Bug Fixes and Changes in 4.3BSD

April 15, 1986

Marshall Kirk McKusick
James M. Bloom
Michael J. Karels

Computer Systems Research Group
Department of Electrical Engineering and Computer Science
University of California, Berkeley
Berkeley, California 94720
(415) 642-7780

ABSTRACT

This document briefly describes the changes in the Berkeley version of UNIX† for the VAX‡ between the 4.2BSD distribution of July 1983 and this, its revision of March 1986. It attempts only to summarize the changes that have been made.

Notable improvements

- The performance of the system has been improved to be at least as good as that of 4.1BSD, and in many instances is better. This was accomplished by improving the performance of kernel operations, rewriting C library routines for efficiency, and optimization of heavily used utilities.
- Many programs were rewritten to do I/O in optimal blocks for the filesystem. Most of these programs were doing their own I/O and not using the standard I/O library.
- The system now supports the Xerox Network System network communication protocols. Most of the remaining Internet dependencies in shared common code have been removed or generalized.
- The signal mechanism has been extended to allow selected signals to interrupt pending system calls.
- The C and Fortran 77 compilers have been modified so that they can generate single precision floating point operations.
- The Fortran 77 compiler and associated I/O library have undergone extensive changes to improve reliability and performance. Compilation may, optionally, include optimization phases to improve code density and decrease execution time. Many minor bugs in the C compiler have been fixed.
- The math library has been completely rewritten by a group of numerical analysts to improve both its speed and accuracy.
- Password lookup functions now use a hashed database rather than linear search of the password file.
- C library string routines and several standard I/O functions were recoded in VAX assembler for greater speed. The C versions are available for portability. Standard error is now buffered within a single call to perform output.
- The symbolic debugger, *dbx*, has been dramatically improved. *Dbx* works on C, Pascal and Fortran 77 programs and allows users to set break points and trace execution by source code line numbers,

---

references to memory locations, procedure entry, etc. *Dbx* allows users to reference structured and local variables using the program's programming language syntax.

- A new internet name domain server has been added to allow sites to administer their name space locally and export it to the rest of the Internet. Sites not using the name server may use a static host table with a hashed lookup mechanism.
- A new time synchronization server has been added to allow a set of machines to keep their clocks within tens of milliseconds of each other.

Bug fixes and changes

Section 1

adb Locates the stack frame when debugging the kernel. Slight changes were made to output formats.

arcv Has been retired to */usr/old*.

as The default data alignment may now be specified on the command line with a −**a** flag. A problem in handling filled data was fixed. Some bugs in the handling of dbx stab information were fixed.

at The user may now choose to run *sh* or *csh*. Mail can now be sent to the user after the job has run; mail is always sent if there were any errors during execution. *At* now runs with the user's full permissions. All spool files are now owned by ''daemon''. The last update time is in seconds instead of hours. The problems with day and year increments have been fixed.

awk Problems when writing to pipes have been corrected.

bc *Bc* will continue reading from standard input, after failing to open a file specified from the command line.

calendar Now allows tabs as separators. A subject line with the date of the reminder is added to each message.

cat Problems opening standard input multiple times have been fixed. *Cat* now runs much faster in the default (optionless) case.

cb No longer dumps core for unterminated comments or large block comments. For most purposes, *indent* (1) is far superior to *cb* .

cc The C compiler has some new features as well as numerous bug fixes. The principal new feature is a −**f** flag that tells the compiler to compute expressions of type **float** in single precision, following the ANSI C standard proposals. The C preprocessor has been extended to generate the dependency list for source files. The output is designed for inclusion in a makefile without modification.

The bug fixes are many and varied. Several fixes deal with type coercion and sign extension. Signed **char** and **short** values are now properly sign-extended in comparisons with unsigned values of the same length. Conversion of a signed **char** value to **unsigned short** now correctly sign-extends to 16 bits (on the VAX). Non-integer switch expressions now elicit warnings and the appropriate conversions are emitted. Unsigned longs were being treated as signed for the purpose of conversion to floating types; the compiler now produces the appropriate complicated instruction sequence to do this right. An ancient misunderstanding that caused *i* *= *d* to be treated as *i* = *i* * (**int**) *d* instead of *i* = (**double**) *i* * *d* for **int** *i* and **double** *d* has been corrected. If a signed integer division or modulus is cast to unsigned, the unsigned division or modulus routine is no longer used to compute the operation.

Some problems with bogus input and bogus output are now handled better; more syntax errors are caught and fewer code errors are emitted. Many declarations and expressions involving type **void** that used to be disallowed now work; some expressions that were not supposed to work are now caught. A pointer to a structure no longer stands a chance of being incremented by the size of its first element instead of the size of the structure when the value of the element is used at the same time the pointer is postincremented. Side effects in the left hand side of an unsigned assignment operator expression are now performed only once. Hex constants of the form 01234x56789 are now illegal. External declarations of functions may now possess arguments only if they are also definitions of functions. Declarations or initializations for objects of type structure where the particular structure was not previously defined used to result in confusing messages or even compiler errors; it's now possible to deduce one's mistake.

Some effort has been put into making the compiler more robust. Initializers containing casts sometimes would draw complaints about compiler loops or other problems; these now work properly. The register resource calculation now takes into account implicit conversions from **float** to **double** type, so that the code generator will not block by running out of registers. The compiler is more diligent about reducing structure type arguments to functions and no longer gives up when it cannot reduce the address to an offset from a register in only two tries. Programs that end in ‘‘\n#’’ no longer cause compiler core dumps. The compiler no longer dumps core for floating point exceptions that occur during reduction of constant expressions. The compiler expression tree table was enlarged so that it does not run out of space as quickly when processing complex expressions such as *putchar(c)*. The C preprocessor no longer uses a statically allocated space for strings. The preprocessor also now handles **# line** directives properly and correctly treats standard input from a terminal or a pipe. Two fencepost errors in the C peephole optimizer were adjusted and it now dumps core less often.

Some minor code efficiency changes were made. An important change is that the compiler now recognizes unsigned division and modulus operations that can be done with masking and shifting; this avoids the usual subroutine call overhead associated with these operations. The computation of register resources has improved so that the number of registers required for an expression is not overestimated as often. Register storage declarations for **float** variables now cause them to be put in registers if the **–f** flag is used. The compiler itself is somewhat faster, thanks primarily to a change that considerably reduces symbol table searches when entering and leaving blocks.

