maze/*

**DESCRIPTION**

*Maze* asks a few questions and then prints a maze.

**BUGS**

Some mazes (especially small ones) have no solutions.

**NAME**

moo – guessing game

**SYNOPSIS**

**/usr/games/moo**

**DESCRIPTION**

*Moo* is a guessing game imported from England. The computer picks a number consisting of four distinct decimal digits. The player guesses four distinct digits being scored on each guess. A 'cow' is a correct digit in an incorrect position. A 'bull' is a correct digit in a correct position. The game continues until the player guesses the number (a score of four bulls).



**NAME**

quiz – test your knowledge

**SYNOPSIS**

`/usr/games/quiz` [ `-i` file ] [ `-t` ] [ category1 category2 ]

**DESCRIPTION**

*Quiz* gives associative knowledge tests on various subjects. It asks items chosen from *category1* and expects answers from *category2*. If no categories are specified, *quiz* gives instructions and lists the available categories.

*Quiz* tells a correct answer whenever you type a bare newline. At the end of input, upon interrupt, or when questions run out, *quiz* reports a score and terminates.

The `-t` flag specifies ‘tutorial’ mode, where missed questions are repeated later, and material is gradually introduced as you learn.

The `-i` flag causes the named file to be substituted for the default index file. The lines of these files have the syntax:

```
line      = category newline | category ':' line
category = alternate | category '|' alternate
alternate = empty | alternate primary
primary   = character | '[' category ']' | option
option    = '{' category '}'
```

The first category on each line of an index file names an information file. The remaining categories specify the order and contents of the data in each line of the information file. Information files have the same syntax. Backslash ‘\’ is used as with *sh*(1) to quote syntactically significant characters or to insert transparent newlines into a line. When either a question or its answer is empty, *quiz* will refrain from asking it.

**FILES**

`/usr/games/quiz.k/*`

**BUGS**

The construct ‘a|ab’ doesn’t work in an information file. Use ‘a{b}’.

**NAME**

*reversi* – a game of dramatic reversals

**SYNOPSIS**

`/usr/games/reversi [ [ -r ] file ]`

**DESCRIPTION**

*Reversi* (also known as ‘friends’, ‘Chinese friends’ and ‘Othello’) is played on an 8×8 board using two-sided tokens. Each player takes his turn by placing a token with his side up in an empty square. During the first four turns, players may only place tokens in the four central squares of the board. Subsequently, with each turn, a player *must* capture one or more of his opponent’s tokens. He does this by placing one of his tokens such that it and another of his tokens embrace a solid line of his opponent’s horizontally, vertically or diagonally. Captured tokens are flipped over and thus can be re-captured. If a player cannot outflank his opponent he forfeits his turn. The play continues until the board is filled or until no more outflanking is possible.

In this game, your tokens are asterisks and the machine’s are at-signs. You move by typing in the row and column at which you want to place your token as two digits (1-8), optionally separated by blanks or tabs. You can also type

- c** to continue the game after hitting break (this is only necessary if you interrupt the machine while it is deliberating).
- g n** to start *reversi* playing against itself for the next *n* moves (or until the break key is hit).
- n** to stop printing the board after each move.
- o** to start it up again.
- p** to print the board regardless.
- q** to quit (without dishonor).
- s** to print the score.

*Reversi* also recognizes several commands which are valid only at the start of the game, before any moves have been made. They are

- f** to let the machine go first.
- h n** to ask for a handicap of from one to four corner squares. If you’re good, you can give the machine a handicap by typing a negative number.
- l n** to set the amount of lookahead used by the machine in searching for moves. Zero means none at all. Four is the default. Greater than six means you may fall asleep waiting for the machine to move.
- t n** to tell *reversi* that you will only need *n* seconds to consider each move. If you fail to respond in the allotted time, you forfeit your turn.

If *reversi* is given a file name as an argument, it will checkpoint the game, move by move, by dumping the board onto *file*. The `-r` option will cause *reversi* to restart the game from *file* and continue logging.

**NAME**

ttt, cubic – tic-tac-toe

**SYNOPSIS**

**/usr/games/ttt**

**/usr/games/cubic**

**DESCRIPTION**

*Ttt* is the X and O game popular in the first grade. This is a learning program that never makes the same mistake twice.

Although it learns, it learns slowly. It must lose nearly 80 games to completely know the game.

*Cubic* plays three-dimensional tic-tac-toe on a 4×4×4 board. Moves are specified as a sequence of three coordinate numbers in the range 1-4.

**FILES**

/usr/games/ttt.k learning file

**NAME**

hangman, words – word games

**SYNOPSIS**

**/usr/games/hangman** [ dict ]

**/usr/games/words**

**DESCRIPTION**

*Hangman* chooses a word at least seven letters long from a word list. The user is to guess letters one at a time.

The optional argument names an alternate word list. The special name ‘–a’ gets a particular very large word list.

*Words* prints all the uncapitalized words in the word list that can be made from letters in *string*.

**FILES**

/usr/dict/words           the regular word list

/crp/dict/web2           the the –a word list

**DIAGNOSTICS**

After each round, *hangman* reports the average number of guesses per round and the number of rounds.

**BUGS**

Hyphenated compounds are run together.

UNIX software is distributed without the –a word list.

**NAME**

wump – the game of hunt-the-wumpus

**SYNOPSIS**

**/usr/games/wump**

**DESCRIPTION**

*Wump* plays the game of ' Hunt the Wumpus.' A Wumpus is a creature that lives in a cave with several rooms connected by tunnels. You wander among the rooms, trying to shoot the Wumpus with an arrow, meanwhile avoiding being eaten by the Wumpus and falling into Bottomless Pits. There are also Super Bats which are likely to pick you up and drop you in some random room.

The program asks various questions which you answer one per line; it will give a more detailed description if you want.

This program is based on one described in *People's Computer Company*, 2, 2 (November 1973).

**BUGS**

It will never replace Space War.



