Fortune C Language Guide

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How to Use This Guide

The Fortune C Language Guide is designed to help you use the C language on the Fortune 32:16. The information included covers those aspects particular to the Fortune system in addition to helpful utilities and more advanced features for very experienced programmers.

The guide is not intended to teach you to program in C. Use the guide along with the C programming manual of your choice. Below is a list of recommended manuals.

- E. W. Kernighan and D. M. Ritchie, The C Programming Language, Prentice-Hall, 1978
- B. W. Kernighan, Programming in C-A Tutorial
- D. M. Ritchie, C Reference Manual

This package includes the following items:

- Fortune C Language Guide
- Two Master disks
- Fortune Systems software registration card

If any item is missing, contact your Fortune Systems dealer for a replacement.

Contents

SECTION I
FORTUNE C LANGUAGE GUIDE

This section contains documentation on the installation of C on the Fortune 32:16, the C compiler, the Fortune symbolic debugger, and machine specific aspects of the Fortune C language. In addition, the support utilities and the interface between Fortran and C on the Fortune 32:16 are discussed.

Using C on the Fortune 32:16

1

C is a general-purpose programming language that runs under the Fortune Operating System on the Fortune 32:16. The Fortune Operating System is a modified version of UNIX, an operating system developed by Bell Laboratories. The C language is simple, efficient, and appropriate for a wide variety of programming applications.

In this section you'll learn first to power up your system. You'll also learn:

- How to install C
- How to format and copy disks
- How to select and leave C
- How to use the C compiler

The first step is to plug in the system. Do this with the power on/off switch in the off position. For your safety, and the protection of the system, use a three-pronged electrical outlet that fits the connector.

Now push in the white dot on the switch to set the power switch to on. Test the airflow with your hand to make sure that the fan is operating.

First you will see the cursor blinking on the screen. Then the message "Fortune Systems 32:16 Please Wait," with the "Please wait" blinking appears. When you see the heading "Please enter the current date and time," the system is ready to receive information.

Use the following procedure to log onto your system. It is read from left to right. The system category shows you what will appear on the screen. Type what you see in the user category. The comments column provides useful information.

	Procedure	Comments
System	Please set the current date and time, then press (RETURN):	
	Today's date is: mm/dd/yy	Type in six digits to represent month, date, and
User	(current date) (RETURN)	year or press the Return key to accept the date displayed. You don't have to type the slashes.

	Procedure	Comments
		Use the Back Space key to backup within a line and the ↑ and ↓ keys to move up and down between date and time. The Cancel key bypasses this entry altogether.
System	Current time is: hh/mm A P	Type in four digits to represent hours and minutes or press the Return key to accept the time displayed. You don't have to type the colon.
User	(Current time) (RETURN)	
System	Date set to (Day Month Date Time Year) Is this correct (Y/N)	Type y or n to indicate correct/incorrect date and time. Typing n returns you to beginning of date.
User	y (RETURN)	
System	File check successful ...	The dots blink while the system checks the files. If any other message appears get help.
	FORTUNE SYSTEMS 32:16 Press (HELP) For Assistance Type in your name and press (RETURN)	

	Procedure	Comments
User	(account name) (RETURN)	Type your account name. Type newuser to create a new account.
System	Type in your password and press (RETURN):	
User	(password) (RETURN)	Type your password. This is requested only if you have one assigned.
System	__% of the available space is currently in use.	When your system reaches 90% full, archive some files to free up more work space.
	FORTUNE SYSTEMS GLOBAL MENU	Make your selection from the Global Menu.

Before you begin to use C, you need to install the programs and files from the two master flexible disks to a hard disk on the system you are using. You need a mininum of 384k of memory to load the C compiler.

The C compiler is loaded through the product maintenance menu. When the global menu appears, select Product Maintenance.

Follow the procedures below to load the software. To do this procedure you must be logged in as manager. First shut down the system. Then turn it on again while holding down the Cancel key.

	Procedure		Comments
System	FORTUNE SYSTEMS GLOBAL MENU		To power down, select s2.
User	s2	(RETURN)	
System	System Management		Choose 30 from the system management menu.
User	30	(RETURN)	
System	Fortune Systems 32:16 ShutDown (takes about 30 seconds) Do you want to continue?		
User	yes	(RETURN)	Wait for system messages.

	Procedure		Comments
System	Software shutdown starting, please wait. Software shut down complete Hardware shut down starting, please wait Hardware shut complete Please turn the Fortune Systems 32:16 off		
User			Press off switch. Now turn on system again, holding down CANCEL.
System	Type any highlighted key.		Press the F7 key.
User		(F7)	
System	Set boot file name		
User	hd02/sa/reconf	(RETURN) (EXECUTE)	Move cursor to Max process size.
System	Max process size		Press the Return key 23 times.
User	256	23 (RETURN) (F1) (F4)	
System	Today's date is Current time is:		Bypass this.

	Procedure	Comments
User	(RETURN) (RETURN) yes (RETURN)	
System	Type in your name and press (RETURN)	Log in again.
User	(your account name) (RETURN)	
System	FORTUNE SYSTEMS GLOBAL MENU	Select s5 to load the software.
User	s5 (RETURN)	
System	PRODUCT MAINTENANCE	
User	i (RETURN)	Type i for the install selection.
System	Fortune Systems Corporation Product Maintenance Please insert flexible disk volume 1. Press (RETURN)	Install the development set first. Put the disk labelled "develoment set" in the drive.
User	(RETURN)	
System	This flexible disk is labeled: Development Set xxxx Volume 1 (date)	

	Procedure		Comments
System	Proceed with installation? (y/n):		
User	y	(RETURN)	The system puts a copy on the hard disk.
System	Copy phase of Development Set ... Menu update ... Development Set installation successfully completed. Press (RETURN) for menu or select ahead		
User		(RETURN)	Remove the flexible disk. Repeat the process to install the second disk labelled "C Compiler."
System	FORTUNE SYSTEMS GLOBAL MENU		You're at the global menu.

Before you can use a blank flexible disk to store your application or other files, the disk must be formatted. From the global menu use this procedure to format a flexible disk.

	Procedure		Comments
System	GLOBAL/MENU S1 System Utilities		
User	s1	(RETURN)	
System	SYSTEM UTILITIES MENU		
User	32	(RETURN)	Select Format Flexible Disk.
System	FORMAT FLEXIBLE DISK		Read screen text. Insert a flexible disk.
	Do you want to continue (yes or not)?:		
User	yes	(RETURN)	
System	Please wait for completion message		Do not press any key while this message is on the screen.

	Procedure	Comments
	Your request is complete Please Remove Your Flexible Disk -Press (RETURN) for menu or select ahead	Your disk is formatted. Remove the disk.
User	(RETURN)	
System	FORMAT FLEXIBLE DISK	You can repeat the formatting procedure at this point by beginning at step 3 again.
User	(RETURN)	
System	SYSTEM UTILITIES MENU	
User	(RETURN)	
System	FORTUNE SYSTEMS GLOBAL MENU	

Make a copy of your software as soon as possible. The procedure below is used to back up your master disks. To do this procedure, you must be logged in as manager.

	Procedure		Comments
System	FORTUNE SYSTEMS GLOBAL MENU		
User	s5	(RETURN)	Selects Product Maintenance.
System	PRODUCT MAINTENANCE		
User	b	(RETURN)	Chooses backup.
System	PRODUCT SELECTION MENU		Options are cc or ds.
User	cc		Select C compiler.
System	Fortune Systems Corporation Product Maintenance Do you want to backup 'C' compiler? (y/n):		
User	y	(RETURN)	

	Procedure	Comments
System	Please label a blank flexible disk: 'C' compiler 1000837-01 Volume 1 (date)	
	Insert the disk into drive #0.	Be sure the disk was previously formatted.
User	(RETURN)	
System	Copy phase ... Successfully ... -Press (RETURN) for menu or select ahead	
User	(RETURN)	Repeat the process to back up the development set disk, choosing ds.
System	FORTUNE SYSTEMS GLOBAL MENU	

From the global menu use the following procedure to choose the UNIX command interpreter where you will run C.

	Procedure		Comments
System	FORTUNE SYSTEMS GLOBAL MENU		
User	!sh	(RETURN)	Type !sh. Use the shift 1 key for !. You are now in direct communication with the operating system.
System	$		The $ shows that the system is ready.

Use the ed editor on your Fortune system to develop and edit programs. Refer to your Fortune Operating System Guide for information about using ed.

When you have finished your work use the following procedure to log out.

	Procedure	Comments
System	$	
User	(CTRL)d	Press the CTRL key and d at the same time.

	Procedure	Comments
System	-Press RETURN for menu or select ahead	
User	(RETURN)	Pressing the Return key returns you to the global menu.

The C Compiler (cc)

CC is the command that activates the C compiler. The compiler reads in source code, and translates that code into machine language which can be understood by the computer. The following are the five steps involved in compiling a C program.

1	Preprocessor	This processes any # sign statements.
2	C Compiler	Code in filename.c is translated into assembly language.
3	Optimizer	Code is optimized and thereby reduced in size. The optimizer also increases the runtime speed.
4	Assembler	The object file (filename.o) is created.
5	Load	The executable file (a.out) is created.

A set of options, described in the next few pages, provides variations in compiling results.

To compile a C program enter

```
cc (options) filename.c ...
```

The argument, or filename you enter whose name ends with .c is a C source program. It is compiled and an executable file named a.out is created. In addition, a .o file is created if the -c option is used or more than one c source file is compiled with the same command. This is the object file, the compiled C program. The .o file can later be processed by the loader, then executed. For example, for the file named test.c:

You Enter	Results
cc test.c	a.out

Any number of .c files may be compiled into one a.out file. Again, .o files will also be created for each .c file.

You Enter	Results
cc test1.c test2.c	a.out test1.o test2.o

Arguments other than the C options described below are taken to be loader option arguments or C-compatible object programs. These object programs are typically produced by an earlier cc run, or libraries of C-compatible routines. These programs and the results of any specified compilations are loaded (in the named order) to produce a runnable program named a.out. To create only .o files, use the -c option. No a.out file will result.

You Enter	Results
cc -c test1.c	test1.o

Object files (.o) may be linked to create an a.out file.

You Enter	Results
cc test1.o test2.o	a.out

Already compiled files (.o) and .c files may be run through the compiler with the following results.

You Enter	Results
cc test1.o test2.c	a.out test2.o

Using the -o option you can name an a.out file.

You Enter	Results
cc -o test test1.o test2.c	test test2.o

The following options are interpreted by cc.

-c Does not link object file with libraries. Leaves only the .o file.

You Enter	Results
cc -c test.c	test.o

-O Calls an object code optimizer. Code size will be reduced 20-25% in size and result in a faster running file.

-v Verbose. Compiler lists passes on the screen as they are executed.

You Enter	Results
cc -v test.c	/usr/lib/cpp -DMC68000 -Uvax file.c /tmp/ctm0013H.s /usr/lib/ccom /tmp/ctm001314.s /tmp/ctm00/313.s /usr/lib/ac -o test.o /tmp/ctm001313.s /usr/bin/ld /usr/lib/crt./o file.o /usr/lib/libc.a

-G The stack growth checking is turned off. This improves the code slightly as long as the stack is not used extensively. It decreases the text size.

> Do not run -G on a program that allocates more than 8K of stack.

For example, the following program will fail under the -G option.

```
main ( )
     {
     int x [4000] ,i;
     For (i = 0; i < 4000;i++)
          x [i] =0;

     }
```

-E Runs only the macro preprocessor on the named C programs. The result is sent to the screen.

You Enter	Results (on the screen)
cc -E test.c	#1 "test.c" (text of program)

-C This prevents the macro preprocessor from removing comments.

You Enter	Results
cc -E test.c	Comments are removed
cc -E -C test.c	Comments remain
cc -E -C test.c ff.c	Comments are put into ff.c

-o output Names the final executable file output and leaves the a.out file undisturbed.

-D*name*=*def*
-D*name*

Defines the *name* to the preprocessor, as with #define. If you give no definition, the name is defined as one.

