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UNIX™/WORLD

THE MAGAZINE FOR MULTIUSER, MULTITASKING SYSTEMS

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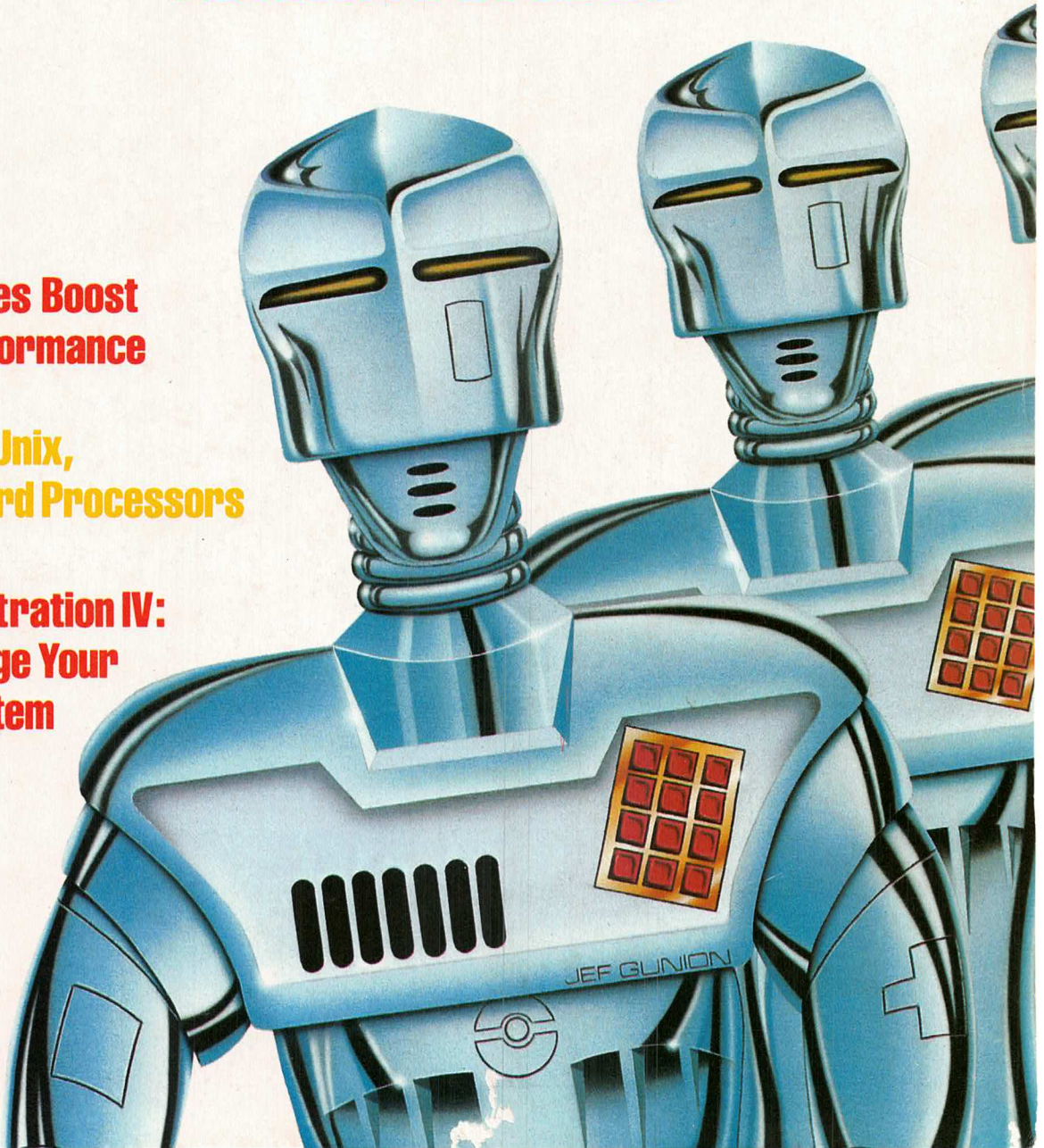
The Touchstone Connectables

THE UNIX SYSTEM AND NEW HARDWARE ARCHITECTURES

New Chip Features Boost Supermicro Performance

Buyers' Guide to Unix, Xenix System Word Processors

Systems Administration IV: Create and Manage Your Own Unix File System



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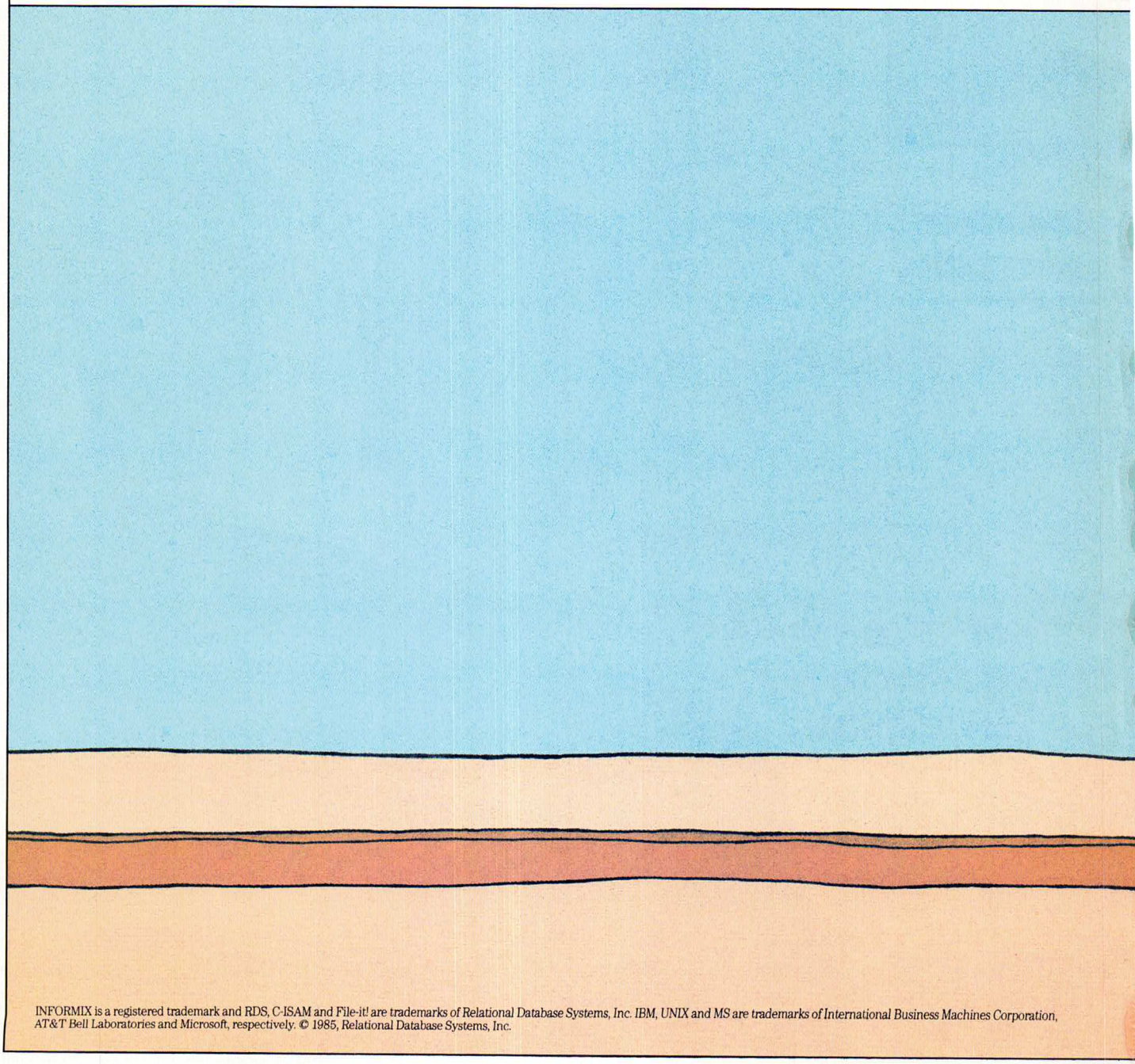

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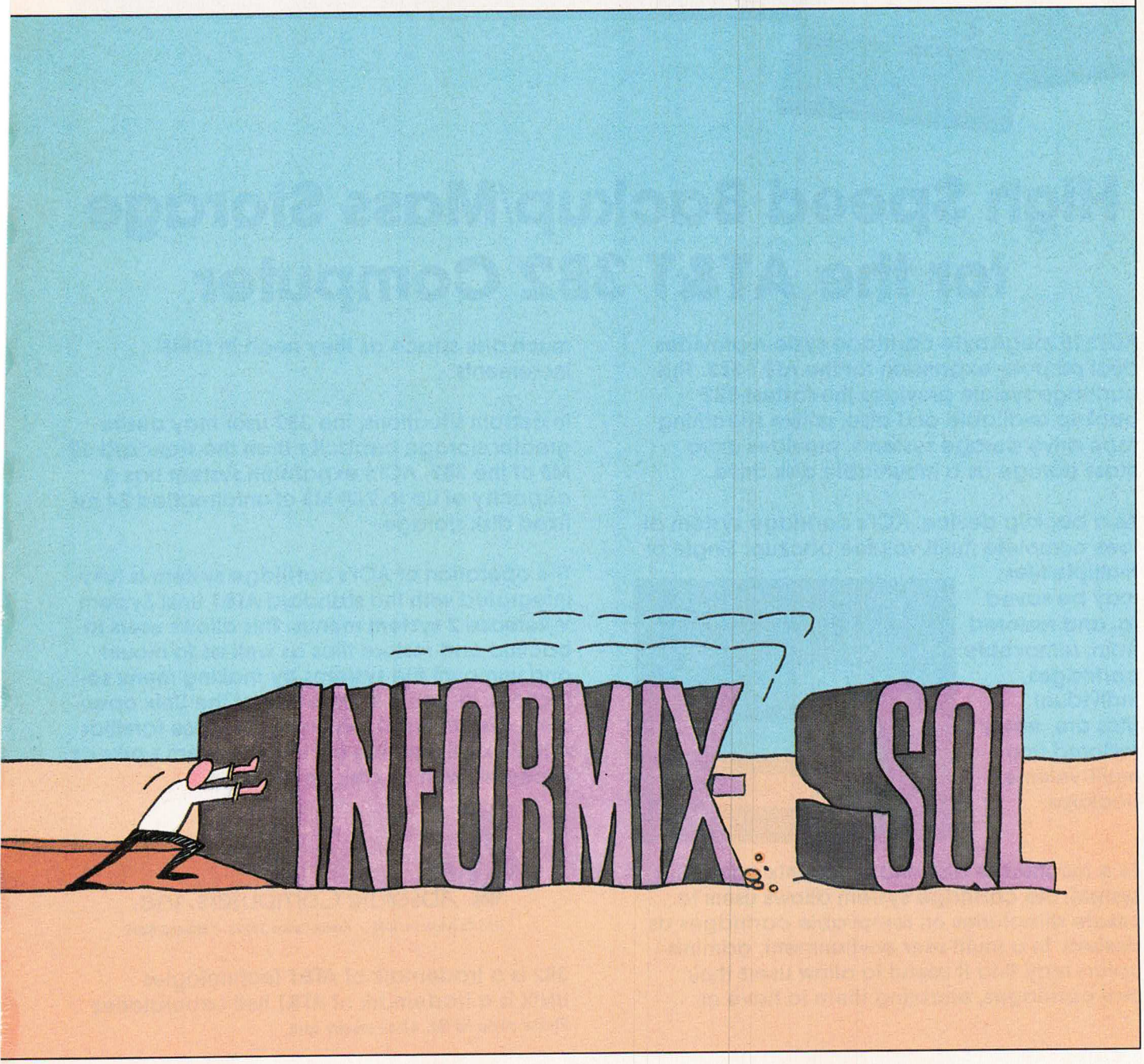

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VOLUME II, NUMBER 7

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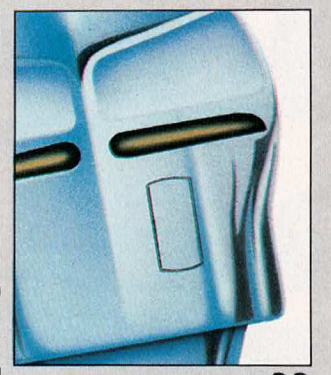

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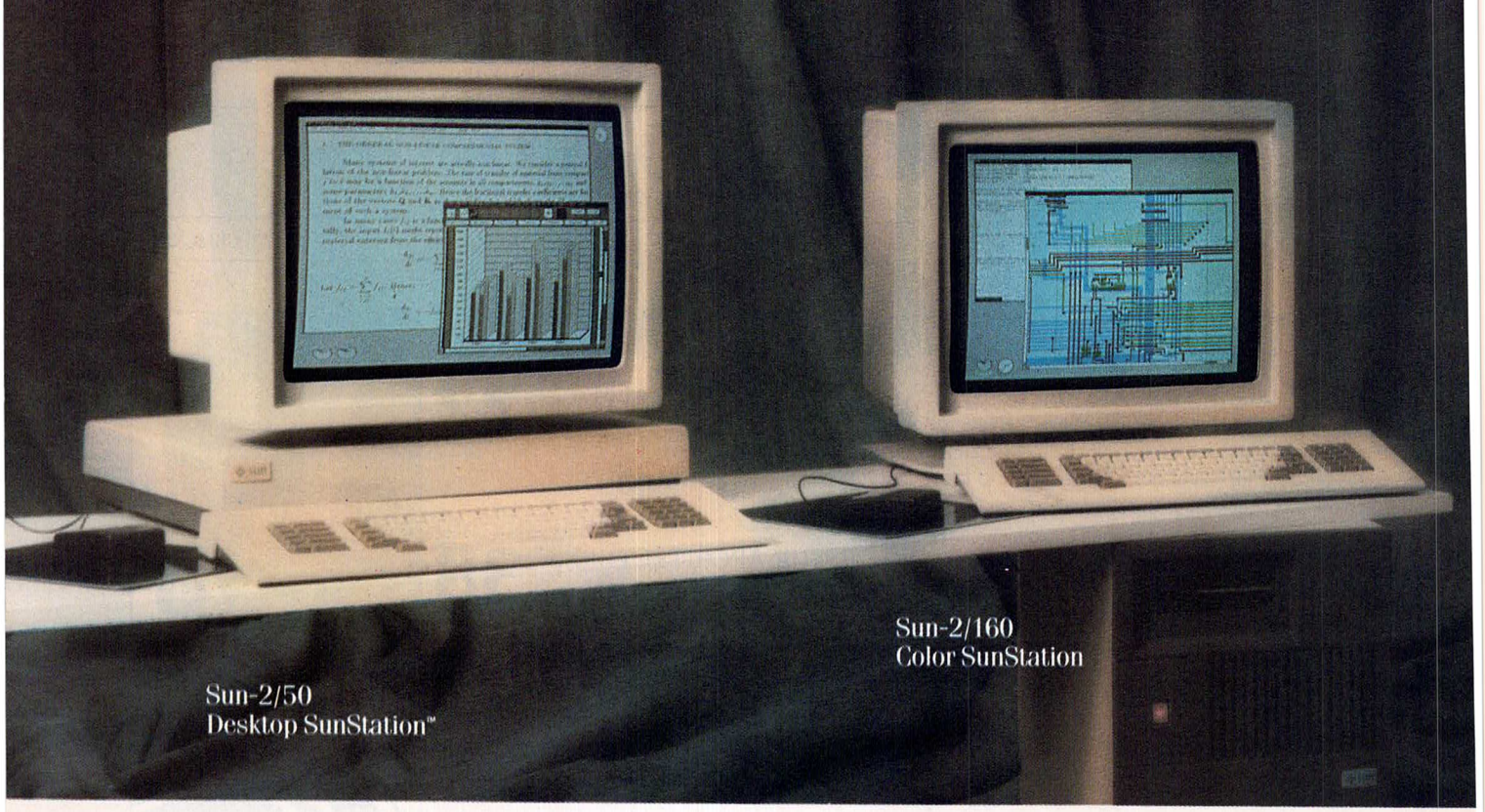
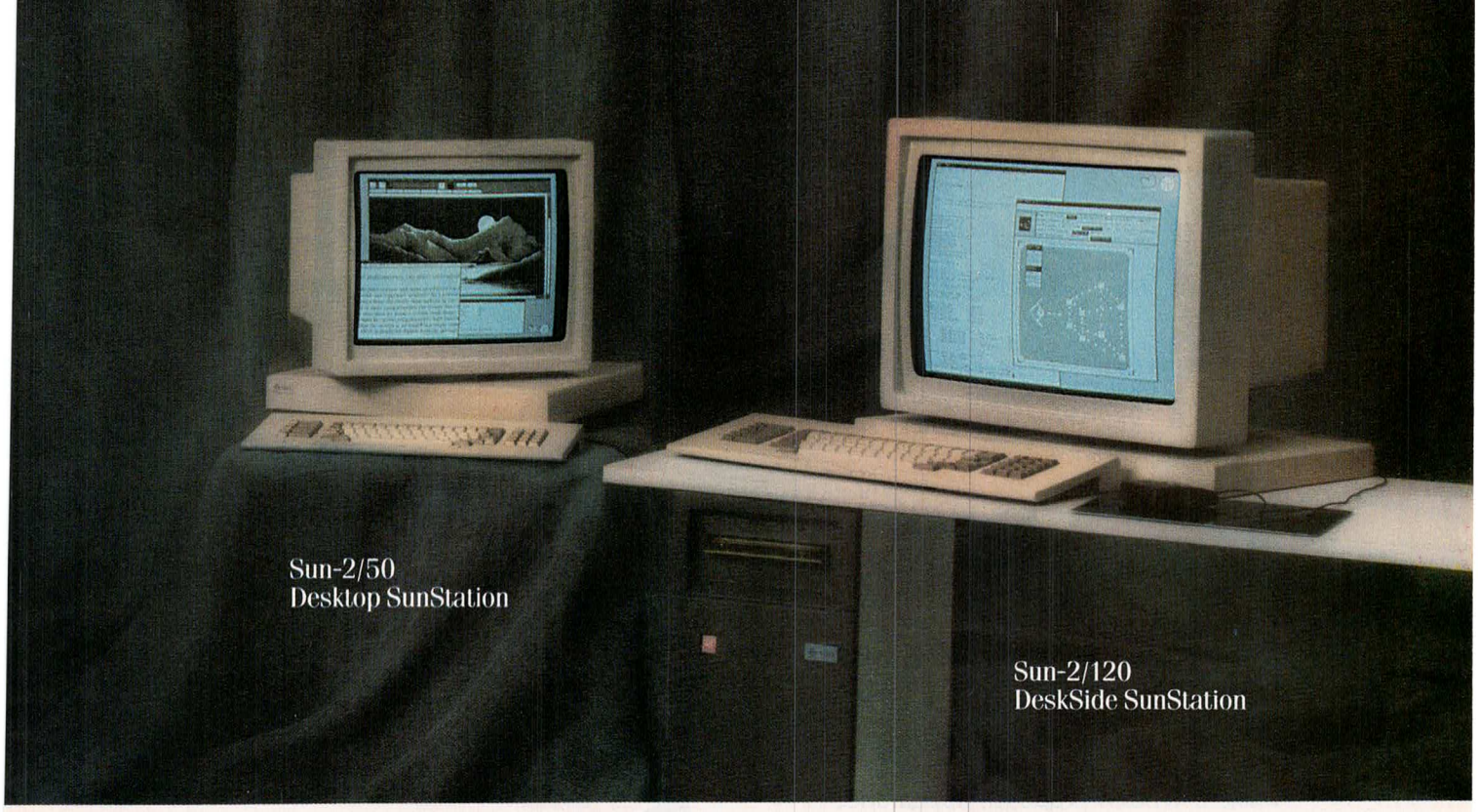


Sun workstations: open architecture, open network, open options.



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UNIX/WORLD

TRENDS

EDITOR'S CONSOLE

This month I am especially proud to bring you some good news—the Western Publication Association, a trade organization comprised of our peers in the 11 western states, has named *UNIX/WORLD* Best New Trade Magazine, 1985, and Best Computer Magazine, 1985. The Maggie Awards, as they are called, are given in recognition of outstanding achievement in design and editorial content.

In the Best New Trade Magazine category, we competed against three worthy opponents covering varied subjects—not just computers—including *VA Practitioner, Signal World*, and *Liberty Street Chronicle*. The major qualification for this Maggie was that the magazine's first issue had to have appeared in 1984.

For the Best Computer Magazine award, we competed against two other well-known magazines—three different issues of *HardCopy* and one issue of *Computing for Business*—for the honors. Our Vol. 1, No. 3 issue, commonly known amongst UNIX/WORLD aficionados as the "hands" issue, won the honors.

I hope you will forgive this little bit of bragging, but we all worked very hard for these Maggies. Although there are few if any equivalents for many of our readers, just imagine if you had designed a software program that was named the best of the year. But enough of bragging, it's time to get on with this issue.

This month we zero in on new hardware architectures and their relationship to and impact on the Unix system. In particular, we serve up one feature each on multiprocessor systems, a new but increasingly popular systems architecture often employed by Unix systems vendors, and new microprocessor chip architectures. Both are of great importance to users and vendors alike, as they promise to both lower costs and substantially boost performance—in common terms, you get more bang for the buck.

Omri Serlin—our regular monthly *Inside Edge* columnist and a foremost authority on supermicros, transaction processing, and multiprocessor systems—does the cover story honors this month with a detailed examination of the multiprocessor systems phenomena, their applications, and their varied architectures.

Next, Mohandas Nair and Philip Barrett of Intel Corp. explore and explain in no-nonsense terms what the new hardware features incorporated in the latest microprocessors really mean for you and your microcomputer's performance. Mohandas Nair, you might recall, last contributed to our Vol. II, No. 2 issue, with "Running with Xenix: Small Systems Administration."

Also of special importance to this month's theme is Omri Serlin's *Inside Edge* column "32-Bit MPU Battle Nears Climax." With his usual insight, Omri will help you sort out the winners and the losers, for all may not be as it seems in this, the latest and most hotly contested race ever amongst the semiconductor merchant princes.

Philip J. Gill
Editor-in-Chief

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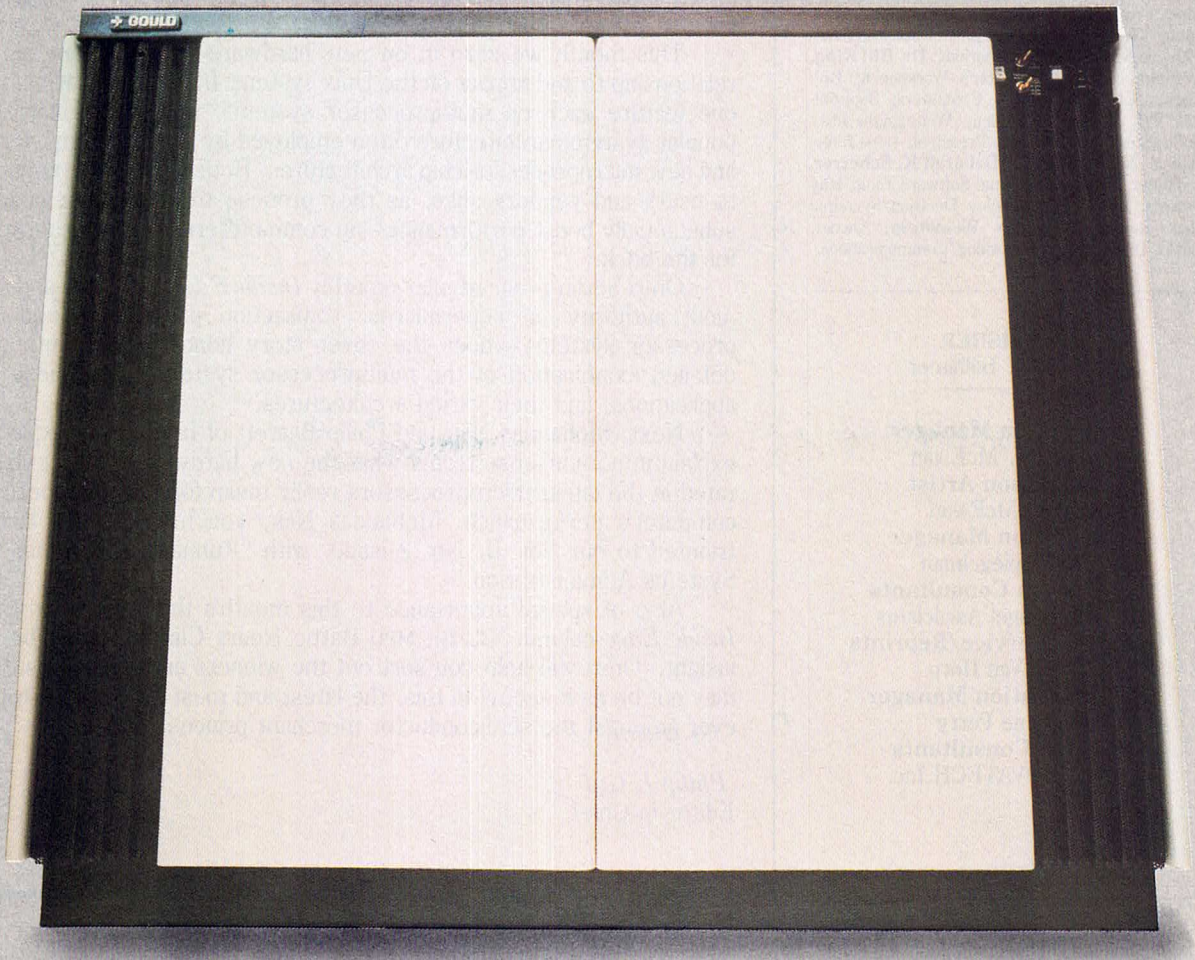

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PowerNode PN9000	400	11.7
CONCEPT 32/97	400	11.7
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CONCEPT 32/6730	140	12.1

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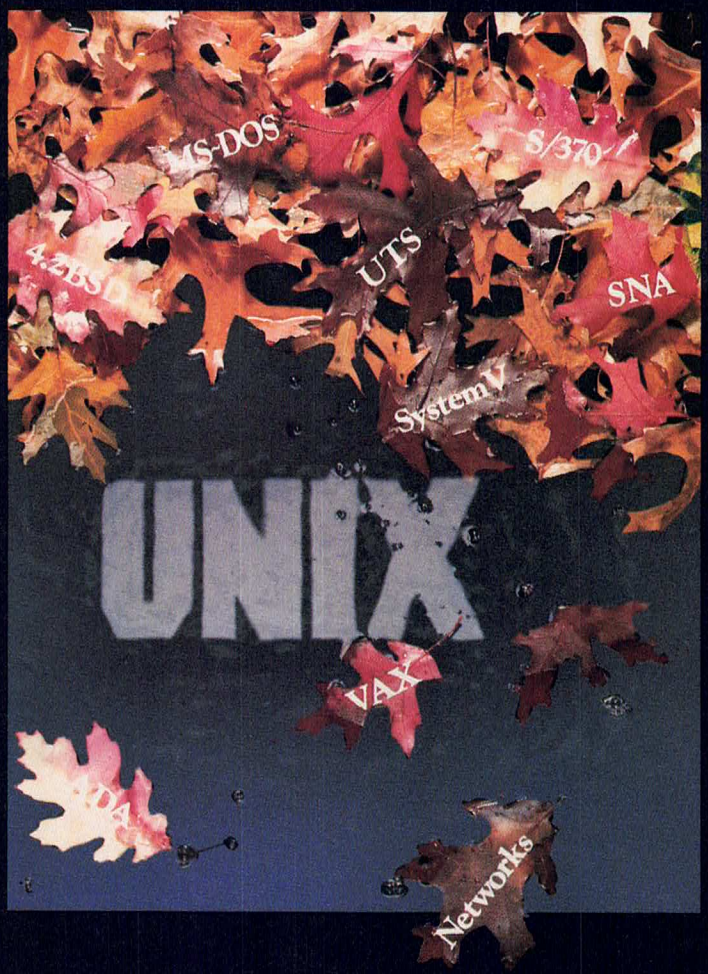

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FOR THE RECORD

Top of the News... ALTOS **Computer Systems** is once again moving to solidify it leadership position in the Xenix multiuser supermicro market. Provided all went of f according to plan, on June 3rd the San Jose, Calif.-based firm unveiled a new 20-user system called (you guessed it) the 2086. Based on an 8MHz **Intel** 80286 chip, the 2086 comes with 1 to 16 Mbytes of main memory and 80 to 140 Mbytes of hard-disk storage, runs Xenix 3.0, and is compatible with **IBM** PC AT Xenix applications. Altos VP Philip White told *UNIX/WORLD* that although the 2086 is optimized for 20 users, it can conceivably support up to 40 users. How, one might ask, can the 80286 MPU support even 20 users when the wise money says that IBM knew full well what it was doing by confining the Xenix/286 AT to three users? White explained that the 2086 incorporates an 8086 to support terminal input/output (I/O) for each 10 users, while a second, separate and independent 8086 controls the disk drive. White said the 2086, which is compatible with all other members of the Altos *x*86 family, carries a quantity-one price tag of $19,000 for a system with 2 Mbytes of main memory, an 80-Mbyte hard disk, a 60-Mbyte back-up streamer tape, one display terminal, and operating system software. That compares to $23,000 to $24,000 for similarly configured **NCR** Tower XP, White claimed.

Altos is also set to add a graphics package to its Altos Office Executive (AOE) integrated office software. AOE Version 1.2 will begin shipping with graphics for $795, up $100 from the previous rendition. . . . Altos is expected to soon reveal it has taken an equity position with an-as-yet undisclosed Unix system software house. Altos is mum right now as the firm apparently supplies software to some Altos competitors as well.

Fortune Revenues Nosedive... Beleagured **Fortune Systems Corp.** continues to limp along. The Redwood City, Calif.-based firm reported a net loss of $3,792,000, or $.18 per share, as compared to the same quarter last year when the firm reported a $3,396,000, or $.16 per share, loss. While the quarterly loss increased only slightly against the same period last year, revenues took a dramatic nosedive, dropping a whopping 35 percent over the same quarter last year—$9,809,000 for the quarter this year as compared to $15,083,000 for the quarter last year. Fortune CEO Jim Campbell noted that OEM orders were down some $3 million during that quarter, and that these figures also reflect a 24 percent decrease in operating expenses attributable to a 22 percent workforce decrease in April. Still, Fortune said cash reserves at the end of the quarter stood at $28 million, up about $1 million from December, 1984. This is the first such increase since the firm's initial public offering a few years back.

