SEPTEMBER 1986

Mini-Micro Systems

THE MAGAZINE FOR COMPUTER SYSTEMS INTEGRATION

A CAHNERS PUBLICATION

SPECIAL REPORTS: DATA COMMUNICATIONS

- Real-time UNIX seizes new products, markets
- FEPs ease migration to new LAN protocols
- IBM's Token-Ring: What are the alternatives?
- Chip set paves the way to Token-Ring access

With modularity, Counterpoint builds multiuser computers

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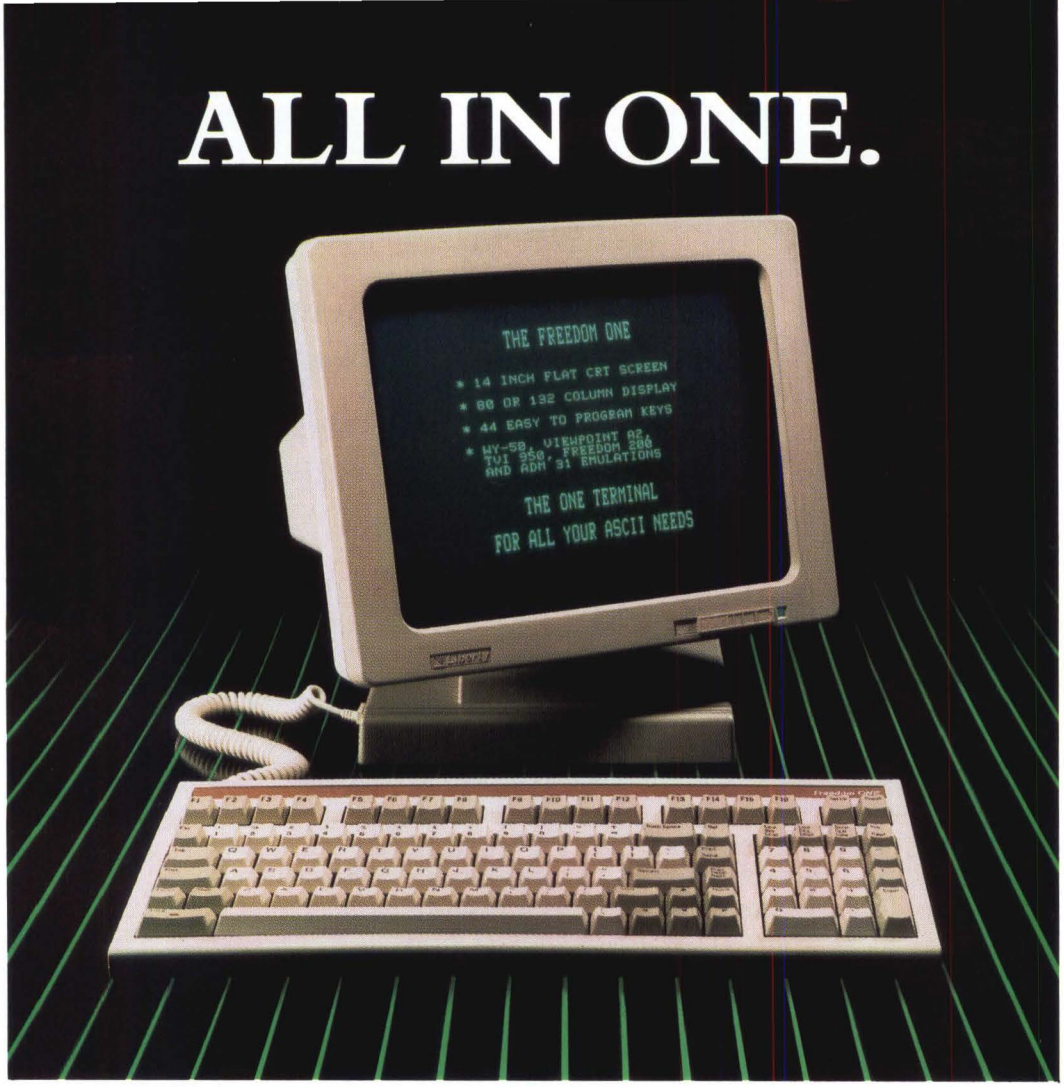

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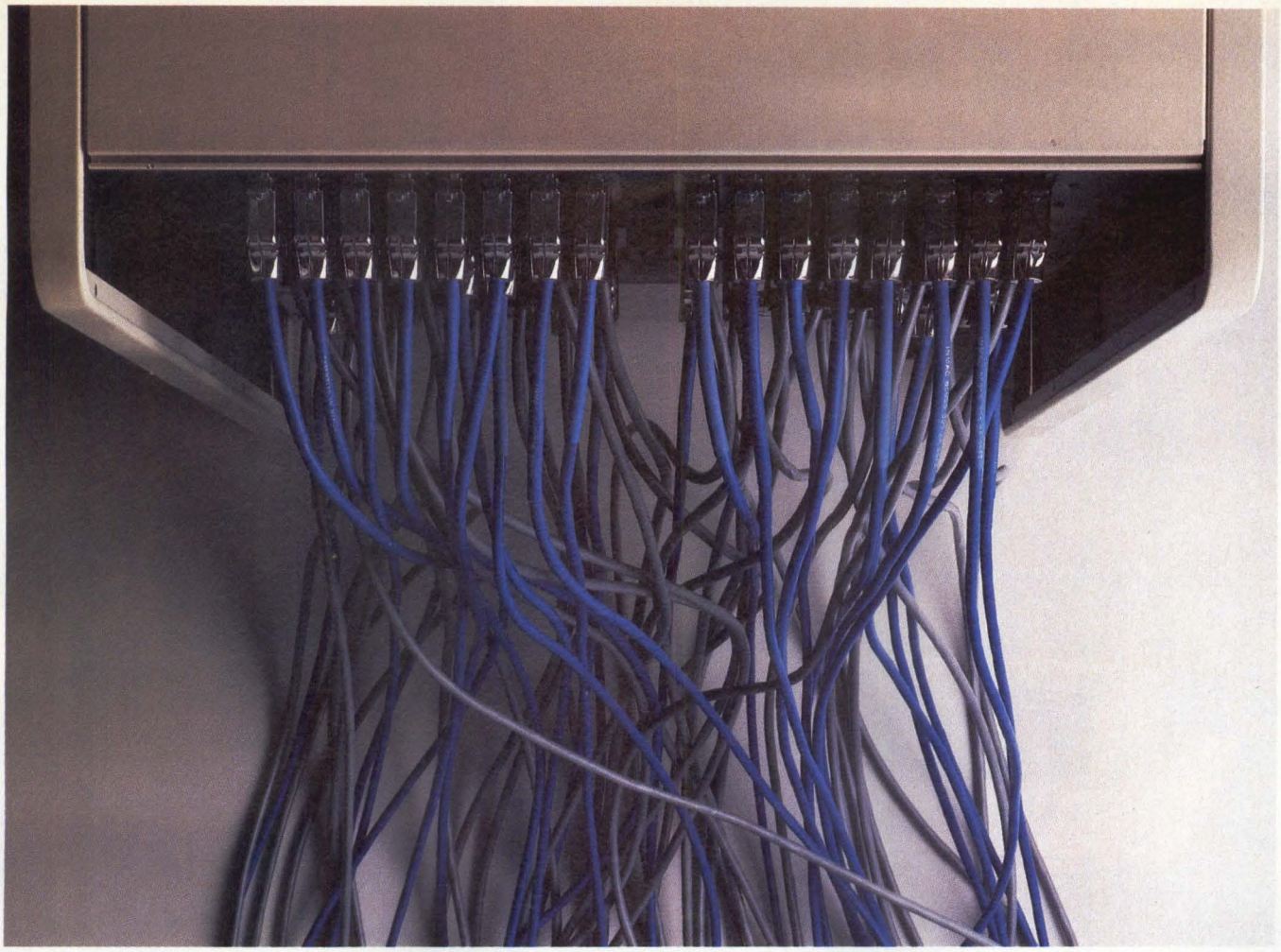

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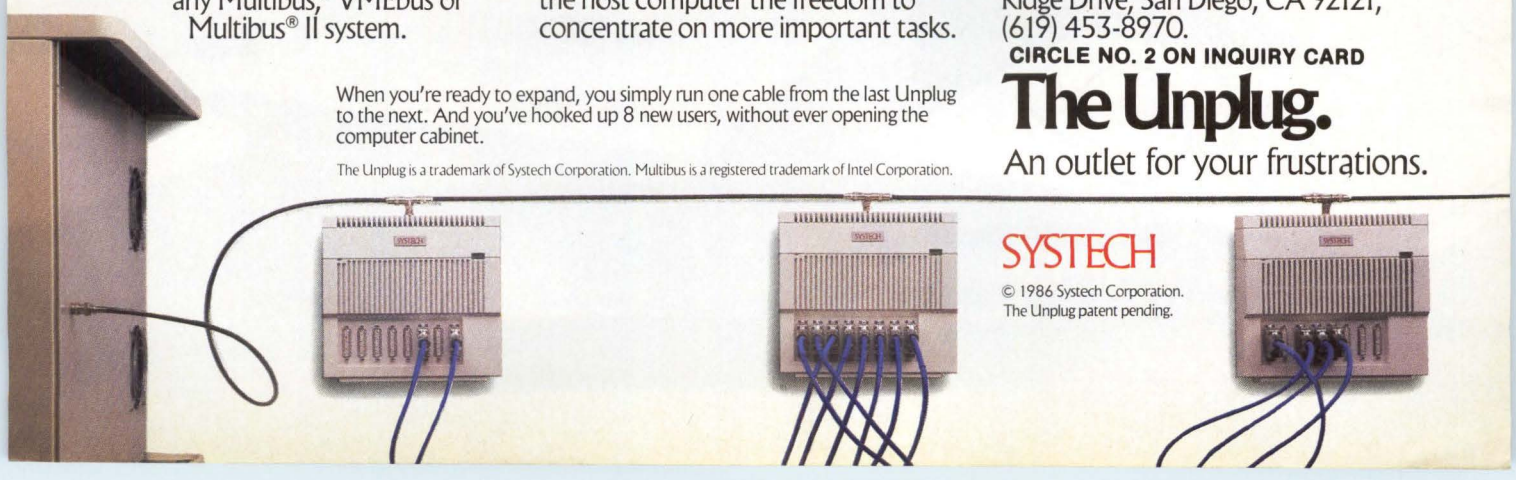

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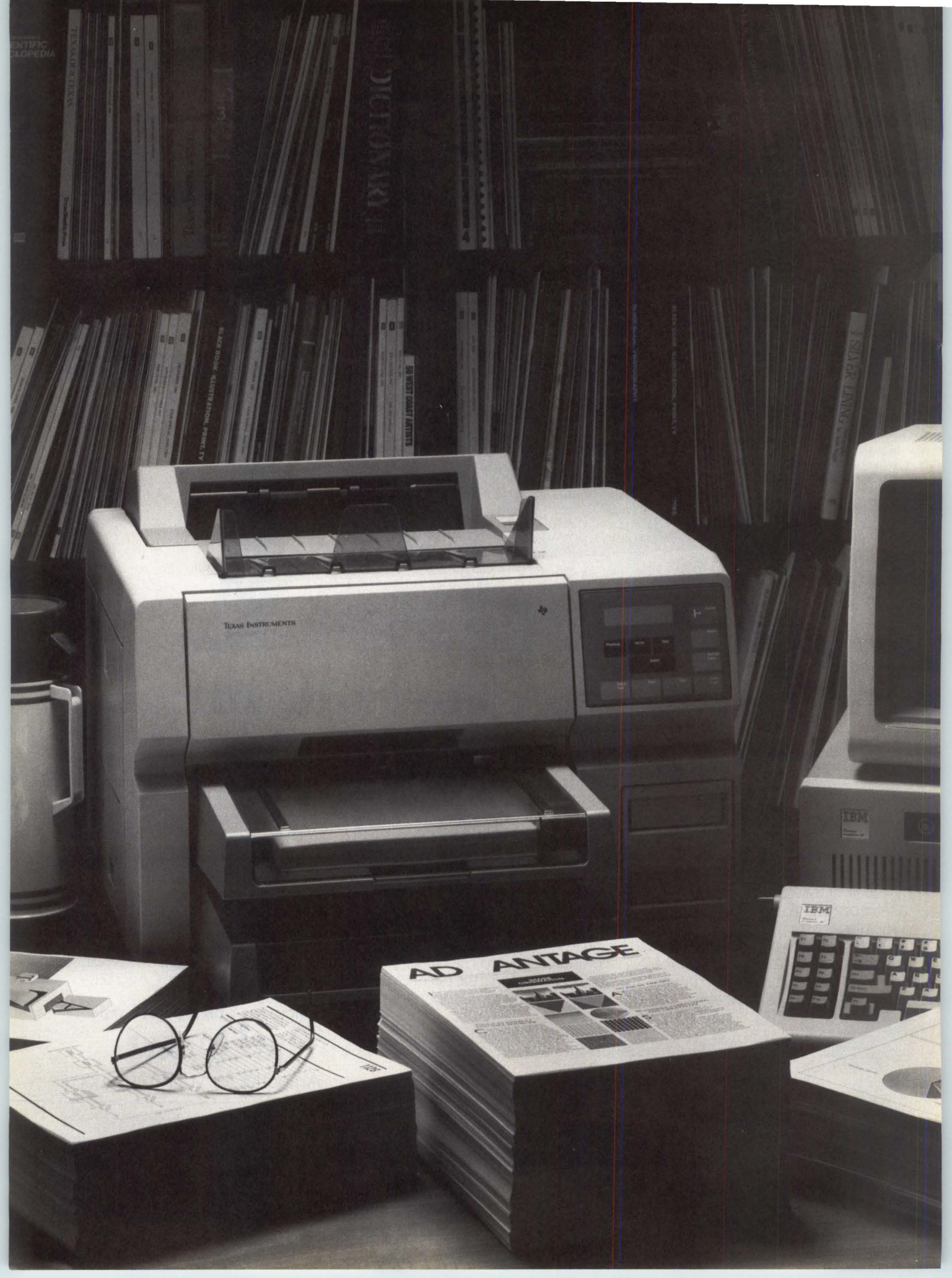
The Unplug patent pending.


TEXAS INSTRUMENTS
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AD ANTAGE

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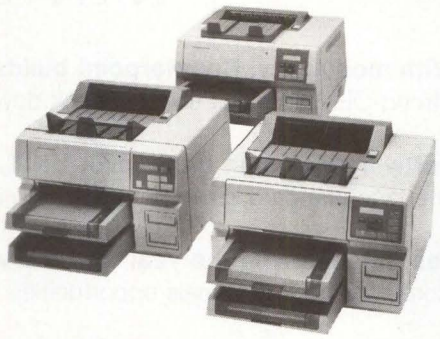

Combined with the right software, you can now have a publishing house right on your desk top.

If you have a personal computer, you are ready to get started. TI's OmniLaser with any IBM®-compatible, Macintosh™, or virtually any PC, and the right software, can help you eliminate costly typesetting, outside design work and printing. At 300-dots-per-inch resolution, the difference between laser printing and daisy wheel or dot matrix is more than mere improvement. It's light years ahead.

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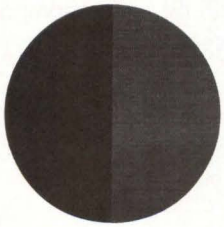

Ours Theirs

The OmniLaser uses the direct positive-imaging exposure process as opposed to the reverse-imaging exposure process used by many other laser printers. The difference, as shown above, is obvious.

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PostScript is the page-description language that drives OmniLaser Model 2108 and 2115 printers to their full capabilities, including rotated type, textures, patterns, halftones, images in any size and shape, and a wide variety of typefaces. Each font has one definition that is used as the basis for any point size. You have complete control over the size and positioning of your text and graphics. PostScript also has built-in commands for point specification, circular arcs, curves, etc. You can perfect your text and graphics on your OmniLaser and PC, and then take your original to a high-quality production facility and skip all the headaches of mechanical assembly. Whether you're composing newsletters, product data bulletins, ad proofs, business presentations, technical manuals, or any type of document, you'll find that with the power of PostScript, you are only limited by your imagination.

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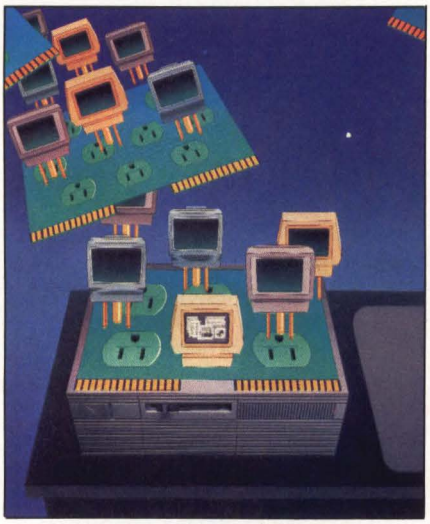

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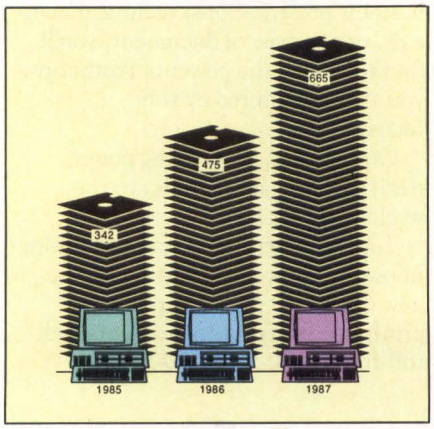

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*Appearing in issues of subscribers who indicate they have DEC computers

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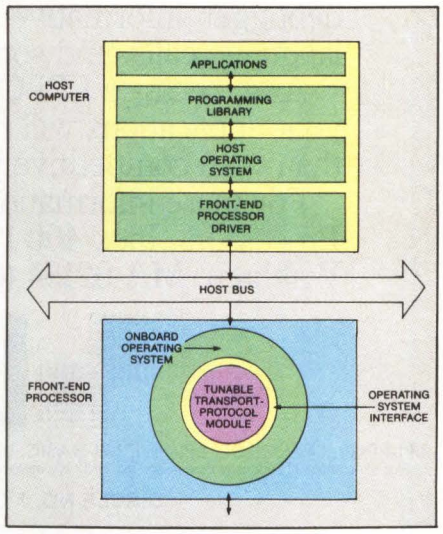

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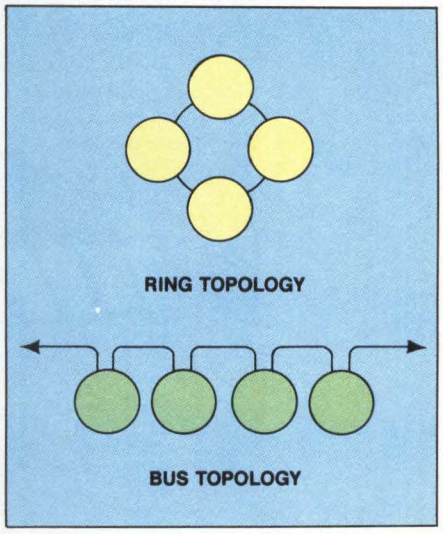

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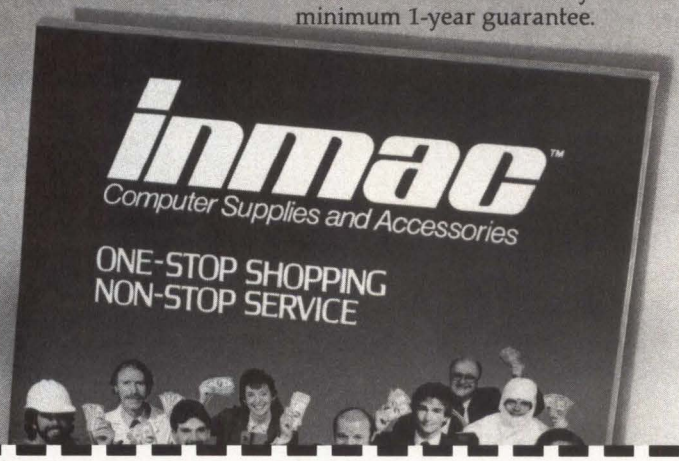

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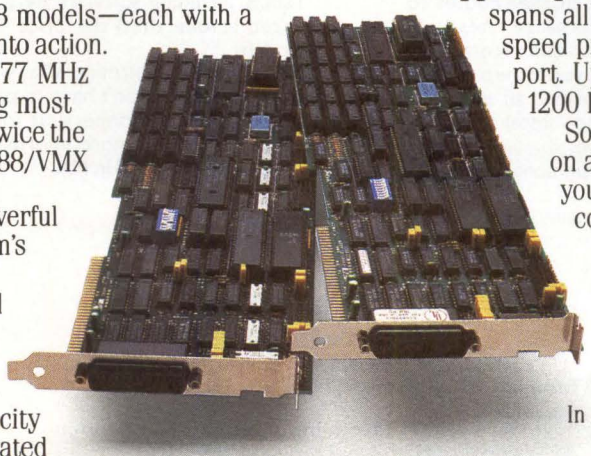

And the board's dual ported memory architecture allows data to pass directly between processors at memory speed—so communications fly through your system.

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Make the Connection

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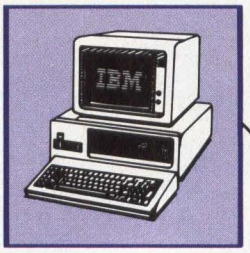

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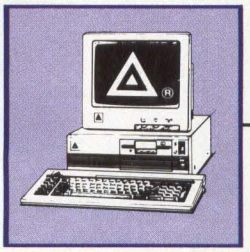
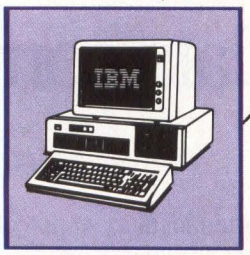


IBM AT™ and Compatibles



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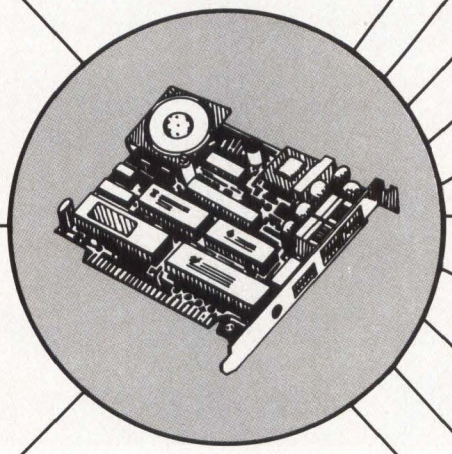

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CIRCLE NO. 6 ON INQUIRY CARD

EDITORIAL

SOFTWARE INDUSTRY GOES CORPORATE

The spectacular growth period for the personal computer software market has ended. In its place has come stability and maturity. For some companies, these market conditions have proved advantageous. For many others, though, the results have proved disasterous. Numerous acquisitions, mergers, and bankruptcies have weeded out the weak, solidified the strong, and neutralized the new. And seemingly overnight, the software industry changed from a pop culture to a corporate structure. But more important, users should benefit immensely from the transformation.

Until recently, software products were sold via technology hype and accompanied by flashy and dazzling promotion. It worked for a long time. Software sales skyrocketed off the charts, fortunes were made and personalities achieved international fame.

Sometime last year, though, the software market saturated. At that time, according to *Business Week*, it had blossomed into a $5 billion industry with about 14,000 companies and some 27,000 different products.

But the flood of software has produced an equal flood of user complaints. For example, a recent *PC World* magazine survey about software education revealed that more than 70 percent of the respondents were dissatisfied with their software. Nearly 50 percent stated that programs did not meet advertised performance and that adequate software support was offered only occasionally. Another 30 percent felt they were misled as to a program's capabilities. And 85 percent believed that software publishers should be held responsible for product performance.

And that's not all. Other user complaints include deficient documentation, lack of telephone help lines, and few money-back warranties. What's more, in a related *PC World* survey, almost 70 percent of the respondents claimed they had illegally copied software to try it out before purchase.

It's understandable, then, that market researcher InfoCorp expects personal computer software sales to plummet to a 15 percent compound annual rate over the next five years, down from the 64 percent yearly growth over the past five years. Most new companies, says *Business Week*, are being forced to go after small niche markets or to sell their products to the market leaders. The result? Market leaders (Lotus Development Corp., Ashton-Tate, IBM Corp., Apple Computer Inc., Microsoft Corp. and Micro Pro International Corp.) have markedly increased their market share. In fact, claims InfoCorp, the top 15 software companies accounted for 72 percent of the $2.2 billion general-applications software market in 1985.

But, whether an industry leader or a new challenger, all software companies must now deal with new pricing and distribution rules. Before, companies made the majority of their sales through retail channels. Now, however, after retail saturation, large corporations have entered the market and have dominated the software sales scene.

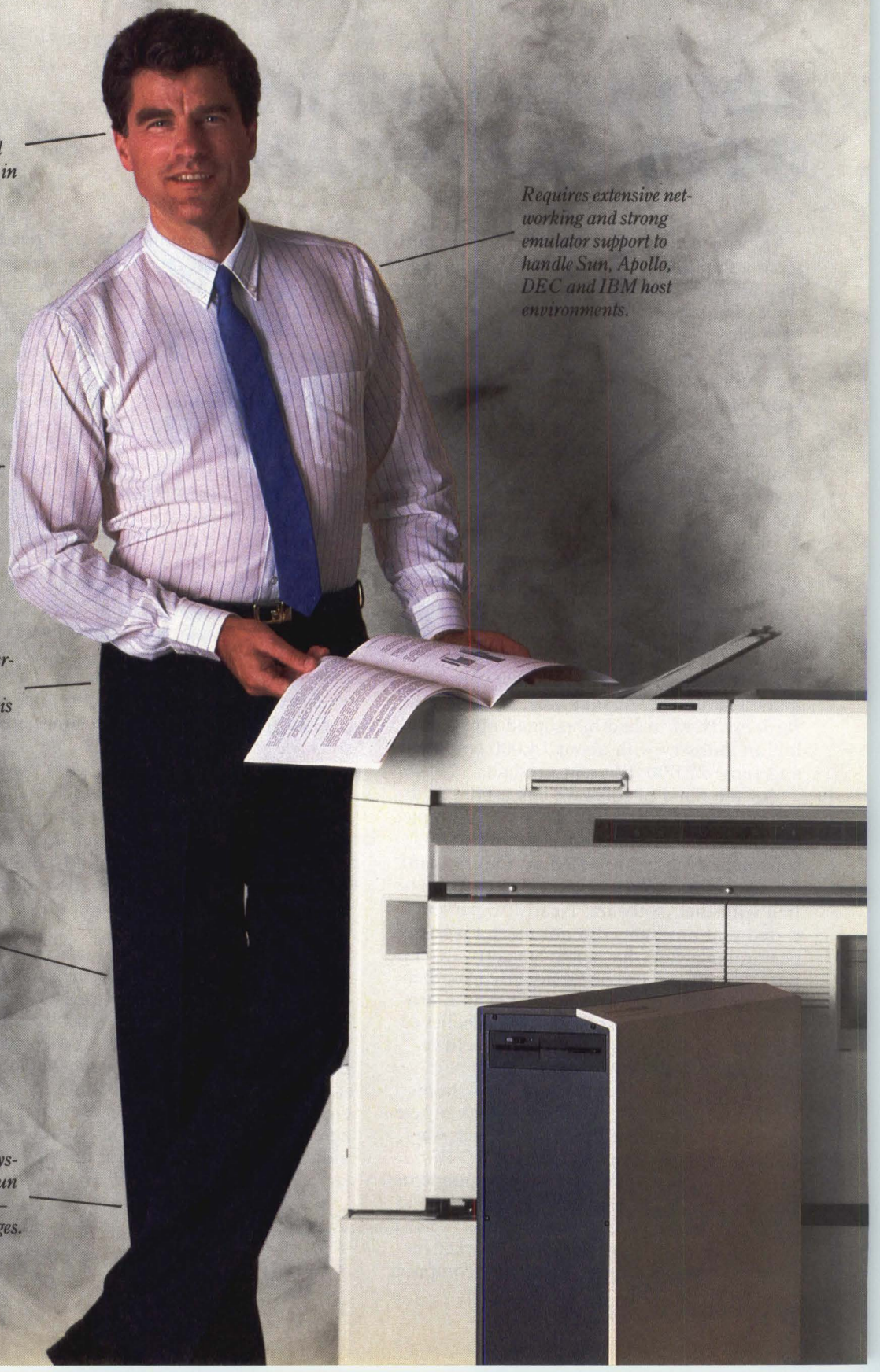
And in these corporations, data processing/management information service managers want to buy via direct sales channels. In addition, corporate managers insist on pre- and post-sales support, service and training. They also insist on getting volume discounts, doing away with copy protection and implementing site licensing.

All of these efforts are infusing much-needed professionalism into the software industry. And satisfied software users can dramatically affect the software business climate. Analysts unanimously agree that corporate purchases of personal software should rise significantly this year. Undoubtedly, if software companies adhere to corporate purchase agreements, then even small-volume and individual buyers will come out on top.

George V. Kotelly

George V. Kotelly
Editor-in-Chief

The Thinking



Looks for typeset-quality printing and demands perfection in text and graphics integration.

Requires extensive networking and strong emulator support to handle Sun, Apollo, DEC and IBM host environments.

Needs to wrap both CAE and document processing needs in one laser printing system.

Wants to protect his investment with a versatile system that is easily upgraded as his needs change.

Expects his system to stand up to heavy demands with advanced page management features like duplexing.

Requires printing systems that actually run at the rated speeds—even on original pages.

Printer's Man.

Who is The Thinking Printer's Man? At IMAGEN, we believe it's the kind of person who recognizes the advantages of dealing with the industry's leading manufacturer of laser printing systems. Someone who can appreciate our understanding of the workgroup environment's need to integrate text and graphics. In both high-volume *and* high-quality printing.

Six years ago, we perfected the technology that optimized laser printing. And at IMAGEN today, we build intelligent laser printing systems with an independent "brain" that allows them to do what they do best, and frees your host computer to do what it does best.

Our printing systems feature a dedicated image processor with three MC68000s that, along with our sophisticated page description languages, offers more flexibility than simple printer controllers can. Like clean text fonts and publication-quality graphics. Anywhere you want them on the page. The kind of quality that can turn documents that need to be read into ones that want to be read.

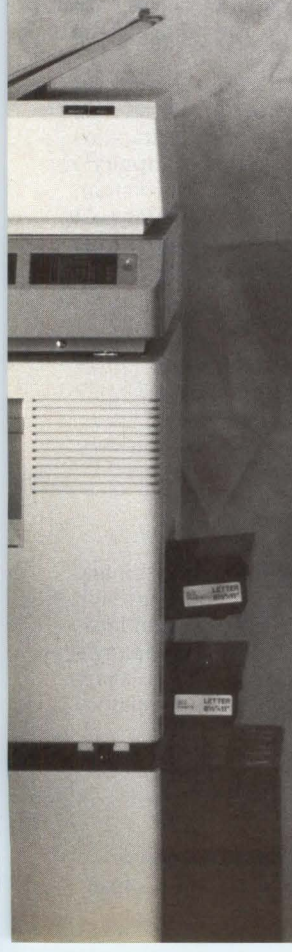
But our printing systems don't compromise quantity for quality.

For example, some suppliers claim their printers can deliver a certain number of pages per minute. But what they really do is print multiple copies of the same original per minute. With IMAGEN's newest system, you can print 20 completely different pages in the same 60 seconds.

IMAGEN laser printing systems offer a variety of innovative page management features that handle automatic duplexing, page reversal, electronic collation and jam recovery. This, combined with the ability to print on 11 x 17-inch paper, allows you to produce as much high-volume, high-quality documentation as you want. With as much technical detail as you need. And all our printers can be connected through Ethernet and other networks.

So, if you'd like to learn more about our laser printing systems, call IMAGEN today at (800) 556-1234 extension 199 in the Continental U.S. In California, call 1-800-441-2345 extension 199.

Because it's time you have a printer that's nearly as smart as you.



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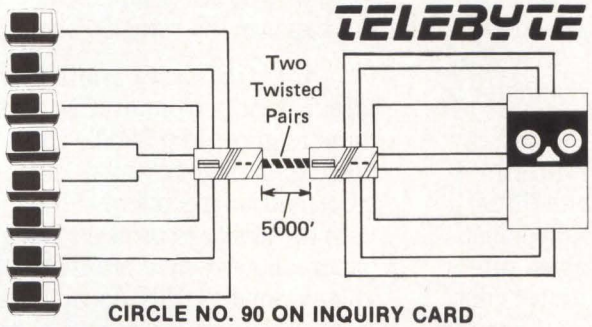
Reduces costly equipment requirements.
Allows simultaneous 8 channel operation.

Input ports can accept full duplex data at any rate up to 19,200 bps. Different speeds in each direction are easily accomodated. The composite port which links multiplexers features a built-in line driver.

Diagnostic features of the QUICK MUX include displays of Receive Data and Transmit Data for each port, Data Error and Data Loss Indicators for the composite link. Switches provide a local loopback or remote multiplexer test.

The Model 570 QUICK MUX with 8-25' cables sells for $548 in single quantity.

Contact us today at Telebyte Technology Inc., 270 E. Pulasky Road, Greenlawn, New York 11740, 800-835-3298 or (516) 423-3232.



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Think of a Viking workstation as another way to add value.

If you're not integrating ergonomic support furniture in your system, you may be missing an easy way to increase margins and add even more value. Users don't like shopping around to complete the system any more than you do. Try buying a good workstation in your area sometime. It's tough, and it sometimes opens the door to competition and criticism.

We think a lot of users care about the system environment, and well-designed support furniture can make your system more comfortable. And therefore more useful and productive.

Call us on our toll-free line. Everyone wins: users get good furniture at no more cost; you increase margins; and we win through economy of scale, even if the scale is just a few units a month.

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CIRCLE NO. 91 ON INQUIRY CARD

LETTERS

ADA STANDARD

To the editor:

I would like to provide a correction to your article, "Software tools slash development time" (MMS, June, Page 95).

On page 99, you note that "Ada is so standardized that binary code produced from one company's compiler should look exactly the same as binary code generated by another company's compiler." This statement is simply not true.

Yes, Ada (a registered trademark of the U.S. government) is standardized, probably more so than any other computer language. But the standardization is at the source code level, not the binary code level. Before a compiler may be legally declared an "Ada" compiler, it must successfully pass a series of over 2,800 validation tests. These tests [comprise] Ada programs whose output and execution [are] checked to insure conformity to the ANSI MIL-STD-1815A.

There are no restrictions placed on the binary code generated from an Ada compiler. To do so would mean standardizing on one particular company's computer hardware, operating system, etc. This would contradict a major goal of Ada: portability of applications among different computer systems.

Bill Brykczynski
Research Staff Member
Institute for Defense Analyses
Alexandria, Va. 22311

Editor's response:

You correctly point out that binary code is not the issue. The sentence should have read, "Ada is so standardized that source code for one company's compiler should look exactly the same as source code for another company's compiler."

—Michael Tucker

The VME BUS and OS-9:

Ultimate Software for the Ultimate Bus.

Modularity. Flexibility. High Performance. Future growth. These are probably the prime reasons you chose the VME bus. Why not use the same criteria when selecting your system software? That's why you should take a look at Microware's OS-9/68000 Operating System—it's the perfect match for the VME bus.

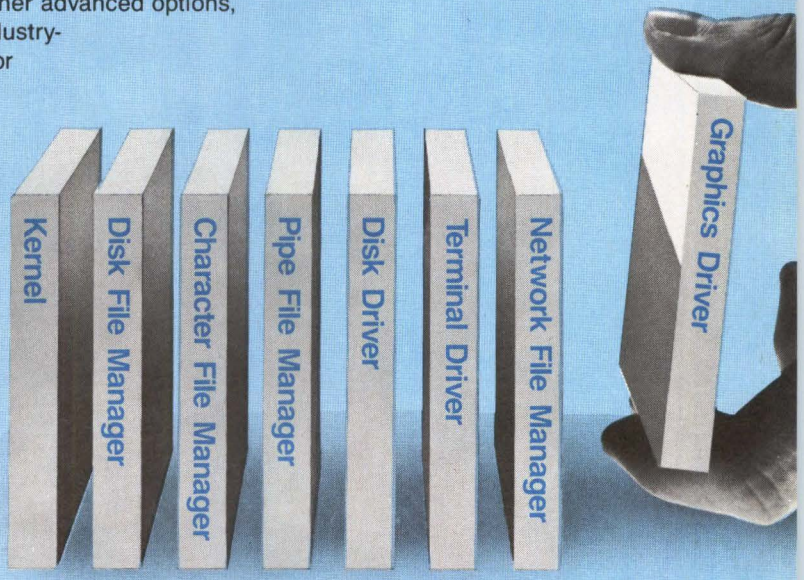
When you're working with VME you must have access to every part of the system. Unlike other operating systems that literally scream KEEP OUT!, OS-9's open architecture invites you to create, adapt, customize and expand. Thanks to its unique modular design, OS-9 naturally fits virtually any system, from simple ROM-based controllers up to large multiuser systems.

And that's just the beginning of the story. OS-9 gives you a complete UNIX-application compatible environment. It is multitasking, real time, and extremely fast. And if you're still not impressed, consider that a complete OS-9 executive and I/O driver package typically fits in less than 24K of RAM or ROM.

Software tools abound for OS-9, including outstanding Microware C, Basic, Fortran, and Pascal compilers. In addition, cross C compilers and cross assemblers are available for VAX systems under Unix or VMS. You can also plug in other advanced options, such as the GSS-DRIVERS™ Virtual Device Interface for industry-standard graphics support, or the OS-9 Network File Manager for high level, hardware-independent networking.

Designed for the most demanding OEM requirements, OS-9's performance and reliability has been proven in an incredible variety of applications. There's nothing like a track record as proof: to date, over 200 OEMs have shipped more than 100,000 OS-9-based systems.

Ask your VME system supplier about OS-9. Or you can install and evaluate OS-9 on **your own** custom system with a reasonably priced Microware PortPak™. Contact Microware today. We'll send you complete information about OS-9 and a list of quality manufacturers who offer off-the-shelf VME/OS-9 packages.



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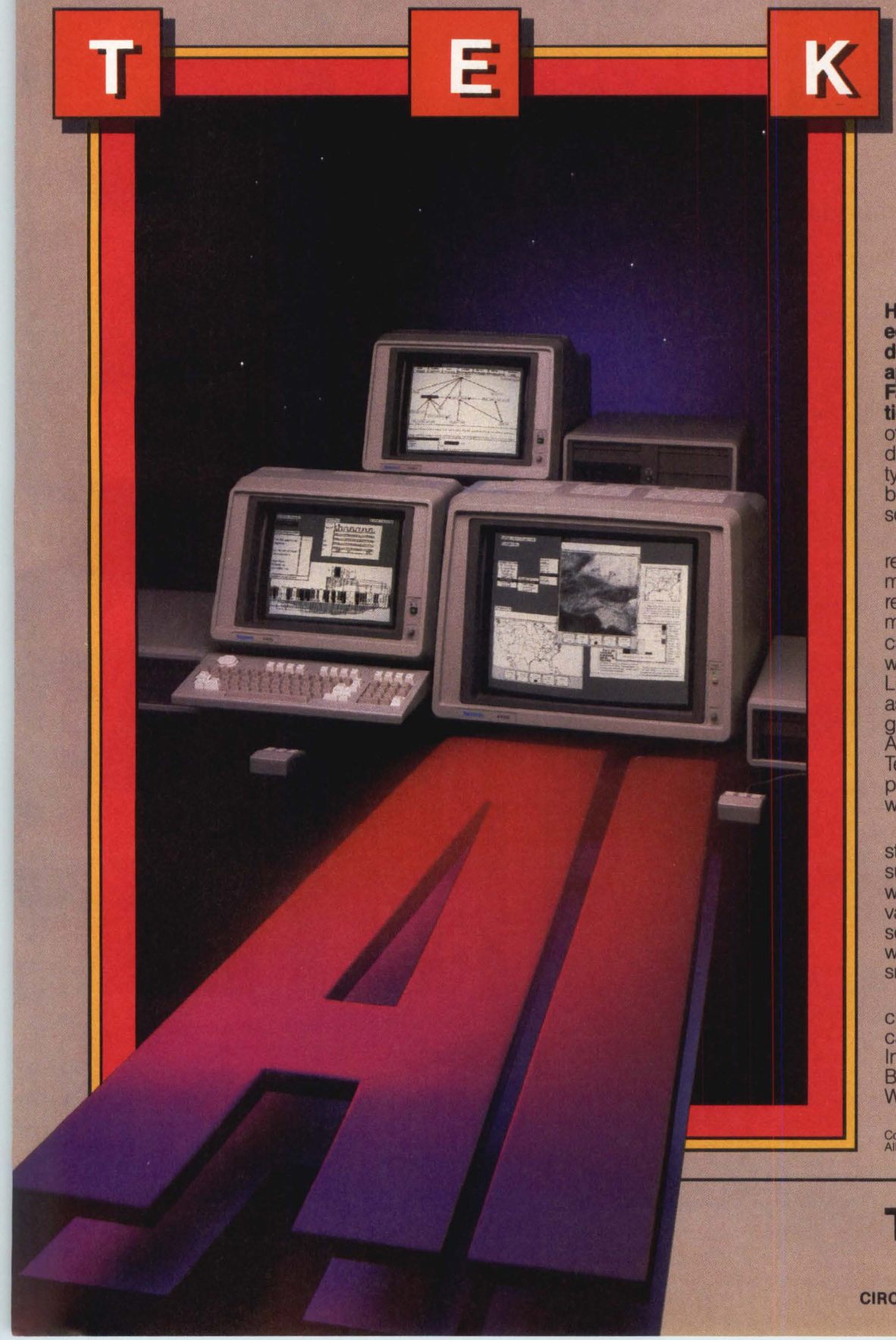
THINK SMART.



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CIRCLE NO. 10 ON INQUIRY CARD

BREAKPOINTS

DEC AIMS PROPRIETARY VAXBI ARCHITECTURE AT OFFICE MARKET

Digital Equipment Corp. has moved aggressively to challenge IBM Corp. in office automation with high-end entries in its proprietary VAXBI series, the VAX 8550 and VAX 8700. One scenario: The two machines, both rated at 6.1 MIPS, would sit in a "regional office" where they would handle an IBM mainframe at the "home office" and a wide range of minicomputers and microcomputers in "sales offices." The pitch is that, while IBM might need up to six operating systems to handle only its own machines, DEC would need just one. The 8550 ($364,000 starting price) has I/O up to 16M bytes per second; maximum memory is 80M bytes. For the 8700 ($433,000 starting price), the maximum I/O is 30M bytes per second; the maximum memory is 128M bytes.—*Jim Donohue*

DATA GENERAL BRINGS OUT FIRST TEO PRODUCTS

Marking its return as an active player in technical/engineering markets, Data General Corp., Milford, Mass., unveiled the first two application programs that ride on its Technical Electronic Office (TEO) software platform. One, TEO/Electronics, is for designers of electrical/electronic circuits; the other, TEO/3D, is for architects, mechanical engineers and people who draw maps. Prices for TEO/Electronics range from $9,000 per user; for TEO/3D, from $25,000 for up to five users to $170,000 for up to 200 users. Running in DG's AOS/VS operating system, TEO integrates seamlessly with DG's office-automation software, Comprehensive Electronic Office (CEO). —*Jim Donohue*

GOLD HILL DISPLAYS LISP FOR '386, PLUG-IN BOARD

Gold Hill Computers, Cambridge, Mass., has announced that it has ported its Common LISP compiler to the Intel Corp. 80386 microprocessor. Gold Hill claims that this is the first Common LISP to come to market for the '386-based systems. Moreover, Gold Hill and AI Architects Inc., Cambridge, Mass., announced a '386-based plug-in board for the IBM PC, PC/XT, PC/AT and compatibles that, the companies say, gives the PC nearly the performance of a dedicated LISP computer. The board, called the HummingBoard, and associated software convert the PC's native processor into a high-volume I/O coprocessor while its own 80386 performs large, memory-demanding operations. With 6M bytes of RAM and the Gold Hill's LISP, HummingBoard costs $7,000.—*Michael Tucker*

TANDY GETS DOWN TO BUSINESS WITH MODEL 3000HL

Tandy Corp., Fort Worth, Texas, has launched its long-awaited assault on the business microcomputer market with the model 3000 HL, designed to be a competitor of the IBM Corp. PC/XT. An upgrade of Tandy's existing model 3000 (launched in 1985), the new computer is powered by the Intel Corp. 80286 microprocessor, as is the PC/XT. Tandy says the 3000 HL runs

four times faster than the PC/XT and, at $1,699 without a monitor, costs 30 percent to 40 percent less. A rigid-disk model will sell for $4,299. Shipments start in September.—*Jim Donohue*

HP ADDS PC CONNECTIVITY TO LOW-END MULTIUSER SYSTEM

Look for November shipments of a new Hewlett-Packard Co. HP 260 multiuser system that will allow personal computers, including HP's Vectra, to be used as terminals. Two versions—Series 30 and Series 40—support up to 15 users, compared to 11 on earlier 260s. The Palo Alto, Calif., company is also telling VARs that applications for the 260 will run on the HP 3000. Reason: Those minicomputers now support HP's Business BASIC, the language of the HP 260. The Series 30, with a 20M-byte rigid disk drive and 512K bytes of RAM, starts at $8,500. The Series 40, which features a disk-caching scheme, 40M-byte Winchester, tape drive and 1M-byte RAM, begins at $15,000.—*Mike Seither*

LUCID LOCKS ON TO THE '386, IBM and XEROX

Common LISP-vendor Lucid Inc., Menlo Park, Calif., has announced an agreement with Intel Corp. to port its compiler to Intel's 80386 microprocessor. A similar agreement has been inked to bring Lucid LISP to the IBM Corp. RT PC. Moreover, Lucid and Xerox Corp.'s Artificial Intelligence Systems revealed an on-going contract whereby Lucid will provide consulting services to Xerox during the development of Xerox's own Common LISP. Lucid is already known as the LISP supplier to such market powerhouses as Sun Microsystems Inc., but these announcements bring the company into the personal computer arena for the first time.
—*Michael Tucker*

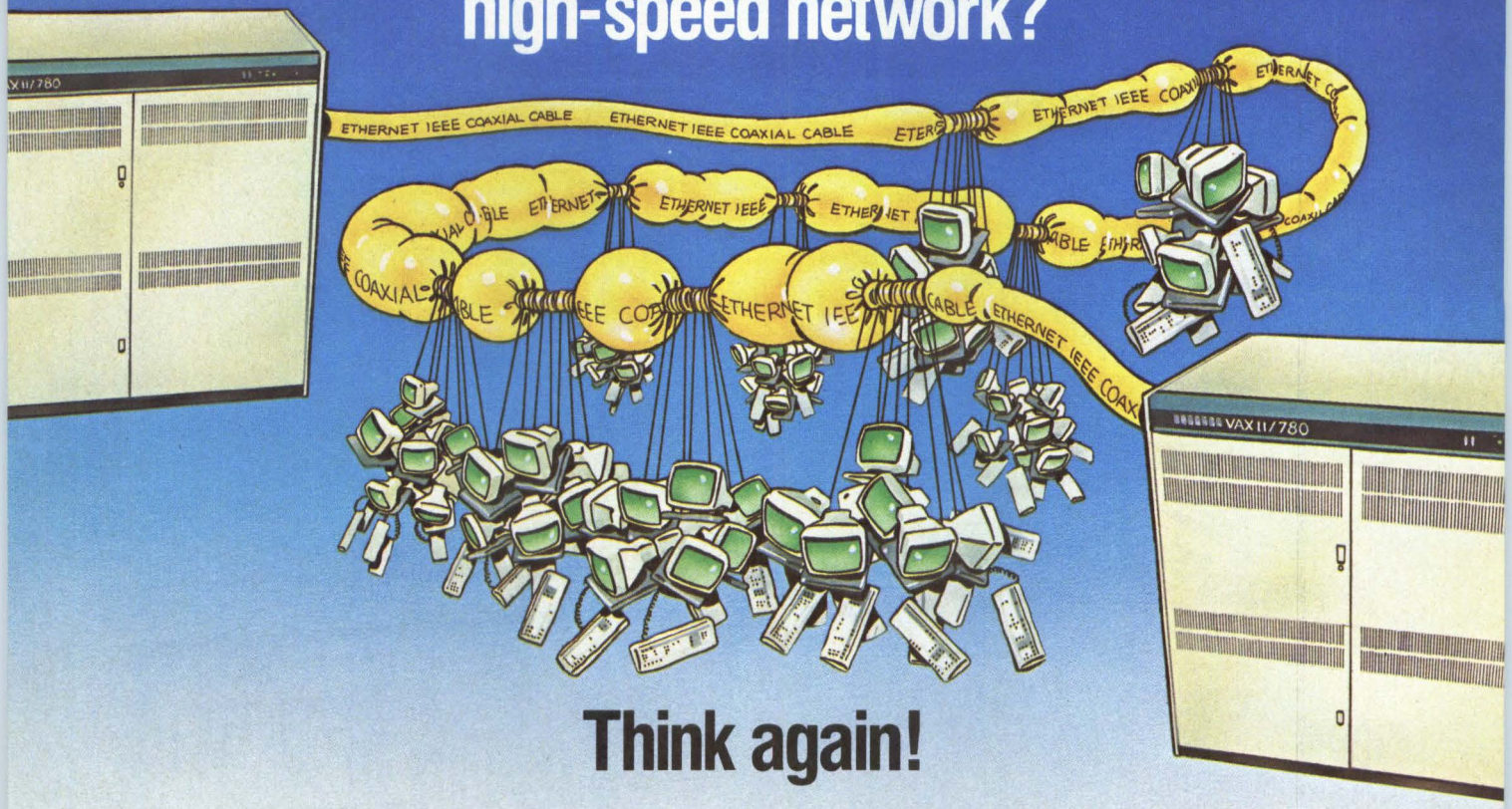
SBE MOVES TO VME WITH LOW-COST MEMORY, COMMUNICATIONS BOARDS

SBE Inc., which has a reputation among OEMs as a supplier of Multibus I products, is now in the VMEbus business. The Concord, Calif., company hopes to make a dent in that market with two low-priced boards it introduced this month. Priced at $1,195 in quantities of 100, the V-MEM-4 offers OEMs up to 4M bytes of global memory, selectable in 1M-byte blocks, and supports 8-, 16- and 32-bit transfers. SBE is also bringing to market the V-COM-8, a $795 eight-channel, serial-port communications board that supports an asynchronous data-transfer rate of 34K baud per channel. Target applications: cluster controllers for terminals or VMEbus data concentrators.—*Mike Seither*

GM LEADS USERS AND VENDORS TOWARD REAL-TIME UNIX STANDARDS

The General Motors Corp. Task Force met for the third time at Industrial Technology Inc. (ITI) in July, to lay the groundwork for a standardized, real-time version of UNIX. Based on users' and vendors' presentations on the subject, the task force will submit to the IEEE P1003 UNIX standards committee a white paper summarizing user requirements for a real-time operating system. The report is expected to serve as the basis for real-time extensions to the UNIX operating system. Anyone wishing to participate

Thinking of tying low-speed terminals onto a high-speed network?



