SEPTEMBER 1987

Mini-Micro Systems®

THE MAGAZINE FOR SYSTEMS INTEGRATION

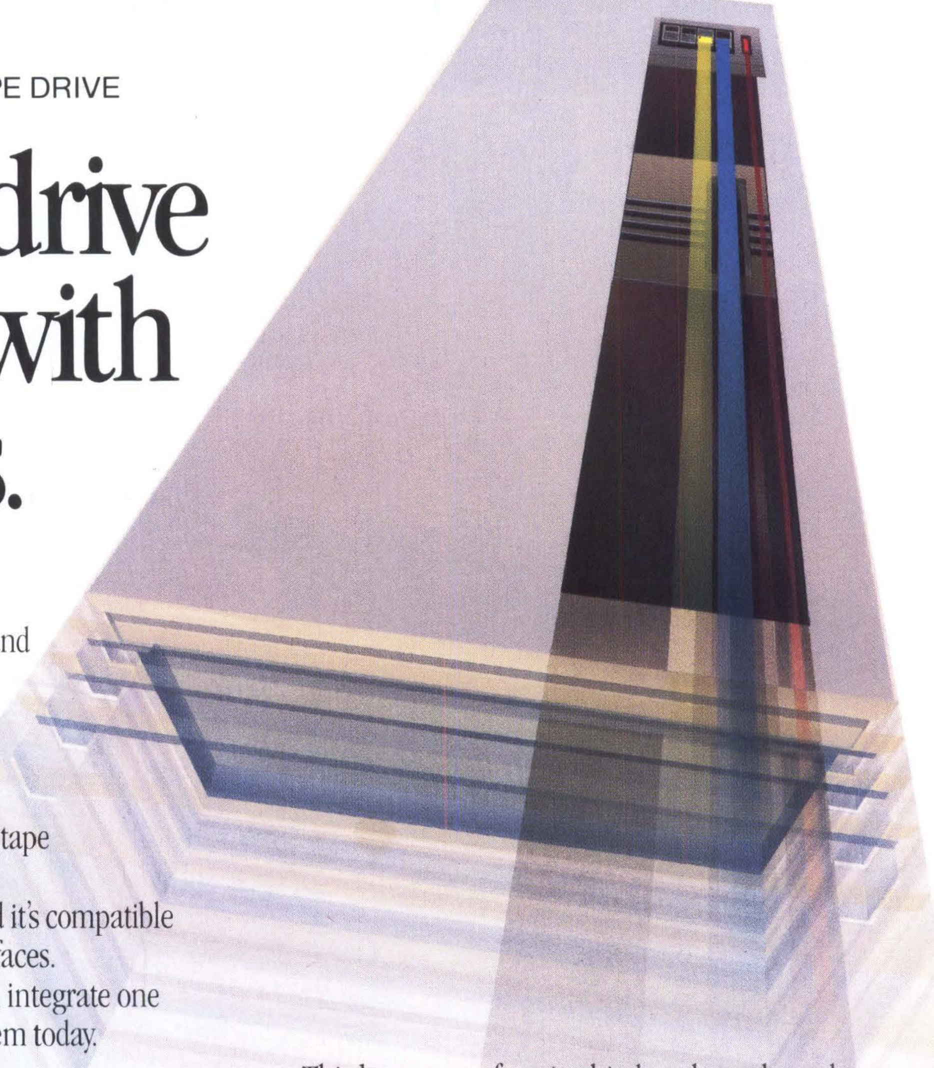
A CAHNERS PUBLICATION

LANs: state of the unions

Plus:
Fiber optics
Multiplexers

FUJITSU'S GCR STREAMING TAPE DRIVE

The tape drive that flies with the Eagles.



You know the Eagle Disk Drive.

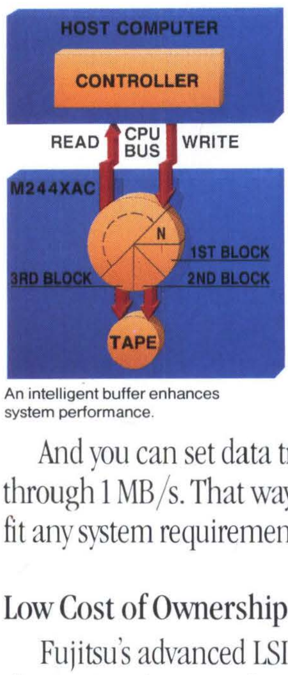
It's second-to-none in performance and reliability.

Did you also know a back-up system exists that matches those impeccably high standards?

The M244X series ½″ GCR streaming tape drive. From Fujitsu America.

The perfect back-up for the Eagle. And it's compatible with STC, Pertec/Cipher, and SCSI interfaces.

So you can integrate one into your system today.



An intelligent buffer enhances system performance.

A Buffer Adds an Extra Edge.

An intelligent 256K buffer dramatically increases the performance of our GCR tape drive. You get block sizes, ramp times and data transfer rates that are all operator selectable.

And you can set data transfer rates from 60 KB/s through 1 MB/s. That way, you can optimize the drive to fit any system requirement.

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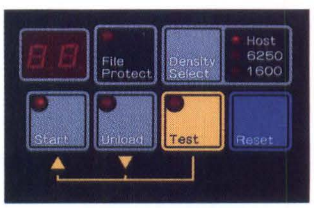

Operator panel displays fault codes for easy troubleshooting.

Fujitsu's advanced LSI electronics eliminate high failure rates.

In fact, our GCR tape drive utilizes automatic error detection to assure data integrity. Diagnostics isolate system faults and eliminate preventative maintenance. All this to give you an incredible 8,000 hours MTBF.

This keeps cost of ownership low throughout the life of your entire system.

Call today for more information. On this or any of our world famous family of data storage products, including Winchester, tape, optical and flexible drives. 408-432-1300.

Or write Fujitsu America, Computer Products Group, 3055 Orchard Drive, San Jose, CA 95134-2017.

Then soar with the Eagles.

A COMPANY WITH CHARACTER AND DRIVE

FUJITSU

FUJITSU AMERICA
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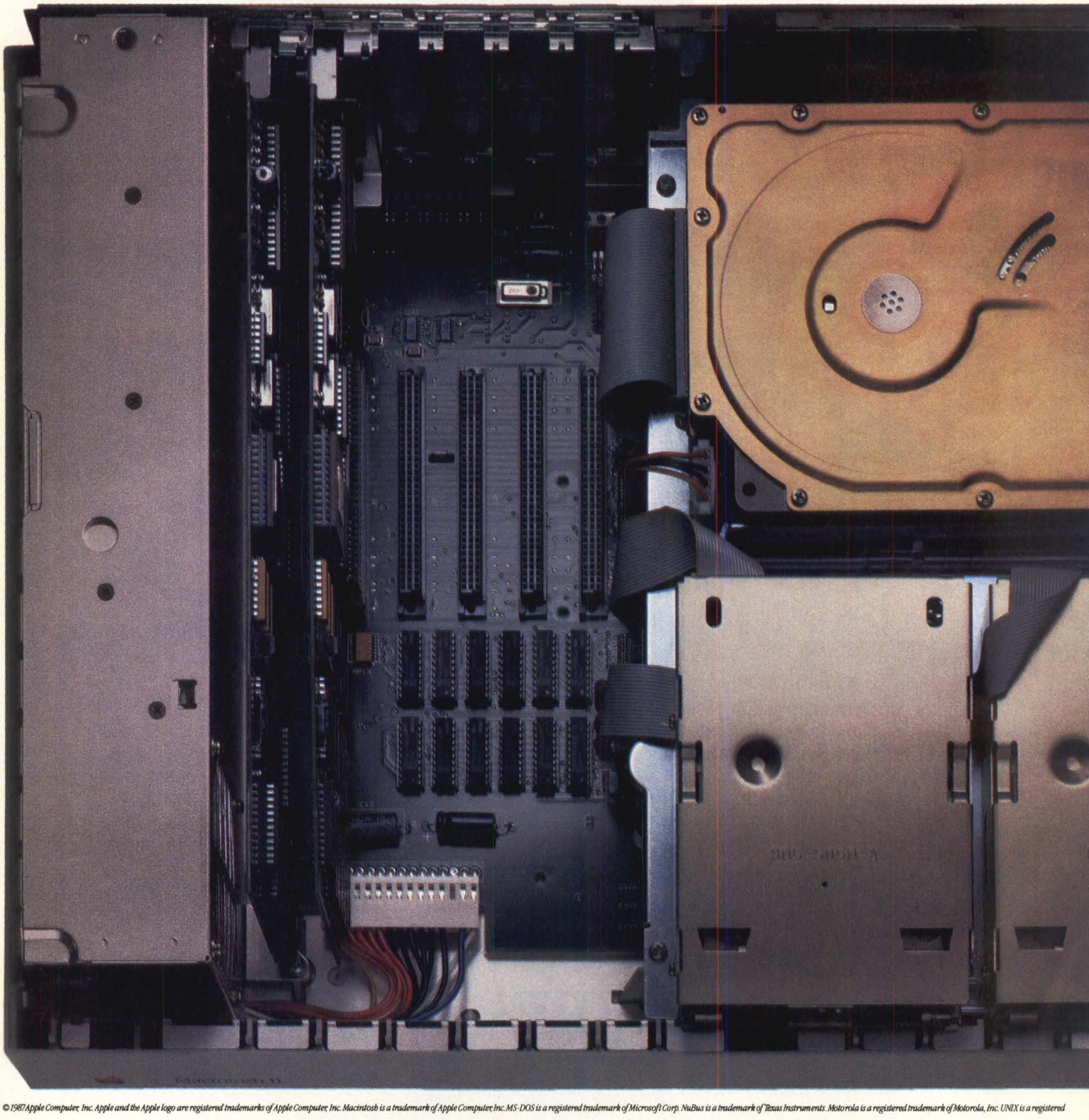
CIRCLE NO. 1 ON INQUIRY CARD

An open invitation to VARs.

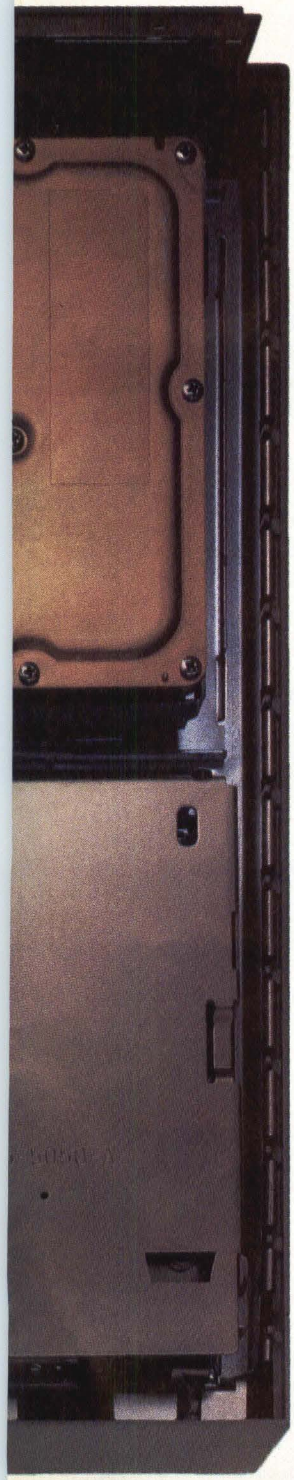


As a VAR, you undoubtedly find increased power very inviting.

Which is why Apple® keeps bringing you more powerful tools to help you build more sophisticated systems.

Our latest leaps in technology, the Macintosh™ SE and Macintosh II personal computers, are two prime examples.

They're designed to let you put together systems that offer more speed and graphics power. And are actually more affordable and easier to use.



Look at the SE, for instance. It comes with up to four megabytes of memory and an optional built-in 20-megabyte hard disk.

And you can add value easily, using its internal expansion slot, external SCSI port and two RS-232 serial ports.

The Macintosh II, on the other hand, offers a VAR even more. It's a full 32-bit machine, based on the new generation Motorola 68020 processor and 68881 math co-processor.

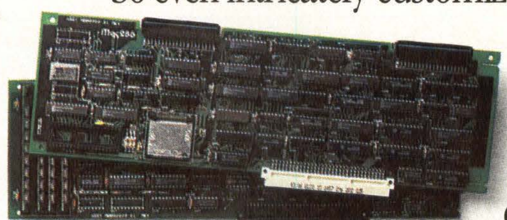
The latter of which can perform complex calculations up to 200 times as fast as conventional computers.

It comes with six internal expansion slots. Memory up to eight megabytes on the motherboard. And hard disk storage of 20, 40 or 80 megabytes.

But even better for your business as a value added reseller, the Macintosh II can be set up to run other operating systems. Like MS-DOS and AT&T UNIX.*

And because its slots are NuBus technology, they not only move information much faster—they have the good manners to "configure" themselves.

So even intricately customized systems are easy to assemble. With no DIP switches to set.



Build your own Macintosh II. Expansion cards let you add new power, such as the ability to run MS-DOS programs.

As for the options you can add, both the SE and II offer some formidable choices.

From co-processor and communications cards to cards that are custom-built for the systems you design.

With the Macintosh II, you can even add a video card for a color monitor that lets you work with 256 brilliant colors from a palette of over 16 million.

Of course, we're offering VARs a lot more than a choice of powerful computers.

We have special programs that make it easier to get the equipment you need for system development. As well as sales programs to help you promote and develop your market.

We can also keep your business healthy with promotional programs and after-sale support. And provide complete Apple product training.

For information about Apple's VAR programs, just call 800-538-9696, ext. 505.

We'll tell you more about how the Macintosh SE and Macintosh II make it easy to add new features. And new customers, too.

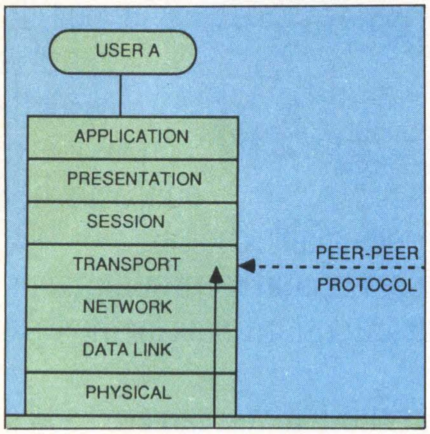
The power to be your best.™

*trademark of AT&T information systems.

Mini-Micro

THE MAGAZINE FOR SYSTEMS

A CAHNERS PUBLICATION



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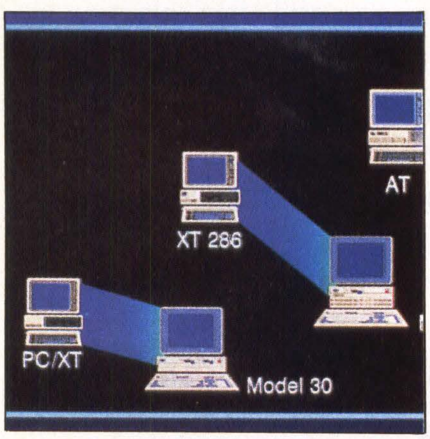

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TCP/IP popularity to skid. . . if vendors adopt OSI 21

Can a more than 10-year-old set of connectivity standards hold up in the face of a super-connectivity standard like OSI? Not in the long run, but there is still some life in an aging, but useful, TCP/IP.

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While most desktop scanners have Japanese roots, they are sold primarily through OEMs in the United States—a connection more and more Japanese scanner manufacturers would like to explore, says a report by CAP International Inc.

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They're 40 percent lighter, 50 percent smaller, and 25 percent faster than conventional electromagnetic printheads. They are also cheaper, all of which should appeal to U.S. OEMs.

IMPACT PS/2: SOFTWARE

Jury still out on OS/2 as developers await final pieces 38

Both IBM and Microsoft are pushing software developers and third-party manufacturers to jump on the OS/2 bandwagon. The only problem is that OS/2, right now, is still more talk than reality.

IMPACT PS/2: MICRO CHANNEL ARCHITECTURE

Micro Channel maze prompts developers to seek alternatives 44

While IBM is betting on the Micro Channel as the backbone of its PS/2 series, third-party board manufacturers point to its limitations, and the cost of leaping over its proprietary hurdles.

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To help you understand LAN's increasing popularity, herewith is a guide to their diverse technologies, topologies, protocols and standards, along with comparisons of the different networks

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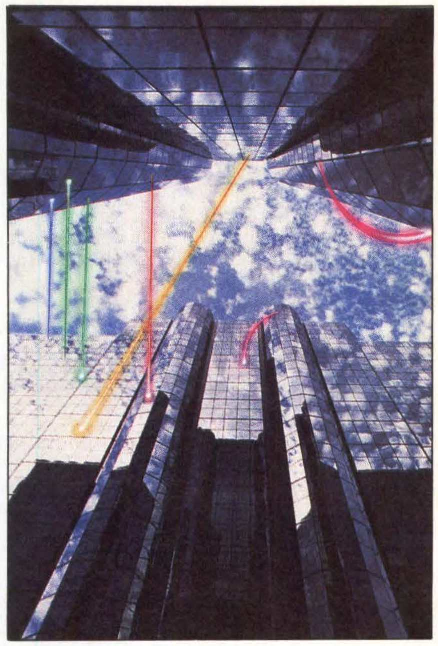

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*Appearing in the European edition only

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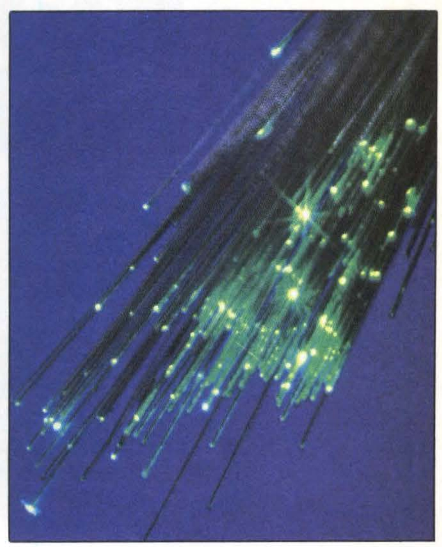

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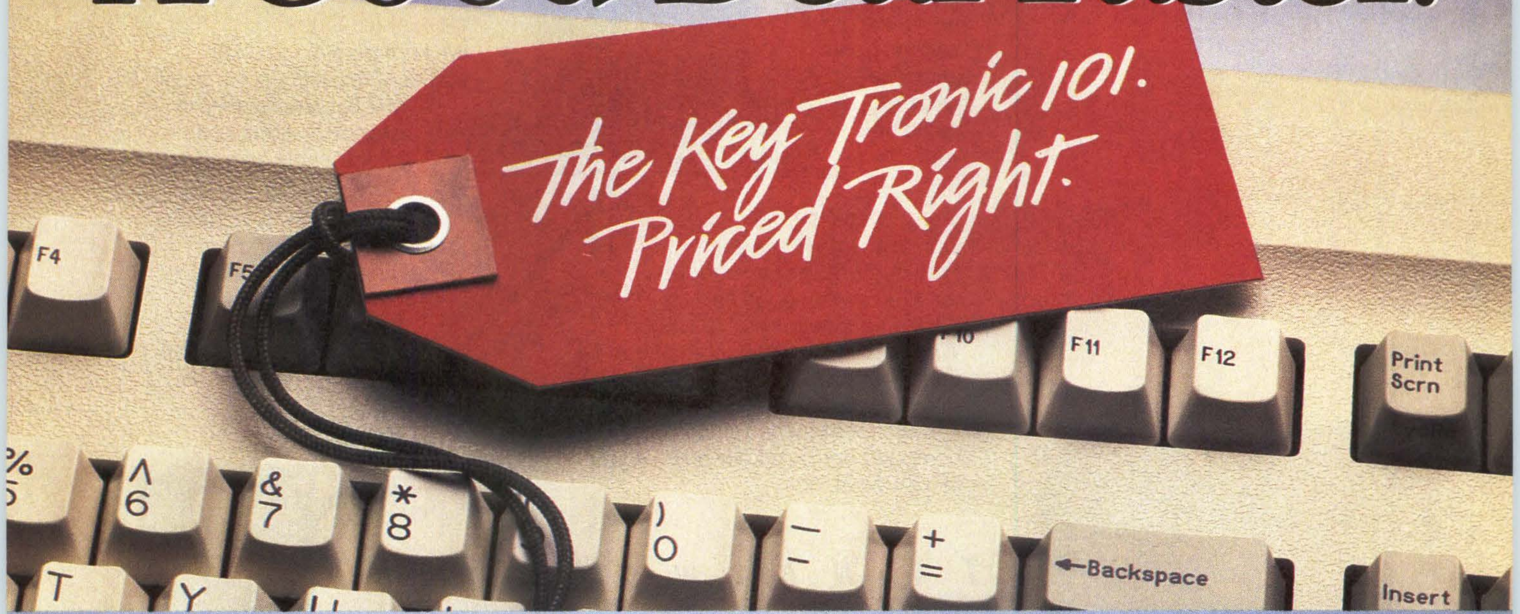
A Good Deal. A Good Deal Faster.



Right now Key Tronic has thousands of top quality 101 keyboards in stock at competitive prices.

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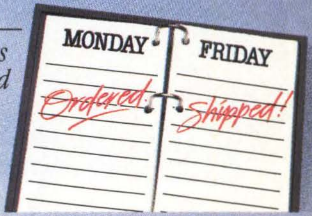

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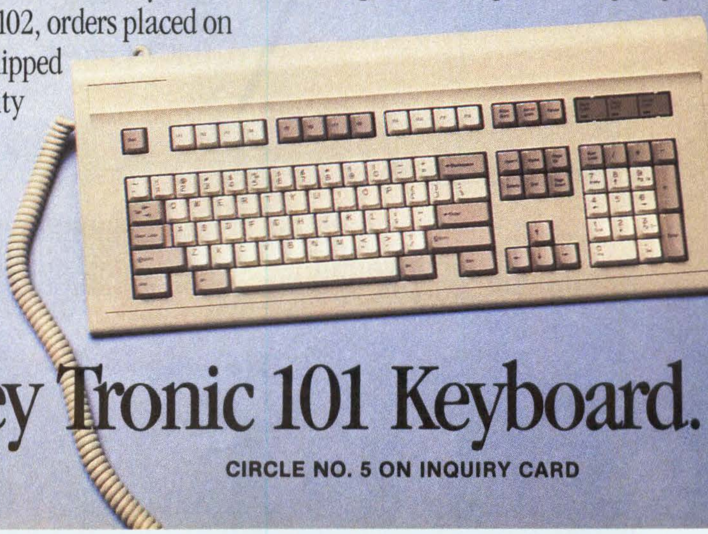


The Key Tronic 101 Keyboard.

CIRCLE NO. 5 ON INQUIRY CARD

Introducing Equinox's New Data PBXs.

More for Less.

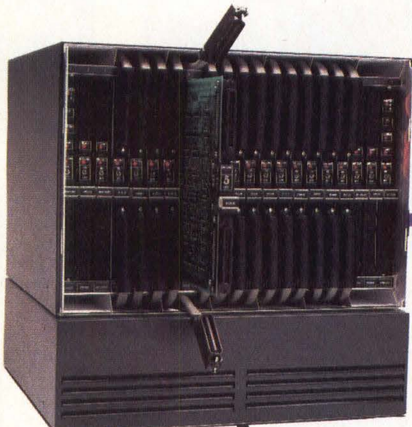
Since 1984 our first generation Data PBXs have provided reliable data switching and connectivity solutions. After shipping over 1000 systems we learned what was good and what could be made even better. Then we set about designing our second generation. Here's what we came up with:

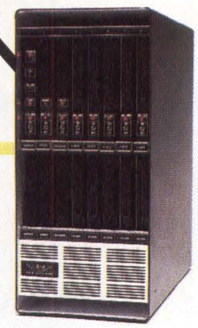
More Throughput
Our new Data PBXs each provide 25 Mbps throughput for 660 simultaneous full duplex connections at 19.2 kbps. With double the throughput of our first generation, and more than any other comparable Data PBX; that's enough for all the terminals, PCs, computer ports and peripherals you can throw at them.

Less $
Reduced manufacturing costs, due to VLSI technology allowed us to lower prices on our second generation Data PBXs. More features for less money means maximum value for your data switching dollar.