**NAME**

ascii – map of ASCII character set

**SYNOPSIS**

**cat /usr/pub/ascii**

**DESCRIPTION**

*Ascii* is a map of the ASCII character set, to be printed as needed. It contains:

|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |  |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| 000 | nu1 | 001 | soh | 002 | stx | 003 | etx | 004 | eot | 005 | enq | 006 | ack | 007 | bel |  |
| 010 | bs  | 011 | ht  | 012 | nl  | 013 | vt  | 014 | np  | 015 | cr  | 016 | so  | 017 | si  |  |
| 020 | dle | 021 | dc1 | 022 | dc2 | 023 | dc3 | 024 | dc4 | 025 | nak | 026 | syn | 027 | etb |  |
| 030 | can | 031 | em  | 032 | sub | 033 | esc | 034 | fs  | 035 | gs  | 036 | rs  | 037 | us  |  |
| 040 | sp  | 041 | !   | 042 | "   | 043 | #   | 044 | \$  | 045 | %   | 046 | &   | 047 | '   |  |
| 050 | (   | 051 | )   | 052 | *   | 053 | +   | 054 | ,   | 055 | -   | 056 | .   | 057 | /   |  |
| 060 | 0   | 061 | 1   | 062 | 2   | 063 | 3   | 064 | 4   | 065 | 5   | 066 | 6   | 067 | 7   |  |
| 070 | 8   | 071 | 9   | 072 | :   | 073 | ;   | 074 | <   | 075 | =   | 076 | >   | 077 | ?   |  |
| 100 | @   | 101 | A   | 102 | B   | 103 | C   | 104 | D   | 105 | E   | 106 | F   | 107 | G   |  |
| 110 | H   | 111 | I   | 112 | J   | 113 | K   | 114 | L   | 115 | M   | 116 | N   | 117 | O   |  |
| 120 | P   | 121 | Q   | 122 | R   | 123 | S   | 124 | T   | 125 | U   | 126 | V   | 127 | W   |  |
| 130 | X   | 131 | Y   | 132 | Z   | 133 | [   | 134 | \   | 135 | ]   | 136 | ^   | 137 | _   |  |
| 140 | `   | 141 | a   | 142 | b   | 143 | c   | 144 | d   | 145 | e   | 146 | f   | 147 | g   |  |
| 150 | h   | 151 | i   | 152 | j   | 153 | k   | 154 | l   | 155 | m   | 156 | n   | 157 | o   |  |
| 160 | p   | 161 | q   | 162 | r   | 163 | s   | 164 | t   | 165 | u   | 166 | v   | 167 | w   |  |
| 170 | x   | 171 | y   | 172 | z   | 173 | {   | 174 |     | 175 | }   | 176 | ~   | 177 | del |  |

**FILES**

/usr/pub/ascii

**NAME**

eqnchar – special character definitions for eqn

**SYNOPSIS**

**eqn** /usr/pub/eqnchar [ files ] | **troff** [ options ]

**neqn** /usr/pub/eqnchar [ files ] | **nroff** [ options ]

**DESCRIPTION**

*Eqnchar* contains *troff* and *nroff* character definitions for constructing characters that are not available on the Graphic Systems typesetter. These definitions are primarily intended for use with *eqn* and *neqn*. It contains definitions for the following characters

|                 |           |                 |   |                |   |
|-----------------|-----------|-----------------|---|----------------|---|
| <i>ciplus</i>   | $\oplus$  |                 |   | <i>square</i>  | □ |
| <i>citimes</i>  | $\otimes$ | <i>langle</i>   | < | <i>circle</i>  | ○ |
| <i>wig</i>      | ~         | <i>rangle</i>   | > | <i>blot</i>    | ■ |
| <i>-wig</i>     | ≈         | <i>hbar</i>     | ℏ | <i>bullet</i>  | • |
| <i>&gt;wig</i>  | ≷         | <i>ppd</i>      | ⊥ | <i>prop</i>    | ∞ |
| <i>&lt;wig</i>  | ≸         | <->             | ↔ | <i>empty</i>   | ∅ |
| <i>=wig</i>     | ≍         | <=>             | ↔ | <i>member</i>  | ∈ |
| <i>star</i>     | *         | <               | ⋈ | <i>nomem</i>   | ∉ |
| <i>bigstar</i>  | *         | >               | ⋈ | <i>cup</i>     | ∪ |
| <i>=dot</i>     | ⋮         | <i>ang</i>      | ∠ | <i>cap</i>     | ∩ |
| <i>orsign</i>   | ∨         | <i>rang</i>     | ⊥ | <i>incl</i>    | ⊆ |
| <i>andsign</i>  | ∧         | <i>3dot</i>     | ⋮ | <i>subset</i>  | ⊂ |
| <i>=del</i>     | ≠         | <i>thf</i>      | ∴ | <i>supset</i>  | ⊃ |
| <i>oppA</i>     | ∇         | <i>quarter</i>  | ¼ | <i>!subset</i> | ⊈ |
| <i>oppE</i>     | ≡         | <i>3quarter</i> | ¾ | <i>!supset</i> | ⊉ |
| <i>angstrom</i> | Å         | <i>degree</i>   | ° |                |   |

**FILES**

/usr/pub/eqnchar

**SEE ALSO**

troff(1), eqn(1)