You Enter	Results
cc -DFLEXNAMES	FLEXNAMES is defined and assigned the value 1.
cc -DFLEXNAMES=12	FLEXNAMES is defined and assigned the value 12.

-U*name* Removes any initial definition of *name* in the preprocessor.

-I*dir* # include files whose names do not begin with / are always looked for first in the directory of the *file* argument, then in directories named in -I options, then in directories on a standard list.

The Fortune Symbolic Debugger

Included on the master disks for C is the Fortune symbolic debugger. Fortune Systems Symbolic Debugger (fdb) is a high-level debugging tool developed by the Fortune Systems Corporation. Fdb is language independent so it will serve as a common debugger for all the high level (compiler) languages supported on the Fortune system.

Fdb is a symbolic debugger which can be used with the C language. The format of the fdb command is:

fdb [objfil [directory]]

You use it to examine your files and to provide a controlled environment for file execution. Objfil is an executable program file which has been compiled with the -g (debug) option. The default for objfil is a.out. Core file is not utilized. Directory is the working directory.

It is useful to know that at any time there is a current line and current file. The default for the current file is the file debugged. However, the current file may be changed with the source file examination commands. There are two types of current line. One is current print line, and the other is current execute line. The current execute line can only be changed with program execution while the current print line can be changed with file examination commands.

Names of variables are written just as they are in C. Variables local to a procedure may be accessed using the form 'procedure: variable'. If no procedure name is given, the procedure containing the current line is used by default. It is also possible to refer to structure members as 'variable.member', pointers to structure members as 'variable→member' and array elements as 'variable [number]' and array elements. Combinations of these forms may also be used.

FILES

The file used by fdb is a.out.

DIAGNOSTICS

Error reports are self-explanatory.

BUGS

Error checking for structured variable elements are not performed.

The fdb commands are summarized below.

Command	Meaning
!	Exits the shell (escape)
,	Displays the content of a variable (same as display command)
&	Displays the address of a variable
RETURN key	Repeats the previously executed command
alias	Defines or cancel alias
break	Sets up a breakpoint
comment	Allows a comment line
delete	Deletes breakpoint(s)
display	Displays the content of a variable (same as , command)
dump	Dumps memory contents
equate	Defines or cancels replacement string
file	Redirects source/input/output file

Command	Meaning
find	Searches a given string from the source file
go	Starts or resumes debugged program execution
help	Shows the summary of fdb commands
print	Prints source lines
quit	Exits from fdb and return to shell
restart	Restarts the debug session with optional parameter
set	Sets debugger options such as user definable prompt string
show	Shows status of debug session such as breakpoint, file, window, alias, last command, equate and procedure
trace	Traces program execution
walk	Single step execution

The following terms are defined as used in this description of fdb.

Breakpoint
A location in a program's execution at which either some debugging command is to be performed or the user wishes to gain control.

Command
Debugging command

Debug option
A compiler directive to have extra Symbol table entries added which are utilized by fdb. The option is specified by -g, thus, sometimes it is called -g option under UNIX environment.

Debugging command
A directive that controls the behavior of a debugger.

Debugging session
A period of time during which a debugger is used.

Debugging mode
Execution of a program in conjunction with a debugger.

Linker/loader
The function of a linker is to link the object modules and produce an executable load module. The function of a loader is to load the load module from disk into memory. The linker is called the loader and the loader is the kernel in UNIX.

Object/load module

The input to the linker is called the object module and the output is the load module. There is no clear difference between object and load module in UNIX. Thus the term object and load modules are used interchangeably.

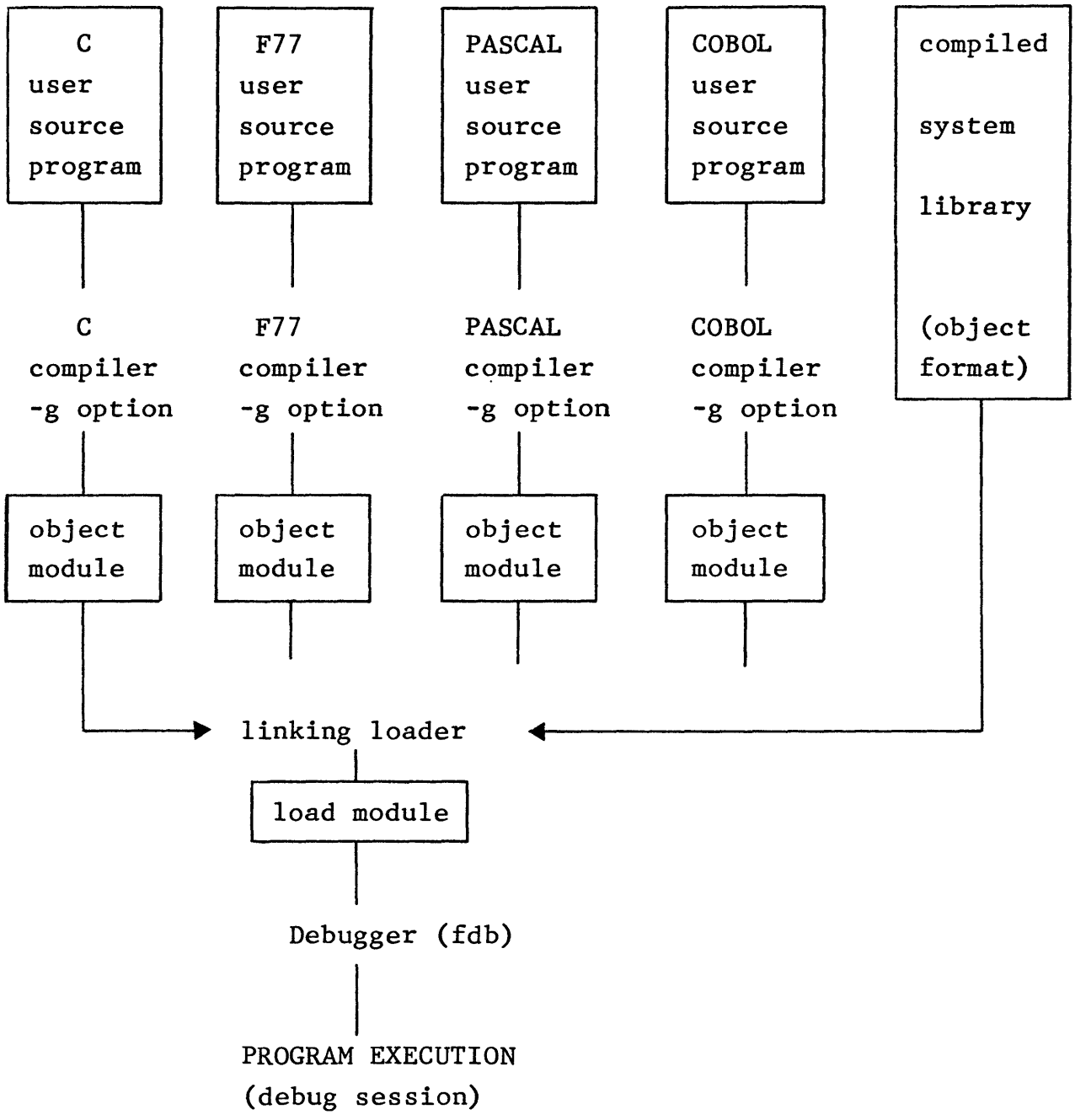
Symbolic debugging

The debugging of programs in terms of their source level names and constructs.

Trace

A display of the dynamic activity of some aspect of a program. Fdb supports the execution trace, the procedure trace and the variable trace.

The following figure shows how fdb is utilized in program execution.



The following are the general rules of the fdb command.

CASE RULE

There is no difference between upper and lower case letters. Combinations of upper and lower case letters are allowed. This rule also applies to the fdb keywords. For example, the following commands are equivalent:

```
equate
EQUATE
EquAte
```

> Upper and lower case letters may be distinct in variable and procedure names. This is language dependent.

3-CHARACTER RULE

Every command can be abbreviated to three characters if desired. For example, the following strings are all legal commands.

```
BRE for break
DEL for delete
EQU for equite ... etc.
```

Some commands may even be abbreviated to one character (please see HELP for details). However, if a command is spelled with more

than the allowed abbreviation (one or three characters), the whole command string should be spelled out. For example, EQ, EQUA and EQUAT are illegal while E and EQU are legal.

LEADING BLANK RULE

All the leading blanks in a command are ignored. So, the following commands are equivalent. One or more blanks and tab characters are equivalent to one blank character.

```
EQUATE
        eQU
              Equate
```

MULTIPLE COMMANDS PER LINE

Multiple commands per line are allowed if they are separated by the semicolon (;). Thus, a semicolon before the Return key has its own meaning (please see NEWLINE for details).

Note that each command in a multiple command line is interpreted. So the first command is performed regardless of the error condition in the subsequent commands. For example:

command 1; command 2; command 3 (RETURN)

is equivalent to

command 1 (RETURN)
command 2 (RETURN)
command 3 (RETURN)

This rule does not apply when a semicolon appears in a string, in a COMMENT command, or in a BREAK - DO command. For example, each of the following commands is a single command.

```
FIND      "a=0;  b=0;  c=0,"
EQUATE    a   ",a/wx;   ,b/c;  ,c;  BREAK WHEN count=100,"
COMMENT   x:=3; was for PASCAL assignment
BREAK 3 DO DISPLAY a; DISPLAY b; SHO FILE
```

DEBUGGER PROMPT

Fdb uses * as a prompt character. When * is prompted on the screen, fdb is ready to accept a command from the user. A user can change the debugger prompt using SET command.

Command Classification

This section describes all the debugging commands supported by fdb. Commands are classified into three categories:

- Commands to set up environment/display information
- Commands for source file examination
- Commands for controlling execution

Each command is presented with the command's grammar in Backus-Naur form, a functional description of the command, and examples.

DISPLAY

The following are the commands used to set up display variables. In BNF notation, display variable is defined as:

```
<display var> ::= ( , | DISPLAY ) <procedure><variable><format spec>;
<procedure>   ::= <empty> |<procedure name> :  ;
<format spec> ::= <empty> |<int spec> |<float spec> |<char spec>;
<int spec>    ::= <byte size> <int form>;
<byte size>   ::= <empty> | b |   h |  l  ;
<int form>    ::=  x |  d  |  o  |  u  ;
<float spec>  ::=  f | g  ;
<char spec>   ::=  c | <string form> ;
<string form> ::=  <string size>  s  ;
<string size> ::=  <empty> | <unsigned> ;
```

This command displays the values of variable(s) at program suspension. The values are displayed according to the user format specification. If format specification is omitted, variables are formatted according to their data type as declared in the program.

For example, suppose the types and contents of variables i, p, a and j are defined as follows:

variable type	name	contents
char	i	'x'
char	*p	"abcxy"
char	a[3]	"ABC"
int	j	0x12345678

The fdb commands and its output values for the example are:

```
,i        : x
,i/x      : 0x78000000
```

```
,i          : x
,i/x        : 0x78000000
,p          : abcxy
,p->/c      : a
,p/3s       : abc
,p/s        :abcxy
,a          : ABC
,a/2s       : AB
,j          : 305419896
,j/x        : 0x12345678
,j/b        : 18
```

EQUATE

In BNF notation, equate is defined as:

<equate> ::= EQUATE <alpha> (<empty> | <string>);

The EQUATE command equates a character to a data string. For the equated character to be expanded, an escape character (%) should precede the equated character. When the equated character appears in a command, it will be expanded inline prior to executing the command. Thus, equate could be used to combine the multiple commands into one or alias commands.

An equate command may be cancelled by equating the previously defined character to a null (empty) string.