Think again!

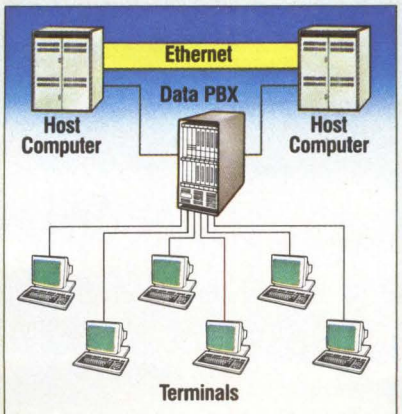
A high-speed LAN is ideal for file transfer, distributed processing and CPU-to-CPU communications. But using it for terminal traffic can cause problems.

You may be tying up bandwidth. Low-speed terminal traffic on a high-speed network can rob bandwidth where it's needed most. That means slow file transfers and sluggish response for all network users. The protocol overhead required for a terminal to send small data packets across an Ethernet® link can mean that only 10% of the 10 Mbps bandwidth is available.

By connecting your terminals through an Equinox® Data PBX and connecting your computers together with Ethernet, your LAN runs at top efficiency. An Equinox Data PBX dedicates a full 12 Mbps to terminal data traffic. More than 1300 devices can run continuous 9600 bps data at the same time, providing the best possible response through the network.

You'll tie up about $500 per terminal. When you consider the cost of Ethernet Terminal Servers, Taps, and Cable, Ethernet can cost between $300 and $800 per terminal. An equivalent solution using an Equinox Data PBX with our 8-channel Terminal Servers and twisted pair wiring is about $100 per terminal.

You could tie up your computer. Some Ethernet LANs handle terminal switching by running special software in your computer. So adding terminal traffic means your computer spends more time running the network and less time running applications. An Equinox Data PBX requires no special software and handles all terminal network processing without disturbing the host. It even allows you to monitor the network load and provides additional security for access control.



We won't tie you down. Putting your terminals on an Equinox Data PBX provides more terminal switching features for less money with greater efficiency, so you can get the most out of your LAN. And because it works with all types of computers and terminals you're not tied to a one-vendor solution.

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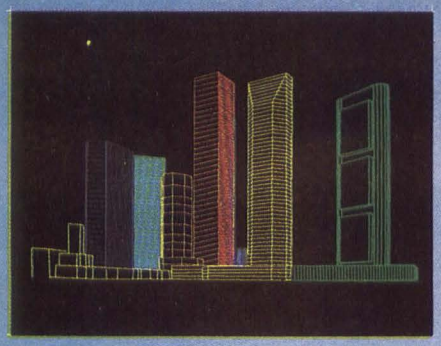

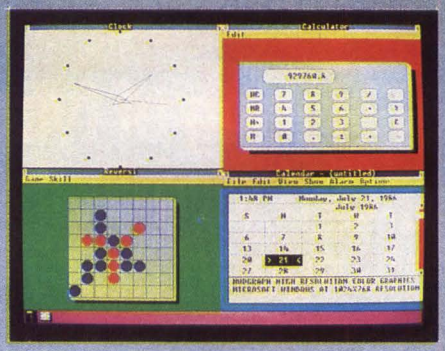

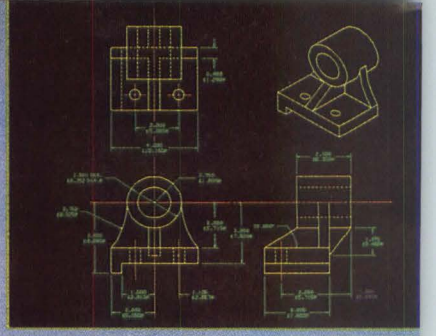

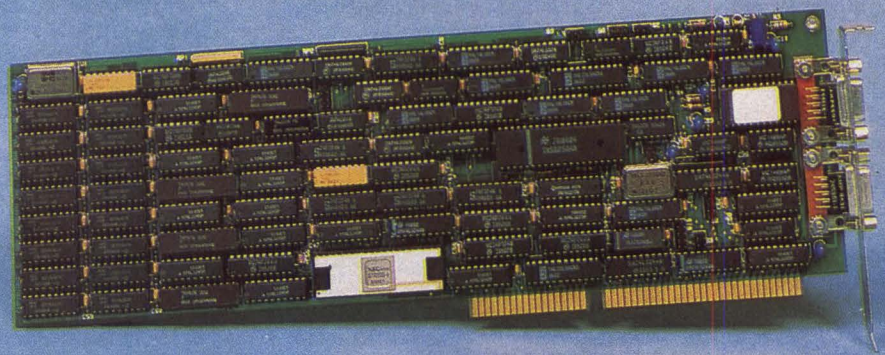

THE MODGRAPH PRISM
PC COLOR GRAPHICS CONTROLLER

The Modgraph PRISM is a high resolution color or gray scale raster scan display controller designed for the IBM PC, XT or AT and compatibles. Utilizing the NEC-7220 graphics controller, bit plane architecture, and dual ported memory, the PRISM is a high performance, cost effective, graphics generator designed for use with popular CAD/CAM/CAE and windowing software packages.

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56 Winthrop St., Concord, MA 01742 (617) 371-2000

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Screen image courtesy of Pointline Comp. Corp. Other images courtesy of Engineering Systems Corp. and Microsoft Corp.

in the creation of the paper should contact David Greenstein, General Motors Technical Center, Warren, Mich., at (313) 947-0571.
—*Wendy Rauch- Hinden*

SYMBOLICS DEBUTS ENHANCED ENTRY-LEVEL, MID-RANGE PROCESSORS

Symbolics Inc., Concord, Mass., is replacing its entry-level 3640 and mid-range 3670 symbolic-processing machines with higher performance VLSI CMOS-based models. With 20 percent greater processing speed than the 3640, and one-fourth the size, the new 3620 has I/O controllers, 4M bytes of main memory (expandable to 16M bytes), a 190M-byte rigid disk and three expansion slots. The new mid-range 3650 is 40 percent faster than its 3670 predecessor and one-half the size. It comes with up to 32M bytes of main memory and a 368M-byte rigid disk. Basic configurations costing $49,000 and $65,000, respectively, are configured with development software.—*Jesse Victor*

Q-BUS, VMEBUS GRAPHICS CARDS FEATURE CONCURRENT WINDOWS

Look for a pair of high-performance graphics display systems for VMEbus computers and Digital Equipment Corp.'s MicroVAX II early next year from Advanced Electronic Design Inc., Sunnyvale, Calif. The board sets will support eight display-memory planes at a resolution of 1,280 by 1,024 pixels and draw 50,000 vectors a second. They furnish multiple concurrent windows for text and graphics. The Q-bus system for the MicroVAX II uses standard facilities of the MicroVMS operating system and costs about $6,500. The double-height VME board is aimed at the UNIX market and will cost about $8,000. Both products are expected to be available in the first quarter of 1987.—*Mike Seither*

XYLOGICS CONTROLLER SUPPORTS 16 PORTS WITH 32-BIT TRANSFERS

If you need full 32-bit data transfers over the VMEbus, consider the model 780 communications controller from Xylogics Inc., Burlington, Mass. It provides 16 full-duplex ports at 9,600 baud or eight ports at 19.2K baud. The dual-height card boosts throughput for UNIX-based multiprocessing, multitasking systems with 10M-byte-per-second direct-memory access and I/O message pipes. Full UNIX TTY subsystem emulation offloads host-computer processing. The $2,495 10-MHz Intel Corp. 80186-based card comes with Xylogics' version of Hunter and Ready Inc.'s VRTX real-time multitasking executive.—*Jesse Victor*

LAPINE, CONNER RETAIN FAITH IN 3½-INCH WINCHESTERS

California disk drive manufacturers LaPine Technology Inc. and Conner Peripherals are so zealous about 3½-inch Winchesters that they build only that size. This month, Milpitas-based LaPine is boosting the capacity of its present line by using run length limited (RLL) encoding to reach 30M bytes. The new Titan RLL 30, with an access time of 65 msec, will be priced under $400 and aimed at the personal computer drive-card market. Meanwhile, Conner is bringing out its first product, the CP 340, a high-performance 50M-byte drive with an embedded SCSI interface. Conner

claims the 340 has an access time of 29 msec. OEM pricing will be about $750. The company, founded by disk-drive veteran Finis Conner and backed by Compaq Computer Corp., has just opened its manufacturing plant in San Jose.—*Mike Seither*

NEW COMPANY READIES HIGH-CAPACITY 3½-INCH WINCHESTERS

Yes, Virginia, there still are disk-drive start-up companies—the newest, Peripheral Technology Inc., Chatsworth, Calif., is betting that their Korean-built 3½-inch Winchesters will match up favorably with similar products. The 20M-byte PT325 and the 30M-byte PT338 supply a 40-msec average access time. Evaluation models are expected to be shipped this month.—*Carl Warren*

VENTURCOM INTRODUCES VENIX E-NET 205 FOR MULTIVENDOR COMMUNICATIONS

VenturCom Inc., Cambridge, Mass., has introduced VENIX E-Net 205. This software program allows IBM Corp. PC/XTs, PC/ATs and compatibles running VenturCom's UNIX-based VENIX System V operating system to be linked to Digital Equipment Corp. VAX minicomputers, and other hardware, via Ethernet using the Transport Control Protocol/Internet Protocol. VENIX E-Net 205, aimed at system integrators, uses Excelan Inc.'s EXOS 205 intelligent Ethernet controller to provide TCP/IP services to the host. This increases networking throughput and application-processing capabilities by downloading CPU-intensive protocol-processing functions to the EXOS controller. That frees the CPU for application processing. VENIX E-Net 205's price of $595 includes two months of telephone support. —*Frances Granville*

SIGMA DESIGNS SHIP 'COOL' PC/AT EXPANSION CHASSIS

System integrators who pack an IBM Corp. PC/AT with high-powered boards often come up short on cooling capacity or slots. Sigma Designs Inc., San Jose, Calif., is offering a solution: the 12-slot ATE Expansion Chassis with four cooling fans. The ATE features its own 275-watt power supply, support for direct memory access and a programmable configuration table. In OEM quantities: $1,500.—*Mike Seither*

TRUVEL'S SCANNER YIELDS X-RAY-LIKE RESOLUTION AND GRAY SCALE

Truvel Corp. of Torrance, Calif.,claims its 300-dpi ZComp prototype digital scanner offers users a 3-to-1 zoom capability that effectively yields 900 dpi. The product supports up to 256 levels of gray for scanned pixels, thus allowing proper handling of halftones that have 64 levels of gray per halftone dot—something no other scanner has achieved. The ZComp, expected to be priced at $5,000, uses a special IBM Corp. PC-compatible interface card. Product availability is planned for early 1987. —*Carl Warren*

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Four times the power of the IBM® PC/XT ...for less.

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The Tandy 3000 HL's 512K RAM lets you run the software that you've grown accustomed to—at a much higher speed for greater efficiency. And you can expand with hard disk drives, modems, and more.

The high power and low price of the Tandy 3000 HL make it perfect for offices requiring several workstations. And the ViaNet local area network can bring your 3000 HLs together with your existing MS-DOS based computers. Users and departments can be more efficient.

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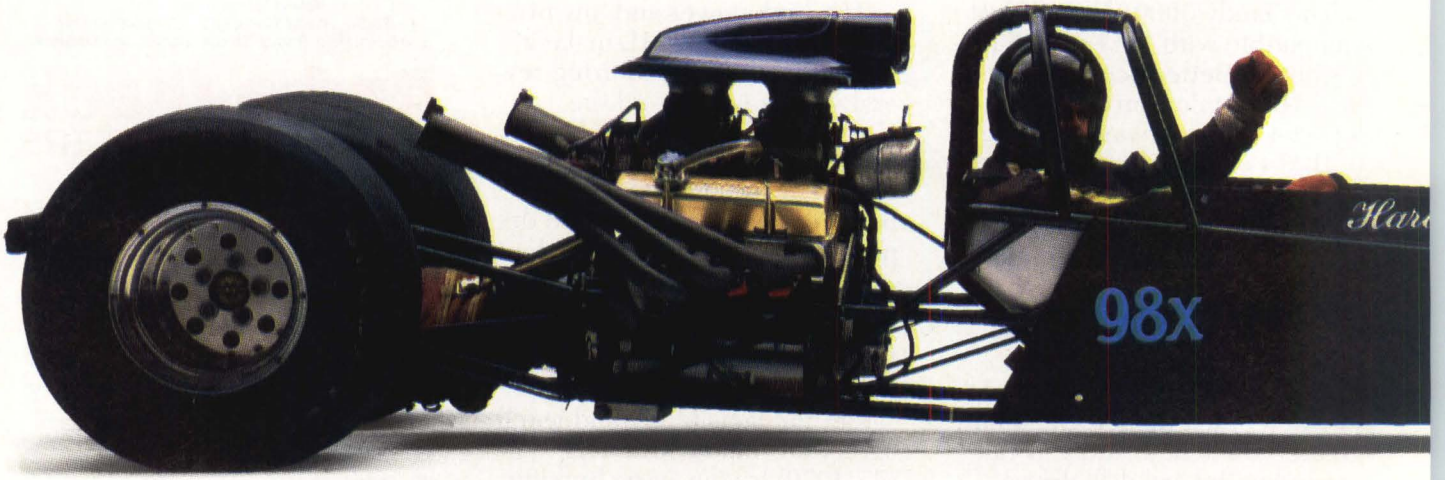
CIRCLE NO. 13 ON INQUIRY CARD

GUESS WHO WINS THE DATA BASE RACE?



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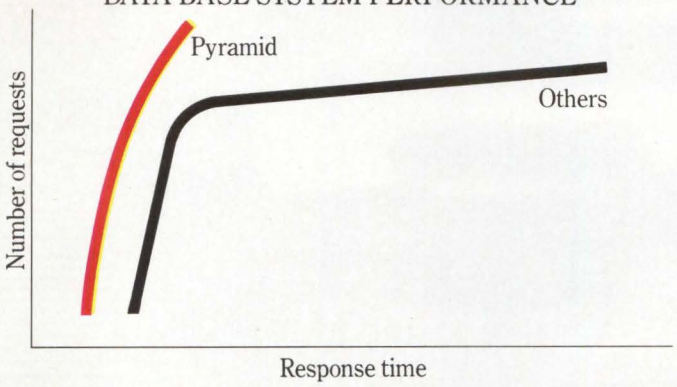
No contest.

When it comes to data base engines, nobody, not DEC,® not HP, not even the mighty IBM,® can out-last, out-blast Pyramid. And the chart below tells the tale.

What it doesn't tell is why. So hold onto your hat.

DATA BASE SYSTEM PERFORMANCE



Other superminis have a very pronounced "knee" in their curve. That's where their I/O subsystems hit the wall. But not Pyramid. Thanks to our distributed processor architecture, we deliver crowd-pleasing performance. For as little as 2/3 the cost of our competitors' systems.

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There's comfort, too.

Yours.

We have strong relationships with every major relational data base manufacturer. So not only will you have a choice of what to run, you'll get support from both us and them. No matter who "them" is.

And since Pyramid systems are open systems, built on widely-supported industry standards, we can give you more different ways to go. Without locking you in. Or locking your other suppliers out. Chances are, they support the same standards. Like UNIX,® for instance.

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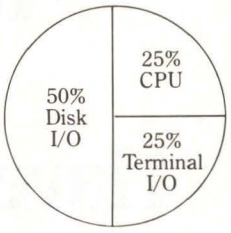
While raw MIPS are important to a data base system's performance, the system still spends most of its time on terminal and disk I/O. That's why we use multiple distributed processors. They put the computing power where you need it. So you're not sitting there spinning your wheels.



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CIRCLE NO. 14 ON INQUIRY CARD

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CIRCLE NO. 15 ON INQUIRY CARD

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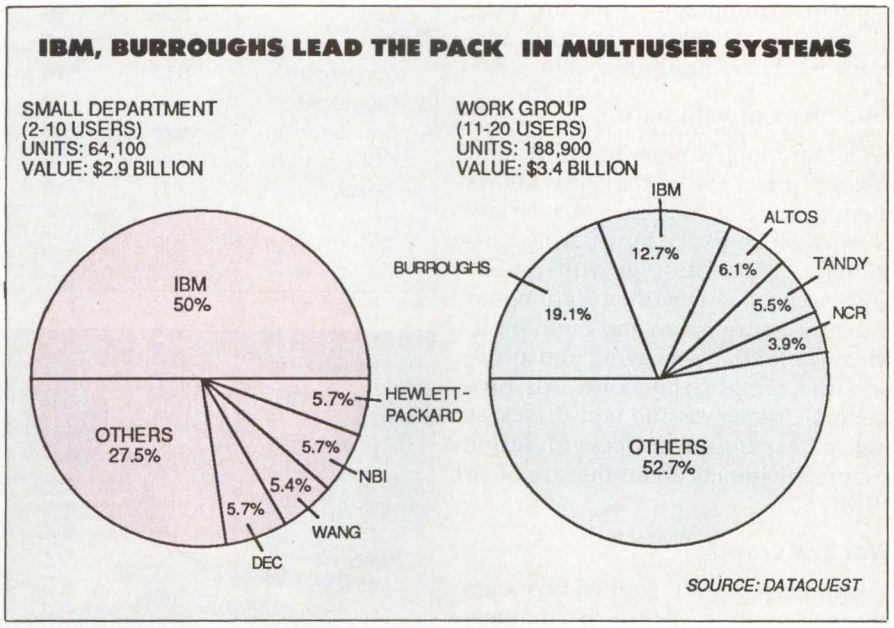
With modularity, Counterpoint builds multiuser computers

Mike Seither
Associate Western Editor

When you try to muscle your way into a crowded market, it helps to have Rambo at your side. That's what Counterpoint Computers hopes it has with AT&T Co.—and other big investors—as it tries to sell its new System 19K multiuser computers.

Counterpoint, based in San Jose, Calif., offers OEMs wide latitude in configuring systems that serve from six to 56 users. The company claims it can do this at prices starting at $9,650 in OEM quantities, which begin at about 50 units, much lower than many key competitors. That could rank Counterpoint among the price leaders for multiuser systems using the Motorola Inc. MC68020 processor.

For example, two competitors based in San Jose, Calif.—Altos Computer Systems and Convergent Technologies Inc.—ask for OEM quantities of 300 units before they cut prices to, respectively, about $8,000 and $6,000 for entry-level versions of their multiuser products.



'Nice and aggressive'

Sandra Gant, an analyst with InfoCorp., a market research concern in Cupertino, Calif., says: "They have a nicely engineered, aggressively priced product that's expandable. It will ultimately be up to Counterpoint's resellers to define the markets."

Other market analysts like Gwen Peterson, director of computer industry service for Dataquest Inc., a San Jose market researcher, are as much interested in Counterpoint's backers and resellers as they are in its products. Peterson says the alliances are sure to open doors. "It's not [Counterpoint's] products so much as its window on world markets that will be interesting to watch," she says.

The biggest name: AT&T, which signed OEM agreements with Counterpoint and is expected to use, and resell, System 19K.

Other major investors include Kyocera Corp., the Japanese giant in ceramic packaging of integrated circuits, and British and Commonwealth Shipping Ltd., a U.K. company with large holdings in high technology.

Multiprocessing is key

Offering multiprocessing capability at the low end of the market is one of Counterpoint's main marketing thrusts, says marketing vice president Paul Rosenfeld. He points out that most of Counterpoint's competitors rely on UNIX-based single-CPU technologies.

"We believe System 19K will redefine what the low-end multiuser computers are going to be," Rosenfeld says. "Our goal is to have a simple but complete line that spans a broad range of price and performance."

Besides Altos and Convergent, the competition includes Burroughs Corp., Charles River Data Systems Inc., Digital Equipment Corp., Hewlett-Packard Co., IBM Corp., NBI Inc., and NCR Corp.

System 19K is based on Counterpoint's Advanced System Platform (ASP), a 32-bit multiprocessing architecture the company originally introduced in March. The first product to roll out of Counterpoint was a standalone monochrome graphics workstation. But with that announcement, Counterpoint emphasized that the basic ASP architecture would be the foundation for not only graphics sys-

tems but also for multiuser computers and network servers.

For the System 19K multiuser system, Counterpoint has augmented the ASP architecture with processors to handle file I/O and tie into peripherals using the small computer system interface (SCSI). In addition, Counterpoint has made networking an integral part of the System 19K by building in an Ethernet adapter as standard equipment—a feature that, if available at all on competing systems, is usually an option only.

'Seamless growth path'

Counterpoint's pitch to OEMs and system integrators is that ASP allows them to address the needs of a variety of vertical markets by offering customers a "seamless growth path." OEMs can begin with a bare-bones one-processor system and build on it. Meanwhile, the packaging and product line remain the same. All processors, disk drives and tape drives, as well as expansion devices, fit inside common cabinets about the size of an IBM PC.

War in a crowd

Counterpoint was formed two years ago under the guidance of company president Pauline Alker. Alker, a former Convergent Technologies executive, was involved in Convergent's major OEM deals with AT&T.

Although it is well-funded, has AT&T in its corner and is strategically allied with large international investors, success is not assured for Counterpoint: It faces formidable competition from a number of entrenched vendors.

At least 150 manufacturers now produce multiuser systems. Of those, about three dozen make UNIX-based multiuser computers driven by Motorola's MC68000 microprocessor family, says InforCorp's Gant. It is the 32-bit MC68020 and Counterpoint's version of the UNIX operating system that form System 19K's backbone.

In its CXIX operating system, Counterpoint has implemented AT&T's UNIX System V 2.2 and has added features of Berkeley UNIX Version 4.2, including the libraries and commands for local area networking.

OEMs may begin with a single bus structure at the low end, or choose to use a double bus designed for higher performance, while still using the same system components and operating system.

Modular cabinets

For low-end applications using up to two processors, Counterpoint offers an asynchronous 32-bit-wide System Composition Bus that can move data at 12M bytes per second. It's the System Composition Bus that ties together up to seven Counterpoint stacked modular cabinets. Using serial arbitration, the bus provides access to all processors, peripherals, Counterpoint's built-in Ethernet interface and custom boards.

For more performance, OEMs can add a synchronous Interprocessor Bus, which has a maximum data rate of 33M bytes per second and uses parallel arbitration. In high-end systems, the Interprocessor Bus handles communication between the terminal, application and graphics processors, while the System Composition Bus takes care of I/O activities.

Counterpoint's Rosenfeld says ASP balances the load of up to six processors in any combination as they exe-

HOW REPRESENTATIVE 68020-BASED MULTIUSER SYSTEMS STACK UP

Vendor	Model	Maximum memory (M bytes)	Operating system	Maximum users	Maximum disk capacity (bytes)	Entry price ($)
Alpha Micro	AM2000	28	AMOS	240	2.4G	19,000 (list)
Altos	3068	16	UNIX	30	570M	7,900 (Q300)
Charles River	Universe	16	UNIX	96	3.2G	19,000 (list)
Convergent	S320	16	UNIX	32	4G	6,000 (Q500)
Cromemco	CS420	16	UNIX	64	280M	27,995 (list)
Counterpoint	System 19K	40	UNIX	56	560M	9,650 (Q50)
NCR	Tower 32	16	UNIX	32	4.7G	21,700 (list)
Plexus	P75	16	UNIX	80	6.5G	23,500 (Q50)

Source: Manufacturers, Mini-Micro Systems

Counterpoint *has designed its multiuser computer to support from six to 56 users. The UNIX-based system can simultaneously balance the work load of up to six application, terminal and display processors.*

cute applications, I/O functions and bit-mapped graphics. Using a distributed dual-port architecture, each processor has local tightly coupled memory; yet each can use the memory of companion processors. Counterpoint is not short on memory. A system can have up to 40M bytes of RAM.

To help accomplish multiprocessing, Counterpoint locates copies of a small part of the UNIX kernel—containing memory and process management, as well as paging—on each processor so that those functions can be handled independently. The drivers for Ethernet and storage peripherals, however, remain in the central processor. □

SOFTWARE VIEWS

In battle over UNIX, POSIX is a peacemaker

Michael Tucker, Associate Editor

The trouble with UNIX is that you can never tell what's news and what isn't. For instance, at this year's NCC, AT&T Co. announced UNIX System V Release Three. The new release—which may have been the subject of more speculation than any technology since the Manhattan Project—was greeted with a yawn heard round the world. The trade press, market analysts and informed users responded grumpily that there was nothing in Version Three that they couldn't have gotten elsewhere.

In all fairness, Release Three wasn't all that bad. The way it handles distributed computing problems, for example, proves it to be good and solid software. But, apparently, good and solid wasn't enough. What was wanted was something Big and Blue. As Three was being analyzed with universal and militant apathy, another version of UNIX was being hailed as a genuine revolution: AIX, the UNIX-compatible operating system used by the IBM Corp. RT PC.

Some observers said AIX proved that UNIX was the wave of the future. Of course, there was another view: that AIX might be a Trojan Horse, bringing an end to UNIX. Speaking informally, one developer told me, "If you look very closely, you"ll see that's what really in there is a [IBM] VM kernel with a UNIX shell."

Meanwhile, almost unnoticed, the IEEE computer society's P1003 working group on UNIX standards (the group includes IBM and AT&T as members) announced POSIX. And, perhaps, it's POSIX that's news in the long run. AIX and Three, because of IBM and AT&T, may dominate events in the large and flashy way of short-lived phenomenon. POSIX, on the other hand, could be as inevitable and eternal as continental drift.

The IEEE working group can't use the name "UNIX" because that is a trademark of AT&T. Therefore, when P1003 set out to build a trial standard that would provide application portability between UNIX-compatible systems, it also had to produce a name for that standard. It came up with POSIX, which combines "Portable Operating System" with the "IX" designation of many UNIX-compatible systems.

POSIX now exists as an IEEE "trial use document." That is to say, it is a specification for software rather than actual software. It spells out exactly how the IEEE thinks applications should interface with UNIX-compatible operating systems like AIX, Three, XENIX and all the rest of that crew. POSIX is concerned solely with the UNIX interface. The people who wrote it deliberately set out to ignore what goes on in the kernel. Their Eleventh Commandment was, "Thou shalt not muck about below the shell."

The history of UNIX has been a story of repeated kernel-level changes. Originally meant as an operating system for software development, UNIX has been gradually forced to do things that it simply wasn't designed to do—for example, jobs in office automation and real time processing. These jobs required extensive revisions at its very heart. Indeed, maybe that was why Three appeared such a dud: It did not contain the fundamental, kernel-level changes that many UNIX fans feel are necessary. But then, since those same UNIX fans are using UNIX for quite dissimilar purposes, requiring quite different kernel-level changes, maybe AT&T would have been damned no matter what it did. Perhaps, too, that was what made AIX so exciting; it did something really dramatic with the kernel, even if that meant throwing it away completely.

A good many people would argue that the very nature of computing, with all those different applications and mutually incompatible requirements, makes a single, all-things-to-all-users super-kernel impossible. If so, then the future of UNIX may be its interface, below which different specialized kernels will be switched in and out, depending on the unique requirements of the application. That interface is POSIX. One could envision a UNIX industry in which vendors would develop vertical-market kernels. Users would then purchase those kernels secure in the knowledge that they would interface with anything else that also maintained POSIX-compatibility.

Yes, this really is the Year of the LAN

Lori Valigra
Contributing Correspondent

After several jump starts, the local area network industry is roaring this year, ignited by the big engines of IBM Corp. Next year could be even better. When IBM revealed key elements of its token ring LAN strategy last October, it brought order to a market awaiting a standard from its largest would-be leader.

"The local area network market has come into its year," says Mark D. Stahlman, research analyst with the Sanford C. Bernstein & Co. Inc., New York, investment research concern. He says IBM introduced a LAN that is easy to use and set up: It will stimulate business for system integrators and value-added resellers. "IBM has accelerated the pace of token ring product introductions and is working closely with a number of independent LAN vendors to push the token ring among them. There will be big opportunities in 1987."

Among those opportunities are products connecting or bridging token ring LANs and the other industry standard LAN, Ethernet. Although Xerox Corp., Stamford, Conn., launched a strategy similar to IBM's five years ago with Ethernet, Xerox lacked the strong computer line and installed base needed to popularize LANs. Ethernet got a much needed boost three years ago when Digital Equipment Corp., Maynard, Mass., began selling products using it, explains George Colony, president of Forrester Research Inc., a Cambridge, Mass., market research concern.

Activity increases

Colony and other industry analysts have noticed a marked increase in activity among system integrators

Token-Ring inventor levies license fees

There was a hitch when IBM Corp. announced its Token-Ring Network local area network last year. IBM didn't own the patent for token ring technology, and some industry participants feared they'd have to pay hefty royalties to the man who did: Olof Soderblom, a former IBM employee.

This summer, Soderblom said he wants royalty fees of 1 percent of the net selling price, to a $275 maximum, depending on the price or volume of product sold. There also is an initial $15,000 sign-up fee and a $10,000 advance for future royalties.

Soderblom claims to have 16 licensees, with 10 pending. Ungermann-Bass Inc. and Bridge Communications Inc. have licenses. The royalties don't apply to IBM, which bought a flat fee license in 1980. Industry analysts estimate the license cost Big Blue's World Trade operation about $5 million.

The right to collect royalties was granted Soderblom after a 16-year, $1-million battle defending repeated challenges to his invention (he invented the token ring concept, not the actual LAN). The patent was reissued in March 1985. "Little did I know that this would become a career of mine," says George Vande Sande, Soderblom's attorney and a partner at Pollock, Vande Sande & Priddy, Washington, which took the case in 1968.

Soderblom came up with the token ring concept in 1967 when he worked for Swedish bank Svenska Handelsbanken. The bank needed an on-line system to attach 2,000 terminals in 500 branch offices spread over 1,500 miles. Soderblom's concept was to use unaddressed or decentralized polling, subsequently called token ring. IBM was one of the primary contractors supplying equipment for the network, and it subsequently used the technology in its retail and banking computer systems and in its Token-Ring Network LAN.

SODERBLOM PATENT LICENSING FEES

Basic fees	$15,000, sign up $10,000 advance or future royalties	
4M-bps	**No. of boards**	**Percentage of**
PC board fees	**sold per quarter**	**net selling price**
	1-6,000	2.75
	6,001-12,000	2
	12,001-XXX	1
Other board fees	**Net selling price ($)**	**Percentage of royalties**
	1-600	4
	601-10,000	2.67+7.98
	10,001-XXX	$275 maximum
Node (box) fees	**Net selling price ($)**	**Percentage of royalties**
	1-10,000	2.75
	10,001-XXX	$275 maximum

Source: Olof Soderblom

Soderblom, who worked for IBM in Sweden from 1969 to 1975, believes he won't face more patent fights. "I can now walk the tightrope without a safety net" he says. His U.S. patent does not expire until 1998.

He's gotten a tidy remuneration for his troubles. Royalty income last year was $750,000, and it topped $1 million in the first five months of this year. He says he's spent about $1 million to prosecute and address patent claims internationally.

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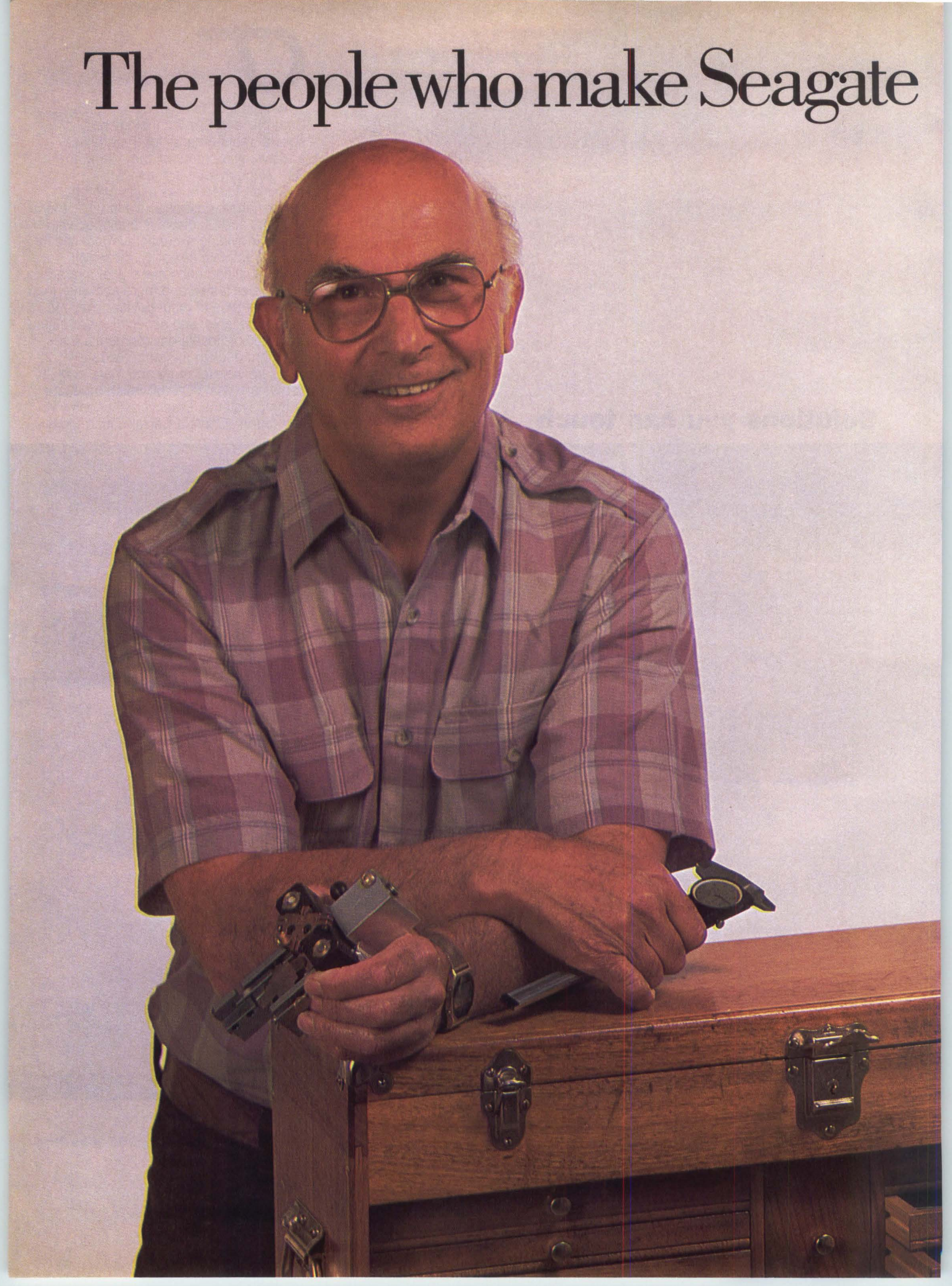

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CIRCLE NO. 17 ON INQUIRY CARD

who are using LANs within departments or small work groups and, increasingly, tying them to larger corporate networks.

Examples:

Bankers Trust Co., New York, is moving to get 18 personal computer networks to communicate with one another and with other computers and networks.

The Travelers, Hartford, Conn., plans to install 1,000 IBM token ring networks nationwide and has spent millions of dollars wiring its renovated buildings for the IBM network.

"Large organizations are making commitments worth $10 million or more to corporate-wide networking," says Ralph Ungermann, president of Ungermann-Bass Inc., Santa Clara, Calif. The company, the largest supplier of general purpose LANs, sold $72 million worth of networks based on Ethernet technology last year.

Judging from the size of some recent LAN purchases (the National Security Agency has awarded AT&T Co. a $50 million-plus contract), the existence of more than 300 equipment suppliers and estimates that only 3 percent of the 14.9 million computer workstations in U.S. companies were attached to LANs last year, the market for the products is large. According to estimates by the investment research concern, Sanford C. Bernstein, the $405 million worldwide LAN market in 1984 should grow to $1.2 billion in 1986 and to $4.9 billion in 1990, an average annual growth rate of 50 percent.

Fortune 1000 firms will buy about 45 percent of the LANs, says Forrester's Colony. He expects IBM to gain a 43 percent market share with the Token-Ring Network and its other network, the PC Network. Colony says IBM could draw in about $1.5 billion in revenues by 1990 from Token-Ring.

Creates opportunities

As did the IBM PC, the Token-Ring Network will create opportunities for system integrators, analysts believe. Already, Apple Computer Inc., Cupertino, Calif.; Bridge Communications Inc., Mountain View, Calif.; 3Com Corp., Mountain View; Ungermann-Bass and software companies such as Microsoft Corp., Bellevue, Wash., have announced support for connections to the Token-Ring Network or other products for it.

Jon Shirley, Microsoft president, says LAN software, particularly applications programs, will represent a bigger portion of his company's revenues. "There's a lot of potential out there. Almost no existing software is designed to take advantage of local area networks, especially software for personal computers," he claims. Microsoft sells its MS-Net software to help programmers write software for any type of LAN.

Another potentially booming market will be for hardware and software that can connect Ethernet and token ring networks. 3Com, Banyan Systems Inc. of Westboro, Mass., and others offer such gateways. Colony says the market for such products was $53 million in 1984 and should expand to $743 million in 1990.

Even IBM sees the need to offer connections to both types of LANs. In late June it announced both Ethernet and token ring connections for its RT PC reduced instruction set computer. The Ethernet adapter card ($850) runs at 10M bits per second; the token ring card ($1,095), at 4M bps.

There'll be opportunities for system integrators and VARs to connect LANs to more complex networks such as DEC's DECnet and IBM's Systems Network Architecture. Companies like Apple, 3Com and Ungermann-Bass are positioned to sell larger network-systems solutions to capture market share in the maze of corporate networks.

3Com is moving from being a LAN-adapter supplier to offering systems for work groups, says president Bill Krause, who estimates there are about 5 million users in 10 million work groups who are potential customers.

DEC is furthest along in tying together all levels of networks, says Colony. DEC includes built-in Ethernet hardware in all new products; the price of the LAN attachment is as little as $50 per computer or terminal. DEC has about 3,400 Ethernet customers, and about half of its VAX minicomputers are sold with networks.

Consultant Stahlman estimates DEC drew $165 million in LAN revenues last year and should sell $220 million worth this year.

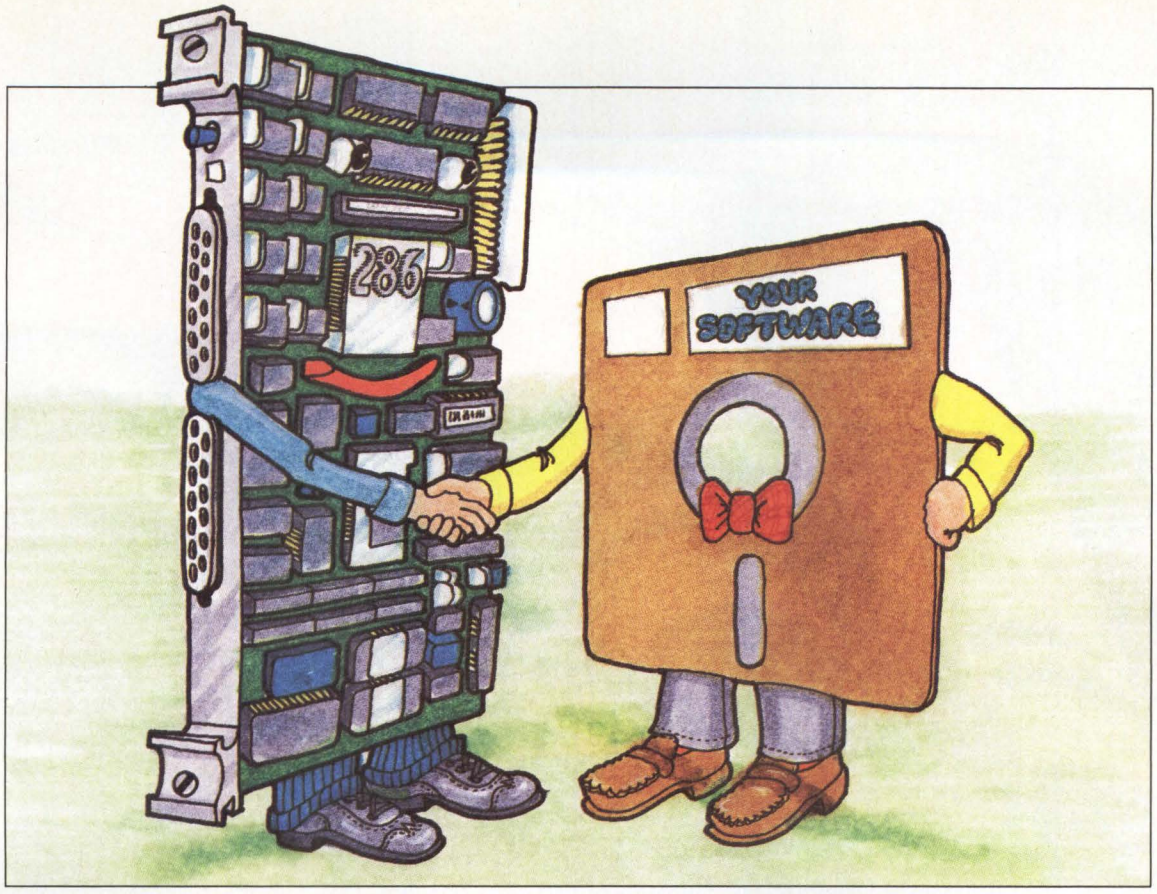
AT&T's ambitions

AT&T, another major competitor, has high ambitions for its LANs and is building sales from its 44,000 customers of private branch exchange (PBX) telephone systems. George Martin, director of computer market-

IBM WILL COME ON STRONG

	Market share (%)			Revenues ($ millions)			Revenue growth (%)		
	1985	1986	1990	1985	1986	1990	1985	1986	1990
Ungermann-Bass	21.0	19.9	15.8	53.6	93.1	268.6	44.0	73.8	10.1
Sytek	11.3	11.8	9.0	28.9	55.1	152.9	85.0	90.6	18.0
Bridge	8.3	8.6	10.1	21.1	40.3	171.6	82.0	90.7	28.0
Micom/Interlan	9.7	8.7	5.4	24.8	41.0	92.3	42.2	65.5	8.9
Network Systems	5.4	6.8	8.2	13.8	31.7	139.1	173.9	129.0	28.9
Other datacomm	25.5	21.2	8.4	65.2	99.2	143.6	143.6	52.2	(12.5)
IBM	0	1.6	8.3	0	7.7	141.8	0	0	57.1
DEC	4.2	4.4	5.8	10.6	20.8	98.5	73.0	95.7	29.9
Other computer	14.6	15.5	18.9	37.3	72.4	321.2	0	94.4	24.9
AT&T	0	1.0	6.4	0	4.5	109.1	0	0	51.7
Other PBX	0	0.6	3.6	0	2.6	61.3	0	0	54.4
TOTAL	100	100	100	255.3	468.4	1,700.0	80.5	83.5	21.5

Source: Sanford C. Bernstein & Co.



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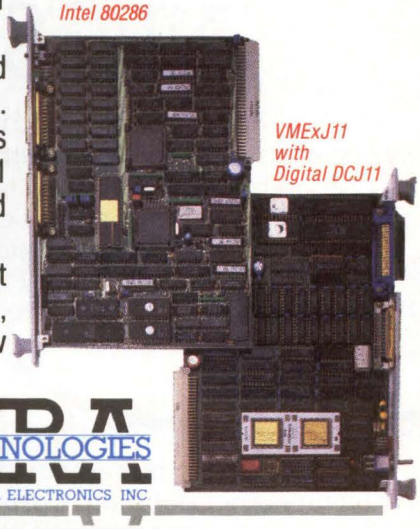

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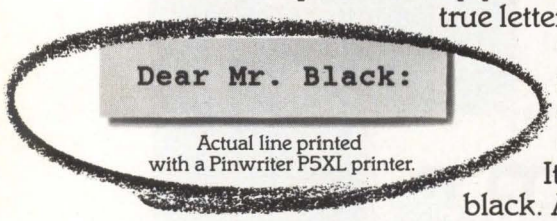

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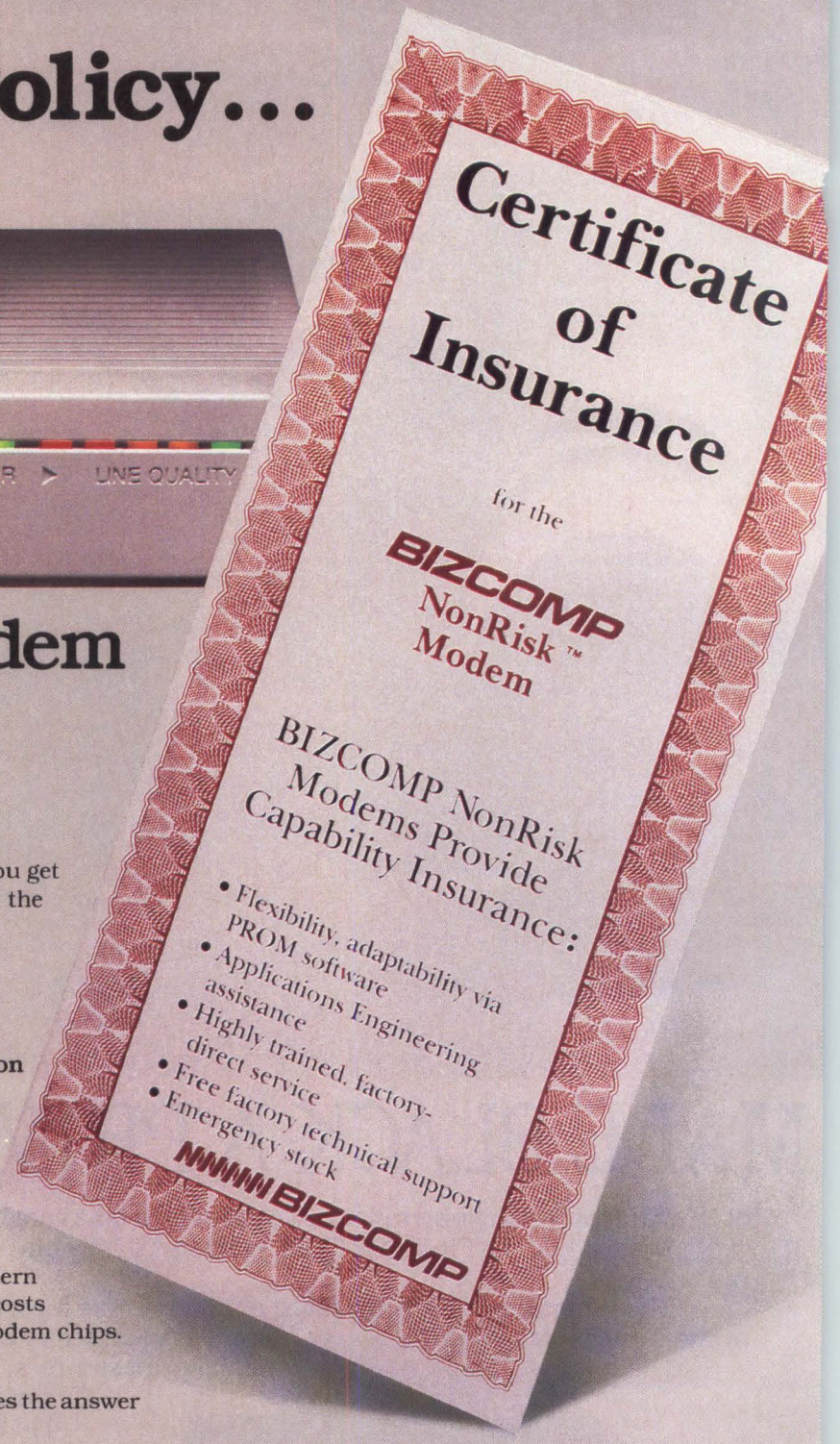

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ing at AT&T in Morristown, N.J., says, "We want to come from our communications strength and initially go after the PBX base to capitalize on our heritage."

AT&T offers several LANs, including a competitor to token ring offerings called Starlan. Martin is keeping all options open. "If a token ring connection is needed in a network, we'll offer it." A minimum Starlan connection—including cable, hardware and software—is $720. Colony says Ethernet costs about $1,000 per computer connection; Token-Ring Network, $1,500. AT&T also offers a PC PBX connection board to connect AT&T or IBM and compatible personal computers to the PBX for $700.

To capitalize on the market potential, independent LAN companies are forming strategic alliances to expand their product lines and distribution channels. Ungermann-Bass and IBM, for example, will codevelop industrial-automation LAN products with Industrial Networking Inc., Santa Clara, Calif., a joint venture company of Ungermann-Bass and General Electric Co. And Ungermann-Bass has signed to work with Hewlett-Packard Co., Palo Alto, Calif., to coordinate support for customers owning Ungermann-Bass broadband Net/One networks and HP 1000 and 3000 minicomputer systems.

3Com and fiber optic company Codenoll Technology Corp., Yonkers, N.Y., have become strategic partners in an agreement that will enable 3Com products to transmit over fiber-optic cable.

Even IBM expanded its distribution by creating a new type of value-added dealer. Instead of just being able to sell one token ring package with each PC sold, the new VADs design, install and maintain LANs for customers with large numbers of standalone personal computers. □

New satellites provide links to remote terminals

Stephen J. Shaw
Washington Editor

A combination of small, inexpensive earth stations and a new generation of communication satellites offers new ways to interconnect host computer systems and remote terminals. Satellite-based data networks, scheduled to appear this year, may permit providers of long-distance telephone service to reach customers directly, bypass local telephone lines and eliminate network access charges now paid to local telephone companies.

Several satellite-system operators have teamed with earth-station manufacturers and providers of recently announced data communications services. A handful of large organizations has also unveiled plans to use thousands of small, interactive satellite "dishes" to beam data between host systems and processors at remote locations.

In May, AT&T Communications began its Skynet Star Network Service. The first customer was AT&T Communications, which will use satellite transponders leased from RCA American Communications Inc., Princeton, N.J., to transmit data at rates between 9.6K bits per second (bps) and 56K bps from a central earth station hub to an unspecified number of remote locations.

According to John Smart, vice president of business markets and services for AT&T Communications, the service is aimed at customers like large retail concerns and financial-service organizations that collect and disseminate data over wide areas.