**NAME**

hier – file system hierarchy

**DESCRIPTION**

The following outline gives a quick tour through a representative directory hierarchy.

```

/      root
/dev/  devices (4)
      console main console, tty(4)
      tty*   terminals, tty(4)
      cat    phototypesetter cat(4)
      rp*    disks, rp, hp(4)
      rrp*   raw disks, rp, hp(4)
      ...
/bin/  utility programs, cf /usr/bin/ (1)
      as    assembler first pass, cf /usr/lib/as2
      cc    C compiler executive, cf /usr/lib/c[012]
      ...
/lib/  object libraries and other stuff, cf /usr/lib/
      libc.a  system calls, standard I/O, etc. (2,3,3S)
      libm.a  math routines (3M)
      libplot.a
              plotting routines, plot(3)
      libF77.a
              Fortran runtime support
      libI77.a Fortran I/O
      ...
      as2    second pass of as(1)
      c[012] passes of cc(1)
      ...
/etc/  essential data and dangerous maintenance utilities
      passwd password file, passwd(5)
      group  group file, group(5)
      motd  message of the day, login(1)
      mtab  mounted file table, mtab(5)
      ddate dump history, dump(1)
      ttys  properties of terminals, ttys(5)
      getty part of login, getty(8)
      init  the father of all processes, init(8)
      rc    shell program to bring the system up
      cron  the clock daemon, cron(8)
      mount mount(1)
      wall  wall(1)
      ...
/tmp/  temporary files, usually on a fast device, cf /usr/tmp/
      e*    used by ed(1)
      ctm*  used by cc(1)
      ...
/usr/  general-purpose directory, usually a mounted file system
      adm/  administrative information
              wtmp  login history, utmp(5)
              messages
                      hardware error messages
      tracct phototypesetter accounting, troff(1)

```

vpacct line printer accounting *lpr*(1)

/usr /bin  
 utility programs, to keep /bin/ small

tmp/ temporaries, to keep /tmp/ small

stm\* used by *sort*(1)

raster used by *plot*(1)

dict/ word lists, etc.

words principal word list, used by *look*(1)

spellhist  
 history file for *spell*(1)

games/

bj blackjack

hangman

quiz.k/ what *quiz*(6) knows

index category index

africa countries and capitals

...

...

include/ standard #include files

a.out.h object file layout, *a.out*(5)

stdio.h standard I/O, *stdio*(3)

math.h (3M)

...

sys/ system-defined layouts, cf /usr/sys/h

acct.h process accounts, *acct*(5)

buf.h internal system buffers

...

lib/ object libraries and stuff, to keep /lib/ small

lint[12] subprocesses for *lint*(1)

llib-lc dummy declarations for /lib/libc.a, used by *lint*(1)

llib-lm dummy declarations for /lib/libc.m

atrun scheduler for *at*(1)

struct/ passes of *struct*(1)

...

tmac/ macros for *troff*(1)

tmac.an macros for *man*(7)

tmac.s macros for *ms*(7)

...

font/ fonts for *troff*(1)

R Times Roman

B Times Bold

...

uucp/ programs and data for *uucp*(1)

L.sys remote system names and numbers

uucico the real copy program

...

suftab table of suffixes for hyphenation, used by *troff*(1)

units conversion tables for *units*(1)

eign list of English words to be ignored by *ptx*(1)

/usr/ man/

volume 1 of this manual, *man*(1)

man0/ general

```

        intro    introduction to volume 1, ms(7) format
        xx      template for manual page
man1/  chapter 1
        as.1
        mount.1m
        ...
cat1/  preprinted pages for man1/
        as.1
        mount.1m
        ...
spool/ delayed execution files
at/    used by at(1)
lpd/   used by lpr(1)
        lock    present when line printer is active
        cf*    copy of file to be printed, if necessary
        df*    daemon control file, lpd(8)
        tf*    transient control file, while lpr is working
uucp/  work files and staging area for uucp(1)
        LOGFILE
                summary log
        LOG.*  log file for one transaction
mail/  mailboxes for mail(1)
        uid    mail file for user uid
        uid.lock
                lock file while uid is receiving mail
wd     initial working directory of a user, typically wd is the user's login name
        .profile set environment for sh(1), environ(5)
        calendar
                user's datebook for calendar(1)
doc/   papers, mostly in volume 2 of this manual, typically in ms(7) format
as/    assembler manual
c      C manual
        ...
sys/   system source
dev/   device drivers
        bio.c   common code
        cat.c   cat(4)
        dh.c   DH11, tty(4)
        tty    tty(4)
        ...
conf/  hardware-dependent code
        mch.s  assembly language portion
        conf   configuration generator
        ...
h/     header (include) files
        acct.h acct(5)
        stat.h stat(2)
        ...
sys/   source for system proper
        main.c
        pipe.c
        sysent.c system entry points

```

```

...
/usr/  src/
      source programs for utilities, etc.
      cmd/  source of commands
            as/    assembler
                makefile
                    recipe for rebuilding the assembler
            as1?.s  source of pass1
            ar.c    source for ar(1)
            ...
            troff/  source for nroff and troff(1)
                nmake  makefile for nroff
                tmake  makefile for troff
            font/  source for font tables, /usr/lib/font/
                ftR.c  Roman
                ...
            term/  terminal characteristics tables, /usr/lib/term/
                tab300.c
                    DASI 300
                ...
            ...
libc/  source for functions in /lib/libc.a
      crt/  C runtime support
            ldiv.s  division into a long
            lmul.s  multiplication to produce long
            ...
      csu/  startup and wrapup routines needed with every C program
            crt0.s  regular startup
            mcr0.s  modified startup for cc -p
      sys/  system calls (2)
            access.s
            alarm.s
            ...
      stdio/ standard I/O functions (3S)
            fgets.c
            fopen.c
            ...
      gen/  other functions in (3)
            abs.c
            atof.c
            ...
            compall shell procedure to compile libc
            mklib  shell procedure to make /lib/libc.a
libI77/ source for /lib/libI77
libF77/
...
games/ source for /usr/games

```

**SEE ALSO**

ls(1), ncheck(1), find(1), grep(1)

**BUGS**

The position of files is subject to change without notice.

**NAME**

man – macros to typeset manual

**SYNOPSIS**

**nroff** –**man** file ...

**troff** –**man** file ...

**DESCRIPTION**

These macros are used to lay out pages of this manual. A skeleton page may be found in the file /usr/man/man0/xx.