Fdb will detect and report recursive equate definitions. For example:

Equate to long variable name

```
equ a "employee"    :define a as an equated character to "employee"
display %ar         :display the content of variable employer
display %e.name     :display the content of variable employee.name
equ a               :cancel the equate definition
, %ae.ssn           :might have been employee.ssn but illegal since
                     equation a was cancelled
```

Equate to Multiple commands

```
equ b   "  SHOW ARG; SHOW LAN; SHOW EQU; ! who "
%b                  :shows the arguments defined, source language,
                    equated characters and the name logged on the
                    system
```

Equate to user defined command (in this case ALIAS is better than EQUATE)

```
equ w    "PRINT   .-5 ! 11"
%w                  :print 5 lines before and after the current line
```

HELP

The HELP command lists every fdb command with a short description. Help can be invoked by pressing the HELP key, typing help, or typing ?. A command that can be abbreviated to one character is represented by one lower case character in parentheses. The following is a list of commands and their descriptions on the help facility.

Command	Description
!	:shell escape
,	:display the content of a variable
&	:display the address of variable
RETURN key	:repeat previous command
ALIAS	:define/cancel alias
BREAK(b)	:set up a breakpoint

Command	Description
COMMENT	:comment line
DELETE(d)	:delete breakpoint(s)
DISPLAY	:display the content of variable (same as ,)
DUMP	:dump memory contents
EQUATE(e)	:define/cancel replacement string
FIND(f)	:search a given string from the source file
FILE	:redirect source/input/output files
GO(g)	:start or resume execution
HELP(h)	:shows legal fdb commands
PRINT(p)	:print source lines
QUIT(q)	:exit from fdb and return to shell
RESTART(r)	:restart the debug session with optional parameter
SET	:set debugger options
SHOW(s)	:show status for breakpt/argument/file/equate procedure
TRACE(x)	:trace program execution
WALK(w)	:single step execution

SHOW STATUS

In BNF notation, show status is defined as:

```
<show status> ::= SHOW  ( BREAKPOINT ¦ FILE ¦
                          WINDOW   <unsigned> ¦
                          ALIAS    ¦  COMMAND ¦ EQU ¦ PROCEDURE ) ;
```

This command is used to show information about the current debugger session at the user's terminal. The information that could be displayed is:

- Breakpoints that are currently set
- Input/output/source files
- A few lines around the current line
- Alias definitions
- Last command as seen by fdb (expanded in case of alias)
- List of all equate symbols and their current definitions
- Procedure stack, for example, the procedure names called to reach the current stop point

These are examples of the SHOW STATUS command.

```
SHOW      PROCEDURE      :procedure names in frame stack
SHOW      BREAKPOINT     :show all the breakpoints defined
SHOW      EQUATE         :show all the equate definitions
SHOW      WINDOW 4       :print 9 lines around the current line
```

COMMENT

Fdb prints the comment line as entered on the output device. This command is used to document the debug session when fdb output is not standard output (terminal). For example:

```
COMMENT  next statement is to test error condition
EQU a; COM ;; This line has two commands even if many ;'s
appeared
```

ALIAS

In BNF notation, ALIAS is defined as:

```
<alias>  ::= ALIAS  (<alias define>|<alias cancel>)  ;
<alias define> ::= <def string><replace string> ;
<alias cancel> ::= <def string> ;
```

This command allows a user to define his/her own debugger command. The user can rename existing fdb commands or combine a few commands into one at his/her convenience.

To redefine the already defined alias, a user should cancel it before redefine. A user can use SHOW ALIAS command to see the alias definitions.

If a semicolon is used in the alias replacement string, multiple commands alias, it must be enclosed in quotes. Note that Case Rule does not apply to the alias definition string. For example:

```
ALIAS     single    WALK   :  redefine single as WALK
ALIAS     step      "WALK;  DISPLAY a"
```

To make fdb commands look like Unix Sdb (may not be recommended though), a user can set up alias definitions as follows:

```
ALIAS     s         WALK
ALIAS     S         WALK IN
ALIAS     w         SHOW WINDOW 5
ALIAS     +         PRINT NEXT
```

VARIABLE ADDRESS

In BNF notation, variable address is defined as:

```
<var address>  ::= & <variable> ;
```

This command is used to display the address of a variable. The address is always displayed in hexadecimal notation. For example:

```
&a          :address of variable a
&b [3]      :address of fourth element of array b
```

SET

In BNF notation, set is defined as:

```
<set option> ::= SET <debug option> ;
<debug option> ::= <user prompt> ;
<user prompt>  ::= PROMPT (<EMPTY> | =) "<string>";
```

This command is used to set up a debug option. Currently only the user prompt setting is available. For example:

```
SET PROMPT = "+"  : debugger prompt is +
SET PROMPT   "Fortune fdb%"
```

Commands for Source File Examination

Several commands are used in examining source files: file definition, find string, print source lines, and dump.

FILE DEFINITION

This is the BNF notation for file definition:

```
<file definition>  ::= FILE <file name>  { <file name>}  ;
<file name>  ::= ( <empty> ¦ < ¦ > ¦ >>    ) <identifier> ;
```

The file definition command is used to refine the source file or redirect the standard input and output devices. It is used to change the file specifications for debugger. Files for the debugged program can be redirected by run time arguments (see RESTART command).

When < or > is followed by a space, fdb will redirect input or output devices to standard devices. >> is to append to the end of existing file. For example:

```
FILE <profile                 :execute fdb commands in profile
FILE  /user/source/test.c     :source file is /usr/source/test.c
FILE > .. /trace              :save debug output in parent's directory
FILE >                        :print debug output on terminal
```

FIND STRING

In BNF notation, find is defined as:

```
<find>  ::= FIND  <string><range>
<range> ::= ( <single line> ¦ <multiple line> ¦ <count> ) ,<range> ;
```

```
<single line> ::= <empty>|<line number> ;
<line number> ::=  ( <unsigned>| NEXT | . ) (+ | -) <unsigned> ;
<multiple line> ::= <single line> / <single line> ;
<count> ::= <single line> ! <integer> ;
```

The FIND command is used to search the source (current) file and print the source line(s) which contain the specified string.

The count is for the maximum number of lines to print, and the default values for the line number is the current line. For example:

```
FIND "Procedure"    :search "Procedure" and print the first line that
                     contains the string from the current line
FIND "if"  3        :find the first "if" from line number 3
FIND "count".-3!10  :find 10 occurrences of "count" from current-3
                     line
FIND "xyz" 10/100   :find "xyz" string from line #10 through 100
```

PRINT SOURCE LINES

In BNF notation, print source is defined as:

```
<print source>  ::= PRINT <range> ;
```

The PRINT command is used to print the specified number of lines (count) from the given starting lines in the source. The default values for the starting line is the current line. For example:

```
PRINT                    :print the current line
PRINT .-10   11          :print (current -10) and current same as
                         PRINT.-10, 11
PRINT .-10/ 11           :print (current-10) through line #11
PRINT .! 6               :print 6 lines from the current line
PRI 3, .-2/ .+3, 10      :print line #3, from (current-2) through
                         (current+3) and line #10
```

DUMP

In BNF notation, dump is defined as:

```
<dump>  ::= DUMP<dump option> <dump spec> ;
<dump option>  ::= <empty> ¦ C  ¦  X   ;
<dump spec>  ::=  <range>  ¦ <var address>  ;
```

This command is used to display the contents of memory. A user can display in character format or in hexadecimal. The default is in hexadecimal format.

Output format is:

```
Space designation:  I for instruction space
                    D for data space
Memory address in hex
16 bytes of contents
```

The memory dump is displayed in a 16-byte unit, and the starting address is always a multiple of 16. If a dump is requested towards the end of a line, for example, mod(address) is between 13 and 15, two lines are displayed. For example:

```
DUMP 0x100          :dump between 0x100 and 0x10f
DUMP 3              :dump between 0x0 and 0xf
DUMP 0x100/0x200
DUMP NEXT           :dump next 16 bytes
DUMP &a             :dump the memory around var a
```

Commands for Controlling Execution

The following commands are used for controlling execution of the debugger: breakpoint, delete breakpoint, go, shell escape, walk, quit, trace, and restart.

BREAKPOINT

In BNF notation, breakpoint is defined as:

```
<breakpt definition> ::= BREAK <break loc> <break command> ;
<break loc> ::= <empty> | <static break> ;
<static break> ::= <module name> <statement spec>
<module name> ::= <empty> | <procedure name> | <procedure name> } ;
<statement spec>::= <line number> ;
<line number> ::= <integer> ;
<procedure name> ::= <identifier> :;

<break command> ::= <empty> | DO <fdb command> ;
```

This command causes a breakpoint to be set at the indicated line number in the source program. The program is stopped before the line is executed. If the specified line is not an executable statement such as a blank or comment line, the breakpoint is set to the first executable line after that.

The module name and/or line number may be omitted in which case the defaults are taken from the current procedure name and the current line number, respectively.

If break command is specified as DO - phrase, fdb executes the command(s) when the breakpoint is reached. Otherwise, the control is transferred to the user. For example:

```
Break                 :break at current line in the current procedure
                      unconditionally
B SUB1:  4            :break at line #4 in the procedure SUB1
BREAK 10 DO ,a; ,b :break at line #10 and print the values of var a
                       and b when the program stops
```

DELETE BREAKPOINT

In BNF notation, delete breakpoint is defined as:

```
<delete breakpt>  ::=  DELETE  ( <empty> ¦ ALL ¦<module name>
                                        <statement spec> )  ;
```

The DELETE command is used to remove the breakpoints. DEL ALL will delete all the breakpoints set up so far. If no parameter is given, then the breakpoint is deleted interactively. Each breakpoint location is printed and a line is read from the standard input. If the user response is d, del, y, yes or ok, then the breakpoint is deleted. Other responses are considered as no. For example:

```
Del GETCHAR: 4          :delete the breakpoint on line 4 of
                        procedure GETCHAR
DELETE                  :no parameter, so interactive deletion
delete SUB1  3?  no     :user does not want to delete line #3 of SUB1
delete SUB3  10? ok     :user wants to delete this breakpoint

Delete all              :delete all the breakpoints
```

GO

In BNF notation, go is defined as:

```
<go>  ::=  GO ( <empty> ¦ <statement number>  )  ;
<statement number>  ::=  <unsigned>  ;
```

The command causes the program to either start or resume execution. If a statement number is specified, the program execution is suspended after executing the specified number of lines from the current position.

The GO command is used to continue the program execution, ignoring the signal that caused the execution to stop (such as user interrupt).

The program will continue to execute until one of the following events occurs:

- Breakpoint
- Program error
- User interrupt
- Normal progaram exit

SHELL ESCAPE

In BNF notation, shell escape is defined as:

<shell escape> ::= ! <shell command> ;

This command allows the user to execute shell command in the middle of a debugging session. Shell allows multiple commands if separated by the semicolon. However, fdb uses the same convention. Therefore, multiple shell commands per line are not permitted in fdb. For example:

```
!date          :print date and time on the input device
!date; !who    :multiple fdb commands
!date; who     :illegal, since multiple shell commands are not allowed
```

WALK

In BNF notation, walk is defined as:

<walk> ::= WALK (<empty> ¦ <unsigned>) (<empty> ¦ IN ¦ 1) ;

This command is useful for single stepping through a section of code. The number of statements to single step could be specified.

The user can walk single step only within the same procedure (WALK IN) or single step even in the called procedure (WALK 1). The default parameter is one so that the program stops after every line is executed. For example, suppose a user walks on the source code that looks as follows:

```
line#10:  count = 10;
line#11:  getvalue();
line#12:  printf(" result= %d \ n",  count);
```

At line#10: WALK, WALK IN and WALK 1 are equivalent. Variable count is set to 10 and execution stopped at line #11.

At line#11: WALK IN will execute the getvalue procedure and stop at line #12. WALK will stop at the first line in the getvalue procedure.

At line#12: WALK has no meaning in the non-systems programming environment. Fdb will not single step the printf routine, and WALK IN and WALK are equivalent.

QUIT

The QUIT command causes you to exit the fdb.