The compiler sources have been rearranged to make maintenance easier. The names of some source files have been changed to protect the innocent; header files now end in *.h*, and names of files reflect their functions. Configuration control has been simplified, so that only a simple configuration include file and the makefile flags variable should have to be considered when putting the compiler together. Redundant information has been eliminated from include files and the makefile, to reduce the chance of introducing changes that will make data structures or defines inconsistent. Values for opcodes are now taken from an include file *pcc.h* that is common to all the compilers that use the C compiler back end. The peephole optimizer can now be compiled without **–w**.

checknr The **.T&** *tbl* directive was added to the list of known commands.

chfn Has been merged into *passwd*(1).

chgrp An option has been added for recursively changing the group of a directory tree.

chmod Can now recursively modify the permissions on a directory tree. The mode string was extended to turn on the execute bit conditionally if the file is executable or is a directory.

chsh Has been merged into *passwd*(1).

clear Now has a proper exit status.

colrm Line length limitations have been removed.

compact Has been retired to */usr/old*.

compress Replaces *compact* as the preferred method to use in saving file system space.

cp No longer suffers problems when copying a directory to a nonexistent name or when some directories are not writable in a recursive copy. The **–p** flag was added to preserve modes and times when copying files.

crypt Waits for *makekey* to finish before reading from its pipe.

csh Has a new flag to stop argument processing so set user id shell scripts are more secure. File name completion may be optionally enabled. *Csh* keeps better track of the current directory when traversing symbolic links. Some major work was done on performance.

ctags *Ctags* was modified to recognize LEX and YACC input files. Files ending in *.y* are presumed to be YACC input, and a tag is generated for each non-terminal defined, plus a tag **yyparse** for the first %% line in the file. Files ending in *.l* are checked to see if they are LEX or Lisp files. A tag **yylex** is generated for the first %% line in a LEX file. In addition, for both kinds of files, any C source after a second %% is scanned for tags.

date The *date* command can now be used to set the date on all machines in a network using the *timed*(8) program. More information is logged regarding the setting of time.

dbx Major improvements have been made to *dbx* since the 4.2BSD release. Large numbers of bug fixes have made *dbx* much more pleasant to use; in particular many pointer errors that used to cause *dbx* to crash have been caught. Some new features have been installed; for instance it is now possible to search for source lines with regular expressions. The Fortran and Pascal language support is much improved, and the DEC Western Research Labs Modula-2 compiler is now supported.

dd Exit codes have been changed to correspond with normal conventions.

deroff *Deroff* no longer throws out two letter words.

diff Context diffs merge nearby changes. New flags were added for ignoring white space differences and for insensitivity to case.

diff3 The RCS version of *diff3* has been merged into the standard *diff3* under two new flags, **–E** and **–X**.

echo No longer accepts **–n***anything* in place of **–n**.

error Support for the DEC Western Research Labs Modula-2 compiler has been added. *Error* will now be able to run when there is no associated tty, so it may now be driven from *at*(1), etc. If the **–n** and **–t** options are selected, *error* will not touch files.

ex Support for changing window size has been added, and terminals with many lines, such as the WE5620, are now handled. Several small bug fixes were installed and various facilities have been made faster. *Ex* only reads the file *.exrc* if it is owned by the user, unless the *sourceany* option is set. It only looks for ‘‘mode lines’’ if the *modeline* option is set. If Lisp mode is set, it allows ‘‘–’’ to be used in ‘‘words’’. *Expreserve* now provides a better description of what happened to a user’s buffer when disaster struck.

eyacc *eyacc* is no longer a standard utility. It has been moved to the Pascal source directory.

f77 The Fortran compiler has been substantially improved. Many serious bugs have been fixed since the last release; the compiler now passes several widely used tests such as the Navy Fortran Compiler Validation System and the IMSL and NAG mathematical libraries. The optimizer is now trustworthy and robust; the many gruesome bugs that it used to inflict on programs, such as resolving different variables in the same **common** block into the same temporary for purposes of common subexpression elimination, have been fixed. **Do** loops, which used to suffer from deadly problems where loop variables, limit values and tests all managed to misfire even without the help of the optimizer, now produce proper results. Many severe bugs with **character** variables and expressions have been fixed; it is now possible to have variable length **character** variables on either side of an assignment, and the lengths of concatenations are properly computed. Several register allocation bugs have been fixed, among them the awful bug that $a = f(a)$ where a is in a register would not alter the value of *a*. Register allocation, though significantly improved, is still pitifully naive compared with the methods found in production Fortran compilers. **Save** statements cause variables to be retained, even if a subroutine returns from inside a loop. It is no longer possible to modify constants that are passed as parameters to subroutines and thus change all future uses of the constant when it is used as a subroutine parameter. Multi-level equivalences are no longer scrambled, and the **cmplx** intrinsic conversion function no longer garbles its result. The compiler now generates integer move instructions where it used to produce floating point move instructions, even when not optimizing, so that non-standard use of equivalences between **real** and **integer** types work as on most other systems. **Assign** statements now work with **format** statements. The ‘‘first character’’ parameter of a substring is now evaluated only once instead of twice. Restrictions on **parameter** variables are now enforced, and the compiler no longer aborts while trying to make sense of impossible **parameter** variables. The restrictions on array dimension declarators are much closer to the standard and much more stringent. Statement ordering used to be much more flexible, and wrong; it is now strictly enforced, leading to fewer compiler errors. The compiler now chides the user for declaring adjustable length character variables that are not dummy arguments. The compiler understands that subroutines and functions are different and prevents them from being used interchangeably. The parser is no longer fooled by excess ‘‘positional I/O control’’ parameters in I/O statements.

Several changes have been made to prevent the compiler itself from aborting; in particular, computed **goto**s do not elicit compiler core dumps, nor do multiplications by zero, nor do unusual statement numbers. The compiler now recognizes and complains about various kinds of hardware errors that can result from evaluating constant expressions, such as integer and floating overflow; it no longer dies when it receives a SIGFPE. Several memory management bugs that caused the compiler to dump core for seemingly random things have met their demise. Some conversion operations used to cause the code generator to emit impossible assembly language instructions that in turn caused the assembler some indigestion; these are now fixed. Some symbol table modifications were made to help out *dbx*(1), so that values of **common** and **parameter** storage classes and **logical** types are now accessible from *dbx*. When the compiler does abort, the error messages produced are now comprehensible to human beings and messy core dumps are no longer left behind. Some effort has been made to improve error reporting for program errors and to handle exceptional conditions in which the old compiler used to punt.

Some improvements in optimization were added to the compiler. Offsets to static data are now shorter than before; the compiler used to produce 32-bit offsets for all local variables. **Real** variables may now be allocated to registers. Format strings in **format** statements are compiled for considerable runtime savings; for various reasons, format strings in character constants and variables in I/O statements are not. Common subexpression elimination now reduces the re-evaluation of exponentiations in polynomial expressions. Some problems with alignment of data that caused ghastly performance degradation have been repaired.

Some changes have been made in the way the compiler is put together. The compiler front end now uses the common intermediate code format established in the include file *pcc.h* to communicate with the back end. The back end has been re-merged with the C compiler sources, so that bug fixes to the C compiler are automatically propagated to the Fortran back end. Similarly, the Fortran and C peephole optimizers were re-merged.

Some new features were added to the compiler. There is now a **−r8** flag to coerce **real** and **complex** variables and constants to double precision and double complex types for extended precision. There is a **−q** flag to suppress listing of file and entry names during compilation. Some foolproofing was added to the compiler driver; it is no longer possible to wipe out a source file by entering ‘‘f77 –o foo.f’’, and it now complains about incompatible combinations of options.