Any text argument *t* may be zero to six words. Quotes may be used to include blanks in a 'word'. If *text* is empty, the special treatment is applied to the next input line with text to be printed. In this way .I may be used to italicize a whole line, or .SM followed by .B to make small bold letters.

A prevailing indent distance is remembered between successive indented paragraphs, and is reset to default value upon reaching a non-indented paragraph. Default units for indents *i* are ens.

Type font and size are reset to default values before each paragraph, and after processing font and size setting macros.

These strings are predefined by –**man**:

\\*R    '®', '(Reg)' in *nroff*.

\\*S    Change to default type size.

**FILES**

/usr/lib/tmac/tmac.an

/usr/man/man0/xx

**SEE ALSO**

troff(1), man(1)

**BUGS**

Relative indents don't nest.

**REQUESTS**

| Request        | Cause | If no Break       | Argument | Explanation   |
|----------------|-------|-------------------|----------|---|
| .B <i>t</i>    | no    | <i>t</i> =n.t.l.* |          | Text <i>t</i> is bold.  |
| .BI <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Join words of <i>t</i> alternating bold and italic.   |
| .BR <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Join words of <i>t</i> alternating bold and Roman.  |
| .DT            | no    | .5i li...         |          | Restore default tabs.   |
| .HP <i>i</i>   | yes   | <i>i</i> =p.i.*   |          | Set prevailing indent to <i>i</i> . Begin paragraph with hanging indent.  |
| .I <i>t</i>    | no    | <i>t</i> =n.t.l.  |          | Text <i>t</i> is italic.  |
| .IB <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Join words of <i>t</i> alternating italic and bold.   |
| .IP <i>x i</i> | yes   | <i>x</i> =""      |          | Same as .TP with tag <i>x</i> .   |
| .IR <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Join words of <i>t</i> alternating italic and Roman.  |
| .LP            | yes   | -                 |          | Same as .PP.  |
| .PD <i>d</i>   | no    | <i>d</i> =.4v     |          | Interparagraph distance is <i>d</i> .   |
| .PP            | yes   | -                 |          | Begin paragraph. Set prevailing indent to .5i.  |
| .RE            | yes   | -                 |          | End of relative indent. Set prevailing indent to amount of starting .RS.  |
| .RB <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Join words of <i>t</i> alternating Roman and bold.  |
| .RI <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Join words of <i>t</i> alternating Roman and italic.  |
| .RS <i>i</i>   | yes   | <i>i</i> =p.i.    |          | Start relative indent, move left margin in distance <i>i</i> . Set prevailing indent to .5i for nested indents. |
| .SH <i>t</i>   | yes   | <i>t</i> =n.t.l.  |          | Subhead.  |
| .SM <i>t</i>   | no    | <i>t</i> =n.t.l.  |          | Text <i>t</i> is small.   |

.TH *n c x* yes - Begin page named *n* of chapter *c*; *x* is extra commentary, e.g. 'local', for page foot.  
Set prevailing indent and tabs to .5i.

.TP *i* yes *i*=p.i. Set prevailing indent to *i*. Begin indented paragraph with hanging tag given by next  
text line. If tag doesn't fit, place it on separate line.

\* n.t.l. = next text line; p.i. = prevailing indent

**NAME**

`ms` – macros for formatting manuscripts

**SYNOPSIS**

`nroff` – `ms` [ options ] file ...

`troff` – `ms` [ options ] file ...

**DESCRIPTION**

This package of *nroff* and *troff* macro definitions provides a canned formatting facility for technical papers in various formats. When producing 2-column output on a terminal, filter the output through *col(1)*.

The macro requests are defined below. Many *nroff* and *troff* requests are unsafe in conjunction with this package, however these requests may be used with impunity after the first `.PP`:

```
.bp      begin new page
.br      break output line here
.sp n    insert n spacing lines
.ls n    (line spacing) n=1 single, n=2 double space
.na      no alignment of right margin
```

Output of the *eqn*, *neqn*, *refer*, and *tbl(1)* preprocessors for equations and tables is acceptable as input.

**FILES**

`/usr/lib/tmac/tmac.s`

**SEE ALSO**

*eqn(1)*, *troff(1)*, *refer(1)*, *tbl(1)*

**REQUESTS**

| Request               | Initial Value | Cause Break | Explanation  |
|-----------------------|---------------|-------------|--|
| <code>.1C</code>      | yes           | yes         | One column format on a new page.   |
| <code>.2C</code>      | no            | yes         | Two column format.   |
| <code>.AB</code>      | no            | yes         | Begin abstract.  |
| <code>.AE</code>      | -             | yes         | End abstract.  |
| <code>.AI</code>      | no            | yes         | Author's institution follows. Suppressed in TM.  |
| <code>.AT</code>      | no            | yes         | Print 'Attached' and turn off line filling.  |
| <code>.AU x y</code>  | no            | yes         | Author's name follows. <i>x</i> is location and <i>y</i> is extension, ignored except in TM.   |
| <code>.B x</code>     | no            | no          | Print <i>x</i> in boldface; if no argument switch to boldface.   |
| <code>.B1</code>      | no            | yes         | Begin text to be enclosed in a box.  |
| <code>.B2</code>      | no            | yes         | End text to be boxed & print it.   |
| <code>.BT</code>      | date          | no          | Bottom title, automatically invoked at foot of page. May be redefined.   |
| <code>.BX x</code>    | no            | no          | Print <i>x</i> in a box.   |
| <code>.CS x...</code> | -             | yes         | Cover sheet info if TM format, suppressed otherwise. Arguments are number of text pages, other pages, total pages, figures, tables, references.  |
| <code>.CT</code>      | no            | yes         | Print 'Copies to' and enter no-fill mode.  |
| <code>.DA x</code>    | <i>nroff</i>  | no          | 'Date line' at bottom of page is <i>x</i> . Default is today.  |
| <code>.DE</code>      | -             | yes         | End displayed text. Implies <code>.KE</code> .   |
| <code>.DS x</code>    | no            | yes         | Start of displayed text, to appear verbatim line-by-line. <i>x</i> =I for indented display (default), <i>x</i> =L for left-justified on the page, <i>x</i> =C for centered, <i>x</i> =B for make left-justified block, then center whole block. Implies <code>.KS</code> . |
| <code>.EG</code>      | no            | -           | Print document in BTL format for 'Engineer's Notes.' Must be first.  |
| <code>.EN</code>      | -             | yes         | Space after equation produced by <i>eqn</i> or <i>neqn</i> .   |
| <code>.EQ x y</code>  | -             | yes         | Precede equation; break out and add space. Equation number is <i>y</i> . The optional argument <i>x</i> may be <i>I</i> to indent equation (default), <i>L</i> to left-adjust the equation, or <i>C</i> to center the equation.  |