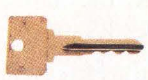
More of the Same
We kept the Equinox hallmarks of reliability, easy installation, comprehensive wiring solutions and user friendly operation.

We based our second generation on the same architecture as our first generation DS-5 and DS-15 Data PBXs. They look the same, configure the same, even the names have stayed the same.





More Connectivity
T1 links join individual Data PBXs to form large multi-node Local or Wide Area Networks supporting many thousands of lines. You can use twisted-pair, telco, microwave or fiber optic links to solve virtually any connectivity problem.



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Dialback Security available as an option shields your network from unauthorized access by dial-in users. This feature lets you restrict dial-up access to designated users at pre-defined locations during specified time periods.

So if you already own an Equinox Data PBX, all the features of our new generation can easily be added to your network.

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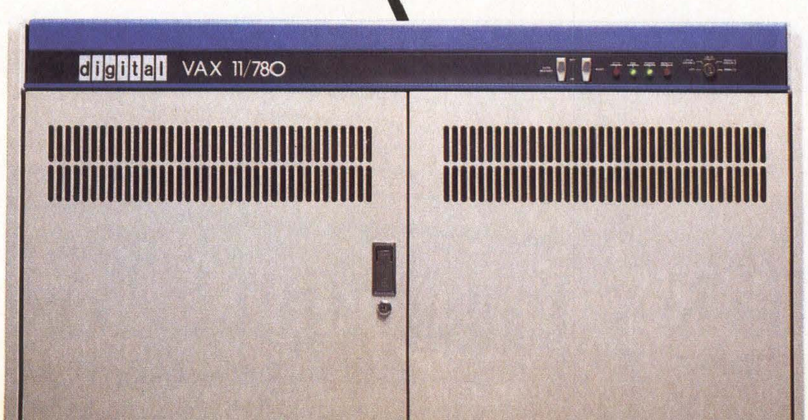
Equinox Systems Inc.
14260 S.W. 119th Avenue
Miami, FL 33186



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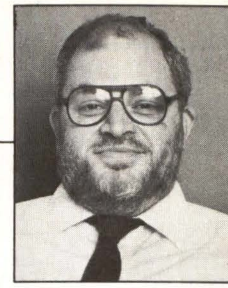
CIRCLE NO. 6 ON INQUIRY CARD

EDITORIAL



A BLESSED EVENT

Once upon a time there was a beautiful princess whose name was Manufacturing Automation Protocol. Her friends called her MAP. She was married to a handsome but recently impoverished prince called General Motors. Everybody called him GM. The prince and princess had two children. One was MAP 1.0 and the other was MAP 2.0. For many years, the prince and princess tried to have a third child, which they planned to call MAP 3.0, but for one reason or another they just couldn't seem to do it.

In their kingdom, which was called the Kingdom of Factory Automation, were many little children who came to the Castle every day to play with MAP 1.0 and MAP 2.0. Although they loved the two MAPs, these little children longed for the birth of 3.0. Everybody said 3.0 would be the playmate of their dreams.

Now, it happened that in the kingdom was a powerful sorcerer called Olsen. Besides being powerful, Olsen was a very rich sorcerer as well. Many years before, he had taken up alchemy and learned to make a magic wand which he called DEC and which, when he waved it, changed hardware and software and firmware into gold. For many years, Olsen was beloved of the prince and princess. He said he loved their babies, and he even made toys for them and all the other children in the kingdom to play with.

Then one day, when the prince and princess were trying to have MAP 3.0, Olsen went to a bunch of evil gnomes called newspaper and magazine reporters and said some shocking things. He told them he didn't think it was really very important, after all, if the princess ever gave birth again. Olsen was the godfather of another baby, called Ethernet. Olsen said this baby could do everything MAP 3.0 was supposed to be able to do. So, he said, there was no need for MAP 3.0 at all.

The prince and princess were shocked. They said, "Goodness gracious, what is it that the Great Sorcerer is trying to do?" They went to some of the wisest men and women in their kingdom and asked them what the Great Sorcerer was trying to do, but these wise people had no idea. They asked astronomers and seers and systems integrators and VARs and sophisticated end users, but none of these professed to have a clue.

In desperation, the prince and princess went into the dank caves of the kingdom and asked the evil and ugly gnomes who lived there what Olsen was trying to do. The gnomes had no more of a clue than anyone else, of course, but their business was to pretend that they did. Their business also was to stir up trouble. So they told the prince and princess that the Great Sorcerer hated their babies and didn't want them to have any more.

The princess cried. The prince became angry. Passions were stirred. The prince roared, "By gum! We're going to have that baby!" Soon, the princess told the prince: "Honey, I'm so excited. I've just come from the doctor—you know, Dr. MAP Users' Group—and he says I'm pregnant." "Sweetheart," trilled the prince, "that is wonderful news. When is the baby due?"

"The Blessed Event will be next June," the princess responded, sitting on the prince's lap and kissing him fondly. "The doctor says he'll perform the delivery at the Convention Center in Baltimore so that everybody, especially Sorcerer Olsen, will see how beautiful the baby is. We'll give the birth a special name. We'll call it the Enterprise Networking Event."

When they heard the news, all the good people of the kingdom were very happy. The children especially were happy. They cheered, "Rah! Rah!" The Sorcerer was not heard to say anything.

But when the evil gnomes called magazine and newspaper reporters heard about the Blessed Event, they were very unhappy. "Horrors!" they cried. "What will we write about for the next year? Even more important, how will we stir up trouble?" The children said, "That's just the point. The Blessed Event is months away. Maybe now everybody, especially you ugly and evil gnomes, will shush up for awhile and give the rest of us a little peace."

And they did. And everybody lived happily ever after—or, at least, until June of 1988.

Moral: If you want peace, don't talk to gnomes.

James F. Donohue
Managing Editor

LETTERS

PRICE CORRECTION

To the editor:

On Page 85 of your April 1987 issue ("Boards, software enrich laser printers"), the price of the OmniLaser Model 2108 from Texas Instruments was erroneously listed as $3,995, when in fact it is $5,995.

Cathy W. Sang
Data Systems Group
Texas Instruments
Austin, Texas 78769

MORE DANG SLANG

Editor's note:

In the "Letters" section of the June issue, a reader from France, Solveig Albrand, complained about the use of American slang in some articles in *Mini-Micro Systems*. His letter drew these responses:

To the editor:

Mr. Albrand complains about the use of slang because it is difficult for non-English (non-American English) speaking people. He has a valid point. However, I feel that there are even better reasons to *not* use slang in technical publications.

First, slang is regional. The same groups of letters in the same order can mean different things to different people.

Second, slang is appropriate only within quotation marks—even in fiction.

Third, communications between humans is difficult at best, and the written word is never the best means of communications. So, *don't obfuscate.*

Fourth, in all matters, aim higher than the general level. Maybe we can reach higher rather than sink lower.

Hal Lines
TRW Inc.
Ogden, Utah 84401

To the editor:

I note that even the gentleman who initiated the letter [Albrand] found the original article to be "the last straw." It is nice that we all do appreciate a good metaphor, whether or not we need to know about the rest of the straw on that proverbial camel's back.

Pam J. Gammarano
Staten Island, N.Y. 10314

TOO, TOO PS/2

To the editor:

In several places in your article on the IBM [Corp.] PS/2 ("IBM PS/2 sparks new fires: vendors, integrators scramble," June, Page 37) you mention that the PS/2 Model 50 processes data twice as fast as the PC/AT. This is simply not true. The Model 50 and 60 both have a 16-bit bus, the same size as the bus on the PC/AT. And the speed of the models 50 and 60 is 10 MHz; 8 MHz for the PC/AT. So, at best, the performance increase is 25 percent (10 MHz vs. 8 MHz).

The article also mentions that the Micro Channel [bus] supports twice as many DMA [direct-memory access] channels as the AT. While it is true that the Micro Channel will support 16 channels, the Model 50 and the 60 will control only up to eight channels. Control of the remaining eight channels is left up to the OEM/system integrator. If more than eight channels are required, then an add-on expansion board—not provided by IBM—must be designed and installed.

There are several features to the new line of IBM machines that should have been mentioned. The new Micro Channel architecture allows for multimaster operation, hardware fault diagnosis and isolation, and software control of hardware configuration. The ability to add bus masters to the Micro Channel will enable users to upgrade their systems with specialized processors and high-performance devices.

System integrators and third-party installation/maintenance organizations will love these machines for their simple installation procedures and clean hardware design. Hardware conflicts in memory space, channel allocation and interrupt assignment are all resolved in real time by the configuration software. In short, the hassles of setting up or upgrading PCs have been elimiated. Nice.

Unfortunately, one of the major drawbacks of the PS/2 line was not even mentioned. That is the use of 3½-inch flexible disks, and with two differing formats, no less. The changeover from 5¼-inch media to 3½-inch media is a major undertaking, and it won't happen overnight. In fact, Compaq Computer [Corp.] is steadfast in its support of the 5¼-inch standard.

One final comment. The ease of manufacture, the high level of semiconductor integration and the clever engineering will enable IBM to get down and dirty on pricing, if clone manufacturers ever become a threat to the new line.

John Draut
Founder/CEO
Jedesys
Menlo Park, Calif. 94025

Editor's response:

While it is true that the IBM PS/2 models 50 and 60 both have a 16-bit data path, and are therefore limited in the amount of data that can be transferred to and from memory, IBM's Micro Channel does a lot more than act as a main data highway. For one thing, the Micro Channel supports a maximum direct memory access transfer rate of 3.33M bytes per second in burst transfer mode. Unlike the PC/AT bus, the Micro Channel can also be controlled by outside devices like intelligent I/O controllers and processors, which synchronize the flow of data and boost overall system performance, despite the 10-MHz clock speed of the Intel Corp. 80286 microprocessor.

As to the stated increase in speed over the PC/AT, these figures are supplied by IBM and admittedly may be maximum performance rates and not the norm under less than laboratory conditions.

The Micro Channel, itself can support up to 15 DMA channels, which IBM claims is more than double the previous capacity of the standard PC. While the models 50 and 60 do not yet take full advantage of the Micro Channel, plans are reportedly in the works to bring these systems up to speed soon. Right now, OEMs and system integrators are a viable alternative.

Once you've bought our CIT224 alphanumeric VT220-compatible terminal, you still have one more decision to make: What to do with the box.

We suggest you throw it away.

You see, the CIT224 terminal's reliability is so good, it makes no sense worrying that it may have to be returned.

That's because its "dead-on-arrival" rate is less than 1%. And there's no other VT220-compatible terminal around with a lower DOA rate.

And when it comes to performance, no other VT220-compatible terminal stacks up to the CIT224's list of features.

Like an easy-to-see 14-inch soft white, amber or green screen, a 7 x 15 character matrix, 11 set-up menus and 45 programmable function keys. Couple this with proven 100% VT220 emulation and a high-tech design cabinet, and you've got the best price-performance ratio of any VT220-compatible terminal on the market.

Improve your bottom line with the CIT224 terminal. And throw away the box.

For more information on the CIT224, contact CIE Terminals, a C.Itoh company, 2505 McCabe Way, Irvine, CA 92714; or call (714) 660-1421 or our toll-free number (800) 624-2516.

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BREAKPOINTS

APPLE BEEFS UP MAC WITH MULTITASKING OPERATING SYSTEM

The new multitasking operating system for Apple Computer Inc.'s Macintosh computers will be shipped with all new Macintoshes beginning late this month. Multifinder, which marks the Cupertino, Calif., company's first foray into mutitasking, allows users to run up to 30 applications at the same time. Systems equipped with add-in boards such as the Mac 286 from AST Research Inc. will be able to move data between MS-DOS and Macintosh applications that are executing concurrently. Users who already own a Macintosh II, SE or Plus can upgrade to the multitasking operating system for $49.—*Mike Seither*

START-UP'S NUBUS BOARDS BOAST TRUE COLOR FOR MAC IIs

Start-up RasterOps Inc. of Cupertino, Calif., has started shipping the ColorBoard 1/104, the first in a series of display processor add-ons for the Apple Computer Inc. Macintosh II. The $2,800 NuBus-compatible board provides 16.7 million colors and 1,024 by 768 pixels, and it plugs into any Macintosh II slot. The company sells through Apple's OEMs and VARs.—*Dave Simpson*

NOVELL TO ANNOUNCE 80386-BASED FILE SERVER

Expect Novell Inc., Provo, Utah, to unveil a file server based on the Intel Corp. 80386 soon; probably before the end of the year. But a version of NetWare for 80386 networks, to be called NetWare 386, won't be available until next year. Novell's corporate planner, Craig Burton, says reports that the 386 file server and operating system will be priced under $2,000 are wrong. Sources say the 386 file server and operating system will support up to 200 network nodes, about twice as many as the current version. Meanwhile, the first operating system designed for 80386 networks—VINES/386 from Banyan Systems Inc., Westboro, Mass.—is scheduled for shipment in November. —*Jim Donohue*

INDUSTRIAL COMPUTER FEATURES MACINTOSH II COMPATIBILITY

Automatix Inc., Billerica, Mass., has introduced an industrial computer that is 100 percent compatible with Apple Computer Inc.'s Macintosh II. The new system, called the AI 90, employs open NuBus architecture and a Motorola Inc. MC68020 32-bit processor. Standard peripherals include a 3½-inch, 800K-byte flexible disk drive and a color or monochrome monitor with a 640-by-480-pixel resolution. Onboard RAM ranges from 1M byte to 8M bytes. Optional software support for MS-DOS and UNIX programs is supplied. The computer is priced at $8,500.—*Megan Nields*

TEK SHIPS THERMAL PRINTER WITH BUILT-IN INTELLIGENCE

Tektronix Inc., Wilsonville, Ore., this month begins shipping the 4693D color printer. Based on thermal wax technology, the 300-dpi device features a four-pass printing technique and a palette exceeding 16 million colors. Differentiating the printer from similar units is built-in image-processing intelligence: a Motorola Inc. MC68020 that can handle up to 2,048 by 1,536 by 24 pixels at a speed of 800K bytes per second. The 4693D costs $7,995; with an add-on rasterizer, $12,995.—*Dave Simpson*

SE RISC PROCESSOR ANNOUNCED BY CELERITY

A new RISC machine for the scientific-engineering community is being an-

nounced this month by Celerity Computing, San Diego. The processor, the 6000, will be in beta test through the end of the year, with production shipments scheduled for the first quarter of 1988. Key specs include Berkeley UNIX Version 4.3 support, 64-bit multiprocessor architecture, one to four scalar processors (or one or two pairs of vector/scalar processors), and 12 MFLOPS total throughput. Prices range from $285,000 to $500,000.
—*Dave Simpson*

TAKING THE RISC: RIDGE UNVEILS NEW SUPERMINI

Look for a new top-of-the-line RISC-based superminicomputer from Ridge Computers at the end of this month. The model 5100 uses parallel instruction execution to run at 14 million Whetstones per second in floating-point mode. It will support up to 128 users simultaneously and provide 144M bytes of main memory, expandable to 1G byte. The Santa Clara, Calif., company claims the machine achieves 14 times the performance of a Digital Equipment Corp. VAX-11/780 in integer operations. A product that upgrades existing Ridge 3200 computers into 5100 units will also be introduced. Prices will range from $109,000 to $148,000, depending on the configuration. Volume shipping is scheduled for 1988.—*Megan Nields*

EMERALD PACKS 2.2G BYTES ON TAPE CASSETTE

Using helical-scan recording technology, Emerald Systems Corp., San Diego, stores as much as 2.2G bytes on an audiocassette-size tape cartridge. The company's VAST (Virtual Archive Storage Technology) device uses a 5¼-inch drive. The company showed the system at this month's PC Expo show (Sept. 1-3, New York). Emerald sells through OEMs, VARs and key distributors such as Novell Inc. The drive and DOS software will be available in volume early next month, with a network version due by the end of the year and a XENIX version by the first quarter of 1988. The drive costs $6,995. Kits including five cassettes, each ranging from one quarter of a gigabyte to 2.2G bytes, cost between $250 and $325.—*Dave Simpson*

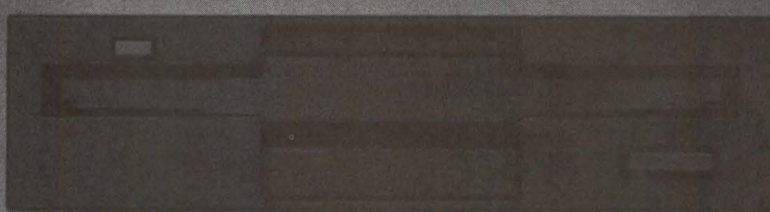
LIQUID CRYSTAL SHUTTER PRINTER AIMED AT HP LASER JET

Data Technology Corp. is getting into the OEM printer business with Casio Computer Co. Ltd. of Tokyo. The first offering by the Santa Clara, Calif., company, which until now has made controllers and disk drives, will be the CrystalPrint VIII, an 8-ppm, 300-dpi printer that lists for $2,495. The printer uses liquid crystal shutter (LCS) technology and is plug-compatible with Hewlett Packard Co.'s LaserJet Series II, but is 33 percent faster, according to the company. Optional cartridges allow it to emulate Diablo, Epson America Inc. and IBM Corp. printers. For OEMs, Data Technology will sell Casio Inc. LCS engines that operate at 6 ppm as well as add-in printer controllers for the IBM PC/XT and PC/AT.—*Mike Seither*

SCSI HOST ADAPTER SPEEDS UP DISK TRANSFER RATE FOR IBM PC/AT

Adaptec Inc., Milpitas, Calif., is expected to unveil a host bus adapter for IBM Corp. PC/AT-type systems in October that will support burst data-transfer rates of up to 10M bytes a second. The company claims that the product is about 40 percent faster than standard disk drive controllers for the AT. The AHA-1540 adapter will be priced at $285 in quantities of 100. The device allows concurrent use of both synchronous and asynchronous SCSI peripherals. In addition, the AHA-1540 features 255 programmable "mailboxes" that

Give Us an Inch.



FD-135 shown actual size.

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hold active commands and data. An onboard processor offloads the host's involvement in I/O tasks by continually scanning the mailboxes and sending information to the appropriate destination.—*Mike Seither*

PS/2 USERS GRIPE ABOUT EXPANSION SLOTS, SYSTEM SIZE

Users of the IBM Corp. PS/2 computer have some gripes, according to Andrew M. Seybold, chairman of the consulting concern, The Seybold Group Inc., Torrance, Calif. The gripes: the Model 50 does not have enough expansion slots (it has three) and the Model 80 is too big a system to fit on a desktop, even though IBM calls it a desktop system.—*Jim Donohue*

FTG SQUARES OFF WITH GRAFPOINT

Going head-to-head with market leader Grafpoint, FTG Data Systems, Stanton, Calif., last week began shipments of version 1.21 of its $695 EMU-TEK Seven Plus software package, which provides IBM Corp. PCs with full emulation of Tektronix Inc. 4107/4205 color graphics terminals. The new version supports a variety of graphics adapters, including IBM's PS/2 VGA.
—*Dave Simpson*

BITSTREAM EXPANDS CUSTOMER BASE FOR FONTWARE

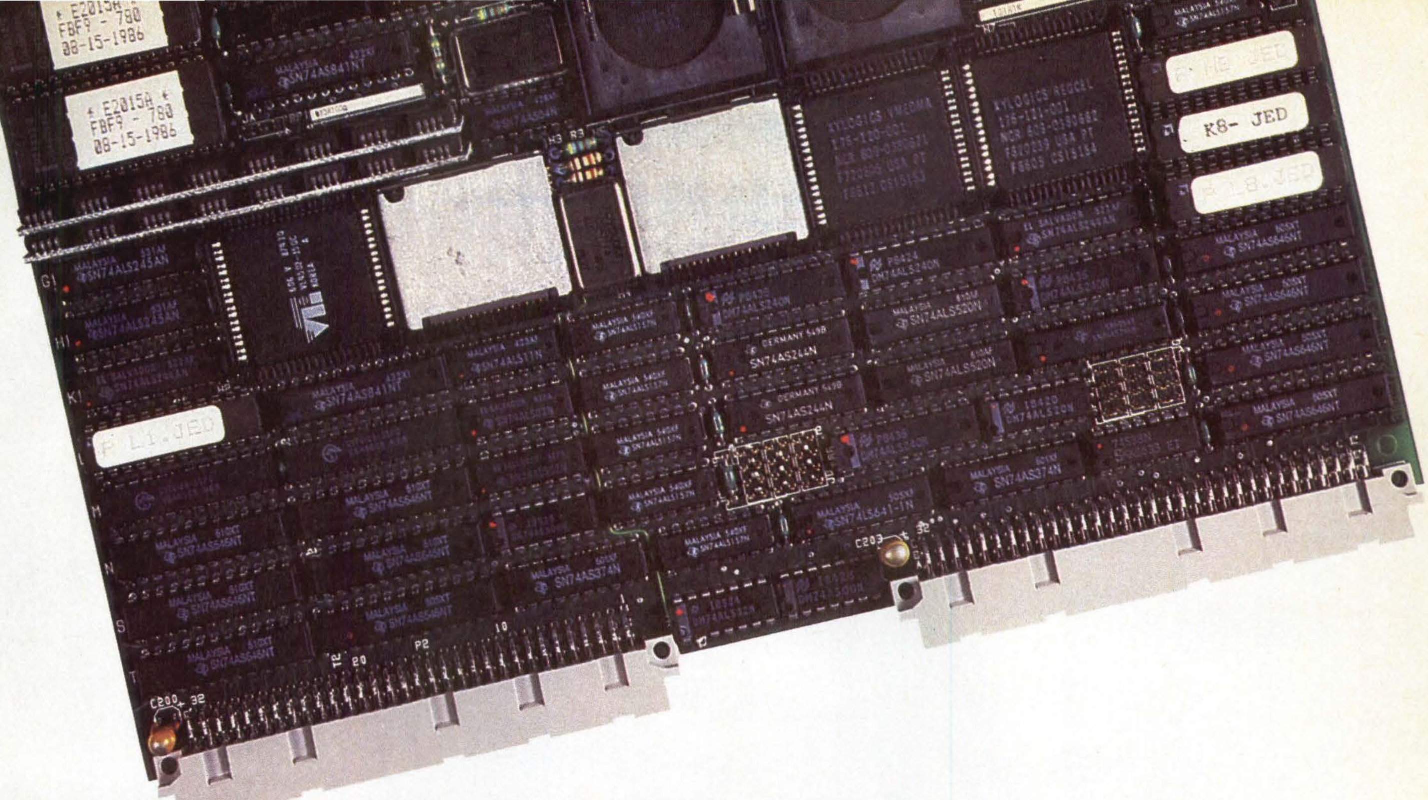
This month, end users join OEMs in being able to buy the Fontware installation program from Bitstream Inc., Cambridge, Mass., which generates bit-mapped fonts on IBM Corp. PCs and compatibles for $95. The program comes in two versions: one for Ventura Software Inc.'s Ventura Publisher, the other for Microsoft Corp.'s Windows. Each program generates fonts from Bitstream's Fontware library—a series of 20 fonts, each in four styles (e.g., roman, bold, italic, bold italic). Fontware offers 80 typefaces, including versions of Times Roman, Helvetica and Century Schoolbook.—*Charles LeCompte*

SUPPLIES OF THERMAL PAPER GET LEAN; U.S. CAPACITY TO EXPAND

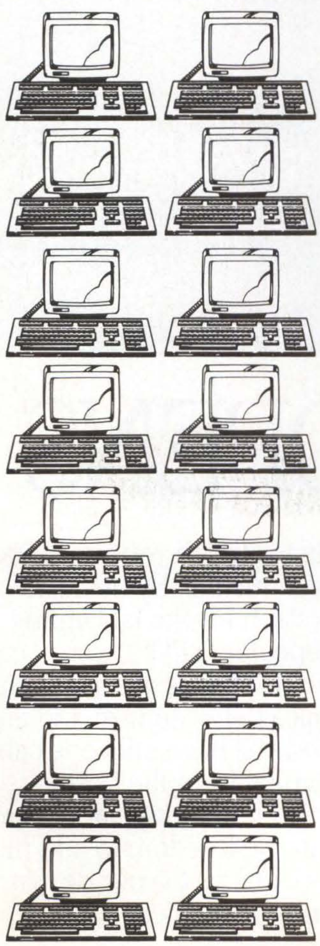
You may be finding thermal paper hard to get. Increasing use in facsimile, bar code labels and industrial and medical imaging has put a strain on supplies. Meanwhile, Japanese vendors like Jujo Paper Co., Tokyo, are said to be cutting back on shipments to the United States, because the rise in the value of the yen against the dollar has trimmed profits. Result: Business at U.S. thermal paper mills is booming. The No. 2 U.S. supplier, Labelon Corp., Canandaigua, N.Y., says sales swelled 50 percent in the first quarter of this year. As supplies tighten, many manufacturers plan expansions.
—*Charles LeCompte.*

TEMPORARY PRODUCTS WILL KEEP DEVELOPERS BUSY OVER NEXT YEAR

With the pieces of OS/2 just now falling into place and with UNIX still five to six years away from being the leading operating system among users, the high-end personal computing market is ripe for products that fill a temporary gap in application software development, according to Terry Colligan, president of Rational Systems Inc., Natick, Mass. For example, Rational has just released a product, called DOS/16M that targets the more than 100,000 serious C language developers, although Colligan admits its lifespan may only be six to 10 months. At that time, OS/2 will kick in, eventually to be replaced by UNIX or some derivative, because UNIX operates on all machines and is familiar to most software engineers.—*Tim Scannell*



16 PORT ASYNCHRONOUS VME CONTROLLER



From The High Performance Disk And Tape Controller Leader Comes The Xylogics 780 VME Bus Asynchronous Controller

A full UNIX TTY interface on Xylogics' 780 controller relieves the processor from the task of "cooking" each character. Because it is hardware tuned to optimize performance, the Xylogics 780 significantly reduces CPU overhead. The 780 supports a terminal transfer rate of 16 full duplex ports at 9600 baud, or 8 full duplex ports at 19.2K baud. Full driver support for UNIX System V and B.S.D. 4.2 is also available.