AT&T joins a number of other communications carriers that have entered the market to provide interactive data services by satellite. GTE Spacenet Corp., McLean, Va., which markets its service under the Skystar-200 label, provides throughput rates ranging from 2.4K bps to 56K bps. MCI Communications Corp., Washington, is expected to announce a

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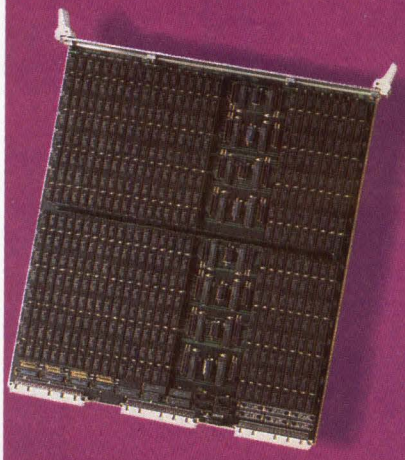

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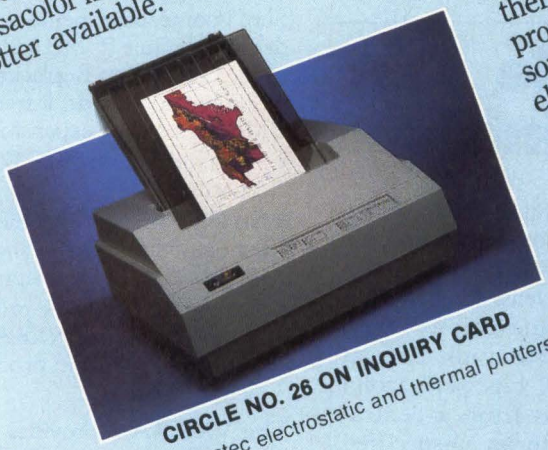

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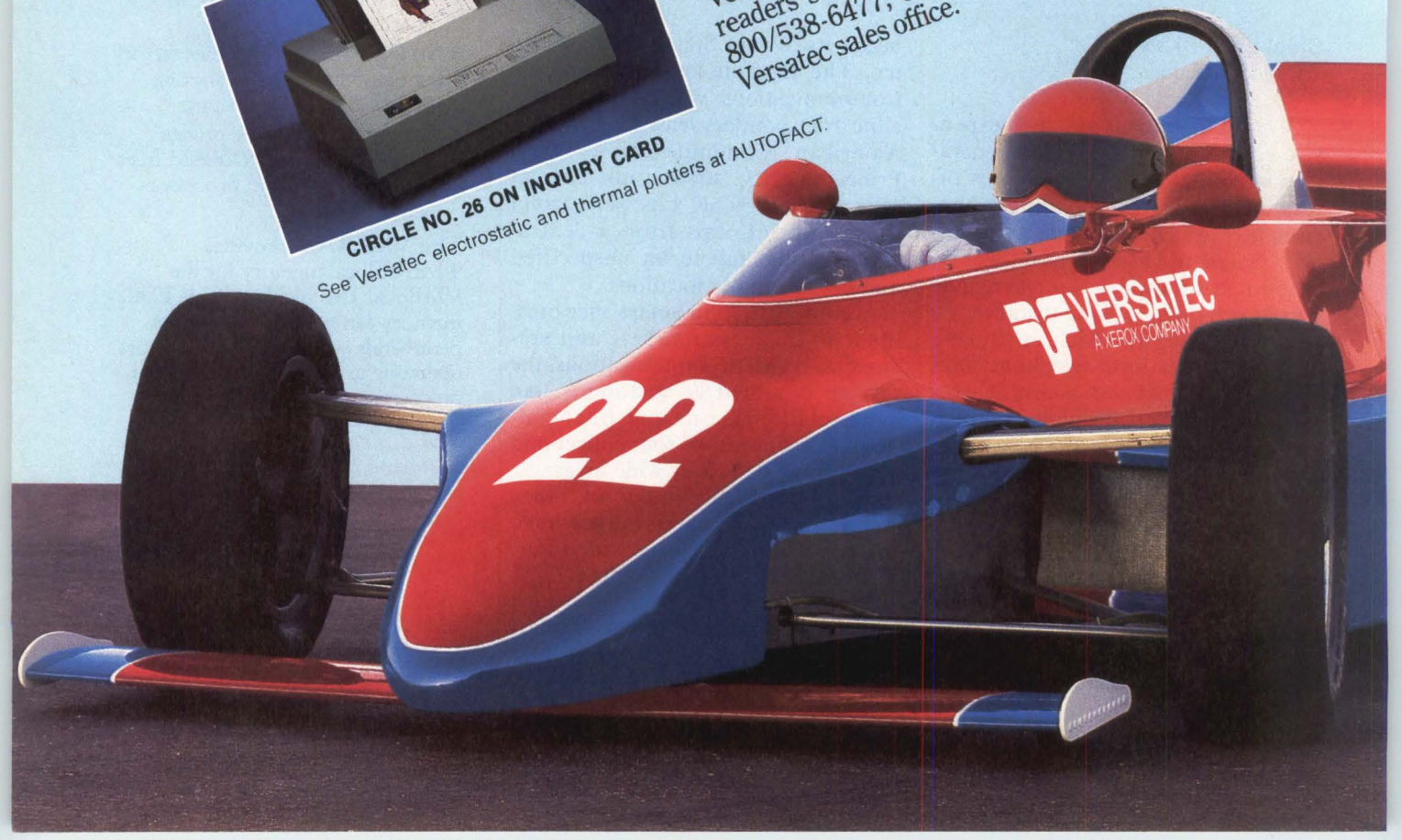


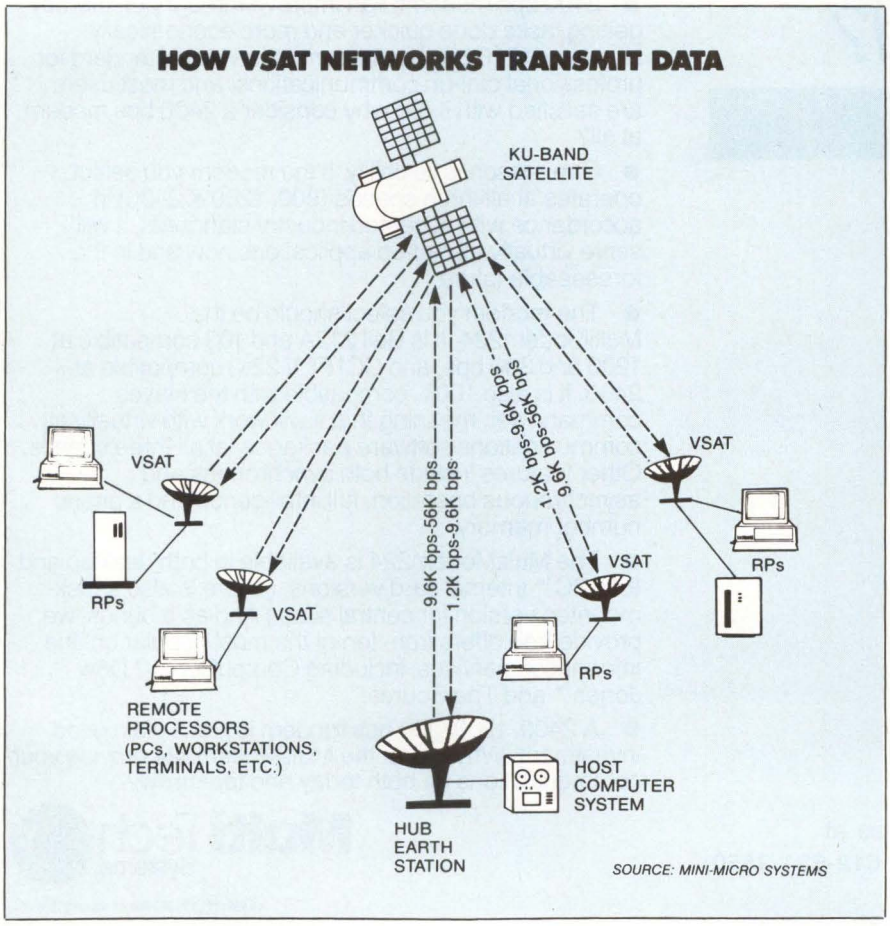
similar service. It would use the three satellites and the marketing staff it acquired last year from Satellite Business Systems, McLean, Va., in the deal that brought in IBM Corp., a former part owner of SBS, as an investor in MCI.

For ground hardware, AT&T has signed a "teaming arrangement" with Harris Corp., Melbourne, Fla. Harris is expected to provide the earth-station terminals, packet-switching and interface equipment to link the stations with host computers and remote processors. In turn, Harris has signed an agreement with Matsushita Electrical Industrial Co. of Osaka, Japan, that will permit Harris to market Matsushita-built earth stations to AT&T and others in the United States.

In a similar fashion, GTE has reached an agreement with NEC America Inc., Fairfax, Va., for NEC to supply its Nexstar line of small earth stations. The stations, designed by NEC's Japanese parent corporation and manufactured in the United States, weigh less than 250 pounds and can be mounted directly at customers' premises on rooftops, outside walls, in parking lots or other locations adjacent to a building. Delivery of the stations is expected to begin sometime next year.

Users line up for networks

Despite this recent activity, potential corporate users of these satellite data networks have not been content to wait for the service providers to develop their offerings. In the past 12



In a VSAT network, *data goes from remote VSAT earth stations at relatively low speeds through a satellite down to a hub earth station. The station is connected with a central host processing system. The network packetizes, addresses and transmits outgoing data from the hub at higher rates to the remote terminals, which pass data to interconnected terminal equipment.*

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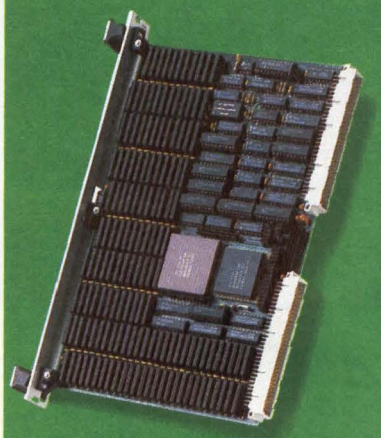

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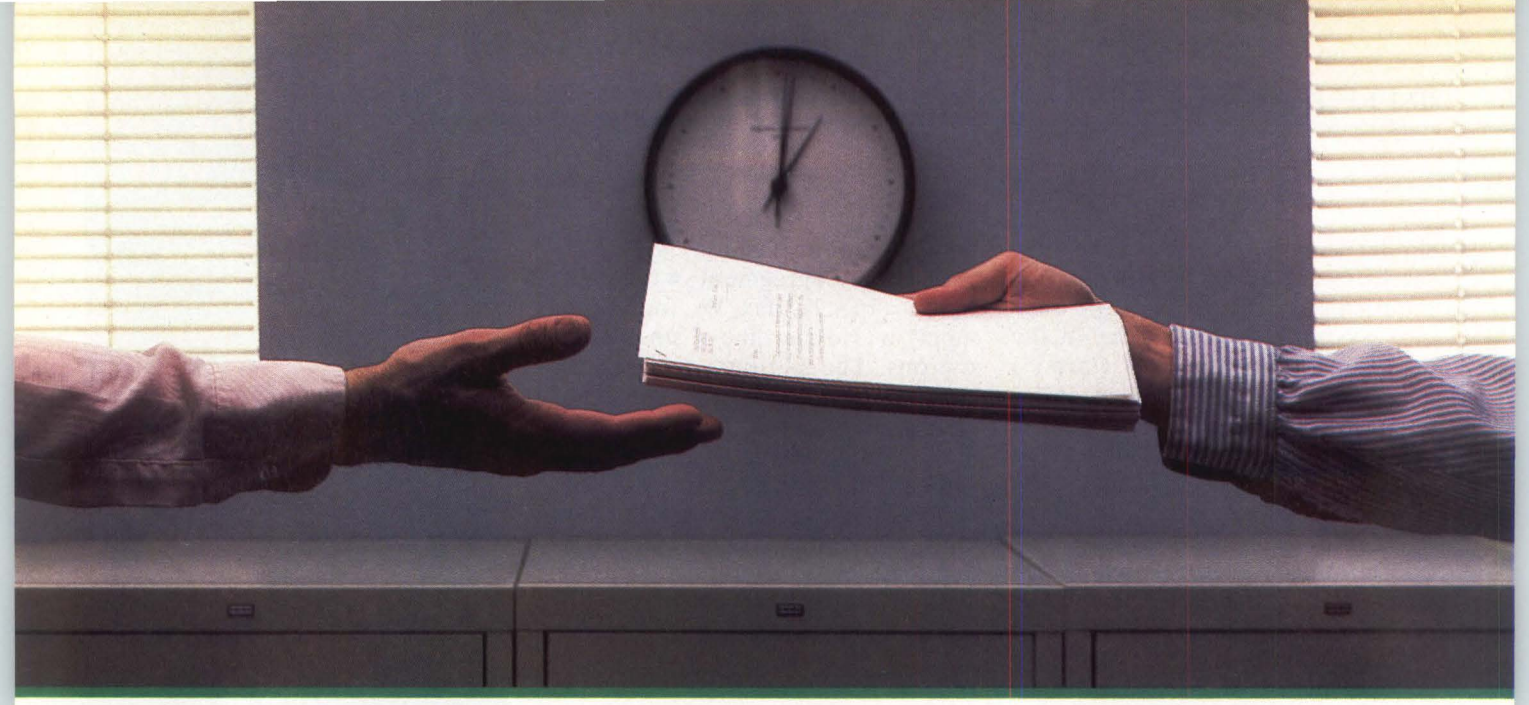

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months, a number of large organizations have announced plans to establish their own networks.

Southland Corp., the Dallas-based parent company of the 7-11 convenience stores, intends to build a network of 8,000 earth stations for low- and medium-speed data applications. Federal Express Corp., Memphis, Tenn., expects to have as many as 25,000 satellite earth stations in place at company facilities by 1990 to carry its Zapmail electronic facsimile service. Retail chains, including several department stores, have also announced their intentions to install satellite data networks averaging 2,000 stations each.

Two related technical developments have converged to attract unprecedented attention to space-based data networks. The first is the emergence of a new class of communication satellites. Launched by RCA and GTE last year, these satellites operate at Ku-band frequencies, or between 12 GHz and 14 GHz. Unlike the 4-GHz-to-6-GHz C-band frequencies, employed by the majority of commercial communications satellites launched in the late 1970s, the new frequency band is not subject to interference from terrestrial microwave systems. These microwave communications systems, prevalent in metropolitan areas, effectively limited the markets for satellite earth terminals in those cities and towns with a large concentration of potential business users.

Secondly, these Ku-band satellites utilize more powerful signal amplifiers than do their C-band counterparts. This has allowed the development of a new class of earth stations, called very small-aperture terminals (VSAT). Measuring no more than 5 feet in diameter, these VSATs are smaller, lighter, easier to install and far less expensive than the 16- and 23-foot-diameter earth terminals that are typically employed in the lower frequency satellite networks.

The VSAT data networks designed by AT&T and others are arranged in a "star" configuration. A central hub earth station, with a larger antenna ranging from about 11 feet to 23 feet in diameter, is connected to the host system. The hub station also performs the packetizing of the data traffic and directs the overall management of the network, including adding the addresses of the remote station where data is to be sent outbound at data rates of up to 56K bps.

The smaller, remote VSATs send data inbound (remote-to-hub) at typical rates of 2,400 bps. The data packets contain address headers that inform the hub station if the data is to be processed by the host computer and stored, or transmitted to any combination of other VSATs.

Lower cost than leased lines

"The combination of satellites and VSATs basically form a sophisticated pipeline for data communications," comments Robert Hendee, vice president for Harris' communications division.

That pipeline is expected to provide a highly economical alternative to leased telephone channels that are traditionally employed for data networks that interconnect a large number of end-user facilities. Although AT&T provides the bulk of the long-distance terrestrial circuits for data traffic, the company and its customers must still rely on local telephone operating companies to provide the local loops. Ordering and installing service for new nodes, modifying traffic rates, or reconfiguring the network through the local telephone companies is often a time-consuming and expensive procedure.

"The local loops are still a problem, and I'm sure AT&T is frustrated with the [former] Bell operating companies," comments telecommunications analyst Walter Morgan, president of the Communications Center of Clarksburg, a consulting organization in Clarksburg, Md. "With VSAT networks, AT&T can bypass the local telephone companies and go directly to their customers' premises."

Under the AT&T Skynet tariff, a 500-node network utilizing two-way data VSATs would cost the user between $250 and $400 per month per location under a seven-year lease. This price includes network design, management and maintenance, as well as the ground hardware and transponder capacity on the satellite. Users do not pay any access charges to

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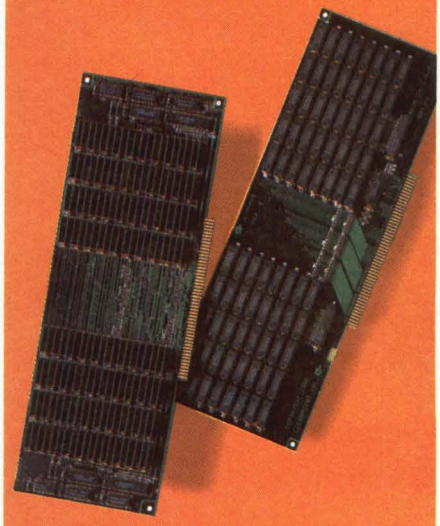

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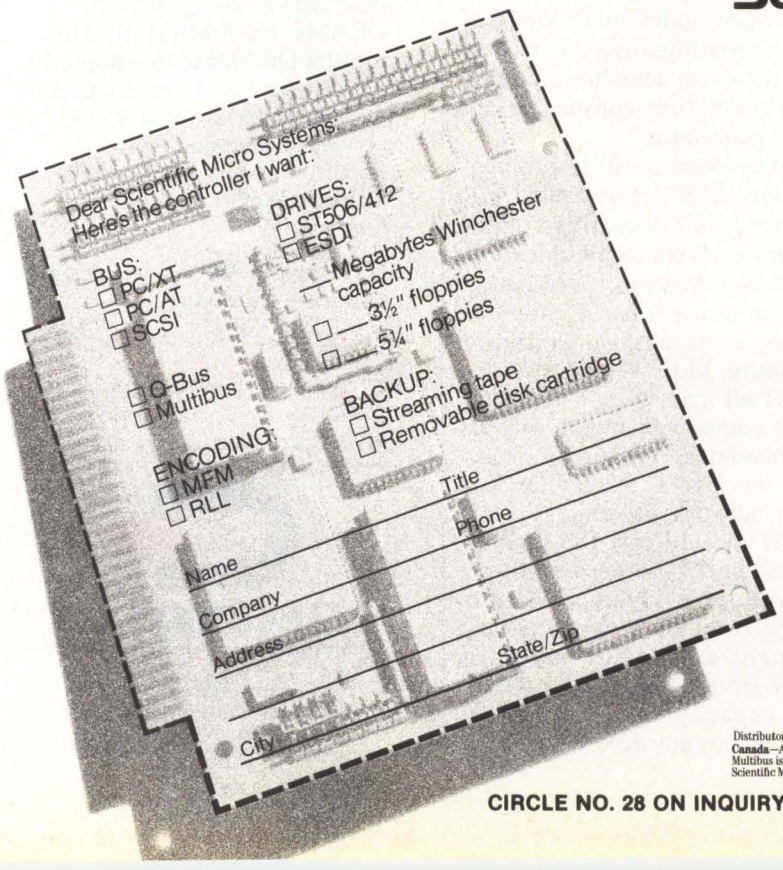

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the local telephone company and can reconfigure their networks quickly by adding or subtracting VSAT stations. According to an AT&T spokesman, customers could realize savings between 20 percent and 25 percent compared with standard terrestrial data service, depending upon the number of sites, their exact locations and the data rates required.

Standard network integration

Integrating satellite-based data networks with existing data-processing systems also promises to be a relatively simple chore. As Harris' Hendee explains, the network's host mainframe or minicomputer would typically be located with the central hub earth station. A Zilog Inc. Z8000-based I/O processor links the front-end processor of the host computer with the station's radio transmission equipment.

The I/O processor utilizes standard RS232 and RS442 connectors. The unit performs the packetizing of the data and otherwise adds the communications protocol, such as the address of the ultimate remote destination, but does not affect the computer protocol. Thus, says Hendee, the satellite pipeline is transparent to the computer system itself.

At the remote terminals, I/O processors reverse the signal processing and pass the data to or from the local processors through the RS232 or RS442 connectors. "The computer system really isn't aware that a satellite link is being employed rather than conventional telephone lines. To the host processor, it all looks the same," Hendee says. □

IBM 'fixes' System/36 as part of product blitz

Lynn Haber, Associate Editor

Last summer, with the announcement of more than 125 products, IBM Corp. attempted to remedy its highly criticized System/36 minicomputer and to accommodate network standards via an Ethernet connection.

Many industry watchers praise IBM's actions. Craig Symons, vice president at the Gartner Group Inc., a research and consulting company in Stamford, Conn., says IBM has taken "a step in the right direction." He contends, however, that Big Blue has more work to do. The most difficult task will be overcoming the negative publicity surrounding the perceived lack of System/36 performance as a departmental computer.

What about the adoption of Ethernet for the IBM RT PC and the various other efforts to make IBM equipment talk to other vendors' machines?

Vicki J. Brown, senior analyst at International Data Corp. (IDC), Framingham, Mass., says of the Ethernet move, "They had to do it if they want to be a major player in the workstation market." Brown says approximately 75 percent of all workstations are shipped with Ethernet. "It's a de facto industry standard."

Even the competition is happy. Bill Johnson, vice president of distributed systems at Digital Equipment Corp., Maynard, Mass., believes IBM's endorsement of Ethernet is a good thing. "IBM has faced up to reality and the fact that Ethernet is something they have to offer their customers," he says.

Gartner's Symons concedes that IBM improved the company's mid-range product lines both in terms of price/performance and communications, but says that, in overall performance and connectivity, DEC has the upper hand. "DEC has the product and technology edge, though not as much as before," he contends, adding: "But, in terms of marketing and aggressiveness, DEC is not IBM."

IDC's Brown estimates that IBM will ship 8,000 to 10,000 RT PCs this year. And with continued improvements in networking, software and price/performance, RT shipments could double in 1987, she says.

IBM introduced three new models of System 36, including a high-end

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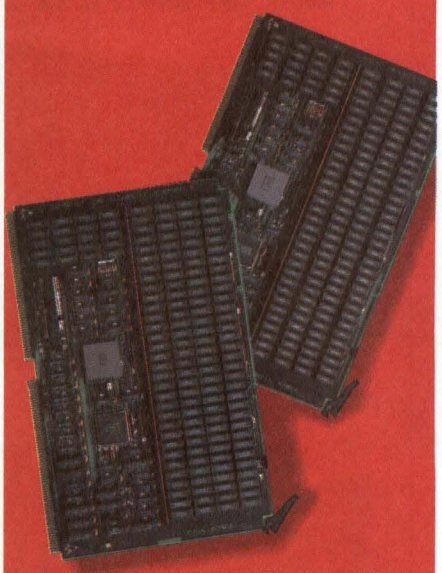

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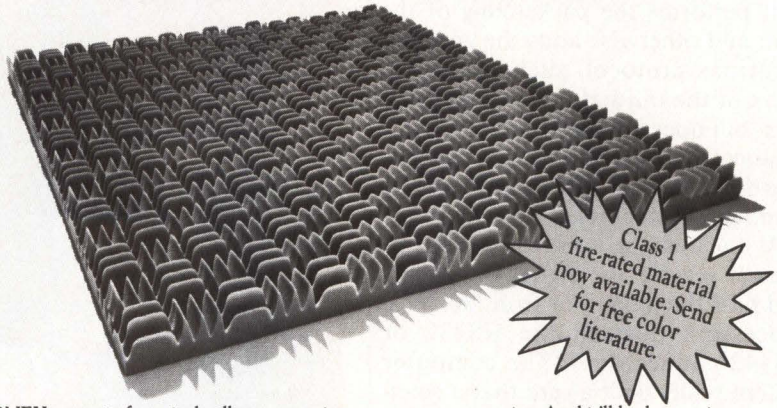

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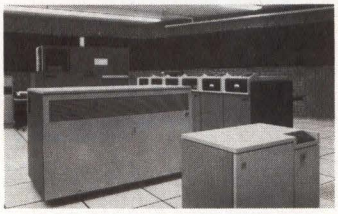

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version and two mid-range devices, along with enhanced software, functionality and communications. According to IBM, the new high-end unit offers 3.5 times more memory—a maximum of 7M bytes—than the current system.

Earlier models of the System/36 satisfied small-business needs—the machine originally was designed as a follow-on to the System/34. But industry concensus was that IBM made a big mistake when, about two years ago, it promoted the System/36 as the cornerstone of its departmental strategy, a market niche it was never intended to serve. Large-business customers soon discovered that the System/36 didn't live up to its billing—and the lights on IBM's marquee, in this arena, faded.

DEC, equipped with the VAX computer system, gracefully took the limelight.

"On a price-per-seat basis, the System/36 wasn't comparable to what some other computer companies were offering," says Gartner's Symons. "Users couldn't get adequate performance to justify it," he adds.

In addition, DEC and others offered users smooth migration paths across their product lines. This allowed users to pick and choose systems according to the individual performance needs of departments and divisions.

Sales of mid-range computer systems, priced between $15,000 and $250,000, are expected to grow at a compound annual rate of 13.9 percent between 1986 and 1991, according to Symons. During the same years, the numbers for mainframes growth is predicted at 7.4 percent; for microcomputers, 9.9 percent.

In a rare move, IBM stepped out of the IBM universe and introduced an $850 baseband adapter card that allows the RT PC workstation to communicate in an Ethernet local area network. Developed in 1981 by DEC, Intel Corp. and Xerox Corp., Ethernet was the basis for the IEEE 802.3 networking standard. Ethernet, a popular industry LAN, has more than 100 vendors.

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announcing a $1,095 adapter card that allows the workstation to be connected to the company's proprietary Token-Ring Network.

DEC's Johnson says he isn't too worried about losing position in the workstation market because of the RT networking options. However, Robert Djurdjevic, president of Annex Research Corp., Phoenix, Ariz., thinks the Ethernet connectivity is aimed directly at DEC, which is heavily dependent on Ethernet. IDC's Brown says traditional workstation vendors like Apollo Computer Corp. and Sun Microsystems Inc. are threatened along with DEC.

Brown asserts, however, that IBM's Token-Ring Network is not as sophisticated a product as Apollo's DOMAIN network or Sun's Network File Service (NFS). "But the Token-Ring is a network solution," she adds, "a feature that the RT desperately lacked, if it was to be a viable workstation product." In a design environment, the ability of workers to easily share project information via networking is a necessity.

IBM replaced its System/38 *minicomputer line with six new models—100, 200, 300, 400, 600, 700. Integrated with the IBM 9335 (far left) and 9332 storage devices, they provide greater flexibility, options in configuration and capacity.*

Sprucing up the middle tier

IBM's new System/36 line includes the high-end 5360 model D, which offers a maximum of 7M bytes of main memory, and the mid-size 5362 models B and C, both of which provide a maximum of 2M bytes of memory. Up to 16 local workstations can now be attached to the entry-level System/36 PC model 5364 with new software, 1M byte of main memory and two workstation ports. Symons notes that, while the number of attachable workstations has been in-

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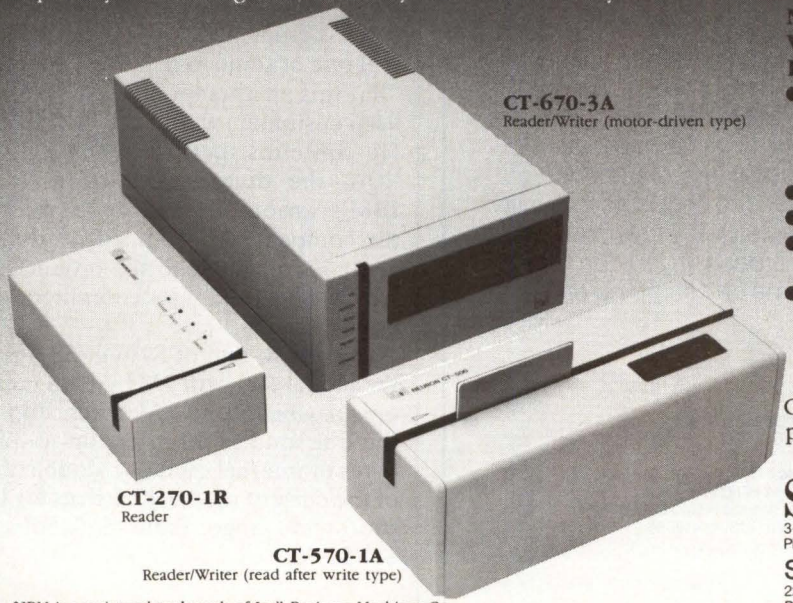

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creased, performance remains the same.

For previous System/36 users, existing 5360 models are field-upgradable to the model D and existing models of the 5362 are field-upgradable to models B and C.

To enhance performance, IBM added an Advanced Peer-to-Peer Networking (APPN) communications facility to Release 5 of the System/36 System Support Program (SSP). According to the company, APPN allows users to communicate across a network of System/36s and System/38s without the need for a central controlling systems network architecture host.

IBM also brought out products that permit operation between a System/36 and a System/38 or a System/370, via Distributed Data Management (DDM). DDM provides System/36 users access to data residing on another System/36, System/38 or System/370 processor using the IBM Customer Information Control System/Virtual Storage (CICS/VS).

Additionally, enhanced features were added to four System/36 office applications—DisplayWrite/36, Personal Services/36, PC Support/36 and Query/36.

Replaces System/38 line

In one fell swoop, IBM also replaced System/38 models 4, 6, 18, 20 and 40 with six new computers—the models 100, 200, 300, 400, 600 and 700. Previous models can be upgraded, on site, with the exception of the model 100, IBM says.

In addition to better price/performance features, which include enhancements to the system's operating system, IBM says they've improved connectivity between the System/38 and System/36, in addition to other computer systems.

Djurdjevic says that IBM is promoting the System/38 as the migration path for users looking to move up from System/36. "The conversion process from the S/36 to the S/38 is still one of some magnitude," he says, "but this an attempt on IBM's part to keep customers within the IBM fold." He contends that, despite the IBM logo, the diverse architectures of IBM's various computer systems put the company at a competitive disadvantage compared to the product offerings of other major computer vendors.

At the low end of System/38 line is the model 100 with 2M bytes of memory expandable to 4M bytes. Top of the line model 700 offers up to 32M bytes of internal memory, double that of the current model 40. Prices for the products range from $37,500 to $385,490. □

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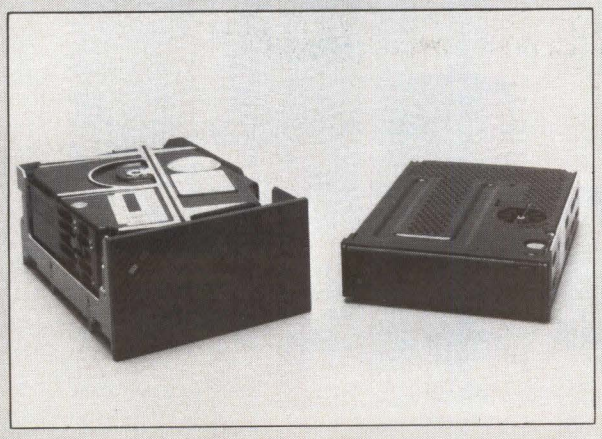

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Artificial intelligence rides out the slump

Michael Tucker, Associate Editor

While most of the computer industry continues to feel the effects of a hard-dying slump, the artificial-intelligence business grows from strength to strength. AI hardware vendors are enjoying a modest boom, AI software companies are finding themselves on the stock market, and mainstream computer makers continue to invest heavily in AI technology.

Most telling of all, though, is the demand for AI professionals. "Everyone in the conventional computer-recruiting industry is hurting," says Marilyn Dee of Marilyn Dee Associates Inc., Boston, which specializes in placing AI experts. "I'm not. If a resume comes in with two years or so of experience, I can place that person almost immediately."

Says Rod Khanna, director of marketing for LISP Machine Inc., Andover, Mass., makers of LISP "engines" (computers designed to run AI applications): "If it hadn't been for the slump we might have done even better than we did. But, on the average, we were much less hurt than the rest of the industry. I'd say we doubled our business last year."

Symbolics Corp., Cambridge, Mass., one of the first companies to commercialize AI hardware, reports similar gains. Revenues went up 73 percent in 1985, to over $69 million, and profits boomed 300 percent.

In late March, Symbolics moved into the value-added reseller market and signed up its first VAR, ICAD Inc. of Woburn, Mass. ICAD will use Symbolics' machines to produce an intelligent workstation for design engineers.

Other makers of LISP machines, including such titans as Xerox Corp., Stamford, Conn., and Texas Instruments Inc., Dallas, are equally bullish.

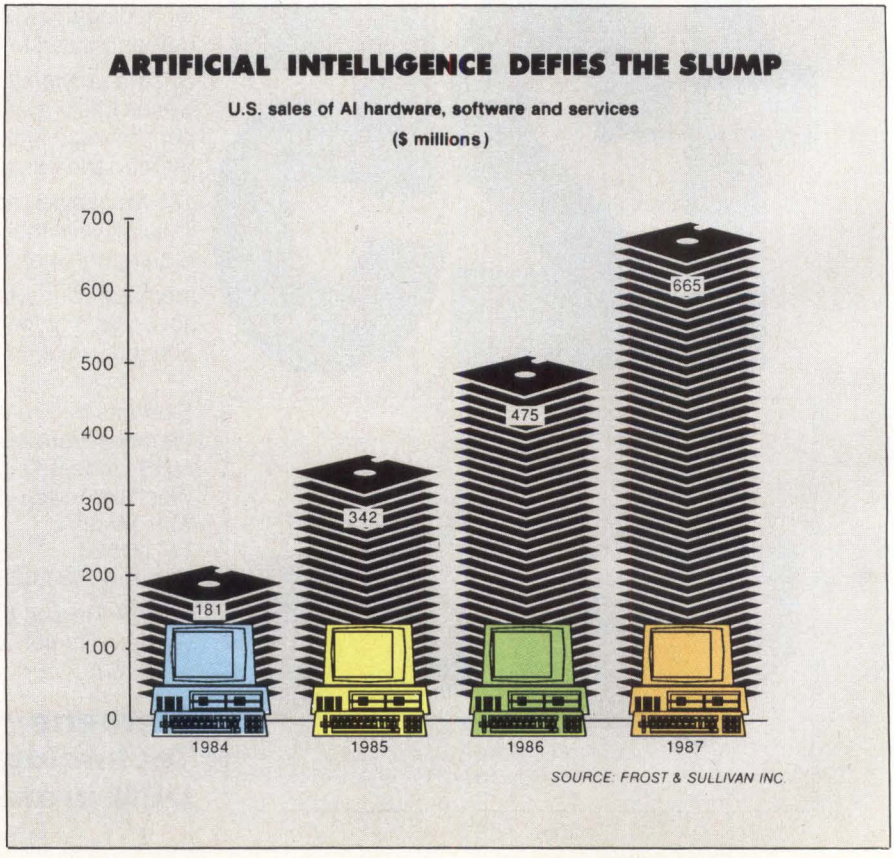
But the real proof of AI's commercial success may be in software development. Programmers and software developers are enjoying an AI gold rush. "I would say that nearly 30 percent to 40 percent of all programmers have some interest in exploiting AI," notes Bruce Lynch, president of The Programmer's Shop, Hanover, Mass., a remarketing company that specializes in tools for programmers. "AI tools are becoming a lot more common," he says, "and for us, they're a stable market."

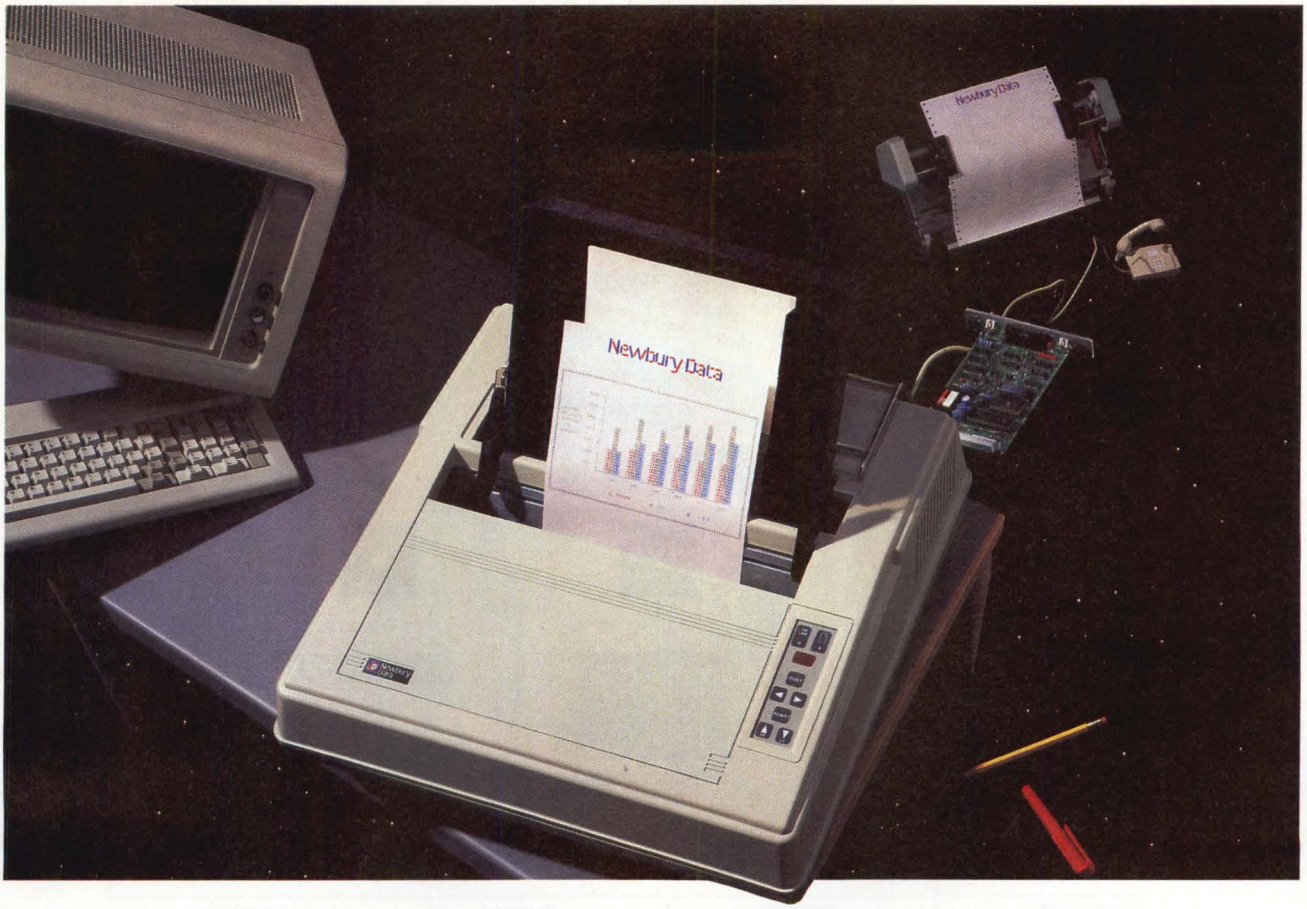
It's a stable market with a lot of players, among them such well-known names as Carnegie Group Inc., Pittsburgh; Inference Corp., Los Angeles; and IntelliCorp, Mountain View, Calif.—all makers of tools for LISP machines and other AI computers. These developers demonstrate faith in their products by taking their stock public.

Teknowledge Inc. of Palo Alto, Calif., is a company that has gone public for the first time. Teknowledge develops expert-system generators for such machines as the Xerox Series 1100 workstation, the Digital Equipment Corp. VAX and, as of this year, the IBM Corp. PC/AT and RT PC. Teknowledge took its stock public in March with an offering of 2,180,000 shares. Despite strong competition from other AI software companies, a volatile market and an uncertain customer base, investors eagerly bought out the entire initial offering at $13 a share—not bad for a company that was incorporated a mere five years ago.

Lotus looks to AI

Mainstream software companies are also getting into the AI business. Most publicized, of course, are companies such as Lotus Development Corp., Cambridge, Mass., which is attempting to mate traditional business applications such as 1-2-3 with more exotic AI software. Lotus is attempting to solve





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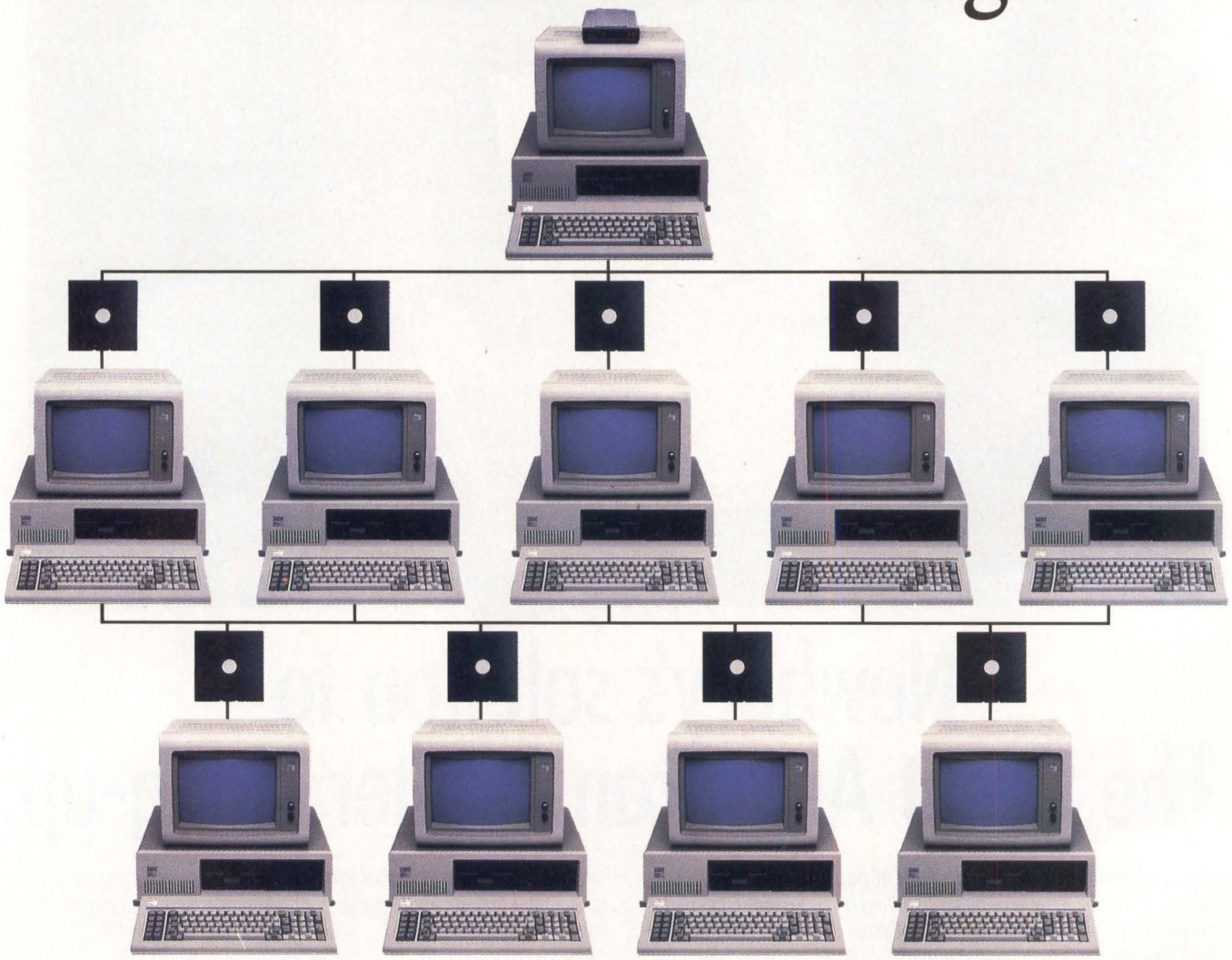

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the technology transfer by helping create an AI development shop, Arity Corp., Concord, Mass. Arity has developed a series of AI products that interface with such Lotus applications as 1-2-3 and Symphony. These new packages include an expert-system generator and an implementation of Prolog, second only to LISP in its popularity as an AI language.

Lotus' strategy in all this has been rather unusual, and other established software concerns would do well to study it. Arity president Peter Gabel was formerly a Lotus employee and a key figure in the development of 1-2-3. Paul Weiss, Arity vice president of research and development, is also a former Lotus employee. Lotus also is one of several sources of Arity's funding along with UST Capital Corp., the venture capital division of United States Trust Company. As a result, Lotus has the best of many worlds. A less savvy firm might have tried to do the kind of research Arity is doing but in an entirely captive R&D division.

Indeed, in-house research has considerable advantages, but given the nature of software development—where the real value of any operation lies in personnel rather than in capital equipment—that approach could have exposed the company to the risk of its employees setting up shop as competitors. With Lotus' approach, where the company effectively plays venture capitalist, those former employees have been converted to suppliers with strong incentives to see their customer succeed.

Morever, Lotus gains the fruit of Arity R&D without having to foot the entire bill. Since Arity is an independent company, a significant part of its funding (as well as a share of the risk of its failure) has been shouldered by other investors, particularly UST Capital.

Lotus calls this kind of arrangement a "spin-out," and there are risks in it for the parent company. It could be balkanized quickly if "entrepreneur fever" should strike an entire R&D staff. But Lotus seems to believe that whatever risks are involved are well worth the rewards of AI products.

Less prominent than Lotus and its child, but perhaps more important to the growth of AI, are the compiler makers. Will a programming language be successful? One need only look at who is writing a compiler for it. And judging by the compiler support teams, AI languages are suddenly very hot markets.

The two languages most often used in AI programming are LISP and Prolog. LISP has long had the lion's share of American AI research, and it's no news that the language has powerful friends in high places. What is news is that some of those friends are manufacturing large-scale concurrent computers. One of the leading LISP merchants is Gold Hill Computers, Cambridge, Mass., whose Common LISP implementation has the largest installed base of Common LISP users around. Last December, Intel Corp. announced that it would be working with Gold Hill to produce a LISP that would work on concurrent, multiprocessing computers—specifically Intel's own iPSC machines.

Prolog is also gaining adherents. For a long time, the language's relative unpopularity in the United States led some experts to believe that Prolog compilers couldn't be sold profitably. Yet companies such as Quintus Computer Systems Inc., Palo Alto, Calif., have become successful by selling Prolog to developers who are looking for an AI language that is easier to use than LISP. Prolog is starting to appear on IBM Corp. PCs. Spencer Leyton, president of software vendor Borland International, Scotts Valley, Calif., announced recently that his company would be marketing a Prolog compiler "in the near future." Borland has been known primarily for its Pascal compiler.

Recently, artificial intelligence came to the the Apple Computer Inc. Macintosh. ExperTelligence Inc., Santa Barbara, Calif., began shipping ExperLisp last year. ExperLisp is a LISP compiler with a lot of Macintosh touches, such as extensive use of graphics, pull-down menus and multiple windows. Perhaps its most unusual characteristic, though, is its use of virtual memory, where the compiler loads code from the disk only when it's actually needed for running the program.

Recruiting to success

The real sign of AI's success, however, may lie in its star players. Companies can conceal their intentions, but not their recruiting. "Everybody's hiring," says Marilyn Dee. "Start-ups, military companies, small firms, large companies—everybody. If I had to give one answer to what they want, I'd say it's expert-system engineers, because expert systems are where they think they can make money. The other thing they're looking for, of course, is LISP hackers."

Dee says that AI experts are experiencing a seller's market. Most of her clients are currently looking for practiced developers who can command salaries in the $50,000 to $100,000 range. In fact, American companies have become so hungry for AI skills that they've begun to raid Europe for talent. Early this year, Dee began wooing software experts at such traditional European AI centers as Edinburgh, Scotland and Paris.

Some proponents of AI argue that mainstream computing, traditionally user-unfriendly and removed from the thought processes of human beings, was desperate for a way to integrate itself with the real world. AI, with its ability to imitate human thought, promises a way to eventually do just that.

Larry Walker, director of the Knowledge Systems Group for Sperry Corp.'s AI research in Bloomington, Minn., explains, "I think AI will create a real revolution. It will close the gap between computers and computer users."