When the Chips Are Down... And the die are cast, there's no turning back for the major semiconductor houses as they now embark on what may turn out to be the hardest fought contest of them all—the 32-bit MPU race. (For more on this subject, see this issue's *Inside Edge* column by Omri Serlin.) For instance, a rather sarcastic and catty ad from **AMD** (which is second sourcing the **Intel Corp.** 80286) takes pointed and mostly accurate swipes at **Motorola Inc.**'s 68020. Meanwhile, **Intel Corp.** is out in force beating at the doors of the industry press to convince us that the 386 is the invincible successor to the 286. The problems here are many, not the least of which are that the 386 is late and is coming from behind. Worse yet, the IC kingpin is making rather grandiose and exaggerated claims that more Unix system-based machines will be based on the 386 than any other chip from Motorola, National, or et al. This claim also has its problems: The 386 won't be sampled till this fall, meaning *no* end-user 386-based products until at least the spring of '87. In short, the 386 will be a negligible market player until then, marginal for the first year to two years thereafter. That's way, way, wa-a-a-a-ay behind, say, the 68020. One rather reliable report we've heard says some 50,000 68020s will be shipped this year alone. Most important, perhaps, is this one fact: Although it's a given that Intel shareholder IBM will base a future PC/workstation on the 386, there's no similar assurance that said PC/workstation will run a Unix system at all, especially considering IBM's confusing signals on the Unix system to date. And IBM is the only one that can shovel out 386-based boxes in sufficient quantity to realize Intel's boast. Of course, Intel might know something we don't, but it's just not telling.

Desktop Invectives... Jean Yates is taking it personally, that there is so little easy-to-use software for the Unix system—as well she might, considering how strongly she's devoted herself and **Yates Ventures** to making sure the Unix system succeeds. Her particular beef is with the companies who have offered up only vaporware in the integrated office system market—we trusted you guys, she says, and what have you given us? Broken promises. At a recent Yates Ventures' "Desktop Directions" seminar in San Jose, Calif., Yates berated the errant firms, telling

them that "we need the product, or we need you to keep your mouths shut." She even named names—Applix, Quadratron, and Handle. Not only that, she says, what's on most Unix system boxes doesn't even meet the *Topview* standard of user-friendliness.

One of the few users at the seminar, a woman from Weyerhauser Corp., backed Yates up 100 percent—users are holding onto the Unix system by their fingernails, waiting for that super-friendly spreadsheet or DBMS, she said. If something doesn't appear soon, she added, they're going to forget about the Unix system and embrace those magic four letters. Does anyone listen to the users? Does anyone talk to the users? In defense of the software houses, Yates thinks too many users suffer from "1-2-3 Syndrome"—if they can't get 1-2-3 on a Unix system, they won't buy it. Give the people what they want, said Jean; "If AT&T won't get down on its knees to Lotus, they need to talk to one of its clones." But AT&T is too busy cutting its own throat with excessive waffling, she added — the dominant force in the Unix system isn't throwing its money to software houses that can produce.

Calm-dex... That's what even the show's producers, The **Interface Group Inc.**, said of Comdex/Spring '85 in Atlanta in a front-page headline of the show's daily. While the article described the show's mood accurately (if not downright politely), it went on to classify the attendees as nonetheless first-class. Nonetheless, some first-class vendors (**Apple**, for example) and *all* first-class new product announcements—traditional ingredients for successful trade shows by anyone's account—stayed home. Judgment by the trade press—Boring!—(except for an apparently rather wild Lotus party). The common chord in many gripes were simply that there are too many trade shows, and that some will fall by the wayside. So expect even more exhibitors and even some trade press to stay home next year.

Rumors of the Month... Despite an important strategic alliance with Unix system-supermicro-vendor **Zilog Inc.** and systems house **Lutzky-Baird** to push the Mac Office concept to Fortune 2,000 accounts, Apple will reportedly go with a Unix system-based file server from another source. . . . **Hewlett-Packard Company** is said to have in the works a new higher-end version of its LaserJet, this one fully loaded with more features and priced somewhere between $5,000 and $7,000. . . . There are bugs galore in the IBM PC AT release of Xenix 3.0, so it looks like the expected rush of applications software may take longer than expected. In fact, some of the more paranoid members of the Unix system community have even gone so far as to claim that IBM has sabotaged Xenix for the AT in an effort to derail the Unix system bandwagon.

News From AT&T... AT&T **Technologies Inc.** has licensed **Alcyon Corp's.** Regulus Operating Systems. Regulus is a realtime, System V-compatible operating system, which runs on the Motorola MC68000 family of microprocessors. AT&T was specifically attracted to Regulus because of its special realtime attributes, according to an AT&T spokesperson. . . . Rumor has it that Regulus will form the basis of a new AT&T-IS computer system due sometime this year or early next. . . . **Absolut Software**, of Boston, has entered into an agreement to provide applications software for a computer system being designed and sold by AT&T **Information Systems** and **Electronic Data Systems Corp.** The AT&T group and the Dallas-based EDS, a unit of **General Motors Corp.**, recently entered into a seven-year contract to jointly market large computer systems. . . . To expand communications through AT&T computers, **The Wollongong Group** and AT&T have signed an agreement under which Wolongong will provide its standard networking product for 3B supermicro and supermini computers under Unix System V. Among capabilities to be provided are: File transfer (FTP), Electronic mail (SMTP); and Virtual terminal (TELNET).

Contracts... According to a recent article in *Computer Systems News*, the U.S. Catholic Church is going to become a big Unix system user. AT&T-IS snatched a $38 million pact away from IBM to sell computers and phone systems to the **National Catholic Group Purchasing Association Inc.** (NCGPA), buying organization for Catholic institutions across the country. According to *CSN*, NCGPA will purchase 10,000 AT&T 6300 PCs, 600 Unix PCs, 200 3B2s, and 7500 Merlin systems.

Unix/World Editor-At-Large Vanessa Schnatmeier contributed "Desktop Invectives" to this month's "For the Record."

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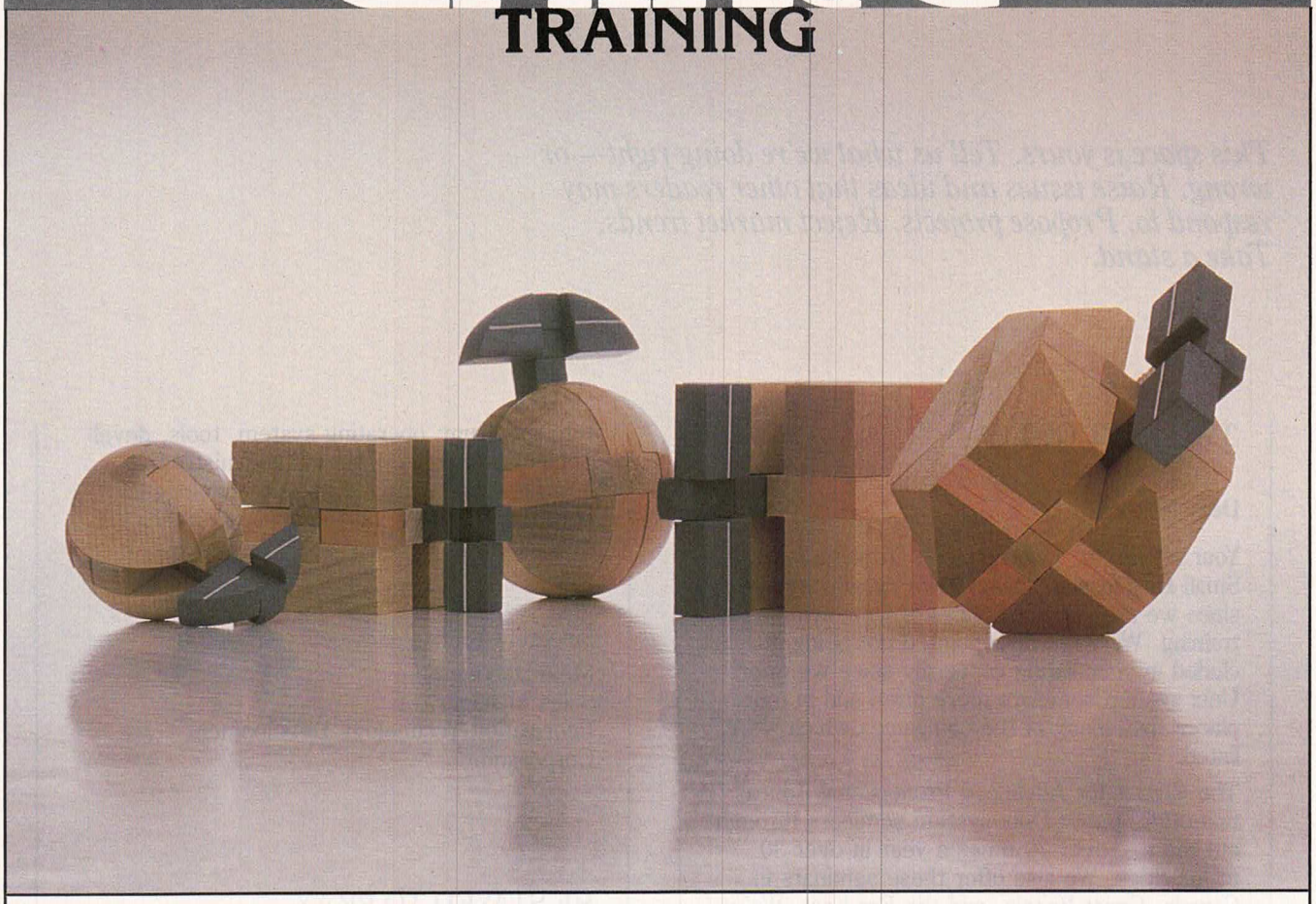

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TWO LEFT OUT

Dear Editor:

Your article on "Unix Systems Training for Small Businesses" (May 1985) caught my eye since we are in the business of Unix system training. We were disappointed not being included in your listing especially since we offer Unix system seminars more often and in more places than many of the companies which were listed.

The Center for Advanced Professional Education offers public Unix system seminars throughout the U.S. over 70 times a year in over 30 major cities. We also offer these seminars in Canada, Great Britain, and the Far East. We've been offering Unix system training since early 1983. All of our seminars are available for in-house presentation.

Regards,

Ed Sawicki
Executive Director
Center for Advanced Professional Education

Dear Editor:

In regard to the May issue of UNIX/WORLD and in particular, concerning the article on "Unix System Training For Small Businesses," I would like to mention a company that has become very aggressive in the Unix system training area for small businesses as well as large corporations. Information Technology Development Corporation is moving to provide quality training to the private business sector after delivering numerous successful courses to various government agencies. ITDC's educational service offers training courses encompassing the entire Unix system spectrum: operating system, tools, development languages, systems administration, software products, and DBMS technology for both the end user and the applications developer.

Sincerely Yours,

Mike Harrington
Sales Manager
Information Technology Development Corporation

HE STAYED TO PRAY

Dear Editor:

I am writing to comment on the contents of the May 1985 issue of your publication.

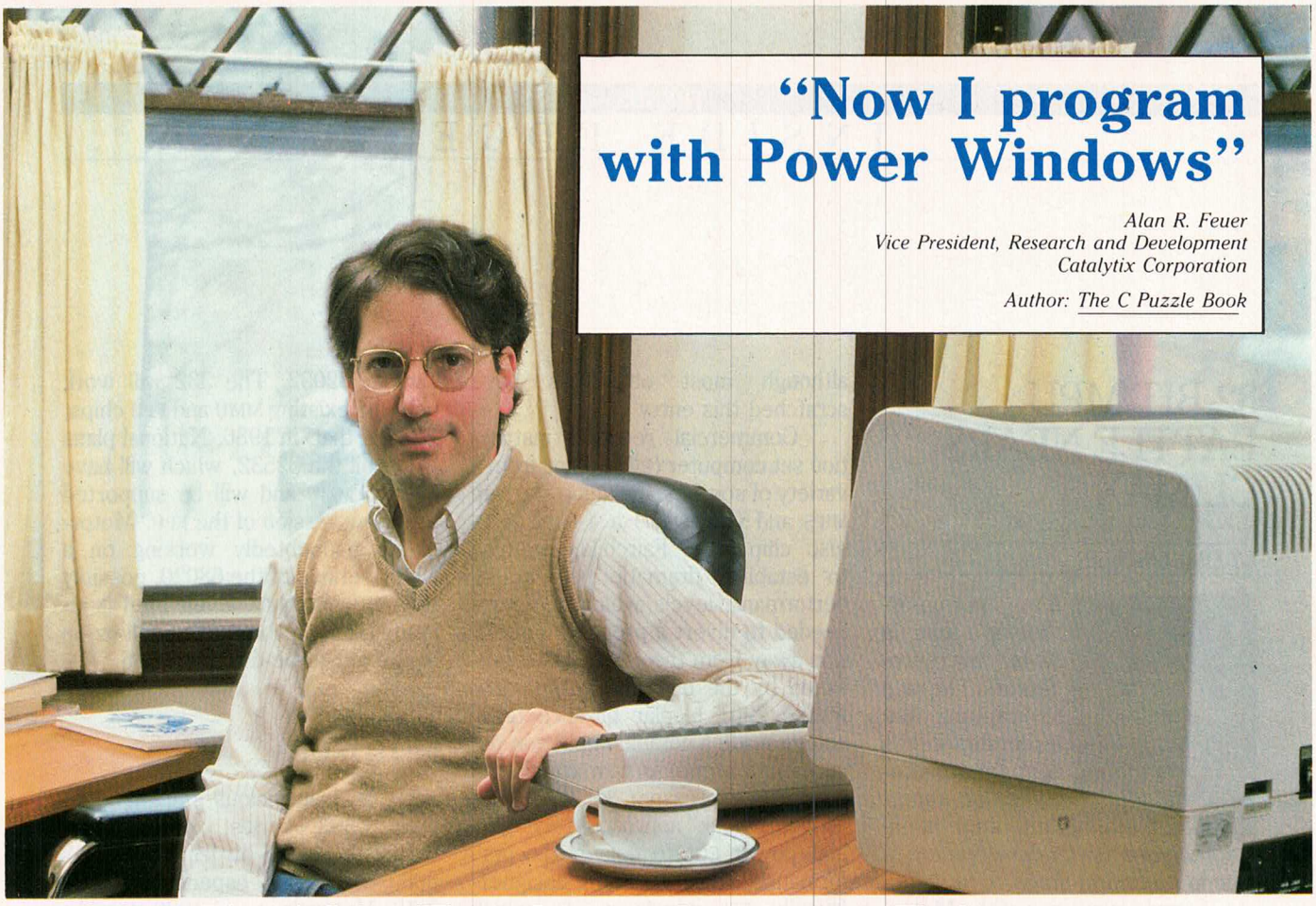
New to the Unix world (my background is PC-DOS), I am in the process of "upgrading" to the world of C Language, multiuser, Unix Z80, and environs. My first impression of your magazine was the reading of Mr. Knapp's message from the publisher's desk, then Mr. Gill's editorial from his "console."

I must say that I had, in a sense, come to scoff, but remained to pray, as they say.
Making a much longer story shorter, I then proceeded to read almost all of the remainder of the magazine, finding it most rewarding. If there are to be a number of PC users that follow my same line of thinking, your publication will be a tremendous help to all of us.

My congratulations, and thank you.

Sincerely,

John A. McMillan
Business Software Consultant



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UW 885

32-BIT MPU BATTLE NEARS CLIMAX

BY OMRI SERLIN

It's "put-up-or-shut-up" time in 32-bit microprocessors. The race to capture the leadership in this next (and probably most important) step in microprocessor (MPU) development is now in its critical stage.

Sample quantities of the Motorola 68020 and the National 32032 are now in the hands of system builders and testers. Intel is very late with its 80386 (386 for short), but its dominant position in the 16-bit marketplace, established through the IBM PC connection, virtually guarantees it a receptive audience.

With parts in silicon, the major players have committed themselves to specific architectures, from which only minor deviations will be possible in the future. Most important, now is that delicate time when computer system manufacturers are unveiling systems based on the new MPUs, but market demand remains in its infancy. Thus, the "bandwagon effect" is still some time away, and calling out the winner at this point is pure guess work.

A number of possible challengers to the "big three" lurk in the shadows, moreover. AT&T announced its willingness to sell its 32-bit CMOS MPU chip set over-the-counter. Hitachi is threatening to unleash its own 32-bit, 5 million instructions per second (MIPS), CMOS MPU late next year. Zilog may still be able to bring out its Z80000, although most observers have scratched this entry.

Commercial reduced instruction set computer (RISC) chips from a variety of sources, including start-up MIPS and (surprise!) a 4-MIPS CMOS RISC chip from Fairchild, promise to establish dramatic new price-performance levels, which are clearly needed to divert a prospect's attention away from the standards established by the big three. And AMD, whose 2901 bipolar bit-slice technology made a notable impact on the supermini scene, is now chiming in with an impressive 29300 32-bit "building block" approach, relying on high-power ECL to deliver the performance, while providing designer-friendly TTL interfaces. TI, which will second-source the National 32032, also recently unveiled bit-slice products.

Less-serious contenders include NCR, with its NCR/32 chip set currently in use only in NCR's own 9300 and 9400 systems and in the Celerity workstation; and Inmos, the U.K.-based outfit with its "transputer."

The "big three"—Intel, Motorola, and National—are already cooking their own next-generation superchips. National is set to unveil the 32332 MPU, which is expected to run at 12 and 15 MHz and yield about three times the performance of the current 32032. The 332 will work with the existing MMU and FPU chips. Beyond that, in 1986, National plans to unveil the 32532, which will have on-chip MMU and will be supported by a new version of the FPU. Motorola is undoubtedly working on a faster version of the 68020, possibly with on-chip MMU. Even Intel is already thinking about a 486 follow-on to the yet-to-be-delivered 386.

NEWS SUMMARY:

The 32-bit MPU race is entering a critical stage. Motorola and National are the current leaders, with Intel expected to join the "big three" towards year end. Weak challenges are being mounted by AT&T and others, but the key challenge will probably come from RISC chips. So far, no hit products have true 32-bit MPUs designed-in.

MOTOROLA

After an inauspicious start with its 8-bit 680X series, which badly trailed the two 8-bit leaders (Intel's 8080/8085 and especially Zilog's Z80), Motorola in mid-1980 staged a stunning coup in the 16/32-bit arena. The 68000, with its 16 Mbyte linear address space, and its 32-bit internal organization, quickly became the most designed-in 16/32 bit MPU, overcoming the one-year lead Intel had with the 8086.

Few of the many 68000-based start-ups made good. Still, the Motorola bandwagon was strong enough to raise interest from some prestige accounts: Hewlett Packard (HP), which uses the part in its 200-series engineering workstations; Apollo, whose very successful workstation line was originally based on the 68000; Tandy with its Model 16 (now 6000); and IBM, whose PC/ 370 uses one specially modified and one standard 68000. IBM Instruments also has a 68000-based desktop, dubbed the 9000.

However, the most meaningful 68000 design-in was the Apple Lisa; while that particular product went nowhere, its follow on, the Apple Macintosh, sold over 250,000 units in 1984, its first year, and accounted for the overwhelming portion of Motorola's 68000 revenues.

In addition to the usual clock

Continued on page 19

speed evolution (4-6-8-10-12.5 MHz), Motorola went on to produce several interesting variants of the 68000.

The 68010 enables the processor to recover from, rather than crash on, a bus error, so a "page missing" condition in a virtual memory implementation can be handled, eliminating the need to use two 68000's—as many early 68000-based systems were forced to do. The 68008 retains the internal 16/32 bit architecture virtually intact, but uses an 8-bit external bus. The 68012 has additional address lines for a larger address space, plus a special synchronization feature useful in multiprocessing implementations.

Now comes the 68020, which is Motorola's entry in the "true 32-bit" MPU race. Despite significant delays in the program, Motorola is now in limited-volume production of the 68020, ahead of all other contenders. The chip offers full (non-multiplexed) 32 bit address and data bases, 12 and 16.7 MHz clock, and performance ranging from 2.1 to 2.7 MIPs. Upward compatibility for user programs is maintained according to Motorola.

INTEL

Intel originated the microprocessor (it released the 4004 in 1972), and has been king of the hill through the 4- and 8-bit stages, although during the latter, Intel's 8080 and 8085 8-bit MPUs had to share the market with the upward-compatible Zilog Z80.

The 8086 was Intel's first venture into the 16-bit arena. The chip proved popular with many system builders, including IBM, which used it in its Displaywriter word processor. However, its success was due to its being first on the scene. (Announced in early 1978 and available in mid-1979, well before all competing 16/32 bit designs.) In technical terms, especially in its 16-bit registers and awkward addressing scheme, the 8086 compared poorly with the Motorola and National designs that followed.

Probably the most serious strategic error Intel made with its 8086 was the segmented addressing scheme, which broke up a 1 Mbyte space into multiple 64K-byte spaces.

Back in the 8/16-bit arena, however, Intel received a tremendous boost when IBM chose the 8088 to power its immensely popular PC, introduced in August 1981. This not only established the 8088 as the highest volume MPU ever, but also created a tremendous momentum for the 8088 and 8086 architecture.

However, Intel took a "side trip" with its 186 and 188 MPUs, which are essentially identical to the 8086 and 8088 respectively, but run at higher clock rates and incorporate a number of other popular ancillary functions.

Another side trip led to a blind alley: the 32-bit 432 chip set, developed by a design group in Aloha, Ore.

Intel's first serious attempt to block the Motorola MC68000 juggernaut was the 80286 (286 for short), code-named Checkmate to underline the intent. Although 286 samples were available as early as the third quarter of 1982, rework due to bugs and production problems delayed production models well into 1983. IBM announced its 286-based PC/AT in August 1984. In its "virtual" or protected mode, the 286 allows each user a 1 GB address and pull, made up of segments varying from 1 byte to 64K byte. The 286 has an on-chip MMU which can support 16 MB of real memory.

The "Force" that Intel is counting on to zap the 68000 Darth Vader is the 80386 (386 for short), of which samples are expected towards the end of this year. The 386 will provide increased performance through additional pipelining and a 32-Mbyte/sec system bus. It will have a true 32-bit architecture, including eight 32-bit registors, and the ability to linearly address 4 gigabyte segments by virtue of having 32-bit offsets (rather than 16 bits, as in the 8086 and 286). The basic "base-and-limit" memory model remains the same as in the 286; however, a demand paging scheme will be implemented "underneath" the 286-like segmentation scheme.

Since samples are at least 3 months away, Intel doesn't want to announce the chip formally. Still, it would like people to stop designing-in the 68000 chip; so beginning in early April, it launched an extensive series of "seminars" at which some details of the 386 are being discussed with prospective customers.

NATIONAL SEMICONDUCTOR

For National Semiconductor, the NS32000 family is a strategic product, intended to move the company away from its traditional forte of being a low-cost, high-volume producer of commodity chips. That market segment is being gobbled by Japanese suppliers. National wants to establish a leadership position in high-value-added parts, such as microprocessors, in which it hopes margins will prove more resilient.

Since National didn't have to worry about an installed base, its Israel-based design team came up with a new, 32-bit architecture, including a 24-bit linear addressing

scheme, which immediately pitted it against Motorola's 68000. In addition, certain similarities to the VAX architecture (for example, the byte ordering scheme) made it easier to port the Unix system to the National chip. Thus, despite being very late in entering the MPU race (October 1983), National generated a good deal of interest and won a respectable number of design-ins.

The original member of the family, a hybrid 16/32-bit unit quite similar to the Motorola 68010, was labeled 16032 initially; now that part carries the designation 32016, while the true 32-bit unit is called the 32032. The new numbering scheme underlines National's contention that the family architecture is inherently 32-bit, while the width of the external bus is indicated by the last two digits. There is an 8-bit version (originally called the 16008) but not much has been said about it recently.

Despite a number of nice technical features, the NS32000 is so far hardly a roaring success. None of the firms basing their design on this MPU have been notably successful in the marketplace. Some are still struggling (for example, Tolerant, Hydra/Encore, Mosaic Technologies), while others have gone under (for example, Syte, Terak).

Performance rather than architecture seems to be the key problem for the NS32000. To deal with the performance issue, National is preparing two more advanced models in the NS32000 series: the 32332, which is due in the second half of 1985, will feature three times the performance of the 32032 and use the current 32082 MMU and 32081 FPU; and the 32532, which will feature on-chip MMU and a higher-performance FPU (32581).

Meanwhile, National is diverting attention from the performance issue by emphasizing the architecture commonality across the family, availability of the support chips, and ease of porting the Unix system to the family.

AT&T

AT&T's initial posture was that it would not make available over the counter its proprietary 32-bit CMOS chip set, known as the Bellmac 32 or the WE32000. In late April, AT&T made an about-face, evidently under pressure after a disappointing first post-divestiture year, and offered the chip set to all who are interested.

The problem is that even though AT&T now rates the chip at 5 MIPS, (after previously characterizing it as 5 MIPs products based on it have exhibited no notable performance edge: the Teletype 5620 "dot-mapped" terminal is a market disaster, and no one is beating down AT&T's doors to get the 3B2 and 3B5 multiuser systems either.

RISC

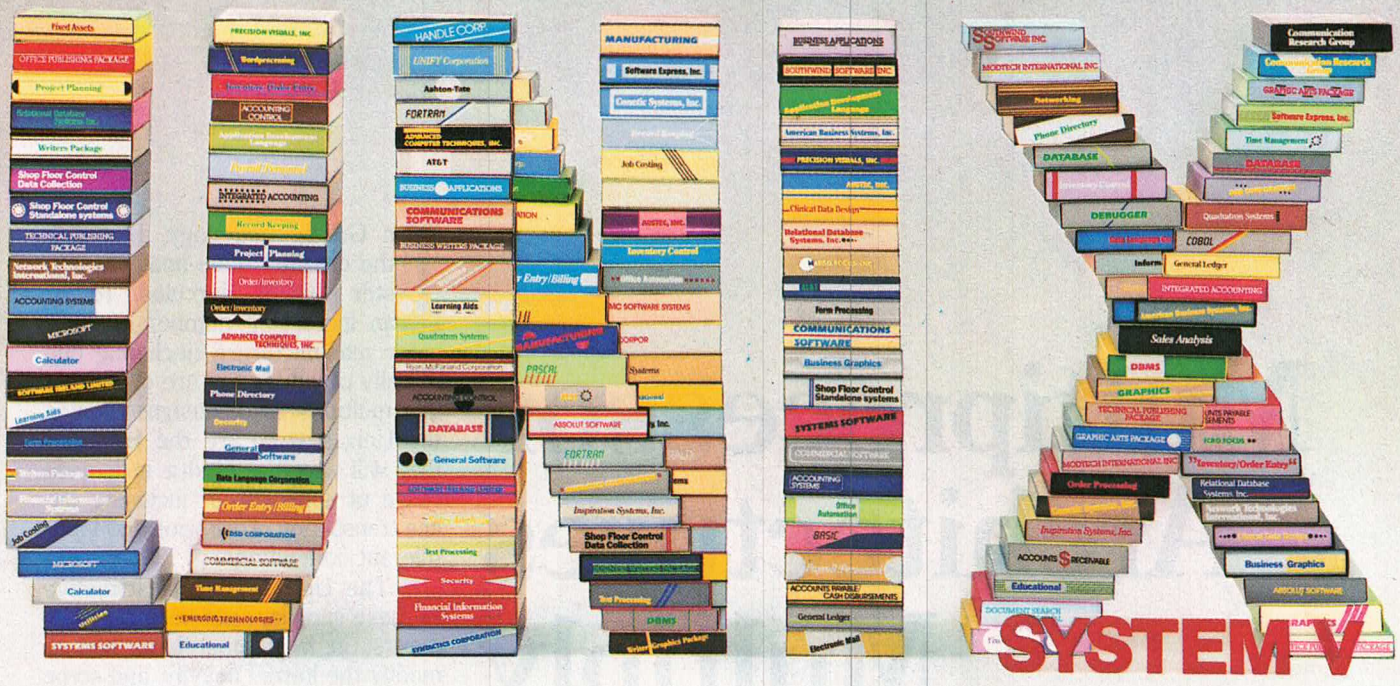
Reduced-instruction set computers originated under that name from student projects at UC Berkeley, led by Professor David Patterson. Since then, RISC has become a current technology fad; an awful lot has been written about the RISC idea, much of it nonsense.

The key contention of Berkeley's RISC design is valid enough: In the past, instruction sets for new computers have been designed without analyzing their usefulness. Traces have shown that in many instances, "powerful" instructions merely add complexity to the CPU design and are rarely (sometimes never) used by high-level language compilers.

There are many flaws in the RISC philosophy, not least of which is that it flies in the face of a large body of evidence gathered during the last 25 years that (1) sacrificing raw hardware performance to achieve a reduction in software complexity is generally the right choice; (2) that microprogramming is an excellent buffer between "complex" macro instructions and regular, simple hardware; and that (3) a fast cache yields the advantages of near-register speeds with zero software complexity.

Still, like it or not, RISC chips are coming, they are likely to pose the most serious price/performance threat to the "big three." □

Omri Serlin heads ITOM International Co., a research and consulting firm in Los Altos, Calif. He is the editor/publisher of Supermicro and the FT Systems Newsletter.