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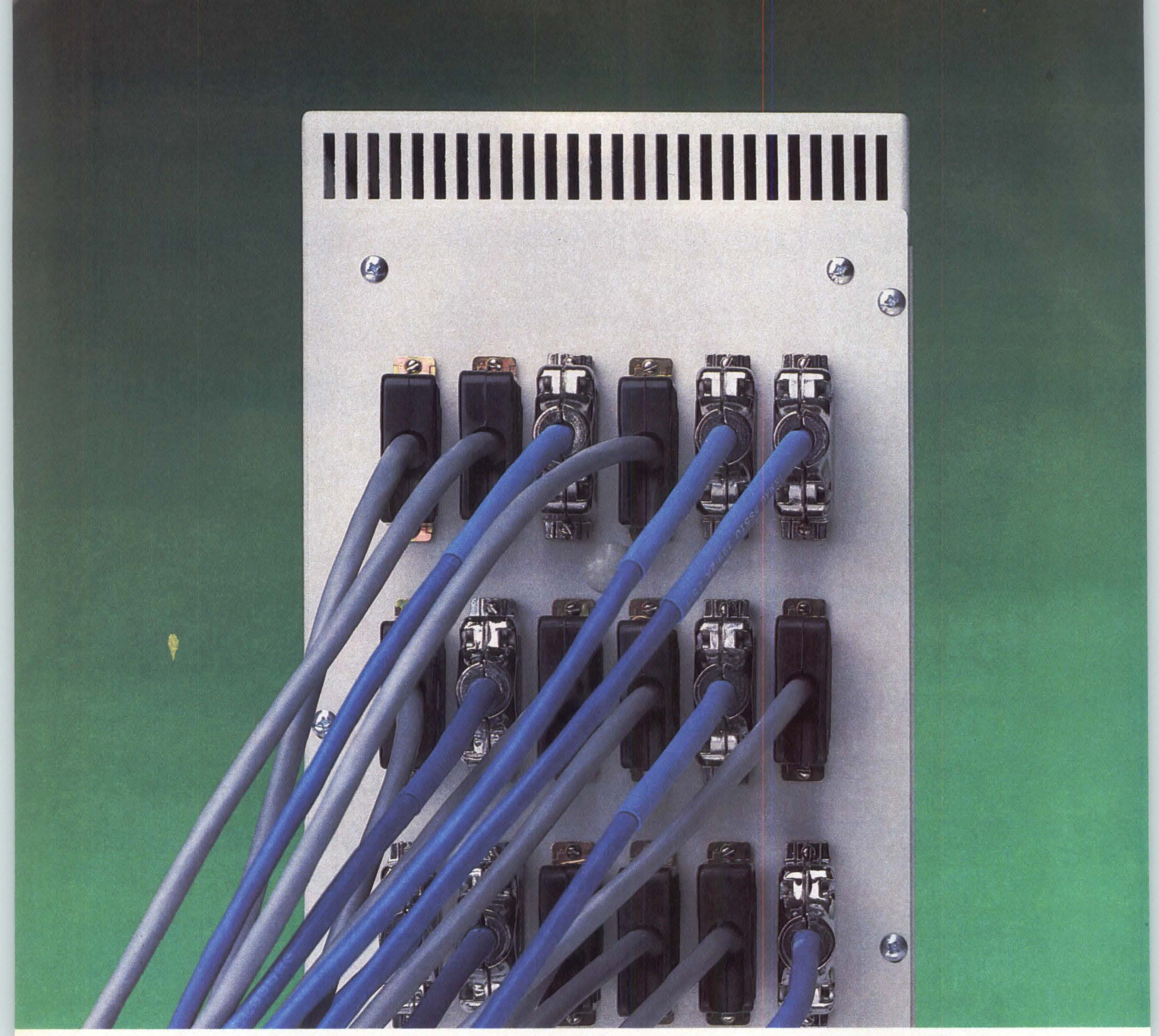

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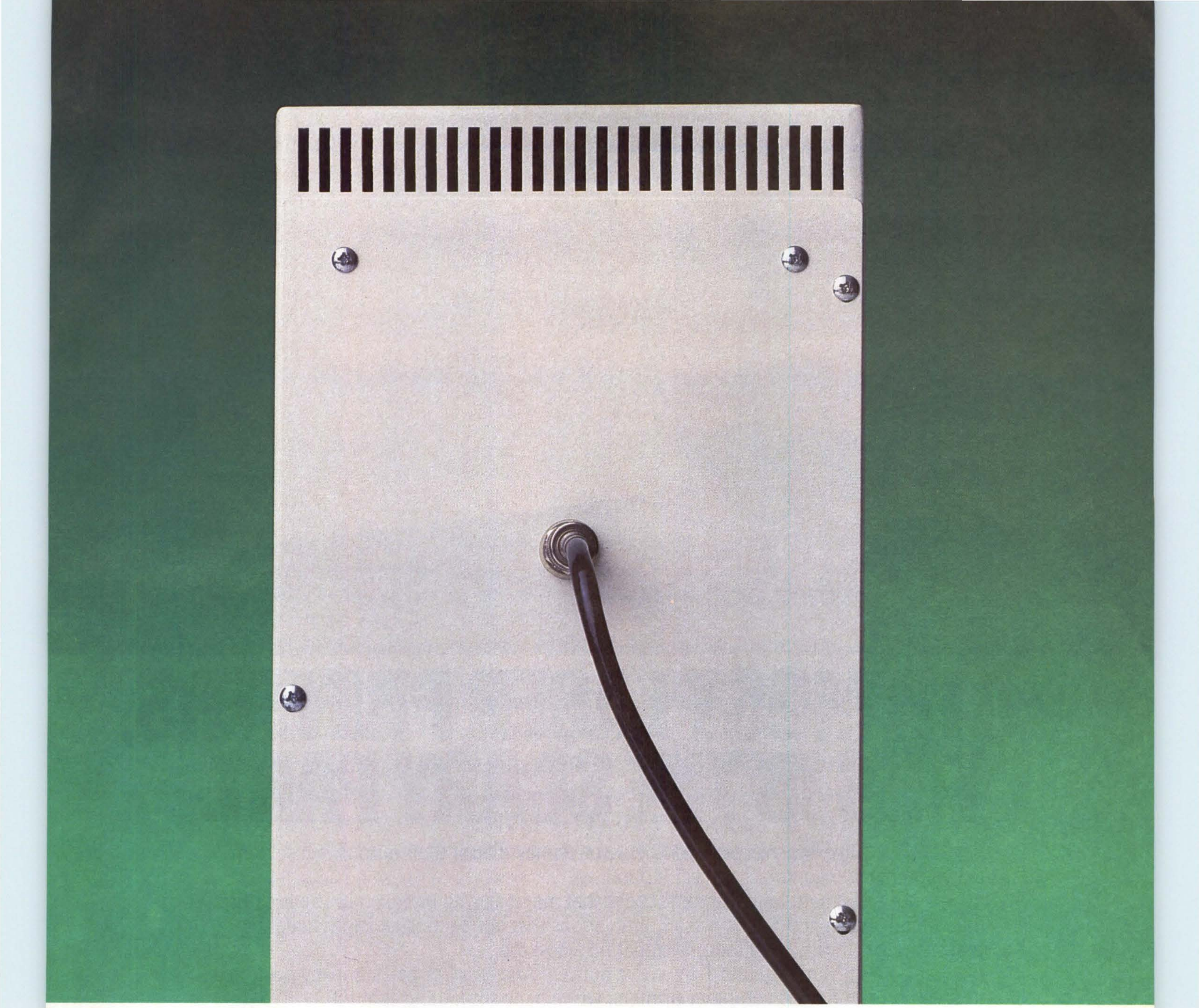

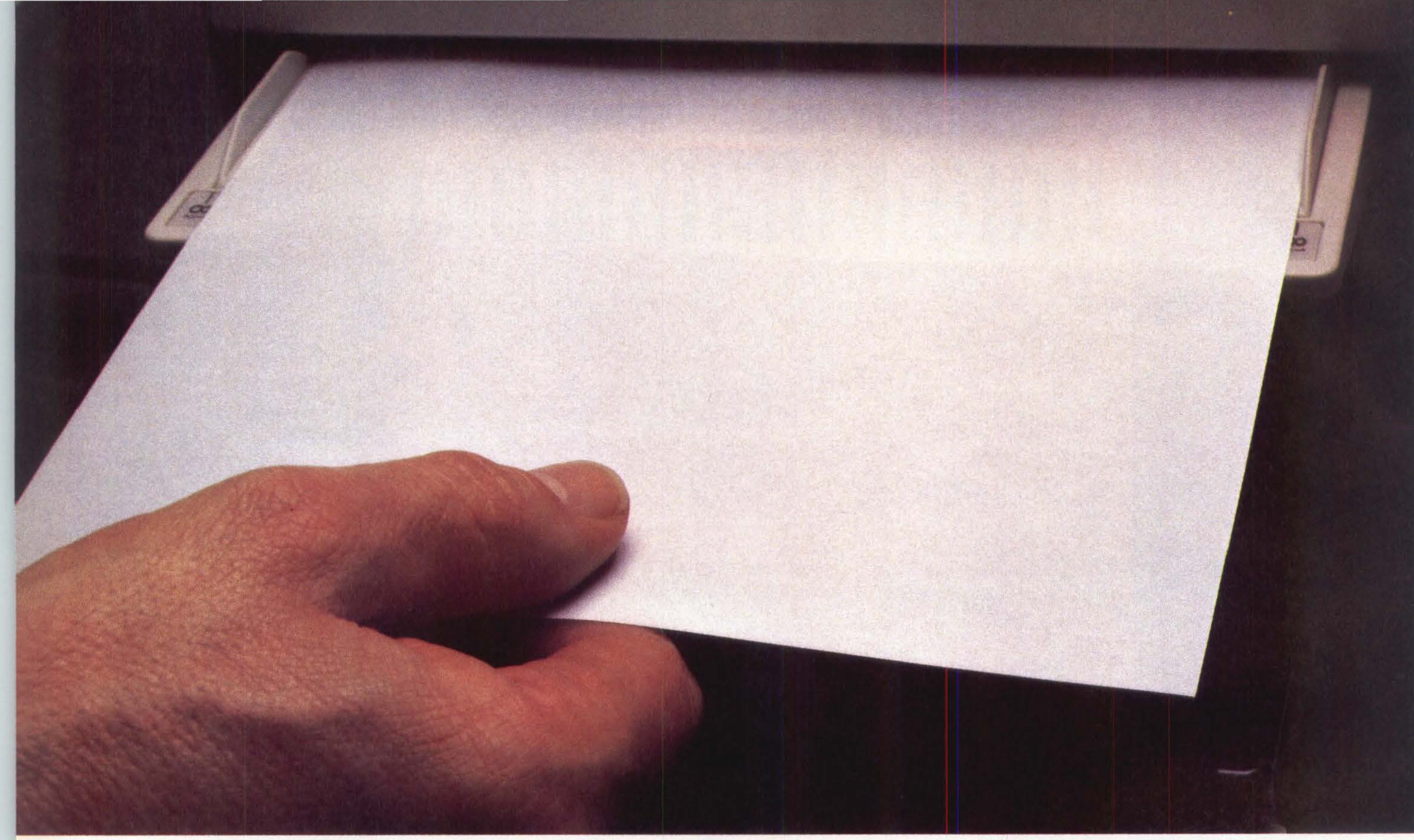

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COMMUNICATIONS STANDARDS

TCP/IP popularity to skid . . .

Tim Scannell, Senior Editor

If something isn't broken, should it be fixed? More important, should it be shelved for something that looks to be better, but is not exactly just around the corner?

These are the questions facing a number of vendors, system integrators and resellers who are busily linking computers and communication networks via a more than 10-year-old set of specifications. The specs were developed by the Department of Defense in an effort to keep government systems on speaking terms. Those wrestling with the old specs are also keeping an eye on the evolution of a new set of rules promoted by the International Standards Organization. These ISO rules could eventually turn their efforts upside down, if some early groundwork is not laid.

The senior set of standards is called the Transmission Control Protocol/Internet Protocol (TCP/IP), and has been adopted by hundreds of system and board manufacturers, making it one of the more prevalent of communication protocols in the $645 million local area network industry. However, since TCP/IP was developed by a government agency, and not by vendor committee, it was never really decided how TCP/IP should be implemented or structured. There are now almost as many versions of the protocol set as there are manufacturers who incorporate it into their products.

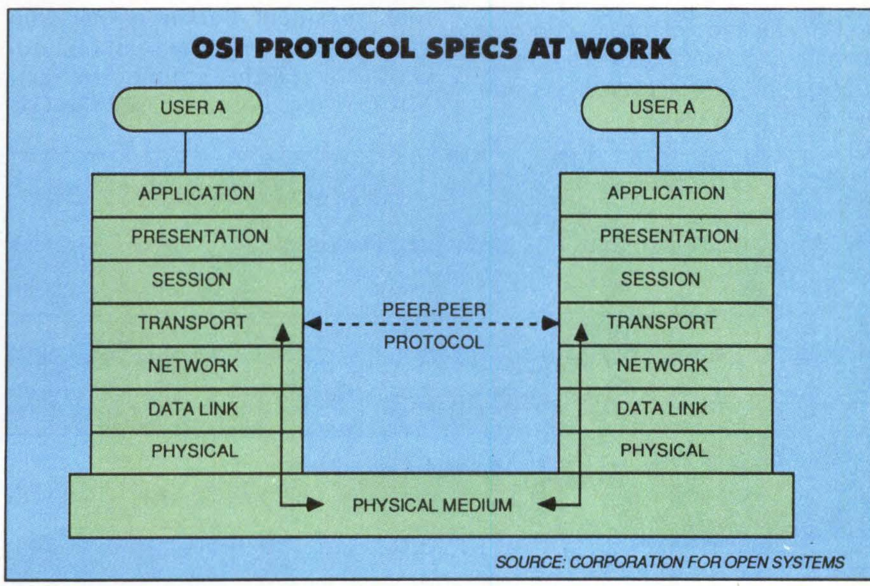
TCP/IP also has some definite limitations that may not affect the connectability of systems, but do hinder the ability of unlike systems to transparently operate with one another. For example, it does not have developed Session, Presentation or Application layers—all of which target the user interface, says Kenneth R. Guy, vice president of Corporate Product Strategy at MICOM-Interlan Inc., Boxborough, Mass. Also, TCP/IP was initially developed for wide-area networks (WANs) and is "much more flakey" when it comes to LANs and to operating within a telephone network.

Standard with no bearer

All of these deficiencies could be corrected, but no one vendor wants to be a "standards bearer." There are too many variations of what should have been a cut-and-dried standard, and there is little profit potential in something that has been virtually given away.

At least one group of vendors—the Coalition for Working Systems—is trying to gather support for some degree of standardization and has even caught the eye of the Defense Communications Agency, which could fund development and support. But, chances are slim that a significant number of vendors will try to revamp something that, for the moment, works fine in terms of connecting similar computers within networks.

In the meantime, leading vendors continue to develop and sell to system integrators and VARs products that adhere to the TCP/IP standard. For example, MICOM-Interlan began volume shipments this month of a group of personal computer connectivity products that are collectively called the TCP Gateway. The products range in price from a controller card that supports StarLAN twisted-pair networks for $199, to an Ethernet multiport control box for $995. In addition, MICOM-Interlan (a $200 million subsidiary of MICOM Systems Inc. of Simi Valley, Calif.) has also been licensed by Digital Equip-



A typical seven-layer *OSI connection between two computer systems would involve peer-to-peer communication with the top three layers dedicated to the user interface and the bottom three focused on the actual data link. This connection could be with two similar or dissimilar computer systems.*

ment Corp. to develop Ethernet-type products for DEC's proprietary VAXBI bus interconnect protocol and DECNet architecture, an indulgence not casually granted by DEC.

"We'll go the way the standards go," says Michael E. Barker, MICOM-Interlan's president, touting the benefits of TCP/IP and downplaying dominating standards such as IBM Corp.'s Systems Network Architecture (SNA).

The way standards eventually go, however, may not be the way most vendors and integrators have planned. In fact, if the ISO and the Corporation for Open Systems (COS) of McLean, Va., have their way—and it seems they ultimately will—they will be faced by an evolving set of rules, called the Open Systems Interconnection (OSI).

Basically, the OSI model is a collection of protocols that lets different computers not only communicate but also interact with one another. Unlike TCP/IP, which has three basic layers of operation, OSI has seven layers. Three of these focus on the user interface, three offer TCP/IP functions, and the other is totally dedicated to making sure the other six layers are in tune with each other.

Linking is a 'strategic need'

The real benefit of OSI, however, is that for the first time a communication standard is being developed by a vendor-user committee and not just by a single agency or company. Even SNA—the most prevalent intersystem networking scheme—was developed by IBM with IBM's best interests in mind, although it too will also migrate to OSI as those pieces fall into place and demand from users rises.

"Every user has decided that interoperability is a strategic imperative," says William V. Fello, president and CEO of Touch Communications Inc., Scotts Valley, Calif., one of the first companies to manufacture OSI-compatible products. In fact, this month Touch begins shipping controller-resident versions of its Touch OSI Ethernet connectivity software to OEMs and large corporate users. It interconnects diverse OSI-compatible LANs. The cost: $300 per copy.

A trend toward migration

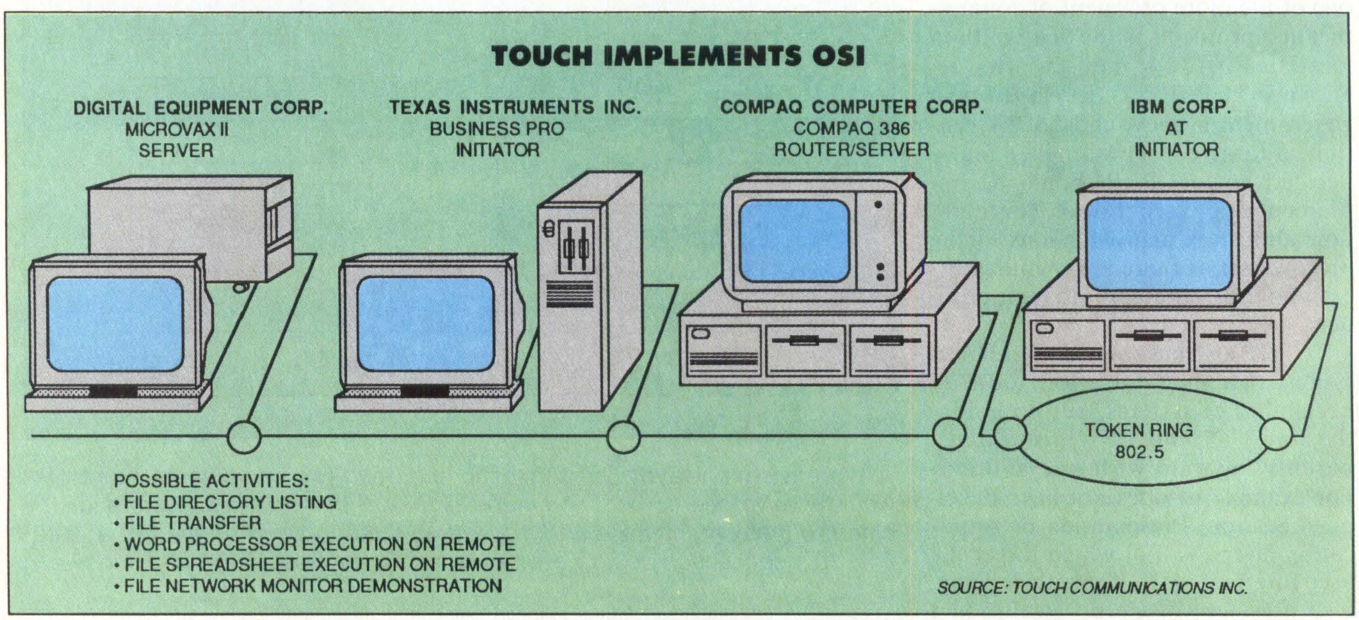
While MICOM-Interlan is presently pushing TCP/IP as a connection tool, president Barker is one who views it as a short-term solution until OSI gets off the ground. In fact, MICOM recently purchased the OSI architecture from Retix Corp., one of seven companies that has successfully tested a multivendor OSI link, and will eventually migrate all of its products to OSI as the model moves from committee to an actual set of specifications. This should be quite a boost to the spread of OSI because MICOM, to date, has more than 180,000 statistical multiplexors and at least 3,000 PBXs (private branch exchanges) installed worldwide. That puts it in the comfortable position of being a technology trend-setter.

In the meantime, MICOM will not be ignoring other areas of potential standards. For instance, early next year it plans to unveil OEM board-level products that are compatible with IBM's PS/2 Micro Channel architecture. This is true "although," Barker says, "we basically see it as just another systems port."

...if vendors adopt OSI

So, the big question is: If OSI is such a hot communications commodity, then why are manufacturers so slow to jump on the bandwagon; why are products still few and far between? The answer, unfortunately, is politics. Presently there are about 62 high-tech companies that are active members of COS, but only about 25

One of the first companies *to actively sell OSI products, Touch Communications has successfully used the OSI stack to link unlike computer systems and LANs. Listed are the Application Layer activities possible over such a network.*



COMMUNICATIONS STANDARDS

percent are users. The rest are equipment vendors. While most agree on the basics of OSI, as well as on the final goals of the project, there is still a great deal of discussion over how OSI should be structured, and who would be responsible for maintaining the standard.

While COS is often described as a standards committee, it prefers to be thought of as simply a standards accelerator. It will provide the forum for discussion, it will give member companies the opportunity to air their ideas, and it will even provide the testing facilities for new products —but don't ask it to dictate or police standards activities. "Everyone is familiar with the problems and possible solutions," said John Gilbert, director of COS Information Services, at a Boston meeting held earlier this year to drum up support for the group.

Paying the price for connectivity

Finally, while COS is an open organization—as opposed to foreign counterparts like Europe's SPAG (Standard Promotion and Application Group) and Japan's POSI, which are restricted to specific businesses—COS exacts a steep price from those who would like to be a part of the club. Every member pays a $25,000 annual membership fee. Member companies with more than $25 million in annual revenues must then also pay another $25,000 to $400,000 per year to be deemed research or senior research members. Basically, the more you pay, the more access you have to COS activities, and the more influence you have on how OSI standards will eventually be written.