Many I/O library bugs were fixed. Auxiliary I/O has been fixed to be closer to the standard: *close* is a no-op on a non-existent or unconnected unit; *rewind* and *backspace* are no-ops on an unconnected unit; *endfile* opens an unconnected unit. *Inquire* returns **true** when asked if units 0-MAXUNIT exist, **false** for other integers; it used to return **false** for legal but unconnected file numbers and errors for illegal numbers. *Inquire* now fills in all requested fields, even if the file or unit does not exist or is unconnected. *Inquire* by unit now correctly returns the unit number. Most of the formatted I/O input scanning has been rewritten to check for invalid input. For example, with an *f10.0* format term, the following all used to read as 12.345: ‘‘1+2.345’’, ‘‘12.3abc45’’, ‘‘12.3.45’’, ‘‘12345e1-’’; they now generate errors. Conversely, the legal datum ‘‘12345-2’’ for 12.345 used to be misread as -1234.52. The *b* format term is now fixed, and *bz* now works for short records. Reads of short **logical** variables no longer overwrite neighboring data in memory. Infinite loops in formatted output (an I/O list but no conversion terms in the format) are now caught, printing multiple records after the list is exhausted. In list directed reads, a repeat count, *r*, followed by an asterisk and a space (and no comma) now follows the standard and skips *r* list items. Repeat counts for complex constants now work. Tabs are now fully equivalent to spaces in list directed input. There are two new formatting terms, *x* for hex and *o* for octal. The library now attempts to get to the next record if doing an **err=** branch on error; the standard does not require this, but it is undesirable to leave the system hanging in mid record. After input errors, the I/O library now tries to skip to the next line if there is another read. This functionality is not required by the standard and is still not guaranteed to work.

The Fortran runtime and I/O libraries have several new features. Many routines and variables have been made static, cutting the number of symbols defined by the library almost in half. Many source files have been reorganized to eliminate the loading of extraneous routines; for example, the formatted read routines are not loaded if a program only performs formatted writes. Standard error is now buffered. All error processing is now centralized in a single routine, *f77_abort*. The *f77_abort* routine has been separated from the normal Fortran main routine so that C code can call Fortran subroutines. Fortran programs that abort normally get a core file only if they are loaded with –**g**; the environment variable **f77_dump_flag** may be used to override this by setting it to *y* or *n*. The *rindex* routine now works as documented. The C library *malloc* and *random* routines may now be accessed from Fortran.

The new VAX math library has been incorporated and some bugs in calling math library routines have been fixed. The routine *d_dprod* was added for use with the –**r8** flag. The *sinh* and *tanh* routines have been deleted as they are loaded directly from the math library. The *log10* routine from the math library is now used by *r_lg10* and *d_lg10*. The *pow* routines now divide by zero when zero is raised to a negative power so as to generate an exception. Complex division by zero now generates an error message.

Appropriately named environment variables now override default file names and names in open statements; see ‘‘Introduction to the f77 I/O Library’’ for details. Unit numbers may vary from 0 to 99; the maximum number that can be open simultaneously depends on the system configuration limit (the library does not check this value). Namelist I/O similar to that in VMS Fortran has been added to the compiler, and library routines to implement it have been added to the I/O library. The documents ‘‘A Portable Fortran 77 Compiler’’ and ‘‘Introduction to the f77 I/O Library’’ have been revised to describe these changes. The new *help* system on the distribution tape in the user contributed software section contains a large set of help files for f77.

fed Has been retired to */usr/old*.

find Some new options have been added. It is now possible to choose users or groups that have no names by using the –**nouser** and –**nogroup** options. The –**ls** option provides a built in *ls* facility to allow the printing of various file attributes; it is identical to ''ls –lgids''. It is now possible to restrict *find* to the file system of the initial path name with the **−xdev** option. A new type, **−type** *s*, for sockets has been added. Symbolic links are now handled better. Globbing is now faster. *Find* supports an abbreviated notation, ''find *pattern*,'' which searches for a pattern in a database of the system's path names; this is much faster than the standard method.

finger Despite numerous changes, *finger* still has Berkeley parochialisms. It has been modified to provide finger information over the network. Control characters are mapped to their printable equivalents (e.g. ˆX) to avoid trojan horses in *.plan* and *.profile* files.

file *File* has been extended to recognize sockets, compressed files (*.Z*), and shell scripts. When it determines that a file is a shell script, it tries to discover whether it is a Bourne shell script or a C shell script. The special bits set user id, sticky, and append-only are also noted. The value of a symbolic link is now printed.

from An error message is printed if the requested mailbox cannot be opened.

ftp Many bugs have been fixed. New features are: support for new RFC959 FTP features (such as ''store unique''), new commands that manipulate local and remote file names to better support connections to non-UNIX systems, support for third party file transfers between two simultaneously connected remote hosts, transfer abort support, expanded and documented initialization procedures (the *.netrc* file), and a simple command macro facility.

gprof Uses *setitimer* to discover the clock frequency instead of looking it up in */dev/kmem*. An alphabetical index printing routine has been added. A few changes were made to the output format; a new column indicates milliseconds per call.

groups Now prints out the group listed in the password file in addition to the groups listed in the groups file.

help Has been superseded by the *help* facility included in the User Contributed Software.

hostid Has been extended to take an Internet address or hostname.

indent Has been completely rewritten; its default mode now produces programs somewhat more closely reflecting the local Berkeley style.

install The *chmod* in the *install* script uses **−f** so that it does not complain if it fails. When *mv*'ing and *strip*'ing a binary (**−s** and not **−c**), the *strip* is done before the *mv* to avoid fragmentation on the destination file system.

iostat Disk statistics are collected by an alternate clock, if it exists. Overflow detection has been added to avoid printing negative times. A call to *fflush* was added so that *iostat* works through pipes and sockets. Code to handle additional disks was added in the same way as in *vmstat*. The header is reprinted when *iostat* is restarted.

kill Signal 0 may now be used as documented.

lastcomm Several bug fixes were installed. *Lastcomm* now understands the revised accounting units.

ld A list of directories to search for libraries may now be specified on the command line.

learn The ''files'' lesson has been updated to reflect the default system tty conventions for erase and kill characters. *Learn* now uses directory access routines so that trash files can be removed properly between lessons.

leave Now ignores SIGTTOU and properly handles the +*hhmm* option.

lex The error messages have been made more informative.

lint Tests for negative or excessively large constant shifts were added. For **−a**, warnings for expressions of type **long** that are cast to type **void** are no longer emitted. A bug which caused *lint* to incorrectly report clashes for the return types of functions has been fixed. *Lint* now understands that **enum**s are not **int**s. The lint description for the C library was updated to reflect sections two and three of the Programmers Manual more accurately. Several more libraries in */usr/lib* now have lint libraries. Changes were made to accommodate the restructuring of the C compiler for common header files.

lisp The Berkeley version of Franz Lisp has not been changed much since the 4.2BSD release. It has been updated to reflect changes in the C library.

ln Now prints a more accurate error message when asked to make a symbolic link into an unwritable directory.

lock *Lock* now has a default fifteen minute timeout. The root password may be used to override the lock. If an EOF is typed, it is now cleared instead of spinning in a tight loop until the timeout period.

logger A new program that logs its standard input using *syslog*(3).

login The environment may be set up by another process that calls *login*. It now uses the new *getttyent* (3) routines to read */etc/ttys*.

lpr Now supports ‘‘restricted access’’ to a printer– printer use may be restricted to only those users in a specific group-id.

mail *Mail* now expects RFC822 headers instead of the obsolete RFC733 headers. A **retain** command has been added. If the PAGER variable is set in the environment, it is used to page messages instead of *more* (1). The **write** command now deletes the entire header instead of only the first line. An **unread**/**Unread** command (to mark messages as not read) was added. If **Replyall** is set, the senses of **reply** and **Reply** are reversed. When editing a different file, *mail* always prints the headers of the first few messages. *Flock*(2) is used for mailbox locking. Commands ‘‘−’’ and ‘‘+’’ skip over deleted messages; **type** *user* now does a substring match instead of a literal comparison. A −**I** flag was added which causes *mail* to assume that input is a terminal.

make A bug which caused *make* to run out of file descriptors because too many files and directories were left open has been fixed. Long path names should not be a problem now. A VPATH macro has been added to allow the user to specify a path of directories to search for source files.