All the same, even the strongest advocates of AI warn integrators against leaping into the field without looking first. "They should be cautious, because there's so much hype in AI," says Dee. "My formula would be to move slowly, make certain you have top-notch technical people, and make just as certain you have top-notch management people." □

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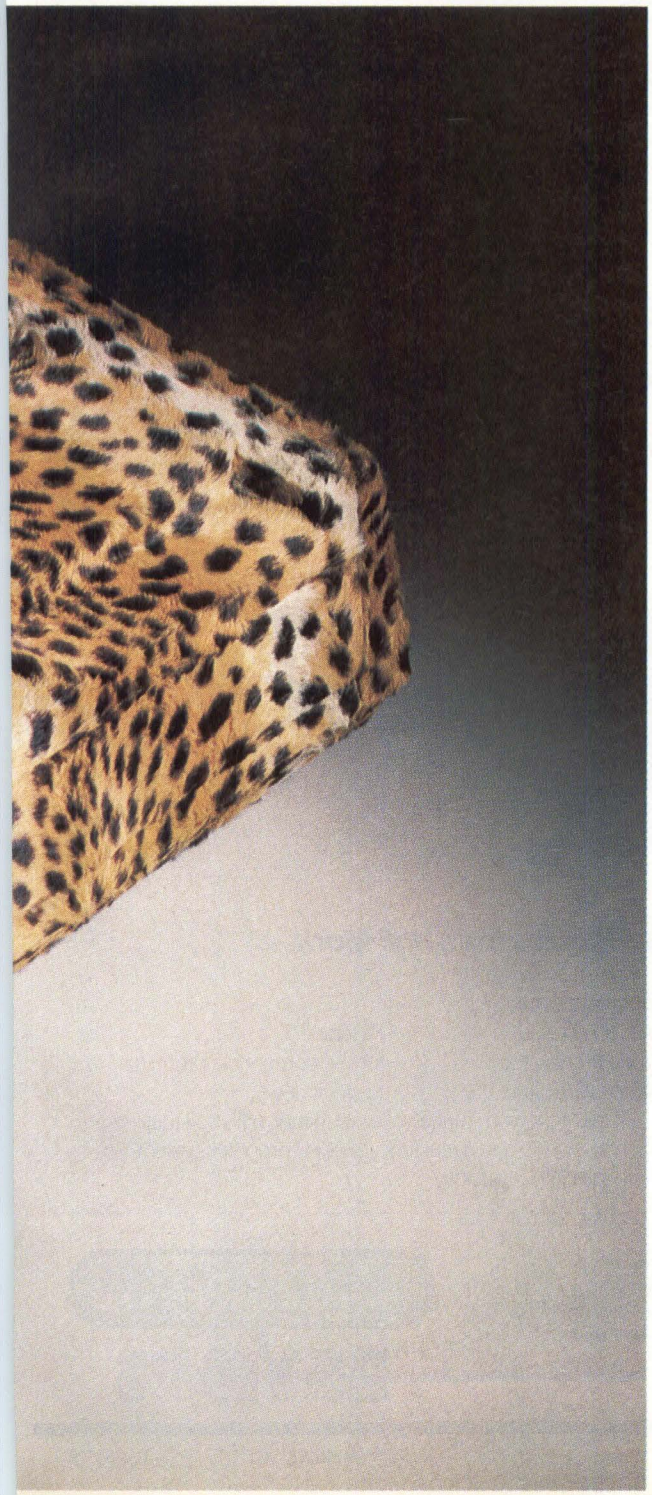

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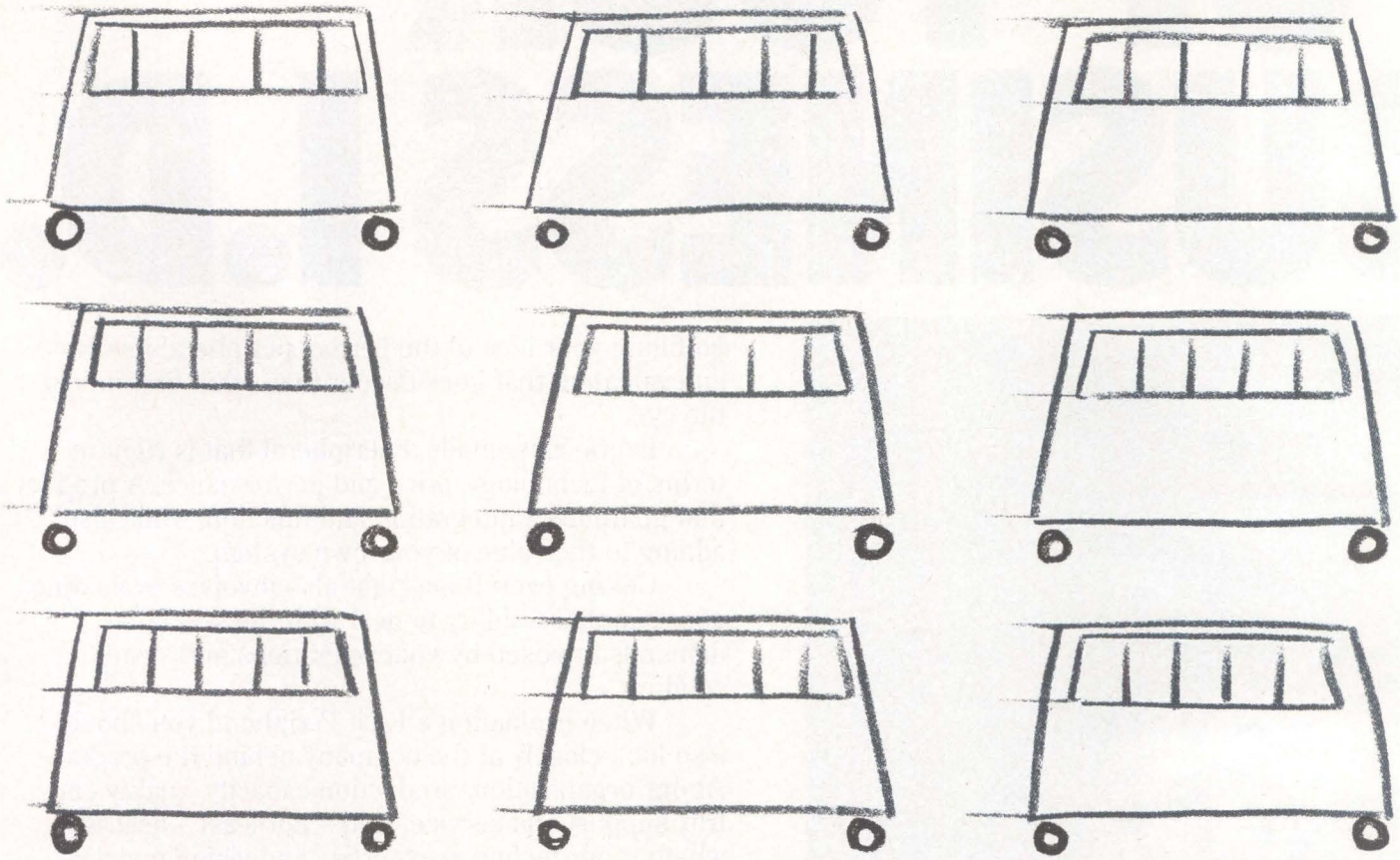

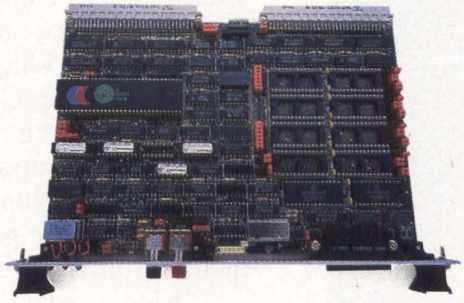

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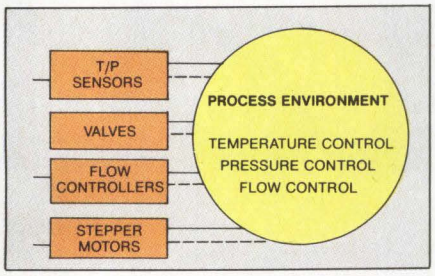
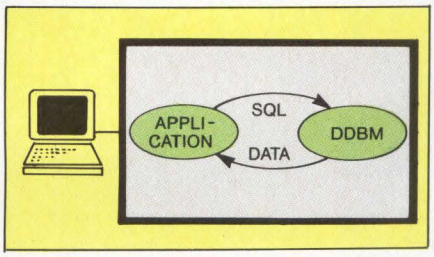
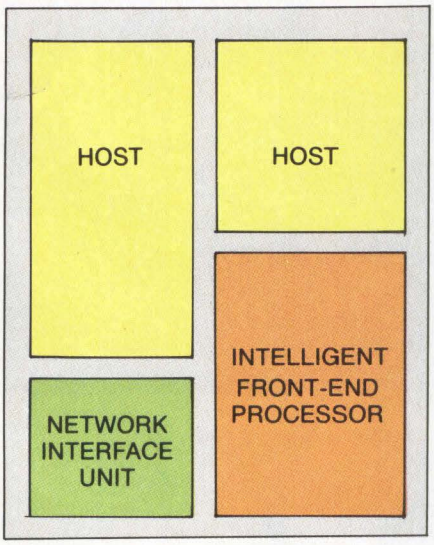


p. 61 . . . . . A real possibility



p. 83 . . . . . New game rules



p. 93 . . . . . FEPs offer path

REAL-TIME UNIX SEIZES NEW PRODUCTS, MARKETS 61

The widespread acceptance of UNIX in the manufacturing arena depends on the ability of vendors to develop real-time capabilities for the operating system. What functions and features are necessary for an OS to be real-time, and how can UNIX be extended or redesigned to provide those capabilities? Who's doing what, and how are they doing it?

LINKING DATABASES FORCES NEW STRATEGIES . .83

Vendors of database management systems are under tremendous pressure to fit their products into distributed environments. However, there are various ways to achieve that goal. Some companies believe that data should be truly distributed, others argue for centralization, and a third camp argues against handling distributed file management within the applications software. We look at the strategies.

FEPs EASE MIGRATION TO NEW LAN PROTOCOLS .93

A confusing plethora of LAN protocol standards has finally emerged. But LAN users and integrators need not fear that the proliferation of these protocols—or of new protocols that emerge in the future—will make current installations obsolete. Front-end processors (FEPs) allow system integrators to preserve their capital investments in LAN equipment while gracefully migrating to new protocols that might better suit their applications.

IBM'S TOKEN-RING: WHAT ARE THE ALTERNATIVES? 105

Big Blue's Token-Ring Network isn't the only game in town. A variety of companies offer some combination of competing or compatible LANs and related equipment and software. But sorting out the LAN selection criteria isn't easy.

CHIP SET PAVES THE WAY TO TOKEN-RING ACCESS 121

Texas Instruments Inc.'s TMS380 chip set allows system integrators and designers to build their own adapter cards for products such as personal computers and printers that can benefit from attachment to IBM's Token-Ring Network. The goal, of course, is to differentiate products in a market that is already crowded.

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REAL-TIME UNIX SEIZES NEW PRODUCTS, MARKETS

Real-time UNIX, long considered a contradiction in terms, suddenly becomes a growth industry due to government and large corporation mandates

Wendy Rauch-Hindin
Special Features Editor

Anyone who has ever had to migrate operational software from one computer and operating system to another knows that application portability leaves much to be desired. In fact, it is sometimes less difficult and expensive to retain a no longer adequate computer than it is to buy a new one and rewrite software.

Realizing that the dominant cost of a computer system today is the development and maintenance of the software, several large-scale users have taken steps to promote software transportability by standardizing on the UNIX operating system.

General Motors Corp., for example, is pushing to make UNIX a standard operating system for its manufacturing plants. As part of this effort, GM has formed a UNIX Task Force, which is comparable in purpose and function to its Manufacturing Automation Protocol (MAP) Task Force and may prove to be as far-reaching. The GM UNIX Task Force is cooperating with the IEEE and /usr/group standards committees to develop general-purpose UNIX standards and also to develop real-time UNIX standards for time-critical manufacturing applications. In fact, an IEEE trial-use UNIX standard was approved in March.

Nor is General Motors alone in its efforts to drive the market toward UNIX. In 1985, the federal government specified UNIX in 80 percent of its RFQs (requests for quotations). Certain financial institutions are looking to decouple their applications from hardware by migrating to UNIX. And large manufacturing firms, like Hughes Aircraft Co. and Chrysler Corp., are experimenting with real-time UNIX pilot programs.

But it's GM that vendors must watch when planning their future UNIX directions. The desire for software transportability is particularly important in manufacturing environments. They are typically multivendor and characterized by rapid advances in technology that require equipment replacement and corresponding application rewrites. So, fresh from its success in organizing manufacturers and vendors to specify and supply MAP-standard communications products, GM is now attempting the same aggressive tactics in regard to UNIX.

Skeptics raise questions

Success is far from assured, though. The development of real-time capabilities for UNIX will determine UNIX's widespread acceptance in the manufacturing market. Many factory, area, cell, and intelligent-device management and control tasks require a real-time operating system (RTOS). UNIX, however, was designed as a systems-and-development operating system, and it lacks many features that an RTOS needs.

In order to adapt UNIX for manufacturing environments, the real-time standards committees must address two questions: What functions and features are necessary for an operating system to be real-time, and how can UNIX be extended or redesigned to provide these capabilities? Skeptics question whether real-time extensions, or patches, to UNIX are the most efficient way to support real-time capabil-

ities, and they wonder how much UNIX can be changed before it is no longer UNIX. Moreover, system integrators are uncertain whether the plans of the computer-manufacturer pacesetters will help or hinder them.

With cooperation from technical experts, users and vendors, details about real-time UNIX's promise, problems and feasibility have been pieced together. But real-time means different things to different people. Therefore, insight into UNIX trends requires some understanding of how the standards group are define real-time systems.

Concerning the pacesetters, IBM Corp. supports real-time capabilities in its UNIX-based RT PC. AT&T Co. also has been investigating methods to integrate real-time features with UNIX since the late 1970s. Several types of real-time UNIX systems are up and running internally, and AT&T says it will soon have a draft form of real-time extensions for its System V Interface Definition (SVID). Digital Equipment Corp. says it will comply with the IEEE P1003 standard, and will have SVID real-time extensions as the market demands them. Hewlett-Packard Co. will shortly announce a real-time version of System V UNIX for its computers. Gould Inc. is moving toward a real-time UNIX for its superminicomputers. Allen-Bradley Co. already offers real-time UNIX in its Vista 2000 computer.

Earmarks of real-time described

An RTOS differs from a general-purpose system in being deterministic—that is, it responds to asynchronous, external events within a set amount of time. The response time may vary from μsec to seconds, depending on the application. High bandwidth, throughput and fast execution are desirable, but are not as funda-

When is an operating system real-time?

The following items are among the requirements for a real-time operating system (RTOS) as agreed on by the IEEE and /usr/group real-time UNIX subcommittees:

- **Response to asynchronous events:** Real-time systems need asynchronous I/O and interrupt-handling capabilities to respond to asynchronous external events within the bounded time required by the real-time system. The I/O response time is often limited by the time needed for memory access, disk access and the speed of the processor bus.
- **Context-switching time:** Real-time systems must service critical tasks immediately, within specific time constraints, regardless of what they are doing when the time-critical event occurs. Context-switching time—a key real-time metric—is the time required to switch between tasks. It is determined by how long it takes the operating system to store the state of the computer and the contents of the registers so that it can return to processing its previous task after servicing the interrupt.
- **Interrupt latency:** Perhaps the most important real-time system metric, interrupt latency is the longest period of time possible for a system to acknowledge the highest priority interrupt and dispatch a process to service it. Unfortunately, interrupt latency is a non-deterministic (not predictable) metric and, therefore, difficult to measure. For various reasons, in most cases, a system cannot guarantee that an interrupt will always be serviced in the same amount of time. The time lag before an interrupt can be serviced is influenced by factors such as the speed of the bus and of the processor (both deterministic) as well as the overhead to select the appropriate routine to service the interrupt, the loading of interrupts on the system and the amount of state that needs to be saved (all non-deterministic). For example, an interrupt may have to wait while an undeterministic number of higher priority interrupts are serviced. The time lag is further complicated because in an operating system there are often critical processing paths that must be completed before an interrupt can actually be processed.
- **Priority interrupts and scheduling:** An RTOS must allow users to define priorities for interrupts and tasks to be scheduled and specify how interrupts are to be serviced. This ensures that the most important tasks are serviced within the allotted allowable time constraints, regardless of other system events.
- **Pre-emptive scheduling:** To guarantee response times, RTOSes must allow a high-priority task to pre-empt execution of a lower priority task as soon as the high-priority task is ready to run.
- **Memory-locking:** Real-time systems generally must allow a program or part of a program to be defined as memory-locked. Locking a program in memory guarantees fast response times because it eliminates time-consuming disk accesses to obtain the program.
- **Contiguous files:** RTOSes should provide the means to optimize data storage on a disk to minimize the seek time when retrieving or writing data. Generally, this calls for storing data in contiguous files.
- **Synchronization:** Real-time systems need a means to synchronize and coordinate the use of shared data and task execution.

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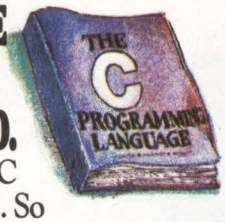

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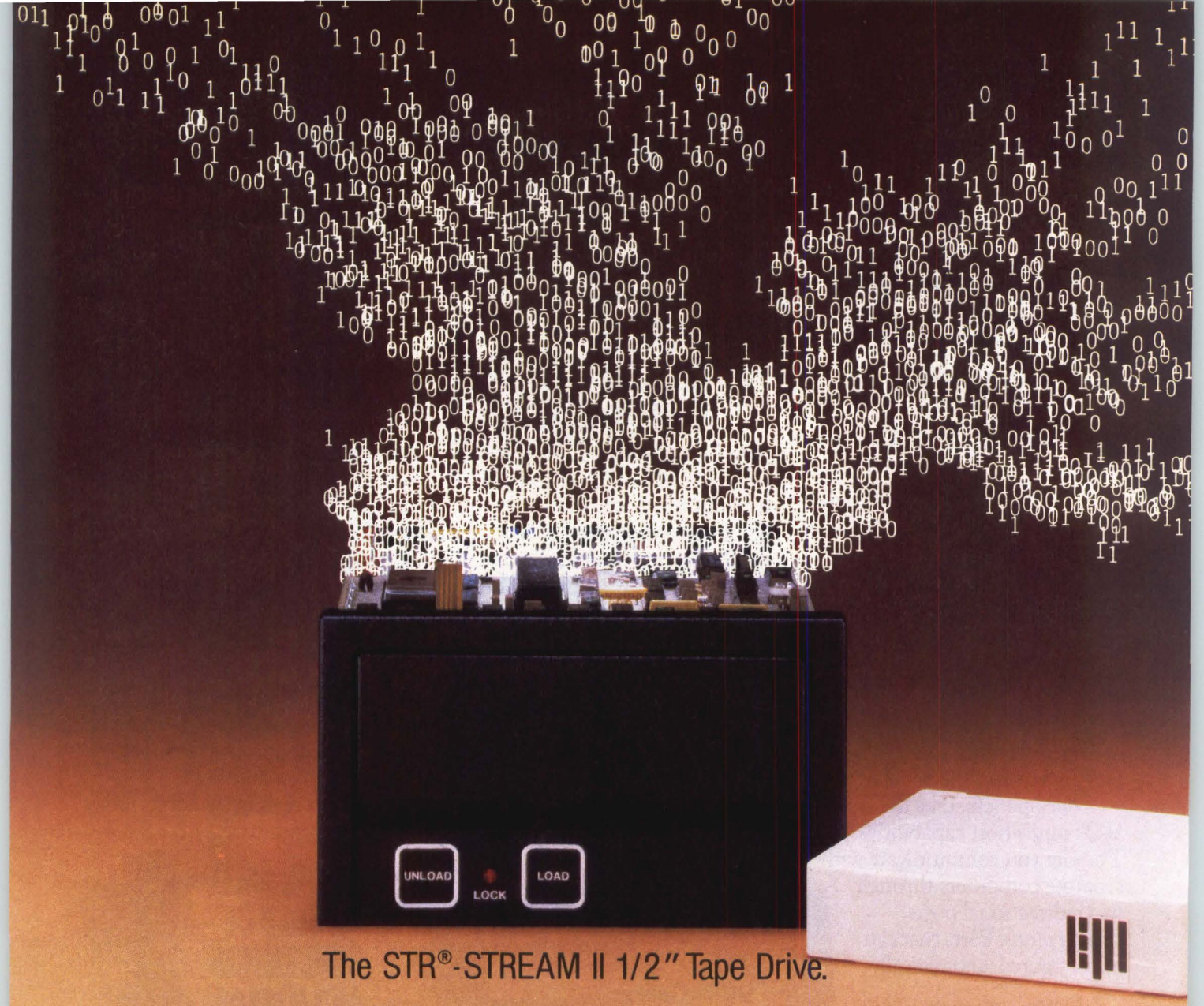

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mental to real-time performance as is deterministic (predictable) response time. Reliable, fault-tolerant performance, however, is necessary to an RTOS. Any other case results in a loss of data and the inability of a possibly critical action to occur.

Many factors must be weighed to decide if an RTOS can meet its response time objectives (see "When is an operating system real-time?" Page 62). Among them, an RTOS must be able to quickly store the state of a machine and switch to a critical task (context switching time). It must be able to quickly respond to an interrupt (interrupt latency). It must allow tasks to be scheduled according to priority and allow high-priority tasks to instantly pre-empt processing of lower priority ones. Contiguous storage of files on disk, a means to synchronize tasks and use shared data, the ability to lock part of a program in memory, and asynchronous I/O are still other RTOS requirements proposed at the IEEE and /usr/group meetings.

What about UNIX?

UNIX, in its current form, is not appropriate for real-time use because it lacks several features necessary for real-time operation. For example, UNIX does not support priority scheduling. It uses a round-robin scheduling technique wherein all users are assigned an equal time-slice. It supports interrupts, but they are all equal. Also, UNIX does not store files contiguously on disk.

In addition, UNIX systems use synchronization methods that many IEEE UNIX standards developers consider inadequate. One method, signals, can be limited and unreliable under certain conditions. For example, if two signals arrive faster than the signal handler can take control, only one bit of status information gets set and the system misses the occurrence of an event. System V also supports semaphores—a more sophisticated synchronization method, but believed by some to be overly complex for a real-time environment and not extensible to local area network environments.

These shortcomings are surmountable, however. But many users and vendors question the ability of a real-time UNIX to match the capabilities of a real-time executive and wonder whether the trade-offs involved make it practical to try.

For many users, though, the prospect of application portability more than makes up for the effort to develop a UNIX standard for real-time computing. As it stands, GM has real-time UNIX pilots controlling and managing its paint shops. Chrysler has real-time UNIX applications in its testing facilities. Several automotive, communications equipment and semiconductor manufacturers are using real-time UNIX for robot control, monitoring, data collection, shop-floor control and production-line tracking. The Navy is investigating a Gould-developed fully functional flight simulator running under real-time UNIX.

UNIX, in its current form, is not appropriate for real-time.

How to make UNIX real-time

There are three major methods of providing UNIX with real-time capabilities. These are in addition to a fourth alternative where a dedicated real-time executive is integrated with traditional UNIX.

The first technique for making UNIX real-time is to add real-time extensions to the UNIX operating system kernel. Typical examples come from Charles River Data Systems Inc. and Masscomp. Charles River created its real-time Unos operating system out of UNIX, as Masscomp did its RTU, by adding real-time extensions such as priority interrupt and scheduling, contiguous files and enhanced-performance and interprocess communications.

Charles River Data also added, as a real-time extension, a non-UNIX synchronization mechanism known as "Eventcounts." Eventcounts was designed originally at the Massachussetts Institute of Technology for multiprocessor synchronization because up-down counting semaphores (one of System V's synchronization techniques) could lose count of event occurrences if one processor increments a semaphore at the same time as another decrements it.

The Eventcounts mechanism avoids this by providing a monotonically increasing counter. This facility is contained in the file name space, so that unrelated routines can use the same counters. This permits passive monitoring and broadcast events—neither of which are supported by signaling (UNIX's other synchronization facility), and only some are supported by semaphores.

A second way to give UNIX real-time features is to change the kernel. For example, when Gould developed its real-time UNIX for a Navy simulation project, it substantially changed certain system calls (such as the "ioctl" call). This gave user tasks more effective control over physical devices.

Actually, many real-time UNIXes, including some of those already discussed, employ a combination of kernel modifications and extensions. Extensions leave the kernel intact and are simple to implement. But certain important real-time capabilities, such as pre-emption of interrupts, must be achieved through kernel

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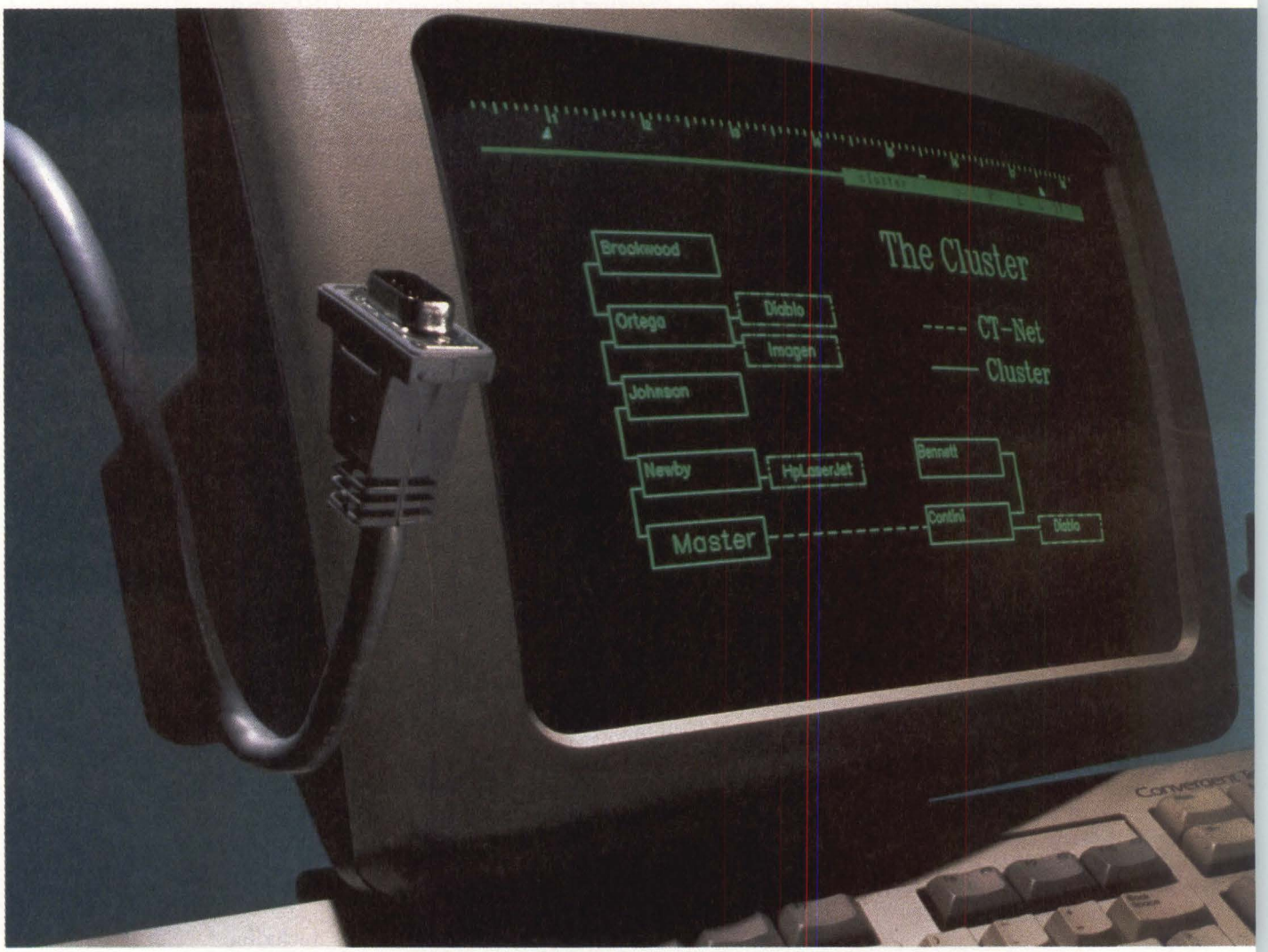

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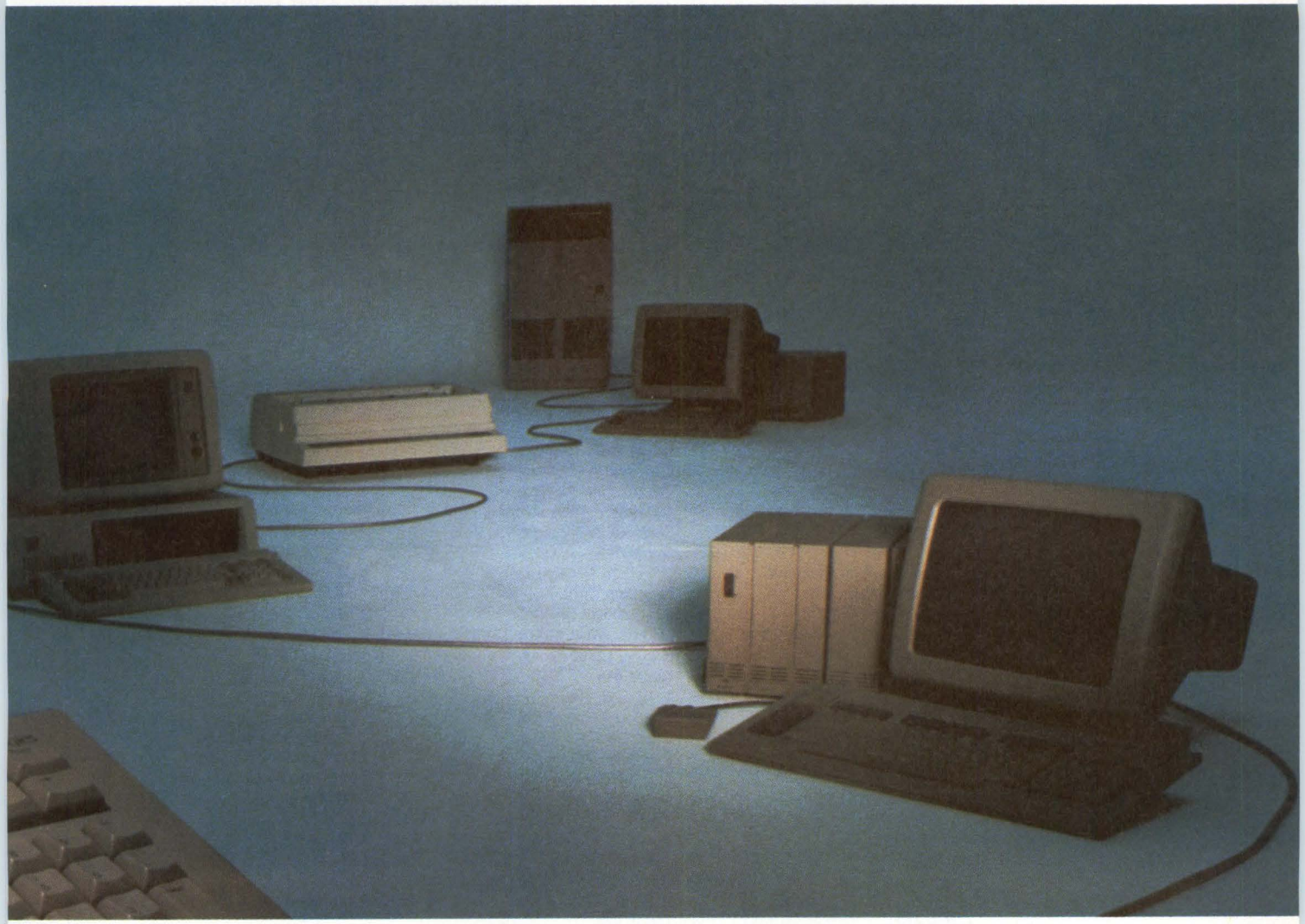

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Real-time UNIX application portability must wait for standards.

modification.

Unmodified, "vanilla," UNIX allows a pre-emption and a context switch to a higher priority process only at the beginning or end of a kernel service. This can cause interrupt latencies in the range of 1 second or more—unacceptable for some real-time applications.

In one hybrid real-time UNIX, Hewlett-Packard modified the HP-UX kernel by inserting kernel pre-emption points throughout the kernel code. This allows pre-emption of an in-process kernel service in order to schedule a higher priority real-time program in response to an interrupt. The kernel modification improved the worst-case response time of the system by 1 to 2 orders of magnitude, depending on the application and the interrupt loading of a system. But HP implemented other HP-UX real-time features as extensions, such as priority-based scheduling, pre-allocation of disk space and certain kinds of performance tuning.

The modified, extended operating system is still compatible with AT&T's SVID because the real-time services are transparent to the SVID and, in fact, run beneath it. But, once IEEE standards are established, and the SVID has real-time extensions, then individual real-time extensions and kernel modifications will no longer be transparent to the SVID. AT&T says that it will probably implement the SVID real-time extensions by providing a UNIX-level real-time interface to communicate with a kernel-process task performing the real-time function. Creation of that task would be transparent to the user.

Developers throw away the kernel

The third technique for developing a real-time version of UNIX is to keep the UNIX interface but replace the UNIX kernel with a real-time kernel. Alcyon Corp., AT&T, and IBM used this technique in developing Alcyon's Regulus; AT&T's Mert and RTR/

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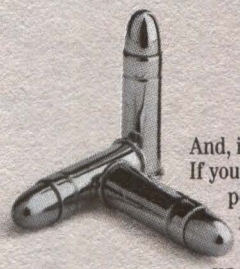

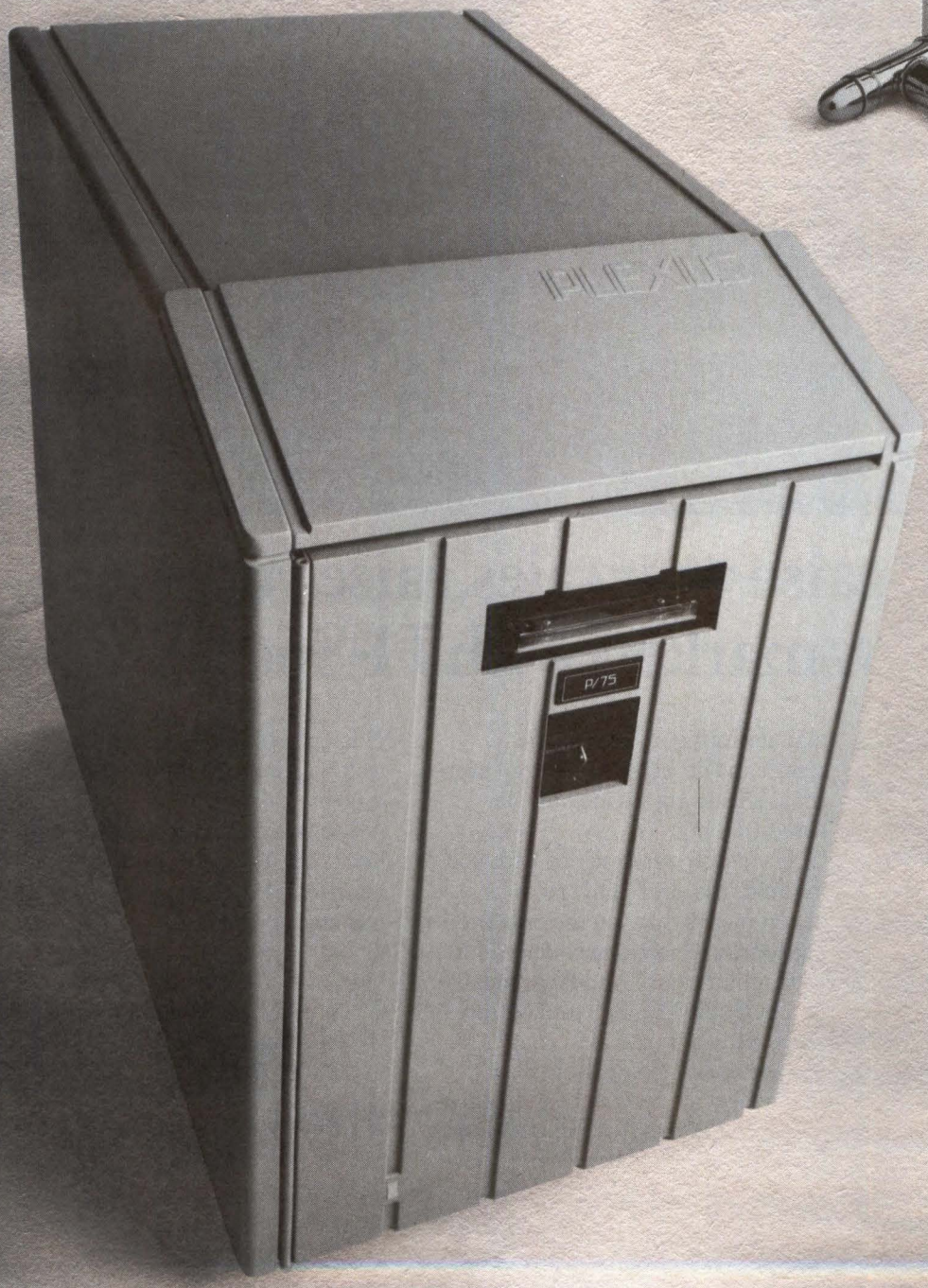

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Dmert; and IBM's AIX/UNIX for the IBM RT PC. This technique provides application portability by fooling UNIX applications. They think they are running on UNIX, and they have no idea of what exists under the UNIX-application interface.

Alcyon attributes its ability to deliver task switch times as low as 700 μsec and interrupt response times as low as 125 μsec, on a 10-MHz Motorola Inc. MC68000 microprocessor, to its replacement of the UNIX kernel with a proprietary one. This response time depends on the interrupt loading and the device drivers on the system.

Despite the kernel replacement, Regulus programmers see a UNIX environment with some extra system calls added to perform real-time tasks. Ordinary UNIX applications are portable because the program interface that they see is UNIX System V Release 2. With UNIX's "nice" command, programmers can transport a UNIX task, assign it a priority, and start it up as a real-time task under Regulus. However, programmers can make changes to increase responsiveness.

For the most part, however, the lack of standards limits real-time application portability across any real-time UNIX. Real-time UNIX applications cannot generally be ported to standard System V because it does not yet support real-time capabilities. Developers cannot count on portability to another vendor's real-time UNIX because every vendor's real-time UNIX is different. But, as real-time UNIX standards, and SVID real-time extensions, are established, real-time application portability will be possible across conformant systems.

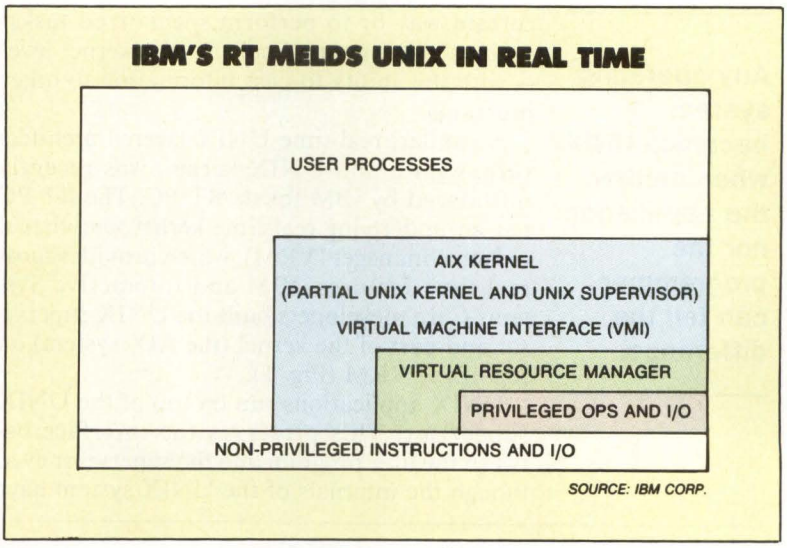

Fig. 1. A real-time UNIX *with a non-UNIX kernel has recently been introduced for the IBM RT PC. The RT PC has the UNIX supervisor and part of the UNIX kernel (the AIX system) on top of a real-time kernel, the virtual resource manager).*

AT&T first with real-time

AT&T's real-time UNIX work in the late 1970s began with the Mert operating system for DEC's PDP/11 computers. Mert grew into Dmert, which is now used in telephone switching applications. Dmert was subsequently renamed RTR (Real-Time Reliable) and it runs on ATTIS' 3B20 computers, where it can use the 3B20's duplicated CPUs and fault-tolerant features.

Mert and RTR/Dmert factor out a two-layer kernel (core kernel and kernel process), which provides the lowest level, and most difficult to change in UNIX, real-time services. These include pre-emptive and priority scheduling mechanisms, asynchronous I/O, synchronization and contiguous files. The UNIX supervisor sits on top of the kernel and interfaces to the kernel services (as did DEC's RSX real-time system at one time).

The UNIX supervisor provides the environment the user sees and provides UNIX functionality to applications that run on top of the UNIX supervisor in user mode. The supervisor can also access the kernel's real-time services via system calls. However, running the real-time functions below UNIX, rather than embedded in it, provides faster response to external interrupts.

As with Regulus, RTR supports standard UNIX application portability (from any System V to RTR) and access to the priority mechanism through the nice command. But real-time UNIX application portability must wait for standards.

Meanwhile, programmers can do most of their real-time programming work at the UNIX level, without needing to learn a new environment. UNIX automatically handles basic real-time functions, like pre-emption of kernel processes and scheduling priorities, via system calls to the kernel.

However, to develop those parts of high-end applications, where it is necessary to achieve particularly rapid response to external events, programmers need to program at the kernel-process level rather than in UNIX. The kernel-process environment is different from that of UNIX. Typically, programmers might write a kernel process to optimize the file system in a

Any operating system becomes UNIX when neither the application nor the programmer can tell the difference.

certain way or to perform specialized tasks, such as event management, at the kernel level —with the ability to pass information to other programs.

A similar, real-time UNIX layered architecture, with a non-UNIX kernel, was recently introduced by IBM for its RT PC. The RT PC has an underlying real-time kernel, the virtual resource manager (VRM), which provides most real-time features. IBM and Interactive Systems Corp. developers built the UNIX supervisor and part of the kernel (the AIX system) on top of the VRM (Fig. 1).

UNIX applications run on top of the UNIX supervisor. This preserves the interface between the user program and the supervisor even though the internals of the UNIX system have been changed.

IBM incorporated its real-time services on the VRM side of the Virtual Machine Interface (VMI) boundary to decrease overhead and to support faster context-switching times with a simpler context-switching method. IBM admits that it could have achieved the same results by modifying the kernel on the AIX side of the boundary. But the RT PC developers felt it was more expedient to start from scratch rather than retrofit extensive changes to part of the kernel.

Like RTR, the RT PC supports two different environments: a UNIX environment (with AIX) and a real-time environment (with VRM). Programmers developing a demanding real-time application will stay pretty much in the VRM environment. However, RT PC developers claim that the VRM has UNIX features because they tried to make it a natural extension of the UNIX environment.

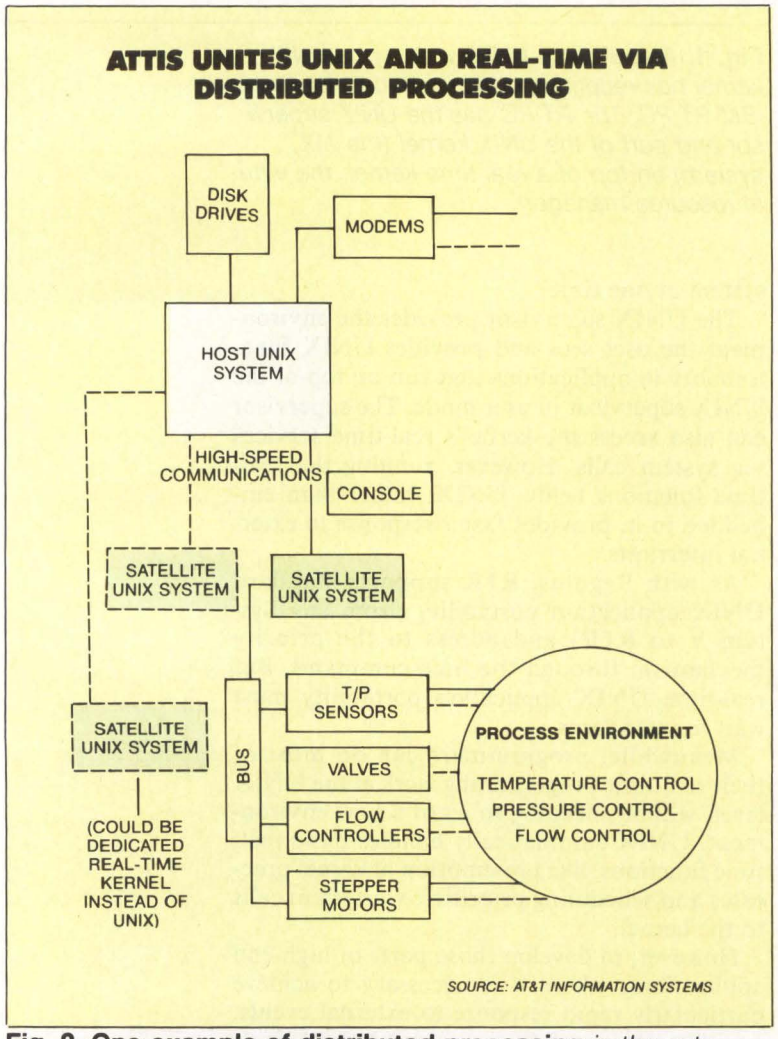

Fig. 2. One example of distributed processing *is the automated process control system used internally by AT&T. A host processor supports a UNIX development environment and then downloads the compiled applications to multiple satellite processors for real-time execution.*

When does UNIX stop being UNIX?

Replacing the kernel raises two questions: What parts of traditional UNIX should be preserved in a real-time UNIX, and when is UNIX so changed that it is no longer UNIX? Concerning the first, the UNIX standards bodies agree that, regardless of any changes, the IEEE P1003 core UNIX standard should remain to ensure applications portability.

Concerning the second question, because portability is the objective of a UNIX standard, then, regardless of what code exists beneath a software or user interface, any operating system —real-time or otherwise—becomes UNIX when neither the application nor the programmer can tell the difference between that operating system and UNIX.

This premise goes a long way toward resolving such questions as the efficiency of an operating system as old and as patched as UNIX. UNIX was developed in the 1970s when software technology was young. It has been repeatedly patched, and will be patched still more to add real-time features, until, over time, some people argue that it will become a kludge.

Jim Isaak, chairman of the IEEE P1003 committee, is firmly convinced that the patch-and-kludge controversy is a red herring. "To get real-time features, you add, change, or replace more and more until finally you have to replace the kernel," he says. "When you do, you eliminate the kludge problem."

Not every UNIX insider is so sure that changing UNIX is the best way to provide UNIX with real-time capabilities. "For high-end real-time applications, it is very difficult to

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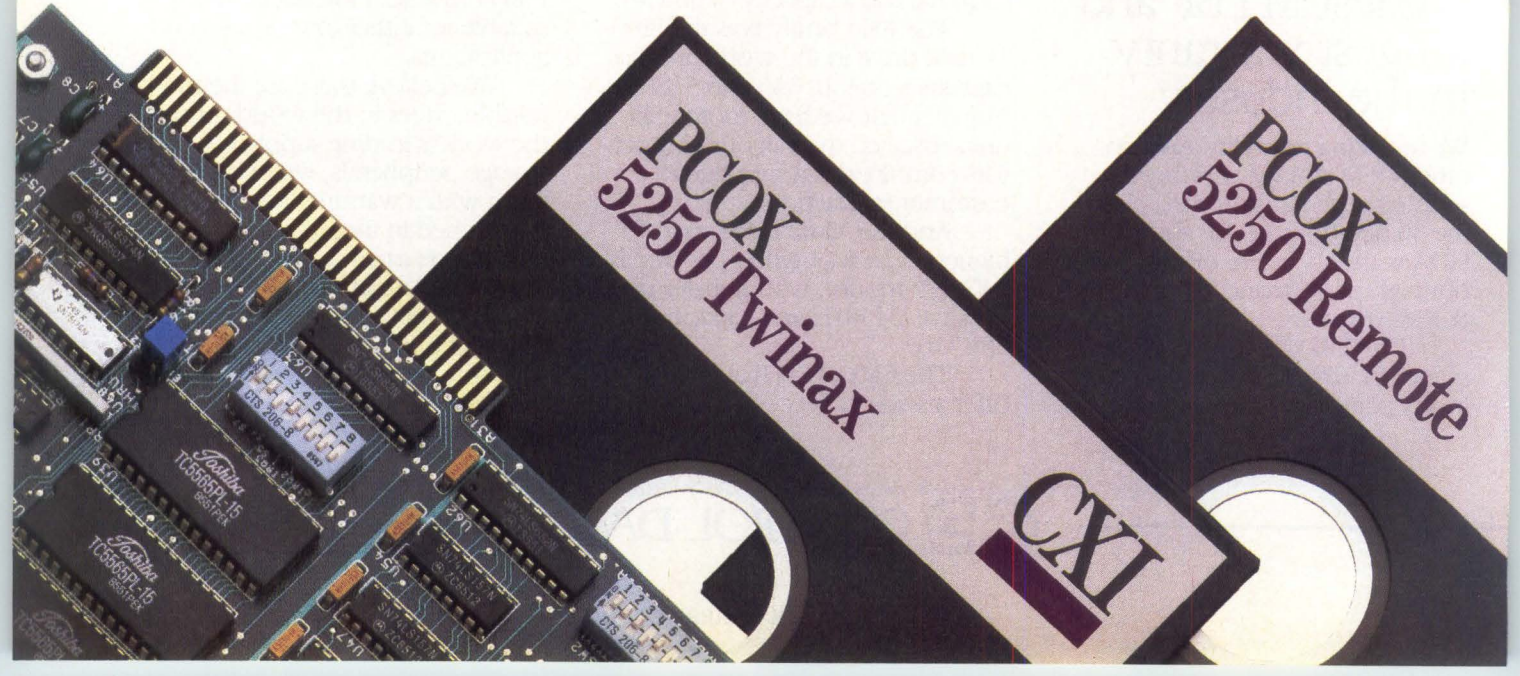

mix time-sharing and real-time applications on one system," says Bruce Weiner, president of /usr/group.

Time-sharing UNIX incurs overhead to support resource sharing. Resource sharing, by nature, creates a non-deterministic situation and is therefore antithetical to real-time tasks that want their resources immediately available. UNIX's interactive, user-friendly features also consume overhead and slow UNIX down. Regardless of the real-time features added, "such a general-purpose system may not be able to guarantee real-time responses in the low-μsec range," Weiner says. "In these cases, you may need a real-time executive, running on a processor dedicated to a particular application and possibly customized for that application."

An alternative real-time UNIX architecture integrates UNIX and a dedicated real time executive via distributed processing techniques. A host processor supports an environment for development of real-time applications and for execution of traditional applications and parts of real-time applications. Outboard satellite processors run dedicated real-time executives.

AT&T uses one such distributed-processing system to internally perform automated process control (Fig. 2). In this system, the host processor supports a UNIX development environment. It downloads the compiled applications to satellite processors for real-time execution. Communications with the satellites are bidirectional via high-speed communications lines.

The satellite processors are UNIX systems, but they are not full-blown SVID UNIX because features like compilers, debuggers and even file systems and schedulers may not be needed for the real-time execution environment. However, the satellite UNIXes may have customized features, specific for the task at hand.

This satellite technique can also be used to distribute real-time processing across UNIX hosts and traditional real-time executives. Many companies have done so.

Automation Engineering, for example, has implemented various real-time systems on VME-compatible intelligent devices that act as front ends to UNIX System V.2 (Xelos) running on Concurrent Computer Corp.'s superminicomputers. Any RTOS can interface to the superminicomputers through the VMEbus. The VME-based external device and the UNIX-based superminicomputer communicate through shared memory, using a direct-memory access connection.

UniFLEX, a modularized UNIX-like system from Technical Systems Consultants Inc., is often used as the real-time satellite executive. UniFLEX can be configured as a 178K-byte set of modules with full UNIX functionality, or users can strip away what they do not need and configure it down to a 9K-byte module. The 9K-module provides the same kind of response times as does the MTOS/PSOS/VRTX-type of real-time executives, claims Don Sinkiewicz, company president.

One typical system, developed by Automation Engineering, is a conveyer/sorting system that sorts packages for loading onto trucks. The application, except for the real-time mechanism controlling the conveyer apparatus, runs on the superminicomputer under UNIX. The superminicomputer passes data from an inventory-control system, a UNIX database and the conveyer/sorting application to the outboard microprocessor to inform the resident real-time system which package to dump or load at different gates in the conveyer system. The outboard microprocessor, acting as an intelligent controller, reacts in real-time as the package reaches the appropriate point. It also passes back information to the UNIX system for further processing.

According to Bud O'Rick, market manager for manufacturing and process control at Concurrent Computer, this distributed technique preserves a great deal of application portability in the absence of a real-time UNIX standard. O'Rick explains that an individual real-time process may be specific to the sensor or to the device it is collecting data from or controlling. But the rest of the application, running under UNIX, is portable to other UNIX computers.

UNIX gets real-time connections

Small, fast, multitasking executives provide real-time capabilities, but little functionality. In fact, they may not even provide a file system. However, they can achieve task-switch times in the 100-to-200-μsec range.

Consequently, most real-time UNIX vendors feel that such systems will always be in demand for critical real-time applications. These systems will be integrated with UNIX systems via high-speed buses, networks and serial links.