In an effort to attract more members, COS this year created two lower classes of membership: affiliate associate and alliance associate. For $500 a year, affiliate members are given a newsletter, discounts on access to the COS database and electronic-mail facilities, and are allowed to offer suggestions to the COS committee. Alliance-associate standing is conferred by invitation only to select organizations that share COS goals.

Despite COS efforts to extend entry into the organization to smaller companies, and to stage various educational seminars—both on its own and with the National Bureau of Standards—there are still some vendors and groups that view COS activities with some degree of skepticism. For example, early this year, the Manufacturing Automation Protocol/Technical and Office Protocol (MAP/TOP) committee decided to join COS, but only as an affiliate member —showing an interest in the group, but not a financial commitment. COS and MAP/TOP have, however, agreed to co-sponsor an unprecedented demonstration of multivendor networking involving 55 computer, factory-automation and communication equipment suppliers next June in Baltimore. This is seen as a positive sign that COS will eventually iron out any problems and convince critics that OSI is the inevitable way to go.

"You can't go on making magic boxes all your life, connecting this to that," says COS technical services director Steve Smith. "There are just too many systems that are too different to worry about." □

SCANNERS

Japanese scanner makers forage for American OEMs

Donald J. Ryan
Special to *Mini-Micro Systems*

If you're an OEM—especially if you plan to sell to the publishing business—there's a Japanese manufacturer of a desktop scanner just aching to talk to you.

These are among the conclusions of a report on desktop scanners prepared by CAP International Inc.

Right now, OEMs are the major force in the U.S. desktop scanner arena. Most of their business comes from publishing, especiallly desktop publishing. These OEMs are American, but their scanners come from Japanese manufacturers.

The principal scanner makers are:

- Ricoh Co. Ltd., Tokyo. Its principal OEMs include Abaton Technology Corp., Pleasanton and Datacopy Corp., Mountain View, Calif.; and AT&T Co.
- Canon Inc., Tokyo. Its OEMs include Cordata Inc., Thousand Oaks, Calif.; and Hewlett-Packard Co., Greeley, Colo.

Recently, three other Japanese scanner makers began exploring OEM relationships in the United States. These are Hitachi Ltd., and Konica, Tokyo; and Sharp Corp., Osaka.

Vieing with the Japanese for U.S. OEMs is another Far East enterprise: Microtek Lab Inc., Gardena, Calif., whose parent company is Microtek International Inc., Hsinchu, Taiwan. Its U.S. OEM is AST Research Inc., Irvine, Calif.

Modified system integrators

Another kind of supplier of desktop scanning systems may be called a modified system integrator. Such a company builds scanning devices, but then becomes a system integrator by adding related hardware, software, interfaces and output devices, like laser printers. These vendors include Advanced Vision Research Inc., San Jose, and Dest Corp., Milpitas, Calif.; and Spectrafax Corp., Paramus, N.J.

Scanner manufacturers and their OEMs can expect a demand from their customers for systems that handle color, that offer higher-resolution scanning, and that provide improved optical character recognition (OCR).

Color. The demand for color scanners will be driven by two factors. First, the business user wants color in as much printed work as possible.

Second, color output devices are available that can print or copy scanned images. These devices include color copiers, ranging in price from $11,000 to more than $50,000, like the Sharp CX 5000 and the Ricoh 5000.

Several vendors, including Sharp

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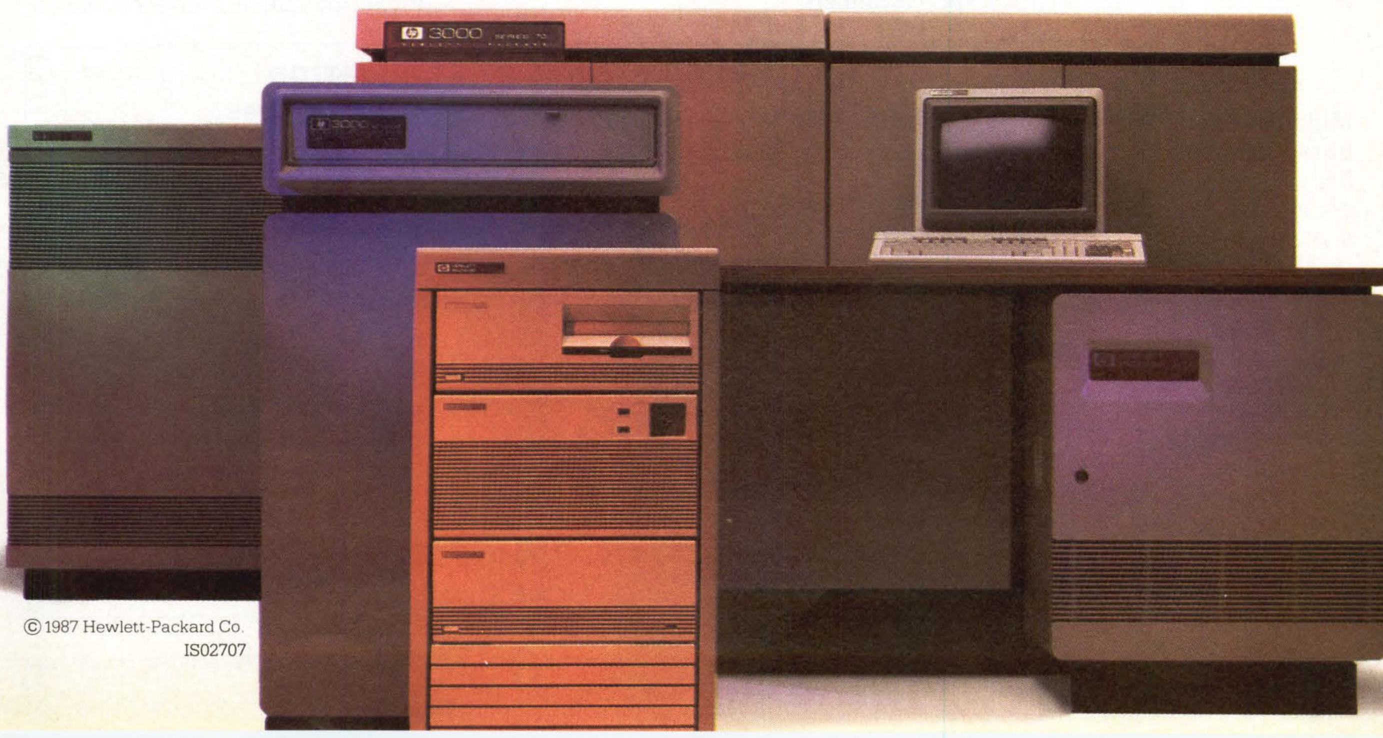


Five giants may have plans

The list of suppliers of desktop scanner systems is not complete. Market researchers like CAP International Inc. see a possibility that five major U.S. companies might soon sell products. Each of these manufacturers could introduce their own scanners, but it is more likely that they'll become OEMs for Japanese scanner makers.

Apple Computer Inc., Cupertino, Calif., is a major player in the desktop publishing business, and it might be expected to introduce a scanner to complete its hardware product line. Several third-party vendors offer desktop scanners for Apple's Macintosh desktop computer.

Digital Equipment Corp., Maynard, Mass., currently offers a high-end scanner, intended for technical publishing applications. Because DEC is a major vendor of office systems, a desktop scanner seems a logical next step for it.

Eastman Kodak Co., Rochester, N.Y., offers electronic publishing systems with high-end scanners from Palantir Corp., Santa Clara, Calif. As with DEC, the desktop would seem a good next target.

Wang Laboratories Inc., Lowell, Mass., introduced the Desktop Publishing Solution this year, built around its PC 200/300 personal computers and its laser printer, the LCS15. It offers no desktop scanners in the package.

Xerox Corp., San Diego, Calif., has imaging expertise in its copier and non-impact printer operations and has entered the publishing arena with its XPS series. Xerox has a high-end scanner, the 150 GIS, but does not have a desktop scanner.

and Ricoh, have recently introduced color desktop scanners. OEMs are sure to follow.

Higher resolution. The resolution numbers for non-impact monochrome printers are increasing, and laser printers will move to a 600-dot-per-inch standard in two or three years. Desktop scanners will match them with resolutions in the 400-to-600-dpi range.

Desktop scanners also will incorporate better gray-scale shading capability. Standard shading in today's desktop image scanners includes 16 shades of gray but will move rapidly to 64 levels of gray. Resolutions will be higher for scanners used for specialized publishing applications.

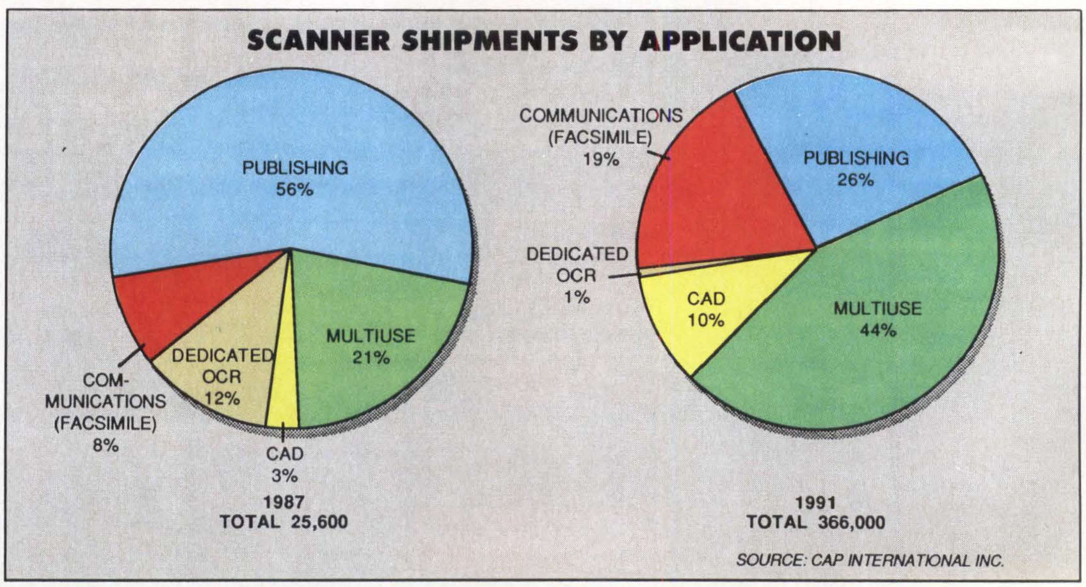
OCR. There are two trends. First, OCR increasingly will become a software option rather than a dedicated-device function. Dest's PC Scan Plus scanner is an example of this trend. Desktop scanners increasingly will have both image- and character-scanning capability.

Second, "trainable" software, much of it based on techniques of artificial intelligence and expert systems, will be available to allow scanners to read non-standard and non-predetermined type fonts. Datacopy's OCR Plus is an early example of trainable OCR software for desktop scanners.

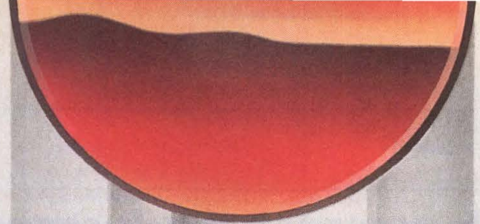
Future software for scanners will perform complex image-processing functions within an application program. That means we'll need a high-level language with a set of imaging commands that can be embedded by software developers directly into an applications program.

These commands will capture the image as a bit map; modify the image (scaling, compression, convolution, half-toning); and convert the data into a final form—raster, vector or ASCII. Datacopy's PreScript is a first step in providing software that handles image processing of scanned pages.

PreScript scanners have a firmware



Multiuse scanners *will be the hot product among desktop scanners over the next several years. Multiuse scanners have application software that permits them to do more than one job: for example, inputting images for both publishing and facsimile communications.*



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*Patents (pending). **Initial OEM evaluation drive kit which includes CP342 drive, paddle board and cable.

High speeds, high accuracy mark scanners at high end

The idea of using a light to scan typewritten images and transfer this information to a computer is not new. So-called "reading machines" debuted about 25 years ago. They were aptly dubbed optical character recognition (OCR) systems, because they recognized typewritten characters by matching images against a character matrix contained in the host computer.

These early OCR systems were not very successful, however. They could only handle a few types of simple documents, could not recognize line art, and were excruciatingly slow. They were also unable to read copies of documents, preferring the original instead, because of the quality of shading, and they became totally flustered if the image to be scanned was blurred or unclear.

Fortunately, scanners and document-processing systems—as they are now called—have come a long way since the days when a scanner had to painstakingly linger over each character and a 60 percent error rate was considered acceptable. Today, high-end scanners like the Compound Document Processor from Palantir Corp., Santa Clara, Calif., can operate at speeds approaching 100 characters per second with a 99.99 percent accuracy rate, claims Daniel A. Macuga, Palantir's president. It can also take a "snapshot" of a 300-dot-per-inch page with mixed fonts and graphics in about a half second, he says.

Systems like this are typically aimed at applications that require scanning at least 75 pages per day and can even keep pace where 1,000 pages per day is the norm. This latter figure is not unusual considering that last year alone nearly 1.6 trillion documents were generated by U.S. businesses, and that by 1990 the figure is expected to reach more than 4 trillion, according to some estimates.

Scanners are also evolving from being standalone single-user systems to a functioning part of a local area network, used by hundreds of people. For example, one variation of Palantir's Compound Document Processor—called the Recognition Server—can be used as a centralized scanning hub, attached to as many distributed "dumb" scanners as an Ethernet local area network will allow, says Macuga.

High-end scanning systems are not cheap. Palantir's Compound Document Processor can cost up to $40,000, and the Recognition Server is priced at $10,500 in quantities of 100. One highly sophisticated system, from Recognition Equipment Inc., Dallas, costs more than $234,000. But, it can read highly complex documents and, with the rise of intra-company publishing and the consequent flood of paper, most organizations do not see such costs as unrealistic.

System integrators and value-added resellers have also jumped on the scanning bandwagon and are actively piecing together systems that target particular niches. Palantir, for example, already has about 60 resellers on board, as well as five OEMs and 20 VARs. But, the company is actively recruiting resellers in all areas such as electronic publishing, database management, forms processing and intelligent office systems.

Obviously, with the entire desktop scanner market so ripe—Datek Information Services Inc., Newtonville, Mass., a division of CAP International Inc., estimates that the market will grow from $85 million this year to $540 million by the end of 1991—Palantir is not alone in its efforts to capture the high end of the spectrum. However, there are fewer players at the top than at the overly crowded low-end segment of the scanning market. Competitors in the high-end segment include:

Ana Tech Corp., Littleton, Colo., which has a family of high-resolution scanners that can convert line art drawings into CAD-compatible raster formats and raster data to vecor formats. The systems can scan documents up to 60 inches wide and are priced from $45,000.

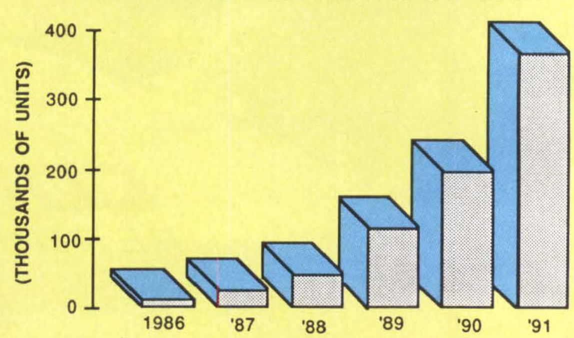
Dest Corp., Milpitas, Calif, an early player with its PC Scan 650, priced at about $1,995; and PC Scan Plus 651 at $2,495.

Fujitsu America Inc., San Jose, Calif., which recently unveiled its first scanners—the M3094A and M3094B—that can read single pages or bound documents and recognize characters of varying resolution and shades. In OEM quantities of 100, they are priced $5,650 and $4,610, respectively

Kurzweil Computer Products Inc., Cambridge, Mass., a Xerox company that offers a PC-based scanning system called Discover. The system costs $9,950 in single quantities, is designed to work in background to other application programs, and recognizes characters by learning their shapes.

At this point, however, there seems to be a lot of room for growth and opportunity. According to CAP International, placements of desktop scanners will mushroom from 26,000 this year to 366,000 in 1991. —*Tim Scannell*

DESKTOP SCANNERS INSTALLED



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The people who made Seagate

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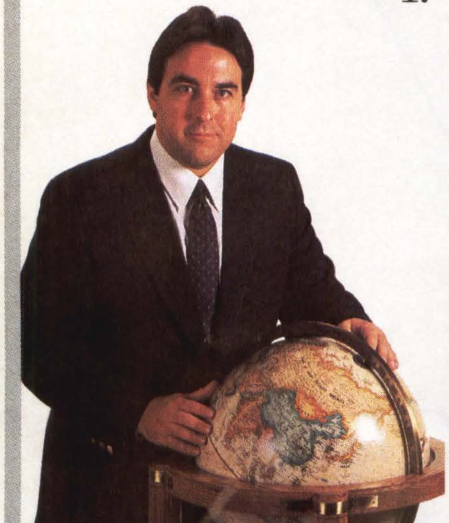

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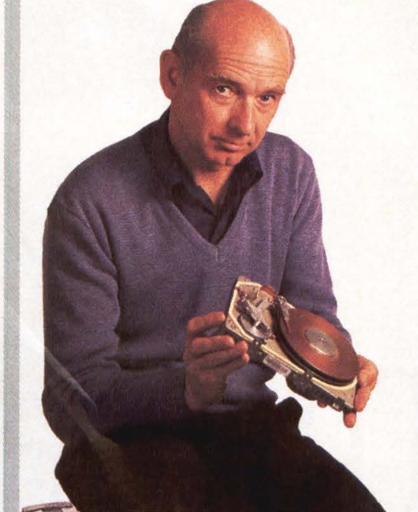

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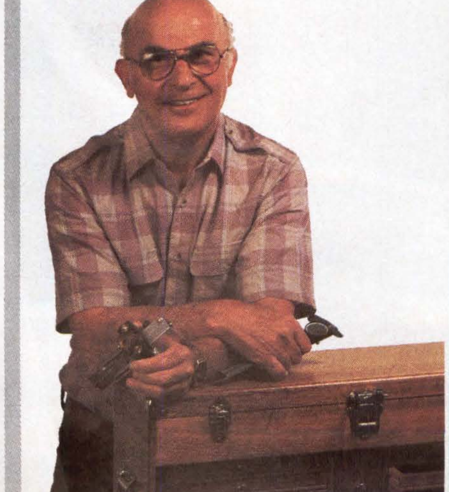

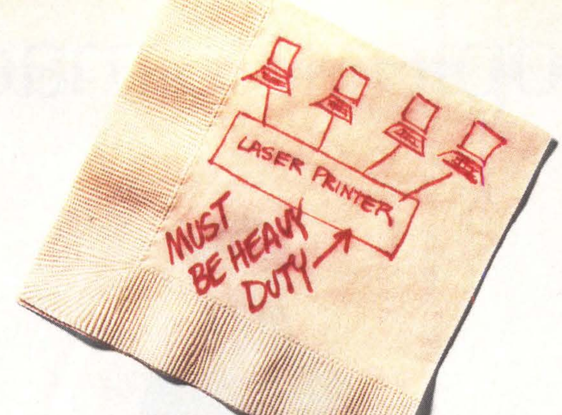

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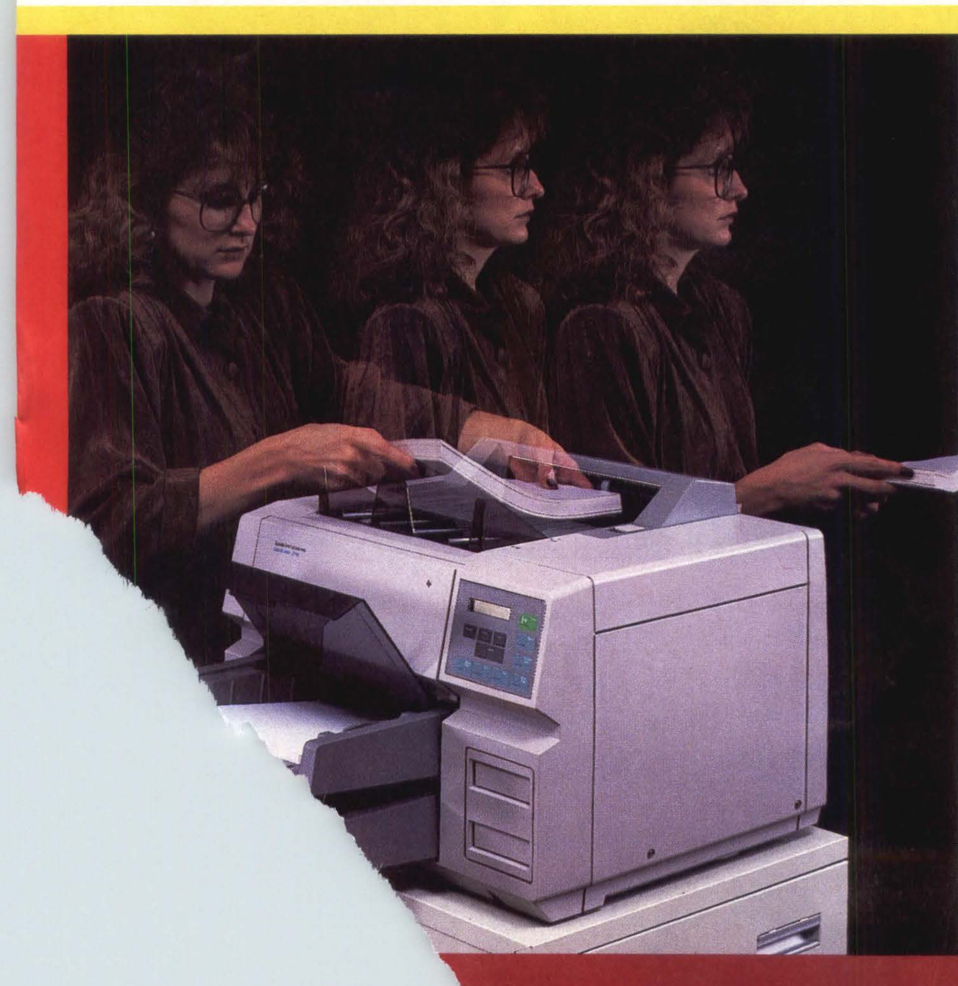

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SCANNERS

interpreter that translates the commands for the processor doing the imaging. It can capture images at 8 bits per pixel, providing 256 gray levels. Other features include six algorithms for half-toning and eight definable windows for capturing information as half tone, vector or ASCII.

Another software development to look for is the standardization of image file formats for computer publishing and graphics. Currently, there are two principal formats. One is the PCX image file format by Z-Soft Corp., Marietta, Ga., for use with its PC Paintbrush. The other is Tagg Image File Format (TIFF) by Datacopy; Aldus Corp., Seattle; and Microsoft Corp., Redmond, Wash. It's for use with a variety of desktop publishing programs, including Aldus' PageMaker.

Functionality is a resident

There are two main trends in product development. The first leads to intelligent scanners with more resident functionality. The second leads to basic scanners with limited functionality and lower prices.

The first trend already has produced products. Canon, Ricoh and Microtek have announced 400-dpi scanners that will operate at significantly faster speeds and handle 52 to 64 gray-scale levels. Expect these scanners to have prices in the $5,000-to-$6,000 range.

Ricoh and Datacopy are working jointly on an intelligent scanner that will incorporate a programmable

PRINTERS

Honeywell Bull Italia readies 'stored-energy' printhead

James F. Donohue, Managing Editor

For 12 years, under various names, what is now Honeywell Bull Italia S.p.A. has been building dot-matrix printers to run on Honeywell computer systems. Since the beginning, its machines have operated with electromagnetic printheads.

Now the wholly owned subsidiary of Honeywell Bull Inc. is trying something new. It's building a prototype of a "stored-energy" printhead which, company executives say, will be 40 percent lighter, 50 percent smaller and, at a 2-kHz needle frequency, 25 percent faster than the electromagnetic variety. "That means it will require less energy to operate it," says Mario Rossi, manager of mechanisms development for Honeywell Bull Italia.