|                 |       |     |  |
|-----------------|-------|-----|--|
| .FE             | -     | yes | End footnote.  |
| .FS             | no    | no  | Start footnote. The note will be moved to the bottom of the page.  |
| .HO             | -     | no  | 'Bell Laboratories, Holmdel, New Jersey 07733'.  |
| .I <i>x</i>     | no    | no  | Italicize <i>x</i> ; if <i>x</i> missing, italic text follows.   |
| .IH             | no    | no  | 'Bell Laboratories, Naperville, Illinois 60540'  |
| .IM             | no    | no  | Print document in BTL format for an internal memorandum. Must be first.  |
| .IP <i>x y</i>  | no    | yes | Start indented paragraph, with hanging tag <i>x</i> . Indentation is <i>y</i> ens (default 5).   |
| .KE             | -     | yes | End keep. Put kept text on next page if not enough room.   |
| .KF             | no    | yes | Start floating keep. If the kept text must be moved to the next page, float later text back to this page.  |
| .KS             | no    | yes | Start keeping following text.  |
| .LG             | no    | no  | Make letters larger.   |
| .LP             | yes   | yes | Start left-blocked paragraph.  |
| .MF             | -     | -   | Print document in BTL format for 'Memorandum for File.' Must be first.   |
| .MH             | -     | no  | 'Bell Laboratories, Murray Hill, New Jersey 07974'.  |
| .MR             | -     | -   | Print document in BTL format for 'Memorandum for Record.' Must be first.   |
| .ND <i>date</i> | troff | no  | Use date supplied (if any) only in special BTL format positions; omit from page footer.  |
| .NH <i>n</i>    | -     | yes | Same as .SH, with section number supplied automatically. Numbers are multilevel, like 1.2.3, where <i>n</i> tells what level is wanted (default is 1).     |
| .NL             | yes   | no  | Make letters normal size.  |
| .OK             | -     | yes | 'Other keywords' for TM cover sheet follow.  |
| .PP             | no    | yes | Begin paragraph. First line indented.  |
| .PT             | pg #  | -   | Page title, automatically invoked at top of page. May be redefined.  |
| .PY             | -     | no  | 'Bell Laboratories, Piscataway, New Jersey 08854'  |
| .QE             | -     | yes | End quoted (indented and shorter) material.  |
| .QP             | -     | yes | Begin single paragraph which is indented and shorter.  |
| .QS             | -     | yes | Begin quoted (indented and shorter) material.  |
| .R              | yes   | no  | Roman text follows.  |
| .RE             | -     | yes | End relative indent level.   |
| .RP             | no    | -   | Cover sheet and first page for released paper. Must precede other requests.  |
| .RS             | -     | yes | Start level of relative indentation. Following .IP's are measured from current indentation.  |
| .SG <i>x</i>    | no    | yes | Insert signature(s) of author(s), ignored except in TM. <i>x</i> is the reference line (initials of author and typist).                                    |
| .SH             | -     | yes | Section head follows, font automatically bold.   |
| .SM             | no    | no  | Make letters smaller.  |
| .TA <i>x...</i> | 5...  | no  | Set tabs in ens. Default is 5 10 15 ...  |
| .TE             | -     | yes | End table.   |
| .TH             | -     | yes | End heading section of table.  |
| .TL             | no    | yes | Title follows.   |
| .TM <i>x...</i> | no    | -   | Print document in BTL technical memorandum format. Arguments are TM number, (quoted list of) case number(s), and file number. Must precede other requests. |
| .TR <i>x</i>    | -     | -   | Print in BTL technical report format; report number is <i>x</i> . Must be first.   |
| .TS <i>x</i>    | -     | yes | Begin table; if <i>x</i> is <i>H</i> table has repeated heading.   |
| .UL <i>x</i>    | -     | no  | Underline argument (even in troff).  |
| .UX             | -     | no  | 'UNIX'; first time used, add footnote 'UNIX is a trademark of Bell Laboratories.'  |
| .WH             | -     | no  | 'Bell Laboratories, Whippany, New Jersey 07981'.   |



**NAME**

terminals— conventional names

**DESCRIPTION**

These names are used by certain commands and are maintained as part of the shell environment (see *sh(1)*, *environ(5)*).

|          |  |
|----------|--|
| 1620     | DIABLO 1620 (and others using HyType II)     |
| 1620-12  | same, in 12-pitch mode                       |
| 300      | DASI/DTC/GSI 300 (and others using HyType I) |
| 300-12   | same, in 12-pitch mode                       |
| 300s     | DASI/DTC 300/S                               |
| 300s-12  | same, in 12-pitch mode                       |
| 33       | TELETYPE® Model 33                           |
| 37       | TELETYPE Model 37                            |
| 40-2     | TELETYPE Model 40/2                          |
| 43       | TELETYPE Model 43                            |
| 450      | DASI 450 (same as Diablo 1620)               |
| 450-12   | same, in 12-pitch mode                       |
| 450-12-8 | same, in 12-pitch, 8 lines/inch mode         |
| 735      | Texas Instruments TI735 (and TI725)          |
| 745      | Texas Instruments TI745                      |
| dumb     | terminals with no special features           |
| hp       | Hewlett-Packard HP264? series terminals      |
| 4014     | Tektronix 4014                               |
| tn1200   | General Electric TermiNet 1200               |
| tn300    | General Electric TermiNet 300                |
| vt05     | Digital Equipment Corp. VT05                 |

Commands whose behavior may depend on the terminal accept arguments of the form **-Tterm**, where *term* is one of the names given above. If no such argument is present, a command may consult the shell environment for the terminal type.