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Multiprocessor Architectures Multiply Unix System Applications

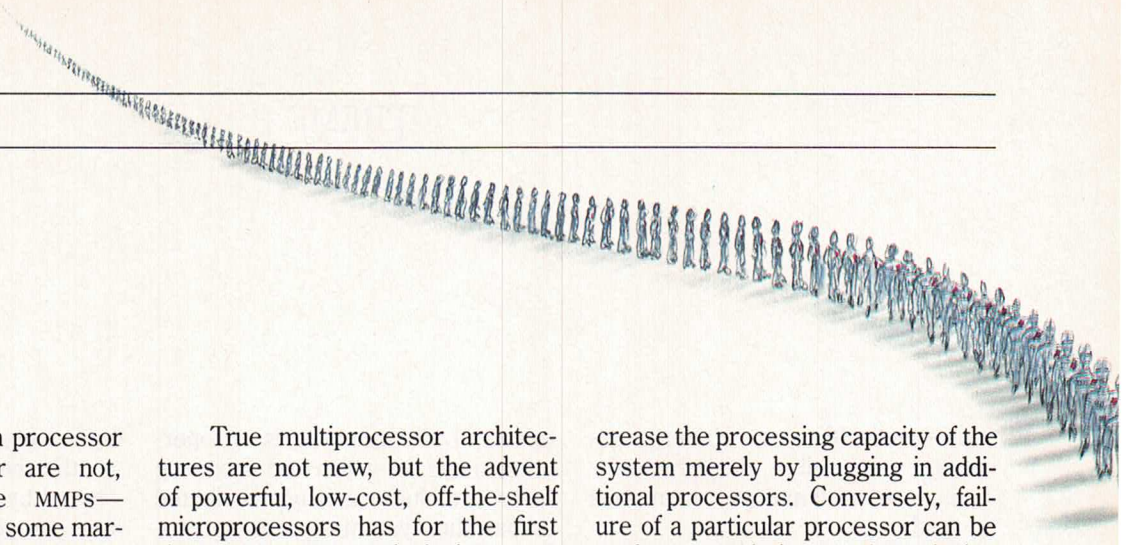
The inherent advantages of MMP architectures—notably graceful growth and configurability over a wide performance range—will win the day for such systems.

BY OMRI SERLIN

In Greek mythology, Hydra is the dreaded, nine-headed monster slain by Hercules. Today, an increasing number of computer manufacturers (including one actually called Hydra) are convinced that multiprocessor designs running the Unix system are the Hercules that will slay the Hydra in a wide range of applications, including online transaction processing and fault-tolerant computing.

The Unix system is attractive to these suppliers not because of its merits; in fact, most have had to modify the kernel heavily, and some have substituted their own. The key motivation for maintaining Unix system compatibility is the hope that the Unix system will soon become accepted as a standard. This is important because it would encourage independent software vendors (ISVs) and would mitigate end-users' objections to the lack of compatibility with established systems, especially those from IBM and DEC, that the new multimicroprocessor (MMP) architectures necessarily feature.

In "true" multiprocessor architectures, several processors (typically more than two) form a resource pool that is orchestrated in some way—either by a single copy of the operating system or by several cooperating systems—to service the load. Systems that package several MPU-based processors in a single



cabinet but dedicate each processor to serve a single user are not, strictly speaking, true MMPs—although they have found some market acceptance because they usually cost less per user than do personal computers.

Some dual-processor Unix-running systems—notably the AT&T 3B20A and 3B20D and the system from Parallel Computers (Santa Cruz, Calif.)—cannot be expanded beyond two processors. Although such systems can offer a high degree of fault tolerance (the 3B20D, for example), they are often not "symmetric." Usually one processor is the master, in charge of input/output (I/O) and load allocation, while the other is a slave, limited in function and operating under control of the master. The AT&T 3B20 models are also not microprocessor-based; the 3B20 CPUs are constructed from minicomputer-type ad hoc TTL logic.

Similarly, designs in which several intelligent microprocessor-based communications and disk controllers (Plexus, for example) support a single central processor do not readily fit into the *true multiprocessor* classification, as this term is interpreted here.

True multiprocessor architectures are not new, but the advent of powerful, low-cost, off-the-shelf microprocessors has for the first time made many such designs economically attractive. That is one of the main reasons for the recent interest in MMP systems. In addition, multiprocessor systems can offer some unique capabilities and advantages compared to more conventional designs.

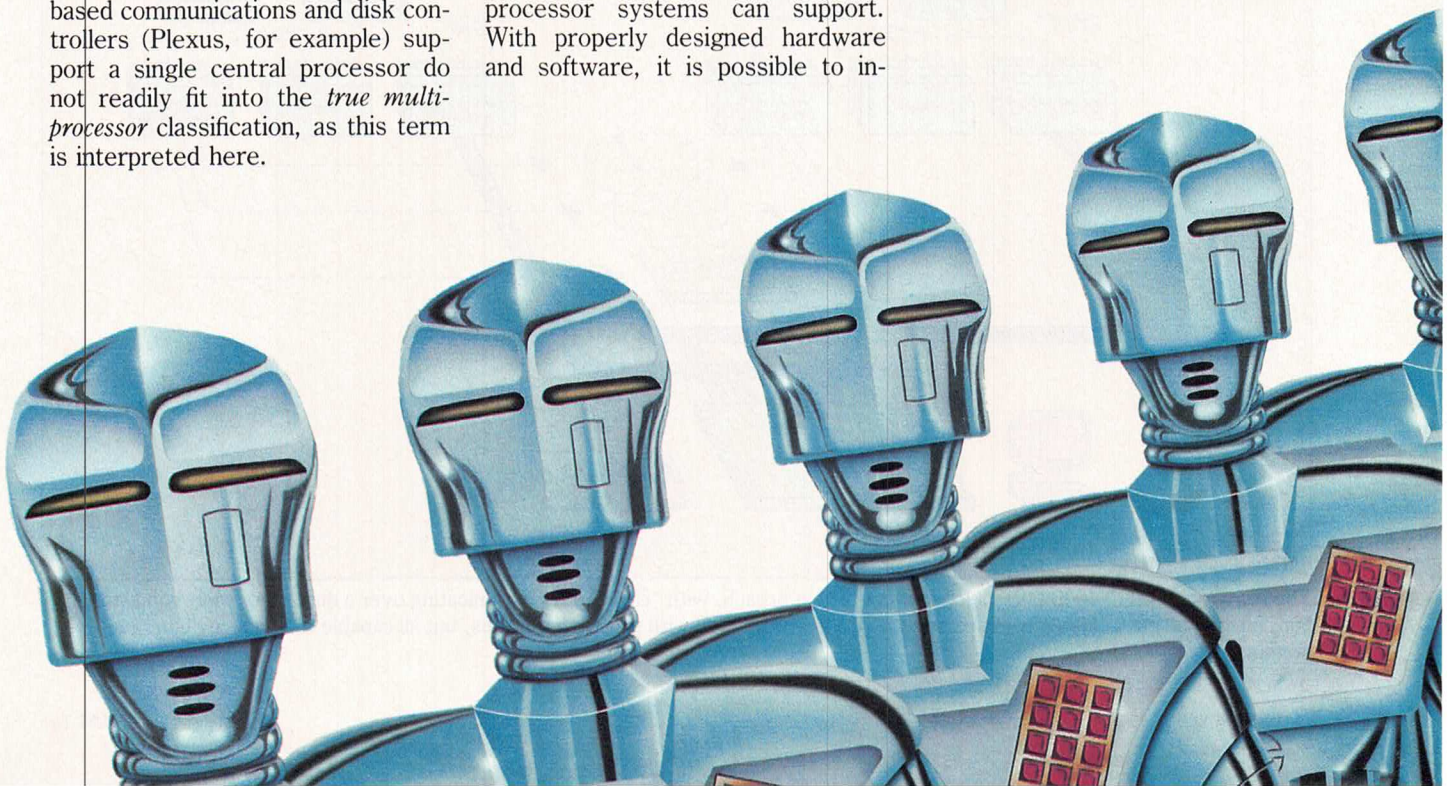
ADVANTAGES OF MMP DESIGNS

Multiprocessor architectures, for example, play a crucial role in fault-tolerant (FT) systems. FT systems typically use processor replication to enable them to recover rapidly and automatically from a processor failure; sometimes replication is used to detect faults as well.

Graceful growth and contraction are key capabilities that multiprocessor systems can support. With properly designed hardware and software, it is possible to increase the processing capacity of the system merely by plugging in additional processors. Conversely, failure of a particular processor can be made to result in merely reducing the system's throughput rather than in a crash.

Graceful growth has great appeal to end-users—and not just to those with high availability requirements. With conventional systems, users who anticipate growth in demand for system capacity have basically only two options: They can either buy excess capacity initially or undergo a painful upgrade from one computer model to another later. Either alternative is far less desirable than the ability to expand the system gracefully.

A main differentiating feature in MMP systems is the degree of coupling between the processors and the memory system. In *tightly coupled* systems, all processors have access to a common shared memory system, usually over a common



wide-bandwidth bus. Earlier systems, especially dual-processor ones, have used multiport memories instead.

Usually (but not necessarily) a single copy of the operating system resides in the common memory; all application processors, and sometimes all I/O processors (if any), execute operating system code from this central copy. The computers from Sequoia Systems, Sequent Computer, and Hydra are of this type, as is the Elxsi system.

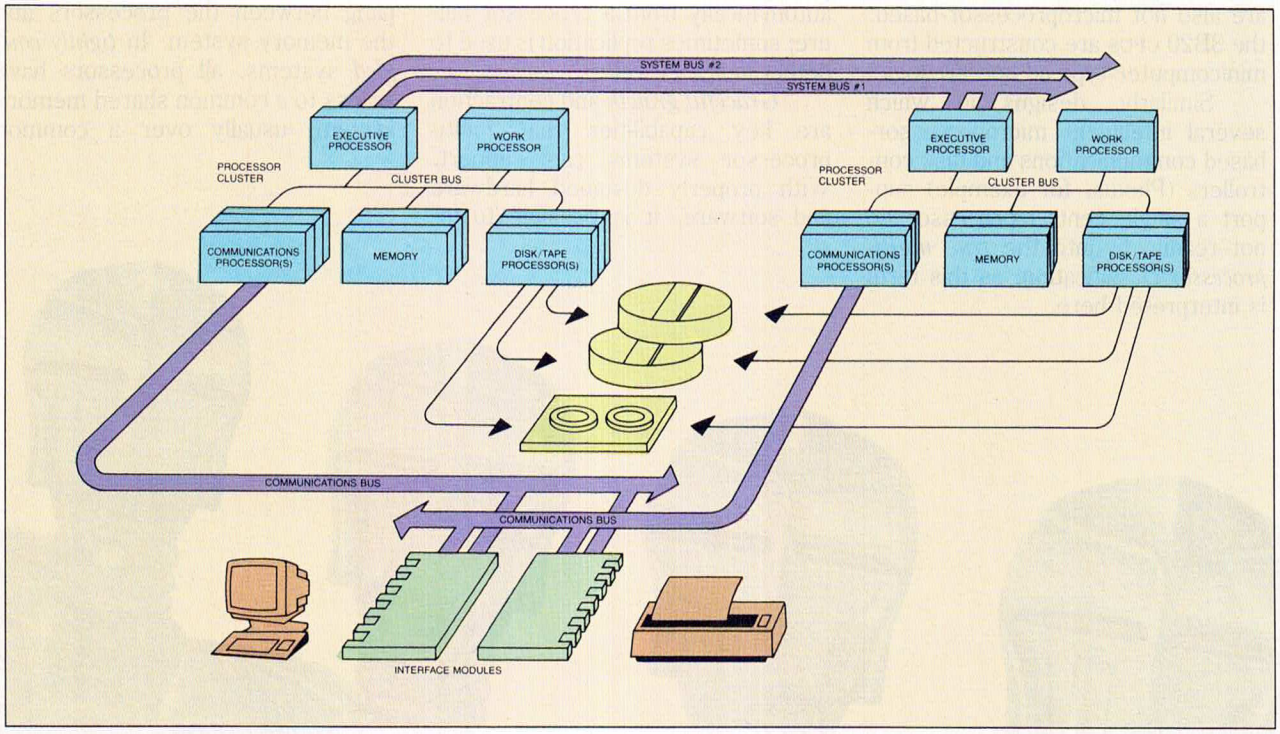
LOAD BALANCING

The advantage of tightly coupled systems is that, in conjunction with appropriately designed software, they can be used to support *load balancing*. Load balancing is an operating mode in which the incoming tasks are automatically distributed across the system so that no processor is overloaded while another stands idle.

Graceful growth and contraction are key capabilities that multiprocessor systems can support.

The effect of load balancing in a computer system is the same as that in a bank lobby or a post office, in which the individual queues in front of each clerk's position are replaced by a single queue, with the customer at the head of the queue being served by the first clerk to became free. Anyone who has been in a slow-moving supermarket checkout line can appreciate the higher efficiency (not to mention fairness) of the single-queue concept.

Such load balancing is more difficult (but not impossible) to achieve with *loosely coupled* systems, in which each processor has a private memory system, with its own copy of the operating system (which may or may not be identical for all processors). Sometimes each such processor also has access to a complement of private peripherals; in FT systems, each peripheral is typically also accessible from at least one other processor. Examples of



The Auragen System 4000 takes a loosely-coupled approach, with "clusters" communicating over a duplexed, wide-bandwidth bus. Internally, each cluster contains several processors, some with private memories, but all capable of accessing common memory systems.

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loosely coupled MMP systems include the Convergent Technologies' MegaFrame, Computer Consoles' Power 7/55, and the Stratus FT200 model.

The key advantage of loosely coupled systems is that they provide better fault containment and hence more robust fault tolerance. They also more readily support *on-line repair,* a facility by which defective components can be removed and repaired without disrupting ongoing operations.

In contrast, an unrecoverable memory failure in a tightly coupled system could lead to the loss of work queue or DBMS buffers. Some systems can recover from such situations. For example, the Sequoia system maintains duplicates of all critical data structures in physically separate memory modules; the AT&T 3B20D replicates the entire memory system and keeps both parts always in mirror-image condition by executing all writes to both parts.

The Power 5/55 from Computer Consoles is an example of a loosely coupled system that *does* implement load balancing. In this system, a local network interconnects all application processors to all terminal controllers. The terminal controllers offer each of their pending transactions to each processor in turn until they find one that will accept it.

Combinations of tight and loose coupling are sometimes found within the same system. The EnMasse system, for example, consists of a tightly coupled "back-end" database controller loosely coupled to multiple terminal servers. The Stratus XA models consist of tightly coupled, four- or six-processor modules in loosely coupled fashion over a LAN-like ring. Tolerant Systems offers a similar, loosely coupled system of tightly coupled, dual-processor modules. In the Auragen system, the basic architecture is that of loosely coupled "clusters" communicating over a duplexed, wide-bandwidth bus. Internally, however, each cluster consists of several processor types, some with private memories, but all capable of accessing a common memory system.

In loosely coupled systems, the processors can be interconnected in a variety of ways. Wide-bandwidth buses, typically implemented as 32- or 64-bit parallel buses, allow fast transfer of large quantities of data. Typical transfer rates are 16 to 32 Mbytes per second. Examples are the Auragen system, cited above, and Convergent Technologies' MegaFrame.

The key advantage of loosely coupled systems is that they provide better fault containment and hence more robust fault tolerance.

The disadvantage is that such buses must be very short physically, so the number of processors plugged into the bus is limited. This is less of a problem in systems that use a local-area network as the interconnection medium (for example, those from Computer Consoles Inc., Stratus, and Tolerant Systems of San Jose, Calif.). The serial coaxial cable used in such networks supports much slower data transfer rates (about 1 Mbyte per second), but it can be extended over hundreds of feet and hence can support a more flexible arrangement of processors.

VARIOUS ENVIRONMENTS

Understandably, Thompson and Ritchie in 1969 could not have anticipated the various environments in which their operating system eventually found itself. Thus, the Unix system until recently had no provisions for supporting a multiprocessor environment, transaction processing missions, or fault tolerance.

All the companies offering the Unix system in conjunction with systems designed for these classes of service have had to do major modifications to the Unix system. In several instances (Sequoia, for example), they simply abandoned the Unix system kernel and wrote their own, retaining Unix system compatibility mainly by supporting some system calls and some utilities. In other instances (Auragen, for example), kernel modifications have been kept to a minimum by substituting external processes for some key kernel functions. Still others maintain both a proprietary system and Unix system; suppliers in this category include Status, EnMasse, and Elxsi.

AT&T began attacking the multiprocessor issue itself when it introduced the 3B20A and 3B20D dual-processor systems to the commercial market. Previously, before the company made its commitment to support Unix System V on all its hardware offerings, the 3B20D ran a unique kernel dubbed "DMERT" (for Duplex Multi-Environment Real Time). Recently, AT&T has taken to calling it "Unix RT/R" (for Real-Time/Reliable).

In addition to understanding the special fault-tolerant configuration of the hardware, the DMERT (Unix RT/R) kernel supports several essential features missing from the

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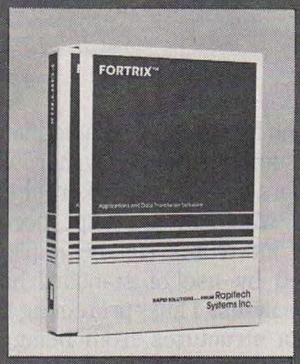

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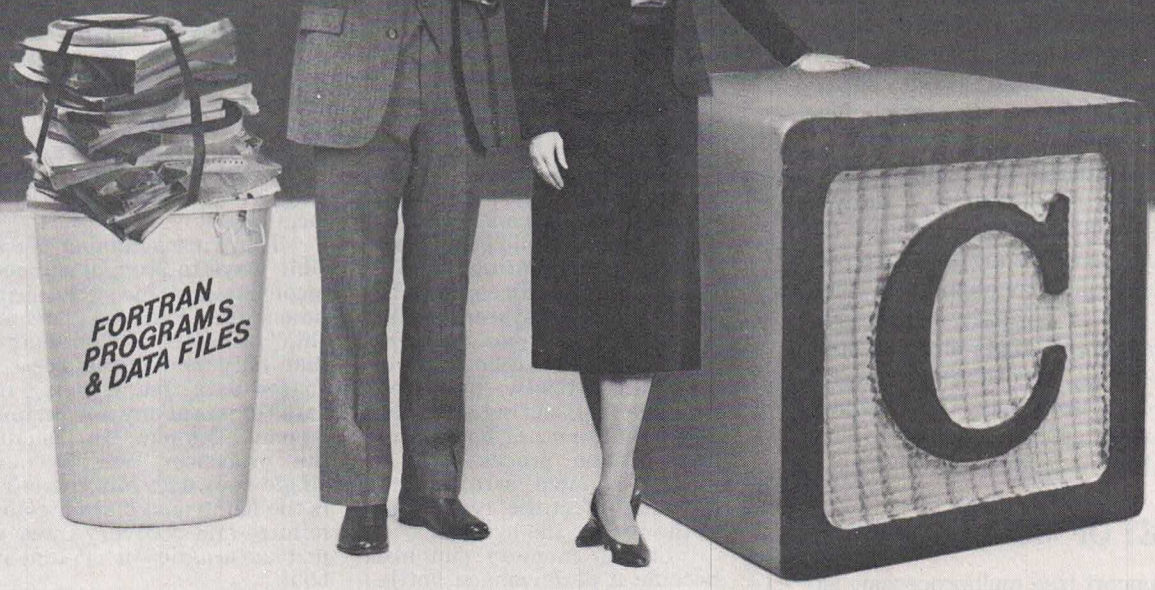

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Unix time-sharing system. Included among these are the ability to lock real-time processes in main memory for fast interrupt response, support for contiguous files to improve the notoriously slow Unix file system performance, a mechanism for file locking to allow concurrent file updates, interprocess communications via variable-size messages between nonrelated processes, and improved crash resistance for the file system.

Somewhat like the IBM VM (virtual machine) operating system, DMERT is, in effect, a "hypervisor" that is capable of supporting one or more "supervisor processes." Each such supervisor can be a nearly standard Unix system kernel. Such "guest kernels" are usually used to support program development activities; the DMERT kernel also supports interrupt-driven real-time tasks, servicing the environment for which the 3B20D was developed (controlling the Number 5 ESS central-office switch, for example).

The 3B20A is a tightly coupled dual-processor system, derived from the 3B20D essentially by the elimination of the mirror-image portion of the duplex memory system. One CPU is normally the master, fielding all interrupts and executing all I/O; the second CPU executes user-level tasks only. The Unix system modifications required to support this mode are relatively mild.

A SET OF MODIFICATIONS

To support true multiprocessing situations, however, AT&T Bell Labs' staffers recently described a set of modifications to the Unix system that allow the multiple processors to execute kernel functions concurrently.

The basic Unix system assumes a single-processor environment and hence is constructed under the assumption that only hardware interrupts can pre-empt kernel execution; when an interrupt occurs, further interrupts can be explicitly inhibited by use of standard hardware facilities. Thus, protecting kernel data structures from being accessed concurrently is never a problem.

In a tightly coupled multiprocessor environment, this assumption is no longer valid. The simplest solution would be to lock the entire kernel so that only one processor at a time could be exe-

TIGHTLY COUPLED MULTIPROCESSOR SYSTEMS

Tightly coupled systems are drawing increasing attention from fault-tolerant suppliers (such as Sequoia and Synapse) as well as from MMP suppliers not claiming any special fault-tolerant features (such as Sequent and Hydra). Tightly coupled systems offer a number of enticing advantages, including more effective load balancing, nearly seamless "graceful growth," and a single system image.

Unfortunately, these substantial benefits are accompanied by some pretty serious disadvantages. For example, if the shared memory is not physically replicated, a hard memory failure can be a tiresome event. Should such a failure affect operating system code, data structures, or database buffers, a system reboot is the only possible recovery. Although such a reboot can be done automatically, the system is unavailable during this operation; on the other hand, a reboot of one processor in a loosely coupled arrangement need not affect the availability of the rest of the system.

Shared memory can also become a performance bottleneck, a problem typically ameliorated by equipping each processor with a fast cache. Such caches minimize main memory accesses and allow concurrent access to duplicate data copies (for example, system instructions executed by the processors).

However, the multiprocessor environment introduces some special problems. If each processor has a private cache, then all caches must always listen to the memory bus and invalidate any entries they hold that are being written into by other processors.

If the caches are managed under a "write into" policy, an even trickier problem arises: *All* caches must be aware of writes into *any* cache because more than one copy of main memory locations may be present in the caches and because more than one processor may wish to write into such locations.

There are a number of possible ways to prevent memory inconsistency in such situations; the Synapse "ownership" scheme, which assures that only one cache copy of shared data that is being updated exists at any one instant, is one example. But, should the processor holding such single-copy data fail, the effect is the same as a main memory failure, and recovery must be just as drastic—a system reboot.

As with all else in this imperfect world, there are no simple answers; every design option carries its own advantages and limitations.

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cuting kernel functions. However, because benchmarks have shown that Unix systems typically spend 40 to 50 percent of the time executing kernel code, this solution would greatly diminish the potential performance advantage of the multiprocessor configuration, especially when more than two processors are available.

Instead, the solution evolved calls for the placement of semaphores around critical portions of kernel code. These internal kernel-level semaphores should not be confused with interprocess communications primitives available at the user level. These semaphores, which act much like "test-bit-and-set" uninterruptible instructions, serialize access to the protected data structure, thus preventing problems arising from concurrent updates by the multiple processors.

Interrupt handling in a multiprocessing environment poses a problem because, in order to achieve full efficiency, interrupts should be routed to the next available or least-loaded processor. Both Sequoia Systems and Sequent Computer have evolved hardware interrupt routers, and Sequent is employing custom VLSI chips for this purpose.

LOOSELY COUPLED SYSTEMS

Loosely coupled systems, such as Convergent Technologies' MegaFrame and Computer Consoles' Power 5/55, present a different set of problems that cannot be solved just with semaphores or locks. Auragen's system is a good example to illustrate the problems designers of such systems face as well as some of the innovative solutions they have evolved to solve these problems.

To take advantage of a multicluster architecture, Auragen pulled file-service routines and terminal I/O functions out of the kernel. The kernel executes on a dedicated "executive processor" in each cluster. The file and TTY functions, along with a demand-paging server and a task-scheduling server, have been made into "system servers" or privileged-user tasks, which can run (subject to some limitations) in any cluster; each cluster is equipped with a 68010-based work processor to execute user tasks and these system servers.

Loosely coupled systems present a different set of problems that cannot be solved with just semaphores or locks.

A key issue in such a system is that of isolating the user tasks from the multiprocessor configuration details. Such isolation is a prerequisite for fault tolerance, graceful growth, and on-line repair. This means that the user's code should be able to access any file, terminal, or communications line without knowing which cluster runs that resource. The classical solution to this requirement is the *message-based* operating system; that is, one in which users communicate with system resources via "messages" addressed to logical entities, the physical locations of which are resolved by the local copy of the operating system.

Unfortunately, the Unix system is a conventional procedure-based system, in which a user task needing a system service executes a procedure call that allows it to execute privileged code. To resolve this problem, Auragen built into its kernel a message system that handles the user's file and terminal I/O calls. In addition, this kernel modification also implements a "queue and count" system, which is used to allow backup processes to take over from ones that have failed.

This recovery scheme works as follows. Each critical "primary" process (user or system server) has an identical "backup" copy in another cluster. Each such backup has access to the queue of input messages sent to its primary since the last synchronization point. The backup also keeps track of the count of output messages issued by its primary since last synchronization. Should the primary fail, the backup will reprocess the input queue, taking care to suppress the output messages already sent by the primary (the message count is used for this purpose).

At periodic intervals, synchronization brings both primary and backup to identical states, discarding the input queue and output count. Synchronization involves committing to "safe" storage all the task's "dirty" pages—that is, those that have been modified, but not yet paged out, since last synchronization.

ROBUSTNESS

Robustness (crash resistance) of the file system is an important requirement in any on-line transaction processing system. Standard Unix is deficient in this area because it keeps both i-node information and actual file data in memory beyond the point that the user begins to treat such data as "committed" (safely stored on disk). Auragen solved this problem by creating *two* file systems: a "safe" version,

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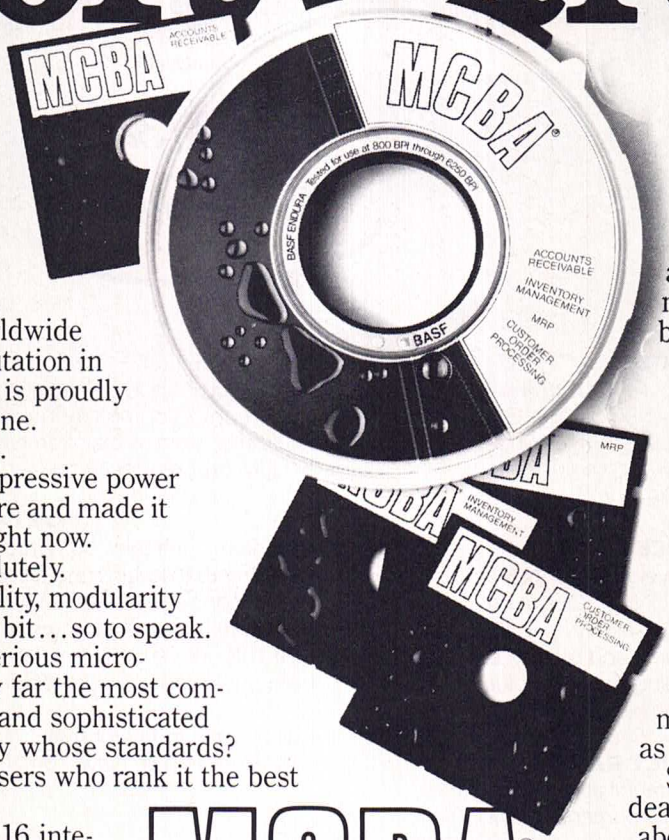

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reflecting data previously committed, and a physically separate "current" version, which encompasses all committed data but for which some new i-node data and file data may still be in memory.

At intervals (the "synchronization points"), the system commits the pending i-node and file information to free blocks on the disk; it then discards the previous "safe" version and declares the one just committed to be the new "safe" version. In addition, Auragen system supports the classical disk-mirroring technique, in which the system maintains two identical copies of critical files on two separate disk drives to allow continued operation in the event of a disk-drive failure.

File system performance in the Auragen system is improved by use of 2K-byte blocks (as opposed to 512K bytes in standard Unix) and by dumping all memory buffers to contiguous disk extents during synchronization.

Because transaction processing tends to involve repetitive invocation of rather small, disk-bound programs, the standard Unix "fork" technique for creating new processes is too slow. Auragen created a special "transaction shell," which, once established, saves the "message channels" to the TTY and file server and passes them on to each transaction process.

In addition, "standard" transaction processes can be created to serve highly repetitive functions. These processes keep in memory not only the read-only code but also the initial-state data segment. Thus, a new instance of such a process can be created very rapidly, without the need to read any disk data.

Other refinements introduced by Auragen include maintaining the runnable process queue by priority so that the process at the top of the queue is always the correct one to run next.

A PROGNOSIS

Will MMP systems be successful? Tandem and Stratus have proven conclusively that a sizable market for FT systems already exists and is growing rapidly: Tandem recorded $532 million in revenues in its eighth year of shipments, and Stratus' revenues have grown from $5 million in 1982 to $40 million in 1984. Sequent, Hydra, Elxsi, EnMasse, and others are now testing the proposition that multiprocessor systems should appeal to a wider audience.

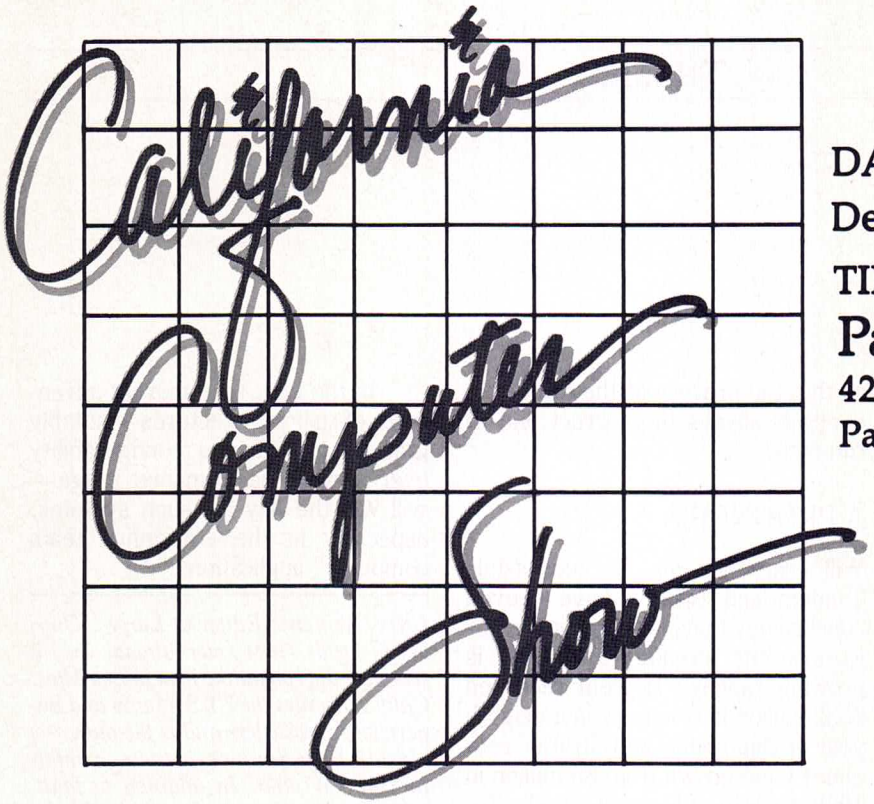
But MMP systems are not a panacea. They are very effective in transaction processing environments, where the load consists of a large number of unrelated, small tasks; however, they are not appropriate for situations where "number crunching" or other long, CPU-intensive jobs are involved.