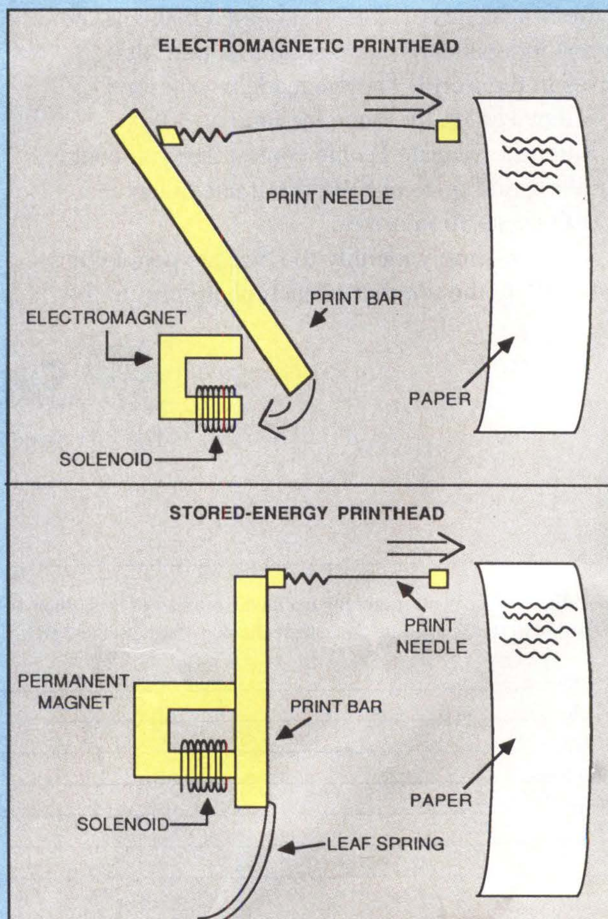
The Italian company is not alone in developing the stored-energy printhead. The Japanese printer maker, Okidata, is building printers with similar technology.

In the electromagnetic printhead, an electric current passes through a solenoid, charging an electromagnet. The magnet attracts the print bar, driving the print needle forward.

In the stored-energy printhead, the electromagnet is replaced by a permanent magnet. Now, when electricity flows through the solenoid, the magnet is neutralized. That releases the print needle, which sits on a steel leaf spring, and the printhead jumps out to strike the paper.

"Killing the magnetic field is a simpler process than setting up a magnetic flux," says Rossi. "Among other things, it's easier to manufacture. We have to do a lot less soldering."

Honeywell Bull Italia hopes to ship its first printers with stored-energy printheads next year. The company, with headquarters in Milan, is looking for OEMs in the United States. It will sell the printheads as well as the printers.



SOURCE: HONEYWELL BULL ITALIA S.p.A.

Contact: Alex Trombetta, Honeywell Bull Italia, 120 Howard Street, San Francisco, Calif. 94105. (415) 974-4340.

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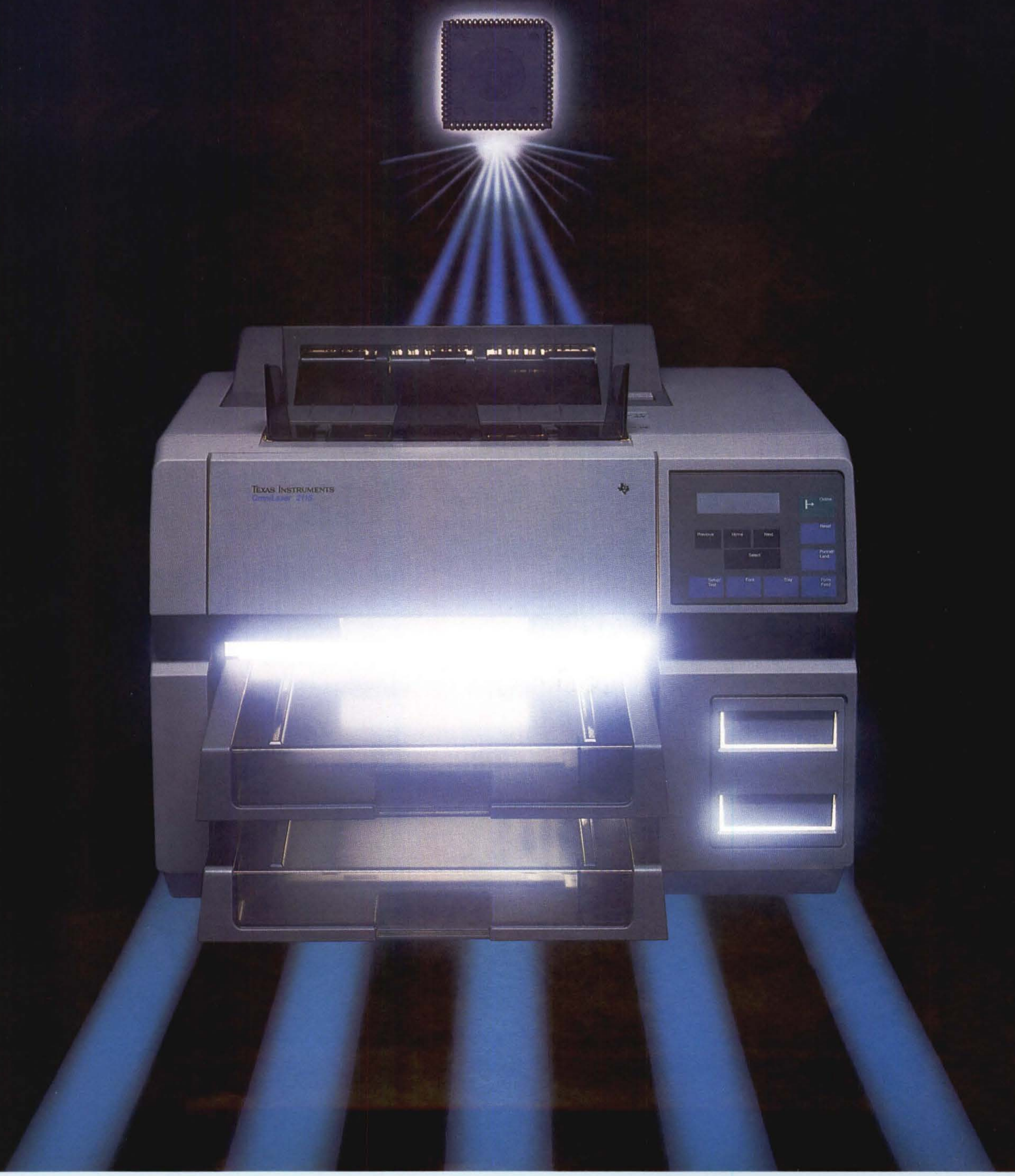

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The latest addition to our printer family is the Model 885 demand document printer. Just like the other family members, it's designed to be rugged and offer superior paper handling. But its differences make it ideal for applications where space is limited and paper waste is a consideration.

We've added a zero tear-off capability that eliminates forms waste. Simply put, it uses just one form where most printers would also use a second. It's front-loading, handles up to five-part forms with ease, and thanks to its small footprint, fits on a desk or countertop.

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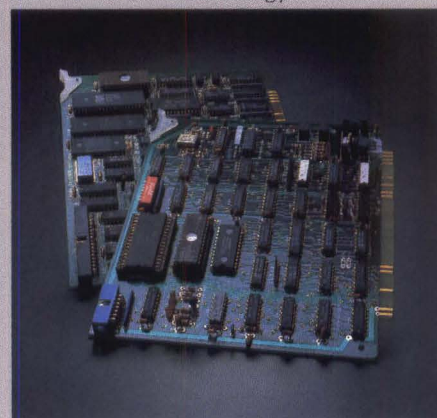

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SCANNERS

image processor to perform complex image-handling tasks such as variable scaling, compression and editing at much faster rates under control of a personal computer.

Meanwhile, prices are falling, to near $1,000 for desktop scanners. Anticipate a price decline of 10 percent a year, compounded, during the period from 1986 to 1991.

The second trend will produce basic "convenience" scanners with simple and limited functions and prices below $500. An example available now is Sharp's line-art scanner, carrying a price tag of $795. □

Donald J. Ryan is director of the image communication systems market requirement service at CAP International Inc., a market research and consulting concern in Marshfield, Mass.

OS/2 SOFTWARE

Jury still out on OS/2 as developers await final pieces

IMPACT PS/2

Mike Seither, Senior Editor

Picture Chrysler Corp. chairman Lee Iacocca and other Detroit executives holding a press conference to announce a new "industry standard" automobile, one that will take car owners into the 21st century.

This new car will have wings, five wheels and enough seats for a dozen passengers, yet take up only half a parking space. It will revolutionize the way people drive, the auto companies claim. Everyone will have one. The only problem is, these execs don't know when this standard-setting car will arrive in showrooms.

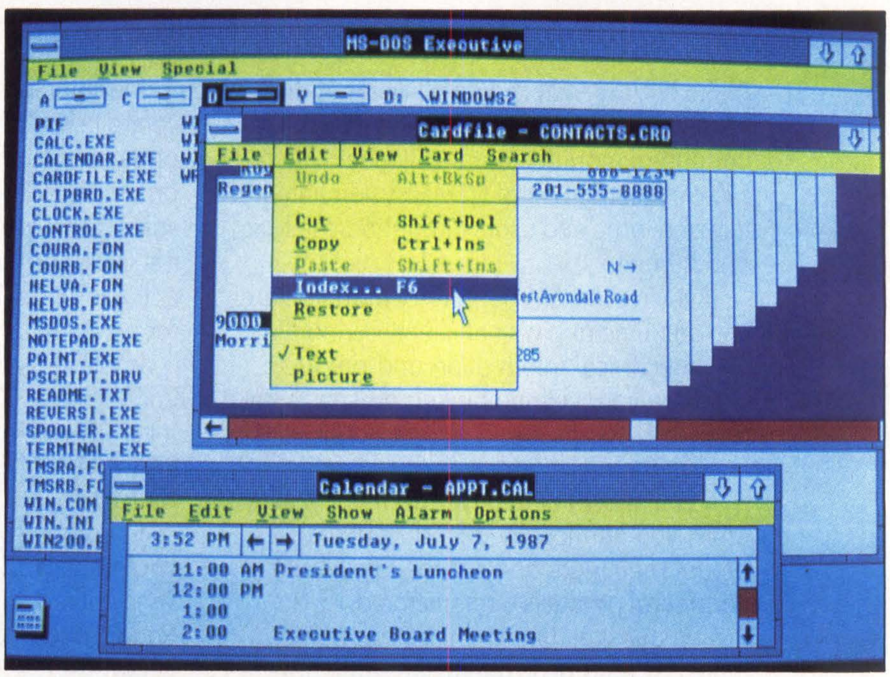
In a way, Operating System/2 has a lot in common with that visionary vehicle. Both IBM Corp. and Microsoft Corp., who are pushing OS/2 as a standard, are busily trying to convince software developers and the third-party manufacturers who sell products to end users to drop everything and build on a product that is not yet there. As a result, OS/2 has been the subject of more attention, confusion and speculation than perhaps any other computer product in recent memory.

Of programs and promises

No one argues about the potential power of OS/2. Operating in the protected mode of the Intel Corp. 80286 and 80386 microprocessors, software developers will no longer be limited to writing applications within the 640K-byte restriction of the DOS operating system. Instead, with OS/2 they can address up to 16M bytes of physical memory and 1G byte of virtual memory. The processors' protected mode is also the key to another OS/2 capability—multitasking. No longer will users be limited to running one program at a time, as they are now under DOS.

There are more promises, of course. OS/2 will allow "most" existing MS-DOS programs to run in an 8086-compatible mode as long as the programs don't have timing dependencies nor directly access hardware, according to Microsoft. For the IBM world, OS/2 will provide a link to the System Applications Architecture (SAA), Big Blue's grand plan for allowing programs to run seamlessly across a variety of system architectures.

In fact, IBM officials say OS/2 will be the "carrier" for SAA at the per-



Although OS/2's *Presentation Manager looks and functions like Windows Version 2.0 (pictured), developers will have to change their MS-DOS programs to work with the new operating system.*

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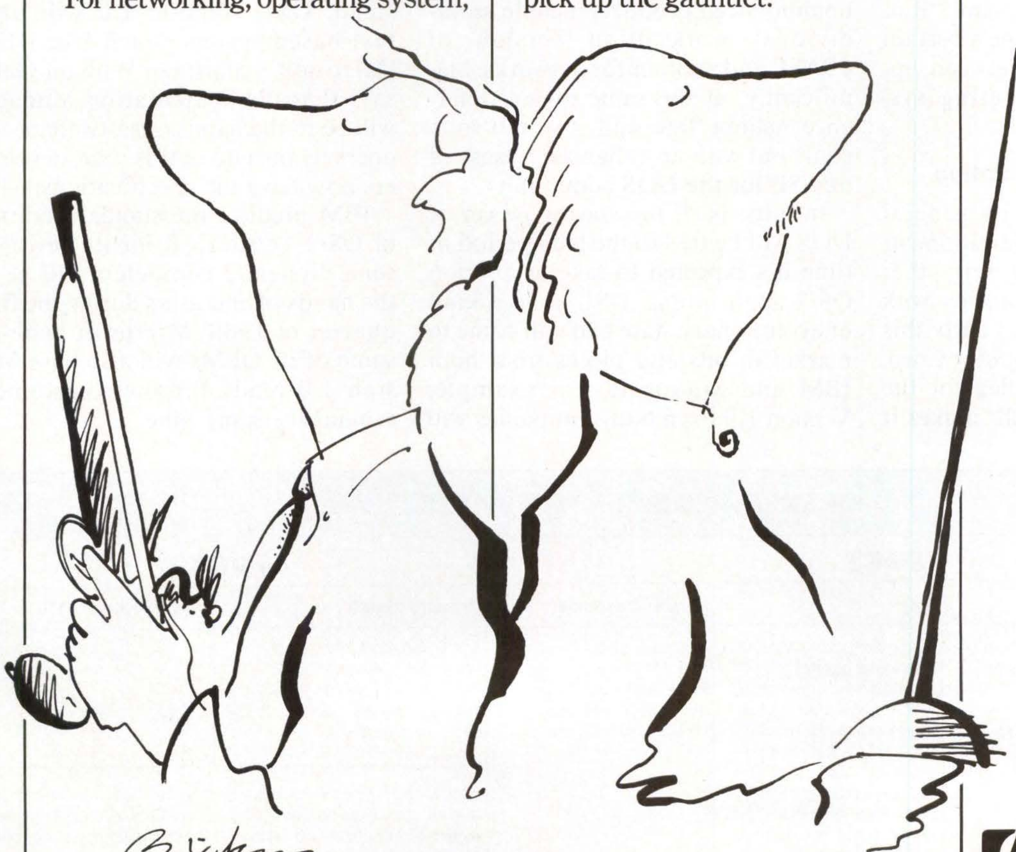

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sonal computer level so that PCs become the terminal of choice for host attachment.

This all sounds great. However, a few things have become clear during the five months that OS/2—such as it is—has begun to reveal itself. First, the single-user, single-tasking DOS operating system, including Version 3.0—which was unveiled along with OS/2—will remain king for the immediate future. It will not suddenly be replaced by OS/2, say many software developers who have had a chance to use Microsoft's OS/2 tool kit and have indicated they have no intention of abandoning the lucrative market in DOS applications.

"We recognize that OS/2 will create another fork in the market road and we will write for it. But we also recognize the importance of evolving our dBASE product line for the DOS world. That's something we cannot ignore," says senior vice president Roy Folk of Ashton Tate Corp., the Torrance, Calif., software giant. "But, with discipline, there can be a certain degree of compatibility between applications for both operating systems."

Microsoft chairman William Gates *stumps for OS/2 as a standard at a New York press conference sponsored by Compaq Computer. Seated from left are Compaq's Rod Canion, Ashton Tate's Edward Esber and Digital Communication Associate's James F. Ottinger; all president/CEOs.*

Bits and pieces of an evolution

Ashton-Tate outlined its general plans for OS/2 product development when it participated, along with other industry heavyweights, in a New York press conference sponsored early this summer by Compaq Computer Corp. of Houston to raise the flag for the new operating system. Folk makes it clear that Ashton Tate was only "indicating a direction and not announcing" dBASE products for OS/2. Those unannounced products include an individual workstation version of dBASE and another for networks. Significantly, at the same press conference Ashton Tate said it would soon come out with an enhanced release of dBASE for the DOS community.

In large part, the staying power of DOS will be tied to the long period of time it's expected to take to develop OS/2 applications. OS/2 is in a kind of evolutionary state and will come to market in bits and pieces from both IBM and Microsoft. For example, Version 1.0 from both companies will not include the Windows Presentation Manager, the much ballyhooed graphical user interface for OS/2. Instead, OS/2 Version 1.0 will be a text-based system much like DOS. (Microsoft's chairman William Gates says that the Presentation Manager will be in the hands of software developers by the end of this year; developers now have the specifications.)

IBM predicts the standard edition of OS/2 Version 1.0 for its new Personal System/2 computers will be in the hands of end users during the first quarter of 1988. Microsoft believes some of its OEMs will also have Version 1.0 ready for their customers around the same time.

CHARTING OS/2's PROGRESS

1987				1988	
April	**June**	**July**	**August-December**	**January-March**	**April-September**
IBM Corp. and Microsoft Corp. announce OS/2.	Microsoft ships software development kits with OS/2 kernel and specifications for LAN Manager two months early. Training sessions begin for application developers.	3Com Corp. and Microsoft announce a joint development agreement for LAN Manager. Lotus Development Corp. and Ashton-Tate Inc. outline plans for OS/2 applications. Novell Inc. goes on record that it will support, but not license, OS/2. Compaq Computer Corp. ships kits to help developers write programs for its systems.	Microsoft ships OS/2 code for LAN Manager and Presentation Manager to developers. Windows Version 2.0 available to end users.	OS/2 Version 1.0 (text only) ready for users from IBM. Availability of Microsoft OS/2 Version 1.0 dependent on OEM product schedules.	
				LAN Manager products to be shipped to OEMs by Microsoft, and to end users and VARs by 3Com. Presentation Manager available from IBM and Microsoft. First applications expected for OS/2 Version 1.0.	

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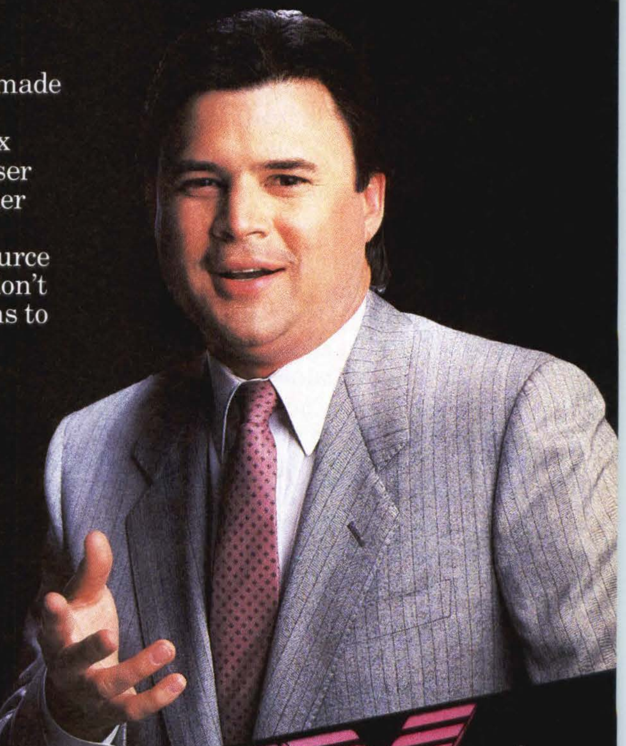

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It's not clear yet how many software companies will decide to support Version 1.0 with text-only applications. Lotus Development Corp., for one, has indicated that it will. The Cambridge, Mass., company plans to have a text-only version of its 1-2-3 spreadsheet program available after the first of the year. Nevertheless, Lotus also plans to introduce a product called 1-2-3G that will work with the Presentation Manager.

Waiting for Windows

Most software vendors, however, are tight-lipped about plans. Instead, they are still evaluating the pieces of OS/2 they have in hand and anxiously waiting for others, particularly the code for the Windows Presentation Manager. There is no doubt developers are interested in OS/2. Since June, Microsoft claims it has shipped more than 1,800 of its OS/2 software-development kits to programmers. And so far about 1,300 software developers have attended OS/2 seminars that Microsoft has around the country.

"There seems to be a lot of confusion about whether people should develop for Version 1.0 or wait for Version 1.1 [with the Presentation Manager]," says Brad Silverman, vice president of engineering for Borland International Inc., the Scotts Valley, Calif., software vendor. "With so many mixed signals it's not clear what the right strategy should be."

Folk of Ashton Tate says: "We don't believe it will be useful to write applications for Version 1.0. One of the advantages of OS/2 is the Presentation Manager, but neither IBM nor Microsoft will commit to a firm date for delivery."

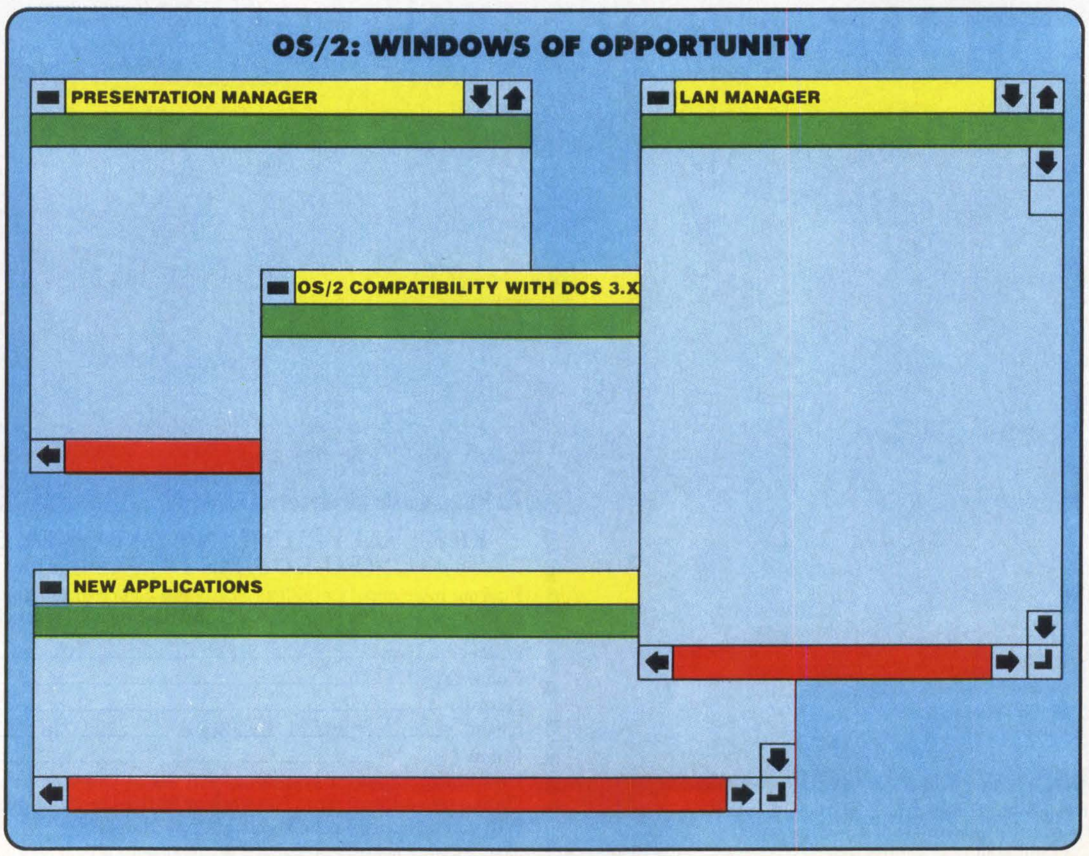
Given that situation, most observers are saying that actual applications that take advantage of the windowing technology won't be on the market for at least a year after developers get the code. IBM says it will announce the availability date of Presentation Manager between now and the end of the year. That's the same time frame within which Microsoft plans to ship the windowing code to its OEMs. Specifications for the Presentation Manager were scheduled for August distribution to developers who bought Microsoft's software development kits.