**SEE ALSO**

*stty(1)*, *tabs(1)*, *plot(1)*, *sh(1)*, *environ(5)*  
*troff(1)* for *nroff*

**BUGS**

The programs that ought to adhere to this nomenclature do so only fitfully.



**NAME**

boot – startup procedures

**DESCRIPTION**

A PDP11/45 and PDP11/70 UNIX system is started by a two-stage process. The first is a primary bootstrap which is able to read in relatively small stand-alone programs; the second (called *boot*) is used to read in the system itself.

The primary bootstrap must reside in the otherwise unused block zero of the boot device. It can be read in and started by the standard ROM programs, or if necessary by keying in a small startup routine. This program is capable of loading type 407 executable files (not shared, not separate I&D). The user types on the system console the name of the program wished, in this case *boot*, followed by a carriage return; the named program is retrieved from the file system that starts at block 0 of drive 0 of the boot device. No prompt is given, no diagnostic results if the file cannot be found, and no provision is made for correcting typographical errors.

The second step, called *boot*, actually brings in the system. When read into location 0 and executed, *boot* sets up memory management, relocates itself into high memory, and types a ':' on the console. Then it reads from the console a device specification (see below) followed immediately by a pathname. *Boot* finds the corresponding file on the given device, loads that file into memory location zero, sets up memory management as required, and calls the program by executing a 'trap' instruction. Normal line editing characters can be used.

Conventionally, the name of the secondary boot program is '/boot' and the name of the current version of the system is '/unix'. Then, the recipe is:

- 1) Load block 0 of the boot device by fiddling with the console keys as appropriate for your hardware. If you have no appropriate ROM, some programs suitable for manual use are given below.
- 2) Type *boot*.
- 3) When the prompt is given, type
 

```
hp(0,0)unix
```

 or
 

```
rp(0,0)unix
```

 depending on whether you are loading from an RP04/5/6 or an RP03 respectively. The first 0 indicates the physical unit number; the second indicates the block number of the beginning of the logical file system to be searched. (See below).

When the system is running, it types a '#' prompt. After doing any file system checks and setting the date (*date*(8)) a multi-user system is brought up by typing an EOT (control-d) in response to the '#' prompt.

**Device specifications.** A device specification has the following form:

```
device(unit,offset)
```

where *device* is the type of the device to be searched, *unit* is the unit number of the device, and *offset* is the block offset of the file system on the device. *Device* is one of the following

```
rp      RP03
hp      RP04/5/6
rk      RK05
```

For example, the specification

```
hp(1,7000)
```

indicates an RP03 disk, unit 1, and the file system found starting at block 7000 (cylinder 35).

**ROM programs.** The following programs to call the primary bootstrap may be installed in read-only memories or manually keyed into main memory. Each program is position-independent but should be placed well above location 0 so it will not be overwritten. Each reads a block from the beginning of a device into core location zero. The octal words constituting the program are listed on the left.

RK (drive 0):

```

012700      mov      $rkda,r0
177412
005040      clr      -(r0)                / rkda cleared by start
010040      mov      r0,-(r0)
012740      mov      $5,-(r0)
000005
105710      1:      tstb     (r0)
002376      bge      1b
005007      clr      pc

```

RP (drive 0)

```

012700      mov      $rpmr,r0
176726
005040      clr      -(r0)
005040      clr      -(r0)
005040      clr      -(r0)
010040      mov      r0,-(r0)
012740      mov      $5,-(r0)
000005
105710      1:      tstb     (r0)
002376      bge      1b
005007      clr      pc

```

#### FILES

/unix – system code  
 /usr/mdec/rpuboot, /usr/mdec/hpuboot – copies of primary bootstrap  
 /boot – second stage bootstrap

#### SEE ALSO

init(8)

**NAME**

crash – what to do when the system crashes

**DESCRIPTION**

This section gives at least a few clues about how to proceed if the system crashes. It can't pretend to be complete.

*Bringing it back up.* If the reason for the crash is not evident (see below for guidance on 'evident') you may want to try to dump the system if you feel up to debugging. At the moment a dump can be taken only on magtape. With a tape mounted and ready, stop the machine, load address 44, and start. This should write a copy of all of core on the tape with an EOF mark. Caution: Any error is taken to mean the end of core has been reached. This means that you must be sure the ring is in, the tape is ready, and the tape is clean and new. If the dump fails, you can try again, but some of the registers will be lost. See below for what to do with the tape.

In restarting after a crash, always bring up the system single-user. This is accomplished by following the directions in *boot(8)* as modified for your particular installation; a single-user system is indicated by having a particular value in the switches (173030 unless you've changed *init*) as the system starts executing. When it is running, perform a *dcheck* and *icheck(1)* on all file systems which could have been in use at the time of the crash. If any serious file system problems are found, they should be repaired. When you are satisfied with the health of your disks, check and set the date if necessary, then come up multi-user. This is most easily accomplished by changing the single-user value in the switches to something else, then logging out by typing an EOT.

To even boot UNIX at all, three files (and the directories leading to them) must be intact. First, the initialization program */etc/init* must be present and executable. If it is not, the CPU will loop in user mode at location 6. For *init* to work correctly, */dev/tty8* and */bin/sh* must be present. If either does not exist, the symptom is best described as thrashing. *Init* will go into a *fork/exec* loop trying to create a Shell with proper standard input and output.