Furthermore, engineering and architectural considerations put a cap on the upper limit of processing capability ("transactions/second") that can be achieved by adding processors. At the low end, MMP systems cannot compete with workstations or personal computers because the architectural "overhead" needed to support upward expansion introduces an added cost factor even to the smallest configuration.

The key problem faced by MMP suppliers is the increasing reluctance of users to acquire nonstandard systems (in other words, systems not compatible with IBM or DEC architectures). Virtually all MMP suppliers are banking on the eventual acceptance of the Unix system as a standard to circumvent this problem.

In the end, the inherent advantages of MMP architectures—notably graceful growth and configurability over a wide performance range—will win the day for such systems, especially in the emerging "team computer" application. □

UNIX/WORLD Editor-at-Large Omri Serlin heads ITOM International Co., a research and consulting firm in Los Altos, Calif. He writes the FT Systems *and* Supermicro *newsletters and is the author of "Inside Edge," which appears monthly in UNIX/WORLD. In addition to fault-tolerant systems and supermicros, his interests include multimicroprocessor systems and local-area networks. He has been active in the computer industry since 1962.*



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UNDERSTANDING THE NEW CHIP ARCHITECTURES:

What They Mean To System Performance and You

Confused by your computer salesman's techno-babble? Don't be. This article defines common hardware features and explores the relationship between them and system performance.

BY MOHANDAS NAIR AND PHIL BARRETT

Buying a new Unix system-based supermicro can be like buying a new car. You and your salesperson may be haggling over the same machine but speaking different languages. Remember how much you had to learn before you could even begin to ask the right questions? You had to learn the language of cars, the common terminology, and relate those terms to your particular needs.

If you are buying a computer, designing one, or just reading about it, you will encounter hardware terms—such as *cache* and *wait states*—that represent features somewhat equivalent to turbo-charged and fuel injection in cars.

In the systems business, many people who use these terms don't actually understand the true ramifications of the hardware features they describe on computer system performance.

SPEED ISN'T EVERYTHING

The battle between systems has "traditionally" been based on the speed of one computer system challenging the speed of another. In fact, the speed of a system is but a side-effect of total system performance. A simple equation to follow is *overall system performance = software + hardware + tuning.*

This equation is a delicate one, and consequently, a multitude of trade-offs emerges when system designers put it to work. These trade-offs, if well executed, do not result in unnecessary system cost. Another key ingredient to the equation is synergy. Being overly simplistic, a system still may not function optimally even when all components of the equation are operating at their individual maximum capacities. For example, you may have to avoid using all the available hardware features of a chip to reduce extensive software changes. Hence, "turbo" systems aren't the only good measure of performance.

IF "TURBO" ISN'T THE NAME OF THE GAME, WHAT IS?

A useful way to evaluate systems is to use the criterion of cost versus performance. If a system costs more than it can provide, you will not use it. Also, if the software is weak but the hardware can do a context switch in *n* nanoseconds, although some engineers may be euphoric, pragmatists won't be excited unless it makes their particular application run faster and more efficiently. If software blends well with hardware, then your system will be both fast and efficient.

Another important question to ask yourself when you consider buying a particular system is "Does my application need these hardware features?" When you're looking for a single-user system that has very little data storage, it doesn't make sense to worry about user-to-user protection schemes or multiuser systems that have superior disk capabilities. Thus, hardware features, software strengths, and fine-tuning must bow to your needs and application requirements.

THE PROCESSOR SUBSYSTEM—THE ENGINE

Just as a car is made up of several major pieces, a microcomputer consists of major subsystems. At the heart of any microcomputer is a microprocessor. Every microprocessor executes an instruction set, and each instruction does a simple piece of work, such as adding two registers together or moving a piece of data into a memory location.


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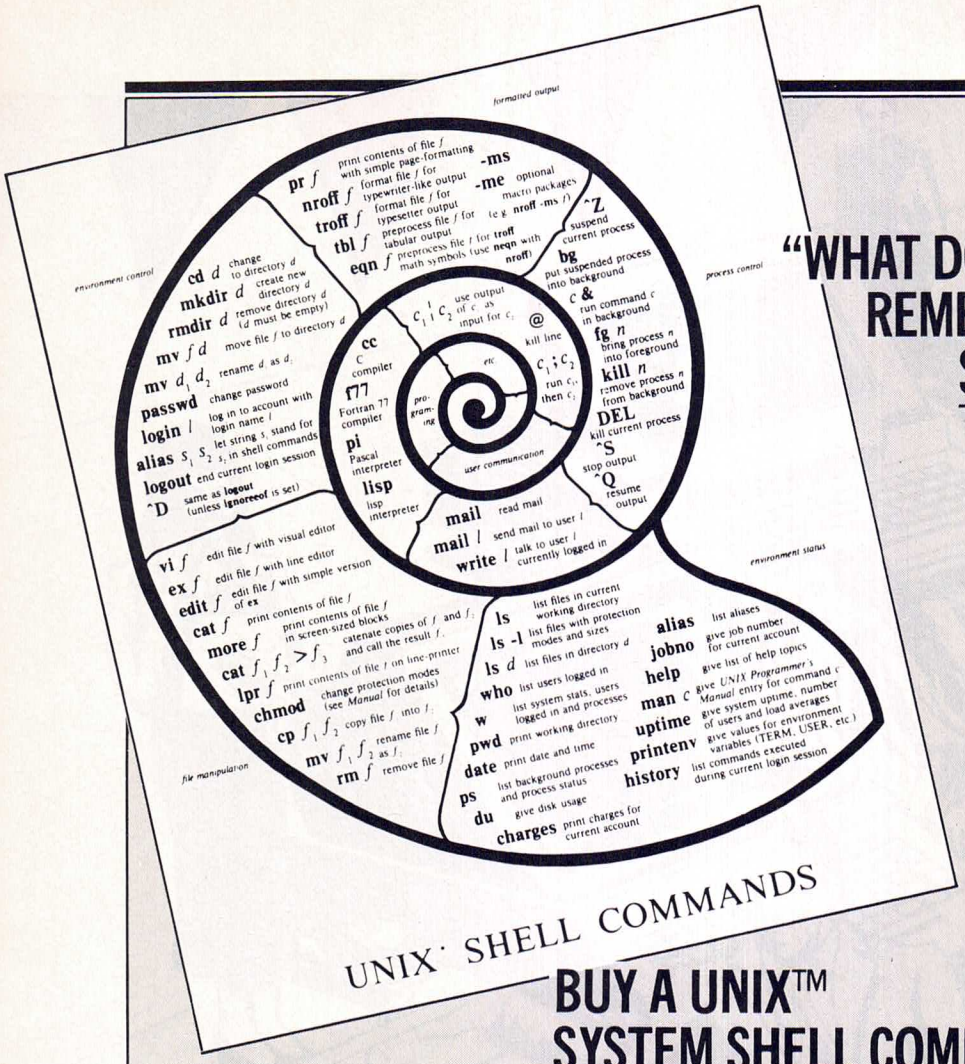

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Instructions are broken down into a series of primitive operations, or *machine cycles* (see the "Glossary" sidebar).

An external *clock chip* usually defines the length of a machine cycle. System manufacturers often tout their machine as running at X Mhz, but you may wonder what that means. The inverse of X is the length of a machine cycle, and it can help you determine the raw performance potential of a microprocessor. An Intel iAPX 286 microprocessor running at 8MHz, for example, has a machine cycle time of 125 nanoseconds (1 eight-millionth of a second).

Simply comparing the *clock rates* of processors to find the faster of two machines is not appropriate, however. Remember that an instruction may require multiple machine cycles; it is the *average* number of cycles per instruction that defines performance potential, rather than the clock rate. The iAPX 286 microprocessor has many instructions that complete in two clock cycles, while the MC68000, for example, has no instructions that are completed in less than four. Thus, an 8MHz iAPX 286 microprocessor is likely to be faster than an 8MHz MC68000, even though their clock rates are equal.

The accepted measure of CPU performance is MIPS (millions of instructions per second), a raw low-level measure that compares microprocessor performance reasonably well. This measure must be taken in light of a high-level language interface, however.

Although MIPS are a good way to predict how well a typical application will do on a given microcomputer, number crunching applications (scientific/engineering) may not do well on a machine that has a high MIPS rating if the computer does not also have good floating-point performance. For such applications, you also need to know the number of floating-point operations that the machine can execute per second, commonly called FLOPS (floating-point operations per second).

Many microprocessors often support the ability to add special-purpose processors, called *co-processors,* to a system. In conjunction with main CPUs, co-processors can provide additional hardware that allows a program to execute floating point instructions 50 to 100 times faster than can a software emulator (that is, software that emulates hardware support).

Number crunching applications will do well on a high MIPS machine without good floating-point.

THE MEMORY SUBSYSTEM—THE GASOLINE TANK

Every system needs memory. System designers must make several decisions about their memory subsystems—such as how much memory, how fast, and how expensive they should be. Each of these decisions directly influences the cost of the final product. The faster the memory system, the more expensive the memory components will be. Often, designers make a decision to use memory components that are slower than the selected microprocessor.

Also, they may choose several different versions of a particular microprocessor, and each must then be matched to the speed of the memory system. One way to do this is to force the microprocessor to wait some number of extra CPU clock cycles until the memory subsystem completes its memory access. Each clock cycle that the microprocessor waits for the memory operation to complete is called a *wait state.*

Wait states directly affect system performance. They can either slow your system down or speed it up. Depending on the application and system, performance will degrade when there are many wait states between the memory and the central processor.

It may be necessary to introduce wait states for the total function of your system, just as you have to make a car engine relate to the slower transmission system so that the car stays under control.

Slow memory is not the only element that induces wait states. The CPU speed must also match the speed of the *bus.* A bus is similar to a party-line telephone in which phones share a line but only one person can use it at a time. A microcomputer bus is used to connect the CPU and memory, or the CPU and I/O devices, or the memory and I/O devices. Data is transferred via the bus. Many systems use a single bus for both memory and I/O, although this can cause problems because the disk I/O portion may be using the bus while the CPU is waiting for access.

An efficient but more expensive technique is to use two buses—one for I/O, one for memory—which gives the CPU an efficient channel to the memory subsystem.

YOU NEED CASH TO HAVE CACHE

Even with fast memory and a fast bus, some processors have such quick clock rates that only very expensive memory will allow them to run at full speed with no wait states. Borrowing a traditional technique

from mainframes, some microprocessor systems use a small portion of high-speed memory, called a *cache,* between the memory subsystem and the CPU.

Cache contains a small amount of high-speed memory that allows the processor to run without requiring wait states. The cache hardware automatically fetches portions of data from the slower system memory and makes it available to the microprocessor. Cache is transparent to the microprocessor; its operation is invisible (with the obvious exception of faster memory operation).

The term *hit rate* is often used to describe a cache and is a simple measure of how it performs. Imagine, for example, that I have a book you want. I keep this book in a drawer deep in my office. If you ask for this book regularly, I should be intelligent enough to leave the book in a more accessible place (in other words, cache). If you ask for the book only at irregular intervals, my hit rate at satisfying your request may be less or more.

The main disadvantage of a cache is money—it requires expensive, high-speed components.

MEMORY SUBSYSTEM MANAGEMENT

Just as you need to monitor gasoline usage in a car, the memory subsystem needs to monitor and manage the memory available to the system. Memory management support takes widely varied forms, but in general it supports two functions: memory mapping and memory protection. These two elements of memory management are closely associated and are generally discussed hand in hand.

Each user program, when running, requires memory. This memory, allocated and managed by the operating system, is mapped into the program's *address space* by the memory mapping portion of the *memory management unit* (MMU). Mapping allows programs and data to be independent of physical memory locations.

Memory protection support, the other element of memory management, allows the operating system to protect memory from unauthorized access. Protection can be used to prevent a portion of memory from being written, read, or executed. There are two major forms of memory management and protection: paging and segmentation.

Your applications and needs are the main criteria for evaluating systems, and all that glitters is not gold.

Paging breaks physical memory into equal-size pages (usually 0.5K bytes to 4K bytes), and each page is protected separately. A program consists of a set of pages grouped into several categories—code, data, stack, and heap—each with the same set of protections. As an example, consider an author typing a manuscript into a computer. From his "outside-looking-in" perspective, the manuscript he is typing appears contiguously on the screen, even though it is separated into sized pages scattered in memory. Protection of these pages in the system is performed on a per-page basis—a model used in several Unix/Xenix-based systems such as the Sun Workstation and the Altos 586.

Segmentation, however, breaks physical memory into pieces of various sizes. In its simplest form, a segmented program consists of two segments: a code segment and a data segment. Here, the same author we mentioned above is working on a manuscript that is divided logically into segments. Protection is applied on a per-segment basis. This scheme was developed to fit the logical association between structured programming styles of modularity and memory management; the IBM PC/AT and the Intel System 286/310 use segmentation in their architecture, for example.

Each of these models has its trade-offs, and they are usually used in combination—in other words, segmentation with paging and so on. Although no significant difference in cost is associated with one model or the other, the various factions of the systems community fight over these models religiously. Most battles are waged from the viewpoint of the software developer who is concerned with architectural trade-offs; users seldom see any major effect of a particular model because the models are hidden in higher-level languages.

SQUEEZING THE MEMORY MANAGEMENT AND PROTECTION ON THE CHIP

Early microprocessors had no MMU on-chip (in other words, the MMU unit attached physically to the processor board), a design carried forward in the MC68000 and NS32000 microprocessor families. These processor families require an off-chip MMU in order to support multiuser time-sharing operating systems, such as Xenix/Unix. Other microprocessor families—the Intel 80286, for example—have integrated MMUs on-board.

An off-chip MMU has some disadvantages: It takes up PC board space; it may induce memory wait states; and it's more expensive.

On the other hand, the off-chip MMU does allow system designers more flexibility because they can implement an MMU most appropriate to their application (this is a double-edged sword in the case of the MC68000). Designers who choose not to use the Motorola MMU, the MC68451, often create MC68000-based systems that are ultimately incompatible with other memory management schemes. Thus, many MC68000 Unix systems cannot share the same binary programs, and porting the Unix system to a new MC68000 system usually requires a rewrite of the memory management code, in addition to any other system-specific differences. This increases the requisite number of changes and, indirectly, the cost of the port.

On the other hand, on-chip MMUs have forced standardization of the MMU structure. Several Xenix/286 ports have been done without source code changes, substantially reducing porting costs, although you have to accept a certain reduction in customization of your memory management and protection scheme.

INPUT/OUTPUT: COMMUNICATING WITH THE OUTSIDE WORLD

In Xenix, Unix, and Unix-like systems, there are two major categories of I/O: disk and serial. Your program and data files usually reside on a disk, and disk I/O deals with creating, reading, writing, and deleting these files from the disk.

Your computer files are stored on a disk drive, which in many respects is similar to a record player. It has digital information encoded in tracks on a rotating magnetic disk, or platter, just as a record has auditory information encoded in its tracks. A disk drive has a pickup device, or head, held by an arm similar to the tone arm and needle of the record player. Just as you can place the needle on any track of the record, the computer can place the head on any track.

But our analogy breaks down in the following places: Typical disk drives have several platters with a head for each surface; the disk drive can read and write information on the track; and the tracks on the disk do not spiral into the center but are each separated, much like a record with a skip in it.

Several aspects of disk drives affect system performance. One aspect is *seek time,* the amount of time it takes to move the head from one track to another. Because this can be quite large in comparison with other typical computer operations, an application program can wait a significant amount of time for the disk head to reach the desired data. Thus, the faster your disk drive can seek, the faster your application will run if it reads or writes a lot of data.

Most disk drive manufacturers measure seek time as the amount of time it takes to seek halfway across the disk. Early microcomputers used inexpensive disk drives with an average seek time of 90 milliseconds, while newer (and more expensive) drives boast 30- to 40-millisecond seek times. If your application must handle significant quantities of data, you are better off paying for the higher performing drives. On the other hand, if your application does not do a lot of disk I/O, or can tolerate lower performance, you can probably get by with the slower and cheaper disk drives.

You will hear more terms relating to disk I/O, such as *rotational latency, access time*, and *look-ahead.* These, too, are important aspects to discuss. (See article "New Perfor-

GLOSSARY

address space: The maximum theoretical amount of memory that a program can access.
bus: A pathway for transfer of data between functional subsystems of a microcomputer. A bus may be very general or special purpose.
cache: A high-speed memory that sits between the microprocessor and memory subsystems. It holds a copy of a small portion of the memory subsystem, allowing the microprocessor to run at full speed and copying portions of the memory as needed.
clock rate: The number of pulses per second generated by the clock chip.
clock chip: A special integrated circuit that creates a series of evenly spaced pulses that are input to the microprocessor.
co-processor: A special-purpose microprocessor that works in conjunction with the main processor, usually to improve performance by performing specific tasks, such as terminal and/or disk I/O, floating point operations, and so on.
hit rate: In a cache, the number of times that the microprocessor accesses memory and finds the desired data in the cache divided by the total number of memory accesses.
machine cycle: The lowest level unit of work that a microprocessor does. An instruction often consists of multiple machine cycles. The length of a machine cycle is defined by the clock rate.
wait state: A microprocessor may not be able to access memory at full speed, so an additional machine cycle may be added to an instruction in order to match the speed of the microprocessor to that of memory.

mance Horizons Through Hardware Solutions" UNIX/WORLD, Vol. II, No. 3).

The bottom line of disk I/O measurement, however, is "How long do you have to wait between asking for data and getting it?" The speed and efficiency of this operation, or a similar write operation, is based on the disk technology used, the speed of the disk, and the strength of the interface to the disk (in other words, the device driver and the operating system itself).

HARDWARE IS ONLY ONE ASPECT

Hardware features are but one aspect of your investigation. In investigating the field, be concerned with upgrading the system of your choice—buying, selecting, or designing systems is like getting married. You may think that you are bringing only one person into your life, but you are actually getting an entire family of products—all the more reason why it is important to take a rational look at what is standing behind any "treasure" that glitters before you. □

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If you've already bought a Unix-based computer, or are about to, this article will help you find the right word-processing software.

BY DAVID KEITH

You've just been assigned to research, purchase, and implement your company's first computer system. You start out where you feel the most comfortable—in the personal computer (PC) market. Your guidelines say word processing must be one of your first priorities, along with a powerful and effective database capability. Certainly, a plethora of word processors are available for personal computers, running the gamut from Apple Writer and Atari Writer all the way up to packages that rival the best dedicated systems, such as WordStar, Samna Word III, and Microsoft Word.

A detailed analysis of the specific requirements of your office environment, however, quickly leads you to the conclusion that personal computers are not quite up to the task, even with the recent availability of network systems. Your research determines that a multiuser system capable of providing a common database and shared files is the obvious way to go.

Your company, however, is not a big enterprise, and a mainframe or large minicomputer is probably not in the cards. The logical conclusion: Consider one of the new, inexpensive, multiuser computers that run the Unix operating system. Now all you need to do is run out and purchase one of the exciting new computer systems that will provide the number of terminals you require at a reasonable price. *Wrong!*

The first mistake people generally make when they decide to purchase a computer system is to buy the hardware first, then look for application programs that will run on their chosen computer and that will still, hopefully, satisfy corporate software requirements.

Remember all those people who bought an Apple Macintosh when it was introduced and then had to wait a full year to get application software! Note the lesson here—your search should start with a comprehensive evaluation of your company's software requirements; then

CHOOSING WORD PROCESSING SOFTWARE

match these needs to machines that will run that software and give you the necessary multiuser capability.

This brief overview of the Unix system word-processing market has been designed to assist you in your purchase decision and, should your company already have taken the plunge and purchased a Unix system-based computer, to provide some help in finding the right word-processing software to run on your present hardware.

FEATURES TO CONSIDER

We have made certain assumptions in preparing this report. As you may surmise by the brevity of our chart, we have chosen only to look at full-featured word-processing software packages—those that provide certain standard word-processing capabilities such as block operations, cursor movement, search and replace, word wrap, and other necessary accoutrements.

Still, it behooves prospective system purchasers to conduct a detailed survey of their specific word-processing requirements to determine if the product they are interested in adequately fulfills those requirements. What we have attempted to do here is provide an overview of the available word-processing packages, including the different flavors of the Unix system under which they run and machines on which they currently operate.

The items we have included in the accompanying chart are those that you might not usually find in simple word-processing or text-editing application programs.

Note, in this instance, that most of these word processors utilize the virtual memory capabilities of the more powerful central processing units (CPUs) available for today's Unix system-based machines. This means, essentially, that file size is limited only by maximum disk space, not by memory availability.

An important feature of 'user-friendly' word processors may be the isolation they afford from the often cryptic idiosyncrasies of the Unix system.

For inexperienced users, an important feature of "user-friendly" word processors may be the isolation they afford from the often cryptic idiosyncrasies of the Unix system. If, in the chart, the section "Unix System Access Required" is marked "No," then average users should be able to conduct all necessary filing and editing operations using simple functions provided directly within the application software itself.

Many of these word-processing products may, in fact, fully utilize the numerous powerful utilities that the Unix system provides. Well-designed application programs, however, should operate these "calls" to the Unix system in a way that is effectively transparent to users. Certainly most computer neophytes would be horrified at the prospect of direct confrontation with the Unix system's copious and obscure command utilities. It could easily take several weeks just to learn what most of these mean, much less how to make them work.

A word about the disparity in the "Suggested Price Range" for the various listed products. Prices at the lower end of the scale are normally for single-user machine configurations. The highest listed prices are for big multiuser minicomputers or mainframes capable of supporting dozens of users. In each instance,

A SAMPLING OF UNIX, XENIX SYSTEM WORD PROCESSORS

PRODUCT (Release Date)	COMPANY	UNIX VERSIONS/ UNIX MACHINES	PRICE RANGE	Minimum RAM Per User	Max. File Size	Password Protection	User-Specific Directories	Unix Access Required	Document Stats. Provided	On-Screen Help	Spelling Checker Included
CRYSTAL WRITER (August 1983)	Syntactics	a-e/1,2,3,6,8,9,10, 11,16,20,26,28	$595–4995	48K	V	Y	Y	N	Y	Y	Y
FINAL WORD, THE (February 1984)	Venturcom Inc.	a,d,f/10; 8088/86 machines	$395	NC	256K	N	U	Y	U	Y	L
HANDLE WRITER (January 1985)	Handle Technologies	a,e/2,3,9,19	$675–1700	128K	V	Y	Y	N	L	Y	Y
INword (December 1981)	Interactive Systems Corp.	b,d,g/10,16	$200–2000	NC	V	Y	Y	N	Y	Y	SP
LATITUDE (October 1984)	Horizon Software Systems	b,c,d,e,f/1,2,10, 16,28	$600–4995	256K	V	Y	Y	N	Y	Y	Y
LEX (January 1983)	SofTest Inc.	a-f/1,5-7,9,10,11, 14,16,17,18,20,22, 23,25, 26,27,28,29	$500–1000	128K	V	N	U	N	Y	Y	Y
LYRIX (November 1982)	The Santa Cruz Operation, Inc.	a-e/1,2,9,10,16,17, 20,22,26,27,30	$595-3995	128K	V	U	U	N	Y	Y	Y
PREVAIL WP (May 1985)	Inspiration Systems	a-d/2,10,18,20,28	$750–6000	512K	V	U	U	N	Y	Y	U
Q-One (February 1983)	Quadratron Systems Inc.	a-f,h/1,2,4,6,9,10, 11-13,15,17,20,21, 22,23-26,29	$495–3000	256K	V	Y	Y	N	Y	Y	Y
R WORD (January 1985)	R Systems	a-c,e/1,20,25,26	$895–1295	30K	V	Y	Y	N	L	Y	Y
UNIWORD (February 1984)	Applied Technology Ventures	a,b,d/10,20	$495–1995	100K	HD	N	U	Y	Y	N	Y
XED 5.20 (October 1981)	Computer Methods Ltd.	a-f,h/2,10,16,20, 26,28,30	$250–15,000	150K	V	Y	Y	N	Y	Y	Y

Unix Operating Systems: a = System V; b = System III; c = Version 7; d = Berkeley Versions; e = Xenix; f = Venix; g = VMIX; h = Ultrix.
Unix Machines: 1 = Altos; 2 = AT&T 3B2/5; 3 = AT&T 7300; 4 = Cadmus; 5 = Callan; 6 = Charles River; 7 = CIE; 8 = Codata; 9 = Convergent; 10 = DEC; 11 = Dual; 12 = Fortune; 13 = Four Phase; 14 = Hewlett-Packard; 15 = Honeywell; 16 = IBM PC/AT 17 = Intel; 18 = Masscomp; 19 = Morrow; 20 = NCR; 21 = Onyx; 22 = PC Compatibles; 23 = Perkin Elmer; 24 = Pertec;

Number Of Dictionary Words	Auto Hyphenation	Mail Merge/List Capability	Search/Sort Capability	Telecommunications Included	Math/Calculator Functions	Automatic Backup	Continuous File Saving	Tutorial Manual/Disk	Table Of Contents Generation	Automatic Index Generation	Automatic Footnoting	ASCII File Input/Output	Auto Reformatting	Multiple-File Windows	Multiple-Column Manipulation	Undo Function	File Merging During Edit	File Linking During Printout	Proportional Space Printout	Multiple-Copy Printout
N/A	Y	Y	Y	P	P	Y	Y	Y	Y	P	Y	Y	Y	Y	L	Y	Y	Y	Y	Y
N/A	N	U	U	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
80,000	N	N	N	N	N	N	Y	Y	Y	N	N	Y	Y	HD	N	N	Y	N	N	Y
50,000	N	Y	Y	U	U	Y	Y	Y	N	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y
30,000	Y	P	P	N	Y	N	N	Y	N	N	Y	Y	N	N	Y	Y	Y	N	Y	N
100,000	Y	Y	Y	N	Y	Y	P	Y	Y	Y	P	Y	N	N	Y	Y	Y	Y	SP	Y
25,000+	L	Y	Y	U	U	Y	Y	Y	P	P	P	Y	L	N	P	Y	Y	Y	P	Y
30,000	Y	Y	Y	SP	N	Y	N	Y	N	N	N	Y	N	Y	Y	Y	Y	Y	N	Y
90,000+	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	P	Y
30,000+	N	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	N	Y
26,700	Y	Y	Y	N	Y	N	Y	Y	N	N	N	Y	Y	N	N	Y	Y	Y	N	Y
N/A	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	HD	Y	Y	Y	Y	Y	Y

Unix Machines continued 25 = Pixel; 26 = Plexus; 27 = Radio Shack; 28 = Sun; 29 = Wicat; 30 = Zilog.

Y = *Yes;* **N** = *No;* **L** = *Limited;* **P** = *Pending;* **U** = *Through Unix Utilities;* **K** = *Kbyte Or Thousand;* **V** = *Virtual Memory Capabilities;* **ln** = *Lines;* **N/A** = *Not Available Or Not Applicable;* **HD** = *Hardware Dependent;* **SP** = *Separate Product;* **NC** = *Manufacturer Chose Not To Comment.*

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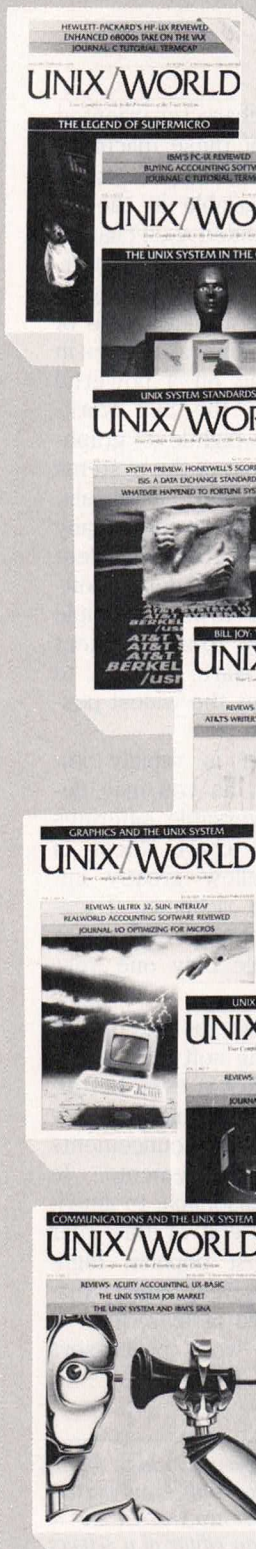

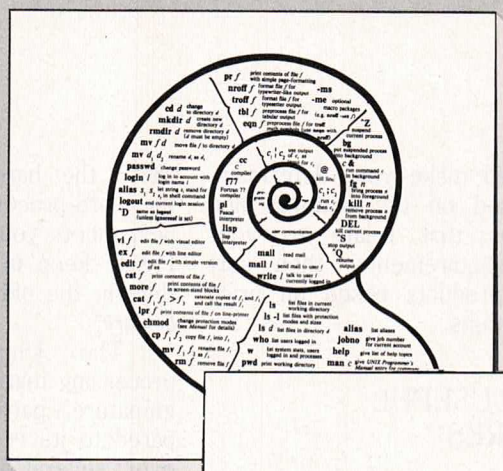

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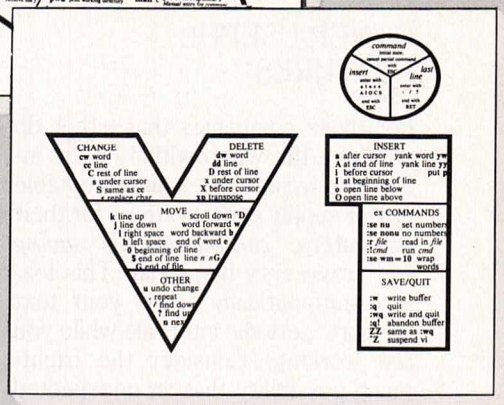

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U104	Vol. 1 No. 4		$6.00	
U105	Vol. 1 No. 5		$6.00	
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			Shipments Outside U.S.A. Add $7.00	
			TOTAL	

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you should make your determinations based on the features and capabilities that relate to your specific requirements; then sort out the products based on price considerations.