TRACE

In BNF notation, trace is defined as:

```
<trace>  ::= TRACE EXECUTION  ;
```

This command is used to display the code-segment labels (code statement line numbers) encountered during program execution. This will also display the source lines. For example:

```
TRACE EXECUTION     :print every line of code executed
```

RESTART

In BNF notation, restart is defined as:

```
<restart> ::= RESTART <option><parameter><file name> ;
<option> ::= <empty> | - <option char> ;
<option char> ::= <alpha> ;
<parameter> ::= <identifier> ;
```

This command is used to restart the debugged program. The user can set up options and parameters for the debugged program and also redirect the standard input/output device for the debugged program.

Suppose a user wants to debug a load module called compiler, whose option is -o and its parameter (file name to save the objects) is compile.o. Type this:

```
fdb compiler
RESTART -o compile.o
```

> There are two types of output during a debug session. One is diagnostic messages from fdb and the other is output from the debugged program.

Fdb allows you to redirect either output. FILE command is used to redirect the debug messages and RESTART is used to redirect the program output.

If a user just presses the RETURN key (Newline Command), it is interpreted as if the previous command was entered.

Because of the newline feature and the multiple commands line feature, a command line that ends with a semicolon is different than one that ends without it. For example:

```
command 1           :this is just one command
command 1;          :this is equivalent to command 1 ; command 1
W                   :single step execution command
(RETURN)            :execute next statement
(RETURN)            :execute next statement
```

SPECIAL CHARACTERS IN A STRING

A quote in a string is represented by two quotes. So "abc""d" is a string of abc"d, and """""""" is "". But """" is an illegal string.

A backslash (\) is used to indicate that a special character is following. So \\ means single\. It is advised to use a backslash whenever non-alphanumeric characters are used. This does not apply in ALIAS replacement string.

If \ precedes %, EQU expansion is suppressed. For example:

```
EQU  A "XYZ"
FIND   "%A"          :search for XYZ
FIND   "\%A"         :search for %A
```

The following example could cause a permanent loop, but will be detected and reported by fdb.

```
EQU a "\%a"          :define itself
%a                   :would-be permanent expansion
```

The steps of a general operating procedure is described here. First the syntax of fdb is reviewed.

The syntax for calling fdb is:

fdb [object-file [directory]]

where:

object-file: an executable program file which has been compiled with the -g (debug) option. The default for object-file is a.out.

directory: a directory where the source file exists. The default for directory is the working directory.

At any time there is a current line and current file. The current file may be changed by FILE command.

These are the steps in the procedure:

1 Compile source programs with -g option
2 Run loader
3 Run fdb

Suppose a C program is saved in test.c and a PASCAL program is in sample.p, and you try to debug the linked program (UNIX command syntax may be changed from time to time). These are the steps you follow.

Procedure	Comments
cc -g test.c -o cobject	/* compile test.c program */
pc -g sample.p -o pobject	/* compile sample.p program */

Procedure	Comments
ld -o junk cobject pobject	/* link 2 objects */
fdb junk	/* invoke debugger */

> If fdb has a bug and causes a permanent loop, you can't get out from fdb by pushing the Cancel key. In this case, hold down the Cancel key about 10 seconds. Then you can get out from fdb and return to the Unix shell.

Support Utilities, Libraries, and Machine Specific Aspects

3

The Fortune Operating System provides a number of utilities and libraries which make routine programming activities easier and less time consuming. In this section you will learn about the utilities and libraries below.

- Archive -ar
- Link Editor -ld
- Make
- Name -nm
- Ranlib
- Size
- Strip
- Libraries
  - libc.a
  - libg.a
  - libm.a

You will also learn about aspects of using C on the Fortune 32:16 which are specific to a 68000 based product.

Ar is used primarily to create and update library files used by the loader. Groups of files are maintained in one archive file. This version of ar uses an ASCII-format archive which can be ported among various machines running UNIX.

SYNTAX: ar key posname afile names(s)...

Element	Purpose
key	One character from the set of options (d, r, q, t, p, m, x). It can be catenated and enhanced with one or more of another set of options (v, u, a, i, b, c, l).
posname	The filename you use to indicate position.
afile	The name for the archive file.
name(s)	The files in the archive file.

Each of the key options is described below.

Option	Description
d	Deletes the named files from the archive file.
r	Replaces the named files in the archive file. If you include the optional character u only those files modified later than the archive files are replaced. If you use an optional positioning character from the set abi, then the posname argument must be included.

Option	Description
	It specifies that new files are to be positioned following a or before b or i posname. Otherwise, new files are placed at the end.
q	Quickly appends the named files to the end of the archive file, disregarding any optional positioning characters and without checking whether the added files are already in the archive. When you are creating a large archive in pieces, use this to avoid quadratic behavior.
t	Prints a table of contents of the archive file. If no names are printed, all the files in the archive are tabled. If names are printed, only those files are tabled.
p	Prints the named files in the archive.
m	Moves the named files to the end of the archive. If you include a positioning character, then the posname argument must be present and, as with r, must specify where the files are to be moved.
x	Extracts the named files. If you give no names, all files in the archive are extracted. x does not, however, alter the archive file.
v	With the verbose option, you receive a file-by-file description of the construction of a new archive file. If you include t a listing of all information about the files will be included. With p each file is preceded by a name.
c	The create option suppresses the usual message produced when afile is created.

Option	Description
l	The local option places files in the local directory rather than in /tmp, where it normally places temporary files.

The link editor, or loader, combines several object programs into one, resolves external references, and searches libraries. In the simplest form several object files are given and ld combines them. An object module is produced. It can be executed or used with the -r option as input for a further ld run. Output of ld is left in the a.out file (unless the -o option is used to specify an output filename) and is executable only if no errors occurred during loading.

SYNTAX: ld option files...

Argument routines are catenated in the order you specify. Unless you use the -e option the entry point of the input of the executable or a.out file is the beginning of the first argument.

If any argument is a library, it is searched only once when it is encountered in the argument list. Only routines that define unresolved external references are loaded. The order of programs within libraries may be important. For example, 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. The first member of a library should be a file named __.SYMDEF. It is understood to be a dictionary for the library as produced by ranlib(1) and is searched iteratively to satisfy as many references as possible.

The symbols etext, edata and end are reserved, and if referenced, are set to the first location above the program, the first location above initialized data, and the first location above all data respectively. Don't define these symbols.

Element	Purpose
Option	ld understands several options (D, d, e, lx, M, N, n, o, r, s) and except for -l (this is the letter l), they should appear before the file names.
Files	These files are to be combined into the object module.

The following is a description of the link editor options.

Option	Description
-D	Takes the next argument as a hexadecimal number and pads the data segment with zero bytes to the length you indicate.
-d	Forces definition of common storage even if the -r flag is included.
-e	The following argument becomes the entry point of the loaded program. Zero is the default. For example, with a program consisting of main( ) and main2( ):

You enter	Result
ld -e main2 filenames.o	When you type a.out the program begins execution at main2.

Option	Description
-lx	This option is an abbreviation for the library name /lib/libx.a, where x is a string. If that library doesn't exist, ld tries /usr/lib/libx.a. The library

Option	Description
	name must be placed last as it is searched for all undefined references when it is encountered.

You Enter	Results
ld filenames.o -lm	The math (m) library is searched.

Option	Description
-M	Produces a primitive load map which lists the names of the files that will be loaded.
-N	The text portion is not made read-only or sharable. Uses "magic number" 0407.
-n	When the output file is executed, the text portion is made read-only. Therefore, it doesn't have to be repeated in memory if more than one copy of the program is being run concurrently. For example, if two or more people are expected to run an editor, loading it with -n can save space.
-o	Gives a name in the place of a.out to the ld output file.
-r	Relocation information is retained. This is useful for running the output through the loader again, if, for example, you don't include all files on the first run.

You Enter	Results
ld -r x.o y.o -o q.o ld q.o z.o	Puts results in q.o. The files x.o and y.o are combined with z.o to make a.out. This is the same as doing ld x.o y.o z.o

Option	Description
-S	Strips the output by removing all symbols but locals and globals.
-s	This is useful if you do not plan to reload, but only to execute. All symbol table and relocation information is removed, thereby saving space.
-T	The text segment origin is set by the next argument, a hexadecimal number.
-t	Traces the name of each file as it is processed and prints it on the screen.
-u	Takes the argument following and undefines it to force loading. This is useful for loading solely from a library.

You Enter	Results
ld -u asin filenames.o library	asin would be included from the library you name.

Option	Description
-X	This discards any symbols that are not local, those whose names begin with ".".

Option	Description
-x	Removes all local symbols and saves space in the output file.

You Enter	Results
ld -x test.c	test.o file that is smaller.

Option	Description
-y*sym*	Lists each file in which *sym* appears, its type, and whether the file references or defines it.

When you are working on a programming project, it is easy to lose track of which files need to be reprocessed or recompiled after a change is made in some of the source code. Make provides a simple means for maintaining up-to-date versions of programs. You can tell make a sequence of commands that creates certain files, and the list of files requiring other files to be current before the operations can be done. Whenever you make a change in any part of the program, use the make command to create the proper files simply, correctly, and with little effort.

Basically, make finds the name of a needed target in the description and ensures that all of the files that the target depends on are current. After ensuring that the supporting files are current, the target is made according to predefined instructions. If supporting files are not current, make will attempt to target each one. The description file defines the graph of dependencies. Make does a depth-first search of this graph and determines what work is really necessary.

In addition, make provides a simple macro substitution facility and the ability to condense commands into a single file for convenience. The make command takes four kinds of arguments: macro definitions, options, description, file names, and target file names.

SYNTAX: make (options) (macro definitions) filenames...

Element	Purpose
Options	The options, from the set (i, s, r, n, t, q, p, d, f), are examined second, after the macro definition arguments.

Element	Purpose
Macro definitions	A macro definition is a line including an equal sign not preceded by a colon or a tab. The name on the left of the equal sign (trailing blanks and tabs are stripped) is assigned to the string of characters to the right of the equal sign (tabs and leading blanks are stripped.) The following are examples: CFLAGS = -I/u/james/mylib The null string is a valid assignment.
Filenames	Remaining arguments are the names of the targets to be made. They are processed left to right. If no such arguments exist, the first filename in the list of description files that doesn't begin with a period is made.

Following is a description of the options used with make.

Option	Description
-i	Ignores error codes returned by invoked commands if the fake target name "IGNORE" is encountered in the description file.
-s	The silent mode doesn't print command lines before executing them. The same action is taken if the fake target name "SILENT" appears in the description file.
-r	Doesn't use the built-in rules.
-n	Commands are printed but not executed. Lines beginning with "@" are also printed.

Option	Description
-t	Updates (touches) the target files rather than issuing the normal commands.
-q	Questions whether the target file is or isn't up to date. Make returns a zero or non-zero status indicating up to date or not up to date.
-p	Prints the complete set of macro definitions and target descriptions.
-d	In debug mode make prints detailed information on files and times examined.
-f	The argument following f names a description file. The name "-" signifies standard input. If you include no -f arguments the file named makefile or Makefile in the current directory is read. When description files are present the contents override any built-in rules.
.DEFAULT	If a file must be made and no explicit commands or appropriate built-in rules exist, the commands in .DEFAULT are used if it exists.
.PRECIOUS	Doesn't remove dependents of this file if quit or interrupt is hit.
.SILENT	This has the same effect as the -s option.
.IGNORE	This has the same effect as the -i option.

Name prints the symbol table of each object file in the list of arguments. A listing for each object file in the archive is produced if an argument is an archive.

Each symbol name is preceded by its value (blanks if undefined) and one of the following letters: U (undefined), A (absolute), T (text segment symbol), D (data segment symbol), B (bss segment symbol), C (common symbol), f file name, or - for sdb symbol table entries. For local symbols (non-external) the type letter is in lowercase. Output is sorted alphabetically.

SYNTAX: nm -option file...

You may use several options with the name utility.

Element	Purpose
Options	The set of options is (a, g, n, o, p, r, u).
Files	These files are the object of the command. The symbols in a.out are listed if no file is given.

The options control the listings. Each option is described below.