The Presentation Manager will closely resemble Microsoft Windows Version 2.0 for DOS and feature overlapped windows, rather than the side-by-side ones found in DOS versions 1.03 and 1.04.

Some software companies are prepared to move fast when they receive the Presentation Manager code. Mark Frederiksen, technical director at Palantir Software Inc. of Houston, says that making the leap from DOS-based Windows 2.0 to the OS/2 Presentation Manager should not be difficult for programmers. Palantir now has 10 applications that run under Windows 2.0, including programs for scanning, word processing, communication and filing.

Inter-tasking opportunities rise

Frederiksen says the most significant characteristic of OS/2 is inter-task communication—the ability to move data around among programs. "Developers will have to come up



OS/2 SOFTWARE

with a standard to do it, but theoretically you could query one vendor's spreadsheet and dump the information into another guy's word processor," he says. "The possibilities are really limitless."

Borland's Silverman says one logical application for inter-process communication would be the ability to have multiple calendars on individual workstations that could communicate with each other over a network. "Think of it as multiuser scheduling as opposed to everyone having his own calendar," says Silverman. "There are a lot of opportunities there."

Networking, of course, is one of the things that Microsoft is trying to get a lot of mileage out of with OS/2. But like other components of the operating system, OS/2's LAN Manager is still quite a way from reality. Although specifications were shipped to developers with the OS/2 development kits, programmers are not expected to see code until later this year. This summer Microsoft brought 3Com Corp., the local area networking company, on board as a development partner for the LAN Manager. The two companies say that LAN Manager products will be ready for shipment in the first half of 1988.

3Com, Santa Clara, Calif., will lend its expertise in protocol support and network adapter cards. It will jointly develop with Microsoft distributed database services, a network windowing interface and message handling as well as directory and gateway services. Other plans for the LAN Manager include beefed up security, audit trails and the ability to execute programs remotely. Under the agreement, Microsoft will distribute LAN Manager with 3Com enhancements to OEMs, while 3Com will sell it to value-added resellers, distributors and retailers.

Nathan Brookwood, a LAN analyst for the Santa Cruz, Calif., investment concern of D.H. Brown Associates Inc., says OEMs will benefit from LAN Manager because they will be getting a turnkey system. "They'll be able to sell a cheap LAN solution with zero [user] technical effort. With Microsoft Networks, OEMs now have to have a communciations programmer to handle things like device drivers and transport mechanisms," says Brookwood.

Notably missing in the LAN Manager portion of the OS/2 puzzle is any mention so far of support by IBM. While some analysts like Brookwood say that IBM eventually will support the LAN Manager, others say IBM will rely on its Extended Edition of OS/2 for communications. IBM has not even announced a date when it will announce the availability of the Extended Edition.

Like it or not, OS/2 appears to be here, at least somewhat. And no one seems to be willing to call it vaporware, at least completely.

Says Ashton Tate's Folk: "This [OS/2] announcement has been vaporous in that Version 1.0 was announced with a date, Version 1.1 has no date, and the extended edition doesn't even have a date for announcement. No one doubts IBM and Microsoft will deliver. It's a matter of when." □

MICRO CHANNEL ARCHITECTURE

Micro Channel maze prompts developers to seek alternatives

Andrew Allison
Contributing Editor

It is clear that IBM Corp. is in the process of positioning the Micro Channel Architecture of the Personal System/2 as a new computing platform, replacing its original PC architecture.

The question is, however, does the new architecture offer enough flexibility and carry enough technical and political weight to force the IBM-compatible PC market as a whole to follow suit? If so, on what timetable?

Jim Orris, general manager of AST Research Inc.'s (Irvine, Calif.) Personal Workstation Enhancement Group, is "surprised that IBM abandoned the AT bus," and reports seeing "very mixed reactions, ranging from abandonment of to commitment to AT hardware compatibility, from customers."

Reflecting the attitude of most other potential suppliers, Holden Jessup, a project leader at Olivetti Advanced Technology Center Inc., Cupertino, Calif., admits that he will welcome the Micro Channel if it catches on as a leading technology. "Olivetti is in the business of satisfying the market needs, and if our customers demand the Micro Channel, we will provide it." However, he quickly adds, "While the Micro Channel (as specified for the PS/2 Models 50 and 60) permits operation at 10 MHz without wait states, it doesn't go far enough to satisfy the needs of the industry, which is looking for 16-MHz operation."

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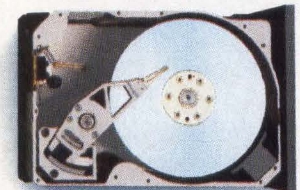

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MICRO CHANNEL ARCHITECTURE

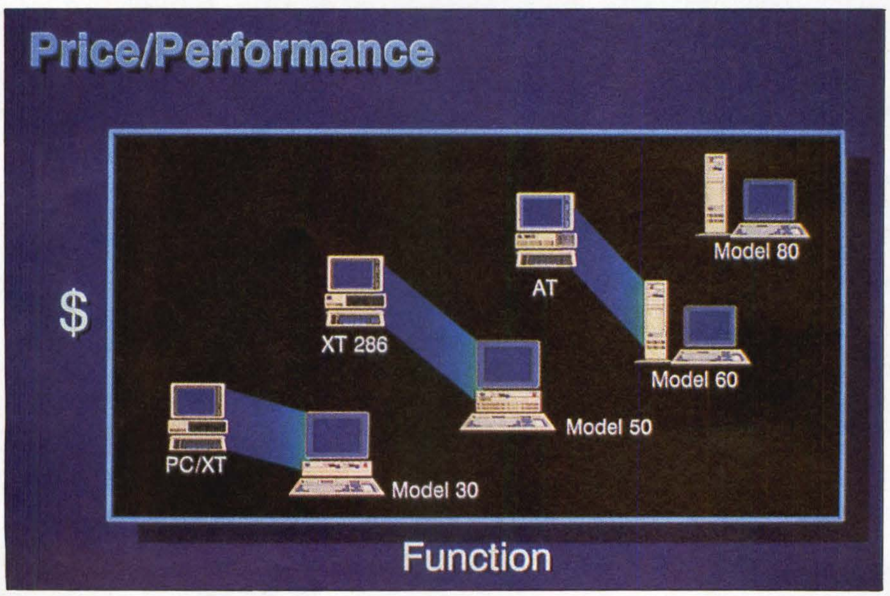
three key technological features of IBM's new Micro Channel Architecture for its PCs, the others being the integrated Video Graphics Architecture (VGA), 3½-inch disk adapters and geographic addressing. In its initial release, the Micro Channel is a 16-bit bus with a video extension. However, specifications for a 32-bit extension are scheduled for release later this year.

The bus is specified for a minimum basic cycle time of 200 nsec, but the Models 50 and 60 invoke a 300-nsec minimum extended cycle, yielding a maximum direct memory access (DMA) transfer rate of 3.33M bytes per second in the burst transfer mode. Unlike the PC and PC/AT buses, which remain under the control of the system processor at all times, the Micro Channel can be controlled by up to 15 other devices (DMA slaves, intelligent I/O controllers or other processors).

From the technical standpoint, the Micro Channel is noteworthy primarily for its programmable option select (POS) feature. The elimination of switches and jumpers, with the consequent ability to dynamically reconfigure the system under software control, is a significant step forward. It remains to be seen, however, whether the benefits justify the high cost of abandoning the AT bus to develop products for a new bus structure.

Given that IBM began work on the Micro Channel Architecture in 1983, one might have expected more, particularly in the area of bus bandwidth. For the 16-bit version, it is about one-tenth of that available from other bus technologies, like the VMEbus and Multibus II.

Putting I/O and processor arbitration, DMA control and the POS capability on the system board, rather than distributing them, reduces the cost of adapters and increases IBM's proprietary leverage, but limits throughput to little more than twice that required by the enhanced small device interface (EDSI) disk controller. As a result, there is not much available to support the multimaster capability. Furthermore, the ability of the bus as currently specified to sup-



IBM is touting *the price/performance ratio of its PS/2 series and Micro Channel Architecture over previous MS-DOS systems. However, add-in board developers may decide to stick with the older IBM PC/AT technology, or pursue Apple Computer's NuBus, which is presently used in the Macintosh II.*

port higher performance processors and controllers in the future is questionable.

How hard and how high the cost

The centralization of these enhancements on the motherboard raises an important non-technical question, namely, how difficult does IBM intend to make the development of Micro Channel-compatible system boards? Although third-party adapter design is being encouraged, several of the Micro Channel features have patent protection.

For example, the use of connector-specific signal lines on the system board is licensed from Computer Automation Inc. Similarly, the arbitration and DMA control are covered by some of the 100 Micro Channel patents rumored to have been applied for. As a result, there may be serious impediments to the development of PS/2-compatible system boards.

By introducing a completely new, mechanically incompatible and proprietary bus architecture, IBM has thrown down the gauntlet to PC-compatible manufacturers (PCCMs) and end users alike. Both groups are faced with the decision as to whether to stay with the multifarious AT-compatible products or abandon their hardware investment and switch to the new architecture.

Sticking with the AT

While many PCCMs have already announced Micro Channel adapters—one of the first being an interface chip set announced by Chips & Technologies Inc. less than two months after the PS/2 introduction—many major computer and software vendors have announced their intention to stay with AT compatibility.

Bob Stillman, chairman of IBM-compatible BIOS (basic input/output system) supplier Award Software Inc., Los Gatos, Calif., feels that the Micro Channel Architecture is "an interesting concept but doesn't offer anything that you can't get at half the price from an AT, without giving up the benefits of the multivendor support." Award is taking advantage of this by diversifying into the design of controllers that achieve Micro Channel levels of performance by making better use of the AT bus.

There are good arguments, for PCCM and reseller alike, in favor of staying with AT bus compatibility. First, for the year or so until OS/2-specific application software becomes available, the PS/2 products will provide little more than AT emulation (MS-DOS programs actually run slower under under OS/2). Furthermore, the market price of AT-compatible PCs fell about 30 percent in the two months following the PS/2 introduction and has continued to drift down since then, increasing the price/performance benefits of the AT.

Another consideration is the fact that the standard edition of OS/2 does not require any of the Micro Channel Architecture features and will be available to AT-compatible systems. Finally, the current level of Micro Channel performance is barely adequate for currently available processors, and it may make more sense to wait for the inevitable enhancement.

The fear, uncertainty and doubt brought about by IBM's emphasis on the proprietary content of the Micro Channel Architecture has caused PCCMs to look for alternatives. For example, an IEEE standards working group (P996) is considering an extended personal computer backplane standard incorporating one of the existing 32-bit bus standards plus an interface between it and a, possibly enhanced, PC/XT-AT bus.

An Apple in their eye

If this approach is adopted, the most likely choice would be IEEE-1196 (NuBus), the low-cost, high-performance standard already chosen by Apple Computer Inc. of Cupertino for the Macintosh II. IBM can be expected to try hard to substitute the 32-bit implementation of the Micro Channel, but would need to make it readily available to PS/2-compatible system suppliers in order to succeed. That would negate the obvious effort to make PS/2 system boards proprietary.

The "open invitation" being ex-

MICRO CHANNEL ARCHITECTURE

tended to value-added resellers by Apple should not be overlooked. Like the Micro Channel, NuBus incorporates geographic addressing and, as pointed out by Ron Hochsprung, Hardware Team leader of the Macintosh II design effort, "NuBus adapters incorporate configuration ROMs, which can contain anything from the adapter ID (required) to complete self-installed drivers on each adapter."

Hochsprung adds that, "Sixty-four bytes of the 256-byte battery-backed parameter RAM in the system are assigned to adapter slots, allowing adapter parameters to be retained between power ups," giving the Macintosh II software-configuration capability similar to that of the Micro Channel. Furthermore, although Macintosh II I/O occurs at a maximum of 4M bytes per second, connector-to-connector transfers can occur at the 37.5M-byte-per-second maximum allowed by NuBus.

The approach adopted by most Intel Corp. 80386-based system suppliers has been to enhance AT bus performance as much as possible without losing compatibility with the installed base. One popular approach is to incorporate a separate channel interface on the motherboard. (Taking memory, mass storage, graphics and LANs off the bus provides more throughput capability than available from the Micro Channel as currently specified.) This approach avoids the 8-MHz I/O restriction imposed by maintaining compatibility with most add-in adapters (i.e. 5.3M bytes per second with one wait state, 2M bytes per second with two).

What should the reseller conclude from all this? Obviously, IBM's position in the marketplace guarantees some measure of success for the Micro Channel Architecture. The amount, however, will depend more upon whether purchasers can be sold on it than on its technical merits, and penetration will be deepest within the large companies where IBM exercises its greatest control.

Nevertheless, MS-DOS and AT-compatible PCs will have a long and vigorous future. If PCCMs succeed in significantly enhancing AT-compatible system performance and/or the availability of OS/2 Extended Edition starts to slip, these could well remain the PC operating system and hardware platform of choice. Another possibility to be kept in mind is that the competition between the AT and Micro Channel architectures could weaken both sufficiently to permit Apple to establish NuBus as the dominant PC bus architecture.

"MS-DOS execution units for the Macintosh II are attractive to suppliers nervous about IBM's intentions and can be expected to proliferate," contends Mike Zachain, director of Apple Product Operations at AST Inc.

Jim Rush, director of Products Marketing at Quadram Corp., Norcross, Ga., agrees with this observation noting that, while his company introduced three Micro Channel adapters at COMDEX last June, it also is expected to have announced its first NuBus product (an MS-DOS execution unit) this month. "The AT bus is well entrenched, NuBus will definitely become a factor, and there will be room for all three for the next several years," says Rush.

He maintains, "We are all going to have to wait a while to see the long-term impact of the Micro Channel, but there are too many good alternatives available for a dramatic shift to occur." □

Andrew Allison is a management consultant specializing in minicomputer and microcomputer technology, products and markets.

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MARKET TRACK

Newcomer Multibus II predicted to gain rapidly on VMEbus

The world of the 32-bit computer bus still belongs to the makers of VMEbus products. But the vendors of products for rival Multibus II are just beginning to come to market, and they will enjoy rapid growth in sales for the next several years. That's according to a study by Venture Development Corp., a market research concern in Natick, Mass.

While shipments for both VMEbus and Multibus II will continue to grow, says the report, "stagnation or decline are foreseen for Multibus I, Q-bus, STD, Unibus, S-100 and several other older, less capable standard bus formats."

The value of worldwide shipments of Multibus II products will go from $21 million last year to $477 million in 1991, for an annual growth rate of 86.5 percent. In contrast, the value of worldwide shipments of VMEbus products will climb from $312 million in 1986 to $676 million in 1991, for an annual growth rate of 16.7 percent. At the same time, worldwide shipments of standard computer bus products will grow from $2.4 billion in 1986 to $3.3 billion in 1991, for an annual growth rate of 6.5 percent.

"For the most part," says the report, "the success of the VMEbus can be strongly attributed to it being, by far, the most commercially available 32-bit format." Meanwhile, "Multibus II is still in the introductory stage, with mature interface chips only now becoming available. Significant chip price reductions are expected over the next four years. Technically sophisticated users . . . regard Multibus II as the bus of choice for the 1990s, and many are designing products today for proper market positioning in the future."

The study says: "It is believed that the technically sophisticated features of Multibus II will find their greatest utility in machine vision, real-time image processing and high-speed graphics."

Backing up moves up front

Prices of backup storage for computer data will decline over the next several years. Some of the price drops will be dramatic. For example: 25 percent a year for medium-performance half-inch cartridge tape drives. A result is that system integrators are coming to view backup storage as an important part of any computer.

That's according to a report by Frost & Sullivan Inc., a market research outfit in New York.

This new spate of interest means that volume shipments of computer backup products like cartridge tape drives and reel-to-reel tape drives will grow at an annual rate of 23.7 percent in the five years from 1986 to 1991, reaching 2.9 million units.

The report says the growth in shipments will occur almost entirely in the minicomputer (46.3 percent a year) and microcomputer (23 percent a year) environements. Shipments to the mainframe market will increase only about 2 percent a year in the same time frame.

Driving the increase in sales, along with cuts in prices, will be technological improvements—including features like self-diagnostics. In addition, says the report, "Today's knowledgeable users have discovered that backup storage has multiple applications, such as data transfer from one computer to another, software distribution and reorganization of data files."

Nevertheless, says the report, "The primary reason for today's demand for backup storage devices is the old reason, security."

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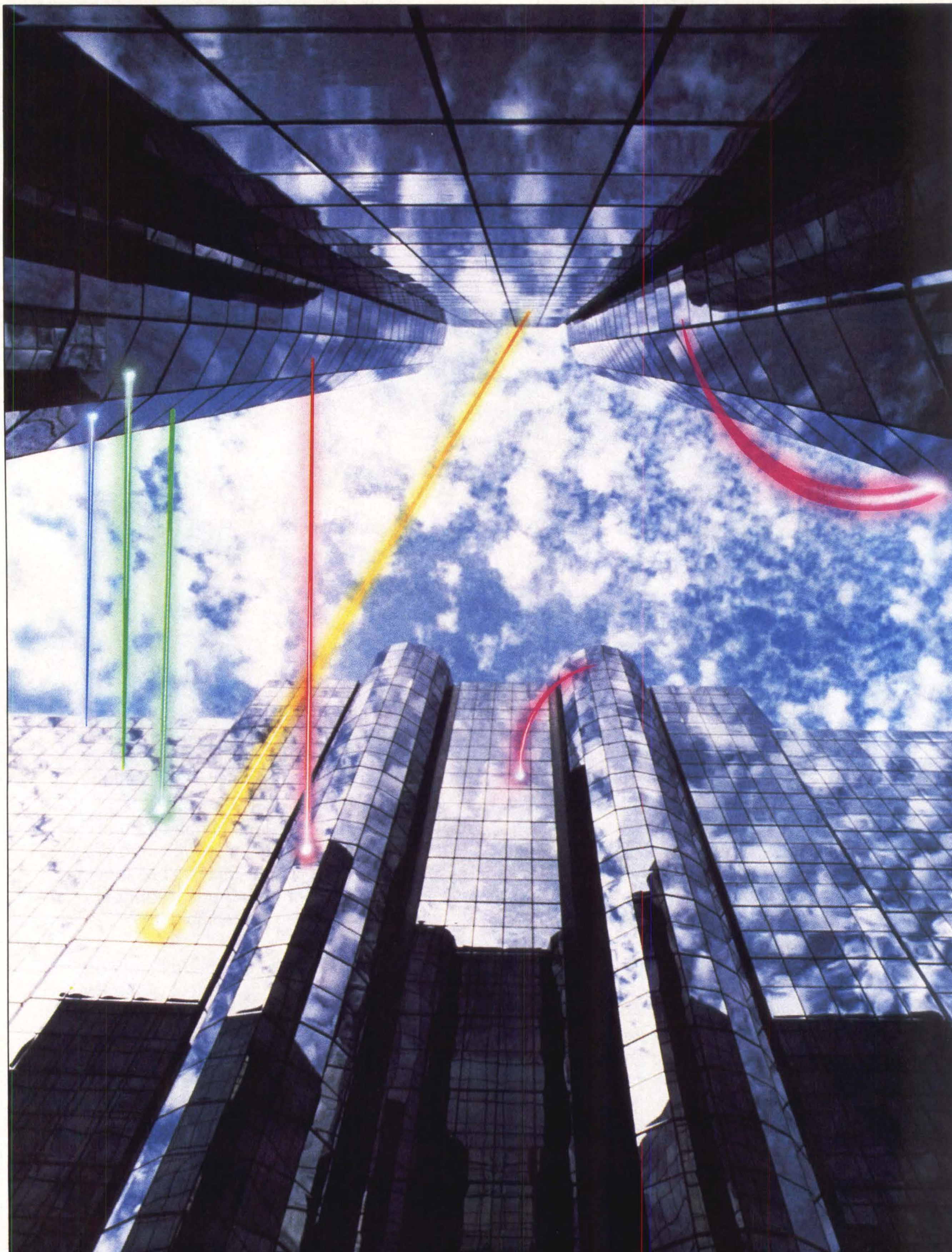

LANs: STATE OF THE UNIONS

To help you understand LANs' increasing popularity, herewith is a guide to their diverse technologies, topologies, protocols and standards, along with comparisons of the different networks

Robert K. Southard, AMP Inc.

Information must be accessible when and where it is needed, or it simply isn't information. Local area networks use effective communication arrangements to move this information. LANs consist of computers or computer-associated devices, electronic hardware interfaces, specialized software and a cabling medium for interconnection.

Often, the computers and their network interfaces connect to a common cable, such as Ethernet. The software is usually contained in a nonvolatile memory at the network interface, which includes a microprocessor and specialized hardware to distribute network intelligence. Because the intelligence is distributed, LAN systems, in most cases, have no single point of failure.

LANs are usually owned by the user, as opposed to being rented, like services from a common carrier. They are geographically limited to communications within a building or to a nearby facility (under several kilometers). Their high bandwidth or data rate provides a variety of services, which are typically implemented through some form of data packet transfer. Thus, LANs handle communication chores requiring very high-speed transmission, but only for short, intermittent periods of time. However, certain LAN techniques allow continuous data transfer.

Uniform interfaces and protocols are a must so equipment can be connected in a standard manner. This approach avoids pitfalls in determining how a particular machine should communicate with others on the network; it also allows interoperability among equipment from various suppliers.

The lay of the LAN

Gray areas exist as to exactly what a LAN is and what it is not. In the past, private branch exchanges (PBXs) and computerized branch exchanges (CBXs) provided the bulk of local voice and data communication, usually through the same system. Today, these exchanges are not generally considered LANs, because they lack uniform interfaces and protocols and have a single point of failure.

Usually a PBX system has a limited bandwith. When dissimilar equipment is connected through a PBX, additional devices, such as protocol converters, must be added and shared when needed by the system users.