OTHER USEFUL FEATURES

For those companies that either do not have the wherewithal or the inclination to purchase uninterruptable power supply (UPS) systems for their computers, *continuous file saving* can prove very beneficial. This feature automatically saves your text at short, periodic intervals while you are working. Consider the frightening possibility that an unexpected power surge or line outage could suddenly wipe out five hours of work. Continuous file saving means that, at most, you might lose just five minutes worth of text input—a most worthwhile feature, to be sure.

You might assume that the word-processing programs on the market the longest are the most likely to have the bugs worked out. (Are we being too generous, perhaps?) On the other hand, maybe the newer products on the market have profited from their predecessors' mistakes and are truly superior products. Please note that the release dates provided in the chart represent the availability date for a company's first version of its word-processing product, not necessarily of its most recent update.

To make an informed purchase, you really must observe *in operation* the software that interests you—ideally in your own work environment and being used for the purposes for which you intended. Creative and understanding computer sales organizations will work closely with you to ensure that you purchase the hardware, as well as the word-processing software, that best meets your company's needs. Please keep in mind at all times, though, the old adage *let the buyer beware!*

The Unix system word-processing market is still relatively immature, particularly when compared to its PC counterpart. However, several outstanding products are available, some of which have been available for years (although most Unix system-based word processors have been released only recently).

THE HEAVIEST HITTERS

Most of these newer packages are still available for only a limited number of computers, and only a few of these offerings provide the wide assortment of features available with the heaviest hitters in the PC ball park. Despite this, all include the benefits of multiuser capabilities that are unavailable on any of the current PC products. You should also be aware that almost all the major PC word-processing software vendors are moving to the Unix system.

By the end of this year, users of the most popular Unix-based machines should have four or five full-featured word processors to choose from.

Perhaps the principal factor limiting the richness of features of today's Unix system word processors is that the majority have been designed to run on several different computers and character-oriented terminals. Most of these machines have neither the bit-mapped graphics capabilities available in the PC world nor the extended ASCII character set that IBM PC compatibles offer.

It could be relatively straightforward to include a wide range of features and operating capabilities in a program running on a powerful computer such as the Sun workstation, which has high-level graphics capabilities. Most of the systems that utilize character terminals, though, simply cannot present many of these features. Because prudent manufacturers generally design software with an eye toward multiple system adaptability, to some extent they restrict software features to give their programs the widest possible user base.

The situation is rapidly improving, however, as you may deduce from the versatile offerings presented in the chart. Most of these products allow greatly improved utility and richness of features when you compare them to what was available only one year ago.

The prognosis for the future of word-processing software in the Unix system market is even better, with numerous companies making almost monthly announcements about further improvements. In fact, it is not unreasonable to anticipate that by the end of this year users of the most popular, high-volume Unix system-based machines should have at least four or five full-featured word processors to choose from. □

David Keith has been working as a freelance computer journalist and market researcher for the past two years. Prior to that, he worked as an editor of a science and health newsletter.

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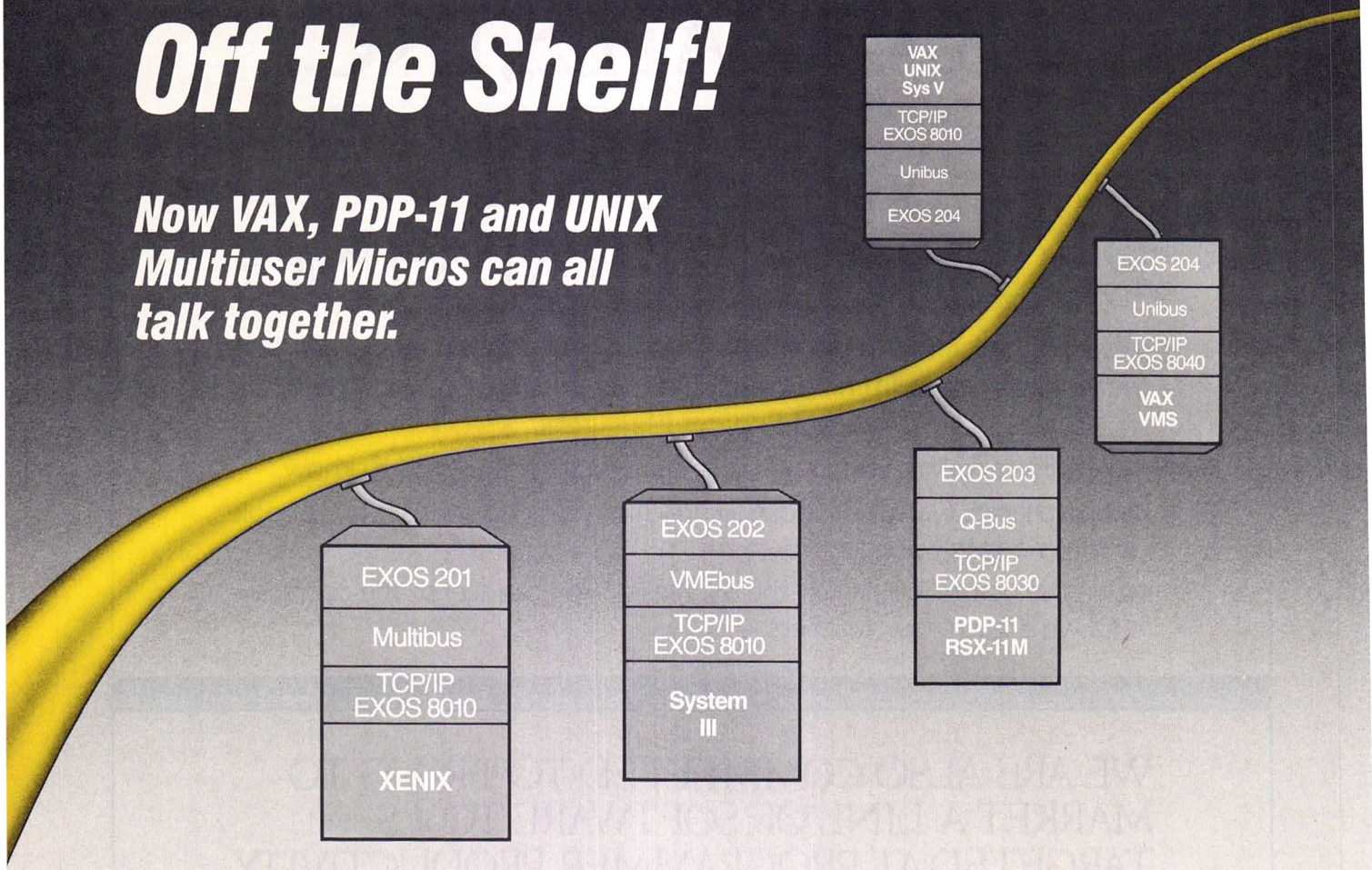

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THE TOUCHSTONE CONNECTABLES:

UNIHOST, PCworks, AND MACLINE

Don't despair! Your company's MS-DOS, Macintosh, and Unix system computers can talk to each other.

BY ALAN WINSTON

Touchstone's MacLine makes the Macintosh useful for many business applications.

MacLine, PCworks, and UniHost — collectively known as the Connectables (from Touchstone Software Corp. of Seal Beach, Calif.)—make it easy to communicate among IBM PCs and compatibles, Apple Macintoshes, and more than 50 different Unix system-based computers. These systems can even transfer files and send mail, and the MS-DOS system can log on as a terminal to the Unix system host! In addition, PCworks and MacLine simplify communication with commercial databases and other computers in the outside world.

You can either buy everything to make up a network, or, because each portion of the system works independently, you can just buy a single copy of PCworks or MacLine, for your IBM or compatible PC or Macintosh, respectively. The Unihost software package, the host-resident portion of these PC/Unix system connection products, is only useful when you use it in conjunction with PCworks or MacLine (See sidebar for supported CPUs). At less than $200 each, PCworks and MacLine are as much in the price range for individuals who want menu-driven communications support as they are attractive to companies wanting to centralize file storage.

I used the Connectables family on an AT&T 3B2/300 with 1 Mbyte of RAM, on an IBM PC with two floppy drives and 256K bytes of memory, and on an Apple Macintosh with an external floppy drive. These were directly connected to each other, so I was not able to test the programs' auto-dial modem support.

DOCUMENTATION

The Connectables documentation consists of three volumes—a *Software Reference Guide* for UniHost,

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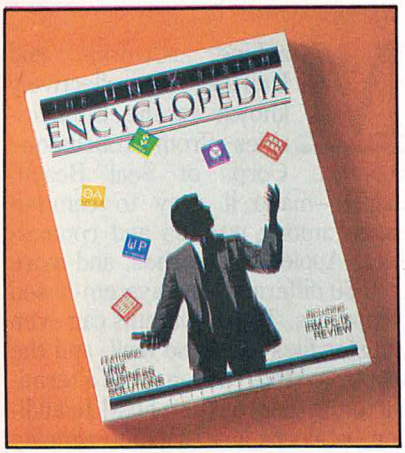

The Unix System Encyclopedia
YATES VENTURES

The UNIX System Encyclopedia is the largest available collection of information about the Unix marketplace. Over 400 pages, with a comprehensive Unix directory. Includes 100 pages of manufacturer specifications, photographs, software reviews, and articles on the Unix system.
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The C Programming Language
Kernighan / Ritchie
PRENTICE-HALL

The C Programming Language is an in-depth guide to programming in C. A true classic, it appeals to all levels of expertise.
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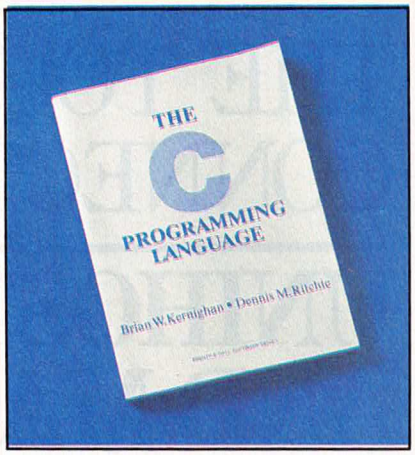

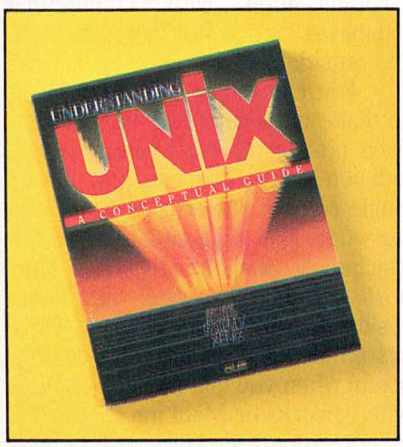

Understanding Unix—
A Conceptual Guide
Groff / Weinberg
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An excellent introduction for managers new to the Unix system, the *Conceptual Guide* introduces you to the reasons for implementing the Unix system.
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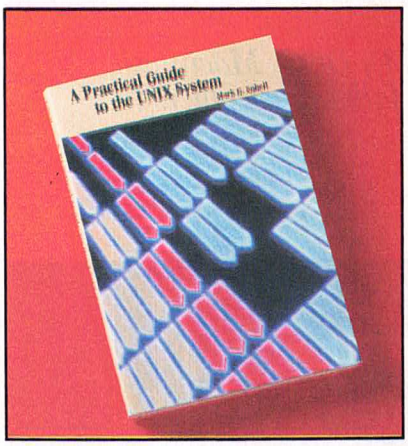
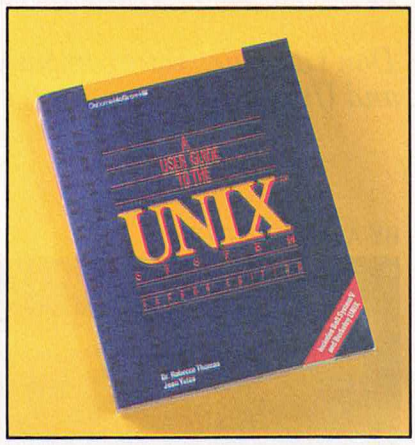


A Practical Guide to the Unix System
Mark Sobell
BENJAMIN CUMMINGS GROUP

A Practical Guide to the Unix System is an excellent reference as well as a detailed learning tool. As an added bonus, the author had included a comprehensive overview of Xenix.
PUBLISHER'S LIST PRICE: $22.95



A User Guide to the Unix System
Second Edition
Dr. Rebecca Thomas / Jean Yates
OSBORNE MCGRAW-HILL

Takes up where *A User Guide to the Unix System* left off. The basics of the Unix System for novices, with hands-on tutorials.
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as well as guides to operations for PCworks and MacLine. All three volumes are well laid out, fairly well proofread, and written in plain English. Those already using personal computers can follow them easily. It would be nice if the manuals had indexes, but their detailed tables of contents help make up for this omission.

The bulk of the volume detailed the language that PCworks and MacLine used to communicate with UniHost, and list memory requirements for UniHost. The user never interacts directly with UniHost, so there is nothing of interest to him or her in the manual.

The PCworks and MacLine manuals have identical structures. My only real objection to them is that Chapters 2 and 8—which concern setup and configuration, respectively—are addressed to technical users. If nontechnical users don't need to read them, why not make the two chapters either a separate appendix or a separate volume rather than putting them in the path of people who aren't interested?

UNIHOST

UniHost consists of a program named `pcwsnet` that is executed on the Unix System as part of a terminal session to handle file transfer and to get certain information from the Unix system, to parts of the microcomputer application using PCworks or MacLine, that need it.

In response to certain menu selections, the micro application logs on to the Unix system host, runs `pcwsnet`, and passes it commands. The UniHost software reference manual describes this command language clearly, although it is primarily of interest only to those who want UniHost to support file transfer as part of their special-purpose application.

In addition to opening, reading, and downloading files, UniHost also performs some functions to support electronic mail.

In addition to opening, reading, and downloading files, UniHost also performs some functions to support electronic mail. In response to a request from the user of the micro, it can read and pass along all header lines on mail messages for this user, allowing each piece of mail to be identified by a subject heading. It can select letters, read them a line at a time, delete them, save them to another mailbox, or forward them to another user. It can also send letters or return a list of everyone on the system who has a mailbox, which allows the electronic mail portion of the micro program to show the user all the possible recipients of a piece of mail. If you want to interact directly with the Unix system, you need only select a terminal emulation option, and then go on as though you were a normal user. In that case UniHost would not be involved at all. Finally, UniHost can start a specified Unix system process, open a pipe to it, and pass the data coming through that pipe down to the program running on a micro using PCworks or MacLine.

Because UniHost only does these things in response to commands from the micro-resident programs, PCworks and MacLine, it doesn't have anything to offer ordinary Unix system users, who will never even see it. It is a good vehicle to support MacLine and PCworks, though, because you can run as many copies of it at once as you want, each one communicating through a different I/O port. (This assumes that `pcwsnet` has been installed in a public command directory such as `/usr/bin` and is thus available to all users.)

PCworks

PCworks, which runs on the IBM PC and compatibles, offers file transfer, remote execution of Unix system commands, terminal emulation, and local execution of MS-DOS commands from its main menu.

To use PCworks, you first install the copy-protected program on another floppy or hard disk and make the necessary configuration entries. Your configuration file determines the content of each menu slot, which can differ for each user.

To configure a given menu slot, you can select it with the arrow keys and then press F3. This puts you into an appropriate configuration

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Corporate: Touchstone Software Corp., 909 Electric Ave., Seal Beach, CA; 213/598-7746.
Management: CEO, Larry Dingus; VP Marketing, Shannon Jenkins; General sales contact, Marilyn Carnes.

TABLE 1: HARDWARE SUPPORTED BY MACLINE

Manufacturer:	Model Number(s):
Apple Computer	Macintosh (128K, 512K)

menu, depending on which submenu you're in. For example, you would get a different configuration form to fill in if you specified a DOS command than you would if you specified a terminal emulator.

You then enter the program by typing `PCworks` when you see the MS-DOS command prompt or by setting up an `AUTOEXEC.BAT` file to load PCworks automatically when you boot the PC. PCworks immediately draws a menu on the screen showing your options. You can use the arrow keys to select an option or type in a keyword or partial keyword. (PCworks decides which option you want as soon as you've typed in enough of the keyword to be unique, and it highlights the selected option as you go.)

PCworks' MAIL/FILE NETWORK OPTIONS

The Mail/File Network options of PCworks allow you to communicate with a Unix system but only through PCworks. That is, you tell PCworks that you want to send mail or transfer files to the Unix system, and PCworks logs on to the Unix system on the other end, waking up UniHost; or it can connect with a Macintosh running MacLine in "Provide Network Services" mode, without going through the Unix System at all. You get menus and "yes/no" questions.

The configuration file for the Mail/File Network manual options specifies what serial port the connection is through (COM1 or COM2), whether the connection is direct or through a modem, what phone number to call to get through (this only works with a Hayes Smartmodem or compatible), the baud rate of the connection, parity, number of stop bits, log-in name and password, home directory on the Unix system, and the name of the spooler program for printing files (usually `lpr`).

TABLE 2: HARDWARE SUPPORTED BY UNIHOST

Altos 586, 986, 8600; all Arete machines; AT&T 3B2, 3B5, 3B20; Callan Unistar; CCI 68000; all CIE machines; Codata 3300; Convergent Technologies MiniFrame; Cromemco 68000; Digital Equipment Corp. PDP-11/44/45/70, VAX-11; Dual 68000; Fortune Systems 32:16; Four Phase 2000; Gould 3267; Heurikon 68K; IBM 3031; Intel 286/310, 86/380; Micro Five 80186; NCR Tower; Onyx C8002; all Parallel machines; all Perkin-Elmer machines; all Pixel machines; Plexus P/25, P/40, P/35, P/60; Pyramid 9000S; Quotron 68000; Sun 2/210; Tektronix 8560; and Zilog System 8000.

Once you have selected the option, PCworks can transparently log on to the Unix system or establish contact with the Macintosh. You can watch the progress of the log-in attempt in the "Network Status" box on the menu. The program then offers you another menu that gives you the options of reading mail, creating mail, downloading or uploading a file (`GET` or `SEND` in PCworks terminology), or printing a file on the Unix host system printer. I wasn't able to test this last function because I had no printers on my test system. I'm not sure that it's supported for the Macintosh.

I may have been spoiled by contemporary word-processing programs, but I expected more from PCworks' mail editor.

You select a keyword in the same way as you do with the main menu. (PCworks is admirably consistent in menu selections and in the meaning of function keys. For example, F1 *always* means exit, and F2 *always* means help.) If you select Read Mail, PCworks displays the Read Mail menu and a summary of letters in the mailbox. You can read, print, delete, forward, or save these, all on the Unix system. You can also change your mind at this point and write a message by pressing F4. The Read Mail features work pretty much as you would expect them to.

Create Mail—which toggles back to Read Mail with F4—is a bit of a disappointment. Although the ancillary functions (save to PC file, print on local printer) appear to be fine, the mail editor itself is idiosyncratic. There is no word wrap; when you reach the end of a line as you type, the cursor stands still and the PC beeps at you, like a typewriter reaching the end of the margin. The editor redraws the entire line every time you backspace, producing a lot of flicker on an IBM color monitor—rather irritating. I may have been spoiled by contemporary word-processing programs, but I expected more from the mail editor. In fact, its interface is worse than the Bell Unix `mail` program—which is rather primitive itself. I tried to avoid using the mail editor by creating a file under WordStar and loading it into the mail editor. (I used WordStar in nondocument mode, to avoid the problem of embedded non-ASCII characters that WordStar uses for printer-control characters and for indicating soft hyphens.) This worked except for one thing. When you create a letter from scratch, the editor asks you for a subject line,

TABLE 3: HARDWARE SUPPORTED BY PCworks

AT&T 6300; Centurion PC; all Columbia machines; Compaq Portable and Desk-Pro; all Corona machines; Eagle PC2, PC Plus, Spirit, Turbo XL; ITT XTRA; Olivetti PC; Otrona 2001; NCR PC Model 4; North Star Dimension; IBM PC, PC/XT, Portable PC; Sperry PC; TeleVideo 1605; Visual Commuter; MAD Computers MAD-1; and other close compatibles.

which later appears on the letter summary. When the letter is in a file loaded from disk, though, you don't get this chance, and the letter is sent without a subject unless you type it manually. This makes it particularly enigmatic on the mail summary screen.

My objections to the editor aside, the mail system works well and seems reasonably intuitive. Of course, I'm a programmer not a non-technical user, so perhaps judging intuition is not my province.

EXECUTING UNIX SYSTEM PROGRAMS

Another submenu lets you execute Unix system programs. When you select an option from this submenu, PCworks logs you on to the Unix system specified in the configuration file and executes the command you have requested. Because the command line is hard-coded in the configuration file, you can't pass any options or arguments when you select it from the menu, except for those pre-specified in the configuration file command. In the file, the command requested may be anything that you can type on one line, such as `ls`, `vi`, or the name of a shell spread. PCworks can automatically invoke a terminal emulation to display the results of the command.

When the execution has finished, you find yourself back in PCworks, with the program asking whether you wish to log off from the Unix system. If you don't say yes, you remain logged on even though you have no way to continue talking to the Unix-based computer.

TERMINAL EMULATION

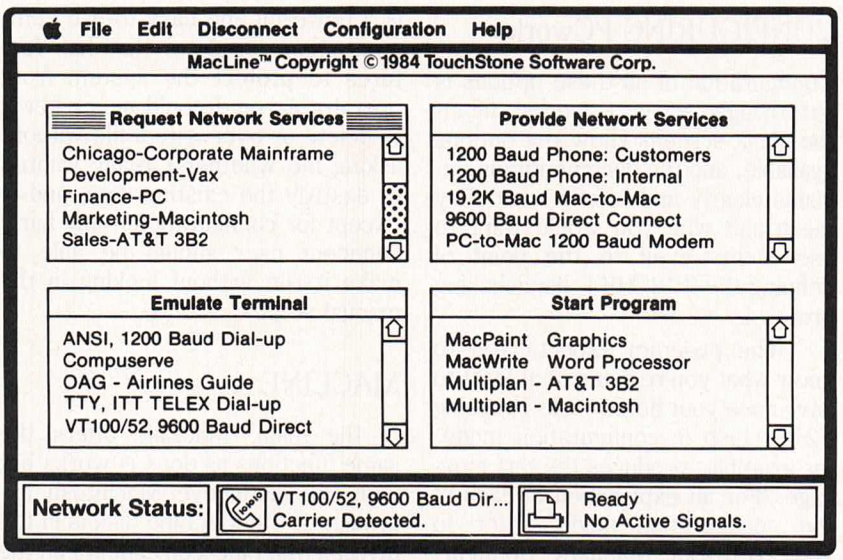
The next submenu offers terminal emulation. The configuration file for this menu's options lets you choose one from among the many types of terminals supported—ANSI standard, TTY, VT-100, or the Fortune terminal from Fortune Systems, etc. These options work locally or remotely, and if you have a Hayes Smartmodem you can auto-dial on-line databases such as CompuServe or The Source. In fact, Touchstone bundles a trial subscription to the Official Airlines Guide on-line database with PCworks and MacLine. Of course, you can use a Unix system as readily as any other kind.

The terminal-emulation software allows you to send data from a DOS file as though you were typing it in and can capture data from the host and save it to a DOS file. It also supports the Print Screen function on the PC.

It is this submenu that makes PCworks of interest even to someone who doesn't want to communicate with a Unix system. PCworks is priced competitively with communications programs intended solely to connect with on-line databases, but it is more flexible and easier to use than many.

EXECUTING MS-DOS COMMANDS

The final submenu allows execution of MS-DOS commands under PCworks. This option suffers the same limitations as the Unix system commands in that you cannot pass command-line arguments. It's really



The machine screen above shows the range of communications options available, ranging from Unix system connections to private and public networks.

annoying that you have to reconfigure each of these commands every time you want to get a directory of drive B instead of drive A. Still, this submenu is a worthwhile feature when, for example, you want to get into an editor to prepare a lengthy message and then return to PCworks without having to reload the program.

This option was the only one that gave me a chance to crash PCworks, although I can't really blame the program. I used the menu selection to activate WordStar. I changed the logged disk drive from A (where PCworks and its configuration file were resident) to B in order to get a directory of files in use there. I then used the R option in WordStar to run another program from it. That program returned nicely *to* WordStar, but when I exited *from* WordStar, the screen went blank and I couldn't even get the PC to come back when I used the reset sequence CTRL-ALT-DELETE. I had to turn it off and start from scratch.

CONFIGURING PCworks

Configuration of all these options is surprisingly easy. PCworks' fill-in-the-blank screens show the options available, and the documentation explains clearly and briefly what they mean and why you would want to use them—even to the point of defining the XON/XOFF handshaking protocol.

The program expects you to know what you're doing or at least to have done your homework. Pressing F2 for help in configuration mode, for example, produces the tart message "For an explanation of each of the configuration fields, refer to your PCworks Manual's Configuration Section."

The menu structure in PCworks has an unfortunate liability, though. You can only configure it to do a maximum of 20 different things, and only five of them in each category. If you need more than five terminal emulators, you can't have them all available at once because you'd have to set them up in a separate configuration file. Because you can't tell PCworks to use a configuration file other than PCworks.CNF, you have to rename the files back and forth, and because PCworks is copy-protected, you can't create multiple copies with different configuration files and slip in the one you want. Having to rename files seems awkward if not dangerous to me.

In the main, MacLine offers many of the same functions as does PCworks but with the distinctive Macintosh approach.

That objection aside, PCworks is a powerful and easy-to-use communications program that has features to protect the system from operator error. I could never get it to delete or overwrite a file without asking me whether I really wanted to destroy the existing data, and—except for configuration—any fairly confident user should be able to make it run without looking in the manual at all.

MACLINE

In the main, MacLine offers the same functions as does PCworks but with the distinctive Macintosh approach. If the MacLine disk is in the drive, a MacLine icon appears on the screen, along with any associated mail or other files that have been saved from previous terminal sessions with the Unix system host.

MacLine displays a menu screen similar to that of PCworks, with several exceptions. The Unix Program and DOS Program submenus have been collapsed into one Start Program menu, and a new submenu Provide Network Services has been added. The COM1 and COM2 network status boxes have been replaced with phone and printer icons.

To select an option, you don't type a keyword. Instead, you place the cursor on top of it using the mouse, click twice to select it, pull down the file menu from the menu bar, select "open," and click twice. If you simply click twice on the desired application, and then click twice more, MacLine does *something*, and then reports a failure.

When executing within the Provide Network Services submenu, MacLine listens on the specified port for a command request and then carries out the request (if valid). Because the Macintosh isn't a true multitasking machine, selecting the Provide Network Services option turns it into a dedicated file server for that one port. This may not be the optimal way to use a Macintosh, especially if it doesn't have a hard disk. If you haven't selected the Provide Network Services option, no one can get at those services on your machine.

The other basic functions of MacLine are essentially the same as PCworks with some nice features added. Instead of displaying the progress of file transfer as a number (percentage complete), MacLine offers a continually updated bar chart, so you can really see progress.

The mail editor has the standard Macintosh editing features, so any users familiar with the Macintosh will have no trouble composing messages.

The configuration function for the Macintosh is positively fun. You use the mouse to punch "radio buttons" for your options and use typical edit functions to handle the text entries.

Because the Macintosh offers "elevator boxes"—screen windows that you can scroll up and down to display much more text than the area of the window shows—the limitation in PCworks on the number of menu selections does not apply. In effect, you can configure MacLine to communicate with an unlimited number of on-line databases.

MacLine does everything that PCworks does, and more. Which program you prefer probably depends on which machine you prefer, as the Macintosh and the PC offer very different ways of doing things.

CONCLUSION

I'd like to see only a few things changed in these products. For one, I'd like the manuals to have indexes, and the technical information should be better segregated from the end-user information. Also, I'd like either a better mail editor in PCworks or some documented way to get a subject header onto letters written using another editor. I also wish there was some way to get around the 20-item limitation in PCworks that didn't involve multiple configuration files.

These matters aside, Touchstone has a solid and reliable family of communications products, each of them easy to use and well suited to its particular environment. At $195 for PCworks, $145 for MacLine, and $295 for UniHost (with quantity discounts available), the Connectables family is a good buy. □

Alan Winston is a freelance writer and full-time programmer/analyst who has been interested in the Unix system for several years. He is a frequent contributor to UNIX/WORLD Magazine.

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C TUTORIAL: COMMAND LINE ARGUMENTS

BY GARY BRONSON

In this issue we are publishing a "C Tutorial" installment contributed by one of our readers, Gary Bronson. In fact, this is Dr. Bronson's second guest contribution, the first having appeared in last month's issue. If you program in C and would like to write about this language, send your inquiries to Dr. Rebecca Thomas, in care of UNIX/WORLD magazine. —Dr. Rebecca Thomas

This month we will look at how data is passed directly into the `main` function of a called C program. So far, all our programs have been invoked by typing the name of the program after the operating system prompt is displayed. Assuming that our Unix system prompt is a `$`, then the complete command line for running an executable program named `showad` is `$ showad`.

If you are using a C compiler on an IBM PC, the equivalent command line would be `A>showad`. As illustrated in Figure 1, this command line causes the program to begin executing, starting with the function `main`.

Now assume that we want to pass the data "three blind mice" directly into `showad`'s `main` function. Recall that data passed into functions are called *arguments*. Like all function argument passing, we will need to take care of both the sending and receiving sides of the transaction. Fortunately, the interface for transmitting arguments into a `main` function has been standardized in C, so both sending and receiving can be done almost mechanically. We'll take things one step at a time to give you a good sense of what is actually happening.