man Support for alternate manual directories for *man*, *apropos* and *whatis* was added. A side effect of this is that the *whatis* database was moved to the *man* directory. If the source for a manual page is not available, *man* will display the formatted version. This allows machines to avoid storing both formatted and unformatted versions of the manual pages. The environment variable MANPATH overrides the default directory */usr/man*. The −**t** option is no longer supported. The printing process has been streamlined by using ‘‘more −s *catfile*’’ instead of ‘‘cat −s *catfile* | ul | more −f’’. Searches of */usr/man/mano* are more lenient about file name extensions. The source for *man* was considerably cleaned up; the magic search lists and commands were put at the top of the source file and the private copy of *system* was deleted.

mesg So that terminals need not be writable to the world, *mesg* only changes the group ‘‘write’’ permission. (Terminals are now placed in group *tty* so that users may restrict terminal write permission to programs which are set-group-id *tty*.)

mkdir Prints a ‘‘usage’’ error message instead of an uninformative ‘‘arg count’’ message.

more Now allows backward scanning. It will also handle window size changes. It simulates ‘‘crt’’ style erase and kill processing if the terminal mode includes those options.

msgs Will no longer update *.msgsrc* if the saved message number is out of bounds.

mv No longer runs *cp* (1) to copy a file; instead it does the copy itself.

netstat Routes and interfaces for Xerox NS networks are now shown. The −**I** option has been added to specify a particular interface for the default display. The −**u** option has been added to show UNIX domain information. Several new mbuf types and statistics are now displayed; subnetting is now understood.

nice Is relative as documented, not absolute.

nroff No longer replaces single spaces with tabs when using the **–h** option.

Pascal The Pascal compiler and interpreter have been extensively rewritten so that they will (nearly) pass through *lint*. In theory they have not changed from a semantic point of view. A few bugs have been fixed, and undoubtedly some new ones introduced. The Pascal runtime support has improved error diagnostics. Real number input scanning now corresponds to standard Pascal conventions rather than those of *scanf*(3S).

passwd The *passwd* program incorporates the functions of *chfn* and *chsh* under **–f** and **–s** flags. Whenever information is changed *passwd* also updates the associated *ndbm*(3X) database used by *getpwnam* and *getpwuid*. Office room and phone numbers are less dependent on Berkeley's usage. Checks are made for write errors before renaming the password file.

plot The output device resolution can now be specified using the **–r** option. Support has been added for the Imagen laser printer and the Tektronix 4013.

pr The buffer is now large enough for 66 x 132 output.

print Has been retired to */usr/old*; use ''lpr –p'' instead.

prmail Has been retired to */usr/old*; use ''Mail -u *user*'' instead.

prof Uses *setitimer* to determine the clock frequency instead of assuming 60 hertz.

ps Saves static information for faster startup. It now prints symbolic values for wait channels.

pti Has been retired to */usr/old*.

ptx Cleans up after itself and exits with a zero status on successful completion.

quota Verifies that the system supports quotas before trying to interpret the quota files.

ranlib The **–t** option updates a library's internal time stamp without rebuilding the table of contents. ''Old format'' and ''mangled string table'' are now warnings rather than fatal errors. Memory allocation is done dynamically.

rcp For the convenience of system managers, *rcp* has moved from */usr/ucb* to */bin*, hence it can be used without mounting */usr*. Remote user names are now specified as *user@host* instead of *host.user* to support Internet domain hostnames that contain periods (''.''). A **–p** option has been added that preserves file and directory modes, access time, and modify time. It now uses *getservbyname* instead of compile time constants.

rdist A new program that keeps files on multiple machines consistent with those on a master machine.

refer The key letter code was fixed so that control characters are not generated. Several problems that caused the generation of duplicate citations, particularly with the **–e** and **–s** options, have been fixed. EOF on standard input is now properly handled. *Refer* folds upper and lower case when sorting.

rlogin *Rlogin* negotiates with *rlogind* to determine whether window size changes should be passed through. If the remote end is running a 4.3BSD *rlogind*, it will agree to accept and pass through SIGWINCH signals to user processes under its control. The **–8** flag allows an 8-bit path on input. The **–L** flag allows an 8-bit path on output. The escape character is now echoed as soon as a second non-command character is typed. A new command character *^Y* has been added to suspend only the input end of the session without stopping output from the remote end (unless **tostop** has been set). The *ioctl* TIOCSPGRP has been changed to *fcntl* F_SETOWN. Several changes have been made to reduce the amount of data sent after an interrupt has been typed, and to avoid flushing data when changing modes.

rm The **–f** option produces no error messages and exits with status 0. The problem of running out of file descriptors when doing a recursive remove have been fixed.

rmdir Improved error messages, in the same fashion as *mkdir*.

rsh The **–L**, **–w**, and **–8** flags are ignored so that they may be passed along with **–e** to rlogin.

ruptime The **–r** flag has been added to reverse sort order.

rwho Now allows hosts with long names (greater than 16 characters).

script Now propagates window size changes.

sed No longer loops when the first regular expression is null.

sendbug Allows command line **–D** arguments to override built in defaults for name and host address of the bugs mailing list. The ‘‘Repeat-By’’ field is now optional. *Sendbug* now checks the EDITOR environment variable instead of assuming *vi*.

sh ‘‘#’’ is no longer considered a comment character when *sh* is interactive. The IFS variable is not imported when *sh* runs as root or if the effective user id differs from the real user id.

size Now exits with the number of errors encountered.

sort Checks for and exits on write errors.

spell A couple of trouble-causing words have been removed from *spell*’s stoplist; *e.g.* ‘‘reus’’ that caused ‘‘reused’’ to be flagged. A few words that *spell* would not derive have been removed from the stoplist. Several hundred words that *spell* derives without difficulty from existing words (*e.g.* ‘‘getting’’ from ‘‘get’’), or that *spell* would accept anyway, *e.g.* ‘‘1st, 2nd’’ etc., have been removed from */usr/dict/words.*

stty Has been extended to handle window sizes and 8-bit input data paths. "stty size" prints only the size of the associated terminal.

su Only members of group 0 may become root.

symorder Now reorders the string table as well as the name list.

sysline Now understands how to run in one-line windows and how to adjust to window size changes. Numerous small changes have been made in the output format.

systat A new program that provides a cursed form of *vmstat*, as well as several other status displays.

tail Makes use of a much larger buffer.

talk The new version of *talk* has an incompatible but well-defined protocol that works across a much broader range of architectures. The new talk rendezvouses at a new port so that the old version can still be used during the conversion. *Talkd* looks for a writable terminal instead of giving up if a user’s first entry in */etc/utmp* is not writable. Root may always interrupt. *Talk* now runs set-group-id to group *tty* so that it is no longer necessary to make terminals world writable.

tar Preserves modified times of extracted directories. The **–B** option is turned on when reading from standard input. Some sections were rewritten for efficiency.

tbl The hardwired line length has been removed.

tcopy A new program for doing tape to tape copy of multifile, arbitrarily blocked magnetic tapes.

tee *Tee*’s buffer size was increased.

telnet *Telnet* first tries to interpret the destination as an address; if that fails, it is then passed off to *gethostbyname*. If multiple addresses are returned, each is tried in turn until one succeeds, or the list is exhausted. If a non-standard port is specified, the initial ‘‘Suppress Go Ahead’’ option is not sent. Commands were added to escape the escape character, send an interrupt command, and send ‘‘Are You There’’. Carriage return is now mapped to carriage return, newline.