Heurikon Corp., for example, offers a distributed real-time system. Its UNIX system is tightly coupled with Hunter & Ready's VRTX on a board, and interfaces to it via a Multibus connection. Another example is Wind River Systems Inc., which integrates UNIX with its real-time VxWorks (an extended version of VRTX that provides run-time and debugging

features) via a Berkeley UNIX Version 4.2 socket interface and Transmission Control Protocol/Internet Protocol (TCP/IP) networking.

The techniques for integrating UNIX and real-time systems do not reflect the potential uses of such systems. For example, in MTOS-UX, from Industrial Programming Inc., communication links between UNIX and real-time MTOS are simple. MTOS logs on to any UNIX over an RS232C serial line. A follow-up system will feature shared memory. But MTOS-UX's real power is in its unusual design that enables it to trigger the downloading and execution of programs from a UNIX machine to an MTOS-based processor, while the real-time program is running.

The design feature responsible is MTOS' support of dynamic memory allocation and dynamic linking and loading. These capabilities allow MTOS to perform an autoconfiguration. That is, a programmer can write an initialization task, running under MTOS, which can be used to load, locate, initialize and start up a complete application from a UNIX host. That task can also dynamically create (or delete) system objects such as semaphores, memory pools, event flags, mailboxes and drivers needed for the program's execution.

Although these dynamic capabilities are useful for many applications, users first think of applying them to diagnostic areas. In one manufacturing application under investigation, users want to connect an MTOS-based machine to a UNIX workstation. The idea is to monitor and control machines, and to detect errors, while assemblies are being put together. When the errors reach a critical level, then the real-time program would be partially replaced by a diagnostic program, which would execute and provide feedback that would help maintenance personnel correct the problem.

For some distributed real-time UNIX systems, a real-time UNIX facilitates integration of the host UNIX and dedicated real-time systems. A real-time, board-level solution at Alcyon, for example, integrates real-time UNIX/Regulus with the real-time kernel PSOS (from Software Components Group). The boards plug into the same backplane. This multiprocessor system can connect to UNIX on the host.

In this integrated system, the application task performs high-speed data collection and analysis under PSOS. The Regulus processor performs the system's overall executive functions, the operator-interface and file-server functions and some real-time tasks. It also supports software development. Regulus also is the intermediary between the UNIX host and PSOS. Because of its real-time capabilities, it communicates more easily with PSOS than could UNIX. Similarly, because it is UNIX-based, Regulus communicates more easily with the host UNIX than could real-time PSOS.

There is no doubt that a real-time version of UNIX not only is possible, but also will be seriously considered as the operating system for many future manufacturing applications. At the same time, it seems there will always be a place for smaller, dedicated real-time kernels.

It is generally accepted that a common operating system, by itself, will not solve all application transportability problems. However, in conjunction with high-level languages, run-time libraries (to execute device-dependent code) and clever software engineering, users and vendors will significantly improve on today's degree of application transportability. □

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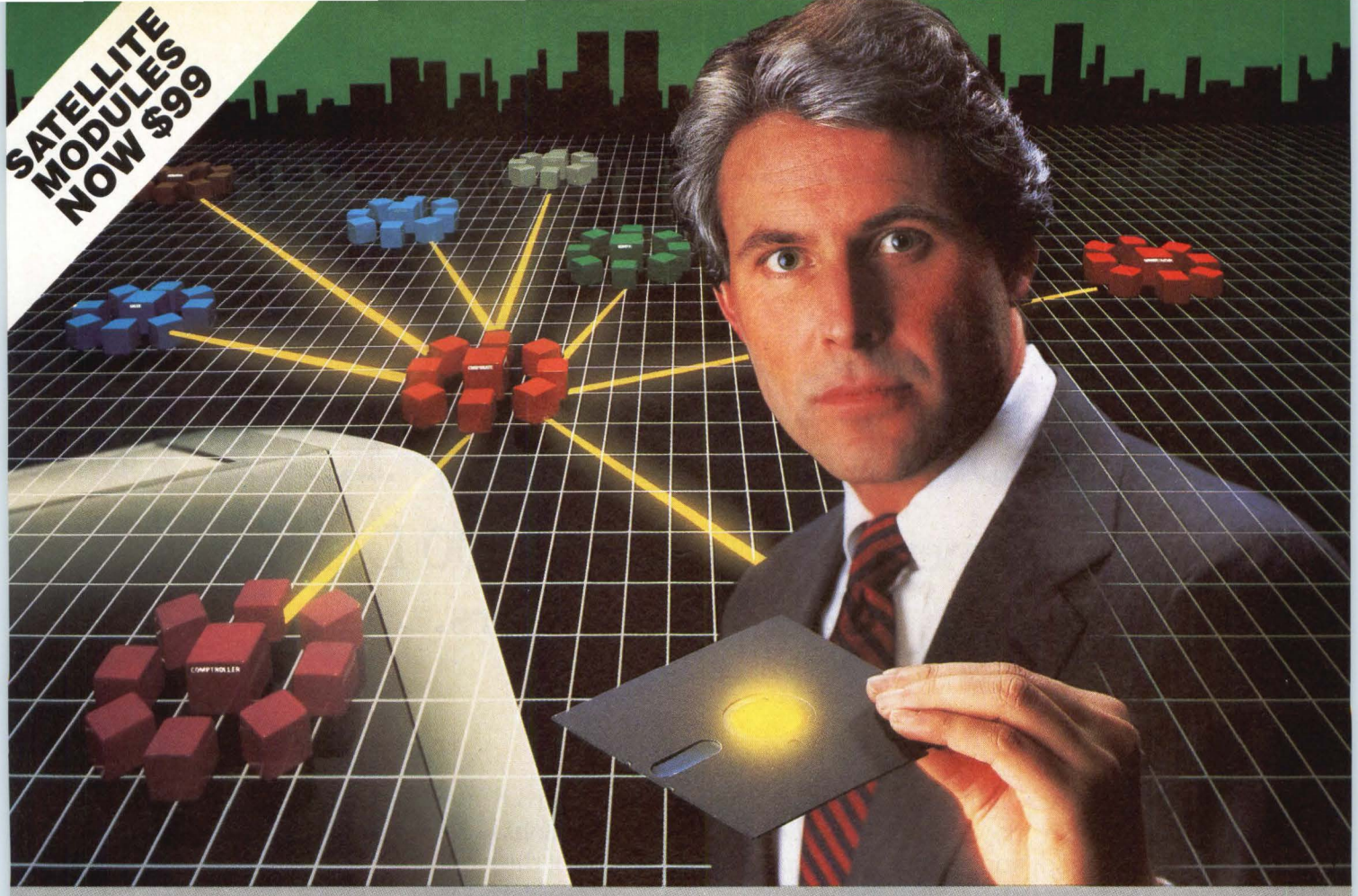

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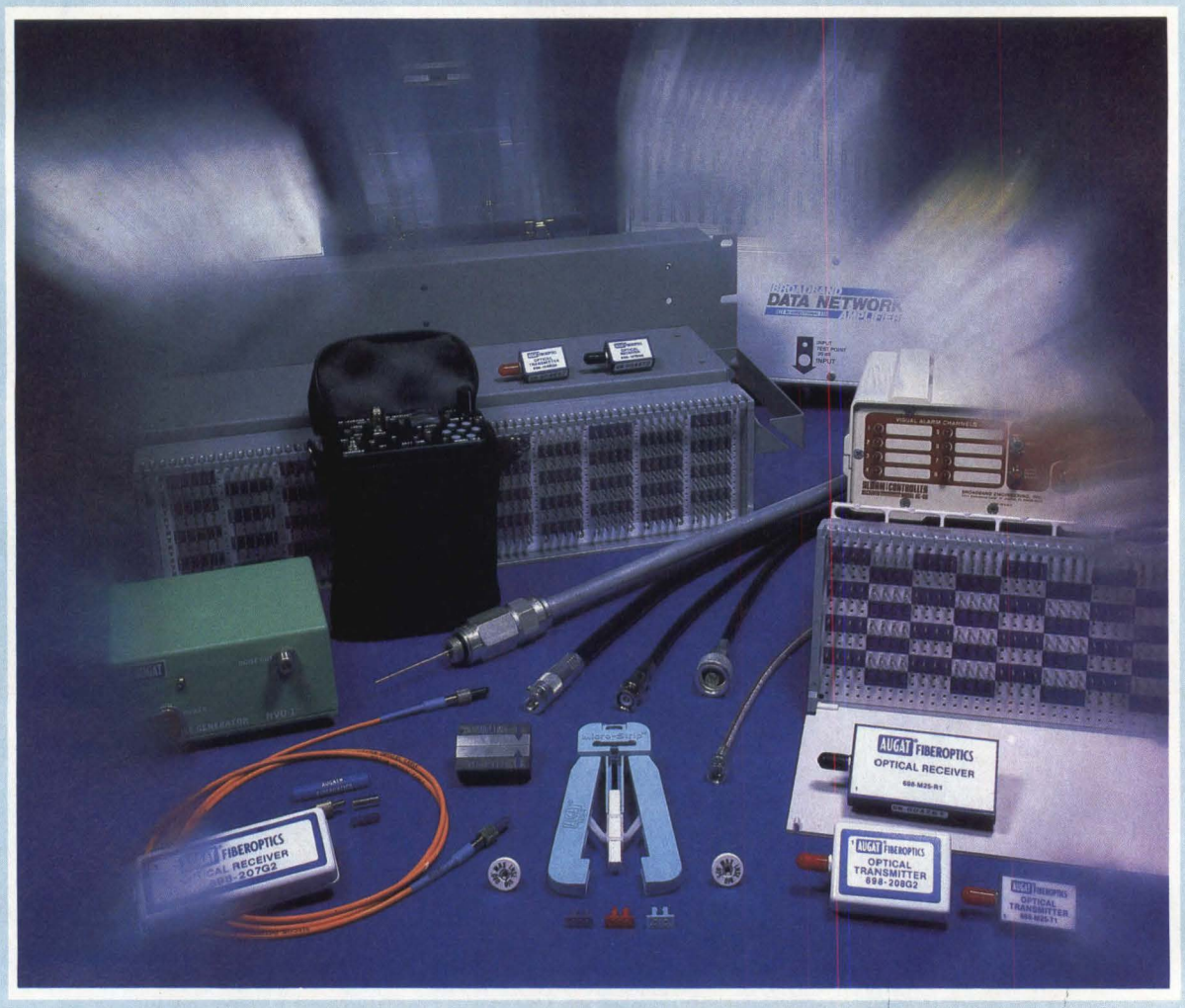

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LINKING DATABASES FORCES NEW STRATEGIES

As data communications options multiply, applications developers must cope with distributed processing as a basic rule of programming

Michael Tucker, Associate Editor

Increasingly, system integrators are not asking if their machines will be required to communicate with other computers but, rather, how. The new realities of computing find the user wanting data transfer and the hardware vendor being forced to configure machines so that they can accommodate local area and wide area networks, packet switching networks, RS232C-based limited area networks and numerous other, often exotic, technologies.

Software vendors, too, are being forced to respond to networking, shaping their products for situations in which distribution of resources and files is the norm. In particular, database management systems are under tremendous pressure to fit distributed environments. At the same time, such database systems are being asked to do something they've never done before outside the mainframe world—manage distributed files. So, DBMS vendors are gradually forming philosophically opposed schools on how that distribution should be done. The major divisions comprise, roughly, those who feel data should be truly distributed, those who feel it should be centralized and, as an emerging third camp, those who would attempt the distribution of data via software removed from DBMS products.

Networking problems appear

In the mainframe world, the problems of distributed file management have been handled for years. But, historically, developers of software for microcomputers have had neither the motivation nor the tools for distributed computing. Personal computers, by nature, were

Networks branch out

Programmers sometimes find it useful to think of a computer network as a single, loosely coupled multiprocessing machine. So, too, can marketers. If a local area network is conceived of as a single machine, so can its potential for modification for vertical markets. Here are two of the newest specialized LANs:

GCLISP Network from Gold Hill Computers Inc., Cambridge, Mass. Introduced last January, GCLISP Network provides an Ethernet link between IBM Corp. PCs or compatibles and LISP engines (or powerful multiuser systems)—running Gold Hill's LISP compiler. GCLISP Network gives developers working in artifical intelligence an inexpensive means of centralizing their investment in LISP, while still bringing the power of the language to the desktops of individuals.

VSLAN from Verdix Corp., Chantilly, Va. Introduced last May, the Verdix secure LAN is one of the first LANs to address both the military and civilian markets. VSLAN is an extremely secure product that encrypts everything that passes through it. Buyers can purchase either the entire LAN, or merely the encryption technology for application in their own networks. In addition to the obvious military and intelligence applications of the product, VSLAN could find uses in such applications as electronic funds transfer and financial-information processing.

meant as standalone systems with little need for communications beyond occasional dial-up access to mainframes.

While the rapid appearance of the networked office and factory is providing the motivation for communications, the tools—standards, protocols, etcetera—aren't coming as quickly. But they are finally starting to appear. And, although the obstacles to microcomputer networking are by no means fully overcome, the efforts of standards committees, network vendors, and multivendor R&D organizations, such as the Corporation for Open Systems, are starting to pay off.

This is particularly true of operating systems, where applications developers are finding major vendors ready to provide networking facilities as basic components of the operating system. For example, in single-user systems, where MS-DOS and PC-DOS dominate, the cooperation of IBM Corp. and Microsoft Inc. has produced NETBIOS, a layer of software that gives DOS-based machines a standard link to networks. In multiuser microcomputers, where AT&T Co. would like UNIX to reign, ATTIS has recently released UNIX System V.3, which specifies mechanisms to handle files in a distributed environment.

But, the existence of these communications facilities doesn't clearly establish how any one piece of software can use them. Developers themselves must answer some basic questions on how their products may be spread over a network. Nowhere is this truer than with DBMSes, which must distribute information across wide areas and multiple users, yet still ensure the integrity of that data despite the chances for error inherent in such a complex, decentralized system.

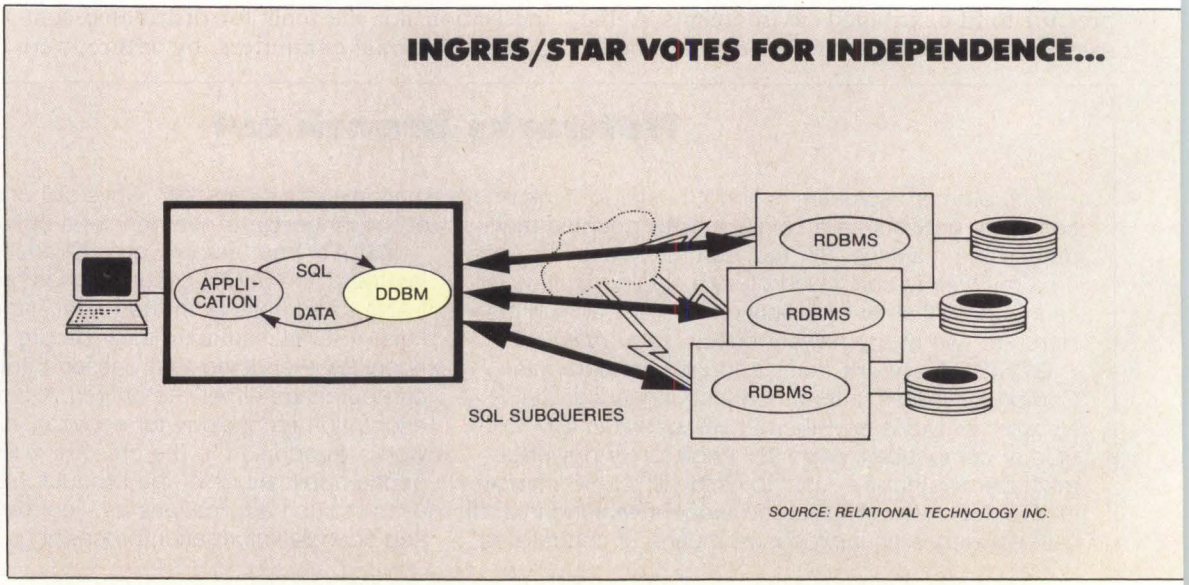
Specifically, a distributed DBMS should provide users the illusion that they are working on a single database, on a single machine. Users should never have to worry about the physical location of any file, how files are protected from conflicting updates and network failures or how copies of any file might exist at any given moment. In other words, a DBMS must provide transparency in file location, replication and failure.

Ingres' Star shines

While virtually every DBMS vendor is experimenting with different approaches to distributed file management, two methods seem to be emerging as the most common. Either the data is completely decentralized and truly distributed among different machines, or the data is centralized in one or more dedicated server machines.

One partisan in the truly distributed camp is Relational Technology Inc. RTI's Ingres relational DBMS (RDBMS) was originally introduced for Digital Equipment Corp. machines running on the VAX/VMS operating system. Over the years, Ingres expanded to include IBM products running under IBM's VM operating system and a host of UNIX-based systems from several different vendors. An MS-DOS version for IBM PCs and compatibles is scheduled for release sometime this year.

Ingres has been particularly popular in large technical applications such as aircraft design (it's been used extensively at Boeing Co., for instance). But this has meant multiple installa-



A truly distributed DBMS, *Relational Technology's Ingres/Star runs on heterogeneous networks and protocols. It uses a distributed database manager (DDBM) to link individual relational database management systems (RDBMS).*

tions of the DBMS running on different machines in different locations. In turn, this has meant that, like all the other DBMS makers, RTI has come under severe pressure from users to turn the product into a distributed system.

In response, RTI announced Ingres/Star in June. Running atop the RTI communications product, Ingres/Net, Ingres/Star will eventually be a truly distributed DBMS. It runs on heterogeneous networks, protocols and machines that will eventually range from microcomputers to mainframes. Initially, it will offer multisite reads and single-site updates of files. But, in a second release scheduled for 1987, the company plans to include multisite updates as well.

Ingres/Star is a distributed database manager (DDBM) that operates as a local DBMS on each node of the network. The nodes must then cooperate in file management. The common language between the different Ingres/Star installations is the Structured Query Language (SQL), made popular by IBM. Essentially, each local DBMS regards every other DBMS with which it has contact as a virtual user. So long as the transaction is in proper SQL, the local Ingres/Star doesn't care whether a query or update comes from a local keyboard or from another DBMS located a hundred miles away.

This means, in turn, that the network can comprise different machines. Because the only information passing between individual Ingres/Star installations is SQL and data, no one local DBMS need concern itself with the hardware, software or operating system of any other copy of Ingres/Star.

Morever, because SQL is an emerging standard in databases, Ingres/Star will eventually be able to communicate directly with other SQL-based DBMSes. Although that startling possibility is still confined to the future, RTI hopes to open "gateways" to other DBMSes by 1987. And by 1988, RTI hopes to open similar gateways to DBMSes that don't use SQL.

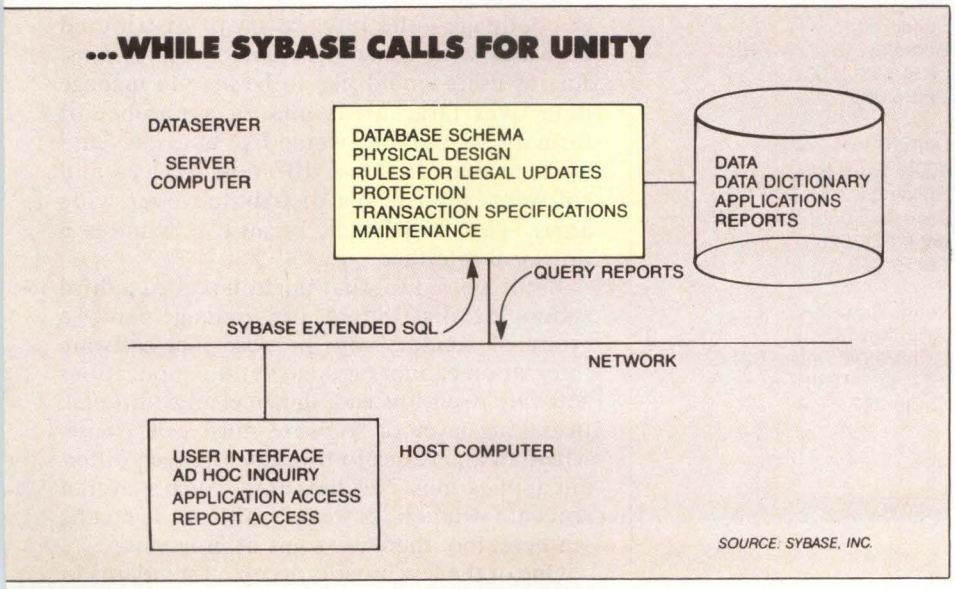
Integration of heterogeneous DBMSes has been called the Holy Grail of the MIS world (MMS, April, Page 63). Many large companies have made huge investments in several different DBMS-products, which they would now like to link via some common interface. Obviously, the product that provides such a link would have a profound effect on the entire computer industry.

DBMSes are under pressure to fit distributed environments.

Centralists strike back

Still, the decentralized approach has its critics. While virtually everyone agrees on true distribution as the ultimate goal of database research, another school of thought holds that data should be centralized somewhere in the network, at least as an interim measure. This "centralist" school thinks, first, that the technology of DBMSes is not yet mature enough to handle the problems of true distribution and, second, that users prefer their data in a single location where it can be carefully controlled and protected.

One member of the centralist school is Sybase Inc., which recently introduced the DataServer, an RDBMS for distributed environments. The DataServer sits on a dedicated node anywhere in the network and controls the actual database. File management is thus done almost as easily and safely as it would be in a single-user system. Users at other nodes of the



One example of the centralized approach *is Sybase's distributed DBMS, which concentrates data within dedicated server machines.*

Developers must answer basic questions on how their products can be spread over a network.

network send SQL queries over the network and the results return to them.

Here, more than one server can operate in a network. In the current version of DataServer, a single SQL query may search or update two or more databases within one machine acting as server, but not in separate server computers. "Eventually, we will ease that restriction," says Robert Epstein, Sybase's executive vice president. "However, the one thing users have told us again and again is that they want centralization. They want control of data."

Unify Corp., makers of the Unify database for UNIX and MS-DOS machines, is another centralist. Unify too has prototypes, rather than products, each of which operate in a distributed environment. The company also envisions data contained in centralized servers, though for reasons having more to do with human nature than technology. "I predict that there will be considerably fewer machines containing data than accessing data," says Unify president Nicolas Nierenberg, "Not because the DBMSes won't be capable of handing more than a few disks, but because database administrators won't be willing to deal with the complexities of DBMSes."

Relational Database Systems Inc. (RDS), makers of the Informix DBMS, leans even more toward centralization. The company can currently support some communications between Informix installations operating MS-DOS based machines. In the future, the company hopes to develop a centralized capacity, with data kept on a UNIX-based server. The DBMS would consist of "back ends" on the server, communicating via SQL with users operating "front ends" at their individual workstations. Later, the company plans to turn this setup into a truly distributed system. "We'll probably have front ends at each personal computer, with each front-end having a corresponding back end at the server," says Jeff Poole, product manager for network products at RDS. "Then, gradually, we'll introduce back ends for personal computers, so that files can be truly distributed."

Other DBMS vendors are certain to enter the distributed database business one way or another. In fact, several companies have recently introduced products that are not distributed databases. These products clearly indicate intentions to get into the game, with SQL as the probable method. One such company is Oracle Corp., vendor of the popular Oracle DBMS for IBM, DEC and compatible machines. In releasing the fifth version of DBMS, Oracle also introduced SQL-Link, a communications product. SQL-Link allows an Oracle DBMS on a microcomputer to send SQL queries to another Oracle DBMS running on a multiuser system.

ASCII and ye shall receive

Although SQL may prove the best route to truly distributed DBMSes, there are problems that the language cannot address. Beyond the distribution of DBMSes, beyond even the integration of heterogeneous databases, lies another challenge—the integration of distributed DBMSes with other distributed applications. Just as users would like to be able to manage data over large areas and in a number of formats, so, too they would like to display and analyze that data via different devices and software, themselves distributed over wide areas. This is difficult, because it requires a universal interface.

But it has led to what might be called a third school of distributed file management—a group of vendors who propose that software integration cannot be done within applications software itself. Instead, they feel an additional, insulating layer of software must exist somewhere in a network to translate between different applications. Needless to say, such a layer of software would be extremely difficult to create, yet here, too, there are signs of progress.

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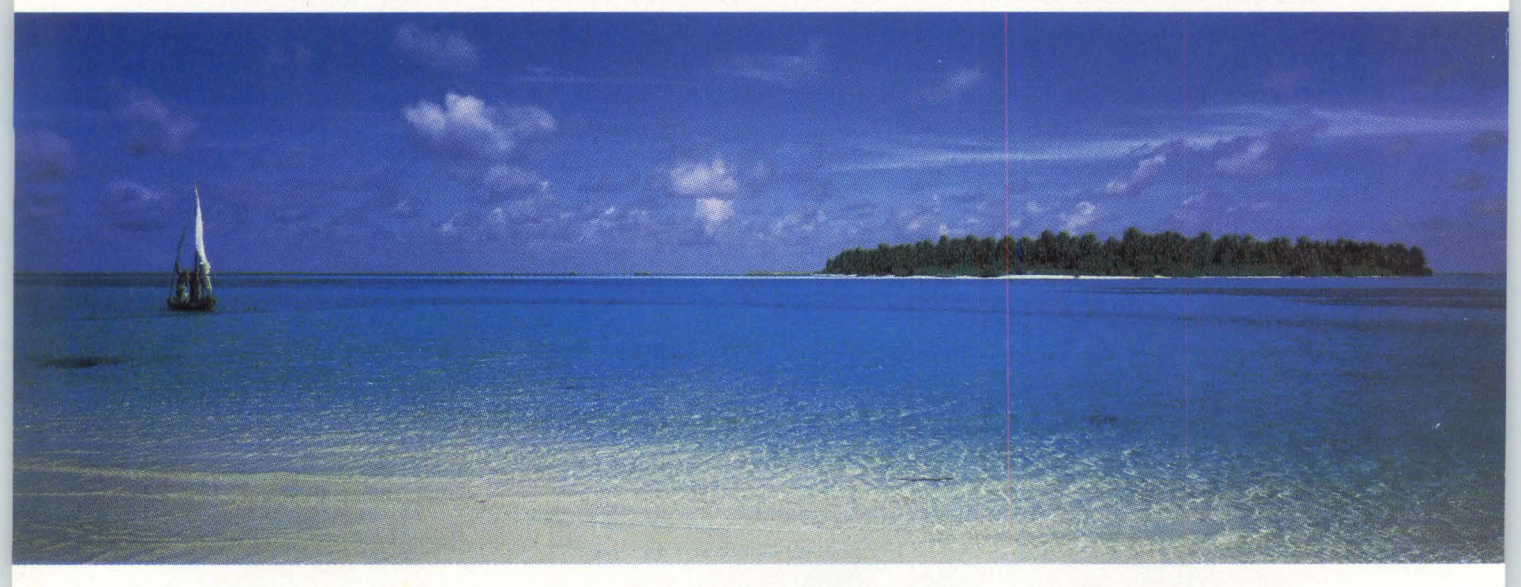

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computing today is ASCII code. It is slow, laborious and nearly 20 years old. But ASCII is nearly universal because it's been the widely accepted means by which machines and human beings have communicated, and human beings are notoriously difficult to reprogram for new formats.

One company that takes advantage of ASCII is VenturCom Inc., with its Prelude Information System. Prelude is a tool kit for developers building distributed applications for groups of UNIX machines—specifically, those that are compatible with AT&T's UNIX V.3 or above.

Prelude consists of over 100 individual modules of code—performing functions ranging from database management to application generation. These modules can run on a single computer or be farmed out to separate machines. Communications between them is conducted by standard ASCII strings, which can be transferred via local or wide area network, dial-up access, or the physical transfer of disks.

In effect, the application builder who works with Prelude designs not for a network but for a single, multiprocessing machine that happens to be loosely coupled. Moreover, because Prelude uses ASCII, it can and does access other software that also uses ASCII. In fact, the company claims that Prelude has been successfully linked to DBMSes from other vendors. This raises the interesting possibility that DBMS vendors will not achieve distributed file management but, rather, have it thrust upon them by increasingly sophisticated ASCII-based systems.

Command Technologies Inc. demonstrates just how sophisticated ASCII-based, distributed systems can be. This small company's chief scientist and co-founder is Calvin Mooers, one of the geninuely grand old names in computing. Mooers has been in the field since 1945. In addition to doing pioneering work in file management, he also helped lead the effort that led to the standardization of ASCII in the early 60s.

Command Technologies markets an I/O-based programming language and operating environment for distributed computing called VXM. Among other attributes, VXM gives the programmer the ability to create a VXM Entity, a semiautonomous module of code that can reside on any node of a network, or even travel from node to node in a network, like a "ghost" in the machine. Moreover, VXM Entities may communicate with one another via ASCII code, and they may control other, non-VXM programs and read their output as long as those programs work in ASCII.

Thus, VXM could give developers the ability to manage distributed applications as they never have before. A developer might, for instance, unite diverse DBMSes by giving each database a resident Entity. The Entity would then act as a virtual user, controlling the database, performing queries and passing the results in ASCII to users or other Entities and their databases.

But, no matter what tool becomes the common language of distributed software, products like VXM, Prelude, Sybase and Ingres/Star show there's no doubt that such a language will eventually come about. What is far less clear is what networking will do for, and to, software developers. In effect, communications networks, rather than individual computers, have become the machines for which developers write—and their products must now take into account both the increased power and complexity that networks provide. □

Ingres/Star will eventually be a truly distributed DBMS.

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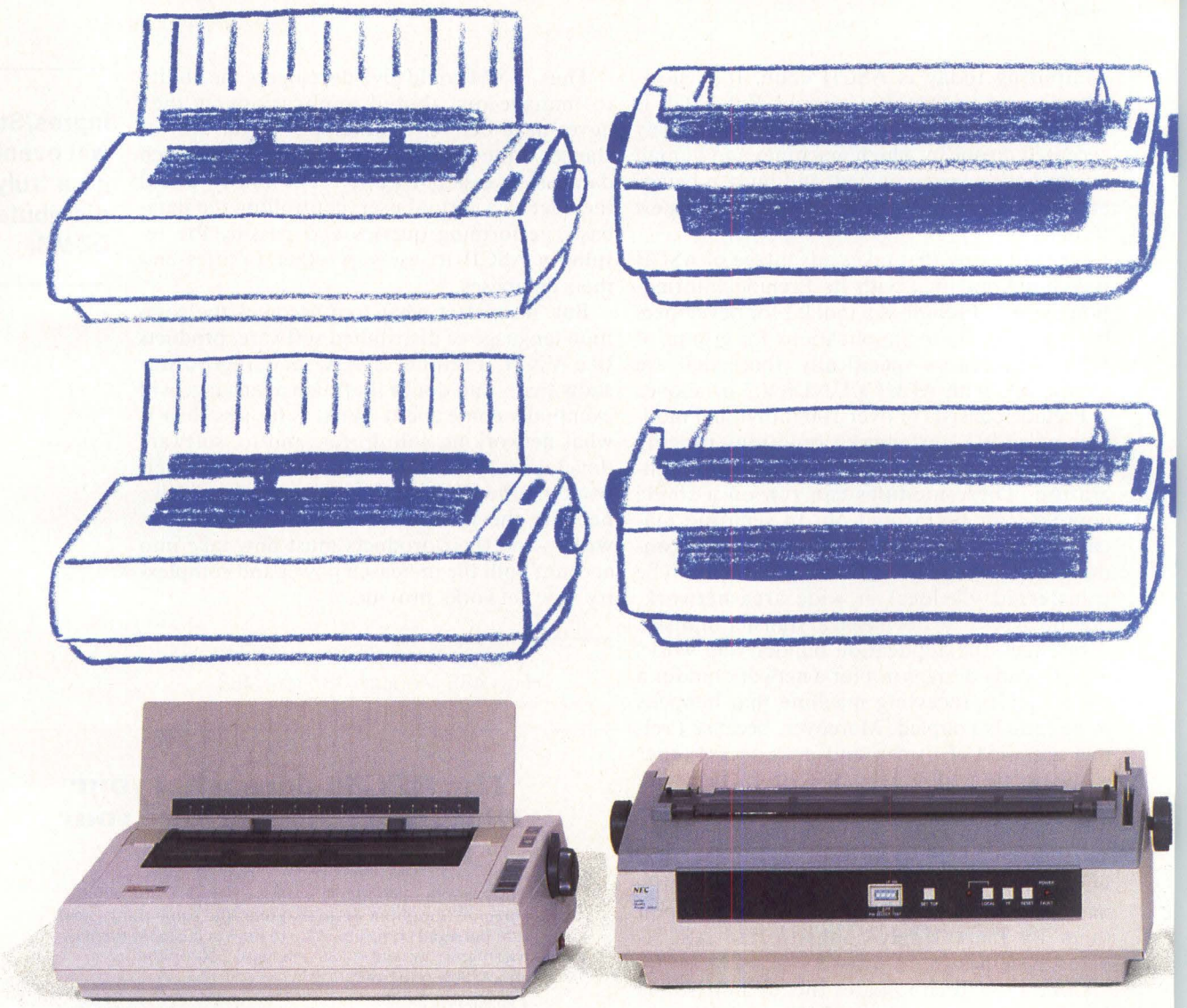

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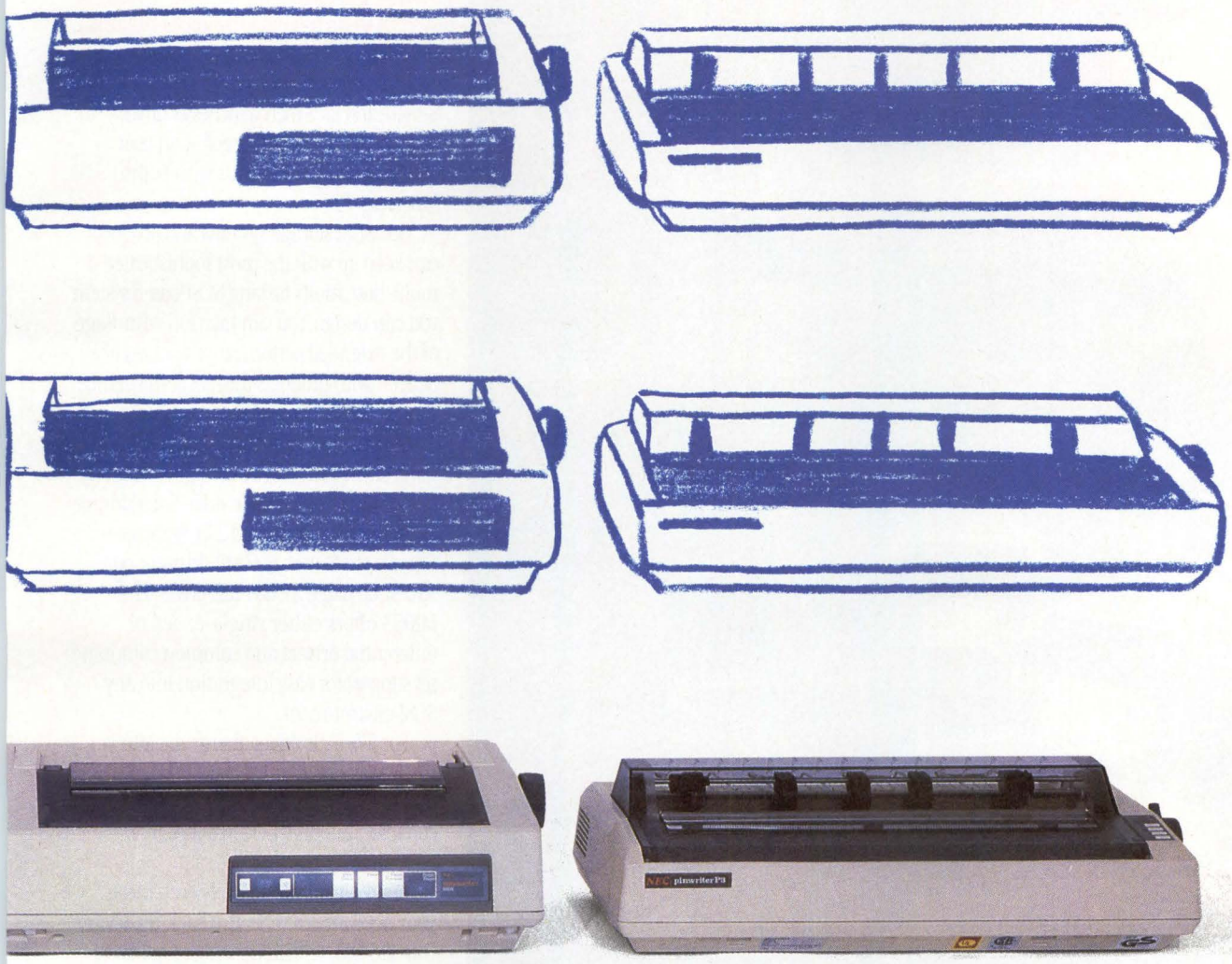

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Steve Spanier, Excelan Inc.

The ability to connect diverse computer equipment is rapidly supplanting performance, features and even cost as the single most important criterion in selecting local area network equipment. In addition, multivendor networks require standard protocols that will enable them to work with incompatible terminals, bus structures, character sets, storage capacities, processing rates and physical media.

Many LAN protocol standards have emerged to address the problem of how to connect multivendor LANs. But LAN users and system integrators need not fear that the proliferation of these protocols—or of new protocols that emerge in the future—will make current installations obsolete. Accepted technologies, such as front-end processors, allow users to preserve their capital investments in LAN equipment. Front-end processors permit easy migration from present to future protocol standards.

Protocols include the International Standards Organization's Open Systems Interconnection (ISO/OSI) reference model, the Manufacturing Automation Protocol (MAP) and the Technical and Office Protocol (TOP).

Standards lay the foundation

The most popular current protocols upon which to build a network are Ethernet, the File Transfer Protocol (FTP), Telnet, the Simple Mail Transport Protocol (SMTP) and the Transmission Control Protocol/Internet Protocol (TCP/IP). These protocols, designed for heterogeneous environments, command a relatively large share of the LAN market.

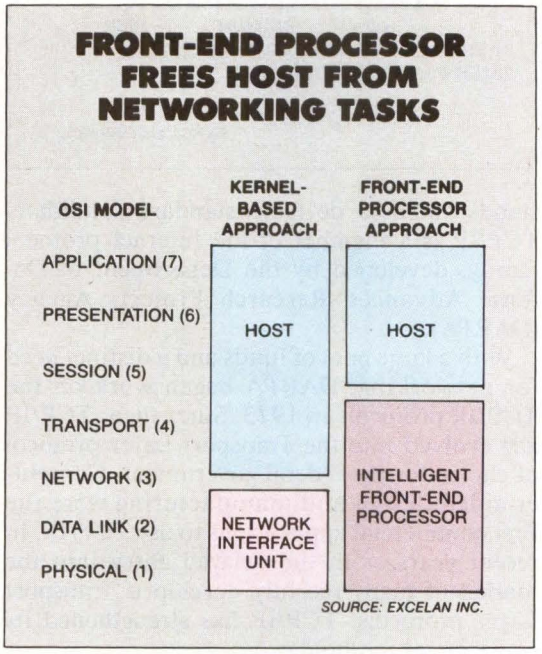

Fig. 1. The front-end-processor approach *offloads the Transport and Network layers of the OSI model to an intelligent front-end processor. The front-end processor performs all network-oriented tasks, thereby freeing the host for local processing.*

Ethernet, a de facto standard, defines layers 1 and 2, the Physical and Data Link layers, of the OSI model. More than 150 companies support Ethernet, which was jointly developed six years ago by Digital Equipment Corp., Intel Corp. and Xerox Corp. The Ethernet specification avoids optional features, thus simplifying the development of compatible variants. Because of its low cost, high bandwidth and flexibility, Ethernet is the most likely media-access technology upon which to build a future network.

At layers 3 and 4, the Network and Transport layers of the OSI model, the question of which protocol is a standard is less clear. Still, TCP/IP

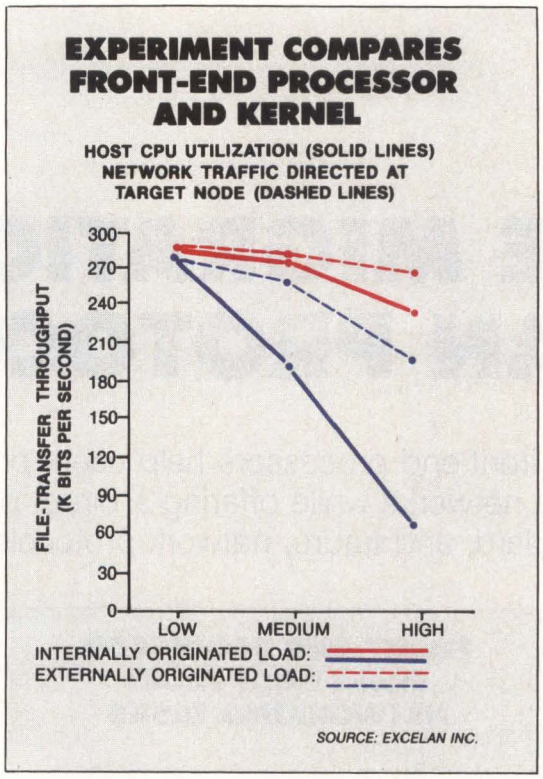

Fig. 2. The front-end-processor approach *(red) outperformed the kernel-based solution (blue) in this experiment. The experiment compared the effect of large file-transfer throughput on a CPU-intensive, internally originated task (solid lines) and on an externally originated task that directs heavy network activity at a target node (dashed lines).*

stands out as a de facto standard candidate. TCP/IP is a member of the Internet protocol family, developed by the Department of Defense Advanced Research Projects Agency (DARPA).

With a large pool of funds and a distinct need for networking, DARPA began work on the TCP/IP protocols in 1973. Since then, TCP/IP has evolved into the Transport Layer protocol of choice for the federal government. Computer-aided design and manufacturing were the first commercial applications to use TCP/IP. In recent years, with the delayed entry into the market of many recently developed Transport Layer protocols, TCP/IP has strengthened its commercial foothold.

Little standardization has occurred at the Application Layer where most users are demanding three applications: file transfer, virtual-terminal emulation and electronic mail. Because of their longevity, specification completeness and association with the Defense Department, the Internet versions of these applications—FTP, Telnet and SMTP, respectively—have gained popularity over the last seven years.

FEPs provide modularity

To achieve the flexibility that allows easy migration to new protocols, a technology must be modular. Modular design allows users to employ smaller entities, which can be more easily understood, used and changed than can larger, unwieldy entities. Dividing a problem into smaller pieces, with each piece representing one task, makes the solution more comprehensible. It also makes solutions more malleable because, if a problem changes slightly, a new solution may be found by changing a few isolated parts rather than by having to alter an unwieldy whole. The OSI model applies modular design principles to networking.

Front-end processors embody the principle of modular design in LAN technology. A front-end processor, a self-contained subsystem, acts as a communications buffer between external data-sending devices, such as other network nodes or satellites, and a main processing unit. Front-end processors in LANs typically comprise a board that plugs into the backplane of a host, allowing that host to communicate on a network with similarly equipped computers.

A front-end processor contains a CPU that runs a streamlined operating system to control the front-end processor's resources. These typically include a network interface, a host interface and enough memory not only to buffer incoming and outgoing network information but also to run software implementing layers 3 and 4 of the OSI model.

The intelligence to run Transport and Network layer software without excessive host intervention is the main difference between the front-end-processor approach and the "kernel-based" approach. The Transport and Network layers run on the FEP without excessive host communication because they are, by definition, concerned with network-oriented rather than host-oriented tasks (Fig. 1).

Putting the network-oriented functions of a computer system onto a front-end processor decouples those functions from the main processing unit. The front-end processor presents a consistent interface to the host, without depending on the host operating system. This reduces the time needed to add new protocols and to adapt the network subsystem to new computer systems. It also helps to relieve the problem of outdated equipment and protocols. Front-end processors also offer high data throughput, efficient use of host memory and easy maintenance.

A front-end processor dedicates its resources, such a processor and memory, to network tasks, thus optimizing network throughput. While the host CPU performs database, spreadsheet and other tasks, the front-end processor uses its own resources to handle all network tasks. This results in increased net-

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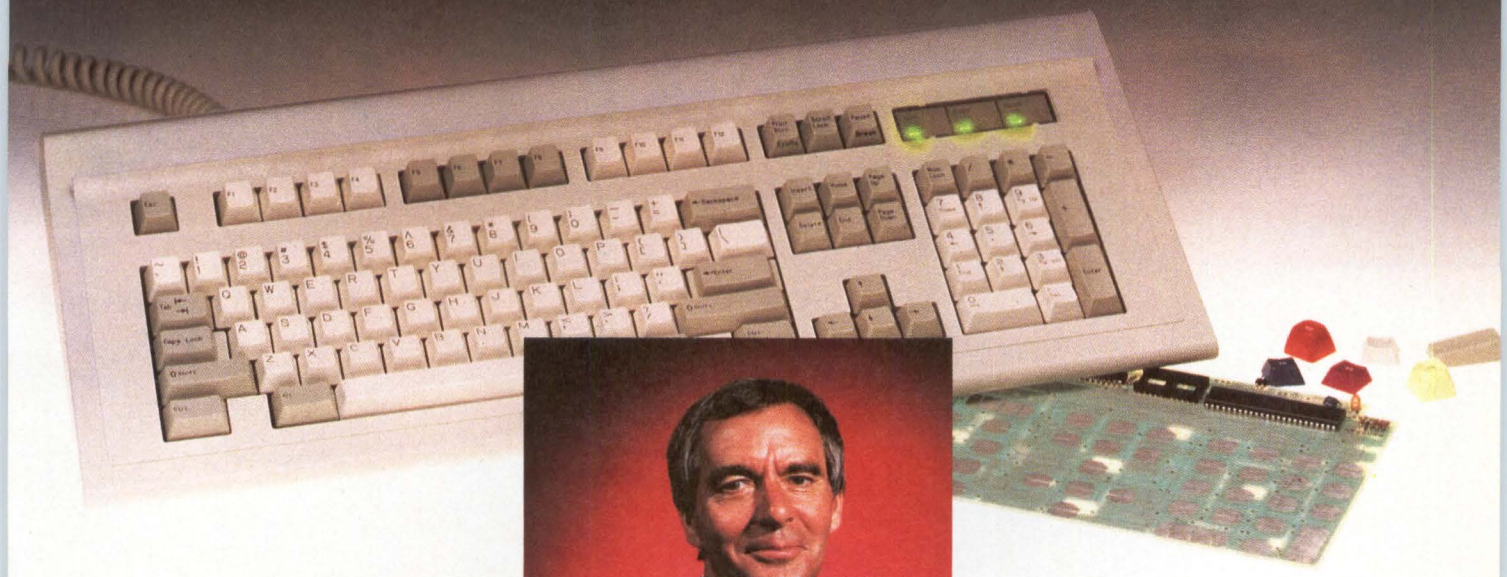

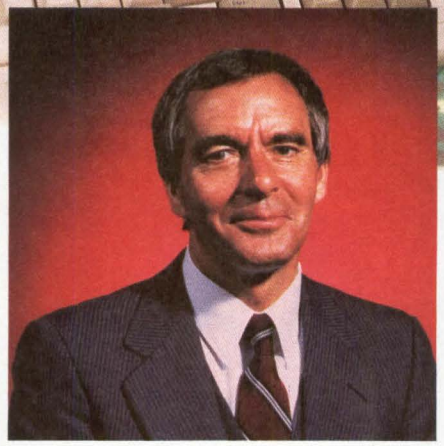

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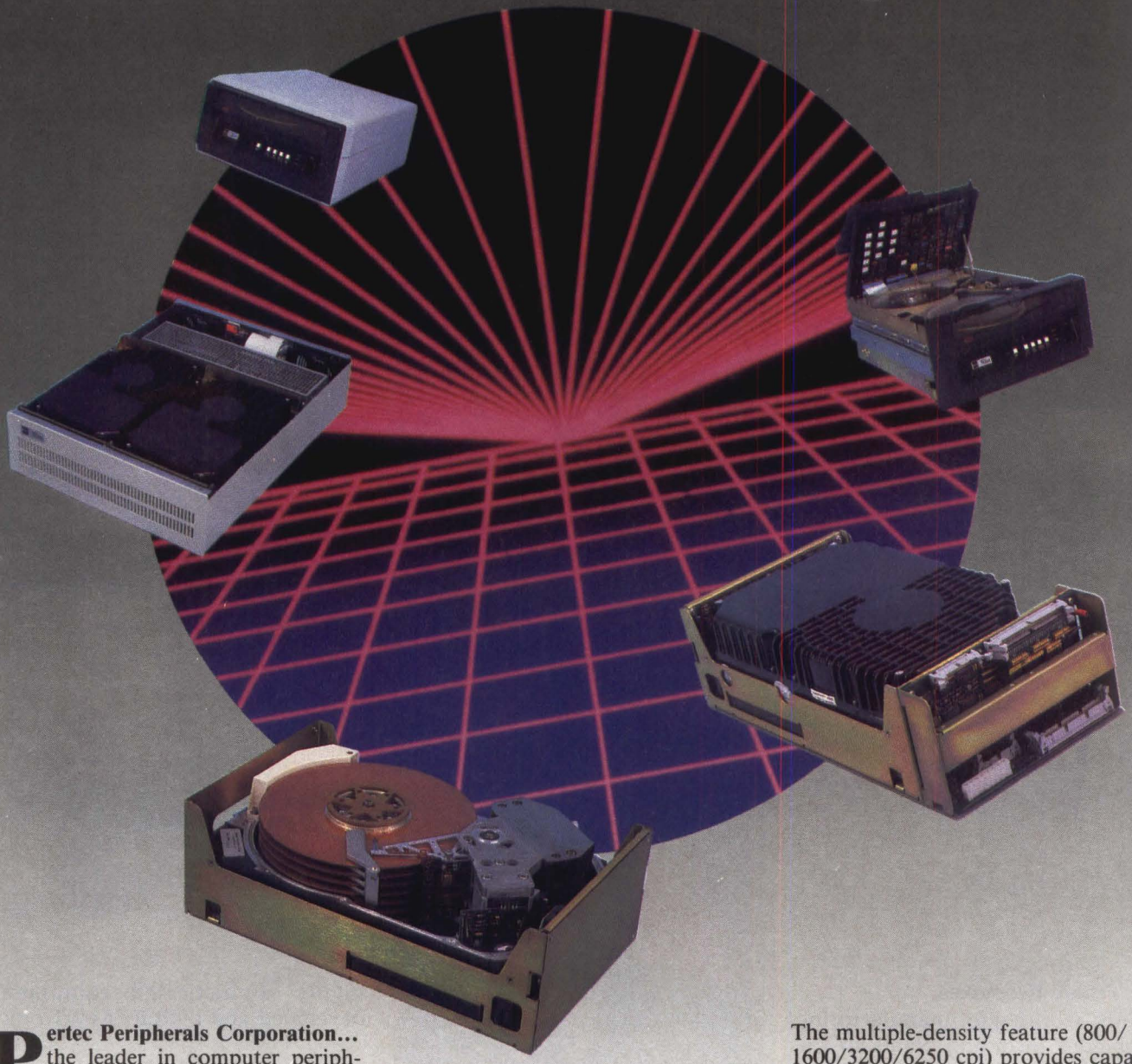

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AT&T Co.	✔	✔				✔			*	✔						✔	✔	✔	
Bridge Communications Inc.	✔	✔	✔			✔					✔						✔	✔	
Communication Machinery Corp.	✔	✔	✔	✔	✔	✔		*		✔							*		
Digital Equipment Corp.	✔	✔	✔				✔										✔	✔	✔
Excelan Inc.	✔	✔	✔	✔	✔		*	✔		✔	*	*	*	*		✔	*		
IBM Corp.	✔	✔							✔	✔	✔		✔				✔	✔	
Micom-Interlan Corp.	✔	✔	✔		✔	✔										*			✔
Sytek Inc.	*	*					✔	*	✔	✔	*	✔	✔	✔			*	✔	
3Com Corp.	✔					✔				*	*					✔			✔
Ungermann-Bass Inc.	✔	✔	✔			✔				✔	✔	✔	✔				✔	✔	✔
The Wollongong Group	✔	✔	✔	✔	✔		*	*					*	*	✔	✔	✔		✔

✔ = already have
* = under development

Source: Mini-Micro Systems

work throughput and decreased host work load during heavy processing periods.