The sending of arguments into a `main` function is trivial. For example, to pass the words "three blind mice" directly into the `main` function of our `showad` program, we need only add the desired words after the program name on the command line: `$ showad three blind mice.`

The words "three blind mice" are three separate string arguments that will be passed into `showad`'s `main` function (assuming that we correctly handle the receiving side of the transaction). Because the arguments are typed on the command line used to call the C program, they are, quite naturally, called "command line arguments."

Upon encountering the command line `showad three blind mice`, the operating system stores it as a sequence of four strings, using 24 bytes (see Figure 2). Notice that each string is terminated with the standard C null character, `\0`.

Thus, the sending part of passing command line arguments into a C program is truly easy. All we have to do is type the arguments on the command line, and the operating system nicely stores them as a sequence of separate strings. We must now handle the receiving side and let `main` know that arguments are being passed to it.

Arguments passed into `main`, like all function arguments, must be declared as part of the function's definition. To standardize argument

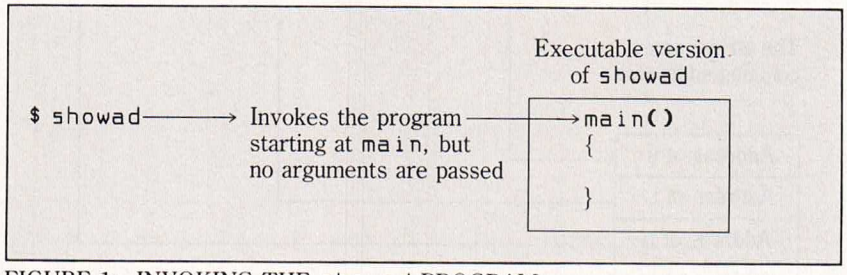

FIGURE 1: INVOKING THE `showad` PROGRAM

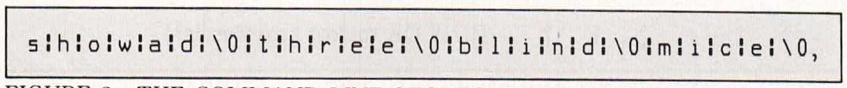

FIGURE 2: THE COMMAND LINE STORED IN MEMORY

passing into a `main` function, only two items are actually passed: a number and an array. The number is an integer variable, which must be named `argc` (short for "argument counter"), and the array is a table (a one-dimensional array), which must be named `argv` (short for "argument values"). See Figure 3.

The integer passed into `main` is the total number of items on the command line. For our previous example, the value of `argc` passed into `main` is four (remember to count the name of the program). The table passed into `main` contains the starting address of each string typed on the command line, as illustrated in Figure 4.

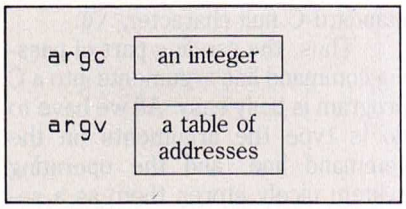

FIGURE 3: AN INTEGER AND A TABLE ARE PASSED TO `main`

We can now write the complete function definition for `main`. Because we will be passing an integer and an array into `main` and because C requires that we name these items `argc` and `argv`, respectively, the first line in `main`'s definition must be `main(argc, argv)`.

To complete `main`'s definition, we have to declare the type of arguments that `argc` and `argv` will be. Because `argc` is an integer, its declaration is `int argc;`.

How about the array named `argv`? Because `argv` is the name of an array whose elements are addresses that point to where the actual command line arguments are stored, its proper declaration is `char *argv[];`.

Spend a minute on this one. Recall from our previous article on pointers (in last month's issue) that a pointer is nothing more than a variable that contains an address. But `argv` is an array of addresses, with each address pointing to a character (as illustrated in Figure 4). The declaration `char *argv[]` accurately describes this array and is read "`argv` is an array whose elements are pointers to characters."

Thus, with all this put together, the full function header for `main`, if it is to receive command line arguments, is as shown in Figure 5.

Notice the beauty of this method of passing arguments into a `main` function. No matter how many arguments are typed on the command line, `main` only needs two standard pieces of information: the number of items on the command line and a table that gives the starting address of where each argument is actually stored.

The `showad` program (see Figure 6A) verifies our description by printing the data actually passed into `main` using `argc` and `argv`. The output of `showad`, for the command line `$ showad three blind mice`, is illustrated in Figure 6B. Notice that we have used pointer notation

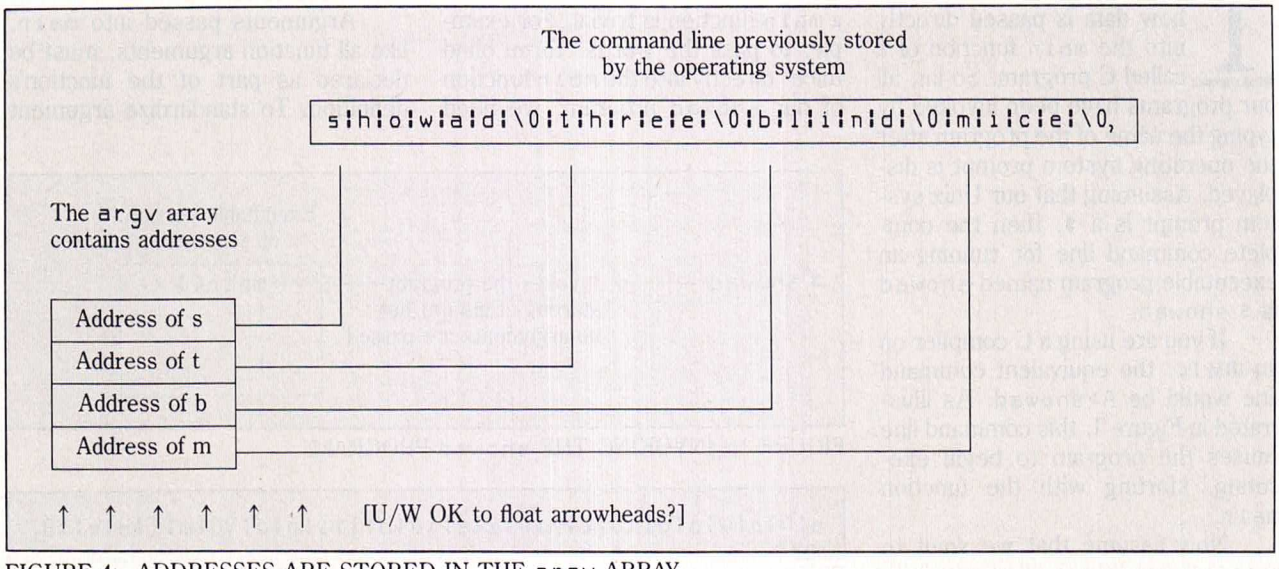

FIGURE 4: ADDRESSES ARE STORED IN THE `argv` ARRAY

```
main(argc, argv)  /* standard main function */

int argc;         /* header for receiving */
char *argv[];     /* command line for arguments */
```

FIGURE 5: FULL-FUNCTION HEADER FOR `main` TO RECEIVE COMMAND LINE ARGUMENTS

```
main(argc, argv)

  int argc;       /*no. of items on the command line */
  char *argv[];   /* an array of addresses */

  {
    int i;

    printf ("\nThe number of items on the command line is %d\n\n",argc);

    for ( i = 0; i < argc; i++)
      {
        printf ("The address stored in argv[%d] is %u\n", i, argv[i]);
        printf ("The character pointed to is %c\n\n", *argv[i]);
      }
  }
```

FIGURE 6A: THE `showad` PROGRAM

```
The number of items on the command line is 4

The address stored in argv[0] is 786435
The character pointed to is s

The address stored in argv[1] is 786442
The character pointed to is t

The address stored in argv[2] is 786448
The character pointed to is b

The address stored in argv[3] is 786454
The character pointed to is m
```

FIGURE 6B: THE OUTPUT OF THE `showad` PROGRAM

in `showad`. Recall from our previous article on pointers (in the June 1985 issue) that `*argv[i]` means "the variable whose address is stored in `argv[i]`." This is usually shortened to "the thing pointed to by `argv[i]`."

Figure 7 illustrates the actual storage of the command line in memory, as reported by the `showad` program. As we anticipated, the addresses stored in the `argv` array "point to" the starting character of each string typed on the command line.

Once command line arguments are passed into a C program, they can be used like any other C strings. For example, the `repeat` program (see Figure 8A) simply repeats its command line arguments. The output of `repeat` for the command line `repeat three blind mice` is illustrated in Figure 8B.

But wait a minute! When we print out `argv[1]`, `argv[2]`, and `argv[3]` in `repeat` (see Figure 8B), we get the words `three`, `blind`, and `mice`. Printing out these same three variables in `showad` (see Figures 6A and 6B) resulted in three addresses being printed. What is really in the `argv` array? Addresses, as we have claimed, or strings, as seems to be indicated by the `repeat` program?

Take a deep breath and relax. The `argv` array truly does contain addresses. The apparent contradiction of outputs is explained by the `printf` function. When the `%s` conversion character is used in `printff()`, as it is in the `repeat` program, it alerts the function that a

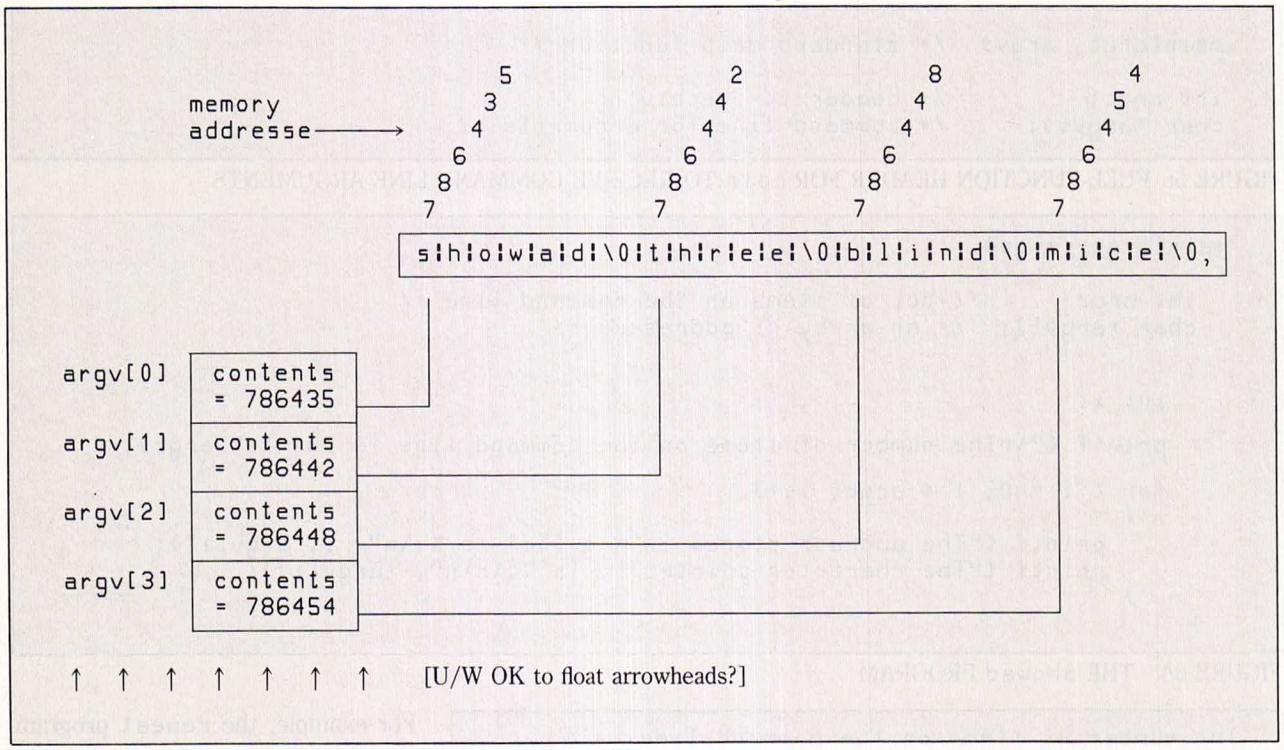

FIGURE 7: THE COMMAND LINE STORED IN MEMORY

```
/* A program that repeats command line arguments */

main(argc, argv)

  int argc;       /* standard argument declaration */
  char *argv[];   /* for passing command line arguments */

  {
    int counter;

    printf ("\nThe following arguments were passed into main: ");
    for (counter = 1; counter < argc; counter++)
      printf ("%s ", argv[counter]);
  }
```

FIGURE 8A: THE repeat PROGRAM

```
The following arguments were passed into main:  three blind mice
```

FIGURE 8B: THE OUTPUT OF THE repeat PROGRAM

```
main(argc, argv)

  int argc;
  char *argv[];

  {

  int i;

  for ( i = 1, i < argc; i++)
  {

  if (*argv[i] == 'a' )
  printf ( "Located the a flag\n");
  else if ( *argv[i] == 'p' )
  printf ( "Located the p flag\n");
  else
  printf ( "Not a valid flag\n");

  }
  }
```

FIGURE 9: A SAMPLE FLAG-SCREENING PROGRAM

```
/* A program to capture input flags */

#include <stdio.h>

main(argc, argv)

  int argc;       /*no. of arguments passed into main */
  char *argv[];   /* an array of addresses */

  {

  int c; printf ("\nThe following is a call to getopt()\n");
  while ((c = getopt(argc,argv,"ap")) != EOF)

  {

  if ( c == 'a' )
  printf ("Successfully located the a flag\n");
  else
  if ( c == 'p' )
  printf ("Successfully located the p flag\n");
  else
  printf ("An illegal flag has been located\n");
  }
  }
```

FIGURE 10: THE `getflg` PROGRAM

string will be accessed. The `printf` function then expects a pointer to the first character in the string; that is, `printf()` requires the address of the first character in the string to be printed, which is exactly what the entries in `argv` provide.

As we have seen, any data typed on the command line is considered to be a string. If you want numerical data passed into a C program, it is up to you to convert the string into its numerical counterpart once it is passed into your program. This typically is not an issue, however, because most command line arguments are used as flags that pass appropriate processing control signals into the invoked program.

For example, a command line might be `$ repeat a p`, where `a` and `p` have specific meaning to the called C program. As such, the flags must be screened and recognized directly within the program receiving them. The `screen` program (see Figure 9) provides sample screening and processing statements. In place of the `printf` statements used in `screen`, appropriate function calls for specific processing, based on the received flag, could be placed.

Rather than write your own screening function, however, the standard Unix System V C library contains the function `getopt()`, which searches for a user-defined set of flags.

In keeping with standard Unix flag notation, the `getopt()` function requires that each flag be preceded by a dash `(-)` on the command line. The call to this function is `getop(argc, argv, "acceptable flags")`, where "acceptable flags" is a list of flags you want your program to recognize. The program `getflg` illustrates the use of `getopt()`, assuming that we only want to recognize and act on the two flags `a` and `p`.

The call to `getopt()`, using `getopt(argc,argv,"ap")`, causes the function to parse the command line and return the next option letter found. If the function encounters an option letter not included in the user-defined list (`a` and `p` in this case), it displays the message `illegal option--`, followed by the offending flag on the screen. □

Dr. Gary Bronson is a professor in the Department of Computer and Decision Systems at Fairleigh Dickinson University, Madison, N.J. He also conducts corporate seminars and workshops in C, Lotus 1-2-3, and dBase III.

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NEW PRODUCTS

SOFTEST SOFTWARE FOR AT&T COMPUTERS

SofTest has announced the immediate availability of its software products SofGram Electronic Mail, LEX Word Processing, and SofType Typesetting System for AT&T 3B2 and 3B5 computers. SofTest's products are also available on a wide range of Unix system- and MS-DOS-based computers.

SofGram Electronic Mail allows users to send and receive messages worldwide through the Telex and TWX networks or locally within their own computer system. LEX includes a four-function calculator, 100,000-word spelling dictionary and a mass mailing/database system. It works with most terminals and printers. SofType automatically transforms normal word-processing files into typeset output. Price ranges for the products are $1000-$3000 for SofGram, $1000-$2500 for LEX, and $2000-$5000 for SofType. For more information, contact SofTest Inc., 555 Goffle Rd., Ridgewood, NJ 07450; 201/447-3901.

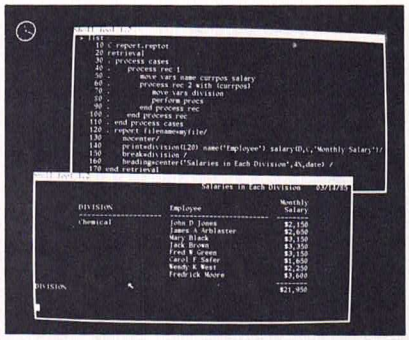
Please circle Reader Service Number 161.

SIR/DBMS FOR SUN WORKSTATIONS

SIR/DBMS developed by SIR Inc. has been converted to run on Sun Microsystem's technical workstations. The system includes a procedural programming language as well as a non procedural relational query language called SQL+, which is SIR's implementation of IBM's Structured Query Language. SIR/DBMS also offers a procedural language for complex retrievals and manipulations and for application development.

In addition to its own statistical capabilities, the Sun version of SIR/DBMS can generate SAS files that can be transferred directly from the Sun workstation to the hardware running the SAS software.

Other integrated components of SIR/DBMS include Forms, a screen-oriented data-entry and retrieval



With Sun's mouse and window management facilities, multiple processes can be performed and viewed concurrently.

system; Host, a language interface; Help, an on-line user assistance facility; and Graph, an interactive system for high-resolution business and statistical graphics.

For more information, contact SIR Inc., 5215 Old Orchard Rd., Skokie, IL 60077; 312/470-9770.

Please circle Reader Service Number 162.

SOFTWARE PROVIDES SOURCE DATA ENTRY

DataSystems Software Corp. has announced Release 2.0 of its EntryManager series. Formerly known as DataManager, the software package provides microcomputers with data entry and distributed data-processing capabilities, such as input validation at character, field, and form levels. Either the Unix system or PC/MS-DOS can utilize the software in either stand-alone or network environments.

The package consists of four modules that execute identical applications under both PC/MS-DOS and the Unix system on different hardware systems. User interfaces remain constant regardless of the system being used. The Designer module allows custom application development with screen layouts that can be source document images; up to 256 screen formats with up to 256 fields each can be designed. The Collector module uses these custom designs for the entry and storage of large amounts of data, checking and validating the data at time of entry at the source.

The Changer module is a file and data reformatter that allows information to be used freely within the system without constraint as to format requirements at the central processor. The Helper module provides a menu user-interface that allows integration of various personal productivity programs with the source data-entry applications. Data-entry, word processing, modeling spreadsheets, local database manipulation, and file management can all be combined into one interactive system, with accessibility controlled by a single keystroke.

EntryManager single-user licenses are $695 for the complete development package and $450 for the run-time version. Versions for local area network (LAN) and multi-user (Unix system) installations are available with pricing schedules for volume discounts and site licensing.

For more information, contact DataSystems Software Corp., 7301 Topanga Canyon Blvd., Canoga Park, CA 91303; 818/887-3300.

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TOM SOFTWARE ON UNIX PC

Tom Software's library of accounting and vertical-market business systems has been ported to the AT&T Unix PC. Available as stand-alone modules in addition to fully integrated packages, the software will

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For more information, contact Tom Software, P.O. Box 66596, 127 S.W. 156th St., Seattle, WA 98166; 206/246-7022.

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RELATIONAL DATABASE SYSTEMS' INFORMIX-SQL

Relational Database Systems has announced Informix-SQL, a relational database management system for microcomputers based on the IBM's Structured Query Language (SQL).

Informix-SQL lets users create and maintain databases, design custom screens and menus, perform

RDS's Informix—a relational database management system.

calculations and aggregate operations, and produce custom-formatted reports. It can be used on both the Unix system and MS-DOS operating systems. Informix-SQL incorporates advanced retrieval techniques, plus it allows an unlimited number of columns, tables, and indexes to be used within a single database.

For more information, contact Relational Database Systems News Bureau at Madison Field Corp., 15250 Ventura Blvd., Sherman Oaks, CA 91403-3201; 213/872-2777.

Please circle Reader Service Number 165.

ASHTON-TATE'S dBASE III SUPPORTS AT&T'S UNIX PC

Ashton-Tate has announced the availability of its database management program dBase III for AT&T's Unix PC. In addition, dBase III is also available for a wide range of MS-DOS-based microcomputers, including the AT&T PC 6300 system.

dBase III allows users to develop customized application programs that put the database files to work. Important features of dBase III include storage capability of two billion records per file (limited by the user's computer system) and 128 fields per database. The program's on-line Assistant supplement is available to help acquaint new users with database functionality.

For more information, contact Ashton-Tate, 10150 West Jefferson Blvd., Culver City, CA 90230; 213/204-5570.

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UPDATED FORTUNE SYSTEMS SOFTWARE AVAILABLE

Several new software packages developed by Fortune System's independent software vendors (ISVs) are now available through the company.

The new 5 Star packages include the following: APPGEN from Software Express; Autograph from Ficor; BAS from Science Management Corp.; C-ISAM, File-it, and Informix, from Relational Database Systems; C/Tools and C/Books from Conetic Systems; Construction Management from PAC; Handshake from C.O.L.T., SST; Integrated Accounting from Trac Line; Laser Printer Extended Interface from Coast Business Systems; Manufacturer's Representative from Ficor; MDX from Clinical Data Design; Philon Fast Compilers from Philon; The Resident from Wallaby; Status/Multitrieve from CP International; Unilaw from Guardian Automated Systems; and /usr/tools from etp systems.

You can obtain a copy of Fortune's All Star Software Catalog by calling the company.

For more information, contact Fortune Systems Corp., 101 Twin Dolphin Dr., Redwood City, CA 94065; 415/595-8444.

Please circle Reader Service Number 167.

NEW MICROSOFT SYSTEMS, APPLICATION SOFTWARE

AT&T has selected Microsoft's systems and application software for use on the AT&T's new Unix PC and existing PC 6300. Microsoft Word, Microsoft Multiplan, and Microsoft BASIC will be available for the Unix PC, and the Microsoft Networks local-area network system and the Microsoft MS-DOS operating system (Version 3.1) will be available for the PC 6300 as part of the AT&T Starlan Network.

The Microsoft BASIC Interpreter implementation follows the Microsoft BASIC standard; applications written in Microsoft BASIC for other systems will run easily on the Unix PC.

In addition, the Microsoft Xenix operating system (Version III) is now available for the PC 6300 as a distributed product from AT&T. The current release of Xenix (Version

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III) is being modified to be Unix System V compatible and will comply to the AT&T System V interface document in the next release.

For more information, contact Microsoft Corp., 10700 Northup Way, P.O. Box 97200, Bellevue, WA 98009; 206/828-8080.

Please circle Reader Service Number 168.

DATAFLEX DBMS FOR MULTIUSER XENIX

At Comdex, Spring Data Access Corp. demonstrated a new version of the DataFlex Application Development Database for the Xenix operating system.

DataFlex is an application development and relational database management system for single and multiuser microcomputers. It runs on most microcomputer operating systems and local-area networks and has now been converted from its original Pascal implementation to C to be compatible with Xenix and other Unix-based operating systems.

DataFlex can support up to 250 data files, permitting over 16 million records per file. The product includes a complete command language for program development, application generators for data-entry screens and reports, a compiler, and a multifile interactive query that allows users to create reports, labels, and data files from database information.

For more information, contact Data Access Corp., 8525 S.W. 129th Terrace, Miami, FL 33156; 305/238-0012.

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LAWSON SHOWS MICROMERGE

Lawson Associates has announced the newest addition to its Mega Tools family of productivity tools.

MicroMerge acts as a data dictionary, allowing microcomputer users to define and select data from the Burroughs mainframe, Lawson General Accounting Software III (GAS III) packages, or any other DMSII-based system users can then download the data to a Burroughs or IBM microcomputer spreadsheet program, such as Lotus 1-2-3, Multiplan, or WordStar.

For use in conjunction with MicroMerge are two Intercomputer Communication Corporation (ICC) products: Intercom 102, which transforms a PC into a Burroughs terminal, establishing a communications link with the Burroughs mainframe; and the Intercom 300/300B, which provides direct file transfer for the data selected by MicroMerge.

For more information, contact Lawson Associates Inc., 2021 E. Hennepin Ave., Hennepin Square Bldg., Minneapolis, MN 55413; 800/672-0200 or 612/379-2633.

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AT&T CHOOSES GSS DEVICE DRIVERS

AT&T has announced it will supply device drivers that support the Graphic Software Systems (GSS) Virtual Device Interface (VDI) for the AT&T PC 6300-compatible Truevision microcomputer graphics boards. AT&T will also supply GSS software with every Unix PC 7300 microcomputer.

The AT&T Truevision Image Capture Board (ICB) and Truevision Video Display Adapter(VDA), introduced in October 1984, allow the AT&T PC 6300 and compatibles to capture, digitize, store, display, and manipulate television-quality pictures.

Because GSS VDI enables users to develop applications independently of any particular hardware, programmers can provide applications to run on any MS-DOS, PC-DOS, or Unix system-based hardware that supports VDI.

GSS VDI controller software is an implementation of the proposed American National Standards Institute (ANSI) VDI standard.

For more information, contact Graphic Software Systems Inc., 25117 S.W. Parkway, Wilsonville, OR 97070; 503/682-1606.

Please circle Reader Service Number 171.

RM/COBOL AVAILABLE ON NEW UNIX PC

Ryan-McFarland Corp. has announced that the latest version of its RM/COBOL compiler is now being marketed by AT&T for its new Unix PC, running under Release 2.0 of Unix System V. The Unix PC implementation of RM/COBOL and its documentation are being manufactured by AT&T and carry the AT&T logo.

List price for the Unix PC implementation is $595 for full development systems and $195 for runtime systems.

For more information, contact Ryan-McFarland Corp., 609 Deep Valley Dr., Rolling Hills Estates, CA 90274; 213/541-4828.

Please circle Reader Service Number 172.

APOLLO DEBUTS DUAL UNIX SYSTEM PORT

Apollo Computer has announced the availability of both 4.2BSD and System V Unix on its professional 32-bit workstation. Domain/IX software lets the two Unix system standards operate as co-resident operating systems on Apollo's Domain workstations, so users can run either version of the operating system or both simultaneously on the same node.

Domain/IX software supports C, FORTRAN-77, ISO Pascal, and LISP programming languages, in addition to a multiwindow debugger. The four compilers share a common code generator, allowing programmers to write different portions of large programs in the most appropriate language and then combine them into one application.

Domain system users are also offered an Ethernet gateway, and TCP/IP provides access to the DEC VAX supermini, as well as other computer systems. The Domain system also supports the X.25 protocol, and communication with IBM host systems is supported by gateway software that emulates several RJE (remote job entry) subsystems, including IBM's Hasp and the standard 2780 and 3780 environments. In addition, all Domain workstations have RS-232C ports and provide VT100 terminal emulation.

Domain/IX software runs on all computational and server nodes in the Apollo family. The price of both 4.2BSD and System V Unix is $425 per node and $9100 per site (up to 100 nodes). The price of 4.2BSD or System V Unix purchased separately is $300 per node and $6500 per site.

For more information, contact 330 Apollo Computer Inc., Billerica Rd., Chelmsford, MA 01824; 617/256-6600.

Please circle Reader Service Number 173.

PERFORMANCE UNVEILED

Heurikon Corp. has announced the expansion of its line of HK68 single-board computer systems with the HK68/M10, a series of new high-performance boards. The HK68/M10, which has no-wait-state operation and a 10-MHz clock rate, can

run up to 44 percent faster than existing boards in the line. Further, disk transfer rates are doubled over current models through the use of 68450 DMAC supporting single-cycle mode data transfers via an on-board SCSI port. SCSI is an ANSI standard x3T9.2 interface for up to eight independent high-speed multimaster devices, such as disks or tape drives.

The HK68/M10 is available with either a 68000 or 68010 CPU and supporting clock speeds of 8, 10, or 12.5 MHz. Another new feature of the HK68/M10 family is the iLBX memory interface for high-speed memory expansion up to 8 Mbytes, reducing demand on the Multibus. Other features standard to the HK68 line include up to 128K-bytes of EPROM, up to 1-Mbyte of on-card DRAM (dynamic random-access memory), four serial ports (19.2K baud), and complete IEEE 796 master/slave capability.

The HK68/M10 supports CP/M-68K, VRTX, and the complete Unix System V. Unix system drivers are available for Ethernet, 9-track tape, floating-point processors, and video imaging.

For more information, contact Heurikon Corp., 3201 Latham Dr., Madison, WI 53713; 608/271-8700.

Please circle Reader Service Number 182.

APOLLO INCREASES WORKSTATION STORAGE CAPACITY

Apollo Computer has announced an 86-Mbyte Winchester disk drive for its DN550 color workstation. The new drive provides an increase of more than 60 percent in formatted data storage capacity over the currently available 50-Mbyte unit.

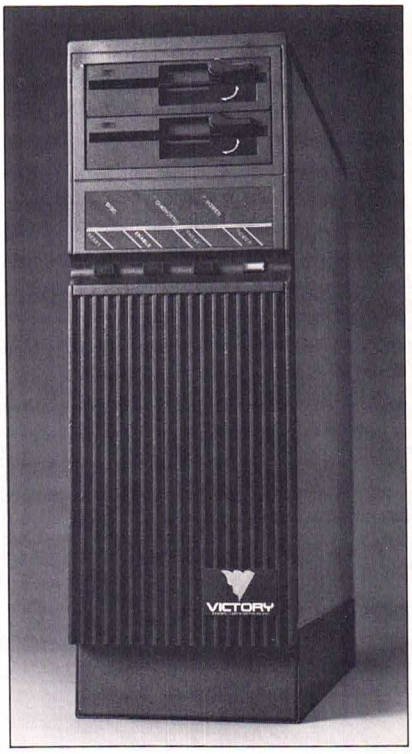
Two versions of the new drive are available. Model MSD-86M includes an 86-Mbyte 5 1/4-inch Winchester disk and controller and is priced at $9500. Model MSD-86M-TC includes the disk, controller, and a 45-Mbyte 1/4-inch cartridge tape unit and is priced at $11,600.