Option	Description
-a	All symbols are included for printing.
-g	Prints only global symbols, not local or fdb.
-n	Sorts numerically rather than alphabetically.

Option	Description
-o	The file or archive element name precedes each output line rather than only the first.
-p	Prints in symbol-table order rather than sorting.
-r	Sorts in reverse order.
-u	Prints only undefined symbols.

Ranlib adds a table of contents named __SYMDEF to the beginning of the archive. This way the archive can be loaded more rapidly. ar(1) is used to reconstruct the archive, so that enough temporary file space is available in the file system containing the current directory.

SYNTAX: ranlib archive...

The ranlib utility uses archive files.

Element	Purpose
Archive	This is the name of the archive file containing a collection of .o files.

Size prints the decimal number of bytes required by the text, data, and bss portions, and the sum in hex and decimal, of each object-file argument.

SYNTAX: size object ...

The size utility uses the object file that you are measuring.

Element	Purpose
Object	The name of the file you are measuring. If you do not specify a file, a.out is used.

To see the size of a particular program, enter the following:

You Enter	Results				
size test.c	text	data	bss	dec	hex
	60	16	0	76	4c

You can do a comparison on file size by running size on a program before and after, using the optimizer which reduces code size.

Strip

Strip removes the symbol table and relocation bits which are usually attached to the output of the assembler and loader. Use this to save space after you have debugged a program.

Strip has the same effect as the -s option of ld.

SYNTAX: strip name ...

The strip utility reduces the size of a file.

Element	Purpose
Name	The file you want to strip.

The following procedure allows you to use these tools: size, nm, strip, ar, ranlib, make, and lint.

1 Create a C language program.

You Enter	Results
ed x.c	A program named x.c is created which prints a message.
a	
main ( ){	
printf ("Hello, World \ n");	
}	
.	
w	
q	
cc x.c	Compiles the program.
ls -l a.out	Lists the output file.
a.out	Runs the program.
size a.out	Displays the size.
nm a.out	Prints the symbol table of the a.out object file.
strip a.out	Strips off the symbol table.
ls -l a.out	Shows that the program is smaller. (use size to show that the symbol table is gone.)

2 Now create two subroutines.

You Enter	Results
ed hello.c	Creates a subroutine named hello.c.
a	

You Enter	Results
`hello ( ){`	
`  printf ("Hello, World \n")`	
`}`	
`.`	
`w`	
`q`	
`ed goodbye.c`	Creates a subroutine named goodbye.c.
`a`	
`goodbye ( ){`	
`  printf ("Goodbye, World \ n");`	
`}`	
`.`	
`w`	
`q`	

3 Compile the subroutines. Then create the main program that calls the subroutines.

You Enter	Results
`cc -c hello.c goodbye.c`	Compiles subroutines. Lists all .o files.
`ls *.o`	
`ed main.c`	
`a`	
`main (* ){`	
`  hello ( );`	
`}`	
`.`	
`w`	
`q`	

4 Compile the main program.

You Enter	Results
cc -c main.c	Compile the program.
ar crv greet.a hello.o goodbye.o	Create the archive even if it already exists.
ar tv greet.a	Prints table of contents of the library
ranlib greet.a	Inserts table of contents in front of library.
cc main.o greet.a	This link edits the archive of .o files with the main program.
nm a.out	Notice hello is in the name list and goodbye isn't.

5 Create a makefile. Use the make utility to create the a.out file.

You Enter	Results

```
ed makefile
a
hello.o: hello.c
goodbye.o: goodbye.c
main.o: main.c
greet.a: hello.o goodbye.o
     ar crv greet.a hello.o goodbye.o
     main: main.o greet.a
     cc -o main main.o greet.a
```

You Enter	Results
.	
w	
q	
make main	Compiles source files that have been changed.

Information on how to use the library functions, arguments, and returns can be found in Section 2. The Fortune Operating System contains numerous libraries designed for many different applications. Some are specifically for use with C. C related libraries are summarized below.

- libc.a is the general C library containing string, input/output, and system functions.
- libg.a contains support routines for the Fortune Symbolic Debugger (FDB).
- libm.a contains math, transcendental, and power functions.

To avoid conflict with library global names, do not use any of the following names for global variables or procedures.

__dbargs	_filbuf	BC	asctime
__dbsubc	_flsbuf	PC	asin
__dbsubn	_getccl	UP	atan
_callc	_innum	abort	atan2
_calle	_instr	abs	atoi
_cerror	_iob	access	atol
_cleanup	_lastbuf	acct	atof
_cret	_regbak	acos	auldiv
_csav	_regsav	alarm	aulmul
_csavl	_sctab	aldiv	aulrem
ctype	_sibuf	allocp	blt
_doprnt	_sighnd	allocs	brk
_doscan	_sobuf	alloct	cabs
_el0tab	_strout	allocx	calloc
_error	l3tol	almul	ceil
_exit	ltol3	alrem	cfree

chdir
chmod
chown
chroot
clear
clearerr
close
cos
cosh
creat
crypt
ctime
devctl
dup
dup2
dysize
ecvt
encrypt
endgrent
endpwent
erf
erfc
errno
execl
execle
execlp
execv
execve
execvp
exit
exp
fabs
fclose
fcvt
fflush
fgetc
fgets
floor
fopen
fork
fpint
fprintf
fputc
fputs
fread
frexp
free
fscanf
fseek
fstat
ftell
ftime
fwrite
gamma
getchar
getegid
getend
geteuid
getfpcl
getfpst
getgid
getgrent
getgrgid
getgrnam
getlogin
getpass
getpid
getpw
getpwent
getpwnam
getpwuid
gets
getuid
getw
gmtime
hypot
index
intss
ioctl
isatty
isinf
isnan
isnorm
j1
j0
jn
kill
ldexp
ldiv
link
lmul
localtim
lock
locking
log
log10
longjmp
lrem
lseek
malloc
mknod
mktemp
modf
monitor
mount
mpxcall
nice
nlist
open
ospeed
pause
pclose
perror
phys
pipe
printf
profil
ptrace
ptrtrap
putchar
puts
putw
qsort
rand
read
realloc
rewind
rindex
sbrk
scanf
setbuf
setfpcl
setfpst
setgid
setgrent
setjmp
setkey
setpwent
setuid
sigfunc
signal
signgam
sigtrap
sin

sinh
sleep
sprintf
sqrt
srand
sscanf
stat
stime
strcat
strcatn
strcmp
strcmpn
strcpy
strcpyn
strlen
strncat
strncmp
strcpy
stty
swab
sync
sys_errl
sys_nerr
system
tan
tanh
tell
tgetent
tgetflag
tgetnum
tgetstr
tgoto
time
times
timezone
tmpnam
tnamatch
tnchktc
tputs
ttyname
ttyslot
uldiv
ulmul
ulrem
umask
umount
ungetc
unlink
utime
wait
wdleng
write
yl
y0
yn
yyportli

Fortune 32:16 Specific Aspects

There are four machine-specific qualities of the Fortune C compiler. Each is explained below.

INTEGERS AND POINTERS

Types Integer, pointer, and long are each 32 bits long. The type short is 16 bits long. Character data is 8 bits long. Unsigned data is the same length as the corresponding signed quantities.

SIGN EXTENSION

Character data is sign extended unless the user declares unsigned character.

BYTE ORDERING

The Motorola 68000 addresses bytes sequentially from high to low order. If you reference the address pointer of an integer (int) as a character (char) you will get the high order byte of the integer (the most significant portion).

ALIGNMENT

All variables and structures are aligned to even byte addresses and occupy an even number of bytes. To maintain machine indepedence when coding in C, be aware of the following issues.

- The length of int may not be the same as anything else, such as a pointer, a long, or a short.

- Addressing should not be done within a basic type.

- Calculating addresses should not be done within a structure.
- The type char may not be sign extended in all calculations.
- Nothing should be accessed within the local frame area, except with declared names.

The optimizer can increase the throughput of your programs. To get the best out of your Fortune optimizer follow these rules.

1 Use register variables as much as possible, especially floating point, to affect code size and speed.

2 Use shorts whenever possible. Although the compiler may occasionally have to extend them, operations with shorts are much faster than character or integer equivalents (except byte moves).

3 Use of logical operations, such as x and y where y is a constant, optimize better than subtraction or comparison. The same is true for the operator.

4 Structures or array references, especially byte arrays, are optimized if their lengths are powers of two.

5 The C language has no common subexpression or invariant code optimizer. Place only necessary expressions inside loops and do not repeat expressions in straight line code.

6 Use register variables in a function only if the variable is used in a loop or is used at least four times in the function for the first register, and three times for succeeding registers.

7 Register variables should be kept on the left-hand side of the expression. For example, write

```
r = f + g;  (r and f are register vars)
```

rather than

```
r = g + f
```

8 Generally, automatics access more quickly than static variables. However, heavily used statics may produce better code than automatic variables.

- If the variable or array is referenced more than three times, place it in static (unless there are no other register variables).

- If the variable is a structure avoid placing it in static.

9 If your program will not allocate more than 8K of stack space, you may compile with the -G option which reduces stack growth and checks calls at every procedure invocation.

10 Use short multiplication and division whenever possible. Cast or convert everything to shorts before doing the operation to ensure the use of hardware instructions. Multiplication or division by a power of two is converted to shifts, however.

11 When moving approximately one half or more of a structure use a full structure move, and then restore the contents. Use full structure move whenever possible.

12 Keep for loops simple, using one variable going through a simple range, rather than lots of conditionals. Use a simple increment such as ++g.

The Fortran/C/Language Interface

4

The C language is well suited for high-speed system applications. Fortran is designed for mathematical and scientific applications. You may find it desirable to write multi-language applications that use the strengths of each language. You may write a program in Fortran, for example, that calls a graphics package written in C. With the language interface capabilities on the Fortune 32:16, C procedures can be written to call or to be called by Fortran procedures. To do this you must know the rules that completed code obeys for procedure names, data representation, return values, and argument lists.

Procedure Names

On UNIX systems the name of a Fortran procedure or a common block is represented as seen. It is accessible from other languages without any additional notation.

Data Representation

The following table shows corresponding Fortran and C declarations.

Fortran	C
integer*2 x	short int x;
integer x	long int x;

Fortran	C
logical x	long int x;
real x	float x;
double precision x	double x;
complex x	struct float r, i; x;
double complex x	struct double dr, di; x;
character*6 x	char x[6];

In Fortran, integer, logical, and real data occupy the same amount of memory.

Return Values

A function in Fortran of type integer, logical, real, or double precision will return the same value as a C routine of the corresponding type. A complex or double complex function in Fortran is equivalent to a C routine that includes an additional argument pointing to the location where the return value is to be stored. In this example,

```
complex function sin(. . .)
```

is equivalent to

```
sin (temp, . . .)
struct  float r, i;  *temp;
```

A character-valued function in Fortran is the same as a C routine which includes two extra initial arguments: a data address and a length. For example,

```
character *15 function strcpy(. . .)
```

is the same as

```
    strcpy(result, length, . . .)
    char result    ;
    long int length;
```

and could be called in C with

```
    char chars  15 ;
    . . .
    strcpy(chars, 15L, . . .);
```

Subroutines are called as if they were integer-valued functions whose value indicates which alternate return value to use. The alternate return arguments are labels and are not passed to the function. They are used to do an indexed branch in the calling procedure. If the subroutine provides no entry points with alternate return arguments, the returned value is not defined.

In this example, the statement

```
    call nref(*10, *20, *30)
```

is treated as if were

```
    goto (10, 20, 30), nret()
```

Arguments Lists

Fortran arguments are passed by address. Also, all type char and dummy procedure arguments pass an argument giving the length of the value. String lengths are long int quantities passed by value. Arguments are given in the following order:

- Additional arguments for complex and character functions
- Address for each item of data or function
- A long integer for each character or procedure argument

The call in

```
external f
character*7 s
integer b(3)
. . .
call sam(f, b(2), s)
```

is the same as

```
int f();
char s[7];
long int b 3 ;
. . .
sam (f, &b 1 ,s, 0L, 7L);
```

The first element of a C array has the subscript zero, whereas Fortran arrays begin at one. Also, Fortran arrays are stored in column-major order; C arrays are stored in row-major order.