FEP outperforms kernel

Excelan Inc. performed an experiment comparing the kernel-based approach with the front-end-processor approach. In the experiment, the company tested the effect of a CPU-intensive (internally originated) task and a network processing (externally originated) task on large file-transfer throughput.

The experiment was run on two host systems: a Sun Microsystems Inc. 2/120 system to demonstrate the kernel-based approach and an NCR Corp. Tower for the front-end-processor approach. The 2/120 system ran Sun's version of the Berkeley UNIX Version 4.2 operating system with TCP/IP networking in the kernel. The Tower system ran the UNIX System V operating system with TCP/IP on an Excelan EXOS 201 front-end processor. Both hosts used the Motorola Inc. MC68010 processor running at 10 MHz, and the Excelan board provided 512K bytes of RAM and an 8-MHz Intel 80186 CPU. Average disk-access times and total disk space for both machines were similar.

In both the internally originated and the externally originated tasks, the front-end processor solution outperformed the kernel-based solution. Predictably, differences became more noticeable as the CPU or network activity increased.

The front-end processor approach also frees valuable host memory for application programs. As application programs become more sophisticated, their need for host memory increases. Because of complex acknowledgement schemes, transport software can consume more than 60K bytes of memory. Running the transport software on a front-end processor allows users to run more host applications than if the transport software were running on the host.

Only operating system experts can overcome the difficulties of integrating Transport Layer network processing into the kernel of machines with different file systems, user interfaces and I/O subsystems. This is because such integration typically reaches deeply into the operating system internals. The task is made even more difficult because it involves tying network processing to operating system characteristics. New versions of the operating system often make the machine unable to perform certain network tasks. Therefore, front-end processor systems, which isolate network processing from the host operating system, are easier to maintain than kernel-based systems.

The main difference between a front-end processor and a link-layer board is that the front-end processor has onboard intelligence. With a front-end processor, a user must absorb the extra cost of a CPU and memory that intelligence entails. However, these are inexpensive to add because CPU and memory chips are widely available and low-cost. In addition, if the network software runs on the host, the host's price generally includes this software. If the network software runs on a front-end processor, its price typically depends on the price of the computer it supports. Generally, the cost of adding front-end processor technology to a

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Bridge Communications Inc.	✓						
Communication Machinery Corp.	✓		✓	✓	✓	✓	
Digital Equipment Corp.				✓	✓		
Excelan Inc.	✓		✓	✓	✓	✓	✓
IBM Corp.						✓	
Micom-Interlan Corp.	✓			✓	✓	✓	
Sytek Inc.						✓	
3Com Corp.						✓	
Ungermann-Bass Inc.	✓	✓	✓			✓	
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computer system is less than 10 percent of the cost of the computer itself.

FEPs allow migration

The Token-Ring and Token-Bus standards, along with the ISO, MAP and TOP protocols, are all likely to become popular in the next five years. ISO, MAP and TOP, as currently defined, specify all seven OSI layers. Token-Ring and Token-Bus resemble Ethernet in that they specify only the Physical and Data Link layer protocols, but they provide different topology and signaling methods than those of Ethernet. Despite this, migration to these new protocols is reasonably simple.

To do so, users and system integrators can replace Ethernet chips with Token-Ring and Token-Bus chips. The newly created front-end processors would be largely compatible with the onboard operating systems used by intelligent front-end processors and fully compatible with the Transport Layer protocol software. Using two front-end processors would enable hosts to coexist on an Ethernet and either a Token-Ring or a Token-Bus network. During the transition between the old and new protocols, computers could actually coexist on both networks.

In addition, ISO has adopted the IEEE 802.3, 802.4 and 802.5 media-access protocols as standards, making migration to ISO easier. Because Ethernet and 802.3 are similar, most front-end processors that support one also support the other. Therefore, users need not change Ethernet/IEEE 802.3 front-end-processor hardware to implement ISO's Physical and Data Link specifications.

If the market decides to migrate from TCP/IP to ISO, front-end-processor vendors will most likely offer both the ISO transport protocol (TP-4) and TCP/IP on their boards. This combination is possible with front-end processors because the protocol software interfaces with the board's operating system rather than with its hardware. Many front-end processor vendors offer wide ranges of available memory space on their boards, and users who want to run more than one transport protocol should make sure that the front-end processors they purchase have sufficient memory for this task.

Current ISO applications, primarily File Transfer, Access and Management (FTAM), are more complex than most other popular applications and, therefore, require more host memory. In this light, the ability to run the Trans-

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port and Network layer protocols on a front-end processor is even more important. The front-end processor and the host-resident driver that communicates with it provide application-transparent network access. Applications that become important standards can therefore survive transitions to many different types of front-end processors.

TOP and MAP use ISO layers 2 through 5, the Data Link through Session layers. TOP uses the IEEE 802.3 specification for the media-access layers, MAP uses the IEEE 802.4 (token bus) specification. MAP defines more Application Layer (level 7) specifications than does TOP, although they both use the OSI FTAM protocol. Because of this similarity between TOP, MAP and ISO, once ISO and token bus are implemented on intelligent front-end processors, MAP and TOP will also be essentially complete.

How to choose a LAN vendor

End users and system integrators would be well-advised to look for four main attributes in LAN vendors: support of popular protocols (Fig. 3), support of major bus structures (Fig. 4), technology flexibility and future plans.

Some LAN vendors provide tools that allow the easy adaptation of products to support new protocols. These elements are essential because they reduce users' dependence on the vendor and allow users to employ the tools to add protocols the vendor lacks. Three such tools are application programming libraries, operating system interfaces and tunable transport-protocol modules (Fig. 5).

Vendor-supplied application programming libraries enable users to write their own network applications and isolate the details of the host operating system, thus making applications more portable. These libraries are important to users who need additional functionality beyond the standard file-transfer, terminal-emulation and mail capabilites offered by most LAN vendors.

Many front-end-processor vendors "open" the architecture of their products by providing documented calls, such as "create process," "send message" or "read memory," to the onboard operating system. These calls allow users and integrators to create protocol packages to replace or supplement those provided by the vendor.

A few vendors allow users to modify some parameters of their Transport and Network layer protocol packages. For example, TCP/IP uses a "window" to help the transmitting node determine whether it should send more data to the receiving node. The ability to modify the window size allows the user to adjust performance for special circumstances.

Finally, end users and system integrators should have reasonably complete information about LAN vendors' future plans. Most LAN companies are not large enough to offer all the new protocols that will appear over the next few years. Each will therefore focus on specific markets and should be prepared to answer detailed questions on market strategies and products. □

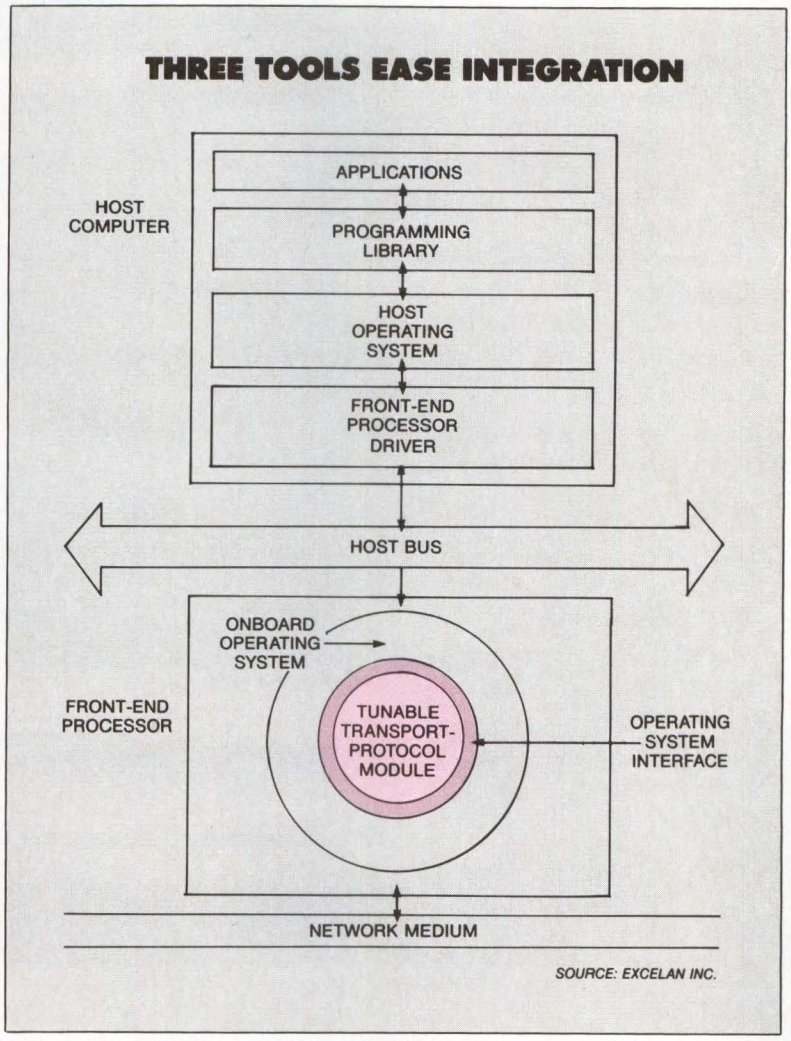

Fig. 5. In a typical front-end-processor architecture, *application programming libraries, onboard operating system calls and tunable protocol modules make it easier for users and system integrators to adapt a vendor's offerings to support specific environments.*

Interest Quotient (Circle One)
High 489 Medium 490 Low 491

Steve Spanier is a technical marketing engineer with Excelan Inc., San Jose, Calif. He holds a master's degree in computer science from West Coast University, Los Angeles.

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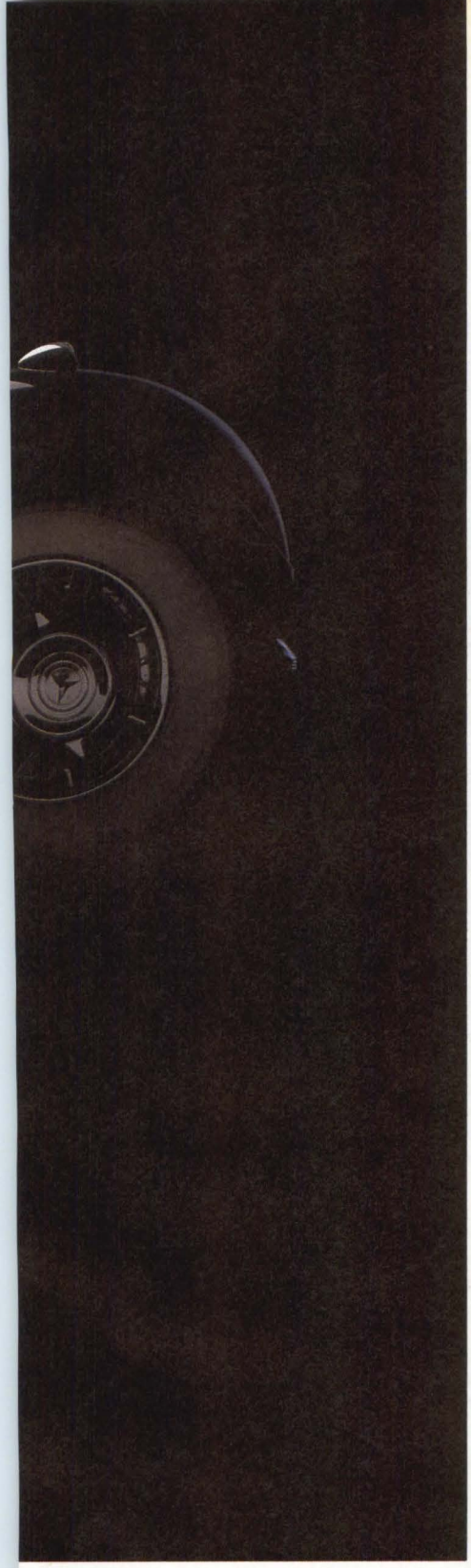

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IBM'S TOKEN-RING: WHAT ARE THE ALTERNATIVES?

IBM's 'serious' LAN has finally arrived, but other LANs should be able to coexist with the Token-Ring

David S. McMaster
Gateway Communications Inc.

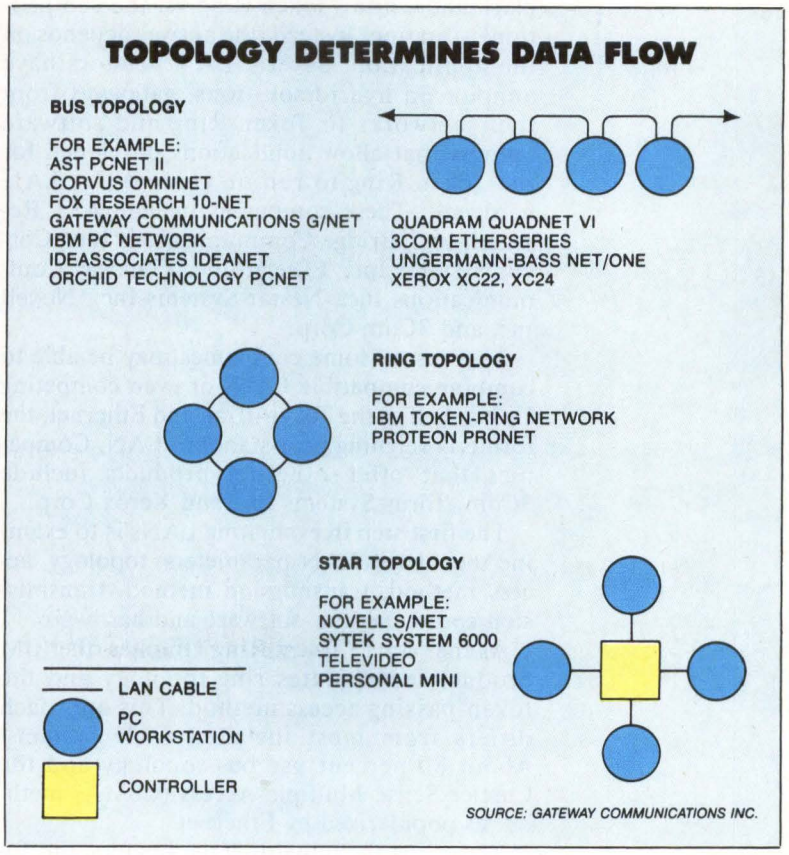
While watchers of IBM Corp. have been anticipating the industry leader's Token-Ring Network for several years now, 1986 marks the year that Token-Ring has finally arrived. Throughout the first half of this year, IBM has been shipping and installing its Token-Ring at an increasing rate. Meanwhile, the industry's response has ranged from wholehearted support to skepticism.

In keeping with tradition, IBM's delivery of Token-Ring hardware and software has in effect "blessed" the technology, making LANs the acceptable approach to connecting and sharing personal computer resources. More specifically, many LAN hardware and software vendors have announced products that either support or are compatible with the Token-Ring, and others have developed gateways that will interface to the Token-Ring.

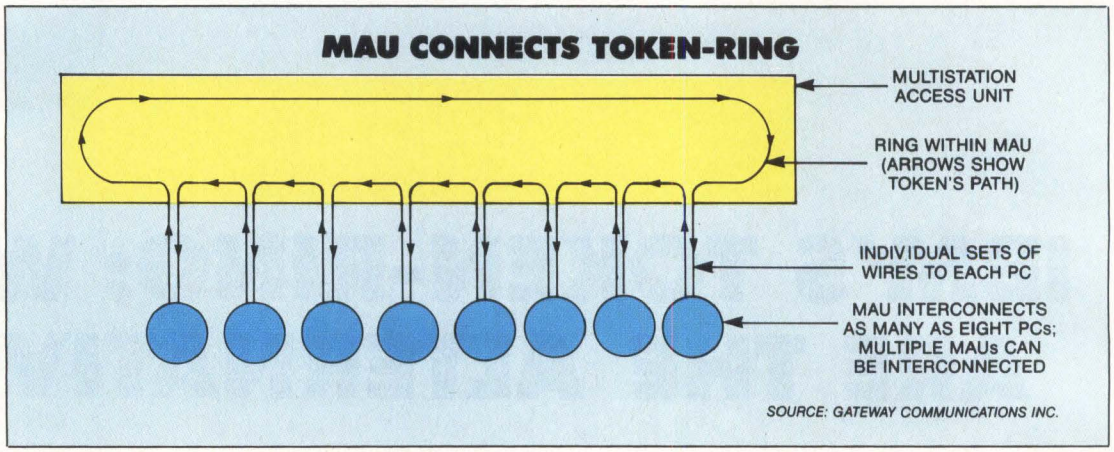
The Token-Ring is not IBM's first PC LAN product. IBM has been shipping the PC Network, which Sytek Inc. produced for IBM, for several years. However, most industry observers point to the Token-Ring as IBM's first "serious" LAN offering. IBM provides a software interface (bridge) that links the Token-Ring and the PC Network.

It's time for action

Before IBM's Token-Ring announcement, many system integrators and in-house PC departments faced with choosing a LAN were playing a "wait-and-see" game, until IBM should play its hand. But they can't wait any



LANs use one of three topologies: *bus, star or ring. A bus topology connects all stations to one cable running the length of the network. A star topology connects all workstations to a central station, which routes data to the appropriate place. A ring connects all workstations in a closed loop.*



The ring in IBM's Token-Ring *resides inside the Multistation Access Unit. Each PC connects to a MAU by individual cable, and each MAU interconnects as many as eight PCs. Users can link MAUs to form a larger network.*

longer. Those who must purchase networking solutions for PC users or customers must now undertake serious evaluations.

The logical question is now: "Is the Token-Ring the way to go?" The question is not a black-and-white "Token-Ring vs. the competition" situation. Instead, the answer depends on the application. Several LAN vendors have announced hybrid solutions, gateways from their networks to Token-Ring and software options that allow applications developed for the Token-Ring to run on competitive LAN hardware. These companies include AST Research Inc., Bridge Communications Inc., Corvus Systems Inc., Excelan Inc., Gateway Communications Inc., Nestar Systems Inc., Novell Inc. and 3Com Corp.

As a result, some companies may be able to combine compatible LANs or even competing LANs such as the Token-Ring and Ethernet, the formerly reigning near-standard LAN. Companies that offer Ethernet products include 3Com, Torus Systems Inc. and Xerox Corp.

The first step in evaluating LANs is to examine their basic LAN parameters: topology, access method, transmission method, transmission speed, cabling, software and hardware.

As the name "Token Ring" implies, the IBM product incorporates ring topology and the token-passing access method. This approach differs from most installed LAN systems: About 80 percent use bus topology and the Carrier Sense Multiple Access (CSMA) method, as popularized by Ethernet.

Regarding the remaining parameters, the Token-Ring LAN is a baseband system operating at 4M bits per second (bps) over twisted-pair wiring. It uses the PC LAN Program version 1.1 software running under IBM's NETBIOS (network basic input/output system). PC LAN Program 1.1, announced in April, is an enhanced version of IBM's original PC Network Program, which IBM provided for its PC Network LAN.

Topology determines the LANscape

Topology refers to the network architecture configuration, or the way in which PCs physically interconnect. The topology of a LAN determines how information will flow across the network. LANs use one of three major topologies: ring, bus or star.

IBM chose ring—the least-used topology—for its LAN. So far, the most visible ring LAN other than the Token-Ring is Proteon Inc.'s ProNet. However, IBM's Token-Ring may change this topology's last-place status.

Ring topology employs a single, relatively short, looped cable interconnecting each of the PCs in the network.

The star topology interconnects each PC to a shared controller via the PCs' individual cables. Any defective node on a star LAN can be fixed from the central hub. However, employing a single controller limits the number of PCs that can be attached to the LAN. If the controller fails, the entire network fails.

About 15 percent of all PC-based LANs employ star topology, making it the second most popular topology. Novell's S-Net, Sytek's System 6000 and TeleVideo Systems Inc.'s Personal Mini employ the star topology.

The bus topology, the most common LAN architecture, interconnects PCs over a shared cable, but the cable ends are not connected. Each station on a bus network connects to the bus and "listens" to the data stream. When the station wants to communicate, it merges its data into the data stream. Bus LANs allow for the easy addition of nodes, and a defective node won't affect any others on the system. LANs that use the bus topology include AST's PCnet II, Gateway's G/Net, IBM's PC Network, Concord Data Systems Inc.'s Token/Net,

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Fox Research Inc.'s 10-Net, IDEAssociate Inc.'s IDEAnet, 3Com's EtherSeries, 3M's PC/LAN and Ungermann-Bass Inc.'s Net/One.

When installed, IBM's Token-Ring looks like a star rather than a ring. The heart of the network is a ring, but the ring is inside the Multistation Access Unit (MAU), an expensive "connector box." Each PC connects to the MAU by individual cable, which gives each MAU the star-like appearance. Each MAU interconnects as many as eight PCs, and users can link MAUs to form a larger network. By bringing all the links to a central node, which facilitates troubleshooting, this configuration takes advantage of the star topology. Another LAN using a star/ring topology is Quadram Corp.'s Quadnet IX. It features a star-shaped ring with infrared fiber-optic cable.

The media compared

LANs use one of three general types of media, or wiring: coaxial, twisted pair or fiber optic, and any of these works on any topology. Many baseband LANs and all broadband LANs use coaxial cable; it is the most popular medium. Coaxial consists of a central insulated conductor wrapped with a braid or foil that shares the same axis as the conductor. Coaxial can carry high-frequency signals; the foil or braid protects the signal from outside interference. Installation, including labor, typically costs $4 per foot and $40 per termination.

With coaxial cabling, each personal computer on a LAN connects to the cable through a twist-lock BNC (baby "N" connector), and a BNC terminator connector terminates the coaxial cable.

The second most popular LAN medium, twisted pair, consists of two wires wrapped around each other. The twining reduces the cable's tendency to pick up electrical noise, which can cause data errors. However, its immunity to noise interference is not as good as that of coaxial, and this can degrade performance. Furthermore, twisted-pair wiring cannot carry data rates as high as can coaxial, and signal levels for twisted-pair wiring normally degrade over much shorter distances than do the signal levels on coaxial cable. On the plus side, at pennies per foot, it offers the lowest cost, and users can install it easily.

For short distances, the Token-Ring can connect via standard telephone-line twisted-pair wiring, which IBM calls Type 3 cable. For longer cable runs, however, IBM recommends shielded twisted-pair cabling, which is more expensive than standard telephone twisted-pair wire or coaxial cable. It adds greater noise resistance, however, and higher data rates.

Fiber-optic cable is still rare, but it is immune to interference from electrical or electronic devices, a factor that can be important in

The practical realities of today's PC-based LAN implementations point to the superiority and cost-effectiveness of baseband.

LANs COME IN MANY VARIETIES

Company	Product	Topology	Access method	Bandwidth	Wiring type
AST	PCnet II	bus	CSMA/CA	baseband	twisted pair
Corvus	Omninet	bus	CSMA/CA	baseband	twisted pair
Fox Research	10-Net	bus	CSMA/CA	baseband	twisted pair
Gateway	G/Net	bus	CSMA/CA/CD	baseband	coaxial
IBM	PC Network	bus	CSMA/CD	broadband	coaxial
IBM	Token-Ring	ring	token passing	baseband	twisted pair
IDEAssociates	IDEAnet	bus	CSMA/CD	baseband	coaxial
Novell	S/Net	star	proprietary	baseband	dual twisted pair
Orchid	PCnet	bus	CSMA/CD	baseband	coaxial
Proteon	ProNet	ring	token passing	baseband	coaxial twisted pair
Quadram	Quadnet VI	bus	CSMA/CA/CD	baseband	coaxial
Quadram	Quadnet IX	star/ring	token passing	baseband	dual twisted pair
Standard Microsystems	ARCnet	star/bus	token passing	baseband	coaxial
Sytek	System 6000	star	CSMA/CD	broadband	coaxial
TeleVideo	Personal Mini	star	proprietary	baseband	twisted pair
3Com	EtherSeries	bus	CSMA/CD	baseband	coaxial
Ungermann-Bass	Net/One	bus	CSMA/CD	baseband/broadband	coaxial
Xerox	XC22	bus	CSMA/CD	baseband	twisted pair
Xerox	XC24	bus	CSMA/CD	baseband	coaxial

CSMA: Carrier Sense Multiple Access
CD: Collision Detection
CA: Collision Avoidance

Source: Gateway Communications Inc.

Token-Ring is not likely to cause the demise of competitive LAN products that have been using CSMA/CD for some time.

harsh environments involving machinery. But fiber-optic cable can cost $10 per foot and $50 per termination. Furthermore, there is a lack of workers who know how to install and maintain it.

There has been debate over the past few years over the virtues of baseband vs. broadband transmission. Broadband systems broadcast a wide number of frequencies over the cable, and, in theory, network nodes "tune in" to different channels. These channels can simultaneously carry voice, video and other signals, unlike baseband, which carries only digital data. However, in most broadband LAN implementations, personal computers attach to the same frequency channel because they do not require voice or video transmissions. Broadband cable also requires more electronics—and, hence, is more expensive—than baseband.

Baseband systems, such as the Token-Ring, send pulses over the wire, and nodes receive those pulses. Baseband systems allow the transmission of only one signal over the cable at a time, and each attached personal computer communicates over that channel.

Baseband seems favored

Thus, the practical realities of today's personal computer-based LAN implementations point to the superiority and cost-effectiveness of baseband. Broadband can extend over greater distances than baseband, however, making it more appropriate as a "backbone" network connecting various widely scattered LANs.

IBM's PC Network, a broadband implementation, supports PCs only on a single channel and does not support voice or video without additional equipment. With such implementations, the added cost and complication of broadband may not be justifiable, which could be a reason for the PC Network's lack of market acceptance.

Access methods: the 'rules of the road'

Access methods ensure that each station has equal access to the network and determine which station has the "right of way." Before IBM introduced the Token-Ring, the most popular access method for baseband and broadband LANs was CSMA/CD (carrier-sense multiple access with collision detection). Both CSMA/CD and the Token-Ring's token-passing access method are IEEE 802 standards.

Debate continues about which method is better. The IEEE 802 committee struggled with this question for years before deciding to adopt both standards. And, because the Token-Ring is not likely to cause the demise of competitive LAN products that have been using CSMA/CD for some time, the two methods will most likely have to coexist.

CSMA allows many users to share the media's single channel for seemingly "concurrent" communications. Each personal computer on the network can send information when the cable is "free." Each in turn constantly "listens" to the cable for messages addressed to them and pulls them off when they appear.

With carrier sense, each personal computer monitors the media to determine whether the carrier is busy. Multiple access means that every personal computer attached to the media has an equal opportunity to communicate. As a result, it is likely that two or more users will attempt to communicate concurrently, or "collide." Collision detection detects these "collisions" and imposes a "backoff" procedure until the personal computer again tries to communicate.

Some CSMA networks use collision avoidance (CA), which imposes algorithms that enable the personal computers to avoid collisions. The algorithms check to see whether a cable is in use before allowing a personal computer to communicate. If a collision does occur, CA ensures that it will not occur again when the personal computer tries to retransmit.

Some vendors have adopted a third technology, error detection and correction (EDC), which guarantees delivery of a message. EDC acknowledges and verifies the data as it returns from the receiving personal computer to the sending personal computer. EDC, a link-level operation, is transparent to the applications and thus differs from error-correction methods that are incorporated into the application program.

IBM's announcement of Token-Ring boosted

Spec summary

- **Product:** Token-Ring Network
- **Manufacturer:** IBM Corp.
- **Topology:** ring
- **Access method:** token passing
- **Speed:** 4M bits per second
- **Media:** twisted-pair wiring
- **Bandwidth:** baseband
- **File-server software:** IBM PC LAN Program
- **Utility software:** file locking, record locking, file security, electronic mail, remote access, print spooling
- **Maximum cable length:** 990 feet

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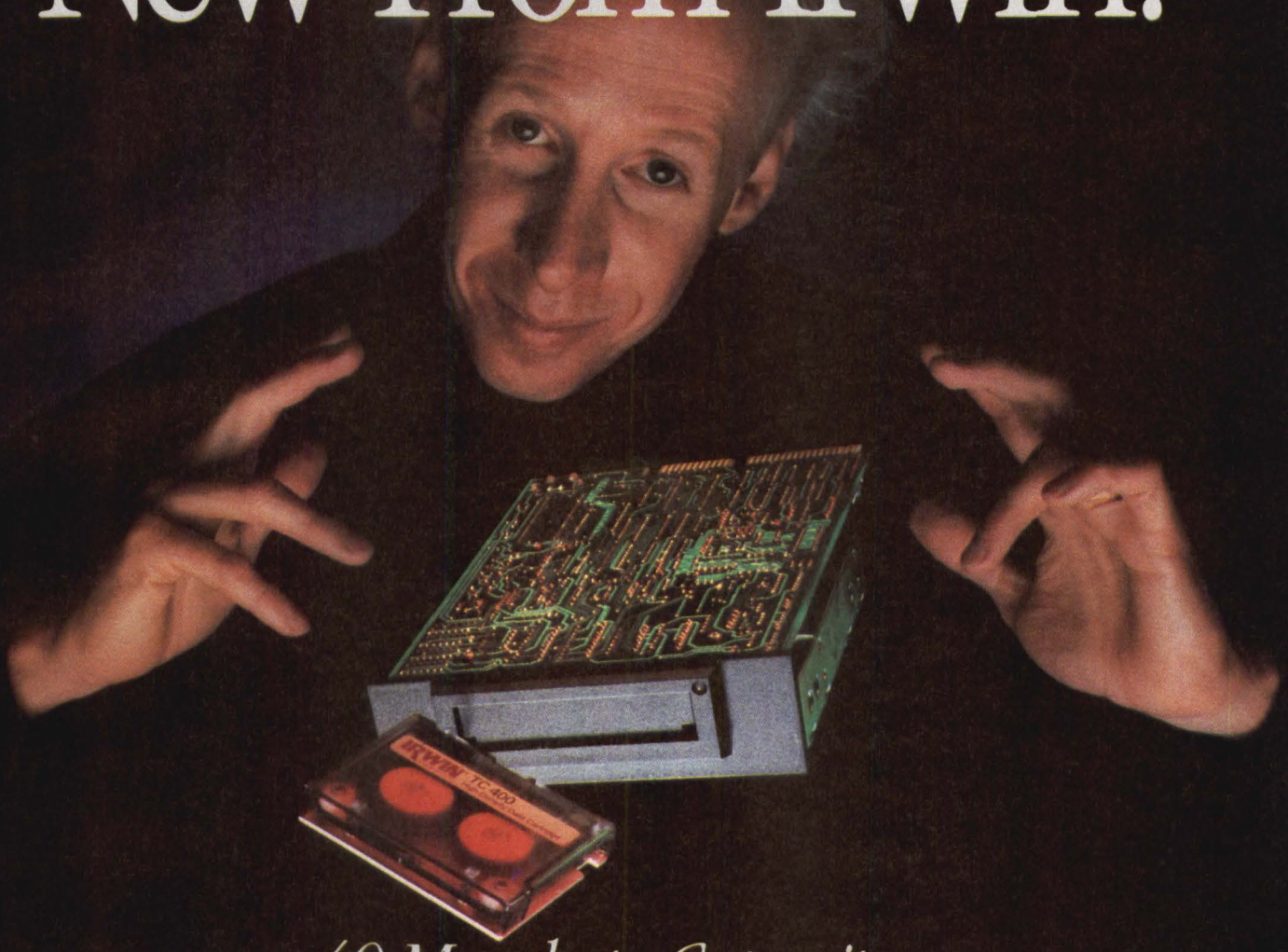

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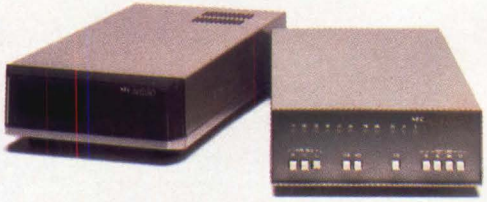

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its place in the industry, thus likely guaranteeing it as an industry standard. Token passing involves the passing of a token, or "envelope," on the LAN from personal computer to personal computer. A personal computer cannot communicate until it has the envelope in which to place the information. The envelope, or "packet," contains data of some predetermined maximum amount. Typical amounts are 128, 256, 512, 1,024 or 2,048 characters.

When a token-passing LAN is started up, the workstations arbitrate among themselves to determine which is the "master" that will generate the token. The personal computers then pass the token around the ring. With token passing, each personal computer on the network has equal access, but each has to wait until the token reaches it before it can communicate. This means that the network is "deterministic," or predictable. However, the more workstations that are added to the network, the longer each has to wait to get on the network.

Deterministic performance is useful in applications such as process control in which predictable service is necessary. However, most personal computer-based LAN environments involve business commmunications, which may be better served by CSMA/CD.

A potential drawback of token passing is that when a personal computer powers off, the ring is broken, much like with old-fashioned "serial" Christmas tree lights. When the ring is

Don't assume that a 10M-bps LAN performs faster than a 1M-bps LAN.

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The term 'LAN operating system' is a popular misnomer because the personal computers on any LAN run under the PC-DOS operating sytem.

broken, the entire token-passing process must begin again. The personal computers must again arbitrate to select a master and regenerate the token, which can take as long as 10 seconds. With CSMA/CD, the powering-off of a PC does not necessitate regeneration. If one "light" goes out, the whole row will not follow suit.

From an application standpoint, token passing might prove superior on a network that is doing file transfers only of a specific, consistent nature. CSMA/CD, on the other hand, better suits networks with a mix of file-transfer and interactive inquiry traffic.

Transmission speed can be deceptive

LAN transmission speed—the speed at which data travels along the cable—is usually measured in megabits per second. The Token-Ring runs at 4M bps, and IBM promises that future versions will be faster. One might assume that a 10M-bps LAN performs faster than a 1M-bps LAN, but this is not usually so. This is because transmission speed does not account for the time it takes for information to move from the media to and through the LAN interface board, the LAN interface software, the PC-DOS operating system, the PC's memory, the application interface and the PC's monitor.

The transmission speed, the software and the access method all measure LAN performance. Users should also consider the incidence of lost tokens, collision, retransmission and backoff. Therefore, benchmark tests provide the only true measurement of relative speed and performance. One approach is to run the application on different LANs being considered. However, if hands-on tests are impractical, users can obtain independent benchmark evaluations that pit the major LANs systems against each other in real-life applications.

The 'LAN OS' myth thrives

Two types of LAN software are available: file-server control software and LAN application software. The term "LAN operating system" is a misnomer because the personal computers on any LAN run under the PC-DOS operating system. What people usually refer to as a LAN operating system is really a file-server operating system, typically a rigid disk-based system, such as an IBM PC/AT. Workstations can use the file-server system for shared access to programs, data, printers and so on.

For example, Novell's NetWare and IBM's PC LAN Program are file managers for the disk-based file servers. Such products provide a LAN with multiuser file access. File-server software provides security, access rights, utilities, disk optimization, file locking, record locking and printer spooling.

A few LAN vendors provide proprietary file-server operating software. Most, however, support one of two industry "standards," one of which is Novell's NetWare. NetWare runs on some 25 LAN hardware systems, including Corvus' Omninet, Gateway's G/Net, IBM's Token-Ring and PC Network and Standard Microsystems Corp.'s ARCnet. In addition, more than 3,000 multiuser application programs run NetWare.

The second "standard" is based on software from IBM and Microsoft Corp. For the PC Network LAN, IBM provides the PC Network Program (PCNP). IBM announced an upgraded version of this software, called PC LAN Program version 1.1, for the Token-Ring. Microsoft offers a similar file-server operating system, called MS-Net.

PCNP, PC LAN Program and MS-Net all use NETBIOS, an extension of the IBM PC's BIOS, which comprises a group of programs in ROM. There are four alternative configurations for each PC workstation networked on the IBM PC LAN Program: redirector, receiver, messenger and file/print server.

The redirector configuration allows a PC to share resources and send messages to other computers. The remote resources appear as if they were attached locally.

The receiver configuration adds the capabilities to receive messages from other users and display, print or store them in a file. The software that enables a PC to receive messages runs as a background task on the PC.

The messenger configuration additionally allows a PC workstation user to switch between a local application and the IBM PC LAN Program. This configuration includes a full-screen editor plus the ability to forward received messages to multiple users.

The file/print configuration establishes the shared file/print server, which can consist of any PC with a rigid disk. An IBM PC/XT or AT usually can act in this configuration, although a dedicated disk subsystem also works. Users can attach as many as three printers to this type of configuration.

This configuration controls access to the shared file/print server down to the subdirectory level. It assigns each network user various levels of access rights: read only, write only, read/write, write to a specific disk or directory, or read/write to a specific disk or directory. The PC-DOS command ATTRIB controls file access. Using network flags and other PC-DOS calls controls access down to the record or field

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NetWare has the edge because of the vast amount of multiuser software available, but IBM will probably give Novell a run for its money.

level.

NetWare's adaptability to most LANs gives it the edge because of the vast amount of multiuser software available, but IBM will probably give Novell a run for its money. The result will probably be that both systems will thrive and spawn ever-increasing libraries of application programs.

In addition to the personal computer workstations and the optional file server, the basic hardware to evaluate when selecting a LAN system is the personal computer interface controller. This is a circuit board controller that manages the physical interface between the personal computer and the LAN. The controller resides in the personal computer for ring networks such as the Token-Ring and bus networks such as G/Net or in the common cluster controller on the network for star networks such as S-Net.

The typical interface controller is a standard-sized personal computer adapter board that plugs into a personal computer expansion slot and connects to the LAN media. For example, on a coaxial-cable-based system, the board usually contains a standard twist-lock BNC.

Most LAN systems use a personal computer's native CPU to control network management and access. This is not always the most efficient arrangement, however, in that the CPU in the personal computer supports PC-DOS and a single-user application. Any additional software such as network management can seriously degrade the performance of a personal computer.

Only a few LANs, including Token-Ring, PC Network and G/Net, use a separate microprocessor on the network interface board to control network management and access. Such a configuration allows the network interface board to offload the personal computer's native CPU of network-management chores.

Pick one—or more

No one system can solve everyone's application. While one LAN may suit a small installation of 10 personal computers on a single floor of a building, another may provide a better solution for interconncting 100 PCs scattered across a complex of buildings.

At the risk of oversimplification, however, it's a safe bet that the current implementation of the Token-Ring will perform adequately at the lower end of this scale: small clusters of workstations in predictable, controlled applications, such as process control or file transfers with some interactive inquiries.

So, although the Token-Ring should become a major market success, it will surely not bury the competition. Alternative solutions will continue to offer better price-performance advantages in certain applications. □

David S. McMaster is president and co-founder of Gateway Communications Inc., a LAN supplier in Irvine, Calif. Previously, he accumulated more than 20 years' experience in the data-communications field, including 11 years at Control Data Corp.

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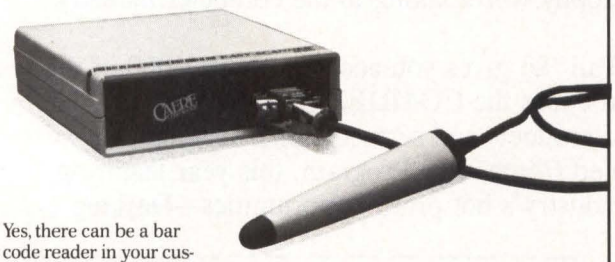

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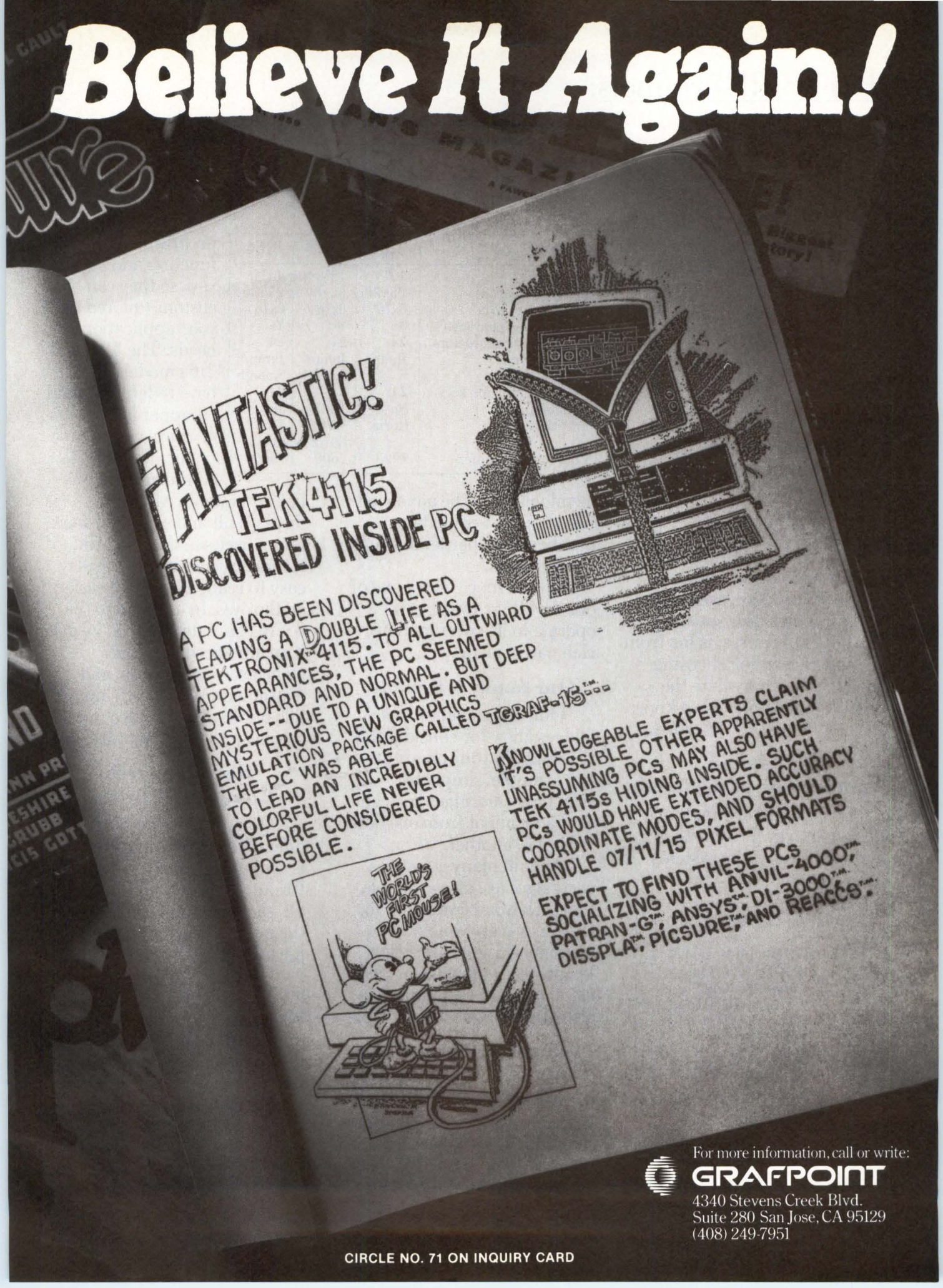

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3163	IBM 3101 Model 881 DEC VT 52* DEC VT 100* TeleVideo 950*
3164	IBM 3101 Model 881

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Character matrix	8x16	8x16	8x16
Double-sized characters	No	Yes	Yes
Line drawing characters	24	24	24
Vertical scroll	Jump	Jump/ Smooth	Jump/ Smooth
Definable function keys	24	24	24
Windowing	No	Yes	Yes
Partitioning	Horiz.	Vert./ Horiz.	Vert./ Horiz.
Characters in buffer	1920	7680	7680

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CHIP SET PAVES THE WAY TO TOKEN-RING ACCESS

A chip set is essential for system integrators who want to build their own custom LAN adapter cards to achieve system-to-system dialogue

James T. Carlo and **Gerald R. Samsen**
Texas Instruments Inc.

After years of operating in their own domains, most computer systems can now communicate with other systems through local area networks. Through the efforts of computer manufacturers, network equipment suppliers, software developers, semiconductor manufacturers and standards organizations, previously self-contained computer hardware now communicates with other systems over LANs that allow them to speak a common language.

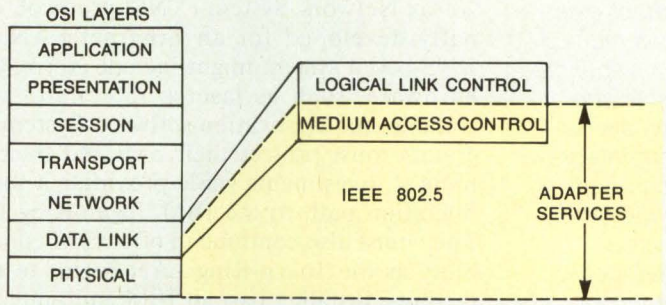
Among the protocols making such networks possible are IBM Corp.'s Advanced Program-to-Program Communications (APPC), the industry-sponsored Manufacturing Automation Protocol (MAP) and Technical Office Protocol (TOP). Such protocols enable equipment for offices, factories and other organizations to communicate with their peers.

However, a single communications standard will not dominate in all applications. Although many architectures are based on the International Standards Organization's Open Systems Interconnection (OSI) model, each architecture works best in its target application. For example, the General Motors Corp. MAP, based on the IEEE 802.4 token-bus connection protocol, suits factory applications, while the IBM Corp. Token-Ring Network is likely to emerge as an industry standard for interdepartmental and companywide office network applications.

IBM offers third-party developers access to the Token-Ring's protocol and software interface specifications by maintaining an "open" architecture. Toward that end, IBM incorporated the bottom two layers of the seven-layer OSI model into the Token-Ring LAN. These two layers, defined by the IEEE 802.5 committee, are the Physical and Data Link layers. In addition, in 1982 IBM began a joint-development program with Texas Instruments Inc. to develop a chip set that would provide compatible connection to the Token-Ring LAN.

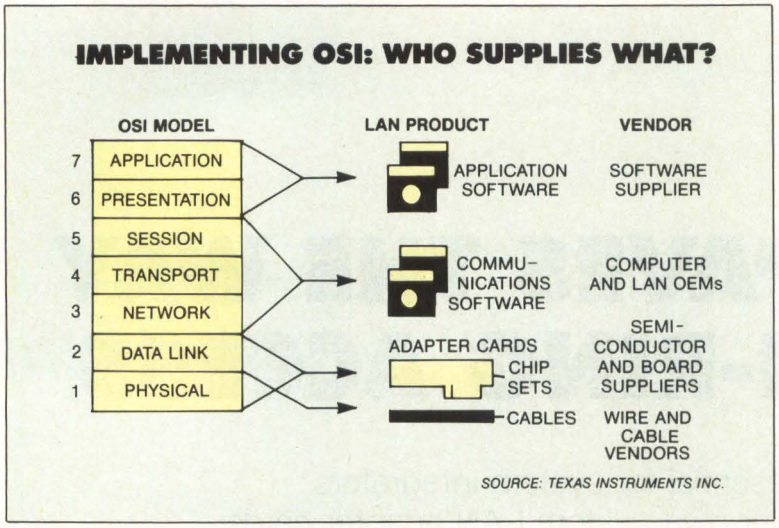
The outcome, the Texas Instruments TMS380 chip set, provides rigorously verified and validated compatible protocols through the Medium Access Control sublayer of OSI's Data Link Layer. The chip set allows system integrators to build their own adapter cards for products, such as personal computers and printers, that can benefit from LAN attachment. System integrators who want to take advantage of this chip set face a twofold decision. First, they must decide which higher layer communications protocols to implement. Second, they

TMS380 EXTENDS THROUGH LOW-LEVEL OSI



SOURCE: TEXAS INSTRUMENTS INC.

The TI TMS380 adapter chip set *provides IEEE 802.5-compatible services to the IBM token-ring LAN. These services extend through the Medium Access Control sublayer of the OSI Data Link Layer.*



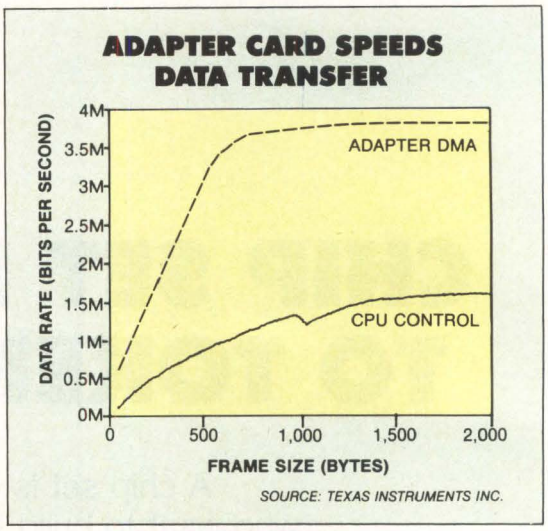
Because the TMS380 chip set *functions at the two lower layers of the OSI model, it does not affect existing communications or application software at higher layers. System integrators can port most higher layers over a TMS380-based adapter card.*

must choose an overall architecture for their network adapter card and select other hardware features that will add value in a particular market.

For example, a network integrator may offer a system based on the Token-Ring LAN and the Xerox Network System (XNS) protocol, originally developed for an Ethernet LAN. The XNS-based system might include Xerox Corp. hardware, such as laser printers and workstations, and application software. System integrators must protect their own and their customers' investments while providing a smooth migration path to the IBM Token-Ring LAN. They must also continue to offer IBM compatibility as the Token-Ring LAN begins to reach the huge installed base of IBM equipment.

Network integrators can accomplish the hardware aspect of this task by using an adapter card that incorporates the TMS380 chip set, thereby implementing the Physical and Medium Access Control layers. Integrators can also preserve the higher layers of the XNS protocols by incorporating a software interface routine between the lower layers of XNS and the Medium Access Control level of the adapter card. Thus, XNS-based applications will be run on the Token-Ring LAN. This approach could leverage the vendor into a specific market whose software base has adopted the Token-Ring Network.