tftp Has many bug fixes. It no longer loops upon reading EOF from standard input. Retransmission to send was added, as well as an input buffer flush to both send and receive.

tip Lock files are no longer left lying about after *tip* exits, and the *uucp* spool directory does not need to be world writable. A new ‘‘~$’’ command sends output from a local program to a remote host. Alternate phone numbers are separated only by ‘‘,’’; thus several dialer characters that were previously illegal may now be used. *Tip* now arranges to copy a phone number argument to a safe place, then zero out the original version. This narrows the window in which the phone number is visible to miscreants using *ps* or *w*. Also fixed was a bug that caused the phone number to be written in place of the connection message. Carrier loss is recognized and an appropriate disconnect action is taken. Bugs in calculating time and fielding signals have been fixed. Several new dialers were added.

tn3270 A new program for emulating an IBM 3270 over a *telnet* connection.

tp Memory allocation was changed to avoid *realloc*.

tr Checks for and exits on write errors.

trman Has been retired to */usr/old*.

tset Can now set the interrupt character. The defaults have been changed when the interrupt, kill, or erase characters are NULL. *Reset* is now part of *tset*. The window size is set if it has not already been set. *Tset* continues to prompt as long as the terminal type is unknown.

users Now much quieter if there are no users logged on.

uucp Several fixes and changes from the Usenet have been incorporated. The maximum length of a sitename has been increased from 7 to 14 characters. *Uucp* has been changed to understand the new format of */etc/ttys*. Support for more dialers has been added.

vacation A new program that answers mail while you are on vacation.

vgrind Has been extended to handle the DEC Western Research Labs Modula-2 compiler and *yacc*.

vlp Now properly handles indented lines.

vmstat The –**i** flag was added to summarize interrupt activity. The –**s** listing was expanded to include cache hit rates for the name cache and the text cache. The standard display has been generalized to allow command line selection of the disks to be displayed. A new header is printed after the program is restarted. If an alternative clock is being used to gather statistics, it is properly taken into account.

vpr Has been retired to */usr/old*.

w Users logged in for more than one day have login day and hour listed; users idle for more than one day have their idle time listed in days.

wall Will now notify all users on large systems.

whereis Now also checks *manl*, *mann*, and *mano*.

which Now sets prompt before sourcing the user’s *.cshrc* file to ensure that initialization for interactive shells is done.

whoami Uses the effective user id instead of the real user id.

window A new program that provides multiple windows on ASCII terminals.

write Looks for a writable terminal instead of giving up if a user’s first entry in */etc/utmp* is not writable. Root may always interrupt. Non-printable escape sequences can no longer be sent to an unsuspecting user’s terminal. *Write* now runs set-group-id to group *tty* so that it is no longer necessary to make terminals world writable.

xsend Notice of secret mail is now sent with a subject line showing who sent the mail. The body of the message includes the name of the machine on which the mail can be read.

xstr Now handles multiple-line strings.

Section 2

The error codes for Section 2 entries have been carefully scrutinized to insure that the documentation properly reflects the source code. User-visible changes in this section lie mostly in the area of the interprocess communication facilities; the Xerox Network System communication procotocols have been added and the existing communication facilities have been extended and made more robust.

adjtime A new system call which skews the system clock to correct the time of day.

fcntl The FASYNC option to enable the SIGIO signal now works with sockets as well as with ttys. The interpretation of process groups set with F_SETOWN is the same for sockets and for ttys: negative values refer to process groups, positive values to processes. This is the reverse of the previous interpretation of socket process groups set using *ioctl* to enable SIGURG.

kill The error returned when trying to signal one's own process group when no process group is set was changed to ESRCH. Signal 0 can now be used as documented.

lseek Returns an ESPIPE error when seeking on sockets (including pipes) for backward compatibility.

open When doing an open with flags O_CREAT and O_EXCL (create only if the file did not exist), it is now considered to be an error if the target exists and is a symbolic link, even if the symbolic link refers to a nonexistent file. This behavior was added for the security of programs that need to create files with predictable names.

ptrace A new header file, <*sys/ptrace.h*>, defines the request types. When the process being traced stops, the parent now receives a SIGCHLD.

readlink Returns EINVAL instead of ENXIO when trying to read something other than a symbolic link.

rename If the ISVTX (sticky text) bit is set in the mode of a directory, files in that directory may not be the source or target of a *rename* except by the owner of the file, the owner of the directory, or the superuser.

select Now handles more descriptors. The mask arguments to *select* are now treated as pointers to arrays of integers, with the first argument determining the size of the array. A set of macros in <*sys/types.h*> is provided for manipulating the file descriptor sets. The descriptor masks are only modified when no error is returned.

setsockopt Options that could only be *set* in 4.2BSD (e.g. SO_DEBUG, SO_REUSEADDR) can now be set or reset. To implement this change all options must now supply an option value which specifies if the option is to be turned on or off. The SO_LINGER option takes a structure as its option value, including both a boolean and an interval. New options have been added: to get or set the amount of buffering allocated for the socket, to get the type of the socket, and to check on error status. Options can be set in any protocol layer that supports them; IP, TCP and SPP all use this mechanism.

setpriority The error returned on an attempt to change another user's priority was changed from EACCES to EPERM.

setreuid Now sets the process *p_uid* to the new effective user ID instead of the real ID for consistency with usage elsewhere. This avoids problems with processes that are not able to signal themselves.

sigreturn Is a new system call designed for restoring a process' context to a previously saved one (see *setjmp/longjmp*).

sigvec Three new signals have been added, SIGWINCH, SIGUSR1, and SIGUSR2. The first is for notification of window size changes and the other two have been reserved for users.

socket The usage of the (undocumented) SIOCSPGRP *ioctl* has changed. For consistency with *fcntl*, the argument is treated as a process if positive and as a process group if negative. Asynchronous I/O using SIGIO is now possible on sockets.

swapon The error returned for when requesting a device which was not configured as a swap device was changed from ENODEV to EINVAL. In addition, *swapon* now searches the swap device tables from from the beginning instead of the second entry.

unlink If the ISVTX (sticky text) bit is set in the mode of a directory, files may only be removed from that directory by the owner of the file, the owner of the directory, or the superuser.

Section 3

The Section 3 documentation has been reorganized into just two sections. The first section contains everything previously in Section 3 except the Fortran library routines. The second section contains the Fortran library routines.