Part 1 System Routines

This set of routines provides the interface of the C language to the UNIX operating system. Using these routines you will be able to access many of the UNIX system calls by way of C programs.

NAME

intro, errno - introduction to system calls and error numbers

SYNOPSIS

#include <errno.h>

DESCRIPTION

Section 2 of this manual describes all the entries into the system. Distinctions as to the status of the entries are made in the headings:

(2) System call entries which are standard in Version 7 UNIX systems.

(2J) System call entries added in support of the job control mechanisms of csh(1). These system calls are not available in standard Version 7 UNIX systems, and should be used only when necessary; to prevent inexplicit use they are contained in the jobs library which must be specifically requested with the -ljobs loader option. The use of conditional compilation is recommented when possible so that programs which use these features will gracefully degrade on systems which lack job control.

(2V) System calls added for the Virtual Memory version of UNIX distributed by Berkeley. Some of these calls are likely to be replaced by new facilities in future versions; in cases where this is imminent, this is indicated in the individual manual pages.

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.

Ø Error Ø

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 which does not exist, or beyond the limits of the device. It may also occur when, for example, a tape drive is not dialed in or no disk pack is loaded on a drive.

7 E2BIG Arg list too long
An argument list longer than 10240 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 which 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 directory. (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 which 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 1.0E9 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)

BUGS
The message "Mount device busy" is reported when a terminal is inaccessible because the "exclusive use" bit is set; this is confusing.

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 Ø 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. Ø 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)

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(8)

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.

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 Ø, any alarm request is canceled. 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 2147483647 seconds.

The return value is the amount of time previously remaining in the alarm clock.

SEE ALSO

pause(2), signal(2), sigsys(2), sigset(3), sleep(3)

NAME

brk, sbrk - 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 1024 bytes). 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.

The vlimit(2) system call may be used to determine the maximum permissible size of the data region; it will not be possible to set the break beyond "etext + vlimit(LIM_DATA, -1)." (See end(3) for the definition of etext.)

SEE ALSO

exec(2), vlimit(2), malloc(3), end(3)

DIAGNOSTICS

Zero is returned if the brk 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. Sbrk returns -1 if the break could not be set.

NAME

chdir - change current working directory

SYNOPSIS

```
chdir(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 `/'.

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.

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 (this is the default) 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. Ability to set this bit is restricted to the super-user since swap space is consumed by the images. See sticky(8).

Only the owner of a file (or the super-user) may change the mode. Only the super-user can set the 1000 mode.

On some systems, writing or changing the owner of a file turns off the set-user-id bit. This makes the system somewhat more secure by protecting set-user-id files from remaining set-user-id if they are modified, at the expense of a degree of compatibility.

SEE ALSO
chmod(1)

DIAGNOSTIC
Zero is returned if the mode is changed; -1 is returned if name cannot be found or if the current user is neither the owner of the file nor the super-user.

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.

On some systems, chown clears the set-user-id bit on the file to prevent accidental creation of set-user-id programs owned by the super-user.

SEE ALSO

chown(1), passwd(5)

DIAGNOSTICS

Zero is returned if the owner is changed; -1 is returned on illegal owner changes.

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 high-numbered file descriptors are closed by exec(2), and it is possible to arrange for others to be closed (see FIOCLEX in 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.

BUGS

A file cannot be closed while there are pages which have been vread but not referenced.

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 Ø 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.

BUGS

A file cannot be truncated while any process has pages set up by a vread on that file which have not been referenced.

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.

BUGS

Dup2 fails if fildes2 was vread from and some of the pages have not been referenced.

NAME

execl, execv, execle, execve, execlp, execvp, exece, environ - execute a file

SYNOPSIS

```
execl(name, arg0, argl, ..., argn, 0)
char *name, *arg0, *argl, ..., *argn;

execv(name, argv)
char *name, *argv[];

execle(name, arg0, argl, ..., argn, 0, envp)
char *name, *arg0, *argl, ..., *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/held signals remain ignored/held 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 Ø 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 Ø.

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:

```
execve(file, argv, environ);
execle(file, argØ, argl, . . . , argn, Ø, 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.

To aid execution of command files of various programs, if the first two characters of the executable file are '#!' then exec attempts to read a pathname from the executable file and use that program as the command files command interpreter. For example, the following command file sequence would be used to begin a csh script:

```
#! /bin/csh
# This shell script computes the checksum on /dev/foobar
#
     ...
```

A single parameter may be passed the interpreter, specified after the name of the interpreter; its length and the length of the name of the interpreter combined must not exceed 32 characters. The space (or tab) following the '#!' is mandatory, and the pathname must be explicit (no paths are searched).

FILES

/bin/sh shell, invoked if command file found by execlp or execvp

SEE ALSO

fork(2), environ(5), csh(1)

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.

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, and should be used to terminate a child process after a fork(2) or vfork(2) to avoid flushing buffered output twice.

SEE ALSO

fork(2), vfork(2), wait(2)

NAME

fork - spawn new process

SYNOPSIS

fork()

DESCRIPTION

Fork and vfork(2) are the only ways new processes are created. With fork , 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.

Vfork is the most efficient way of creating a new process when the fork is to be followed shortly by an exec, but is not suitable when the fork is not to be followed by an exec.

SEE ALSO

wait(2), exec(2), vfork(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.

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)

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)

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 standard 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.

The following call is peculiar to the Berkeley implementation, and also applies to any open file:

```
ioctl(fildes, FIONREAD, &count)
```

returning, in the longword count the number of characters available for reading from fildes.

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, or if request attempts to modify the state of a terminal when fildes is not writeable.

Ioctl calls which attempt to modify the state of a process control terminal while a process is not in the process group of the control terminal will cause a SIGTTOU signal to be sent to the process' process group. Such ioctls are allowed, however, if SIGTTOU is being held, ignored, if the process is an orphan which has been inherited by init, or is the child in an incomplete vfork (see jobs(3))

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'.

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 pid. See sigsys(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. (A single exception is the signal SIGCONT which may be sent as described in killpg(2), although it is usually sent using killpg rather than kill).

If the process number is Ø, the signal is sent to all other processes in the sender's process group; see tty(4) and also killpg(2).

If the process number is -1, and the user is the super-user, the signal is broadcast universally except to processes Ø, 1, 2, the scheduler initialization, and pageout processes, and the process sending the signal.

Processes may send signals to themselves.

SEE ALSO

sigsys(2), signal(2), kill(1), killpg(2), init(8)

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.

NAME

link - link to a file

SYNOPSIS

```
link(namel, name2)
char *namel, *name2;
```

DESCRIPTION

A link to namel 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 namel 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.

On some systems the super-user may link to non-ordinary files.

NAME

lseek, tell - move read/write pointer

SYNOPSIS

```
long lseek(fildes, offset, whence)
long offset;

long tell(fildes)
```

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 Ø, 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(fildes) is identical to lseek(fildes, ØL, 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.

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.

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 Ø 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(8)

DIAGNOSTICS

Mount returns Ø 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 Ø 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.

BUGS

If a file containing holes (unallocated blocks) is read, even on a file system mounted read-only, the system will

attempt to fill in the holes by writing on the device.

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), fork(2), renice(8)

NAME

open - open for reading or writing

SYNOPSIS

```
open(name, mode)
char *name;
```

DESCRIPTION

Open opens the file name for reading (if mode is Ø), 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 Ø). 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.

BUGS

It should be possible to optionally open files for writing with exclusive use, and to optionally call open without the possibility of hanging waiting for carrier on communication lines.

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). Upon termination of a signal handler started during a pause, the pause call will return.

SEE ALSO

kill(1), kill(2), alarm(2), sigsys(2), signal(2), sigset(3), setjmp(3)

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.

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.

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:

Ø 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 Ø 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 and VAX-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 Ø) 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 Ø177 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 Ø mod 4. On a VAX-11, `word' also means a 32-bit integer, but the `even' restriction does not apply.

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

Ptrace is unique and arcane; it should be replaced with a special file which can be opened and read and written. The control functions could then be implemented with ioctl(2) calls on this file. This would be simpler to understand and have much higher performance.

On the Interdata 8/32, `as soon as possible' (request 7) means `as soon as a store instruction has been executed.'

The request Ø 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.

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.

Unless the reader is ignoring or holding SIGTTIN signals, reads from the control typewriter while not in its process group cause a SIGTTIN signal to be sent to the reader's process group; in the former case an end-of-file is returned.

SEE ALSO

open(2), creat(2), dup(2), pipe(2), vread(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.

BUGS

It should be possible to call read and have it return immediately without blocking if there is no input available. As a single special case, this is currently done on control terminals when the reading process has requested SIGTINT signals when input arrives (see tty(4)).

Processes which have been orphaned by their parents and have been inherited by init(8) never receive SIGTTIN signals. Instead read returns with an end-of-file indication.

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 or effective ID.

SEE ALSO

getuid(2)

DIAGNOSTICS

Zero is returned if the user (group) ID is set; -1 is returned otherwise.

NAME

signal - catch or ignore signals

SYNOPSIS

```
#include <signal.h>

(*signal(sig, func))()
void (*func)();
```

DESCRIPTION

N.B.: The system currently supports two signal implementations. The one described here is standard in version 7 UNIX systems, and is retained for backward compatabililty. The one described in sigsys(2) as supplemented by sigset(3) provides for the needs of the job control mechanisms used by csh(1), and corrects the bugs in this older implementation of signals, allowing programs which process interrupts to be written reliably.

A signal is generated by some abnormal event, initiated either by user at a terminal (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 with no one to read it
SIGALRM  14   alarm clock
SIGTERM  15   software termination signal
         16   unassigned
```

N.B.: There are actually more signals; see sigsys(2); the signals listed here are those of standard version 7.

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.

If, when using this (older) signal interface, a caught signal occurs during certain system calls, the call terminates prematurely. In particular this can occur during an ioctl, read, or write(2) on a slow device (like a terminal; 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.

If a process is using the mechanisms of sigsys(2) and sigset(3) then many of these calls are automatically restarted (See sigsys(2) and jobs(3) for details).

SEE ALSO

sigsys(2), kill(1), kill(2), ptrace(2), setjmp(3), sigset(3)

DIAGNOSTICS

The value (int)-1 is returned if the given signal is out of range.

BUGS

The traps should be distinguishable by extra arguments to the signal handler, and all hardware supplied parameters should be made available to the signal routine.

If a repeated signal arrives before the last one can be reset, there is no chance to catch it (however this is not true if you use sigsys(2) and sigset(3)).

The type specification of the routine and its func argument are problematical.

NAME

stat, fstat - get file status

SYNOPSIS

```
#include <sys/types.h>
#include <sys/stat.h>

stat(name, buf)
char *name;
struct stat *buf;

fstat(fildes, 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_IFMPC   0030000   /* multiplexed char special */
#define        S_IFMPB   0070000   /* multiplexed block special */
#define   S_ISUID   0004000        /* set user id on execution */
#define   S_ISGID   0002000        /* set group id on execution */
#define   S_ISVTX   0001000        /* save swapped text even after use
#define   S_IREAD   0000400        /* read permission, owner */
#define   S_IWRITE  0000200        /* write permission, owner */
#define   S_IEXEC   0000100        /* 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 fildes is associated with a pipe, fstat reports an ordinary file with an i-node number, restricted permissions, and a not necessarily meaningful length.

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.

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.

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.

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
 *
 * jam 810817
 */
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 time zone (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)

NAME

times - get process times

SYNOPSIS

```
#include <sys/types.h>
#include <sys/times.h>

times(buffer)
struct tms *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 is either 50 or 60 depending on your locality.

This is the structure returned by times:

```
/*
 * Structure returned by times()
 */
struct tms {
     time_t    tms_utime;          /* user time */
     time_t    tms_stime;          /* system time */
     time_t    tms_cutime;         /* user time, children */
     time_t    tms_cstime;         /* system time, children */
};
```

The children times are the sum of the children's process times and their children's times.