If you cannot get the system to boot, a runnable system must be obtained from a backup medium. The root file system may then be doctored as a mounted file system as described below. If there are any problems with the root file system, it is probably prudent to go to a backup system to avoid working on a mounted file system.

*Repairing disks.* The first rule to keep in mind is that an addled disk should be treated gently; it shouldn't be mounted unless necessary, and if it is very valuable yet in quite bad shape, perhaps it should be dumped before trying surgery on it. This is an area where experience and informed courage count for much.

The problems reported by *icheck* typically fall into two kinds. There can be problems with the free list: duplicates in the free list, or free blocks also in files. These can be cured easily with an *icheck -s*. If the same block appears in more than one file or if a file contains bad blocks, the files should be deleted, and the free list reconstructed. The best way to delete such a file is to use *clri(1)*, then remove its directory entries. If any of the affected files is really precious, you can try to copy it to another device first.

*Dcheck* may report files which have more directory entries than links. Such situations are potentially dangerous; *clri* discusses a special case of the problem. All the directory entries for the file should be removed. If on the other hand there are more links than directory entries, there is no danger of spreading infection, but merely some disk space that is lost for use. It is sufficient to copy the file (if it has any entries and is useful) then use *clri* on its inode and remove any directory entries that do exist.

Finally, there may be inodes reported by *dcheck* that have 0 links and 0 entries. These occur on the root device when the system is stopped with pipes open, and on other file systems when the system stops with files that have been deleted while still open. A *clri* will free the inode, and an *icheck -s* will recover any missing blocks.

*Why did it crash?* UNIX types a message on the console typewriter when it voluntarily crashes. Here is the current list of such messages, with enough information to provide a hope at least of the remedy. The message has the form 'panic: ...', possibly accompanied by other information. Left unstated in all cases is the possibility that hardware or software error produced the message in some unexpected way.

blkdev

The *getblk* routine was called with a nonexistent major device as argument. Definitely hardware or software error.

devtab

Null device table entry for the major device used as argument to *getblk*. Definitely hardware or software error.

iinit

An I/O error reading the super-block for the root file system during initialization.

out of inodes

A mounted file system has no more i-nodes when creating a file. Sorry, the device isn't available; the *icheck* should tell you.

no fs

A device has disappeared from the mounted-device table. Definitely hardware or software error.

no imt

Like 'no fs', but produced elsewhere.

no inodes

The in-core inode table is full. Try increasing NINODE in param.h. Shouldn't be a panic, just a user error.

no clock

During initialization, neither the line nor programmable clock was found to exist.

swap error

An unrecoverable I/O error during a swap. Really shouldn't be a panic, but it is hard to fix.

unlink - iget

The directory containing a file being deleted can't be found. Hardware or software.

out of swap space

A program needs to be swapped out, and there is no more swap space. It has to be increased. This really shouldn't be a panic, but there is no easy fix.

out of text

A pure procedure program is being executed, and the table for such things is full. This shouldn't be a panic.

trap

An unexpected trap has occurred within the system. This is accompanied by three numbers: a 'ka6', which is the contents of the segmentation register for the area in which the system's stack is kept; 'aps', which is the location where the hardware stored the program status word during the trap; and a 'trap type' which encodes which trap occurred. The trap types are:

|   |   |
|---|---|
| 0 | bus error                                   |
| 1 | illegal instruction                         |
| 2 | BPT/trace                                   |
| 3 | IOT   |
| 4 | power fail                                  |
| 5 | EMT   |
| 6 | recursive system call (TRAP instruction)    |
| 7 | 11/70 cache parity, or programmed interrupt |

- 10 floating point trap
- 11 segmentation violation

In some of these cases it is possible for octal 20 to be added into the trap type; this indicates that the processor was in user mode when the trap occurred. If you wish to examine the stack after such a trap, either dump the system, or use the console switches to examine core; the required address mapping is described below.

*Interpreting dumps.* All file system problems should be taken care of before attempting to look at dumps. The dump should be read into the file `/usr/sys/core`; `cp(1)` will do. At this point, you should execute `ps -alxk` and `who` to print the process table and the users who were on at the time of the crash. You should dump (`od(1)`) the first 30 bytes of `/usr/sys/core`. Starting at location 4, the registers R0, R1, R2, R3, R4, R5, SP and KDSA6 (KISA6 for 11/40s) are stored. If the dump had to be restarted, R0 will not be correct. Next, take the value of KA6 (location 022(8) in the dump) multiplied by 0100(8) and dump 01000(8) bytes starting from there. This is the per-process data associated with the process running at the time of the crash. Relabel the addresses 140000 to 141776. R5 is C's frame or display pointer. Stored at (R5) is the old R5 pointing to the previous stack frame. At (R5)+2 is the saved PC of the calling procedure. Trace this calling chain until you obtain an R5 value of 141756, which is where the user's R5 is stored. If the chain is broken, you have to look for a plausible R5, PC pair and continue from there. Each PC should be looked up in the system's name list using `adb(1)` and its ':' command, to get a reverse calling order. In most cases this procedure will give an idea of what is wrong. A more complete discussion of system debugging is impossible here.

**SEE ALSO**

`clri(1)`, `icheck(1)`, `dcheck(1)`, `boot(8)`

**NAME**

*cron* – clock daemon

**SYNOPSIS**

*/etc/cron*

**DESCRIPTION**

*Cron* executes commands at specified dates and times according to the instructions in the file */usr/lib/crontab*. Since *cron* never exits, it should only be executed once. This is best done by running *cron* from the initialization process through the file */etc/rc*; see *init(8)*.

Crontab consists of lines of six fields each. The fields are separated by spaces or tabs. The first five are integer patterns to specify the minute (0-59), hour (0-23), day of the month (1-31), month of the year (1-12), and day of the week (1-7 with 1=monday). Each of these patterns may contain a number in the range above; two numbers separated by a minus meaning a range inclusive; a list of numbers separated by commas meaning any of the numbers; or an asterisk meaning all legal values. The sixth field is a string that is executed by the Shell at the specified times. A percent character in this field is translated to a new-line character. Only the first line (up to a % or end of line) of the command field is executed by the Shell. The other lines are made available to the command as standard input.