The routines *memccpy, memchr, memcmp, memcpy, memset, strchr, strcspn, strpbrk, strrchr, strspn,* and *strtok* have been added for compatibility with System V. These routines are similar to the string and block handling ones described in the *bstring* and *string* manual pages. The 4.3BSD *string* and *bstring* versions should be faster than these compatibility routines on the VAX.

abort Sets SIGILL signal action to the default to avoid looping if SIGILL had been ignored or blocked.

ctime Daylight savings time calculations have been fixed for Europe and Canada. Programs making multiple calls to *ctime* will make fewer system calls. The include file has moved from <*sys/time.h*> to <*time.h*>.

ctype *iscntrl* has been fixed to correspond to the manual page. Space is a printing character. *isgraph* is a new function that returns true for characters that leave a mark on the paper. *toupper, tolower,* and *toascii* have all been documented.

curses The library handles larger termcap definitions and handles more of the ‘‘funny’’ termcap capabilities. The old *crmode* and *nocrmode* macros have been renamed *cbreak* and *nocbreak* respectively; backwards compatible definitions for these macros are provided. The erase and kill characters and the terminal’s baudrate may be accessed via *erasechar*, *killchar*, and *baudrate* macros defined in <*curses.h*>. A *touchoverlap* function has been provided, and bugs in *overlay* and *overwrite* have been fixed.

dbm Has been rewritten to use the multiple-database version of the library, *ndbm*.

disktab Has added support for two new fields indicating the use of *bad144*-style bad sector forwarding and filesystem offsets specified in sectors.

encrypt Now works correctly when called directly.

execvp No longer recognizes ‘‘-’’ as a path separator.

frexp Now handles 0 and powers of 2 correctly. This routine is now written in assembly language for the VAX.

gethost* *gethostbyaddr* and *gethostbyname* have been modified to make calls to the name server. If the name server is not running, a linear scan of the host table is made. With an optional C library configuration, these routines may instead use an *ndbm* database for the host table. One of these lookup mechanisms must be specified when compiling the C library. The default is to use the name server. *gethostent* has no equivalent when using the routines calling the name server. The *hostent* structure has been modified to support the return of multiple addresses. The external variable *h_errno* has been added for returning error status information from the name server, such as whether a transient error was encountered.

getopt A new routine for parsing command line arguments. It is compatible with the System V routine by the same name.

getpw* *getpwnam* and *getpwuid* use a hashed database using *ndbm* for faster lookups by user name and id.

gettty* *getttyent* and *getttynam* are new routines for looking up entries in the new version of */etc/ttys*. The new header file <*ttyent.h*> describes the associated structures.

getusershell A new routine for retrieving shell names from a file listing the standard interactive shells, */etc/shells*, for the use of *passwd* (1) and servers providing remote host access.

getwd *Getwd* no longer changes directories in calculating the working directory; this eliminates problems with return to the current directory, and results in fewer *stat* calls.

inet_makeaddr Properly handles INADDR_BROADCAST.

longjmp On errors, *longjmp* calls the routine *longjmperror*. The default routine still prints ‘‘longjmp botch’’ and exits; this may be replaced if a program wants to provide its own error handler.

malloc *Malloc* underwent a major rework. Memory requests of page size or larger are always page aligned, and are now optimized for sizes that are a power of two. The debugging code has been improved.

math The math library has been rewritten to improve the speed and accuracy of the routines on VAXen with D-format floating point support and machines that conform to the IEEE standard 754 for double precision floating point arithmetic. The library also has improved error detection and handling; for the VAX, the library generates reserved operand faults for invalid operands. Many new functions have been added. Two functions have changed their names; *gamma* is now *lgamma* and *fmod* is now *modf*. The old math library is available as −lom.

mkstemp Is a new routine similar to *mktemp* except that it returns an open file descriptor for a temporary file. It is intended to replace *mktemp* in programs (run as root or setuid) that must be concerned with atomic creation of temporary files without the possibility of having the temporary file relocated to an unexpected location by a symbolic link.

ndbm A new version of *dbm* that allows multiple databases to be open simultaneously.

nlist Now returns −1 on error or the number of unfound items.

perror A few of the error messages have been made more accurate.

plot Supports many new devices: Tektronix 4013, AED graphics terminal, BBN Bitgraph terminal, terminals using the DEC GiGi protocol, HP 2648 terminals and 7221 plotters, and Imagen laser printers (240 or 300 dots per inch). Libraries also exist for generating plot files from Fortran programs and for plotting on ‘‘dumb’’ devices such as a standard line printer.

popen Dynamically allocates an array for file descriptors. The new signal interface is now used.

psignal New signals have been added to the list.

random An initialization bug that messed up default generation was fixed.

rcmd Cleans up properly. A problem with doing multiple calls within one program was fixed.

ruserok Now is more flexible about the format of *.rhosts*. Domain style hostnames do not need full specification if they are a part of the local domain, as determined by *hostname* (1). *Ruserok* is more paranoid about ownership of *.rhosts*.

scandir Handling of overflow has been fixed.

setjmp The signal stack status is now set correctly.

siginterrupt A new routine to set the signals for which system calls are not restarted after signal delivery.

signal Keeps track of new features when changing signal handlers.

sleep A couple of races have been fixed.

stdio Has been modified to dynamically allocate slots for file pointers. Output on unbuffered files is now buffered within a call to *printf* or *fputs* for efficiency. *Fseek* now returns zero if it was successful. *Fread* and *fwrite* have been rewritten to improve performance. On the VAX, *fgets*, *gets*, *fputs* and *puts* were rewritten to take advantage of VAX string instructions and thus improve performance. Line buffering now works on any file descriptor, not just *stdout* and *stderr*. *Putc* is implemented completely within a macro except when the buffer is full or when a newline is output on a line-buffered file. Some sign extension bugs with the return value of *putc* have been fixed.

string The routines *index, rindex, strcat, strcmp, strcpy, strlen, strncat*, and *strncpy* have been rewritten in VAX assembly language for efficiency. The C routines are included for use on other machines. Only *Makefile*s need to be modified to select the version to be used.

syslog The third parameter to *openlog* is a ‘‘*facility code*’’ used to classify messages. References to <*syslog.h*> should be replaced with references to <*sys/syslog.h*>.

ttyslot Uses the new *getttyent* routine.

ualarm A simplified interface to *setitimer*, similar to *alarm* but with its argument in microseconds.

usleep A new routine which resembles *sleep* but takes an argument in microseconds.

Section 4

The system now supports the 64Kbit and 256Kbit RAM memory controllers for the VAX-11/780 and VAX-11/785, the second UNIBUS adapter for the VAX-11/750, and the new VAX 8600 with UNIBUS and/or MASSBUS peripherals. The Unibus management routines for network interfaces have been generalized in 4.3BSD; this change requires stylized changes within most of the network drivers. A number of changes were made to each terminal multiplexor driver as well. See sections 9 and 11 of the ‘‘Changes to the Kernel in 4.3BSD’’ document for details.

New manual entries in Section 4 have been created to describe the new communications protocols and network architectures that are supported. The most recent addition in 4.3BSD is the Xerox Network System protocols.

arp *Ioctl*s have been added to enter and delete entries in the Internet-to-Ethernet† address translation tables. Entries may be made permanent, and may be ‘‘published’’ to allow a host to act as an ARP server.

ddn A new DDN Standard Mode X.25 IMP interface driver.

de A new DEC DEUNA 10 Mb/s Ethernet interface driver.

dhu A new DEC DHU-11 communications multiplexor driver.

dmc The configuration flags may be used to specify how to set up the device. Multiple outstanding DMA requests can now be handled. A new encapsulation is used that allows multiple protocols to be supported, but is incompatible with that used by 4.2BSD and earlier Ultrix releases.

dmz A new DEC DMZ-32 communications multiplexor driver.

ec Has a corrected backoff algorithm. Multiple units are supported by placing the Unibus memory address in the device *flags* field.

ex A new Excelan 204 10 Mb/s Ethernet interface driver.

hdh A new ACC IF-11/HDH IMP interface driver.

idp A description of the new Xerox Internet Datagram Protocol.

il The driver has additional diagnostics and now supports Xerox NS.

ip Support for IP options was added.

ix A new Interlan NP100 10 Mb/s Ethernet interface driver.