A CBX, also known as a data PBX, is a central switching device used with computers; it doesn't establish voice communication. As a form of data switch, the CBX establishes virtual point-to-point communication between com-


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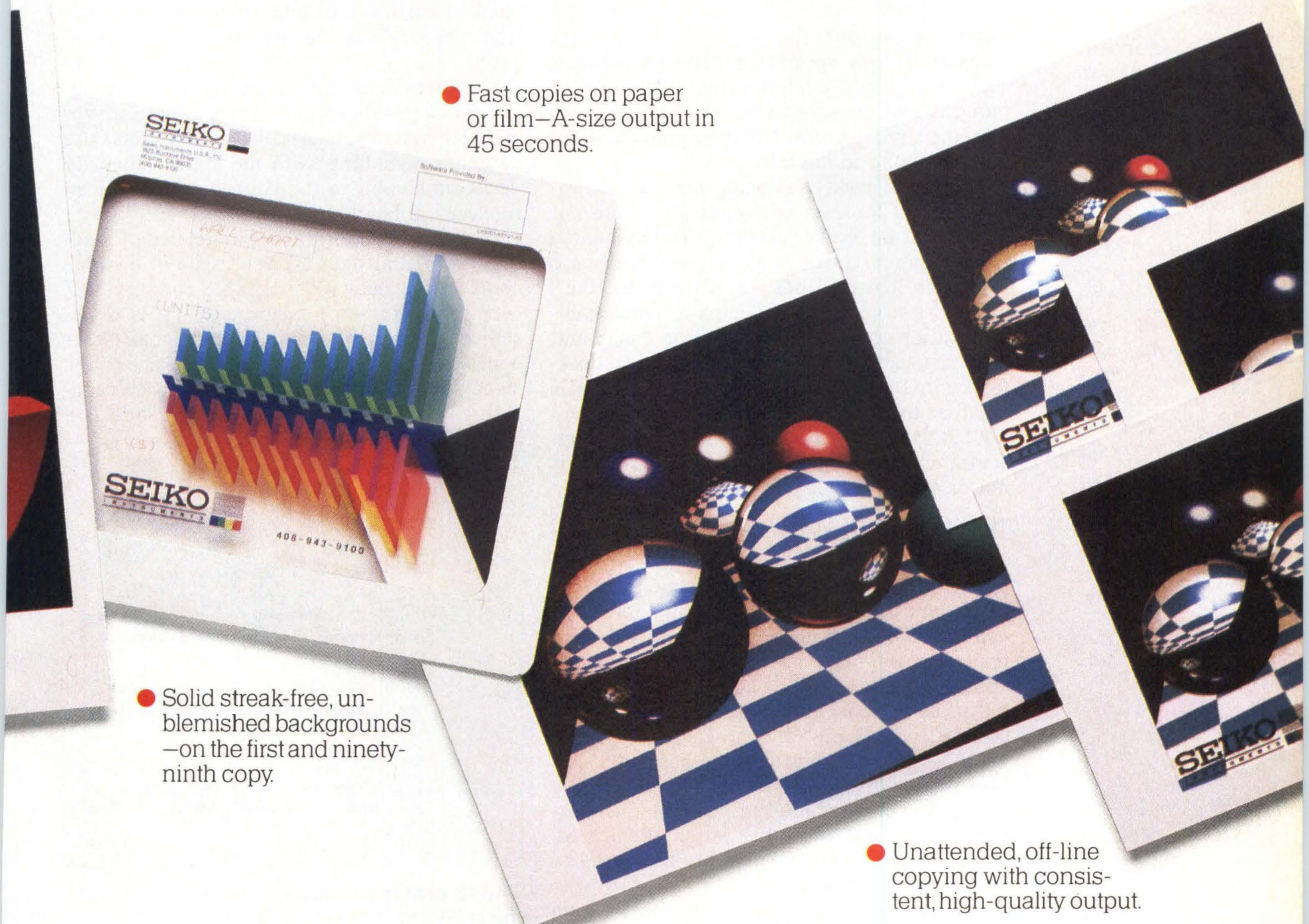

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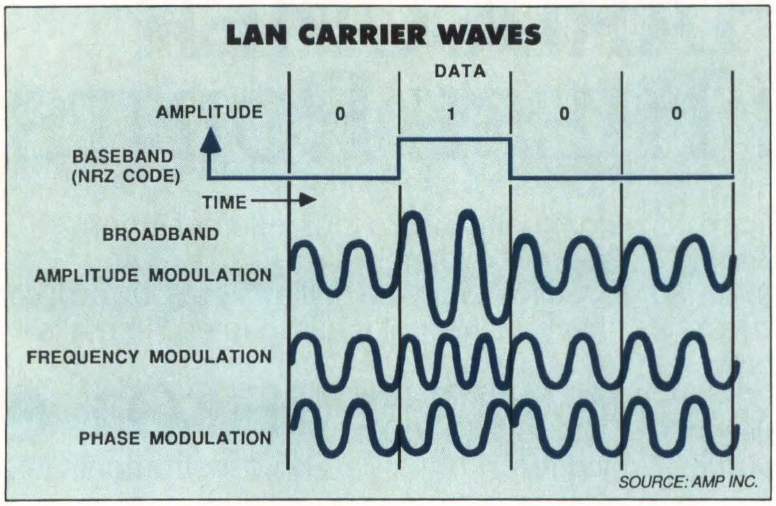
Visuals courtesy of Ramtek Corporation, Matra Datavision, Computer Design Equipment Incorporated.



Baseband frequencies *with simple, non-return to zero, code are ample for unsophisticated transmission. But most LANs need the capacity of high-frequency, broadband transmission, as furnished by amplitude modulation (AM), frequency modulation (FM) and phase modulation (PM).*

puters or peripherals, as required for data transfer. It may support additional features such as user port contention, queuing of user requests and password security. Although addressing similar needs, CBXs lack many of the features found in modern LANs.

Computer packet-switching networks, commonly used for data communication, are not considered LANs, because they usually handle long-distance traffic and rely on hardware (switches, leased lines, satellite links, etc.) owned by more than one company. Other communication chores, such as electronic mail and file sharing, are handled by connecting a desktop computer to an electronic switch or PBX and then to a large computer. These systems are not LANs, because network intelligence is concentrated in the PBX or large computer; it is not dispersed throughout the network.

TECHNOLOGY

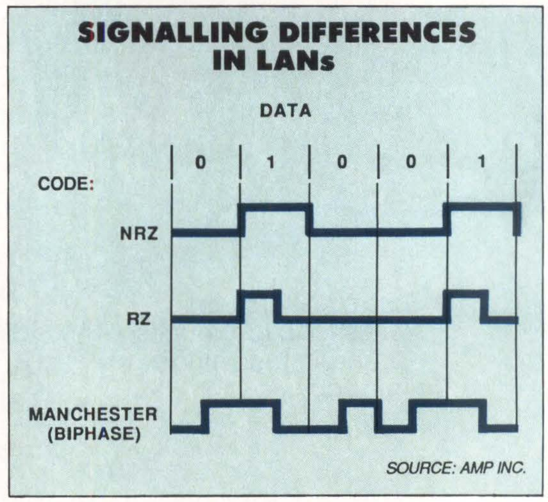
The major cable is a network medium that interconnects stations. Twisted-pair cable is inexpensive but, in most cases, limits performance to low data rates; about 1M bits per second. It can reach 10M bps over limited distances. Coaxial cable, used in over 90 percent of today's LANs, has acceptable bandwidth—from 10M bps to more than 100M bps over limited distances—to match the capability of system components. But, it is relatively expensive. Triaxial and other forms of shielded, controlled-impedance cable are also used to interconnect stations.

Optical fiber represents an area of high growth and decreasing costs, with high performance driving the technology. Because of the short distances involved in LANs, multimode fiber (at 850-nm wavelength) is finding immediate application. In the future, the 1,300-nm wavelength will increase in popularity as compatible electro-optic components become easily available.

Concerning modulation, each bit of digitally transmitted information is represented by a signal change on the network medium. If the bit is represented as a particular signal level, it is called baseband modulation or signalling. If the bit is represented by either amplitude, frequency or phase of an RF (radio frequency) carrier, it is called broadband modulation or signalling. Baseband modulation allows for simpler electronics using line drivers and receivers, but is limited to typical digital electronic speeds in its information-carrying capacity. Broadband modulation requires RF circuitry similar to that of CATV devices, but delivers signals on various frequency bands or channels. Each channel carries a sizable amount of information, approaching the capacity of a baseband LAN.

Optical systems rely on the amplitude modulation of a light beam, which is a form of carrier as in RF systems. Generally, these systems use baseband signalling, with the optical intensity variation similar to the voltage variation seen in electrical baseband systems.

In digital encoding, a feature related to modulation, digital data are represented by some code on the network. A simple code is NRZ (non-return to zero), where each bit is represented by a state of the modulated signal. Other codes can impart special characteristics to the signal, thus enhancing network hardware capabilities. For example, Manchester code is a



These profiles of LAN *frequencies illustrate the differences among non-return to zero, return to zero and Manchester codes. In NRZ, there is no return to a reference voltage between bits, as with RZ. Manchester code doubles the signalling rate by using two states to encode each bit.*

biphase code that employs two states to encode each bit of data. This code doubles the signalling rate (or baud rate) on the network. Manchester code is used in Ethernet applications and many optical-fiber links, since it allows an average 50 percent duty cycle to the network signals.

Traffic collisions cause garble

An area somewhat unique to LANs, access method, stems from LANs' distributed network intelligence. One method to access the LAN medium is through contention. Any unit on the LAN may send data whenever it wants. Because, when two devices send signals concurrently the data becomes garbled, most contention schemes require that stations listen to the network and send data only when the network is idle. But then, if two stations begin transmitting simultaneously, a data collision results. Collision detection schemes reduce the time collisions exist in a network, thus improving the overall network throughput. Contention systems function without collision detection. Error checking usually is included in message transmission software, and garbled messages are repeated.

Another way for stations to gain network access is through token passing, where a special message (the token) is sent from station to station. A station can transmit a message on the network only after it receives what is called a "free token" from another station, indicating that the network is accessible. Tokens take on several forms, depending on the type of network in which they are employed. A free token can be a simple message of a few bytes going from one station to the next. Another kind of network may require the free token to include the destination station's address, and perhaps the sending station's address. The shorter the free token, the faster it's passed around the network.

When a station receives a free token and requires access to the network, it issues a "busy token." This token includes the addresses of the source and destination stations and precedes the transmitted data. Other network status information, priority codes and error detection and correction (EDAC) information may be included in the message. A special bit sequence, called a preamble, may also precede the message to initialize circuits in the receiving station.

When passing the token around the network, a station may go off-line; and be unavailable to receive this special message and pass it on. Also, the token can be corrupted by noise so it is never detected as being received, and network activity ceases. The network usually requires one unit to serve as a watchdog or controller to handle these conditions.

TYPICAL DATA SPEEDS

Data source	Data rate (k bits per second)
Sensors, security	0.1
Common terminals	1.2-4.8
Graphics character	4.8-9.6
Word processor	9.6
Facsimile	9.6
Line printer	19.2
Data enquiry terminal	56
Digitized voice-real time	64
File server-light duty	100
Graphics-noncompressed pixel	256
Gateway to outside network	1,500
File server-block transfer	10,000
Video-noncompressed	25,000
Video-broadcast quality	80,000
Host channel	10,000-100,000

SOURCE: AMP INC.

A time-slot network allows each unit to send data only during a designated time interval. No one station uses full capacity, since each unit transmits only during a small percentage of the total time available. Here, system effectiveness suffers, because the capacity required is not uniform from station to station, nor is it static with time. Also, the time slot handles voice communications. This real-time voice transfer requires access to the communication system on a regular, repeatable basis. A time-slot network supplies this capability, while neither the contention nor token-passing access methods do this for any appreciable number of voice connections.

TOPOLOGY

The arrangement, or connectivity, among the stations in a LAN is referred to as its topology. The two most common arrangements are the bus and ring, although tree and star topologies are sometimes seen. Each of these arrangements promote certain performance differences in a particular network.

Bus topology involves a linear, usually continuous, medium where all units attach directly, often by tapping. Each station transmits and receives signals on this commonly shared medium, following the access-method protocols for the network. These signals usually travel in both directions on the bus from their point of insertion, until dissipated in terminators at the bus' ends. A bus is like open-air broadcasting, since any station's transmission is detected by every other station in the network.

Ring topology connects each station to the one preceding and the one following. This results in a continuous, closed path upon which signals circulate throughout the network, usual-

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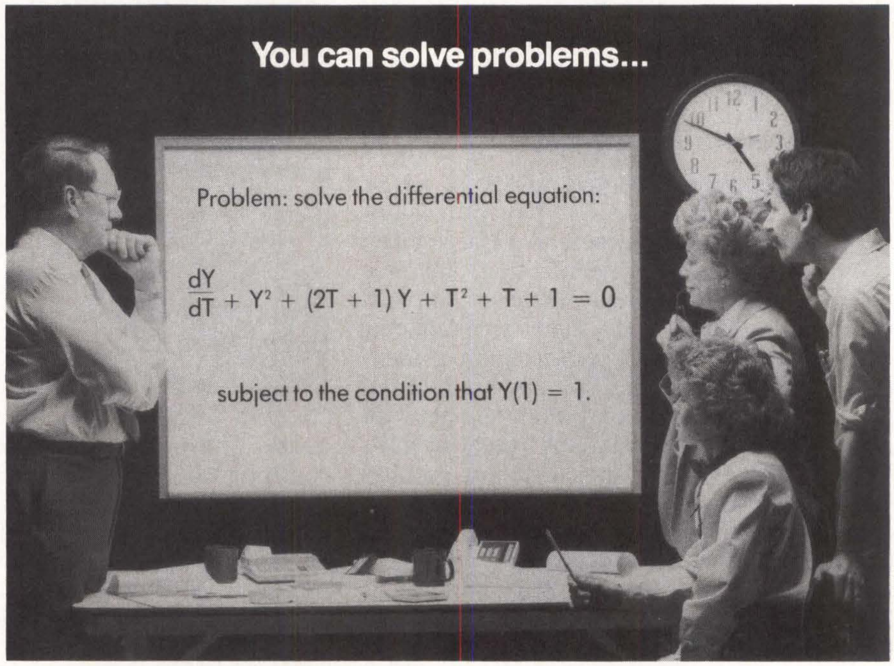

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(C1) DEPENDS(Y,T)$

(C2) DIFF (Y,T) + Y ^2 + (2*T + 1)*Y + T ^2 + T + 1;

(D2) $\frac{dY}{dT} + Y^2 + (2T + 1)Y + T^2 + T + 1$

(C3) SOLN:ODE(D2,Y,T);

(D3) $Y = -\frac{\%C\,T\,\%E^T - T - 1}{\%C\,\%E^T - 1}$

(C4) SOLVE(SUBST([Y = 1, T = 1],D3),%C),NUMER;

(D4) [%C = 0.5518192]

(C5) SPECIFIC_SOLN:SUBST(D4,SOLN);

(D5) $Y = -\frac{0.5518192\,T\,\%E^T - T - 1}{0.5518192\,\%E^T - 1}$

and Numerically.

```
(C6) FORTRAN(D5)$
          Y = -(0.5518192*T*EXP(T) - T - 1)
     1         /(0.5518192*EXP(T) - 1)
```

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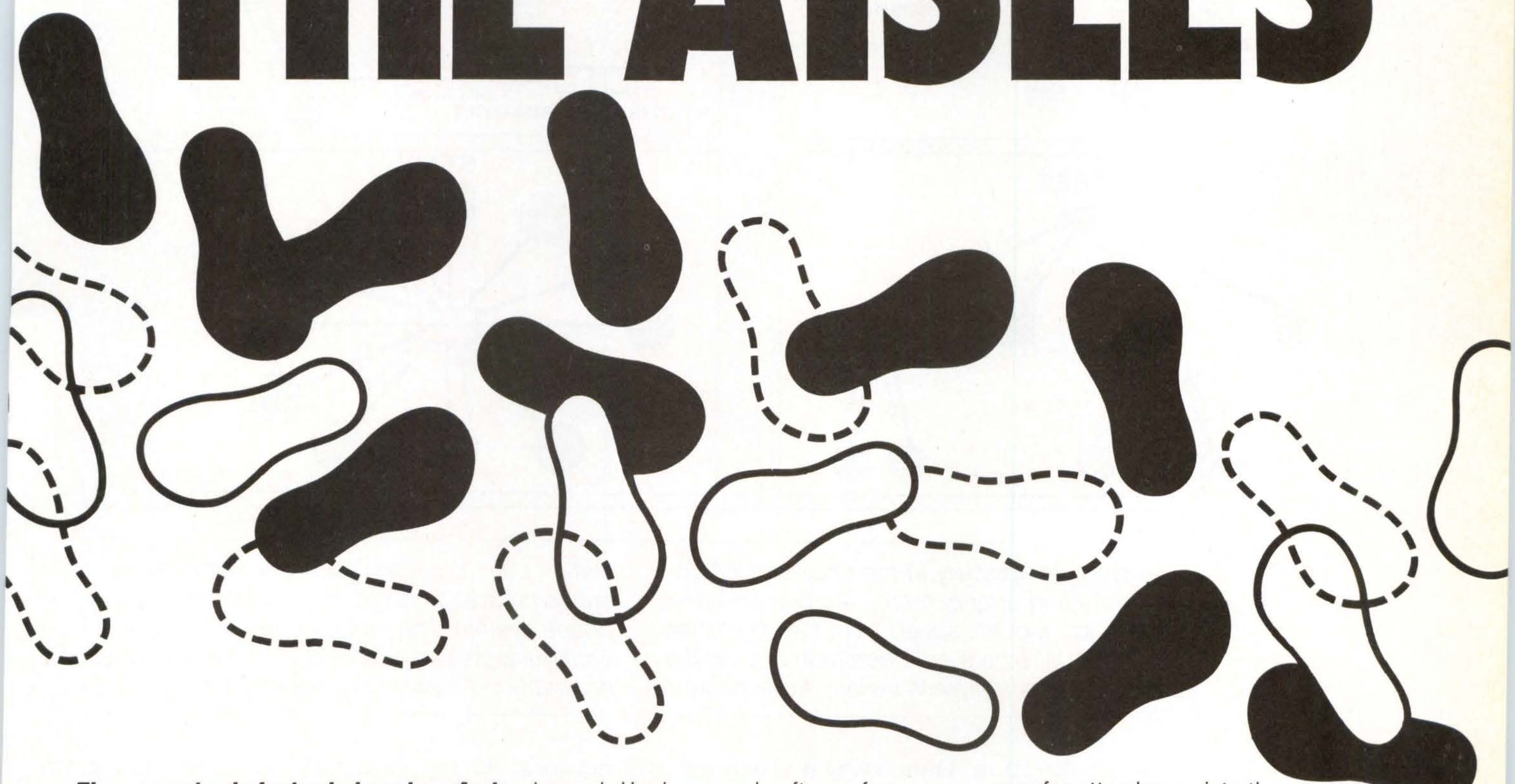

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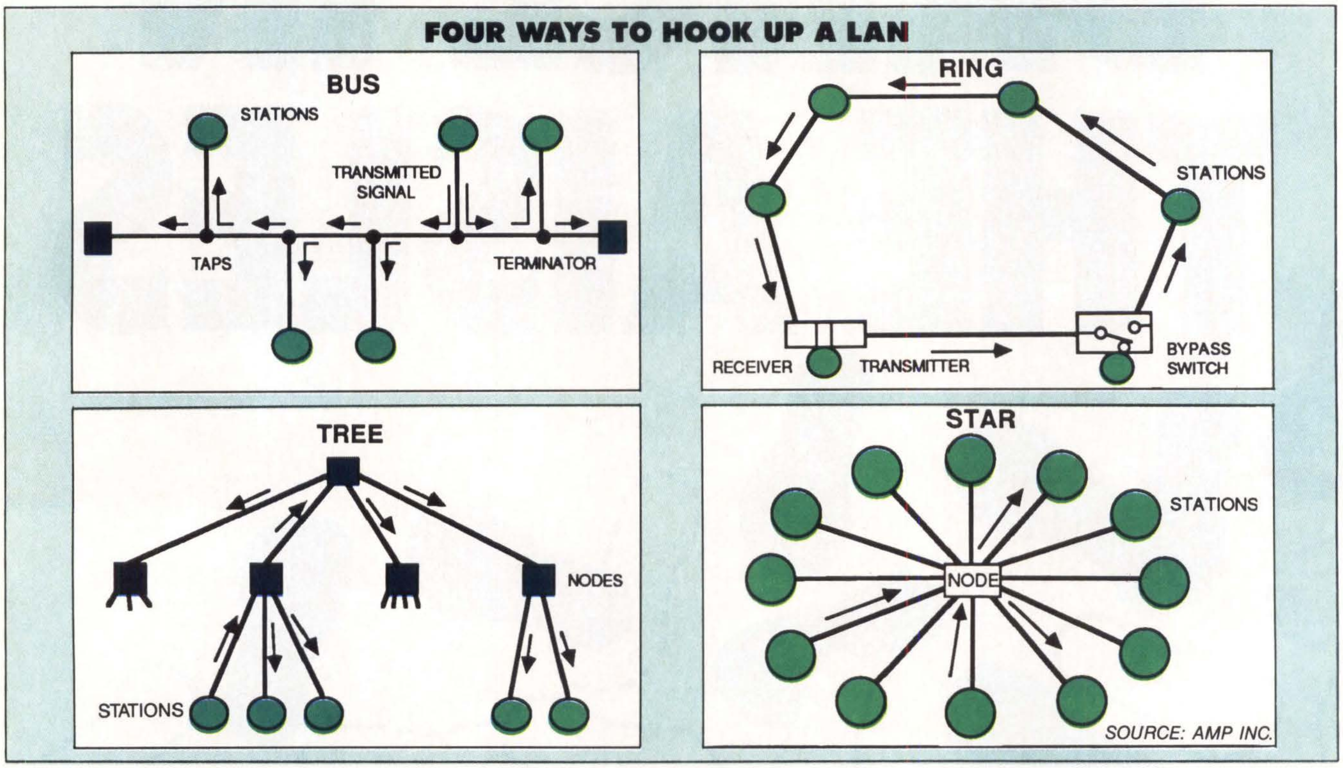

Topology is destiny *in the choice of LANs. Two common arrangements are bus and ring. In the first, signals speed from the orginating station to all others on a common bus. In the second, a signal travels serially from station to station until it reaches its destination. The hierarchical tree arrangement is typical of the phone system. The central node in the star configuration can either serve the other nodes or simply be a passive transfer point.*

ly in one direction. Thus, a ring is visualized as a series of point-to-point links. When a station transmits, only the following station receives the message. This station either retransmits the message to the succeeding station or carries out some action directed by the message. Since proper operation of a ring requires each station to do one or the other, certain inherent problems must be dealt with. For example, if a station is turned off or disconnected from the ring, some mechanism must assure that the station is properly bypassed. This is often done with a relay or sometimes manually by using jumpers or a special shorting connector.

In the tree topology, multiple branching connections are formed in a hierarchical arrangement. A station usually transmits to a higher level network node, which passes the message along to another station or to an even higher level network node. This topology is used in many LAN and non-LAN networks, such as the local phone system.

Somewhat similar to the tree, star topology has each station connected to a central node. The stations communicate only with this node. The node could be an active element in the network, having duties like message routing, priority designation and network maintenance. It could also be passive, simply a tie point. In this case, the network has broadcast properties, because any station's message ultimately arrives at every other station. This makes star's performance similar to that of bus topology.

An important distinction between two other topology areas, physical and logical, must be established. Physical topology refers to the wiring of a system; logical topology refers to the flow of signals in the network. A system wired in star topology could have stations connected point to point, in order to function like a ring. This popular approach is called star-wired ring, and is used by IBM Corp.'s Token-Ring Network and other networks.

PROTOCOLS

LANs use uniform protocols and interfaces, thus allowing dissimilar equipment to communicate easily. Previously, vendors of communication systems defined their particular standards independently of each other. For LANs, a standardization effort has existed for some years with wide industry acceptance. Under the

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International Standards Organization, this standardization effort is called the Open Systems Interconnection (or ISO OSI) model. The model embodies these following concepts: defined protocols for messages and their exchange; hierarchical structure of tasks; functional grouping of tasks, defined boundaries between tasks (interfaces); encapsulation of information with headers and trailers; and defined communication between tasks on equal hierarchical levels, as well as between the next higher and lower task.

The OSI tasks are specified in the following seven layers:

• **Physical Layer,** concerning transmission of bits on the media, thereby involving mechanical/electrical concerns and dealing with hardware. Specified are connector and pin assignments, voltage levels and the methodology of initial connections (involves RS232-like specifications).

• **Data Link Layer,** controlling a single channel with data segmented into groups of data bits (a specified number). Additional bits (a header and trailer) are added to the groups to form frames. This function usually involves specialized electronics in the interface, and some intelligence in the station-to-network interface.

• **Network Layer,** involving moving messages from place to place within the network. In this layer, frames are put together to form packets, which contain routing/sequencing information for proper passage through the network. This layer is usually implemented in specialized hardware and software in the interface.

• **Transport Layer,** involving end-to-end message flow, routing and message integrity. Packets are put together to form messages. This lowest layer with hardware dependency is mainly implemented in software (like Session, Presentation and Application layers).

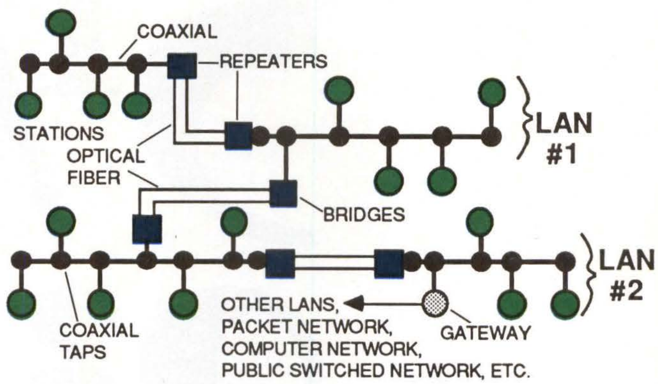
• **Session Layer,** managing dialogue between users and sets up and terminates communications in the network; it provides the equivalent of a network log-on function.

• **Presentation Layer,** performing code conversions and format translations. It not only establishes the character set and meaning but also controls line length, page length, text compression and data encryption/decryption. This is a software function.

• **Application Layer,** including the software drivers that interact with users' application programs. The OSI architecture interfaces a user's hardware to the communication system and may allow terminal support, file transfer, mail service, etc.