SEE ALSO

time(1), time(2), vtimes(2)

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 Ø22 (write access for owner only). The mask is inherited by child processes.

SEE ALSO

creat(2), mknod(2), chmod(2)

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).

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)

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 1024 characters long and begin on a 1024-byte boundary in the file are more efficient than any others.

Writes to the control terminal by a process which is not in the process group of the termainl and which is not ignoring or holding SIGTTOU signals cause the writer's process group to receive a SIGTTOU signal (See jobs(3) and the description of the LTOSTOP option in tty(4) for details).

On some systems write clears the set-user-id bit on a file. This prevents penetration of system security by a user who "captures" a writeable set-user-id file owned by the superuser.

SEE ALSO

creat(2), open(2), pipe(2)

DIAGNOSTICS

Returns -1 on error: bad descriptor, buffer address, or count; physical I/O errors.

BUGS

It would be nice to be able to call write and have the call return with an error indication if there was no buffer space for the written data, rather than blocking the process.

Processes which have been orphaned by their parents and have been inherited by init(8) never receive SIGTTOU signals. Output by such a process is permitted even when they are not in the process group of the control terminal.

Part 2 Library Functions

2

These procedures provide the runtime support for the C language. This support includes various methods of I/O, a variety of mathematical functions (including the transcendental functions), and a general set of subroutines to facilitate programming.

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.

(3J) These functions are part of the job control facilities, contained in the library " .}S 3 1 "" " "-ljobs"" "." " " "" "" "" "" The job control facilities are outlined in jobs(3).

(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. Files in which such libraries are found are named on 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>.

NAME

abort - generate a fault

DESCRIPTION

Abort executes an instruction which is illegal in user mode. 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)
int 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 smallest integer.

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 (Ø-11), day of week (Sunday = Ø), year - 19ØØ, day of year (Ø-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 Ø, 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(-(6Ø*4+3Ø), Ø) is appropriate because it is 4:3Ø ahead of GMT and the string GMT+4:3Ø 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, iscntrl, 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)
iscntrl	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

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. M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

NAME

exp, log, log1Ø, pow, sqrt - exponential, logarithm, power, square root

SYNOPSIS

```
#include <math.h>

double exp(x)
double x;

double log(x)
double x;

double log1Ø(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; log1Ø returns the base 1Ø logarithm.

Pow returns x8y9.

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 Ø and sets errno to EDOM when the second argument is negative and non-integral and when both arguments are Ø.

Log returns Ø when x is zero or negative; errno is set to EDOM.

Sqrt returns Ø when x is negative; errno is set to EDOM.
S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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. M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

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) S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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

In addition, each type may be followed by a '+' to have the file opened for reading and writing. "r+" positions the stream at the beginning of the file, "w+" creates or truncates it, and "a+" positions it at the end. Both reads and writes may be used on read/write streams, with the limitation that an fseek, rewind, or reading an end-of-file must be used between a read and a write or vice-versa.

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.

The read/write types do not exist on all systems. Those systems without read/write modes will probably treat the type as if the '+' was not present. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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.

If stream is stdin and the standard output is line buffered, then any partial output line will be flushed before any call to read(2) to satisfy the fread.

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 Ø upon end of file or error.

BUGS

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*28n9 indirectly through eptr.

Ldexp returns the quantity value*28exp9.

Modf returns the positive fractional part of value and stores the integer part indirectly through iptr. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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 Ø, 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, ØL, Ø).

SEE ALSO

lseek(2), fopen(3)

DIAGNOSTICS

Fseek returns -1 for improper seeks. M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

NAME

gamma - log gamma function

SYNOPSIS

```
#include <math.h>

double gamma(x)
double x;
```

DESCRIPTION

Gamma returns ln |G(|x|)|. The sign of G(|x|) is returned in the external integer signgam. The following C program might be used to calculate G:

```
y = gamma(x);
if (y > 88.Ø)
     error();
y = exp(y);
if(signgam)
     y = -y;
```

DIAGNOSTICS

A huge value is returned for negative integer arguments.

BUGS

There should be a positive indication of error. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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 (32-bit integer on a VAX-11) 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 Ø (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;

setgrent()

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 (Ø) 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 (Ø) 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_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 (Ø) 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.
S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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. M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

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 M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

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, ltol3 - convert between 3-byte integers and long integers

SYNOPSIS

```
l3tol(lp, cp, n)
long *lp;
char *cp;

ltol3(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.

Ltol3 performs the reverse conversion from long integers (lp) to three-byte integers (cp).

These functions are useful for file-system maintenance where the i-numbers 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 callcc return a null pointer (Ø) 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 Ø, the block pointed to by ptr may be destroyed.

The current incarnation of the allocator is unsuitable for direct use in a large virtual environment where many small blocks are to be kept, since it keeps all allocated and freed blocks on a single circular list. Just before more memory is allocated, all allocated and freed blocks are referenced; this can cause a huge number of page faults.

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

nlist - get entries from name list

SYNOPSIS

```
#include <nlist.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 Ø. See a.out(5) for the structure declaration.

This subroutine is useful for examining the system name list kept in the file /vmunix. 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 Ø if the file cannot be found or if it is not a valid namelist.

BUGS

On other versions of UNIX you must include <a.out.h> rather than <nlist.h>; this is unfortunate, but <a.out.h> can't be used on the VAX because it contains a union which can't be initialized.

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) S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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). S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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 `\Ø'.

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 Ø, 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.

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 Ø 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 Ø through MAXUINT, where MAXUINT equals 4294967295 on a VAX-11 and 65536 on a PDP-11).

% 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. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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. Fflush (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.

Errors can occur long after the call to putc. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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), ferror(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-scrt 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 Ø 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 28329 to return successive pseudo-random numbers in the range from Ø to 28319-1.

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. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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 charac-

ters 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 `\Ø', 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.

99f7 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 preceeded by 1 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 preceeded 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 Ø, 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[5Ø];
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\Ø'. Or,

```
int i; float x; char name[5Ø];
scanf("%2d%f%*d%[1234567890]", &i, &x, name);
```

with input

```
56789 Ø123 56a72
```

will assign 56 to i, 789.Ø to x, skip `Ø123', and place the string `56\Ø' 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. S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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 the standard output is line buffered when directed to a terminal. Other output streams directed to terminals, and the standard error stream stderr are normally not buffered. If the standard output is line buffered, then it is flushed each time data is read from the standard input by read(2).

SEE ALSO

fopen(3), getc(3), putc(3), malloc(3)

BUGS

The standard error stream should be line buffered by default.

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 Ø.

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) M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

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 -J/2 to J/2.

Acos returns the arc cosine in the range Ø to J.

Atan returns the arc tangent of x in the range -J/2 to J/2.

Atan2 returns the arc tangent of x/y in the range -J to J.

DIAGNOSTICS

Arguments of magnitude greater than 1 cause asin and acos to return value Ø; 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. M=1 .ds]D Fortune Operating System M=1 .ds]E Development Set M=2 .ds]D System Routines M=3 .ds]D Library Functions M=5 .ds]D File Formats

NAME

sinh, cosh, tanh - hyperbolic functions

SYNOPSIS

```
#include <math.h>

double sinh(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) S=1 .ds]D Fortune Operating System S=1 .ds]E Development Set S=2 .ds]D System Routines S=3 .ds]D Library Functions S=5 .ds]D File Formats

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:

stdin	standard input file
stdout	standard output file
stderr	standard error file

A constant `pointer' NULL (Ø) 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.

For purposes of efficiency, this implementation of the standard library has been changed to line buffer output to a terminal by default and attempts to do this transparently by flushing the output whenever a read(2) from the standard input is necessary. This is almost always transparent, but may cause confusion or malfunctioning of programs which use standard i/o routines but use read(2) themselves to read from the standard input.

In cases where a large amount of computation is done after printing part of a line on an output terminal, it is necessary to fflush(3) the standard output before going off and computing so that the output will appear.

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, c;
```

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 and VAX-11'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.

Part 3 File Formats

3

The file formats describe the structure and conventions of particular UNIX system files. Two examples of these files are the a.out file, which is the file output by the assembler and loader, and the ttys file, which is the file containing the terminal initialization data.

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 VAX-11 is:

```
/*
 * Header prepended to each a.out file.
 */
struct exec {
        long    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_trsize; /* size of text relocation */
        unsigned a_drsize; /* size of data relocation */
};

#define OMAGIC  0407       /* old impure format */
#define NMAGIC  0410       /* read-only text */
#define ZMAGIC  0413       /* demand load format */

/*
 * Macros which take exec structures as arguments and tell whether
 * the file has a reasonable magic number or offsets to text|symbo
 */
#define N_BADMAG(x) \
    (((x).a_magic)!=OMAGIC && ((x).a_magic)!=NMAGIC && ((x).a_magi

#define N_TXTOFF(x) \
        ((x).a_magic==ZMAGIC ? 1024 : sizeof (struct exec))
#define N_SYMOFF(x) \
        (N_TXTOFF(x) + (x).a_text+(x).a_data + (x).a_trsize+(x).a
#define N_STROFF(x) \
        (N_SYMOFF(x) + (x).a_syms)
```

The file has five sections: a header, the program text and data, relocation information, a symbol table and a string table (in that order). The last three may be omitted 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. The size of the header is not included in any of the other sizes.

When an a.out file is executed, three logical segments are set up: the text segment, the data segment (with uninitialized data, which starts off as all Ø, following initialized), and a stack. The text segment begins at Ø in the core image; the header is not loaded. If the magic number in the header is OMAGIC (Ø4Ø7), 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. This is the oldest kind of executable program and is rarely used. If the magic number is NMAGIC (Ø41Ø) or ZMAGIC (Ø413), the data segment begins at the first Ø mod 1Ø24 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. For ZMAGIC format, the text segment begins at a Ø mod 1Ø24 byte boundary in the a.out file, the remaining bytes after the header in the first block are reserved and should be zero. In this case the text and data sizes must both be multiples of 1Ø24 bytes, and the pages of the file will be brought into the running image as needed, and not pre-loaded as with the other formats. This is especially suitable for very large programs and is the default format produced by ld(1).

The stack will occupy the highest possible locations in the core image: growing downwards from Øx7ffff000. The stack is automatically extended as required. The data segment is only extended as requested by break(2).

After the header in the file follow the text, data, text relocation data relocation, symbol table and string table in that order. The text begins at the byte 1Ø24 in the file for ZMAGIC format or just after the header for the other formats. The N_TXTOFF macro returns this absolute file position when given the name of an exec structure as argument. The data segment is contiguous with the text and immediately followed by the text relocation and then the data relocation information. The symbol table follows all this; its position is computed by the N_SYMOFF macro. Finally, the string table immediately follows the symbol table at a position which can be gotten easily using N_STROFF. The first 4 bytes of the string table are not used for string storage, but rather contain the size of the string table; this size INCLUDES the 4 bytes, the minimum string table size is thus 4.

The layout of a symbol table entry and the principal flag values that distinguish symbol types are given in the

include file as follows:

```
/*
 * Format of a symbol table entry.
 */
struct nlist {
        union {
            char      *n_name; /* for use when in-core */
            long      n_strx;  /* index into file string table */
        } n_un;
        unsigned char n_type;  /* type flag, i.e. N_TEXT etc; see
        char          n_other;
        short         n_desc;  /* see <stab.h> */
        unsigned      n_value; /* value of this symbol (or sdb of
};
#define  n_hash       n_desc   /* used internally by ld */

/*
 * Simple values for n_type.
 */
#define  N_UNDF       0x0      /* undefined */
#define  N_ABS        0x2      /* absolute */
#define  N_TEXT       0x4      /* text */
#define  N_DATA       0x6      /* data */
#define  N_BSS        0x8      /* bss */
#define  N_COMM       0x12     /* common (internal to ld) */
#define  N_FN         0x1f     /* file name symbol */