For more information, contact Apollo Computer Inc., 330 Billerica Rd., Chelmsford, MA 01824; 617/256-6600.

Please circle Reader Service Number 183.

NEW VME MC68000 UNIX SYSTEM V SUPERMICROCOMPUTER

Victory Computer Systems has announced the MicroFactor II, a VMEbus-based, multiuser, Unix System V supermicrocomputer.



Victory Computer Systems' multiuser MicroFactor II, Unix System V supermicrocomputer.

The MicroFactor II supports a complete line of co-processors, programming languages, application packages, and operating systems. It features a MC68000 CPU, 2-Mbytes of RAM, 190-Mbytes of disk storage, and Ethernet compatibility with TCP/IP. Each MicroFactor II is shipped with UniPlus+ System V from UniSoft.

The MicroFactor II multiuser system sells for less than $7500.

For more information, contact Victory Computer Systems Inc., 1610 Berryessa Rd., San Jose, CA 95133; 408/259-7370.

Please circle Reader Service Number 184.

NEW HP LOCAL-AREA NETWORK FOR HP 9000 SERIES 500 COMPUTERS

Hewlett-Packard's new local-area network (LAN) uses standard protocols to link HP 9000 Series 500 computers one another and to HP 3000 computers.

HP 9000 LAN replaces the previous HP 2285A LAN and consists of Network Services/9000 Series 500 software (HP 5093/4) and the LAN/500 Link interface card (HP 27125A).

Network Services/9000 Series 500 (NS/9000) software provides communication between Series 500 HP-UX computer systems and HP 3000 computer systems using file-transfer capability over IEEE 802.3 LANs. HP-UX is derived from a Unix operating system. It offers several networking services between Series 500 systems, supporting network file transfer, remote program management, interprocess communication, and remote-file access.

HP is offering a trade-in program to make it easier for existing customers to upgrade to the new LAN system. From May 1 to November 1, 1985, U.S. customers can return HP 2285A LAN units and receive a $700 credit toward the purchase of the LAN/500 Link interface card. For

a single-user HP-UX system, the HP 50953 NS/9000 software is $1700 for the first computer on the network and $850 for each additional computer.

For a multiuser HP-UX system, the HP 50954 NS/9000 software is $4000 for the first computer and $2000 for each additional computer. The HP 27125A LAN/500 Link is $2200.

For more information, contact your local HP sales office listed in the white pages of the telephone directory.

Please circle Reader Service Number 185.

APPGEN SYSTEM AVAILABLE TO PERKIN-ELMER COMPUTER USERS

APPGEN, an application generator designed by Software Express, is now available to users of Perkin-Elmer Series 3200 superminis running under Xelos, a derivative of AT&T Bell Labs' Unix System V, Release 2, operating system. Also, APPGEN will be ported soon to the Perkin-Elmer Model 7350A supermicrocomputer.

APPGEN utilizes a complete English-language interface and offers an optional set of APPGEN-developed financial applications. Users can build applications by utilizing the system's fill-in-the-blanks screen formats to provide transaction-driven, integrated commercial applications that can include a large number of files, screens, menus, and reports.

The APPGEN Financial Series contains integrated comprehensive packages including general ledger, accounts receivable, accounts payable, payroll, and inventory/order entry. Additional packages, such as accountant's client write-up, fixed assets, job cost, and professional

time reporting, are also available. These applications work together or separately to provide the correct combination for user-specific needs.

For more information, contact Perkin-Elmer Corp., 2 Crescent Place, Oceanport, NJ 07757; 201/530-5900.

Please circle Reader Service Number 186.

SEQUENT GETS ANSI STANDARD GRAPHICS

Sequent Computer Systems has announced a licensing agreement with Graphic Software Systems (GSS). That will make GSS graphics tools based on ANSI specifications available to Sequent customers on the firm's Balance 8000 multiprocessor computer. The software tools give Balance 8000 users a standardized way in which to incorporate graphics into computer-aided engineering and other graphics-oriented applications running under the Unix operating system. Availability of Balance 8000 graphics based on the GSS tools is targeted for the fourth quarter of 1985.

For more information, contact Sequent Computer Systems Inc., 14360 N.W. Science Park Dr., Portland, OR 97229; 800/854-0428 or 503/626-5700.

Please circle Reader Service Number 187.

FULL-SCREEN PROCESSOR FOR UNIX/XENIX

Information Concepts has announced the release of FSP, a full-screen processor for Unix/Xenix-based systems. FSP is a productivity tool that permits software developers to incorporate full-screen form

and menu displays and editing features into their applications.

A distribution licensing agreement for FSP is available for computer manufacturers and distributors that want to incorporate FSP into their standard operating system package. In addition, development and run-time licensing agreements are available for software developers.

A single-copy license for FSP costs $950 or $250 per year on a leasing basis.

For more information, contact Information Concepts Inc., 9th Floor, 1331 H St. NW, Washington, D.C. 20005; 202/628-4400.

Please circle Reader Service Number 188.

TELEXPRESS UNIX/XENIX SOFTWARE

The Teleterm communications package is now available for Tandy Model 16/6000 Xenix-based systems. The package supports a wide variety of modem types and also allows users to define their own.

Teleterm X is compatible with other systems currently running Teleterm EM and operates in many network environments. It also works with most protocol convertors to facilitate synchronous communications.

The new package retains Telexpress' disk-to-disk file transfer capabilities, which can be performed among all other models and brands equipped with Teleterm EM. The product also supports XMODEM (or Modem7) protocol. Typical uses include transfer of reports, remote text transmittal to publishers, or transmission of data or object files between other Teleterm-equipped systems, including those based on MS-DOS, TRS-DOS, or Unix/Xenix operating systems. Teleterm X also permits file upload/download with any asynchronous system and supports auto dial and auto log-on. Teleterm X's price is $395.00.

For more information, contact Telexpress Inc., P.O. Box 217, Willingboro, NJ 08046; 609/877-4900.

Please circle Reader Service Number 189.

NEW XEROX PRINTERS

Xerox has announced a letter-quality, dot-matrix printer and a new extended-character daisywheel printer.

The Companion 34LQ printer is a 132-column, dot-matrix printer that produces letter-quality printing at speeds up to 60 characters per second. In the draft-quality mode, the 34LQ can operate at speeds up to 270 characters per second. The printer has a dual serial and parallel interface, which operates in both a Diablo 630 mode with extended-character-set .capability and an IBM-compatible mode. It uses fanfold and single-sheet paper and is equipped with a single-sheet auto loader as standard equipment; an optional dual-bin automatic sheet feeder is also available.

The Diablo 630 ECS is a daisywheel printer that is compatible with

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most personal computers. It offers extended-character-set capability and combines the features of two current models: the 630 ECS API (all-purpose interface) and the IBM-compatible 630 ECS. The extended-character set permits users to print up to 400 characters.

The Companion 34LQ printer is priced at $1595, and the Diablo 630 ECS sells for $2295.

For more information, contact Xerox Corp., Xerox Square 006, Rochester, NY 14644; 716/423-5078.

Please circle Reader Service Number 190.

SCO XENIX 3.0 FOR PC 6300

AT&T Information Systems has announced plans to promote and distribute The Santa Cruz Operation's current 3.0 version of the Xenix operating system for use with the AT&T PC 6300.

AT&T has also announced upgrade plans for the PC 6300, including 512K-bytes of memory, a built-in 20-Mbyte hard disk, and an 8087 math co-processor, all of which allow AT&T's microcomputer to take advantage of the Xenix operating system.

For more information, contact The Santa Cruz Operation, 500 Chestnut St., P.O. Box 1900, Santa Cruz, CA 95061; 408/425-7222.

Please circle Reader Service Number 191.

APPGEN SOFTWARE DIRECTORY BOWS

Software Express has announced the release of its Software Directory, a library of Unix system software. Every vertical-market package listed in the software directory runs on 50 machines, ranging from supermicros, such as the IBM PC/AT, to mainframes, such as those from Amdahl.

All the packages in the library were developed using APPGEN, a Unix-based application generator. APPGEN eliminates the developer's need to write or generate code; instead, the user creates and customizes an application through a series of English-language prompts. The developer's responses build parameters that drive the standardized functions in the APPGEN run-time module, thus creating a specific application.

The Software Directory is available directly from Software Express for $10.

For more information, contact Software Express, 2925 Briarpark Dr., 7th Floor, Houston, TX 77042; 800/231-0062 or 713/974-2298.

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EMERGING TECHNOLOGY SIGNS AT&T, TANDY, DRI

Emerging Technology, developer of office-automation software products for business and personal microcomputers, has announced major

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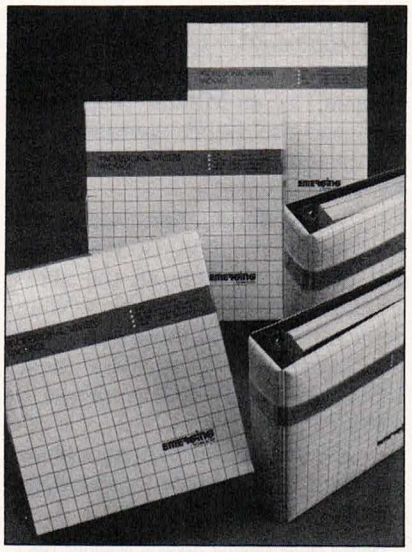
OEM contracts with AT&T, Tandy, and Digital Research.

AT&T will distribute a Unix system version of Emerging Technology's Edix + Wordix word-processing software for use with the AT&T 3B computer line. In the second quarter of this year, AT&T will offer Emerging Technology's complete Professional Writer's Package, which includes two additional software programs: Indix, an index generator; and Spellix, a spelling checker. AT&T will also offer Emerging Technology's Offix software, a personal office-management system.



The Professional Writer's Package word processing software from Emerging Technology

Edix + Wordix for 3B computers is now available through the AT&T Information Systems sales force. The software is $680 for the 3B2 and $1360 for the 3B5.

In the second OEM agreement, Tandy Corp. will produce and distribute Emerging Technology's Offix software under the Tandy brand name. It will be available in Radio Shack Computer Centers in early May for $99.95. Internationally, Tandy will distribute the German, Dutch, French, and Spanish versions of the software through Radio Shack. Offix can be run on either the Tandy 1000, 1200, or 2000 personal computers.

Emerging Technology's OEM contract with Digital Research Corp. allows Digital to incorporate Emerging Technology's text editor Edix into their Concurrent PC-DOS operating system. The trade name for the new product is DR Edix; it replaces Digital's command-line editor.

For more information, contact Emerging Technology Consultants, 1877 Broadway, Boulder, CO 80302; 303/447-9495.

Please circle Reader Service Number 193.

ON-LINE CONSULTING SERVICE FOR UNIX SYSTEM

Information Technology Development Corp. (ITDC) has introduced an on-line Unix system consulting service, which includes an electronic bulletin board, technical documentation, and a "help" disk.

ITDC's other services include Unix system and C contract software development and consulting, Unix system administration, Unix system-based packaged software, and Zilog hardware. In addition, ITDC's information center consulting service offers assistance with business systems planning, information center planning, information center development, and networking.

For more information, contact Information Technology Development Corp., 9952 Pebbleknoll Dr., Cincinnati, OH 45247; 513/741-2098.

Please circle Reader Service Number 194.

NEW DATA GENERAL DESKTOP COMPUTER

Data General Corp. has announced a new dual-microprocessor computer system, the Desktop Generation Model 45. The system runs Desktop/UX a native Unix operating system based on AT&T's System V. The company has also announced a series of OEM-based enhancements for other models of the Desktop Generation line.

The Model 45 is a multiuser system based on the Motorola 68000 microprocessor and Data General's microEclipse processor. This dual architecture allows the microEclipse to offload time-consuming input/output operations from the Motorola 68000, which is dedicated to running Unix system applications. The microEclipse processor also supports a complete range of Desktop Generation peripherals, including printers, storage devices, and terminals.

A basic Model 45 configuration includes 512K-bytes of memory, a 15-Mbyte disk, and one floppy disk drive. It supports up to eight users and can be configured with up to 4-Mbytes of memory and 142-Mbytes of disk storage. The Model 45 also supports most of the peripherals currently available on other products of the Desktop Generation line, including a cartridge tape drive.

Desktop/UX and the Desktop Generation Model 45 will be available 90 days after receipt of order. The Model 45 costs $11,845; Desktop/UX license is $1800 and a TCP/IP license for the Model 45 is $750. For more information, contact Data General Corp., 4400 Computer Dr., Westboro, MA 01580; 617/366-8911.

Please circle Reader Service Number 195.

GVC INTRODUCES NS32016-BASED UNIX SYSTEM

GVC has announced a multiuser Unix system that uses National's series 32000 microprocessors. Based on the company's GVC-16 Multibus board, the system includes 1-Mbyte of RAM, a 45-Mbyte Winchester disk, and the Genix operating system (National's port of the Berkeley 4.1 Unix system).

Two different versions of the system are available. Both the GS1 and the GS2 include all the above features, but the GS2 adds a Multibus card cage with three open slots for expansion. The GS1 costs $8900, and the GS2 is priced at $9900.

For more information, contact GVC Inc., 222 Third St., Cambridge, MA 02142; 617/576-1804.

Please circle Reader Service Number 196.

MT. XINU CONNECTS UNIX SYSTEMS TO APPLE NETWORK, LASERWRITER

Users and developers of Unix-based systems can now communicate with Apple's Macintosh-based AppleTalk network using Xinet technology available from Mt. Xinu.

Using Xinet, AppleTalk network servers, such as the LaserWriter laser printer, are accessible

to any user on a connected Unix system. In addition, the Unix system acts as a server on the AppleTalk network; individual Macintosh workstations can take advantage of the Unix system's mass storage, communications, and other facilities. Xinet protocols can co-exist with other protocol families on Ethernet networks, and Xinet technology can also provide a bridge between Ethernet and AppleTalk networks.

Mt. Xinu has released Xinet in both binary form and in C language source. The binary version is available as an addition to Mt. Xinu's MORE/bsd VAX/Unix product. The C language source is available to Unix software and hardware developers who wish to connect their products to AppleTalk networks.

For more information, contact Mt. Xinu Inc., 739 Allston Way, Berkeley, CA 94710; 415/644-0146.

Please circle Reader Service Number 197.

RDS, AT&T CO-LABEL PC 6300 SOFTWARE

An open-ended, co-labeling and distribution agreement has been signed between Relational Database Systems (RDS) and AT&T Information Systems. Through the agreement, RDS will supply its database software for the AT&T-IS PC 6300; and AT&T will co-label and sell through its AT&T-IS distribution channels. The products involved are Informix, a relational database management system designed for experienced computer users; and an interactive Informix-compatible file manager.

A co-labeling and distribution agreement also exists for the same RDS software to be sold with AT&T's 3B family of microcomputers.

For more information, contact Relational Database Systems News Bureau at Madison Field Corp., 15250 Ventura Blvd., Sherman Oaks, CA 91403-3201; 213/872-2777. □

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UNIX/WORLD'S "New Products"" section is provided as a service to our readers, and our selection criteria are based solely on the needs of our readership. If you would like to have your product news considered for publication, please address your correspondence to UNIX/WORLD Magazine, New Products Editor, Castro St., Suite 1220, Mountain View, CA 94041. Because of the large number of press releases we receive, UNIX/WORLD cannot verify the accuracy of claims made by a product's manufacturer. We advise that you thoroughly test any product before buying.

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SYSTEMS ADMINISTRATION: CURES FOR BUSINESS ILLS

PART 4, CREATING AND MANAGING YOUR FILE SYSTEM

BY DR. REBECCA THOMAS

Last month we discussed the steps necessary to maintain a file system properly, one of the most important aspects of your Unix system. Maintaining a Unix file system is one thing, but creating one is another matter altogether. As system administrator, you'll be called upon to do both quite often. So first, we outline the general steps for creating a file system from scratch. After your file system has been put into use, the system administrator needs to monitor usage of the system disk. When the disk fills up, the Unix system can't be used until some files are removed from it. Most Unix systems provide several utilities for monitoring how much disk space is still available or has been allocated already.

The specifics for creating a file system vary greatly from one system implementation to another, but we can discuss the steps in a general way. Consult your system documentation for the specifics of creating a file system for your particular system.

You may have to create a file system when you first set up your Unix system or if your present file system becomes corrupted beyond repair. Before you can create a file system, though, you must first format the disk that it will reside on.

The disk is a memory storage device that arranges its information in sectors along concentric tracks. In order for the Unix system to read or write information to the proper sector, the sectors must be organized in a scheme that the operating system can understand, and information about the disk must be stored on the disk itself. The disk-formatting program arranges and writes this important information on the disk. You should be aware that

a. Bell Version 7 command line format
/etc/df [*filesystem*. . .]

b. Berkeley command line format
/etc/df [**-i**] [**-l**] [*filesystem*. . .] [*filename*. . .]

c. Bell System III and V command line format
/etc/df [**-t**] [**-f**] [*filesystem*. . .]

FIGURE 1: USING THE `df` COMMAND

formatting erases any previous information on the disk.

Disk-formatting programs are designed for a particular disk and disk controller hardware, so you need to consult your system documentation for details on how to format your hard or floppy disks.

CREATING A FILE SYSTEM WITH `mkfs`

After you have formatted the disk, use the `mkfs` command (or `newfs` on Berkeley 4.2BSD) to create a file system. This command builds all the necessary data structures for the file system—such as the superblock, the inodes, the free-block list, and the "empty" data blocks.

The basic command line format is `/etc/mkfs` *name size*, where *name* is the name of the storage device on which the file system will reside and *size* is the capacity of the file system measured in blocks. You will need to consult your system documentation for the storage device name and maximum size that you can specify on a particular disk.

MANAGING DISK SPACE

The complete Bell Unix operating system requires a large amount, some 8 to 10 Mbytes, of disk space, so most Unix systems installed on a microcomputer must have at least a 10-Mbyte system disk. In this case, you may still have to remove the on-line manual system (in the `/usr/man` directory) and the games (in `/usr/games`) to leave enough working space. Certainly, a 10-Mbyte disk precludes use of the system by several users. We recommend a *minimum* disk capacity of 20 Mbytes (after formatting) if you have more than one user on your system.

It seems that, no matter how much disk space you start with, it never takes long for the system disk to fill up, especially if the system has several users. When the disk is full, you can no longer use your Unix system. In the next installment of this series, we will detail some ways to remove files from the system disk and archive them onto more permanent storage media.

In general, though, files accumulate on the system disk because users don't remove their unwanted files often enough. Thus, sooner or later, the system administrator must ask users to decide which files to archive from the system disk.

The system administrator should monitor use of the system disk and take the necessary steps to avoid running out of disk space. The Unix system provides several utilities for monitoring disk usage, and we'll discuss use of these commands in a moment. Whenever disk space is critically low, the system administrator should place a warning in the message-of-the-day file, `/etc/motd`. You see the contents of this file displayed each time you log in to the system. Now let's look at the commands.

THE DISK FREE COMMAND—`df`

Use the `df` command first to see how much disk space is available. Simply enter `df` (or `/etc/df`, if necessary), and this command displays the number of free disk blocks for all mounted file systems.

The Bell Version 7 `df` command has no options, but you may limit the report to one or more particular file systems by specifying an argument, *filesystem,* for each file system you wish `df` to examine. Figure 1A shows the command line format for accomplishing this.

Figure 1B depicts the command line format to use with the Berkeley version of `df`. This version recognizes a couple of options and an additional argument. If you specify the `-i` option, `df` reports the number of free inodes. The `-l` option causes `df` to count all the blocks in the free-block list as a double-check. In this case `df` takes a little longer to complete.

With the Berkeley version, you can also indicate the desired file system by specifying *filename,* which is the name of any file in the target file system, instead of indicating *filesystem,* which is the device name. For instance, let's say that `/usr` is the directory to which the file system `/dev/hd01` was mounted. You could request `df` to check the available space on this mounted file system by specifying the directory name `/usr` (or any file within that directory or its subdirectories) on the invocation command line.

The Bell System III and V versions recognize a different set of options, as shown in Figure 1C. The

number of free inodes is displayed by default. The `-t` option reports the total number of allocated blocks and inodes as well. The `-f` option causes `df` to count the blocks in the free-block list (as did the corresponding `-l` option with the Berkeley version).

The Bell versions let you specify the file system in two different ways—either as a device name or as a mount point. (The mount point is the directory to which the file system is mounted.) For instance, if we mounted the `/dev/hd01` file system onto the `/usr` directory, then `/usr` would be the mount point.

THE DISK USAGE COMMAND—`du`

If `df` reports that the free disk space is dangerously low, the system administrator should ask all users to run `du` on their home directory. The report should help users locate large files that they no longer need to keep on the system disk. Also, the administrator should run `du` from the root directory to locate large system-related files. Many systems have accounting functions that create log files that grow as information is appended. Often these files can be processed, any needed information extracted, and then removed from the system disk.

Figure 2 shows the command line format for all versions of `du`. If you do not indicate a directory argument, `du` uses the current working directory as the point from which it begins totaling disk usage. Specify a *dirname* if you wish to begin accumulating usage from a different directory. In any case, `du` scans the initial directory and all its subdirectories and reports the number of blocks occupied in each directory. Note that this command gives information in terms of 512-byte blocks, independent of the actual disk block size.

du [*option*] [*dirname*. . .]

FIGURE 2: COMMAND LINE FORMAT FOR USING THE `du` COMMAND

a. Command line format
/etc/quot [*option*. . .] [*filesystem*]

b. Sample output without options.

```
# /etc/quot /dev/root
/dev/root:
3624        root
485         adm
122         bin
28          uucp
9           beccat
3           junes
3           johnk
1           billk
# □
```

c. Command line format for producing cross-reference listing
/etc/ncheck *filesystem* **| sort -n | /etc/quot -n** *filesystem*

d. Sample output of cross-reference listing

```
# /etc/ncheck /dev/rhp0a | sort -n | /etc/quot -n /dev/rhp0a
/dev/rhp0a:
root        /lost+found/.
root        /tmp/.
operato     /etc/operator/.
bin         /bin/.
root        /dev/.
aps         /arch/ultrix/.
aps         /arch/rp06/.
. . .
# □
```

FIGURE 3: USING THE `quot` COMMAND

If you want to learn only the total number of blocks occupied, specify the summary (`-s`) option on the command line. The `-a` option (mutually exclusive with `-s`) causes `du` to report the sizes of *all* files individually (not just directories).

The Bell System III and V versions have a report option (`-r`), which is useful for enabling error messages regarding directories that cannot be read, files that cannot be opened, and so on. Normally, such errors are silently ignored, so you could get an underestimation of the actual disk usage.

THE DISK QUOTA COMMAND—`quot`

Berkeley and some Bell systems provide a convenient utility, `quot`, for summarizing the total number of occupied disk blocks for each system user. Figure 3A shows the invocation command line syntax. You can change the report format by using the appropriate option. If you don't indicate an option, `quot` reports the number of blocks for the files owned by each file system account.

For instance, Figure 3B shows a result of running `quot` on a small Unix system. The output consists of two columns: The left-hand column displays the number of blocks oc-

a. Command line elements
find *pathname-list. . . condition-list action-list*

b. Command line format for using **-exec** argument
find *pathname-list condition-list* **-exec** *cmd* {} \;

c. Command line for locating files older than a month
find / -atime +30 -print

d. Command line for locating files older than a month and larger than 10 blocks.
find / -atime +30 -size +10 -print

e. A command line for removing located files interactively.
find / -atime +30 -size +10 -ok rm {} \;

FIGURE 4: USING THE `find` COMMAND

cupied by the user, and the right-hand column lists the identity of the user. The report is sorted so that the users who own the largest number of blocks appear first—this way, the "greedy" users stand out.

If you also want a count of the number of files each user owns, specify the `-f` option. The `-c` option prints a list of the files in three columns—the left column is the file size in blocks, the middle column is the number of files with that block size, and the right column is a cumulative total of blocks. Note that this option does not list the file owners.

The `-n` option is generally used to produce a cross-reference listing of all files and their owners. The Bell Labs documentation suggests that you use the command line shown in Figure 3C to accomplish this. Here, `ncheck` produces a list of all inode numbers for *filesystem*. These numbers are then sorted in increasing numerical order by `sort`. The sorted output is piped into `quot -n`, which produces a display listing the owner for each file (sorted by inode number). Figure 3D depicts part of a sample report. Note that the ellipses (. . .) indicate further output.

THE FIND COMMAND—`find`

The `find` command is generally available for use by all system users and is a valuable aid for the system administrator. Use this command to locate one or more files that satisfy criteria you specify. Because you are interested in managing disk space, you will want to specify criteria to locate files and directories that are wasting space. As an example, one approach would be to locate large files that have not been accessed for some time and that might no longer be needed.

After it has located each file, `find` allows you to do one of several different operations on that file. You can request that the full path name of the file be printed, or you can request that a Unix command operate on this file, either interactively or without your intervention. The syntax for the `find` command is awkward but powerful. Figure 4A enumerates the elements that make up the `find` command line.

To begin, you need to indicate what directory or directories you want the `find` command to search. You may indicate more than one directory in *pathname-list* if each directory is separated by a space. The utility searches each directory and all of its subdirectories in an effort to find a file that meets the criteria in *condition-list*. Most of the *condition-list* items for this command are listed in Figure 5.

The conditions shown in the second part of this table take a numerical argument, *n*, which must be a whole decimal number. Precede the number by a plus sign (+) to indicate any value larger than *n* and a minus sign (-) to indicate values less than *n*.

You can combine the condition-list items for `find` with logical operators to form one large condition-list. The logical operations are listed below in order of decreasing precedence. Thus, parentheses take precedence over any of the other operations, and they are frequently used to group conditions. You can see how to combine the condition-list items using these operators in the following examples:

(one) Conditions that are grouped with parentheses are operated on first. Because the shell gives parentheses a special interpretation, they must be "protected" or escaped with a backslash as you enter the `find` command line: `\(` and `\)`.

COMMAND GLOSSARY

`mkfs`	make a file system (Bell Unix system)
`newfs`	make a (new) file system (4.2BSD)
`df`	display amount of free disk space
`du`	list file usage in a directory
`quot`	determine file usage per system user
`find`	locate files wasting disk space

(two) Negate or reverse the logical meaning of a condition or a parenthetical grouping of conditions by prefixing the unary NOT operator, the exclamation mark (`!`). This operator means find all files that *do not* meet the specified conditions indicated after this operator.

(three) You can link conditions in the logical AND sense simply by placing them on the same command line.

(four) You can specify alternate conditions by using a logical OR operator, the `-o` option, between the conditions and then enclosing those conditions in escaped parentheses.

Once `find` has located a file, an action can be performed on the file. If you don't specify an *action-list* argument when you invoke `find`, no output or action is performed at all! Most commonly, `-print` is specified so that the path name of the located file is displayed. The last section of the table shows a list of several possible actions you may specify.

Choose the action-list argument `-exec` to invoke a Unix system command to operate on any files that meet the criteria in condition-list. A pair of braces (`{}`) must appear on the `find` command line where the file argument for the Unix command would normally be indicated. The full path name of any files that `find` locates will then replace the braces, and the Unix command will act on those files one at a time. When you use the braces, you must end the invocation command line with a semicolon, which must be escaped from interpretation by the shell, generally with a backslash. Figure 4B depicts a sample command line format to use with the `-exec` argument.

If you request the action-list argument `-ok`, `find` executes the Unix command only if you type a `y` after being prompted with the path name for the file that meets the selection criteria. We recommend this interactive approach for commands that alter a file permanently, such as `rm`, which removes a file.

Figure 4C shows an example of `find` that locates all files that have not been accessed (`-atime`) for over a month (`+30`) and displays their pathnames. (Access means that the file has been either read or written to.)

Some of the files that `find` has located may be so small as to be of no consequence, so let's add the condition that they be larger than 10 blocks (see Figure 4D). Here

a. Condition-list arguments:

-name *filename*
Specify the name of the file to be *filename* (can use wildcard abbreviations if shell metacharacters are escaped).

-perm *onum*
Find file with octal permission mode *onum*.

-type *x*
Specify file type to be *x*, where *x* may be
d directory
f ordinary file
c character device file
b block device file
p named pipe (FIFO) (Bell Systems III and V)

-user *uname*
Locate file owned by *uname* (can be user name or ID).

-group *gname*
Locate file with group name *gname* (or group ID).

-newer *file*
Find file modified more recently than the argument *file*.

b. Condition-list arguments that take numerical values:

-size *n*
Find file with size *n* blocks.

-links *n*
Locate file with *n* links to it.

-atime *n*
Find file accessed *n* days ago.

-mtime *n*
Find file modified *n* days ago.

-ctime *n*
Find file created *n* days ago (Bell versions only).

c. Action-list arguments:

-print
Display the path name.

-exec *cmd*
Execute the Unix system command, *cmd*.

-ok *cmd*
Execute *cmd* interactively.

FIGURE 5: COMMAND LINE ARGUMENTS FOR THE **find** COMMAND

we have combined the conditions `-atime +30` and `-size +10` in a logical AND sense by including both conditions on the same command line. Finally, Figure 4E shows you how to remove these files with the interactive action command `-ok`.

By now you should have an idea of the steps involved in creating and managing a file system. In the next installment, we will discuss one of the most important procedures you must perform for maintaining your Unix system—namely backing up your file system. □

Dr. Rebecca Thomas, UNIX/WORLD's Editor Emeritus, is an author of A User Guide to the Unix System, *the second edition of which is now available. She is currently writing a book on Unix systems administration.*

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SPOOLING TO MULTIPLE PRINTERS

BY DR. REBECCA THOMAS

This month's contribution comes from Paul Liebow, who has set up a spooling system to direct the printing of files to one of three different printers. Although the examples shown are specific to his particular Unix system implementation, interested readers may adapt the submitted (Bourne) shell scripts to work on their own system.

Dear Dr. Thomas:

Wicat's System 200 print spooling system has a number of bugs. For example, `lpr` always sets the serial printer port to 9600 baud. Because our Diablo 630 API has a top speed of 2400 baud and because `lpr` only works for one port, I wrote the following shell scripts to replace Wicat's `lpr` command. They provide print spooling for up to three different printers—two Diablos loaded with letter-size paper and one with wide fanfold paper.