Crontab is examined by *cron* every minute.

**FILES**

*/usr/lib/crontab*



**NAME**

getty – set typewriter mode

**SYNOPSIS**

*/etc/getty* [ char ]

**DESCRIPTION**

*Getty* is invoked by *init*(8) immediately after a typewriter is opened following a dial-up. It reads the user's login name and calls *login*(1) with the name as argument. While reading the name *getty* attempts to adapt the system to the speed and type of terminal being used.

*Init* calls *getty* with a single character argument taken from the *ttys*(5) file entry for the terminal line. This argument determines a sequence of line speeds through which *getty* cycles, and also the 'login:' greeting message, which can contain character sequences to put various kinds of terminals in useful states.

The user's name is terminated by a new-line or carriage-return character. In the second case CRMOD mode is set (see *ioctl*(2)).

The name is scanned to see if it contains any lower-case alphabetic characters; if not, and if the name is nonempty, the system is told to map any future upper-case characters into the corresponding lower-case characters.

If the terminal's 'break' key is depressed, *getty* cycles to the next speed appropriate to the type of line and prints the greeting message again.

Finally, *login* is called with the user's name as argument.

The following arguments from the *ttys* file are understood.

- 0 Cycles through 300-1200-150-110 baud. Useful as a default for dialup lines accessed by a variety of terminals.
- Intended for an on-line Teletype model 33, for example an operator's console.
- 1 Optimized for a 150-baud Teletype model 37.
- 2 Intended for an on-line 9600-baud terminal, for example the Telextronix 4104.
- 3 Starts at 1200 baud, cycles to 300 and back. Useful with 212 datasets where most terminals run at 1200 speed.
- 5 Same as '3' but starts at 300.
- 4 Useful for on-line console DECwriter (LA36).

**SEE ALSO**

*init*(8), *login*(1), *ioctl*(2), *ttys*(5)

**NAME**

*init*, *rc* – process control initialization

**SYNOPSIS**

*/etc/init*

*/etc/rc*

**DESCRIPTION**

*Init* is invoked as the last step of the boot procedure (see *boot(8)*). Generally its role is to create a process for each typewriter on which a user may log in.

When *init* first is executed the console typewriter */dev/console* is opened for reading and writing and the shell is invoked immediately. This feature is used to bring up a single-user system. If the shell terminates, *init* comes up multi-user and the process described below is started.

When *init* comes up multiuser, it invokes a shell, with input taken from the file */etc/rc*. This command file performs housekeeping like removing temporary files, mounting file systems, and starting daemons.

Then *init* reads the file */etc/ttys* and forks several times to create a process for each typewriter specified in the file. Each of these processes opens the appropriate typewriter for reading and writing. These channels thus receive file descriptors 0, 1 and 2, the standard input, output and error files. Opening the typewriter will usually involve a delay, since the *open* is not completed until someone is dialed up and carrier established on the channel. Then */etc/getty* is called with argument as specified by the last character of the *ttys* file line. *Getty* reads the user's name and invokes *login(1)* to log in the user and execute the shell.

Ultimately the shell will terminate because of an end-of-file either typed explicitly or generated as a result of hanging up. The main path of *init*, which has been waiting for such an event, wakes up and removes the appropriate entry from the file *utmp*, which records current users, and makes an entry in */usr/adm/wtmp*, which maintains a history of logins and logouts. Then the appropriate typewriter is reopened and *getty* is reinvoked.

*Init* catches the hangup signal SIGHUP and interprets it to mean that the system should be brought from multi user to single user. Use 'kill -1 1' to send the hangup signal.

**FILES**

*/dev/tty?*, */etc/utmp*, */usr/adm/wtmp*, */etc/ttys*, */etc/rc*

**SEE ALSO**

*login(1)*, *kill(1)*, *sh(1)*, *ttys(5)*, *getty(8)*

**NAME**

makekey – generate encryption key

**SYNOPSIS**

**/usr/lib/makekey**

**DESCRIPTION**

*Makekey* improves the usefulness of encryption schemes depending on a key by increasing the amount of time required to search the key space. It reads 10 bytes from its standard input, and writes 13 bytes on its standard output. The output depends on the input in a way intended to be difficult to compute (i.e. to require a substantial fraction of a second).

The first eight input bytes (the *input key*) can be arbitrary ASCII characters. The last two (the *salt*) are best chosen from the set of digits, upper- and lower-case letters, and '.' and '/'. The salt characters are repeated as the first two characters of the output. The remaining 11 output characters are chosen from the same set as the salt and constitute the *output key*.

The transformation performed is essentially the following: the salt is used to select one of 4096 cryptographic machines all based on the National Bureau of Standards DES algorithm, but modified in 4096 different ways. Using the input key as key, a constant string is fed into the machine and recirculated a number of times. The 64 bits that come out are distributed into the 66 useful key bits in the result.

*Makekey* is intended for programs that perform encryption (e.g. *ed* and *crypt(1)*). Usually its input and output will be pipes.

**SEE ALSO**

crypt(1), ed(1)

**NAME**

update – periodically update the super block

**SYNOPSIS**

**/etc/update**

**DESCRIPTION**

*Update* is a program that executes the *sync(2)* primitive every 30 seconds. This insures that the file system is fairly up to date in case of a crash. This command should not be executed directly, but should be executed out of the initialization shell command file.

**SEE ALSO**

*sync(2)*, *sync(1)*, *init(8)*

**BUGS**

With *update* running, if the CPU is halted just as the *sync* is executed, a file system can be damaged. This is partially due to DEC hardware that writes zeros when NPR requests fail. A fix would be to have *sync(1)* temporarily increment the system time by at least 30 seconds to trigger the execution of *update*. This would give 30 seconds grace to halt the CPU.