#define  N_EXT        01       /* external bit, or'ed in */
#define  N_TYPE       0x1e     /* mask for all the type bits */

/*
 * Other permanent symbol table entries have some of the N_STAB bit
 * These are given in <stab.h>
 */
#define  N_STAB       0xe0     /* if any of these bits set, don't

/*
 * Format for namelist values.
 */
#define  N_FORMAT     "%08x"
```

In the a.out file a symbol's n_un.n_strx field gives an index into the string table. A n_strx value of 0 indicates that no name is associated with a particular symbol table entry. The field n_un.n_name can be used to refer to the symbol name only if the program sets this up using n_strx and appropriate data from the string table.

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 byte in the text or data which is not a portion of a reference to an undefined external symbol is exactly that value which will appear in memory when the file is executed. If a byte in the text or data involves a reference to an undefined external symbol, as indicated by the relocation information, then the value 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 to the bytes in the file.

If relocation information is present, it amounts to eight bytes per relocatable datum as in the following structure:

```
/*
 * Format of a relocation datum.
 */
struct relocation_info {
        int       r_address;        /* address which is relocated */
        unsigned  r_symbolnum:24,   /* local symbol ordinal */
                  r_pcrel:1,        /* was relocated pc relative alread
                  r_length:2,       /* 0=byte, 1=word, 2=long */
                  r_extern:1,       /* does not include value of sym re
                  :4;               /* nothing, yet */
};
```

There is no relocation information if a_trsize+a_drsize==0. If r_extern is 0, then r_symbolnum is actually a n_type for the relocation (i.e. N_TEXT meaning relative to segment text origin.)

SEE ALSO

adb(1), as(1), ld(1), nm(1), sdb(1), stab(5), strip(1)

BUGS

Not having the size of the string table in the header is a loss, but expanding the header size would have meant stripped executable file incompatibility, and we couldn't hack this just now.

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:

```
/*
 * Accounting structures
 *
 * jam 810817
 */

typedef unsigned short comp_t; /* "floating pt": 3 bits base 8 exp,
struct  acct
{
        char    ac_comm[10];    /* Accounting command name */
        comp_t  ac_utime;       /* Accounting user time */
        comp_t  ac_stime;       /* Accounting system time */
        comp_t  ac_etime;       /* Accounting elapsed time */
        time_t  ac_btime;       /* Beginning time */
        short   ac_uid;         /* Accounting user ID */
        short   ac_gid;         /* Accounting group ID */
        short   ac_mem;         /* average memory usage */
        comp_t  ac_io;          /* number of disk IO blocks */
        dev_t   ac_tty;         /* control typewriter */
        char    ac_flag;        /* Accounting flag */
};

extern  struct  acct            acctbuf;
extern  struct  inode           *acctp;/* inode of accounting file *

#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

aliases - aliases file for delivermail

SYNOPSIS

/usr/lib/aliases

DESCRIPTION

This file describes user id aliases that will be used by /etc/delivermail. It is formatted as a series of lines of the form

name:addr1,addr2,...addrn

The name is the name to alias, and the addri are the addresses to send the message to. Lines beginning with white space are continuation lines. Lines beginning with `#' are comments.

Aliasing occurs only on local names. Loops can not occur, since no message will be sent to any person more than once.

This is only the raw data file; the actual aliasing information is placed into a binary format in the files /usr/lib/aliases.dir and /usr/lib/aliases.pag using the program newaliases(5). A newaliases command should be executed each time the aliases file is changed for the change to take effect.

SEE ALSO

newaliases(1), dbm(3), delivermail(8)

BUGS

Because of restrictions in dbm(3) a single alias cannot contain more than about 1000 bytes of information. You can get longer aliases by ``chaining''; i.e. make the last name in the alias by a dummy name which is a continuation alias.

NAME

ar - archive (library) file format

SYNOPSIS

#include <ar.h>

DESCRIPTION

N.B.: This archive format is new to this distribution. See old(8) and arcv(1) for programs to deal with the old format.

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 string 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  "!<arch>\n"
#define SARMAG 8

#define ARFMAG "`\n"

struct ar_hdr {
        char    ar_name[16];
        char    ar_date[12];
        char    ar_uid[6];
        char    ar_gid[6];
        char    ar_mode[8];
        char    ar_size[10];
        char    ar_fmag[2];
};
```

The name is a blank-padded string. The ar_fmag field contains ARFMAG to help verify the presence of a header. The other fields are left-adjusted, blank-padded numbers. They are decimal except for ar_mode, which is octal. The date is the modification date of the file at the time of its insertion into the archive.

Each file begins on a even (0 mod 2) boundary; a new-line is inserted between files if necessary. Nevertheless the size given reflects the actual size of the file exclusive of

padding.

There is no provision for empty areas in an archive file.

The encoding of the header is portable across machines. If an archive contains printable files, the archive itself is printable.

SEE ALSO

ar(1), ld(1), nm(1)

BUGS

File names lose trailing blanks. Most software dealing with archives takes even an included blank as a name terminator.

NAME

core - format of memory image file

DESCRIPTION

UNIX writes out a memory 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 memory image is called `core' and is written in the process's working directory (provided it can be; normal access controls apply).

The maximum size of a core file is limited by vlimit(2). Files which would be larger than the limit are not created.

The core file consists of the u. area, which currently consists of 6 pages, beginning with a user structure as given in /usr/include/sys/user.h. The kernel stack grows from the end of this 6 page region. The remainder of the core file consists first of the data pages and then the stack pages of the process image.

In general the debugger adb(1) is sufficient to deal with core images.

SEE ALSO

adb(1), signal(2), vlimit(2)

NAME

dir - format of directories

SYNOPSIS

```
#include <sys/types.h>
#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 DIRSIZ    14
#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 " .}S 3 1 "(" " "/"" "" "),"" "" "" where `..' 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       10
#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         dinode         c_dinode;
     int       c_count;
     char      c_addr[BSIZE];
} spcl;

struct    idates {
     char      id_name[16];
     char      id_incno;
     time_t         id_ddate;
```

```
};

#define   DUMPOUTFMT     "%-16s %c %s"       /* for printf */
                                  /* name, incno, ctime(date) */
#define   DUMPINFMT "%16s %c %[^\n]\n"  /* inverse for scanf */
```

NTREC is the number of 1024 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 (1024-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(8), dumpdir(8), restor(8), 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=:/usr/ucb:/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 /etc/termcap (termcap(5)) for a list of terminal types.

SHELL The file name of the users login shell.

TERMCAP The string describing the terminal in TERM, or the name of the termcap file, see termcap(5),termlib(3).

EXINIT A startup list of commands read by ex(1), edit(1), and vi(1).

USER The login name of the user.

Further names may be placed in the environment by the export command and `name=value' arguments in sh(1), or by the setenv command if you use csh(1). Arguments may also be placed in the environment at the point of an exec(2). It is unwise to conflict with certain sh(1) variables that are frequently exported by `.profile' files: MAIL, PS1, PS2, IFS.

SEE ALSO

csh(1), ex(1), login(1), sh(1), exec(2), system(3), termlib(3), termcap(5), term(7)

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)

BUGS

The passwd(1) command won't change the passwords.

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(8)

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
user's real name, office, extension, home phone.
initial working directory
program to use as Shell

The name may contain `&', meaning insert the login name. This information is set by the chfn(1) command and used by the finger(1) command.

This is an ASCII file. Each field within each user's entry is separated from the next by a colon. 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, then /bin/sh 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.

Appropriate precautions must be taken to lock the file against changes if it is to be edited with a text editor; vipw(8) does the necessary locking.

FILES

/etc/passwd

SEE ALSO

getpwent(3), login(1), crypt(3), passwd(1), group(5), chfn(1), finger(1), vipw(8), adduser(8)

BUGS

A binary indexed file format should be available for fast access.

User information (name, office, etc.) should be stored elsewhere.

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

ttytype - data base of terminal types by port

SYNOPSIS

/etc/ttytype

DESCRIPTION

Ttytype is a database containing, for each tty port on the system, the kind of terminal that is attached to it. There is one line per port, containing the terminal kind (as a name listed in termcap (5)), a space, and the name of the tty, minus /dev/.

This information is read by tset(1) and by login(1) to initialize the TERM variable at login time.

SEE ALSO

tset(1), login(1)

BUGS

Some lines are merely known as "dialup" or "plugboard".

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:

```
/* a la types.h 4.1     81/03/21        */

/*
 * Basic system types and major/minor device constructing/busting macrc
 */

/* major part of a device */
#define  major(x)  ((int)(((unsigned)(x)>>8)&0377))

/* minor part of a device */
#define  minor(x)  ((int)((x)&0377))

/* make a device number */
#define  makedev(x,y)       ((dev_t)(((x)<<8) | (y)))

typedef unsigned char   u_char;
typedef unsigned short  u_short;
typedef unsigned int    u_int;
typedef unsigned long   u_long;

/* SHOULD USE long RATHER THAN int HERE BUT IT WOULD GIVE LINT ON THE K
/* GASTRIC DISTRESS AND DON'T HAVE TIME TO FIX THAT JUST NOW */
typedef  struct    _physadr { int r[1]; } *physadr;
typedef int     daddr_t;
typedef char *  caddr_t;
typedef u_short ino_t;
typedef int     time_t;
typedef int     label_t[13];    /* regs d2-d7, a2-a7, pc */
typedef short   dev_t;
typedef int     off_t;
typedef int     mem_t;
typedef u_long  tim_id_t;       /* timeout id */
typedef int (*faddr_t)();       /* Pointer to a function */
```

```
#ifdef  KERNEL
typedef int     vector_t;       /* interrupt vectors */
#define NULLVECTOR ((vector_t) -1)
#endif  KERNEL

typedef u_char  bool_t;
#ifndef YES
#define YES 1
#define NO  0
#endif  YES

#define MAX_LONG  0x7FFFFFFFL
#define MAX_INT   0x7FFFFFFF
#define MAX_SHORT 0x7FFF
#define MAX_CHAR  0x7F

#define MAX_U_LONG  0xFFFFFFFFL
#define MAX_U_INT   0xFFFFFFFF
#define MAX_U_SHORT 0xFFFF
#define MAX_U_CHAR  0xFF

#ifndef lint
#define void int   /* so berkeley void coersions will work */
#endif
```

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(8).

FILES

/etc/utmp
/usr/adm/wtmp

SEE ALSO

login(1), init(8), who(1), ac(8)

NAME

uuencode - format of an encoded uuencode file

DESCRIPTION

Files output by uuencode(1) consist of a header line, followed by a number of body lines, and a trailer line. Uudecode(1) will ignore any lines preceding the header or following the trailer. Lines preceding a header must not, of course, look like a header.

The header line is distinguished by having the first 6 characters "begin ". The word begin is followed by a mode (in octal), and a string which names the remote file. A space separates the three items in the header line.

The body consists of a number of lines, each at most 62 characters long (including the trailing newline). These consist of a character count, followed by encoded characters, followed by a newline. The character count is a single printing character, and represents an integer, the number of bytes the rest of the line represents. Such integers are always in the range from Ø to 63 and can be determined by subtracting the character space (octal 4Ø) from the character.

Groups of 3 bytes are stored in 4 characters, 6 bits per character. All are offset by a space to make the characters printing. The last line may be shorter than the normal 45 bytes. If the size is not a multiple of 3, this fact can be determined by the value of the count on the last line. Extra garbage will be included to make the character count a multiple of 4. The body is terminated by a line with a count of zero. This line consists of one ASCII space.

The trailer line consists of "end" on a line by itself.

SEE ALSO

uuencode(1), uudecode(1), uusend(1), uucp(1), mail(1)

NAME

wtmp - user login history

DESCRIPTION

This file records all logins and logouts. Its format is exactly like utmp(5) except that a null user name indicates a logout on the associated typewriter. Furthermore, the typewriter name `~' indicates that the system was rebooted at the indicated time; the adjacent pair of entries with typewriter 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

/usr/adm/wtmp

SEE ALSO

utmp(5), login(1), init(8), ac(1), who(1)