[*Doctor's notes:* Figure 1A lists `lexprk`, which spools data for the Diablo with the wide paper, and Figure 1B shows `lexpr`, which spools it for a Diablo with the narrower paper; `lexpr` copies the file to be printed to the smaller of two "queue directories." The "lex" prefix comes from the name of the word-processing software that the author uses, Lex-68.]

The shell script `diablo.cat` does the actual work of moving the data from the spooled file to the appropriate printer. Each of three different `diablo.cat` shell procedures is called once a minute from `/usr/lib/crontab`. [*Doctor's notes:* Figure 2A lists `diablo.cat`, and 2B shows the corresponding entries in `crontab`. The file `LOCK` in Figure 2A is a dummy file with appropriate write permissions enabled.]

Note that in reference to `diablo.cat`, the file `top` contains a single ASCII form feed character, and `reset` contains the Diablo reset escape sequence; `top+10pitch` contains a form feed followed by an escape sequence that assures 10-pitch operation. The Diablo printer needs about three seconds to act on the reset sequence, hence the `sleep 3` command.

PICKING YOUR PAGES

Mr. Liebow later submitted another related shell script—one that spools selected pages from a document to the appropriate "queue directory."

Dear Dr. Thomas:

Our word-processing software, `lex/68`, does most things right, but printing one or more pages from a large document is too complicated. The enclosed shell script, which I

a. Listing of `lexprk`:

```
$  cat -n lexprk
   1    if test $# -lt 1; then
   2         echo "lexprk: usage is lexprk file-name..." >&2
   3    fi
   4    for i in $*
   5    do
   6         if test ! -s $i; then
   7              echo "lexprk: $i is not found or empty" >&2
   8         elif test -d $i; then
   9              echo "lexprk: $i is a directory" >&2
  10         elif test ! -r $i; then
  11              echo "lexprk: $i is not readable" >&2
  12         else
  13              cp $i /usr/diablo/tmp3/$i$$
  14         fi
  15    done
$ □
```

b. Listing of `lexpr`:

```
$  cat -n lexpr
   1    if test $# -lt 1; then
   2         echo "usage: lexpr file-name..." >&2
   3    fi
   4    for i in $*
   5    do
   6         if test ! -s $i; then
   7              echo "lexpr: $i is not found or empty" >&2
   8         elif test -d $i; then
   9              echo "lexpr: $i is a directory" >&2
  10         elif test ! -r $i; then
  11              echo "lexprk: $i is not readable" >&2
  12         else
  13              set `du /usr/diablo/tmp1`
  14              s1=$1
  15              set `du /usr/diablo/tmp2`
  16              s2=$1
  17              if test $s1 -le $s2; then
  18                   cp $i /usr/diablo/tmp1/$i$$
  19              else
  20                   cp $i /usr/diablo/tmp2/$i$$
  21              fi
  22         fi
  23    done
$ □
```

FIGURE 1: THE SPOOLERS

a. Listing of diablo.cat:

```
$ cat -n diablo.cat
   1    cd /usr/diablo
   2    if test ! -s lock$1; then
   3         ln LOCK lock$1
   4         if test -s temp$1/*; then
   5              cat top reset >/dev/diablo$1
   6              sleep 3
   7              for i in tmp$1/*
   8              do
   9                   cat $i >/dev/diablo$1
  10                   rm $i
  11                   cat top+10pitch >/dev/diablo$1
  12              done
  13         fi
  14         rm lock$1
  15   fi
$ □
```

b. Typical crontab entries:

```
$ cat /usr/lib/crontab
* * * * * diablo.cat 1
* * * * * diablo.cat 2
* * * * * diablo.cat 3
$ □
```

FIGURE 2: THE DRIVERS

a. The general pp invocation command line:
pp *filename* [*start-page* [*stop-page*]]

b. Listing of pp:

```
$  cat -n pp
   1   case $# in
   2   1)   varskip=1;
   3        varcopy=99999;;
   4   2)   case $2 in
   5        [0-9]|[0-9][0-9])   varskip=$2;
   6                            varcopy=$2;;
   7        *)   echo "pp: page argument must be a decimal number" >&2;
   8             exit;;
   9        esac;;
  10   3)   case $2 in
  11        [0-9]|[0-9][0-9])   varskip=$2;;
  12        *)   echo "pp: start-page must be a number" >&2;
  13             exit;;
  14        esac;
  15        case $3 in
  16        [0-9]|[0-9][0-9])   varcopy=$3;;
  17        *)   echo "pp: end-page must be a number" >&2;
  18             exit;;
  19        esac;;
  20   *)   echo "usage: pp filename [ start-page [ end-page ]]" >&2
  21        exit;;
  22   esac
  23   if test ! -s $1; then
  24        echo "pp: $1 not found or is empty" >&2
  25   elif test -d $1; then
  26        echo "pp: $1 is a directory" >&2
  27   elif test ! -r $1; then
  28        echo "pp: $1 is not readable" >&2
  29   else
  30        inp=$1
  31        set `du /usr/diablo/tmp1`
  32        s1=$1
  33        set `du /usr/diablo/tmp2`
  34        s2=$1
  35        if test $s1 -le $s2; then
  36             tempid=1
  37        else
```

Continued

FIGURE 3: THE pp SPOOLER

call pp (for pick pages), does the job with a simple command line.

[*Doctor's notes*: Figure 3A shows the general invocation command line for the pp script listed in Figure 3B. In the listing, the constant NEWPAGE stands for a literal FORMFEED ("Control-L"), which pp recognizes as starting a new page. If only *filename* is indicated, the entire file is printed. Specify one decimal number after *filename* to print a single page and indicate another decimal number on the command line for specifying a range of pages.]

I'm not happy with the method used to check for numeric page numbers—there must be a better way. The command is quite slow. I'll rewrite it in C when people complain about the speed, but for now it does the job.

[*Doctor's query:* Any complaints?]

Contributions by Paul Liebow
W.R. Grace & Co.
New York, N.Y.

Dr. Rebecca Thomas, UNIX/WORLD's Technical Editor, is an author of A User Guide to the Unix System, the second edition of which is now available. She is currently writing a book on Unix system administration.

"Wizard's Grabbag" is a regular feature of UNIX/WORLD. Submit your shell scripts, C programs, or tips and techniques that ease the burdens of system administrators and programmers to "Wizard's Grabbag," UNIX/WORLD, 444 Castro St., Suite 1220, Mountain View, CA 94041. Authors of published entries receive $50 for shell scripts, awk scripts, sed scripts, lex, yacc, and C programs, or tips.

Please follow these guidelines for reader contributions: Write your shell scripts, C programs, and other code so that it is portable across different versions of the Unix system. If possible, it should run without change on Bell Version 7, Systems III and V, and

```
38              tempid=2
39          fi
40          awk "BEGIN {
41              sk = $varskip - 1
42              cp = $varcopy
43              if (sk >= cp) {
44                  printf(\"pp: start-page must be <= end-page\n\")
45                  exit
46              }
47          }"'{
48              if (NR == 1 && $1 == "NEWPAGE")
49                  next
50              while (pg< sk) {
51                  if ($1 == "NEWPAGE")
52                      ++pg
53                      next
54              }
55              while(1) {
56                  print $0
57                  if ($1 == "NEWPAGE") {
58                      ++pg
59                      if (pg == cp)
60                          exit
61                  }
62                  next
63              }
64          }' $inp >/usr/diablo/tmp$tempid/$inp$$
65      fi
$ □
```

FIGURE 3: THE pp SPOOLER

Berkeley 4.x. Thus, you should use "universal" Unix utilities such as `who am i` (all systems) in lieu of `whoami` (Berkeley only), and the Bourne shell, if possible, when coding shell scripts. However, C shell scripts are also welcome because most of our readers now have access to this popular command interpreter. Use the standard I/O library when writing C code.

In addition, use the lint syntax checker to eliminate nonportable constructions and compile the code with a portable C compiler such as `pcc` to help ensure portability. Hardware dependencies, such as terminal control sequences, should be eliminated or at least minimized and isolated to one code region or to a separate module. Keep your example as short as possible, say under 100 lines of code. □

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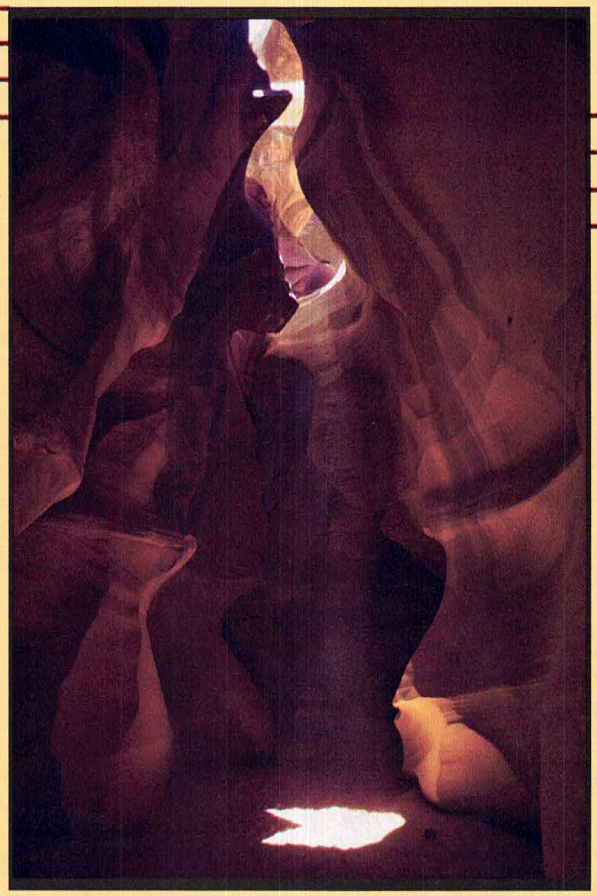

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SPERRY

FIVE COMMON PROBLEMS

BY BILL TUTHILL

When working with small computers, almost every user is also a system administrator. This month I present the first article of a two-part series that explains how to solve the most common problems that new users encounter. This month's column concentrates on typical user problems. Next month's column will concentrate on system problems and should be helpful to everyone except users at large computer centers.

EVERYTHING IN CAPITALS

Unlike most operating systems, the one this magazine favors is case-sensitive—that is, uppercase and lowercase letters are not the same. To accommodate terminals that produce only uppercase, the Unix system looks for lowercase at log-in time and acts accordingly. Sometimes people press the Shift Lock key on their terminals and mistakenly log in with capitals. Realizing the mistake, they change to lowercase before giving the first command, at which point the system won't accept lowercase.

If this happens, type `stty -lcase` to prevent uppercase from being mapped to lowercase. If you forget this command, you can always log out and log back in again using lowercase.

GETTING LOST

Files on the Unix system are placed in directories, which are structured as a hierarchy of arbitrary depth, like the root system of a large tree. The deeper the directory hierarchy, the bigger the tree. PC-DOS supports a Unix-like hierarchical directory mechanism, but CP/M has a flat directory structure, with no subdirectories.

Directories are useful for organizing files by user and by project, but they also make it possible for unwary users to get lost. This is especially true if you have inherited somebody else's set of directories and files, or if you are curious enough to explore the system. Berkeley Unix has a convenient command `ls -R` that allows you to explore an entire directory hierarchy.

If you ever get lost, type `pwd` to print the working directory, which is your current location on the system. If you recognize the location, and are close to where you want to be, just change directory to the proper place. But if you're totally lost, it's possible to go back home—that is, to the same location where you logged in. When issued with no argument, the `cd` command returns you to your home directory.

NO SUCH FILE OR DIRECTORY

Often users try to print a file that isn't there. Suppose you want to look at your resume on the screen, using the `more` command to prevent output from scrolling by too fast. If the system tells you there's no such file, first, look at the files in that directory using the `ls` command. Perhaps "resume" isn't in that directory but is in the subdirectory named "Personal". Running the `ls` program on this directory will show that your resume is in fact inside this directory. You can change into this directory and look at your resume using the `more` command.

If you know that a file is hidden somewhere in a directory hierarchy, you might be able to locate it with the `find` command. Give some part of the filename you are sure about, preceded and followed with a backslash-star (this instructs the Unix system to match anything): `% find . -name \*memo\* -print`. The period (.) means start looking in the current working directory; `-name` means look for files named by the following argument; and `-print` means type out the names of files meeting all criteria. If you don't tell `find` to print, it won't do anything when it finds a matching file.

In 4.2BSD, most system utilities print out helpful error messages such as "No such file or directory". On Bell Version 7 and System V, however, some utilities print uninformative error messages such as "can't open." Several things could cause this error, including the problem explained in the next section.

PERMISSION DENIED

The Unix system is provided with a file security mechanism that allows you to set read, write, and execute permissions on a per-file basis for owner, group, and everyone else. Read permission means you can examine a file, as with the `page` command. Write permission means you can change a file, say with an editor, such as `vi`. Execute permission means you can run a file as a program. These meanings apply only to ordinary (or plain) files; when applied to directory files, the permissions mean something different. Read permission for a directory means that you can list it with `ls`. Write permission means you can create or delete files in a directory. Execute permission means you can change into a directory with `cd` or with a pathname expression.

Often people forget to type the name of the command they want to use in front of the file argument. You might, for example, type `letter` instead of `vi letter`. Because

you're referring to a regular file, not an executable program, the system responds by saying "Permission denied"—you don't have execute permission for that file.

Occasionally you want to look at somebody else's files. You might do this because you're a snoop or because someone asks you to look at something. Suppose Tom tells you he has written a memo you should look at, which is in the file `/usr/tom/memo`. You try to look at it, but you don't have permission. Run `ls -l` (long listing) to determine why not, as demonstrated in Figure 1.

Only the owner, Tom, has read and write permission for this file. The first field in a long listing shows read(r), write(w), and execute(x) permission for owner, group, and everyone else, in triads. A minus sign indicates a lack of permission. The initial minus sign, however, indicates a plain file. As shown by the final command in Figure 2, `root` and group `staff` can read from and write to the `/etc/termcap` file. The `/bin/rm` command is readable, writable, and executable by `root`, readable and executable by group `staff`, and just executable by everyone else.

If Tom wants to make his file available to you, he has to enable read permission for everyone. He can do this by issuing the command `chmod o+r memo` to change permission modes. If you and he are in the same group, however, he can make the file readable only by himself and other group members by issuing the command `chmod g+r memo` (g stands for group).

Groups are a good way to preserve a modicum of security while allowing group members to cooperate on shared projects. Berkeley Unix allows users to be members of multiple groups at the same time. Version 7 and System V allow users to belong to only one group at a

```
% page resume
resume: No such file or directory
% ls
Personal        calendar        letter
% ls Personal
resume          valentine
% cd Personal
% page resume
```

FIGURE 1: USING THE `ls` COMMAND

```
% page/usr/tom/memo
memo: Permission denied
% ls -l /usr/tom/memo
-rw-------  1 tom          2470 Apr 17 13:17 memo
% ls -lg /etc/termcap
-rw-rw-r--  1 root       staff       92157 Feb  9 20:14 /etc/termcap
-rwxr-x--x  1 root       staff       20480 Feb  9 20:09 /bin/rm
```

FIGURE 2: UNDERSTANDING FILE OWNERSHIP

time. Without multiple group membership, groups are of little use—users end up changing groups so often they get confused, and files often end up with the wrong group ownership.

NO ECHO

Sometimes after running buggy software (for instance, games written by undergraduates), nothing you type appears on the screen. Typing a carriage return may or may not elicit a response from the computer. Sometimes you can type normal commands and get normal answers, except that what you type does not appear on the screen. You are probably in noecho mode, which means that the system does not echo what you type on the screen.

The solution is simple but differs from version to version of the Unix system. On Berkeley Unix, press line-feed (not Return), then type `reset`, and press line-feed again. Note: if your terminal doesn't have a key labeled line-feed, type a Control-J instead. On Bell System III or V, press line-feed, then type `stty sane`, and press line-feed again. This will restore the terminal to its normal modes.

NEXT MONTH

The second installment of this series will discuss: core dumps, what to do when there; no space left on device; system crashes; I/O error; not enough core; and too many open files. □

Bill Tuthill, a member of the technical staff at Sun Microsystems (Mountain View, Calif.), was previously a systems analyst at Imagen Corp. and a programmer at UC Berkeley.

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Readers who have computer merchandise or services to sell, buy, or trade and who want to be included as a classified advertiser in UNIX/WORLD Magazine should write to: Advertising Department, Tech Valley Publishing, 444 Castro Street, Suite 1220, Mountain View, CA 94041. 415/940-1500. The rate for the classified section is $12 per line. The deadline for ads is the 20th of the 2nd month prior to publication. Please include complete name and address in every ad.

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WHEN IS THE UNIX SYSTEM NOT UNIX?

Operating System Design: The Xinu Approach by Douglas Comer
PUBLISHED BY PRENTICE-HALL, 474 PAGES, $31.95 (HARDBACK ONLY)

REVIEWED BY RAY SWARTZ

Unix system source code is a legally protected trade secret of AT&T. Those who use the Unix system do so under a strict licensing agreement, which means that unless you purchase a source license from AT&T (or work for someone who has), you cannot find out exactly how the Unix system works.

To the vast majority of Unix system users, this presents no problem. They couldn't care less about the operating system's innards. As a serious C programmer and Unix system user, however, I find this enforced ignorance frustrating.

One solution is to read technical articles published by Bell Labs and other organizations that discuss the general details of the Unix system. Another is to attend conferences to pick up some true wisdom. At best, these are haphazard approaches that often lead to intellectual dead-ends.

A more direct and satisfying learning experience is to read *The XINU Approach* by Douglas Comer. Comer has designed and written a Unix-like operating system that he calls XINU. XINU, which is UNIX spelled backwards, is an acronym for "XINU Is Not Unix." I have been told by people familiar with both the Unix and XINU source code that the underlying concepts are the same for both systems.

The author suggests this book as a text "for advanced undergraduate or graduate-level courses" in computer science. It assumes a good deal of knowledge about computers and computer terminology. The programs that make up XINU are written in C and make heavy use of data structures, such as lists, stacks, and queues. Further, readers should be fluent in C.

HOW THIS BOOK IS WRITTEN

The book starts slowly and gradually picks up speed. The early chapters spend a good deal of time discussing general operating system and computer hardware concepts. Each chapter covers one specific part of the system. This helped me assimilating the material because I could focus on each section without having to refer constantly to other parts of the book.

This "grand design" is one of the book's strengths. It constantly builds on information previously introduced. As I read it, I felt as if I were being "guided" through the material.

The XINU Approach makes excellent use of what few illustrations it contains. On several occasions, a well-timed graph provided the insight I needed to understand the idea being discussed. More diagrams would have been useful, however.

REVIEW HIGHLIGHTS

- **Highly recommended for advanced C programmers and others interested in what makes Unix and other operating systems work.**
- **Not recommended for anyone else.**

Operating systems, no matter how general in design, must be made to work on a specific piece of computer hardware. Thus, XINU contains "a few machine-dependent routines written in LSI-11 assembler language." Some familiarity with assembly language programming comes in handy for understanding these routines.

Even given this book's well-organized format, it is not for beginners. It has an academic emphasis, covering the material in a rigorous manner. Although most of the code is a direct implementation of ideas in the text, the programs listed perform a designated task directly, without simplification. Readers must be prepared to dig into this code with both hands.

CONTENTS

The XINU System contains six different sections that describe the operating system and its implementation. Section 1 consists of Chapters 1 to 3 and serves as an introduction to operating system and computer hardware concepts. The third chapter discusses list processing. It includes code to manage lists, FIFO and priority queues and explains how to initialize each structure as well—this is all done within the context of XINU.

The second section covers concurrent process management. Chapter 4 introduces two key ideas: process scheduling and context switching. Process scheduling maintains a list of processes that are ready to be executed. Context switching is the method that XINU (and other multitasking systems) uses to swap the currently executing process with another one. A context switch places the old process (the one being replaced) in the ready list

(process table), searches the list for the next process to execute, and then begins running this new process. In addition, this chapter covers the process table structure and several related defined terms.

Chapters 5, 6, and 7 build on the ideas presented in Chapter 4. Chapter 5 expands the number of available process states, shows how processes are created and terminated, and shows routines that move processes among the different states.

Chapter 6 introduces *semaphores*, counters that are associated with some system resource. Every time a specific resource is needed, the semaphore associated with it is checked. If its value is zero, the resource is available, otherwise it is in use and the requesting process must wait. The discussion of how XINU coordinates processes is excellent.

Chapter 7 describes interprocess communication—when one process wants to send a message directly to another one. An example of this in the Unix system is when a child process terminates, sending its parent an exit code. In XINU, as in some versions of the Unix system, a message consists of an integer value only.

The third section, Chapters 8, 9, and 10, covers hardware related details of XINU—specifically, memory management in Chapter 8, interrupt processing in Chapter 9, and real-time clock management in Chapter 10. The major problem with this section is that the LSI 11/02, upon which this version of XINU was implemented, has no memory management capabilities. Modern computers have dedicated chips to perform these tasks, as well as other tasks discussed here. Although informative reading, the discussion in these chapters seems a bit dated.

The fourth section concerns ways to connect the XINU system to input and output (I/O) devices. Because any given computer can have a multitude of peripherals, it is particularly important that the system be flexible enough to handle new devices. Chapter 11 proposes a strategy for implementing an I/O interface by creating a list of "high-level" operations, such as `getc`, `putc`, `read`, `write`, `open`, `close`, and so on.

Interfacing devices to XINU involves mapping these general I/O operations into those performed by a specific device. The software that does this is called a *device driver* and must be custom-made for each device. Chapter 12 demonstrates this process by creating a driver for a "standard computer terminal with a keyboard." Chapter 13 discusses system initialization—how to start up the system.

Section 5—Chapters 14, 15, and 16—constructs software to implement a network that connects multiple, independent XINU systems. Chapter 14 explains "the difficult problem of communication" and designs a data-link communication driver. Chapter 15 adds high-level memory management and message passing; routines that help manage the network. Chapter 16 discusses the transmission protocol of the XINU network and writes the programs that control it. The system is called a *frame manager,* and it sends message *packets* between systems on the network.

Chapters 17 and 18, which comprise section 6, implement a disk-based file system. Chapter 17 describes the driver program for the disk, and Chapter 18 constructs a file system that is based on *i-blocks*, which closely resemble the Unix system's *i-nodes*.

The last two chapters are general ones that talk about the system as a whole, now that the design work has been completed. Chapter 19 discusses exception handling, concentrating on engineering and programming techniques. One nice touch is that the author presents a version of the standard library function `printf()`. Chapter 20 describes how to transform the individual pieces into a unified operating system and creates a program called `config` that configures an operating system from a specification file.

The book contains two appendices. Appendix 1 is a 7-page "quick" introduction to C. Good luck! Appendix 2 is the XINU programmers' manual.

I learned a great deal from this book and recommend it highly to people interested in the intricacies of an operating system such as Unix. For those of us who are intrigued by these sorts of things, it is a well-conceived work that provides insightful coverage of the area. *The XINU System* is not casual reading, though. You need to study the book, not just read it.

As far as I know, XINU is not available commercially. The book's preface does say, however, that a machine- readable version of the software is available for a nominal charge. In any case, even though XINU is a Unix-like system, remember "XINU Is Not Unix." □

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rier established on some of the alternates' circuits. It can sometimes take numerous calls just to get one connection going, and then that connection is often so noisy as to be almost unusable.

COSTS AND QUALITY

Now some people will stand up at this point and tell me how they *never* have problems with the alternates. And no doubt they believe this to be true. As I said above, some call routes are better than others, and some people presumably receive what they consider to be "acceptable" service from their alternate carriers . . . though the low level of quality that some people consider to be acceptable is at times truly amazing to behold.

As a general rule, the alternates that operate totally on a WATS resale basis may have better quality connections (once the calls have been established) than the private networks—but both suffer from the problems of overloaded facilities. Many of the WATS resellers have nowhere near sufficient WATS lines to handle the number of customers they've signed.

But some people figure that due to the alternates' "lower" rates, they come out ahead by not using AT&T. Over time, these people may be in for a rude awakening. Even where the alternates' rates are genuinely lower than AT&T's, this is an artificial situation. AT&T's rates are being held somewhat above the ideal levels through FCC edict—but this won't last too much longer and AT&T's rates will eventually fall. The alternates' rates have been lower because of the "cheap" nature of their interconnect to the telephone network—but that advantage is falling by the wayside with the coming of "equal access," and you can expect to see their rates rise (in fact, that trend has already started). Ultimately, one can expect AT&T's rates to become competitive with those of the alternates across the board, which could greatly change the nature of the game as far as the alternates are concerned. Future events in the area of long-distance services are certain to be interesting to say the least.

The editor tells me that I've run out of room for this month, but there's still quite a bit of material to cover on this topic. So, next month I'll continue with the second half of this discussion, and delve once again into the convoluted world of long distance services. See you then. □

—Lauren—

```
UUCP: {decvax, ihnp4,
       seismo, clyde,
       bonnie}!vortex!
       lauren
```

Lauren Weinstein is a computer/telecommunications consultant living in Los Angeles. He has been involved in an array of projects that range from the mundane to the bizarre. He has particular expertise in the fields of computer networking, the Unix system, microcomputer technology, and telecommunications systems.

EQUAL ACCESS—UNEQUAL SERVICE PART I

BY LAUREN WEINSTEIN

Back in the good old days, you knew what you were getting when you dialed a long distance call. Certainly the service from AT&T didn't qualify as perfect, but in comparison to some of the alternatives available today, AT&T frequently comes out smelling like a rose.

I am presuming that everyone reading this is familiar with what I mean by "alternatives." I'm referring, of course, to the breed of new long-distance carriers that have been popping up (and in some cases dying out) like mushrooms. The more "stable" of these AT&T competitors include the MCI and Sprint services, but there are a host of others as well. I wouldn't be surprised to see ads for "Harry and Joe's Long-Distance Service." Who would have thought that long-distance services could become a cottage industry?

The alternates (as I'll call them from here on) generally fall into one of two categories. The first is the entity (such as MCI and Sprint) that operate private telecommunications networks. The other type is the WATS reseller—these latter folks set up interfaces to AT&T WATS lines and resell call time via bulk discount breaks and the like. Actually, even the private network operators are WATS resellers to a degree. Since none of the private networks are anywhere near as extensive as AT&T's net, the private network alternates generally use rented AT&T WATS circuits to complete calls to areas their own private nets don't service directly.

SNAP, CRACKLE, POP

The alternates' advertisements are generally pretty simple. The *claim* is that you pay a lot less than AT&T charges but that you get the same level of service. A classic ad runs something like this:

"Gee, John, isn't this an expensive call? How can you afford to talk so long?"

"Oh, never mind the cost . . . I'm using (Blank) . . . ."

My version is a little bit longer:

"Gee, John, isn't this an expensive call? How can you afford to talk so long?"

"Oh, never mind the cost . . . I'm using (Blank) . . . ."

"What? I can't hear you."

"I'm using (Blank) . . . ."

"Try again, there was this funny buzzing sound . . . ."

"I'm not using AT&T. I'm using ***(BLANK)****!"*

"I'm hearing another conversation. John, are you there? Hello, hello? . . . "

An exaggeration? Uh, well, not really. How many of you have experienced having to ask someone who called you on an alternate service to call back on AT&T, so that you could hear them without special effects, such as buzzing, echoes, and other similar undesirable sounds?

As if variable audio quality weren't bad enough, the alternates have, by and large, been taking on customers much faster than their facilities could grow, resulting in massive trunk congestion in many areas. Trying to get calls through during business hours can rapidly become boring, as you are faced with endless fast-busy signals (indicating all trunks busy). And that's when you're lucky! Much of the time, your repeated call attempts are met only with hiss, silence, or unidentifiable sounds reminiscent of the film "The Texas Chainsaw Massacre." And better yet, many alternates even *charge* you for those uncompleted calls . . . but more on that later.

Exaggeration again? No, I don't think so. Sure, you can get bad circuits on AT&T as well as on the alternates. But the number of blocked and dropped calls, poor quality calls, and just generally the extreme variability of call quality from call to call and place to place is generally substantially worse with the alternates. Using the alternates can be something like playing telephone roulette. You *might* sometimes get a good circuit. Then again, you might not, with the odds varying in an unpredictable manner. Small wonder that many businesses, after trying the alternates for a while, have returned to AT&T. They often can't use a cheaper service when the result is unreliable call quality, dropped and blocked calls, and similar problems. It's just too embarrassing trying to conduct business under such conditions.

For modem users, the problems are even more serious. By and large, the variation in call quality of the alternates can wreak havoc on modems operating at 1200 bits per second and above. The quality of these circuits is frequently just not up to snuff for "high-speed" modems. The quantity of random noise "hits" (the notorious "{{{{" patterns on the screen) is often much higher with the alternates than with AT&T. Also substantial problems are associated with just getting modem car-

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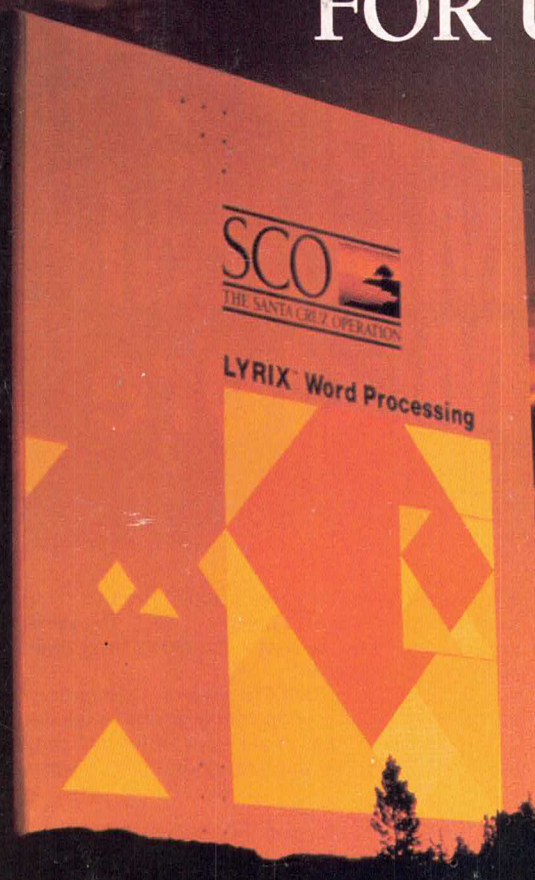

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