† Ethernet is a trademark of Xerox Corporation.

np A new device for downloading microcode into the Interlan NP100 10 Mb/s Ethernet interface driver.

ns A description of the new Xerox Network Systems protocol family.

nsip A description of the new software network interface encapsulating NS packets in IP packets.

ps The driver for the Picture System 2 has a small change in interrupt handling.

pty A new mode was added to allow a small set of commands to be passed to the pty master from the slave as a rudimentary type of *ioctl*, analogous to that of PKT mode. Using this mode or PKT mode, a *select* for exceptional conditions on the master side of a pty returns **true** when a command operation is available to be read. *Select* for writing on the master side has been fixed.

spp A description of the new Xerox Sequenced Packet Protocol.

tcp An option was added to disable small-packet avoidance under certain circumstances.

tty PASS8 mode has been added to pass all 8 bits of input. New *ioctl*s were added to support the getting and setting of window size information for the terminal. A signal was added to notify processes when the window size changes.

Section 5

A new subdirectory, */usr/include/protocols,* has been created to keep header files that are shared between user programs and daemons. Several header files have been moved here, including those for *rwhod*, *routed*, *timed*, *dump*, *talk*, and *restore*.

Two new header files, <*string.h*> and <*memory.h*>, have been added for System V compatibility.

disktab Two new fields have been added to specify that the disk supports *bad144*-style bad sector forwarding, and that offsets should be specified by sectors rather than cylinders.

dump The header file <*dumprestor.h*> has moved to <*protocols/dumprestore.h*>.

gettytab New entries have been added, including a 2400 baud dial-in rotation for modems, a 19200 baud standard line, and an entry for the *xterm* terminal emulator of the *X* window system. New capabilities for automatic speed selection and setting strict xoff/xon flow control (**decctlq**) were added.

termcap Many new entries were added and older entries fixed.

ttys The format of the ttys file, */etc/ttys*, reflects the merger of information previously kept in */etc/ttys*, */etc/securetty*, and */etc/ttytype*. The new format permits arbitrary programs, not just */etc/getty*, to be spawned by *init*. A special **window** field can be used to set up a window server before spawning a terminal emulator program.

Section 6

aardvark The ‘‘Dungeon Definition Language’’ processor has been updated to run on 4.3BSD, so that games such as aardvark now work again.

battlestar A third generation adventure game.

canfield The user interface has been improved so that one need not type so many carriage returns between games. Players are charged a maximum of three minutes of think time between moves should they put a game on hold for an extended period of time.

fortune Has yet more adages (not better ones, just more).

hunt The latest addition, a maze battle game for multiple players.

mille Now plays slightly more intelligently, and prevents discarding of safeties.

robots Much like the old game of chase, except different.

rogue Has been made more of a scoundrel.

Section 7

hier Has been updated to reflect the reorganization to the user and system source.

me Some new macros were added: **.sm** (smaller) and **.bu** (bulleted paragraph). The *pic*, *ideal*, and *gremlin* preprocessors are now supported.

words Two new word lists have been add to */usr/dict*. The 1935 Webster's word list is available as web2 with a supplemental list in web2a.

Several hundred words have been added to */usr/dict/words*, both general words (‘‘abacus, capsize, goodbye, Hispanic, ...’’) and important technical terms (all the amino acids, many mathematical terms, a few dinosaurs, ...). About 10 spelling errors in */usr/dict/words* have been corrected.

Several hundred words that *spell* derives without difficulty from existing words (*e.g.* ‘‘getting’’ from ‘‘get’’), or that *spell* would accept anyway, *e.g.* ‘‘1st, 2nd’’ etc., have been removed from */usr/dict/words.*

Section 8

Major changes affecting system operations include:

- The format of the ttys file, */etc/ttys*, has been changed to include information about terminal type.
- The *crontab* file used by *cron* has a new field in each line to specify the user ID to be used.
- A new Internet server-server, *inetd*, listens for service requests on a number of ports and spawns the appropriate server upon demand. Fewer of the Internet services now require long-lived daemon processes.
- The *bad144* program can now be used to add new bad sectors to the bad sector file. Replacement sectors are rearranged as needed to sort the new sectors into the bad sector list. Reformat operations to mark bad sectors to the bad sector table should still be done only with the system running single user.
- *Getty*'s description file, */etc/gettytab*, now describes what program should be run in addition to the other information that it used to include.

arff Has been extended to understand multiple directory segments. This allows it to handle the console RL02 pack on the VAX 8600.

arp A new program for examining and modifying the kernel Address Resolution Protocol tables.

bad144 *Bad144* has new options to add sectors to the bad sector table and to attempt to copy sectors to their replacements before marking them bad. It verifies that the file is properly sorted. Verbose and no-write options allow dry runs.

catman Now allows a list of manual directories. Links are properly set up so that the manual source need not be kept on line on all machines.

checkquota Runs multiple filesystems in parallel. Quotas for users with zero blocks are left around but they are deleted if the user-id no longer exists.

chown Was modified to be recursive. *Chown* accepts an *owner.group* syntax to change owner and group simultaneously. The group-id will be set correctly when dealing with symbolic links.

comsat *Comsat* is now invoked by *inetd*. It reaps its child processes correctly. Large systems with many terminal lines are now handled.

config Swap size may be specified. **Maxusers** is no longer truncated. The name of the generated *Makefile* is now capitalized. Object files may now be listed for inclusion in the *files* file and will be added to the compilation properly. Optional files may be listed multiple times if different options require their inclusion. **Swapconf** supports larger unit numbers. *Config* builds a new file containing definitions for counting device interrupts.

cron */usr/lib/crontab* has a new format to specify the user-id under which the process should be run.

diskpart Handles disks with either cylinder or sector offsets and that do not use *bad144* bad block forwarding.

dump When dumping at 6250 bpi, the tape is written in 32Kb records instead of 10Kb records. Efforts have been made to improve the consistency of dumps made on active file systems (though the practice is still NOT recommended). The Caltech streaming dump modifications using a ring of slave processes have been incorporated. *Dump* makes a better estimate of the size of the dump by attempting to account for files with holes. The error messages have been made less condescending.

edquota Can edit quotas on filesystems where a user does not have any usage.

fingerd A new daemon to return user information; it runs under *inetd*.

fsck *Fsck* has been sped up considerably by eliminating one of the two passes across the inodes. It has also been taught to create and grow directories so that it can now rebuild the root of a file system as well as create and enlarge the *lost+found* directory as necessary.

ftpd Among the new facilities supported by the FTP server are: the ABOR command for transfer abort, the PASV command for third party transfers, and the new RFC959 FTP commands (such as STOU, ‘‘store unique’’). *Ftpd* now uses *syslog* to log errors, and is invoked by *inetd*.

gettable Now has a flag for checking the version without retrieving the whole host table.

getty *Getty* supports automatic baud rate detection based on carriage return. Support for window system startup has been added. The login banner can now include the terminal name. The environment is set up now and passed to *login* .

htable Some byte ordering problems have been fixed. It is more intelligent about gateway handling. A looping problem with single character host names has been fixed.

ifconfig *Ifconfig* has been augmented to allow different address families. The current families understood are *inet* and *ns*. *Ifconfig* has additions to set up subnets of Internet networks, change Internet broadcast addresses, and set destination addresses of point-to-point links.

implog Handles class B and class C networks.

inetd A new program to spawn network servers on demand. *Inetd* listens on each port listed in its configuration file */etc/inetd.conf*. When service requests arrive, it passes the original socket or a newly accepted socket to the designated server for the service. Several trivial services are implemented internally.