The TMS380 architecture integrates the functions of a LAN adapter into a five-chip set—the TMS38030 system interface, the TMS38010 communications processor, the TMS38020 protocol handler and the TMS38051 and TMS38052 ring-interface pair. The chip set is the heart of a printed circuit card that allows many products to attach to the Token-Ring LAN. Implementing the chip set



DMA-based data transfers *from a TMS380 adapter card to a host system are consistently faster than those performed under host-CPU control.*

on an adapter card allows various communications protocols to be ported on top of the Medium Access Control and Physical layers. This leaves the choice of higher layer protocols up to system integrators, who base their selections on such factors as time to market, communications compatibility and installed base.

Choose the protocols

In most cases, system integrators implementing the TMS380 chip set must offer interface-emulator routines, called adapter handlers, which provide an interface between the lower layers of the selected protocol stack and the adapter. The adapter handler makes the token-ring adapter appear to the higher level protocol as the Data Link Layer of Ethernet or some other protocol. This routine provides compatible connection to the Token-Ring and preserves customers' previous investments in off-the-shelf communications and application software. This software uses such protocols as XNS, the Department of Defense's Transmission Control Protocol/Internet Protocol (TCP/IP) and many proprietary protocols implemented in such networks as Datapoint Corp.'s ARCnet and Corvus Systems Inc.'s Omninet.

For personal computer environments, IBM promotes its Network Basic Input/Output System (NETBIOS) and APPC, the application interface for communications within IBM's Systems Network Architecture (SNA). NETBIOS and APPC use the IEEE 802.2 Logical Link Control (LLC) sublayer of the OSI model.

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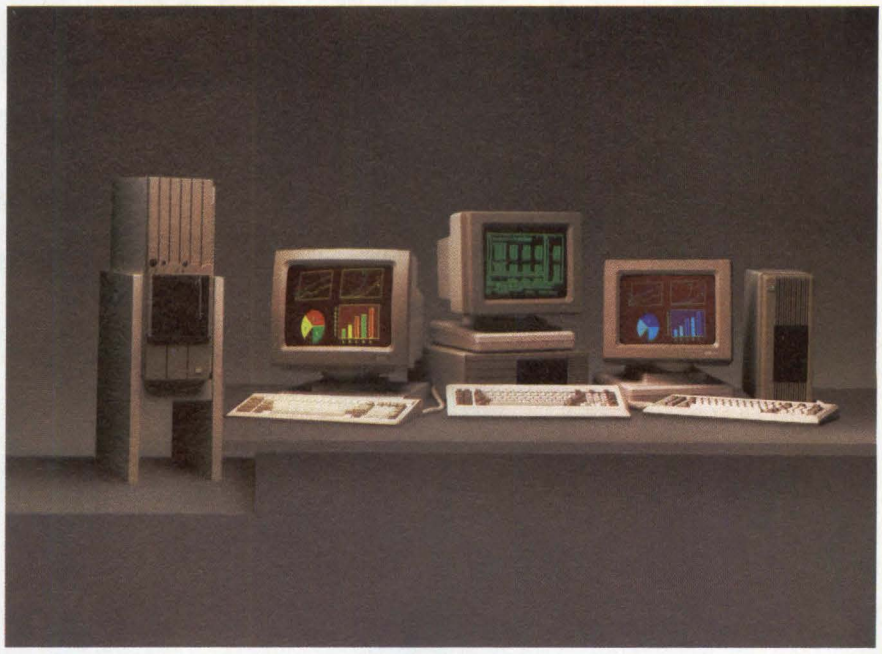

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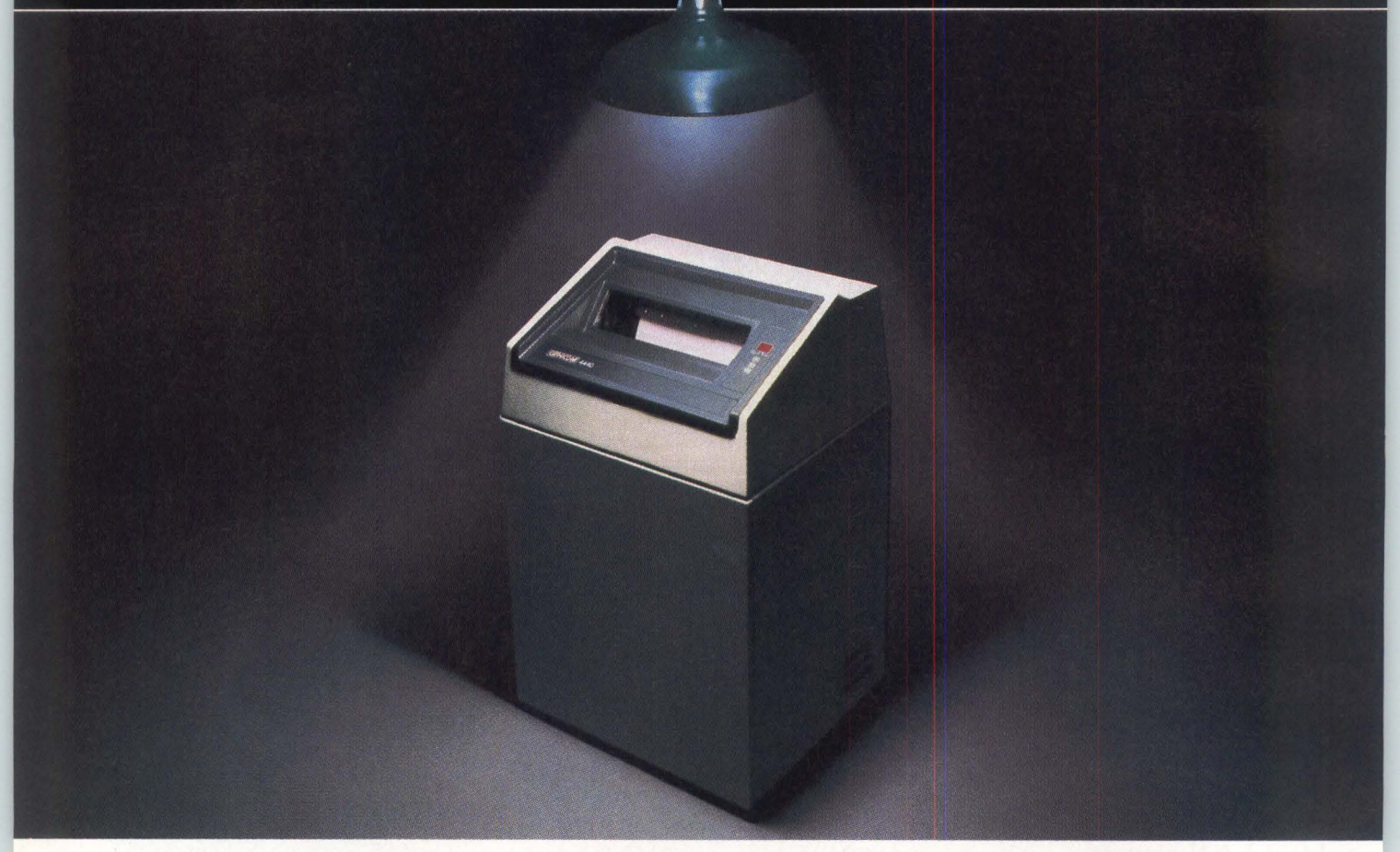

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Thus, integrators wanting to implement NETBIOS and APPC must embed 802.2 link-station functions to LLC in their interface-emulator software.

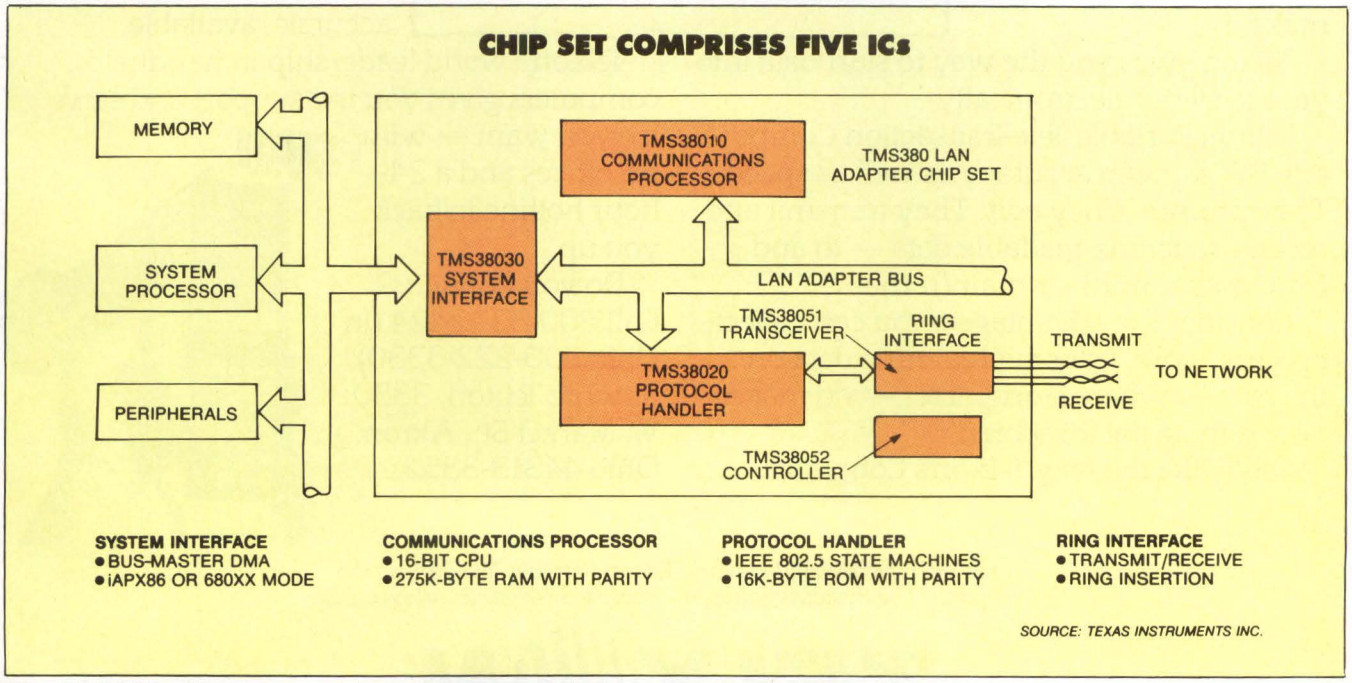
The 802.2 LLC draft standard and its addenda define several classes of service, each of which incorporates a mix of LLC types. For example, APPC uses both Type 1 and Type 2 LLC, corresponding to unacknowledged connectionless, or datagram, services and acknowledged connection-oriented, or virtual-circuit, services. In addition to Type 1 service, MAP incorporates Type 3 service, which corresponds to acknowledged connectionless service, or datagram with acknowledge.

Make the buy-or-build decision

System integrators who build their own cards can distinguish their offerings from those of their competitors by providing cards that can accept special communications software and other value-added functions. But integrators who decide to build their own cards must face the drawbacks of time and cost that this approach entails. However, the TMS380 chip set facilitates LAN adapter-card design. In the most basic case, the integrator must provide only the "glue" necessary to interface the chip set to the backplane of a product.

Of the TMS380's five key components, the primary interface to the system integrators' backplanes is the TMS38030 system interface. This device provides a 40M-bit-per-second direct-memory-access (DMA) channel to the attaching product. Two chips, collectively called the ring interface, are bipolar—the TMS38051 ring-interface transceiver and the TMS38052 ring-interface controller. These chips contain the digital and analog circuitry to connect the adapter chip set to a LAN through separate receive and transmit channels. The TMS38010 communications processor executes the adapter software within the TMS38020 protocol handler, which provides compatible logical connection to the Token-Ring Network through the IEEE 802.5 Medium Access Control protocol. The embedded communications processor includes diagnostics, which increase the reliability of the network adapters.

However, system integrators have other methods of adding value to hardware. If they select these options, they must first make several architectural decisions. For example, if they want to connect their products to a restricted backplane, they must choose which data-transfer technique to use instead of DMA. The IBM PC and most compatibles restrict expansion cards to bus-slave operation. Thus, the interface between the adapter chip set and the PC's backplane must accommodate this restriction. In this approach, the PC's processor handshakes with glue logic on the adapter card to



The TMS380 chip set *comprises five integrated circuits: a communications processor for overall control, a handler for the IEEE 802.5 protocols, two interfaces to connect to the IBM token-passing ring's twisted-pair wiring and an interface to provide a DMA channel to the attached system.*

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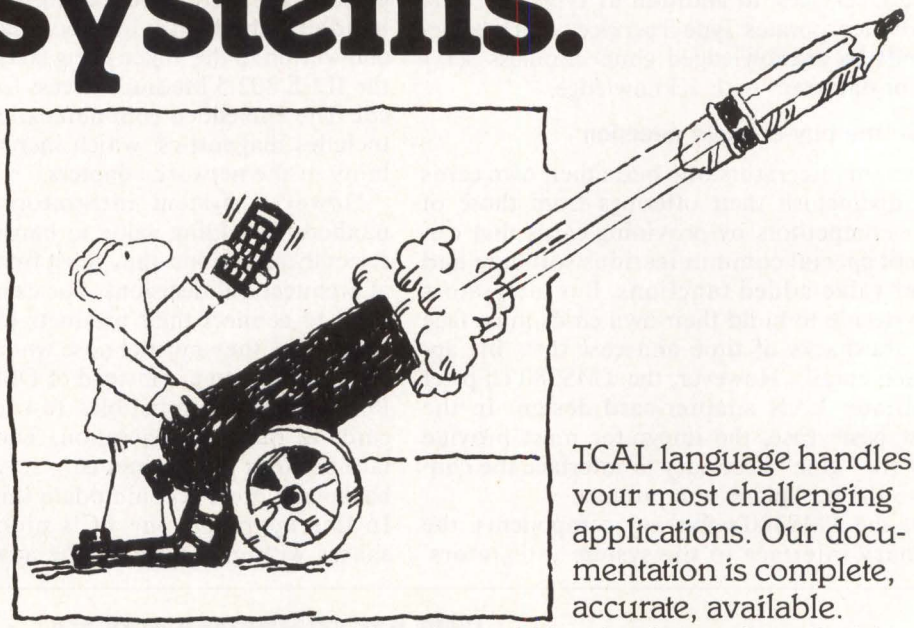

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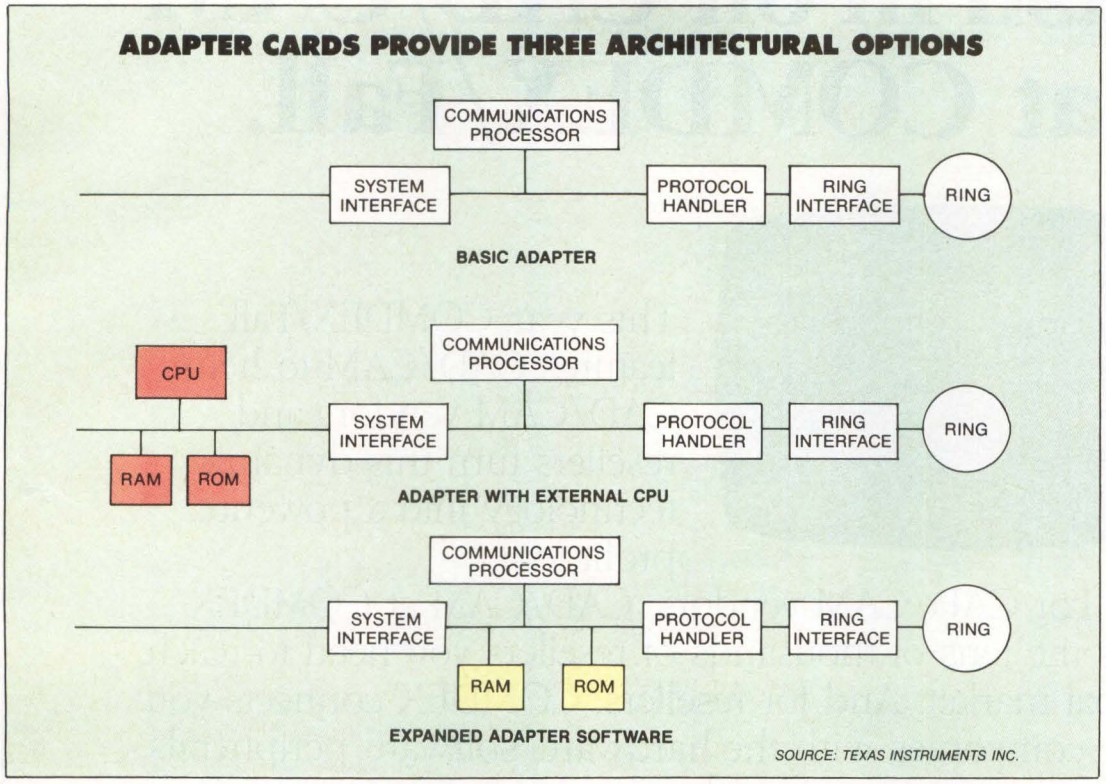

Architectural options *for implementing Token-Ring adapter cards employ a basic adapter with the full TMS380 chip set (top), incorporate a satellite processor and migrate higher level protocols on-card (center), or expand the set's software with additional protocol software (bottom).*

move data under program control. However, this is not usually a consideration with high-performance backplanes such as Multibus or VMEbus. With these backplanes, the TMS380 chip set uses a high-speed DMA interface to move data to and from the ring.

Three basic architectures

System integrators can best take advantage of the flexibility and efficiency of the TMS380's capabilities by providing the adapter card with bus-master capability to the backplane, which increases data-transfer speed. In many applications, such as with the PC, obtaining such high performance is not necessary to the end-to-end response time of the applications. However, some performance-critical applications necessitate the full TMS380 DMA capability.

System integrators must also decide whether to migrate some communications protocols to the adapter card. If they decide to do so, they must then decide where to draw the boundary between on-card and host system functions and whether to add a satellite processor to execute these added protocols, or to let the TMS38010 communications processor execute these functions. These decisions again involve time- and cost-to-market considerations, performance requirements and other trade-offs.

There are two basic architectural configurations for an adapter card. In the most basic approach, the integrator can use a TMS380 chip set to construct a Medium Access Control level adapter card providing the complete IEEE 802.5 Medium Access Control protocols. The integrator need add no other software or specialized hardware to the adapter card. In this situation, the host system processor executes all higher level communications protocols.

Another option involves expanding the software functions of the TMS380 chip set itself to perform high-level protocols. One approach to this option would be to migrate the IEEE 802.2 LLC to the TMS380. In this case, the communications processor would provide compatible Medium Access Control and LLC functions.

The decision to include a satellite processor, rather than to expand the TMS380's software, is based primarily on risks involved in modifying the TMS380's validated Medium Access Control protocol software. Because IBM and TI tested and ratified the software to assure compatibility, integrators must revalidate the software to maintain compatibility whenever they change the software. However, cost/performance gains may outweigh any potential risks inherent in this approach. □

Interest Quotient (Circle One)
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James T. Carlo is local area network system manager, and **Gerald R. Samsen** is LAN application manager at Texas Instruments Inc., Houston.

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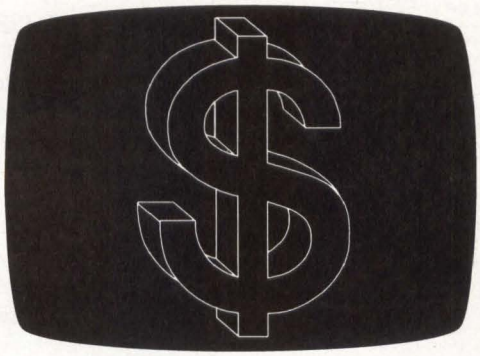

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CIRCLE NO. 77 ON INQUIRY CARD

MicroPDP-11/53

The Entry-Level 16-bit Q-bus Supermicrosystem

digital

The MicroPDP-11/53 is the entry-level, 16-bit supermicrosystem with an attractive price and performance combination that will meet the best of your computing requirements. The MicroPDP-11/53, with approximately twice the system performance of the MicroPDP-11/23, offers just the extra boost of power you may need to solve your realtime or multitasking problems.

At the center of the MicroPDP-11/53 is a 15-megahertz, J-11 single-board computer that contains 0.5 Mbytes of onboard memory. This computing engine can easily devote itself to your dedicated process control program or become a shared resource for your department's multiuser workload. Whatever the job, the MicroPDP-11/53 demonstrates superlative performance.

As is the standard with all PDP-11 systems, the MicroPDP-11/53 is fully compatible with the proven 16-bit PDP-11 architecture and the thousands of PDP-11 software tools and applications in existence today. Along with this compatibility is support for a wide variety of Q22-bus mass-storage devices and communications interfaces, including two new half-height disk drives. Its trim size is small enough to fit comfortably and quietly into your personal work area. And with DECnet and Ethernet networking capability, the MicroPDP-11/53 can send, share, and store files from other systems in your department or organization.

With improved performance at an appealing price, the MicroPDP-11/53 enhances 16-bit computing to help you meet your business goals. And better yet, Digital has it now.

Literature Distribution

For additional copies of this information sheet write: PDP-11 ED-28903-41, 200 Baker Avenue, Concord, Massachusetts 01742.

Current PDP-11 users: If you would like to be added to our PDP-11 mailing list please indicate the CPUs you are currently using on the back of your business card and send it to the above address.

Highlights

- Features a high-performance, single-board computer with 0.5 Mbytes of onboard memory.
- Allows for memory expansion for up to 4 Mbytes with parity MOS memory in increments of 0.5, 1, or 2 Mbytes.
- Has complete MicroPDP-11/73 instruction set, including the Extended Instruction Set (EIS) for compatibility with the full line of MicroPDP-11 processors.
- Includes floating-point instructions for increased instruction execution.
- Supports a comprehensive set of communications interfaces and mass-storage devices, including two new half-height disk drives.
- Supported by an extensive number of operating systems, high-level languages, development tools, and application packages.
- Easily integrates into networking environments or into local area networks with DECnet and Ethernet.

The Single-board Computer – A First for MicroPDP-11 Systems

The MicroPDP-11/53 is based on the high-speed, 15-megahertz J-11 chip set. Accompanying this microprocessor on the same quad-height module is 0.5 Mbyte of dynamic RAM, parity MOS memory. This economical combination of CPU and onboard memory saves on module space and input power and, more importantly, increases the basic system performance to approximately twice that of the MicroPDP-11/23.

The MicroPDP-11/53 single-board computer comprises:

- A J-11 chipset, including 16-bit I/O, addressing capability up to 4 Mbytes, maximum clock rate of 15 megahertz, and onboard memory management.
- Complete MicroPDP-11/73 instruction set, including floating-point instructions and the Extended Instruction Set (EIS).
- Q22-bus interface that supports block-mode DMA and up to 4 Mbytes of physical memory.
- One console serial-line unit and one printer serial-line unit.
- 32-Kbyte, erasable read-only memory (ROM) for bootstraps and diagnostics.

Half-height Storage Can Increase Your Storage Capacity

The Q-bus links the MicroPDP-11/53 with a compatible set of mass-storage devices. Two new half-height disk drives, the RD31 and the RX33, are available for the first time on a supermicrosystem. At half the height of their predecessors, their size allows more storage devices to be housed directly in the system chassis. There is now room for three integrated mass-storage devices, as opposed to two full-height devices.

Offered as integrated storage devices, the RD31 is a 20-Mbyte Winchester fixed-disk subsystem, and the RX33 is a 1.2-Mbyte single-diskette subsystem. And the following full-height storage devices can be added externally to your MicroPDP-11/53:

- 71-Mbyte RD53 Winchester fixed-disk subsystem.
- 31-Mbyte RD52 Winchester fixed-disk subsystem.
- 95-Mbyte TK50 cartridge-tape subsystem.

The Q-bus also has a wealth of peripherals developed for it by Digital. You can select from a wide range of communications interfaces, videodisplay terminals, hardcopy terminals, and system printers.

Flexible Packaging for Your Style of Working

The MicroPDP-11/53 is packaged in a trim, versatile enclosure that can fit underneath, beside, or on top of your desk. It is also available in a rack-mount model for cabinet integration. This package features an eight-slot backplane and space for three half-height storage devices or for two full-height storage devices. Ample space exists for memory and communications options and room for connecting as many as 26 I/O devices.

Software That Is Proven and Available

The MicroPDP-11/53 runs Digital's leadership 16-bit operating systems.

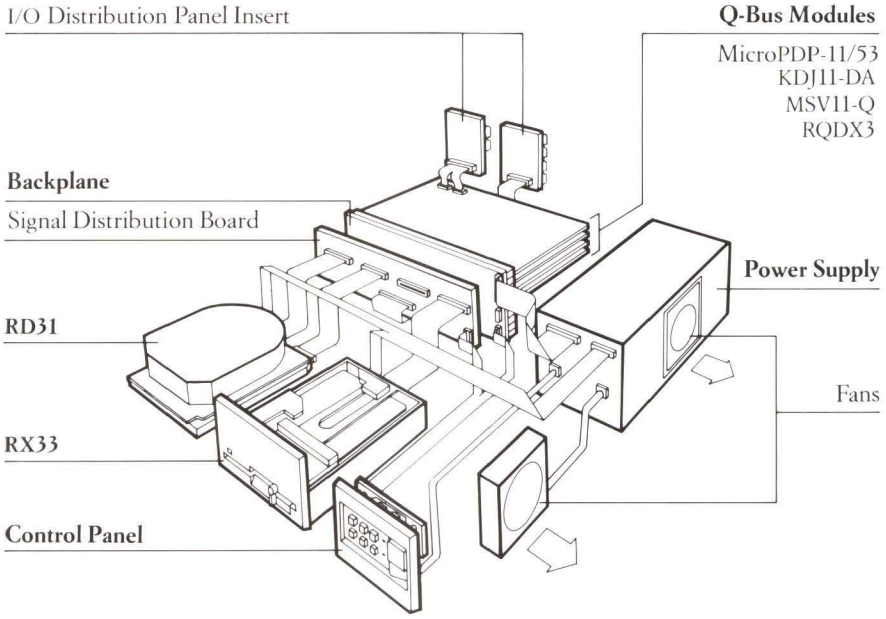
These are proven operating systems that efficiently and effectively meet a variety of demands – from small, dedicated laboratory and industrial control systems to larger, multiuser information management systems.

Micro/RSX and Micro/RSTS are tailored specifically for the MicroPDP-11 family. Micro/RSX is a low-cost version of Digital's larger RSX-11M-PLUS. It combines the multiuser, realtime capability of RSX with refined commercial capabilities. And Micro/RSTS is a subset of the RSTS/E system that is a multiuser, timesharing system environment.

Also available is RT-11, a single-user, realtime system; RSX-11M-PLUS, RSX-11M, and RSX-11S, three multiuser, realtime systems; RSTS/E, a multiuser, timesharing system; CTS-300, for small business timesharing; ULTRIX-11, Digital's enhanced native-mode UNIX* software; MicroPower/Pascal, an advanced development tool kit; and DSM-11, a multiuser operating system with high-performance, data management capability.

Digital's own layered software includes a wide variety of high-level languages and data management tools. Supported high-level languages include BASIC, C, COBOL, DIBOL-83, FORTRAN-77, FORTRAN IV, MUMPS,* and Pascal. Data management tools include DATATRIEVE-11, a query report-writing and data-maintenance system; RMS-11, a record management system; and FMS-11, a forms management system.

And thousands of application software products already exist for the MicroPDP-11/53 in virtually every



area of science, education, government, business, and industry. These products have been developed both by Digital and third-party software developers. Ask your sales representative for a copy of the *PDP-11 Software Source Book,* a guide to the more than 2,000 applications packages that are available today.

Tie Together Your System, Department, and Organization

A wide variety of communications hardware and software is available to make the MicroPDP-11/53 supermicrosystem interface with the widest possible range of communications and networking applications. Digital's powerful DECnet software supports communications between Digital systems, and between Digital systems and other manufacturers' systems. The MicroPDP-11/53 is also supported by Ethernet local area networking. Ethernet allows large amounts of data to be exchanged at high rates among various departments of an organization, within one building or within a complex of buildings.

Digital's Commitment To Service

Like all of Digital's products, the MicroPDP-11/53 and its system software have been designed for reliability. And Digital's customer services organization is ready to provide quality support. Digital is the complete service vendor and has the products and tools to back its commitment to customer satisfaction.

If You Would Like To Know More

Find out just what the MicroPDP-11/53 can do for you. Call your local Digital sales office, Digital OEM, or Authorized Digital Distributor for an indepth discussion of the MicroPDP-11/53 solution.

digital

Specifications

Power Requirements		
Line voltage	120 Vac	240 Vac
System power	4.4 amperes	2.2 amperes
Power source phasing	Single	Single
Voltage tolerance	90-128 VRMS	176-256 VRMS
Line frequency tolerance	47-63 Hz	47-63 Hz
Input power	345 watts	345 watts
Operating Environment		
Temperature range	15-32°C (59-90°F)	
Relative humidity	20-80% noncondensing	
Maximum operating altitude	2.4 km (8,000 ft)	
Physical Characteristics		
Pedestal Model		
Height	62.2 cm (24.5 in)	
Width	25.4 cm (10.0 in)	
Depth	72.4 cm (28.5 in)	
Weight	32 kg (70 lb)	
Tabletop Model		
Height	15.2 cm (6.0 in)	
Width	56.5 cm (22.25 in)	
Depth	72.4 cm (28.5 in)	
Weight	32 kg (70 lb)	
Rackmount Model		
Height	13.3 cm (5.25 in)	
Width	48.3 cm (19.0 in)	
Depth	64.8 cm (25.5 in)	
Weight	25 kg (55 lb)	

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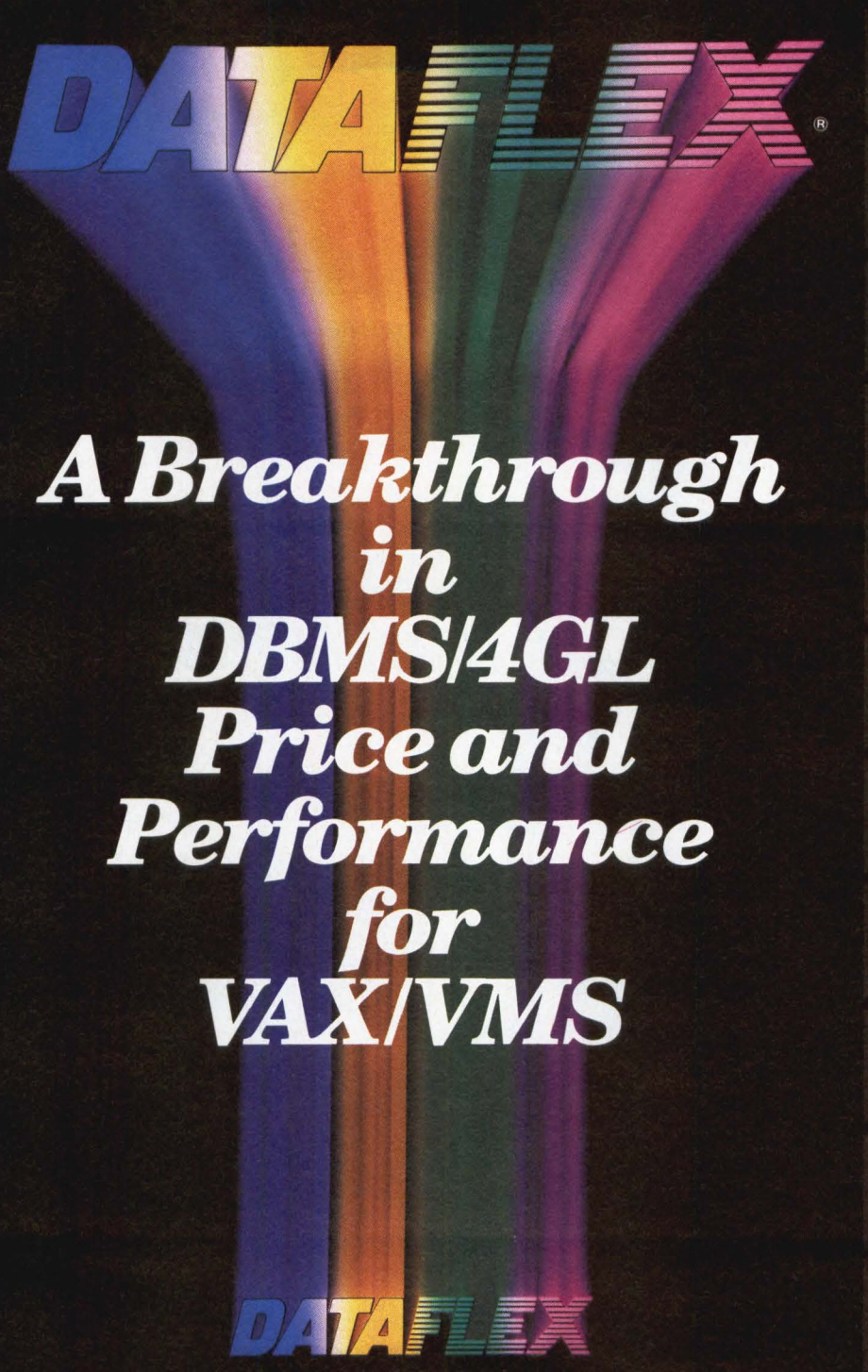
*Third-party trademarks: UNIX is a registered trademark of AT&T Bell Laboratories; MUMPS is a registered trademark of Massachusetts General Hospital.



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you the information you need when you need it. Plus, applications can be transported to and from VAX, UNIX V, XENIX and PC systems without change. Pricing for VAX systems starts at $1,800. Call today for complete details.

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CIRCLE NO. 78 ON INQUIRY CARD

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For mechanical, electrical, mapping, architectural, and surveying applications, we've designed the TRUE GRID 8000 Series digitizers with active areas ranging in size from 11 × 11 inches to 24 × 36 inches. Featuring a high resolution of .001 inches and built-in RS-232-C compatible interface, these precision digitizers can be used with either of our new three-button or 16-button cursors.

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CIRCLE NO. 79 ON INQUIRY CARD

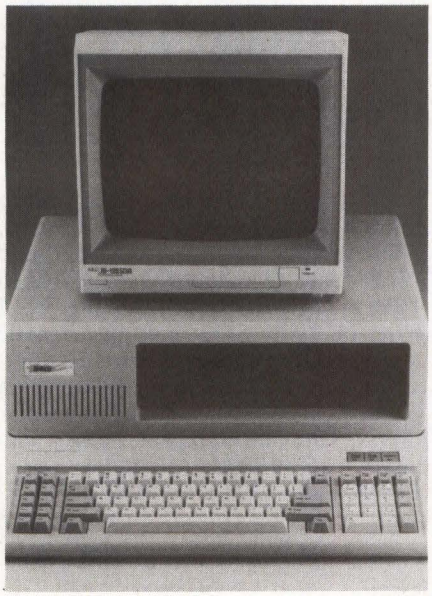
NEW PRODUCTS

SYSTEMS

Computer furnishes 640K-byte memory

- IBM compatible
- 10M-byte disk drive
- Eight slots

Offering IBM PC/XT compatibility, the Long Island PC/XT employs 640K bytes of main memory and a 360K-byte



flexible disk drive. The system includes eight expansion slots and a 10M-byte rigid disk drive expandable to 120M bytes. Serial and parallel ports are standard. The computer operates with all IBM-compatible software. $1,495. **Bi-Tech Enterprises Inc.,** 10 Carlough Road, Bohemia, N.Y. 11716-2996, (516) 567-8155.

Circle 379

Personal computer runs faster than IBM PC

- 360K-byte disk drive
- 8086-1 processor
- Video controller

Running four times faster than the IBM PC and 1.6 times faster than the IBM PC/AT, the Series 30 personal computer utilizes an 8086-1 microprocessor. The unit contains a 360K-byte flexible disk drive and a monochrome video controller. It is geared toward OEMs and VARs. RAM is 512K bytes, expandable to 640K bytes. $1,456, quantity 50. **Datavue Technical Systems,** 4355 International Blvd., P.O. Box 2687, Norcross, Ga. 30093, (404) 564-5780.

Circle 380

Multiuser system targets businesses

- 68000 processor
- 256K bytes of memory
- Six I/O ports

Targeting small businesses, the Zebra 1350 multiuser computer employs an MC68000-based CPU with zero wait states. The system supplies 256K bytes of memory, 20M bytes of disk storage, six serial I/O ports and one parallel printer port. It runs under the Pick operating system. Options include a proprietary LAN controller and synchronous communications. The unit can be configured with 512K bytes of memory. $9,300. **General Automation,** 1045 South St., P.O. Box 4883, Anaheim, Calif. 92803, (714) 778-4800.

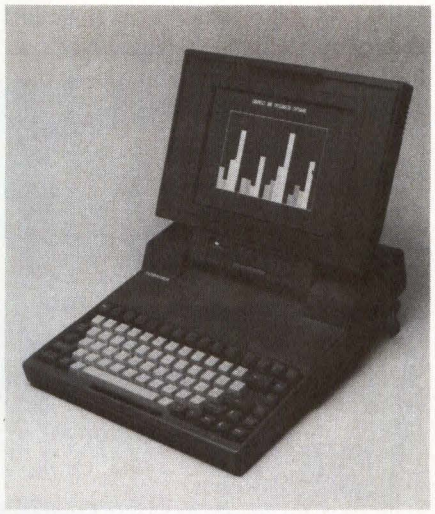
Circle 381

System aims at OEMs

- 80286 processor
- 1M-byte RAM
- 128K-byte ROM

Targeting OEMs, the TCS-7000 is an IBM PC/AT-compatible computer. The system utilizes an 80286 processor and operates under MS-DOS 3.0 and higher. It provides 640K bytes of RAM expandable to 1M byte and 64K bytes of ROM expandable to 128K bytes. Features include a 24-bit and a 16-bit address bus. The unit supports a 2M-byte RAM card, a serial/parallel card and color graphics cards. $2,595. **Tatung Company of America Inc.,** Computer Products Division, 2850 El Presidio St., Long Beach, Calif. 90810, (213) 637-2105.

Circle 382



Portable displays 80 by 25 characters

- 3½-inch drive
- 640K-byte RAM
- 10M-byte disk drive

A portable personal computer, the T3100 weighs 15 pounds. The IBM-compatible unit uses an 80286 processor running at 8 MHz. It offers 640K bytes of RAM, a 720K-byte, 3½-inch flexible disk drive and a 10M-byte rigid disk drive. The screen displays 80 by 25 characters with a 640-by-400 pixel resolution. Interfaces are supplied for an RGB color monitor, a parallel printer and an external disk drive. $4,499. **Toshiba America Inc.,** Information Systems Division, 2441 Michelle Drive, Tustin, Calif. 92680, (714) 730-5000.

Circle 383

Computer suits IBM PC/AT

- 80286 processor
- 512K bytes of RAM
- Three configurations

The A*Star PC/AT is an IBM PC/AT-compatible microcomputer available in three configurations. Model 100 includes 512K bytes of RAM, a 1.2M-byte flexible disk drive, eight expansion slots and an 80286 microprocessor. Model 200 offers a 20M-byte rigid disk

drive and a serial/parallel adapter; model 300 supplies a 30M-byte rigid disk drive. $1,495 to $2,495. **Wells American Corp.,** 3243 Sunset Blvd., West Columbia, S.C. 29169, (803) 796-7800.

Circle 384

Computer achieves IBM PC compatibility

- 8088-2 processor
- 640K bytes of memory
- Two RS232C ports

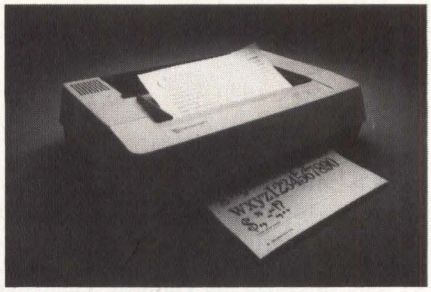
An IBM PC-compatible computer, the XT/MARK 2 features a dual-speed 8088-2 microprocessor that runs at 4.77 MHz or 8 MHz. The system includes 640K bytes of memory, two half-height flexible disk drives, two RS232C ports and a parallel printer port. An MS-DOS operating system and utility software are standard. Features include five expansion slots and a built-in tape backup controller. $1,495. **Magnum Computer Inc.,** 12090 S.W. Garden Place, Portland, Ore. 97223, (503) 684-8000.

Circle 385

Scanning system provides OCR

- 300-dpi resolution
- IBM PC interface
- Proprietary software

JetReader is a scanning system that provides optical character recognition and image processing capabilities. Scan times are 43 seconds at 300 dpi and 289 seconds at 200 dpi. The unit provides



automatic paper feed, an IBM PC interface and proprietary software. Full-page conversions take less than a minute for translation and scanning. $2,950. **Datacopy,** 1215 Terra Bella Ave., Mountain View, Calif. 94043, (415) 965-7900.

Circle 386

Minicomputer supports up to 40 workstations

- 4M bytes of memory
- 16 ports
- 360K-byte disk drive

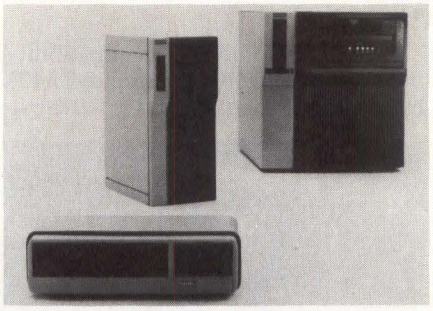
The VS65T minicomputer supports up to 40 workstations with as much as 4M bytes of main memory, a 360K-byte flexible disk drive, 16 ports and a 16K-byte cache memory. A 32-bit microprocessor achieves a 200-nsec instruction time. The unit accommodates six intelligent I/O processors and a variety of emulation products and interface options. $25,000 and higher. **Wang Laboratories Inc.,** 1 Industrial Ave., Lowell, Mass. 01851, (617) 459-5000.

Circle 387

Computers aim at business use

- Three models
- 32 users
- 15M bytes of RAM

Geared toward business applications, the 3235, 3255 and 3280 are additions to the System 3200 series. All computers utilize a 68000 or 68020 micro-



processor. Model 3235 supports up to 32 users. It supplies 20 RS232C ports, 500M bytes of rigid disk storage and 256K bytes of memory expandable to 10M bytes. Model 3255 supplies 15M bytes of RAM and a built-in magnetic tape drive and supports up to 64 workstations as does the model 3280, which offers eight 330M-byte Winchester disk drives. $24,000 and higher. **Pertec Computer Co.,** 17032 Armstrong Ave., Irvine, Calif. 92714, (714) 863-7580.

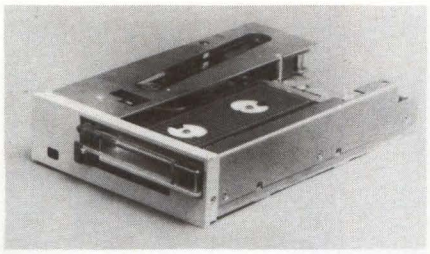
Circle 388

Computer suits IBM PC/XT

- 8088-2 processor
- 256K bytes of RAM
- Eight expansion slots

Operating at 4.77 MHz or 8 MHz, the PC-88 Turbo High-Speed Personal Computer is compatible with the IBM PC/XT. The unit supplies an 8088-2 microprocessor and an MS-DOS 2.11 operating system. Standard RAM is 256K bytes, expandable to 640K bytes. Features include a 5¼-inch, half-height, flexible disk drive; eight expansion slots; a serial printer port; and a parallel printer port. The computer runs GW BASIC, COBOL, FORTRAN, Pascal and all IBM software. $1,275. **Intelligent Data Systems Inc.,** 14932 Gwenchris Court, Paramount, Calif. 90723, (213) 633-5504.

Circle 389



Tape drive runs at 72 ips

- 10,000 bpi
- 125M-byte capacity
- 90K bytes per second

A half-height, quarter-inch cartridge tape drive, the model 5125E operates at 72 ips with a data-transfer rate of 90K bytes per second. The device is compatible with the QIC-120 format. It records data on 15 tracks at a density of 10,000 bpi for a formatted capacity of 125M bytes. A QIC-36 interface is included. The unit aims at OEMs. $555. **Wangtek,** 41 W. Moreland Road, Simi Valley, Calif. 93065, (805) 583-5255.

Circle 390

Disk drive mounts on card

- 75-msec access time
- 5M bytes per second
- 21M bytes

A rigid disk drive mounted on a card, the 21M-byte SlotMachine fits into a single slot on the IBM PC, PC/XT, PC/AT and compatibles. It provides a 5M-byte-per-second transfer rate, a 75-msec access time and a built-in disk-testing microprocessor. The subsystem supports a second rigid disk drive. $499. **Kamerman Labs,** 7861 S.W. Cirrus Drive, Beaverton, Ore. 97005, (800) 522-2237.

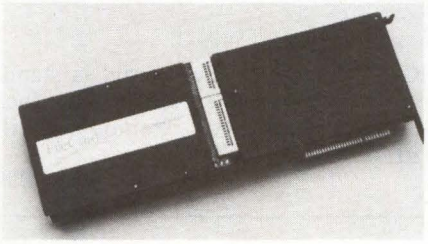
Circle 391

Tape drive stores 125M bytes

- Two interfaces
- 15-track recording
- 5¼-inch unit

The RoadRunner II is a 5¼-inch, half-height streaming tape drive. Available with a QIC-02 or a SCSI interface, the unit achieves a 125M-byte storage capacity. It reads and writes QIC-120 and QIC-24 data formats. Features include 15-track recording, single-axis head positioning and write precompensation. $775, QIC-02; $995, SCSI. **North Atlantic Industries Inc.,** 60 Plant Ave., Hauppauge, N.Y. 11788, (516) 582-6060.

Circle 392



Disk drive stores 20M bytes

- 5M bps transfers
- 80-msec access time
- 3½ inches

Offering a 20M-byte capacity, the FileCard20 is an internal rigid disk slot card. The 3½-inch device furnishes a 5M-bps transfer rate and an 80-msec access time. Features include plated media, head-lock and IBM PC/XT compatibility. The unit can be operated as a bootable drive C or as a second rigid disk using MS-DOS 2.0 or higher. MTBF is 10,000 hours. $895. **Western Digital Corp.,** Enhanced Peripherals Division, 2445 McCabe Way, Irvine, Calif. 92714, (714) 863-0102.

Circle 393

Optical disk suits IBM PC and compatibles

- 230M-byte capacity
- 2.5M-bps transfer rate
- 1-msec access time

A WORM optical disk system, N/Hance 525 suits the IBM PC and compatibles. The system supplies 230M bytes of formatted storage capacity, an optical disk, a 5¼-inch removable disk cartridge, an IBM PC short-board con-

CIRCLE NO. 81 ON INQUIRY CARD

troller and device-driver software. It generates a data-transfer rate of 2.5M bps and an average track-to-track access time of 1 msec. The unit can be used internally or externally. $3,495. **N/Hance Systems,** 908R Providence Highway, Dedham, Mass. 02026, (617) 461-1970.

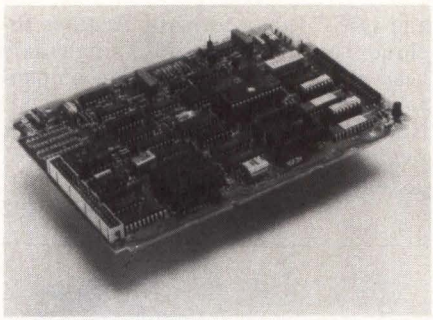
Circle 394

Tape controller links SCSI to QIC-120

- 1.8M-byte data rate
- GCR techniques
- Selectable formats

The T100 streaming tape controller links SCSI to QIC-36 and QIC-120. It features a 1.8M-byte asynchronous data rate, SCSI disconnect/reconnect and QIC-11 or QIC-24 selectable media formats. A SCSI copy command allows the device to read or write from other SCSI devices without host intervention. Data integrity is maintained through use of GRC techniques. Full parity is standard. $395. **Adaptive Data Systems Inc.,** 2627 Pomona Blvd., Pomona, Calif. 91768, (714) 594-5858.

Circle 395

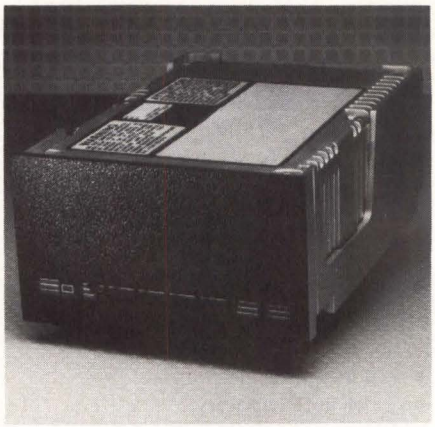


Disk drives achieve 382M-byte capacity

- 5¼ inches
- 18-msec access time
- SCSI controller

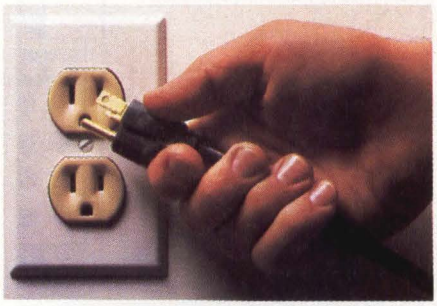
Offering unformatted capacities of 382M bytes and an average access time of 18 msec, models 1558 and 1578 are 5¼-inch Winchester disk drives. The 1558 provides ESDI, hard or soft sectoring and a 10M-bps transfer rate. Model 1578 supplies an on-board SCSI controller and a 1.25M-byte-per-second transfer rate. MTBF is 30,000 hours. $1,900. **Micropolis Corp.,** 21123 Nordhoff St., Chatsworth, Calif. 91311, (818) 709-3300.

Circle 396



This is all it takes to get IBM, Apple, Tandy, Macintosh and Compaq talking to each other.

And it's simple and inexpensive.



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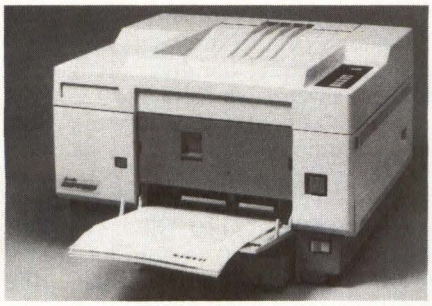
CIRCLE NO. 95 ON INQUIRY CARD



Laser printer runs at 8 ppm

- 384K bytes of memory
- Epson FX-80 emulation
- 10 bit-mapped fonts

The LaserPro EXPRESS laser printer produces 8 ppm. It offers Epson FX-80, HP LaserJet, Diablo 630 and Qume Sprint 11 emulation and provides 384K bytes of memory and 10 bit-mapped fonts. Software compatibility includes Wordstar, Lotus 1-2-3 and Symphony. Features include a 250-sheet paper cassette and a 100-sheet output tray. $1,895. **Office Automation Systems Inc.,** 8352 Clairemont Mesa Blvd., San Diego, Calif. 92111, (619) 576-9862.