init May run commands other than *getty*. Large systems are no longer a problem. Window systems may be started.

lpc A new command, **down**, disables queueing and printing, and, optionally, creates a status message displayed by the *lpq* program. The **up** command reverses the effect of the **down** command. The **status** command now displays the contents of the print queue in addition to the status of the daemon process. The **clean** command does a better job of removing incomplete queue entries.

lpd A new capability, **hl**, may be used to print a job’s banner after the contents of the job. Error logging is now done with *syslog*(3). Hosts permitting remote access may now be specified in the file */etc/hosts.lpd* (in addition to */etc/hosts.equiv*). A master lock file is now used so that */dev/printer* can be automatically removed. Symbolic links to spool files are now checked carefully to close a security hole. All printing parameters are now properly reset for each job. Remote spooling connections now time out if the server crashes. Errors in spooling filters are now reported to users via mail. When servicing a remote job, files are not transferred unless enough disk space is available.

mkfs Will print the filesystem information without creating the filesystem. Filesystem optimization may be specified.

mkhosts A new program to rebuild the */etc/hosts* dbm database. Note that this database is not used with the default name server configuration.

mkpasswd A new program to rebuild the */etc/passwd* dbm database.

mount Better error messages are returned when *mount* fails. When checking */etc/fstab* to find the device name of a file system when only the mount point is specified, it also checks the *type* field to insure that the entry is **rw**, **ro**, or **rq**.

named Is a new program implementing the Internet domain naming system. It is used to perform hostname and address mapping functions for the standard C library functions, *gethostbyname* and *gethostbyaddr* if *named* is running.

newfs Supports new options to *mkfs* .

pac Has a new option, **−m**, to cause machine names to be disregarded in merging accounting information. The per-page cost is now taken from the printer description if it is not specified on the command line with the **−p** option.

ping Is a new program for sending ICMP echo requests.

pstat Can handle kernel crash dumps and new terminal multiplexers. Core dumps should be less frequent.

repquota Only prints entries for users that have files (or blocks) allocated.

restore The interactive mode of *restore* now understands globbing. Interrupting interactive mode returns to the prompt. A new input path name may be specified on each volume change. The tape block size is calculated dynamically unless it is specified with the **−b** flag on the command line.

rexecd Now runs under *inetd* .

rlogind Propagates window size changes in a backward compatible way. This is negotiated at startup time. *Inetd* now starts up the server.

rmt Uses large network buffers for better performance.

route Will handle subnets. Flags were added to specify whether a name is a host or a network. Multiple addresses are tried until an operation is successful or there are no more addresses to try.

routed Is more strict about received packets' formats and values. Subnet routing is handled. Point to point links are handled. Gateways to external networks advertise a default route instead of all networks. The loopback network number is no longer compiled in. When a process is terminated, it tells its peers that its routes are no longer valid.

rshd Is started by *inetd* . The address is passed through if the host name for the address cannot be determined.

rwhod Should be less expensive to run. Broadcasts are done less frequently and path lookups are shorter. Large systems are handled better.

rxformat Will now operate if the standard input is not a terminal.

sa Supports alternate accounting files. The units of CPU time have changed.

savecore Works correctly when given an alternate system name. Dump partitions smaller than the memory size are handled more gracefully.

sendmail Several bugs have been fixed. Upper case letters are allowed in file names and program arguments in the alias file. Multiple recipients sharing a receive program are not collapsed into one delivery. List owners on queued jobs have been fixed. Commas in quoted aliases work. Dollar signs in headers are no longer interpreted as macro expansions. Underscores are allowed in login names.

Substantial performance enhancements have been made for large queues. If the **Y** option is not set, all jobs in the queue will be run in one process, with host statuses cached; this uses more memory but generally improves performance. The job priority now includes creation time and number of recipients (the **y** option) as well as the message size (the **q** option) and the job precedence (the **z** option); this priority is modified by the **Z** option whenever it fails to complete. No attempt is made to run large jobs if the load average is too high.

The **$[** ... **$]** syntax can be used on the RHS of a rewriting rule to canonicalize a host name using *gethostbyname*. This is especially useful when running the version of *gethostbyname* that calls the name server.

Error reporting has been improved. Some limits have been increased. Security holes have been plugged. *Syslogd* and *vacation* are now part of the standard system.

Minor changes have been made to the configuration file. The RHS of aliases are no longer checked while the alias file is rebuilt unless the **n** option is set to improve performance. The character substituted for blanks in addresses is settable by the **B** option. The default network name (formerly hardwired ''ARPA'') is settable with the **N** option. The **E** mailer option escapes ''From'' lines with a '>' on delivery (formerly the default to the local mailer).

shutdown Has flags to specify that it should not sync the disks and that it should skip the disk checks after rebooting.

swapon Error messages have been cleaned up and now specify the device to which they correspond.

syslogd Formerly *syslog*, allows the classification of messages based on *facilities*. The configuration file has been restructured.

talkd Now runs under *inetd*. New version, new protocol.

telnetd Handles pty allocation better. *Inetd* now starts the server. Interpretation of carriage return-newline now conforms with the standard, but is compatible with the 4.2BSD *telnet* client.

tftpd Now works with other clients and is started by *inetd*.

timed A new program for maintaining time synchronization between machines on a local network.

trpt The *trpt* program to examine TCP traces now prints the traces in the correct order. It has been extended to follow traces as a connection runs.

tunefs Supports the new filesystem optimization preferences.

uucpd A new server, invoked by *inetd*, for running uucp over network connections.

vipw Builds the new hashed lookup table. */etc/passwd* will not be left unreadable if root has a restrictive umask.

XNSrouted A new daemon, similar to *routed*, that implements the Xerox NS routing protocol.

Appendix A – User Contributed Software

Several new programs have been contributed to the Berkeley distribution.

ansitape Is a new program for handling tapes in ANSI format and for transferring files between UNIX and VMS.

B Yet another new language.

cpm	Is a file transfer protocol between UNIX and CP/M.
dipress	A new program to convert *ditroff* output to Xerox Interpress format.
emacs	Is a public domain version of *emacs*.
help	An extensive new UNIX help facility.
hyper	A router and log program for the Hyperchannel.
icon	The latest and greatest version from Arizona.
jove	Is a simplified *emacs*-style editor.
kermit	A file transfer protocol between UNIX and microcomputers.
mh	This release includes MH Version 6.3, with Berkeley modifications. It has been rewritten numerous times since the original version release with 4.2BSD. Each utility is now infinitely programmable.
mkmf	Has been separated from *SPMS*.
mmdf	Is a new set of mail reading and transport programs.
news	The latest revision of the Usenet news programs, B news 2.10.3 beta.
np100	Utilities to download the Interlan NP100 Ethernet board.
patch	Is a new program designed for taking diffs and applying them to the source file. If you only look at one new program, this is the one!
pathalias	A new program that attempts to discover uucp path routing.
pup	An implementation of the Xerox PUP protocols and several useful programs that use them.
rn	A new interface for reading (or ignoring) news.
sumacc	A C compiler set of programs for doing MacIntosh software development.
sunrpc	Yet another RPC protocol.
tac	Is a program that displays a file in reverse line order.
umodem	Another file transfer protocol between UNIX and microcomputers.
X	A new window system that was developed at MIT. This distribution supports the DEC VS100, the Sun and the DEC b/w VAXStation II (QVSS).
xns	A courier RPC mechanism that runs on Xerox NS, and many useful applications developed at Cornell University.