Circle 397

Dot-matrix printer performs at 200 cps

- Four or seven colors
- 136 columns
- RS232C interface

A letter-quality, dot-matrix printer, the Printstation 260 performs at 200 cps with four or seven-color capability. The 136-column device generates charts and graphics in landscape or portrait mode. Features include IBM PC color graphics, Epson FX-80 emulation and eight international character sets. A Centronics parallel and an RS232C interface are standard. $1,495. **Centronics Data Computer Corp.,** 1 Wall St., Hudson, N.H. 03051, (603) 883-0111.

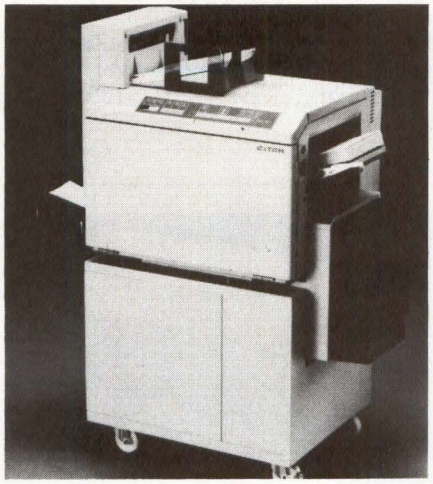
Circle 398

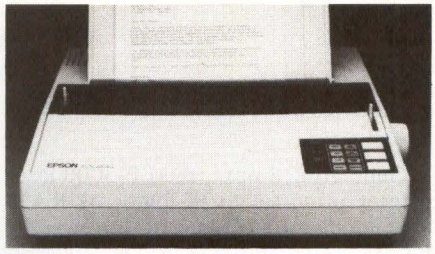
Printers execute 30 and 45 ppm

- Ion deposition
- 300 by 300 dpi
- DEC compatible

Using ion-deposition technology, the CIE 3000 series printers execute 30 and 45 ppm. The units are geared toward DEC computers. They supply a 300-by-300-dpi resolution. Features include a 500-sheet feeder, self-test and landscape and portrait modes. $12,995, 30 ppm; $15,540, 45 ppm. **CIE Systems Inc.,** 2515 McCabe Way, Irvine, Calif. 92713, (714) 660-1800.

Circle 399





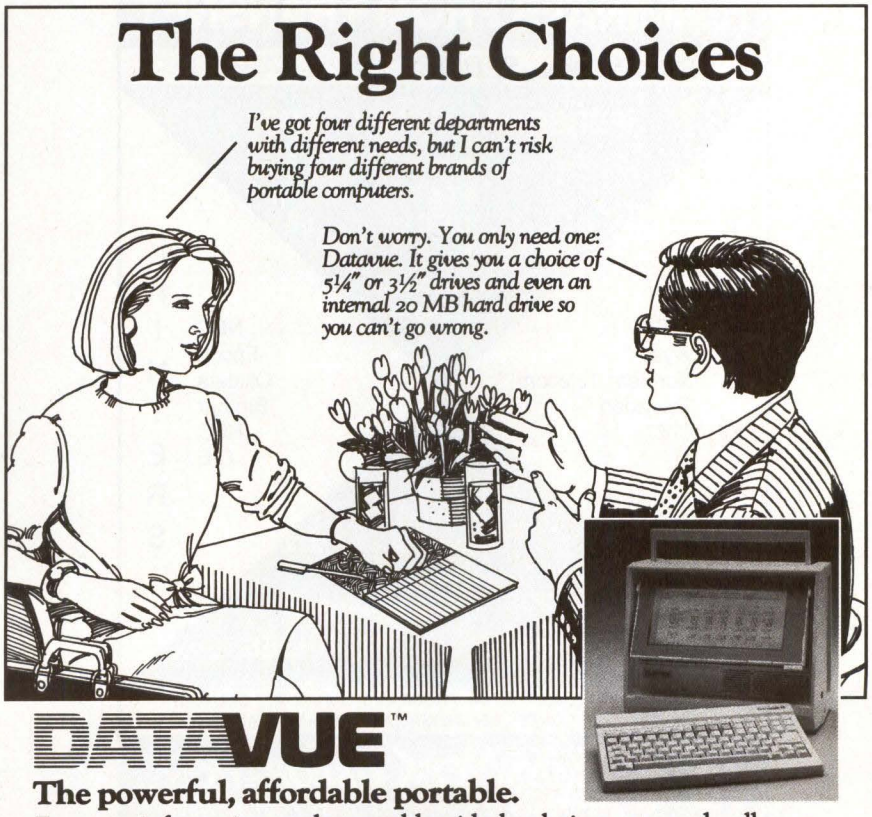
Dot matrix printer runs at 300 cps

- 8K-byte buffer
- 80 columns
- IBM emulation

An 80-column dot matrix printer, the EX-800 runs at 300 cps, draft, and 54 cps, NLQ. Features include an 8K-byte buffer, a bidirectional tractor, automatic sheet-loading and a color option. Parallel and serial interfaces are standard. The device emulates IBM printers. $749. **Epson America,** Computer Products Division, 2780 Lomita Blvd., Torrance, Calif. 90505, (800) 421-5426.

Circle 400

The Right Choices



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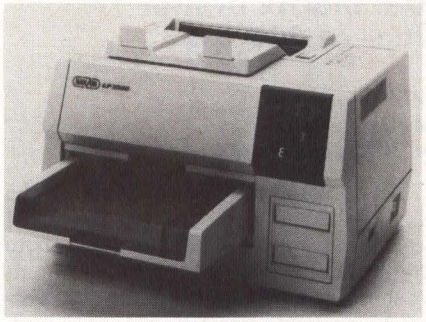
CIRCLE NO. 82 ON INQUIRY CARD

Printer generates 8 ppm

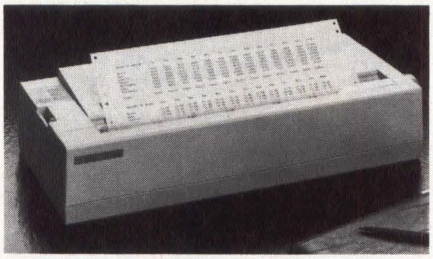
- 300 by 300 dpi
- 512 bytes of RAM
- Six fonts

Generating 8 ppm, the LP-3000 laser printer provides 512K bytes of RAM expandable to 2M bytes. Resolution for bit-mapped graphics is 300 by 300 dpi.



The printer emulates the HP LaserJet and LaserJet Plus, Diablo 630 and Epson FX-80. It supports the full IBM graphics character set. Serial and parallel interfaces are supported. Features include six fonts, a 250-sheet paper tray and automatic page eject. $3,980, 512K bytes; $4,995, 2M bytes. **HanZon Data Inc.,** 18732 142nd Ave. N.E., Woodinville, Wash. 98072, (206) 487-1717.

Circle 401



Ink-jet printer executes 192 cps

- 192 by 192 dpi
- 48 dB(a)
- Two interfaces

The HPQuietJet Plus ink-jet printer runs at 40 cps, NLQ, and 160 and 192 cps, draft quality. It executes resolutions of 96 by 96 dpi, 192 by 96 dpi and 192 by 192 dpi. Noise level is 48 dB(a). Serial and parallel interfaces are standard. The model handles tractor-feed and cut-sheet paper from 4 to 15 inches across. It supports IBM character sets and is compatible with many software packages including Lotus 1-2-3, Wordstar and Framework. $799. **Hewlett-Packard Co.,** 18110 S.E. 34th St., Camas, Wash. 98607, phone locally.

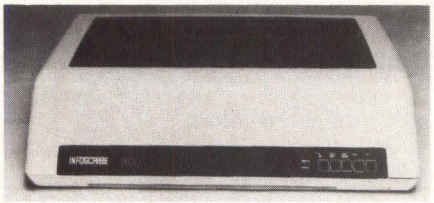
Circle 402

Daisywheel printer runs at 30 cps

- IBM compatible
- 12 cpi
- Minus 59 dB(a)

A daisywheel printer, the D2000 is geared toward the IBM PC and compatibles. The unit produces 30 cps at 12 cpi. Character pitch is 10, 12 and 15 cpi. It prints in unidirectional or bidirectional mode. Noise level is less than 59 dB(a). Features include a 2,500-hour MTBF, a soft parameter setup and automatic paper feed. $695. **Facit Inc.,** 9 Executive Drive, Merrimack, N.H. 03054, (603) 424-8000.

Circle 403



Printer generates 400 cps

- 144 by 144 dpi
- IBM emulation
- Multiple fonts

The model 1400 dot matrix printer generates 400 cps, draft, 200 cps, correspondence quality and 80 cps, NLQ. It supplies 72-by-72-dpi and 144-by-144-dpi resolutions. Multiple fonts may be resident, and two fonts can be downloaded from the host computer. The unit provides Diablo 630, Epson, and IBM interface emulations. It employs standard tractor paper handling. $1,845. **Infoscribe Inc.,** 1808 Michael Faraday Court, Reston, Va. 22090, (703) 689-2805.

Circle 404

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Terminals are DEC compatible

- 14-inch screen
- 720 by 336 pixels
- Tektronix Plot 10

The models 955 and 9220 graphics terminals supply Tektronix 4010/4014 compatibility while running Tektronix Plot 10 programs. They display resolutions of 720 by 336 pixels and 640 by 240 pixels, respectively, on a 14-inch screen. The 9220 is compatible with DEC's VT52, VT100 and VT220 terminals. Features include circle and arc generation, bar and polygon fill and eight line-types. Display RAM is 32K bytes. $1,129. **TeleVideo Systems Inc.,** 550 East Brokaw Road, P.O. Box 6602, San Jose, Calif. 95150-6602, (408) 745-7760.

Circle 405

Terminal provides 26 or 44 lines

- 14-inch screen
- 16 function keys
- IBM keyboard

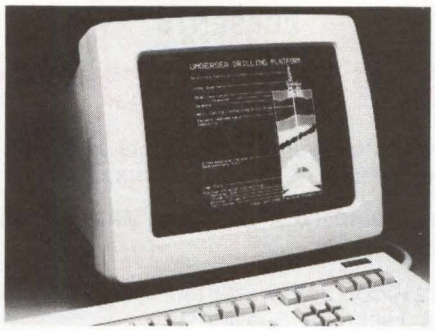
The WY-60 ASCII terminal furnishes a resolution of 7 by 12 characters in a 10-inch by 16-inch matrix. It supplies 26 or 44 lines of text in an 80- or 132-column format. Screen size is 14 inches. The unit supports IBM PC/AT, IBM 3161 and WY-50 keyboards. Up to seven pages of display memory are supplied. Features include 16 dedicated function keys and 66 programmable functions. The terminal emulates Data General, Lear Siegler, TeleVideo, ADDS and Hazeltine devices. $699. **Wyse Technology,** 3571 N. First St., San Jose, Calif. 95134, (408) 433-1000.

Circle 406

Terminal offers 249 fill patterns

- 16 colors
- 38.4K-baud throughput
- Tektronix compatible

The ColorTrend 4100 model 100 is a graphics terminal for data representation and analytical applications. It supplies 16 colors and 249 fill patterns, 100 of which are programmable. Throughput is 38.4K baud. The Tektronix-compatible unit contains programmable function keys, a detachable keyboard



and commands such as paint, circle and zoom. $1,995. **Intecolor Corp.,** Intecolor Drive, 225 Technology Park, Norcross, Ga. 30092, (404) 449-5961.

Circle 407

Terminal emulates DEC units

- 1,024 by 780 pixels
- 80, 132 columns
- 60-Hz display

A composite terminal, the GO-235 emulates DEC's VT100 and VT220 units. The terminal offers a resolution of 1,024 by 780 pixels and a 60-Hz non-interlaced display. It writes up to 52 lines of text in 80 or 132 columns. $1,695. **GraphOn Corp.,** Tower One, Fifth Floor, 1901 S. Bascom Ave., Campbell, Calif. 95008, (408) 371-8500.

Circle 408

Monitors perform CAD/CAM applications

- 16-, 20-inch unit
- 1,024 by 1,280 pixels
- 60-MHz raster scanning

Suiting CAD/CAM and graphics applications, the CD-S1611 and CD-S2011 are color monitors with a 1,024-by-1,280-pixel resolution. The 16- and 20-inch units offer a standard dot pitch of 0.26 mm and 0.31 mm, respectively. They use a 60-MHz non-interlaced scanning system. $2,500, CD-S1611; $3,000, CD-S2011. **C. Itoh Electronics Inc.,** 5301 Beethoven St., Los Angeles, Calif. 90066, (213) 306-6700.

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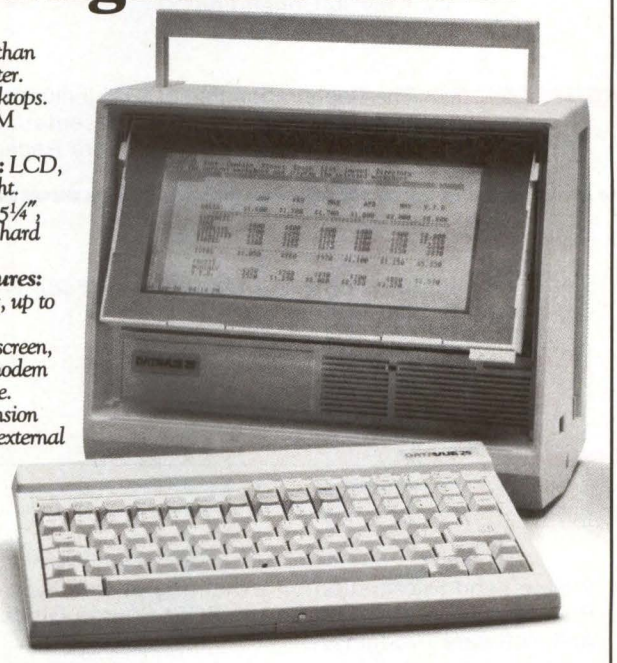

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- WORKSHOPS
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CIRCLE NO. 19 ON INQUIRY CARD

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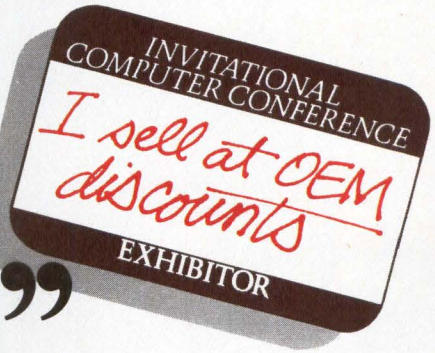

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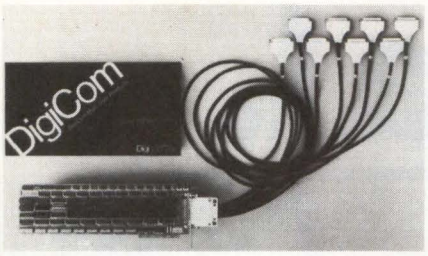
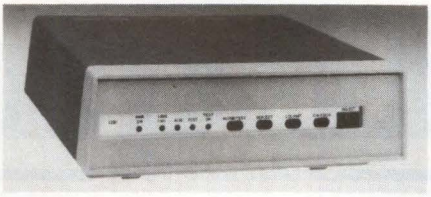


Communications board supplies eight ports

- 50 to 19.2K baud rate
- Stop bits
- Odd or even parity

The DIGICOM/8 communications board contains four or eight asynchronous serial ports. Selectable baud rates for each port range from 50 to 19.2K. The unit provides 5-, 6-, 7- or 8-bit characters, odd or even parity and 1, 1½ or 2 stop bits. As many as four boards can be linked to supply 32 serial communications ports. $649. **DigiBoard Inc.,** 6751 Oxford St., Louis Park, Minn. 55426, (612) 922-8055.

Circle 410

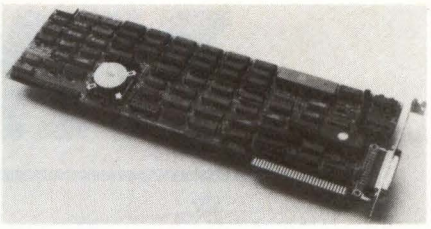


Multiplexer uses up to 16 channels

- RS232C compatible
- Four configurations
- 56K and 64K bps

A time division multiplexer for 56K-bps and 64K-bps applications, the KILOMUX 1281 interleaves up to 16 channels and supports data rates of up to 19.2K bps. The unit allows selection of RS232C, RS422, RS423 or CCITT V.35-compatible interfaces. It accommodates synchronous and asynchronous channels and comes in four configurations. $2,000 and higher. **General DataComm Industries Inc.,** 1475 Straits Turnpike, Route 63, Middlebury, Conn. 06762-1299, (201) 574-1118.

Circle 412

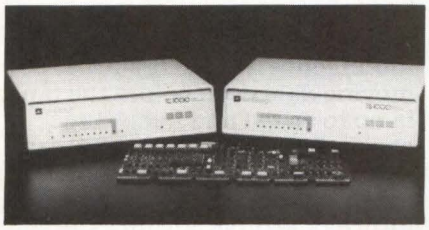


Communications board targets OEMs

- 800K bps
- 80186 processor
- 512K bytes of memory

Targeting OEMs and system integrators, the WNIM-186 communications board is based on the 80186 microprocessor. The device generates speeds of up to 800K bps. It supports X.25, SNA/SDLC, asynchronous and bisynchronous data transmission. Up to 512K bytes of dual-ported memory with parity is supplied. $795. **Gateway Communications Inc.,** 16782 Red Hill Ave., Irvine, Calif. 92714, (714) 261-0762.

Circle 413



Multiplexers suit DEC users

- Asynchronous units
- 64K bps
- Self-test

Asynchronous multipoint multiplexers, the TC-1000 UNIbus Concentrator and the TS-1000 Switching Multiplexer work with DEC products. The TC-1000 supports 64 simultaneous sessions with terminals at remote sites. It emulates the asynchronous portion of eight DEC DMF-32 Communications Controllers. The TS-1000 connects terminals from four remote sites to a central-site CPU. Up to 32 computer ports and terminal connections are supported at each site. Both units offer speeds up to 64K bps. Features include self-test. $7,500, TS-1000; $2,100, TS-1000. **ComDesign Inc.,** 751 S. Kellogg Ave., Goleta, Calif. 93117-3880, (805) 964-9852.

Circle 411

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ICM's WS-286 contains all the common local area network components on one board—including ARCnet, SCSI, 1 MByte RAM, and 5 expansion slots. This greatly reduces system complexity, repair costs, and stock of multiple costly components.

The on-board SCSI controller provides easy interface to ICM's single-board disk and tape controller—so the WS-286 may be used as both a fileserver and inexpensive diskless workstation, supporting Novell and TurboDOS. It fits into standard IBM-XT enclosures without software or hardware modification. The 80286-based workstation operates at 10 MHz with no wait states when accessing on-board peripherals and RAM, while the expansion slots operate at 4.77 MHz to allow full XT expansion card compatibility.

Call ICM for more information and Reseller pricing.

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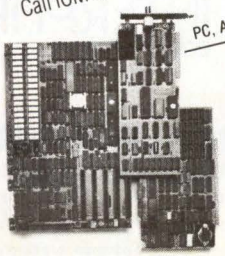

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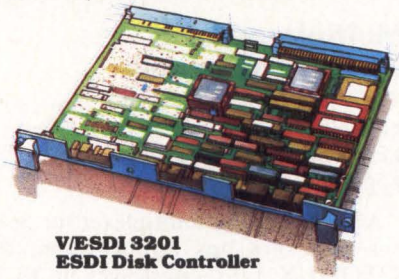
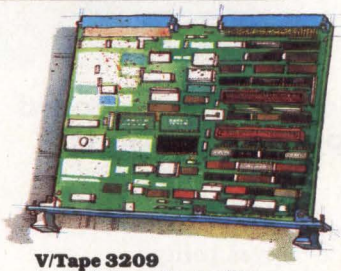
V/SMD 3200
SMD Disk Controller



V/ESDI 3201
ESDI Disk Controller



V/Tape 3209
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V/SMD 3200 SMD Disk Controller—is the industry's preeminent 32-bit SMD controller with more V/SMD 3200's installed today in VMEbus systems than any other similar product. It interfaces to any SMD or SMD-E drive with data rates up to 24 Mb/s, and adapts to your system environment through programmable system parameters.

Interphase's multitasking Virtual Buffer Architecture℠ permits the V/SMD 3200 to move data with extraordinary speed and is the key to zero-latency operation. The on-board 68000 processor manages a pool of buffers and state machines, which allow it to immediately start moving data no matter where the head lands on the track. It can transfer an entire track of data in one disk rotation and by pre-fetch caching, will continue to read and cache data even after it has finished transferring those requested. These cached sectors can then be transferred without an additional disk access.

V/ESDI 3201 ESDI Disk Controller—using the powerful Interphase Virtual Buffer Architecture, handles the latest high-speed 5¼" ESDI disk drives with hundreds of Megabyte capacities. A sister product to the V/SMD 3200 SMD disk controller, the V/ESDI 3201 is the logical migration path from SMD storage devices to a 5¼" form factor. Totally software compatible with the V/SMD 3200, the V/ESDI 3201 will "PLUG AND PLAY" with existing drivers to protect software investments for the future.

A 24 Mb/s disk drive front-end ensures complete compatibility with future higher speed drives.

V/Tape 3209 ½ Inch Tape Controller—represents the Interphase commitment to design compatibility and ease of integration through its close-coupling with both V/SMD 3200 and V/ESDI 3201 disk controllers. It supports 8, PERTEC interface, ½" 9-track tape drives at speeds of 200 ips and above and is the perfect controller for start/stop or streaming applications.

An Interphase exclusive CacheFlow℠ feature allows expensive drive performance with an inexpensive drive by eliminating the need for costly intelligence and large buffers. An on-board processor and 8K or optional 128K buffer create intelligent FIFOs that start moving data even before the tape is up to speed and keeps tape streaming. The V/Tape 3209 can run at up to 320 ips, at 6250 bpi, meaning that it will handle future tape drive advances.

FIND OUT MORE

Our family approach to these and other VMEbus products makes your task much easier. From peripheral controllers to system foundations, from our Design Assistance Group to our First Time User Program, no one is VMEqual to Interphase. To learn more about our products, our support or anything else, just call:

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CIRCLE NO. 8 ON INQUIRY CARD

Software targets system integrators

Targeting system integrators, Intelligent Query is a tool for application software developers. The product is based on a data dictionary and artificial-intelligence concepts. It combines an intelligent query language, a custom report writer and a graphics utility. Database files can be transferred directly to Lotus worksheets without reformatting. $300. **Programmed Intelligence Corp.,** Suite 5, 3069 Amwiller Road, Atlanta, Ga. 30360, (404) 446-8880.

Circle 414

Network file manager runs under OS-9

The Network File Manager runs under OS-9, a real-time, multitasking operating system. The software-based product combines the file and I/O systems of all connected computers into one file system. Existing utility application software can be used. The package is compatible with a variety of LAN or long-haul data communications hardware. $60 per copy. **Microware Systems Corp.,** 1866 N.W. 114th St., Des Moines, Iowa 50322, (515) 224-1929.

Circle 415

Software supports IBM token-ring

A software key for IBM's Token-Ring Network, NETBIOS works in conjuction with DOS 3.1 to handle the operating system requirements of networks. The product is available in versions for MultiLink Advanced multiuser software and LANLink, a software-driven network. $495. **The Software Link,** Suite 632, 8601 Dunwoody Place, Atlanta, Ga. 30338, (404) 998-0700.

Circle 416

Graphics software addresses business

A business graphics software package for the IBM PC and compatibles, SYON offers a choice of 11 graphs. It integrates text and graphs. The package loads and edits files from any IBM-compatible word-processing software package and integrates software such as Lotus 1-2-3 or MultiPlan. Resolution is 640 by 200 monochrome pixels and 320 by 200 color pixels. $199. **Stella Systems,** Suite 185, 10430 S. De Anza Blvd., Cupertino, Calif. 95014, (408) 257-6644.

Circle 417

Worksheet supplies four functions

Logistix is an integrated software package that combines time-management, database, spreadsheet and graphics functions. The worksheet measures 2,048 rows by 1,024 columns. It supplies intelligent memory management, color-support formatting options and more than 150 screens of context-sensitive help. The database stores 2,027 records by 64 fields. $450. **Lattice Inc.,** P.O. Box 3072, Glen Ellyn, Ill. 60138, (312) 858-7950.

Circle 418

Software accesses DEC files

Dataware enables users to access Digital Equipment Corp. disk files and output peripherals from IBM PCs. The software is supplied with a proprietary VT-220 emulator. PC users can transfer information to and from DEC files. $195. **Logicraft Inc.,** 410 Amherst St., Nashua, N.H. 03063, (603) 880-0300.

Circle 419

C compiler runs with MS-DOS 2.0

A C compiler, LET's C provides a complete C language, full UNIX compatibility and a standard C library. The product runs on the IBM PC and compatibles under MS-DOS 2.0 or higher. It requires 128K bytes of RAM and disk drives. $495. **Mark William Co.,** 1430 Wrightwood Ave., Chicago, Ill. 60614, (312) 472-6659.

Circle 420

Bus Specific Networks

NEW FUTURE

Finally PC-DOS capabilities on S-100 systems—a major breakthrough the noncompatibility barrier.

For the first time, you can run monochrome PC-DOS and MS-DOS—including Lotus 123, Wordstar, and Sidekick—on your existing S-100 system. All with the brand new CPS-16F, a powerful single board network processor, only from ICM. It fits existing installations without a LAN hookup and has low entry requirements for TurboDOS Systems. The CPS/MS-1000 package (with 1000 opportunities) consists of the CPS-16F processor; M/STER—ICM's monochrome graphics PC-emulating terminal; PC-DOS; TurboDOS/PC; and ICM's exclusive MS-1000 software.

ICM brings PC-DOS to the S-100 industry. Call ICM for Reseller pricing on the CPS/ MS-1000 package and info about our upcoming products.

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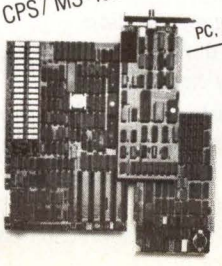

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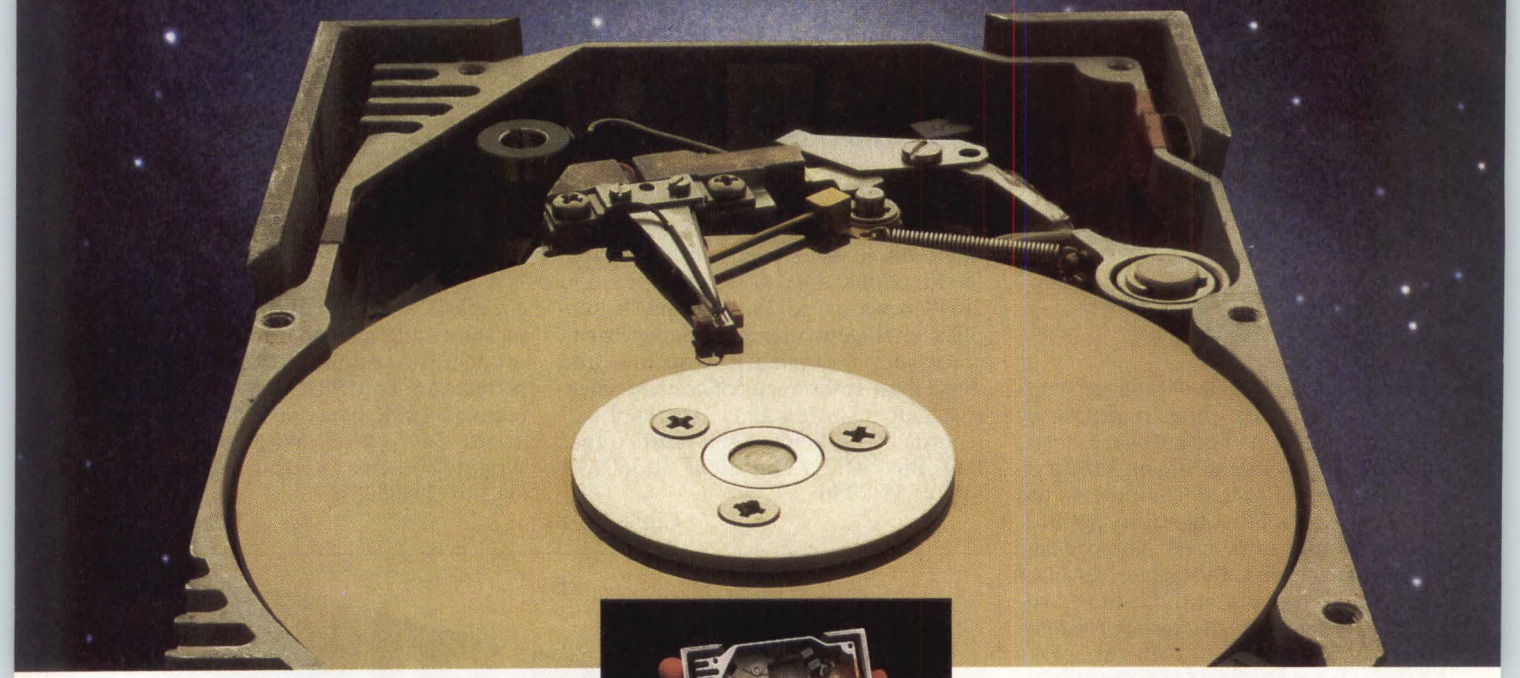
CIRCLE NO. 88 ON INQUIRY CARD

THERE'S A REASON WHY THEY DON'T PARK PLANES ON THE RUNWAY.



Parking violations.
Most Winchester manufacturers "park" the read/write heads on the media. That's where the trouble starts. Like stiction between the heads and media causing drive failure on start-up. Or shock and vibration causing the heads and media to slap together, which can mean errors, lost data, head crashes.

Heads-up technology.
That's why all Titan™ 3.5-inch 20 Mbyte Winchesters have LaPine's patented head lifters. To hold the heads off the media during power-down. So there are no take-offs and landings. Not only do the heads never "park on the runway," they never touch the media at all.

Top flight performance.
Because the heads don't rest on the media, LaPine's Titan drives are virtually shockproof, built to withstand 60 G's shock and 2.5 G's vibration. And at 5°C to 55°C, the operating thermal range is the widest around. To speed system throughput, track-to-track access time is just 15 MS, with an average access time of 65 MS.

Shockproof 3.5-inch 20-Mbyte Winchesters that eliminate head-disk wear and stiction — completely.

LaPine means reliability.
Only LaPine eliminates the three main causes of Winchester failure:

- *Eliminates stiction.*
  Heads don't touch or park on media, so they can't adhere.
- *Prevents head/media wear.*
  Heads never contact disks, even during power down.
- *Ends head-slap.*
  Shock and vibration can't damage the heads or media.

For your customers, this means reliability, durability and data dependability. In even the most demanding applications. And now they're backed by the only two year warranty in the industry.

Available now.
To compete in today's systems markets, you need the most reliable Winchester storage there is. You need LaPine. Affordable quality you and your customers can't afford to be without.

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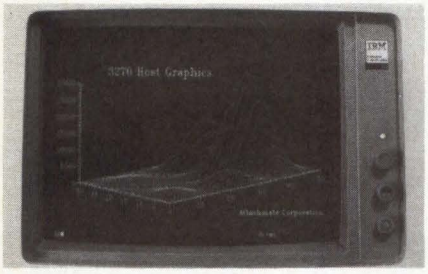
CIRCLE NO. 92 ON INQUIRY CARD

Software accesses color graphics

- IBM compatible
- Coaxial adapter
- Four host sessions

The Attachmate 3270 Host Graphics Program allows personal computers to access host-generated color graphics. The software uses a proprietary coaxial adapter and a 3270-PC emulation program to manage up to four concurrent



host sessions. Combinations of 3270 text and graphics can run simultaneously. Host graphics screens can be saved and edited locally. The IBM Color Graphics Adapter and Enhanced Graphics Adapter are supported. $595. **Attachmate Corp.,** 3241 118th S.E., Bellevue, Wash. 98005, (206) 644-4010.

Circle 421

Software handles multiple projects

- 18 menus
- Six windows
- 25 Help-screens

Running on an IBM PC with 256K bytes of RAM, Project Major is a project-management software program that uses Lotus 1-2-3. The package supplies 18 menus, 25 Help screens, six windows and a sample tutorial. Data entry is done with menus or single keystrokes. Setup codes are provided for 80 printers. A print menu selects fonts and line spacing. $69.95. **Hunter Consultants,** 15 Chipping Green Drive, Arden, N.C. 28704, (704) 684-0947.

Circle 422

Operating system addresses 16M bytes

- 16-bit OS
- Multitasking
- 32 users

A multiuser, multitasking operating system, THEOS 286-Virtual addresses up to 16M bytes of RAM. As many as 32 users can run applications simultaneously. The 16-bit operating system provides built-in security and memory management. $695. **THEOS Software Corp.,** Suite 100, 201 Lafayette Circle, Lafayette, Calif. 94549-4370, (415) 283-4290.

Circle 423

DBMS emulates dBASE III Plus

- MS-DOS support
- 10 files
- Help system

Compatible with Ashton-Tate's dBASE III Plus, dBXL supplies extended language features, MS-DOS and PC-DOS support, a Help system and networking capabilities. The software utilizes the same data and index files as dBASE III Plus. As many as 10 files can be open simultaneously, each with up to seven open index files. No copy protection. $695. **WordTech Systems Inc.,** P.O. Box 1747, Orinda, Calif. 94563, (415) 254-0900.

Circle 424

Software suits math applications

- For IBM PCs
- 384K bytes of RAM
- Numerical analysis

MathCAD aims at computer aided mathematics applications. The software runs under MS-DOS 2.0 and higher on the IBM PC, PC/XT, PC/AT and compatibles. It requires 384K bytes of RAM. The package supports 8087 and 80287 coprocessors, the IBM graphics printer and the Hewlett-Packard laser jet printer. Applications include numerical analysis and document results. $189. **MathSoft Inc.,** 1 Kendall Square, Cambridge, Mass. 02139, (617) 577-1017.

Circle 425

Bus Specific Networks

NEW SIZE

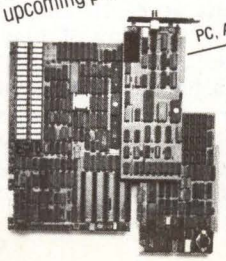
Quadruple the number of users in one S-100 chassis with our new 4-in-1 processor board.

More compact, our new CPS-Q6A opens a myriad of new opportunities. Only from ICM. Combining four 8-bit network processors on a single board shrinks the bus space, uses 35% less power and costs less per processor. Designed to operate at 10 MHz, it offers S-100 users the highest degree of performance and system integration available in the market today!

ICM's CPS-216 is also available—with two 16-bit network processors operating at 8 MHz with 256K RAM each, all on a single board.

ICM provides the system integrator with the best price performance products possible. Call ICM for Reseller pricing on the CPS-Q6A and CPS-216 package and info about our upcoming products.

PC, ARCNET, AND S-100 APPLICATIONS.



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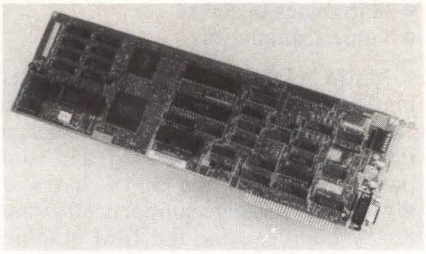
CIRCLE NO. 89 ON INQUIRY CARD

SUBASSEMBLIES

Controller suits IBM PC, PC/XT and PC/AT

- 16 colors
- 640-by-350 resolution
- 1,024 characters

A controller card for color or monochrome graphics, the EGA Master is compatible with IBM's Enhanced Graphics Adapter. The device runs on the IBM PC, PC/XT and PC/AT. It



provides 256K bytes of memory and 640-by-350 resolution for text and graphics in 16 colors from a 64-color palette. The card supplies smooth scrolling, smooth panning and the production of 1,024 programmable characters. $395. **Tecmar Inc.,** 6225 Cochran Road, Solon, Ohio 44139-3377, (216) 349-0600.

Circle 426

Single-board PC runs faster than IBM PC/AT

- 8086-1 processor
- 512K bytes of RAM
- 16-bit words

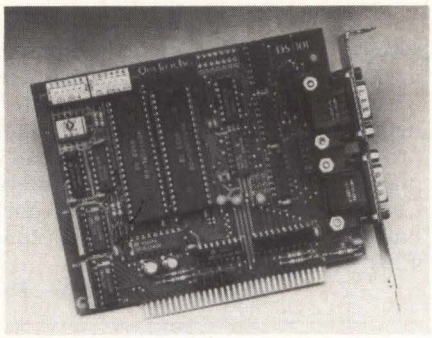
The 8612 single-board personal computer runs 1.6 times faster than the IBM PC/AT and over four times faster than the IBM PC/XT. The device is mounted on a full-size personal computer expansion card. It utilizes an 8086-1 microprocessor and 512K bytes of RAM to handle data in 16-bit-wide words. The unit is geared toward OEMs and VARs. $626. **Datavue Techical Systems,** 4355 International Blvd., P.O. Box 2687, Norcross, Ga. 30093, (404) 564-5780.

Circle 427

Boards run at 19.2K bytes

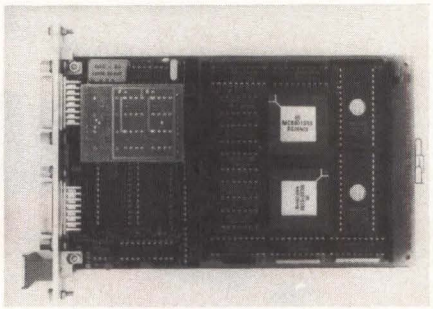
- IBM PC compatible
- Interrupts
- Switch-selectable

The DS-101 and DS-102 boards pro-



vide dual, independent RS232C interfaces for asynchronous communication. For use with the IBM PC, PC/XT, PC/AT and compatibles, the 19.2K-byte boards may be used as two serial ports or disable units. Switch-selectable addressing allow the devices to be reassigned as additional serial ports or anywhere else in the available I/O space. Interrupts are supplied. Optional software supports baud rates up to 19.2K. $295. **Qua Tech Inc.,** 478 E. Exchange St., Akron, Ohio 44304, (216) 434-3154.

Circle 428



SBC aids VMEbus

- Four configurations
- 200-nsec access time
- 16, 32 bits

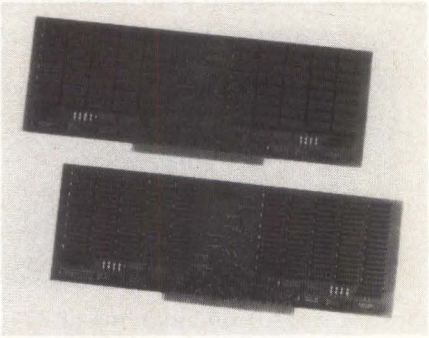
A 16/32-bit single board computer for the VMEbus, the VMP68KB offers a choice of four microprocessors. The ruggedized unit performs real-time applications at 8, 10 and 12 MHz. It features 128K bytes of dynamic RAM, a 200-nsec access time and a seven-level interrupt handler. The device supplies eight programmable control lines for parallel I/O and two independent serial I/O ports. $1,095. **PEP Modular Computers Inc.,** 600 N. Bell Ave., Pittsburgh, Pa. 15106, (412) 279-6661.

Circle 429

Board suits IBM RT PC

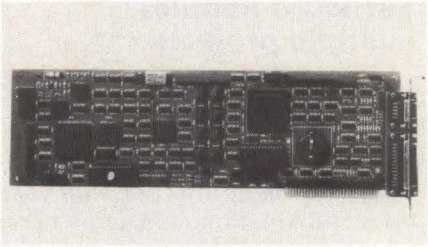
- 8M bytes of memory
- Two 40-bit arrays
- 150-nsec access time

Add-in memory boards for the IBM RT PC, the RTRAM/4 and RTRAM/8 offer 4M and 8M bytes of memory, respectively. Up to 16M bytes are configurable for the full address space of the RT PC. The boards are organized as



two 40-bit arrays to allow interleaved operation. Data access time is 150 nsec. $1,895, RTRAM/4; $4,395, RTRAM/8. **Clearpoint Inc.,** 99 South St., Hopkinton, Mass. 01748, (617) 435-5395.

Circle 430



Board incorporates IBM EGA

- 2M bytes of memory
- Rigid disk controller
- Two ports

A multifunction board for the IBM PC/XT, All Aboard combines IBM EGA or IBM monochrome and color graphics support, up to 2M bytes of expanded memory, a rigid disk controller and serial and parallel ports. The device occupies one slot. $545, monochrome and color graphics; $795, EGA support. **IDEAssociates Inc.,** 35 Dunham Road, Billerica, Mass. 01821, (617) 663-6878.

Circle 431

Package furnishes voice recognition

The PC Executive Secretary offers voice-recognition and telephone-managment capabilities to the IBM PC and compatibles. The hardware/software package reproduces speech at rates of 4,000 bps. Functions include automatic answering, message recording and playback and automatic call logging. $1,695 **VOTAN,** 4487 Technology Drive, Fremont, Calif. 94538, (415) 490-7600.

Circle 432

Graphics controller targets OEMs

The Ω3610 graphics display controller achieves a 1,280-by-1,024 pixel and 60-Hz color resolution. Targeting OEMs, the unit includes 32 bit-planes and a custom bit-slice processor. It can define 16 million colors. Vector drawing mode is 6 million pixels per second, and rectangle-fill is 160 million pixels per second. Features include a 16-bit, double-buffered interface or an IEEE-488 interface. The unit operates in full-raster mode and performs pan and zoom. $16,950. **Metheus Corp.,** 5510 N.E. Elam Young Parkway, Hillsboro, Ore. 97123, (503) 640-8000.

Circle 433

Emulation adapter fits in IBM PC

The Advanced 3278/79 Emulation Adapter fits in either a full or half slot of an IBM PC, /XT or /AT, allowing the PC to emulate an IBM 3278 monochrome terminal or an IBM 3279 color terminal. Files are transferred to and from host systems in 3270 environments. Multiple concurrent 3270 sessions may be implemented. $595. **IBM Corp.,** 900 King St., Rye Brook, N.Y. 10573, (914) 934-4000.

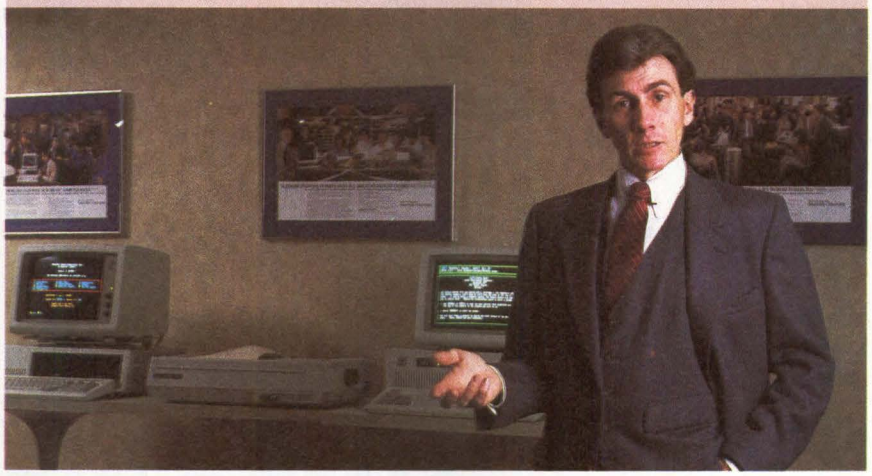
Circle 434

Board furnishes up to 2M bytes of RAM

- 8086-1 processor
- Standard ports
- Single-slot unit

The Dream Board is an IBM PC- and PC/XT-compatible multifunction

"I need a LAN that works with our existing hardware."



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board that offers 512K bytes of RAM expandable to 2M bytes of EMS-compatible RAM. Occupying a single slot in the PC, the device utilizes an 8086-1 microprocessor. Serial and parallel ports are standard. $795. **Univation Inc.,** 1231 California Circle, Milpitas, Calif. 95035, (408) 263-1200.

Circle 435

Memory board suits 200 PC applications

- 8M bytes of memory
- Windowing software
- PC-DOS compatible

A memory and multifunction board for the IBM PC, PC/XT and compatibles, SixPacPremium increases the PC's memory by 2M bytes. The PC-DOS-compatible device supplies two serial ports, one parallel port and proprietary windowing software. Memory is expandable to 8M bytes. The board is compatible with over 200 PC application programs. $595 to $1,395. **AST Research Inc.,** 2121 Alton Ave., Irvine, Calif. 92714, (714) 863-1333.

Circle 436

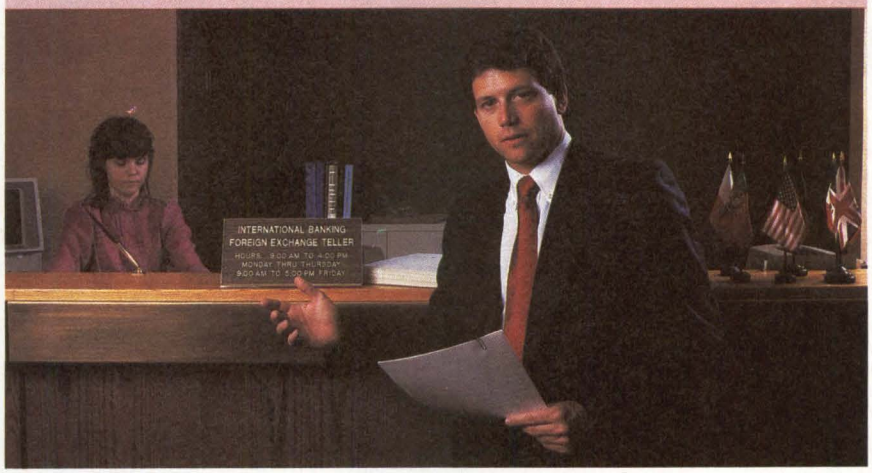
Graphics adapter converts color to gray

- 8-by-14-dot characters
- 1,024 by 348 pixels
- IBM PC compatible

A monochrome and color graphics adapter, the Chauffeur HT is compatible with the IBM PC, PC/XT and PC/AT. It converts color to 16 shades of gray for monochrome monitors. Text is displayed as 8-by-14-dot characters with a 1,024-by-348-pixel display. The device runs all IBM Color Graphics Adapter and Monochrome/Printer Adapter software on standard RGB color monitors. Up to 16 colors are supported. The unit also drives 256-kHz color monitors. Features include a parallel printer port and PC Accelerator software. $349. **STB Systems Inc.,** Suite 125, 601 N. Glenville, Richardson, Texas 75081, (214) 234-8750.

Circle 437

"I need a LAN that lets us communicate with other buildings—or other continents."



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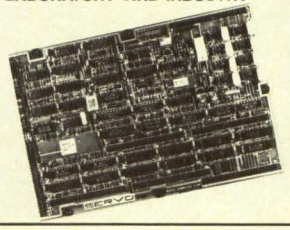

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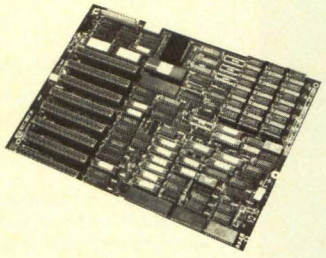

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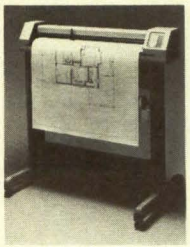

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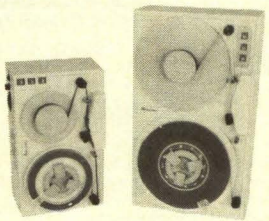

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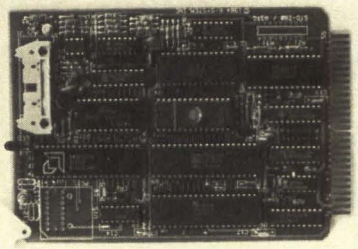

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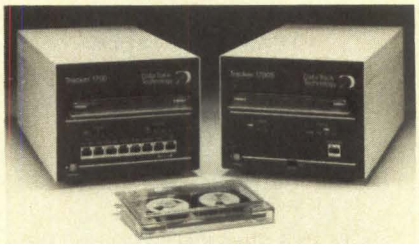

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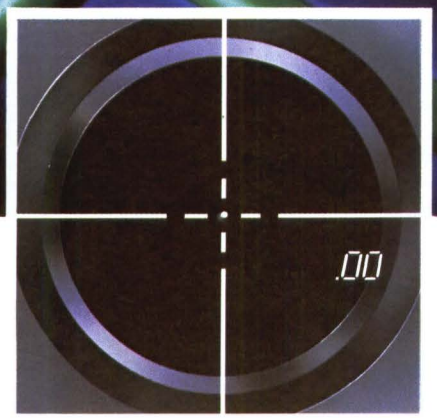

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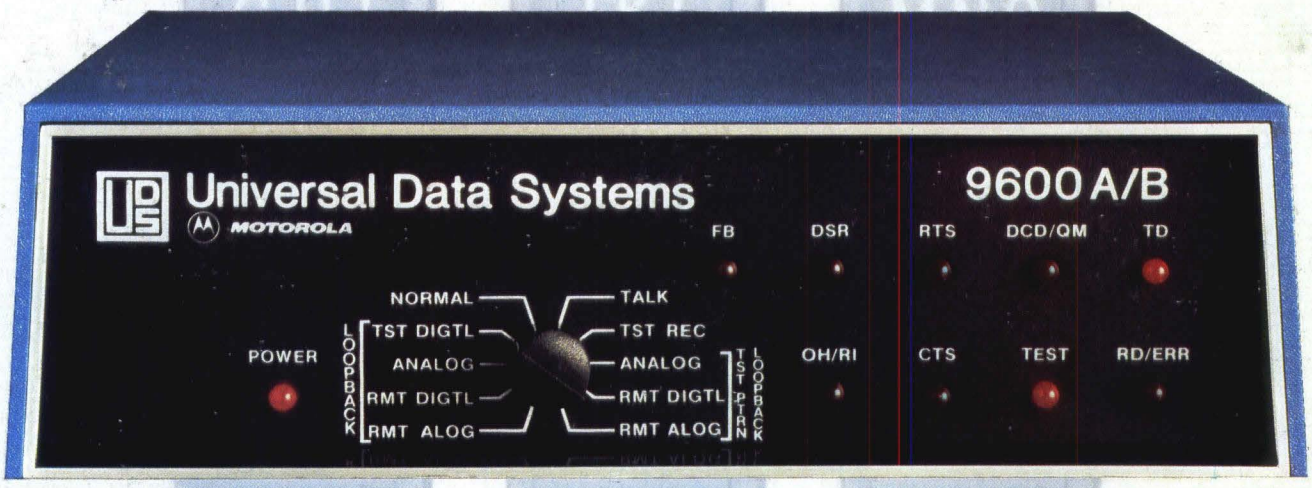

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