A total communication system requires all of these layers to be functional; a typical interconnection system deals only with the Physical Layer.

FROM ONE LAN TO ANOTHER



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LAN connectivity *is achieved through repeaters, bridges and gateways. Repeaters carry messages between two sections of a single LAN, bridges introduce similar LANs and gateways link dissimilar LANs and non-LAN systems.*

Ties the knot between LANs

The OSI model does not imply that all LANs are directly compatible. Different types of LANs still need special apparatus to communicate with each other, as may the same types of LANs. The OSI model provides defined and differentiated methods of effective intercommunication—with repeaters, bridges and gateways playing an important part.

Repeaters operate at the bit, or Physical level of the OSI model. They extend a particular LAN past the normal physical boundaries imposed by its electrical characteristics and the media used. A repeater restores voltage levels, sharpens signals and deploys them over an additional section on the same LAN. The sections on the two sides of a repeater form a single LAN. Therefore, the LAN operates on only one message at a time.

Bridges operate at the frame level, or Data Link Layer, of the OSI model. They allow identical LANs to communicate. A bridge permits two LANs to function independently, yet provides a path for one LAN to easily communicate with another LAN. Each commercial LAN probably offers a bridge product that accomplishes these functions.

Gateways operate at the packet or message levels, which correspond to the Network and Transport layers, respectively. Gateways connect dissimilar LANs and can also link up to an external, non-LAN communication service. A wide variety of gateway devices is commercially available.

STANDARDS

With many LAN hardware suppliers, interoperability must be assured to users. To pro-

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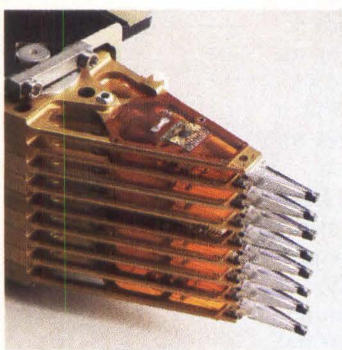

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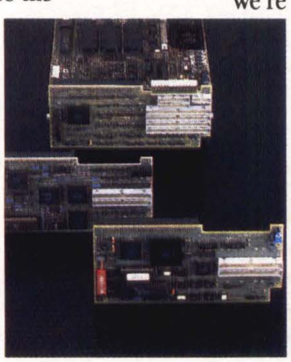

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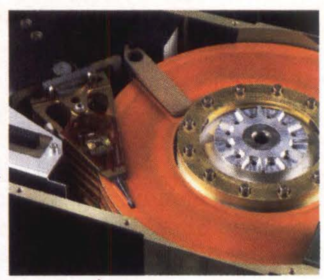

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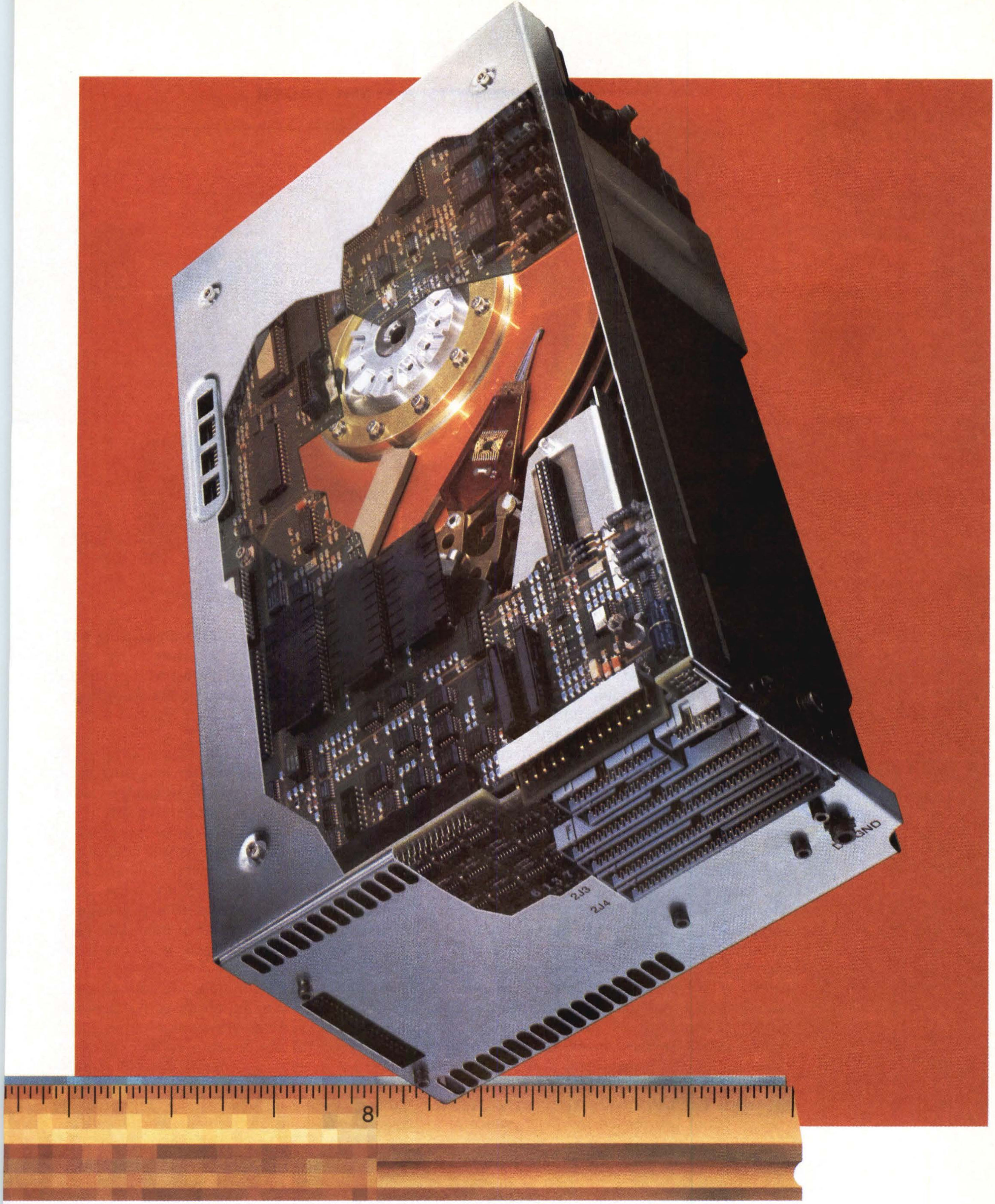
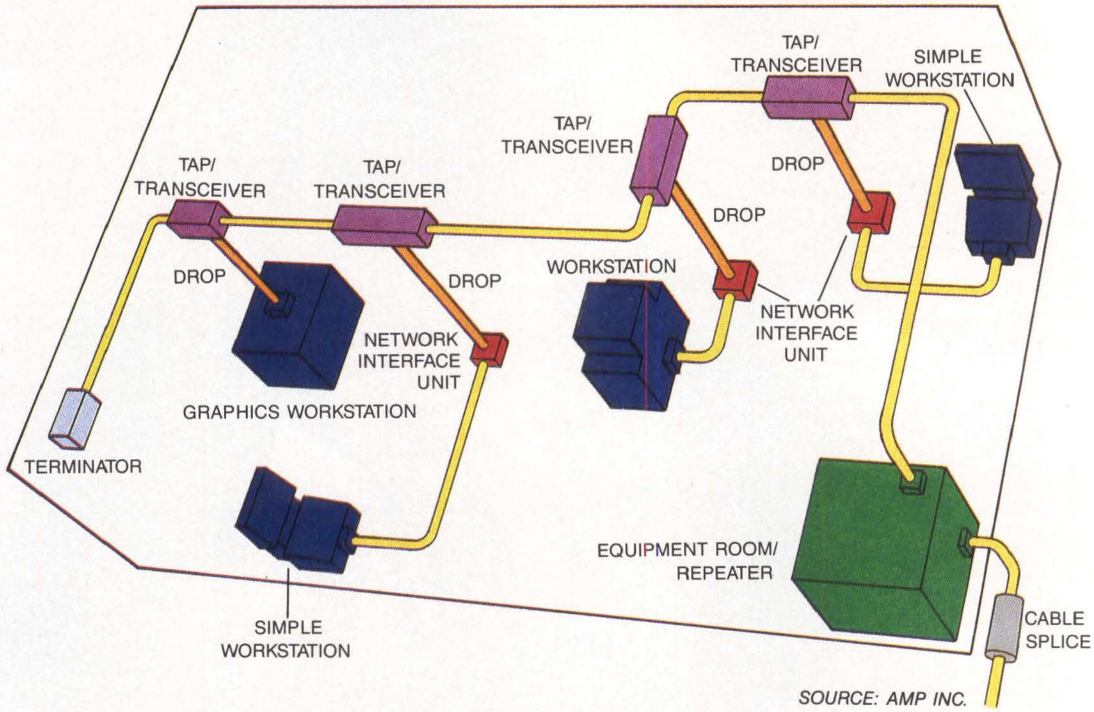
CONTROL DATA


8
2J3
2J4
GND

The CSMA/CD protocol, *as shown here, operates best in lightly loaded applications. A large, high-grade coaxial cable allows for easy tapping by workstations. Some applications of the IEEE 802.3 standard employ optical fiber.*

PROTOCOL WITH A LIGHT TOUCH



SOURCE: AMP INC.

mote this result, standardization efforts through various industry committees are necessary. And since there is not a single network design meeting all possible applications, a variety of standardization committees work on LAN definition. Some major activities are undertaken by the IEEE 802 committee. Most of one subcommittee's work is involved with specific LAN implementations at the Physical Layer. Two other subcommittees review and standardize the higher network levels, as an umbrella to the other subcommittees. IEEE 802.1 deals with network architectures; IEEE 802.2 deals with logical link control. The latter addresses Data Link layers; the former is involved with higher layers in the OSI model.

The IEEE 802.3 LAN standard, known as the carrier sense multiple access with collision detection (CSMA/CD) bus, is closely associated with Ethernet and involves contention access on a bus topology. To reduce simultaneous transmissions on the bus, CSMA/CD's design requires that the transmitting station listen to the bus and confirm that no transmission is in progress. This is called carrier sense. Active transmissions are sensed by the presence of a DC voltage (due to signals) on the coaxial media. Collision detection avoids data-stream overlap and garbling when more than one station transmits simultaneously. Collisions are detected when a transmitting transceiver senses improperly high DC voltage levels caused by having two or more signals. When a collision is detected, the interface stops transmitting until later. The transsceiver also sends a jam signal out over the bus so all network stations are alerted to the collision and can act accordingly.

Performance considerations

Operating at a 10M-bps data rate (20M baud), due to the Manchester encoding used, the bus' best performance is in lightly loaded applications that allow almost instantaneous bus access. Because of the random nature of collisions, bus performance is not deterministic, and performance characteristics and message transmission delays are not predictable. Obvious problem areas are priority messages, such as with a fire-detection system, and voice traffic, where uniform access to media bandwidth is required.

A large-diameter, high-grade coaxial cable allows invasive tapping on an active network, through a coaxial tap. However, obtaining high network performance tends to be expensive. Other LAN versions, installed under THIN-NET or CHEAPER-NET, use less expensive cable (RG-58) but experience higher cable losses. This situation limits network lengths to less than IEEE 802.3's 2,500 meters. Also, these systems use simple BNC connectors and T couplers for device attachment.

Optical-fiber versions of the bus typically employ a star connection to a central location that houses either an active or passive optical coupling scheme to distribute signals. Often,

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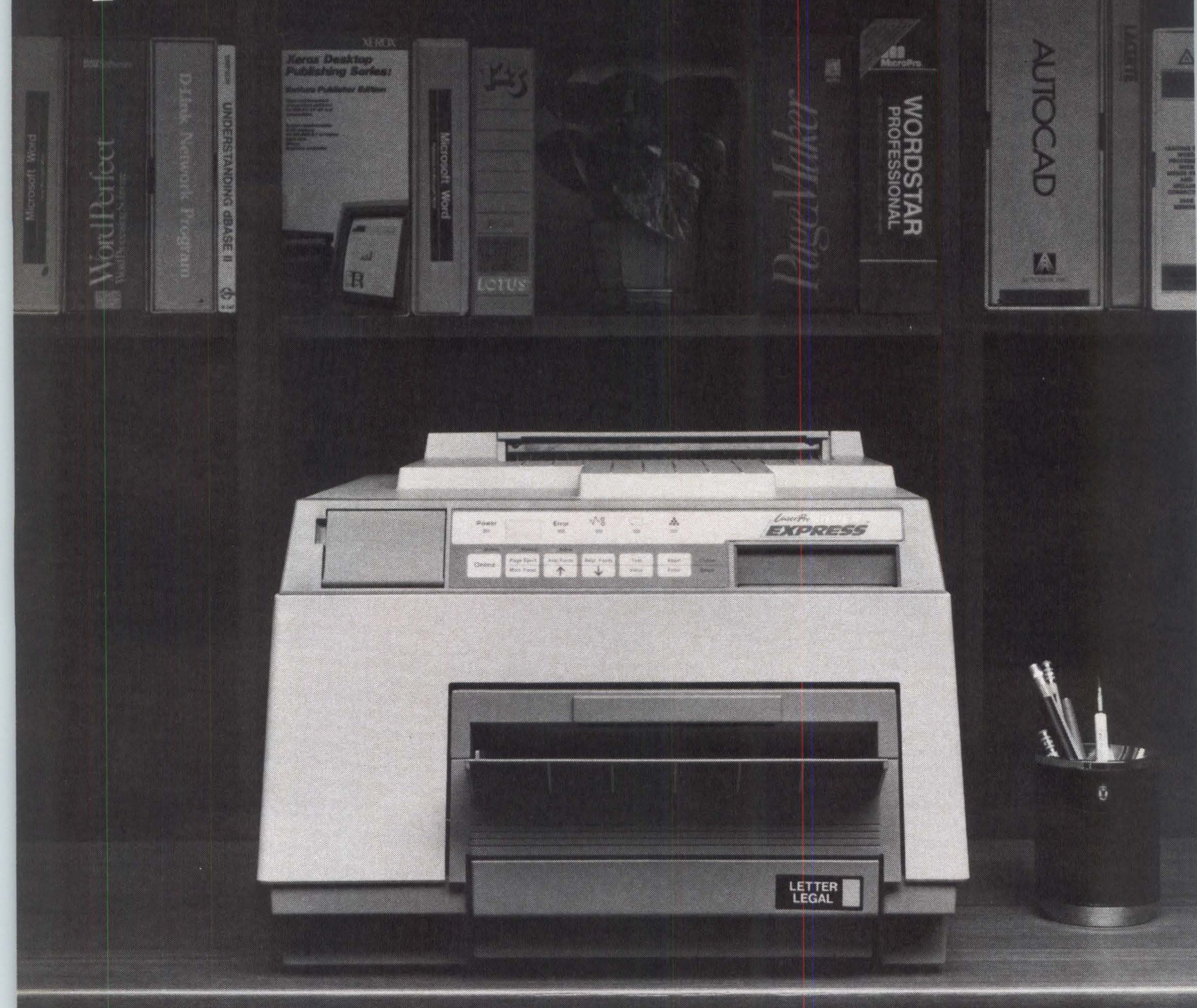

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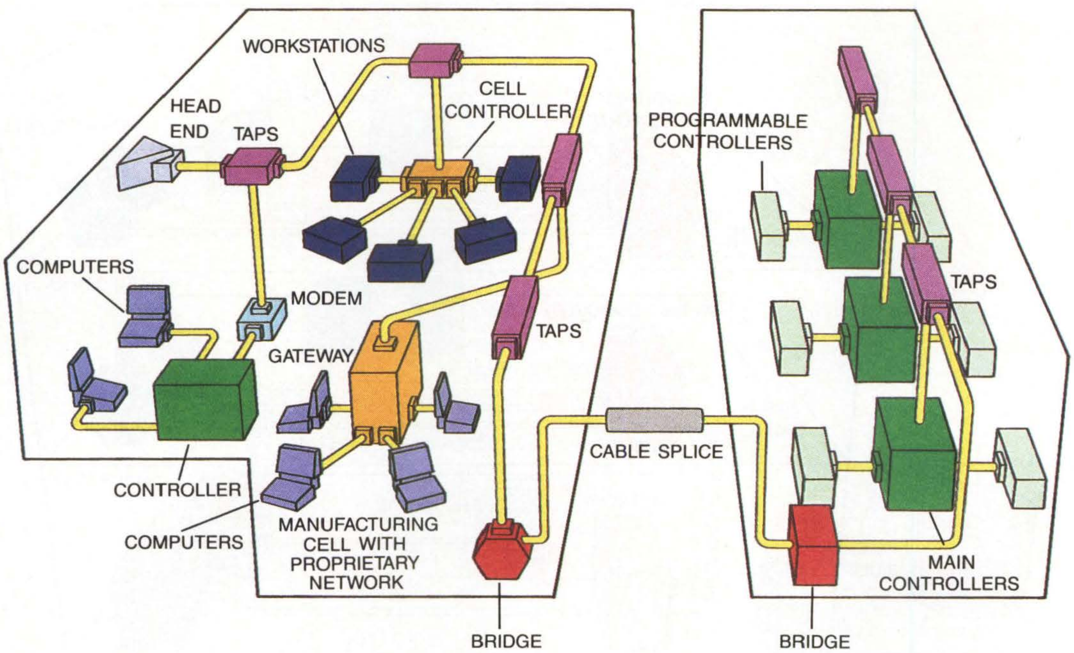


SOURCE: AMP INC.

The broadband token bus *protocol uses coaxial cable to support high data rates in serving large-system configurations. Based on the IEEE 802.4 standard it enjoys support in MAP applications.*

collision detection is implemented at this central location, rather than at individual stations. Frequently, optical fiber interconnects two segments of an Ethernet system physically separated by at least a kilometer. An optical, point-to-point link is used with repeaters to regenerate the bus signals.

The IEEE 802.3 LAN standard is the most popular one. It is found in a variety of applications using desktop computers, workstations and host processors. Most systems use coaxial cable, either standard or thin size, while some employ optical fiber.

The IEEE 802.4 LAN standard, known as token bus, has strong support from IBM,General Motors Corp. and others, through the MAP (Manufactuers Automation Protocol) program. Token bus, a broadband modulation system using coaxial cable to support high data-rate paths, is advantageous where large communication systems are required. It can be implemented on a large RF communication system subchannel that has independent channels for CATV, voice, point-to-point trunks or other LANs. The user installing a broadband RF communication system is assured of a variety of services over the common medium. Baseband implementations are in the planning stage, and in the future, will be employed with less complex systems. Both types will operate at a 5M-bps or 10M-bps data rate for each token bus.

Broadband coaxial communication systems are expensive, require a high degree of engineering to design and maintain an installation and feature a head end. This equipment receives all signals in the system, and provides frequency translation to another channel for retransmission of signals to other network stations. Since the head end represents a single point of failure in the system, it must be ultra-reliable.

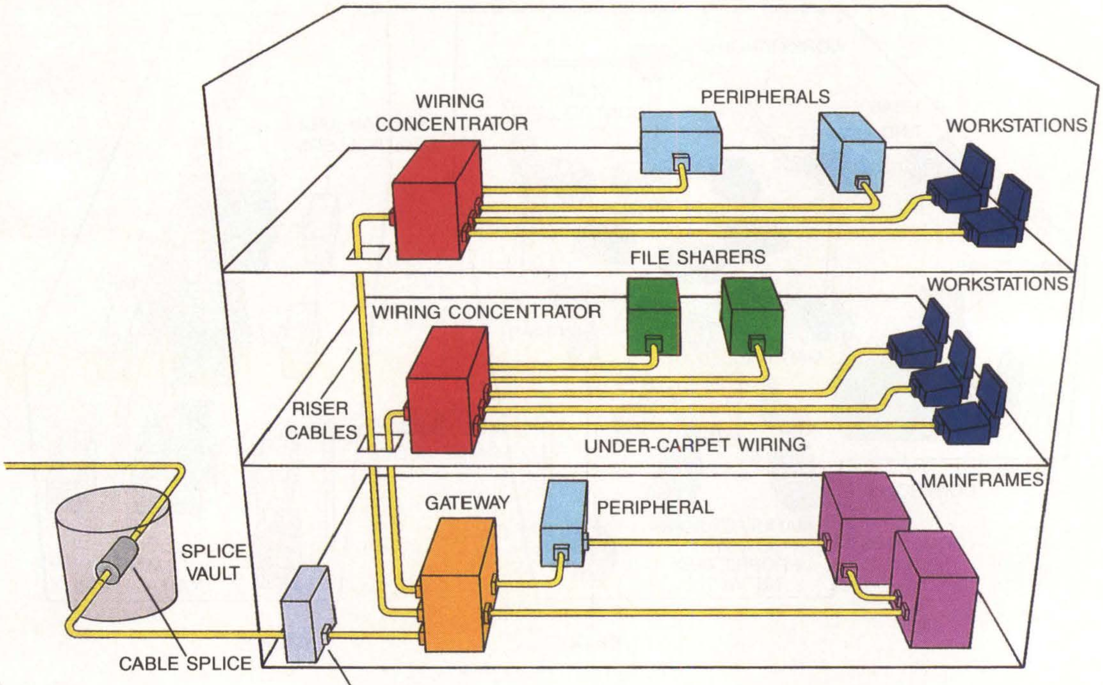
Some optical fiber proposals appearing in token bus employ baseband modulation and different connection schemes. In the future, they will mesh with the copper-based systems being proposed.

The IEEE 802.5 LAN standard, known as token ring, is receiving major interest from large computer manufacturers for use in office automation and similar tasks. Texas Instruments is working with IBM on a custom chip to implement the interface functions. This chip will allow low-cost access to the token ring. Speeds for these networks are expected to be 1M bps, 4M bps or 16M bps.

Token bus and token ring networks work well because they have the advantage of deterministic and predictable performance. Priority schemes, built into the token's data structure, allow message priority to be easily implemented. Heavy loading and turn-taking (resulting from token passing) are effectively handled by this priority system. Passing the token ring in a ring topology is accomplished quickly, since token retransmission can begin after the

The token-passing ring *protocol, based on the IEEE 802.5 LAN standard, accommodates office-automation and similar applications. Message priority is quickly and easily handled. While twisted-pair, coaxial and optical wiring can all be used, FDDI networks, as above, employ only optical fiber.*

PROTOCOL WITH VERSATILITY



SOURCE: AMP INC.

token's first bit is received.

Because a station has to wait for the token before transmitting, there can be significant delays in starting a message in a large network. Another disadvantage is the requirement for a designated monitor on the network to manage the token. This monitor handles problems such as a lost or garbled token, or the loss of a station from the ring. Complications arise when the designated monitor is lost from the ring. Token rings handle voice only under certain conditions and for a limited number of channels.

Token ring can use twisted-pair (useful to about 2 MHz only), coaxial cable and optical fiber. The point-to-point nature of ring topologies makes them strong candidates for optical-fiber applications.

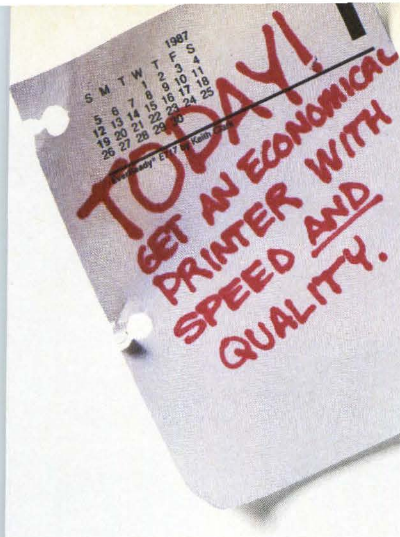
The IEEE 802.6 LAN standard, known as the Metropolitan Area Network (MAN), specifically addresses extending LAN technology to a larger geographical base. There is also a strong emphasis on providing voice communication as well as data. Proposals for MAN have involved ring topologies with time-slot access methods, and strong emphasis on optical fiber. High-speed rings form a backbone for communication among many smaller, lower speed rings. This effort is still in its early stages, and other proposals are being accepted for MAN standardization.

The ANSI ASC X3T9.5 LAN standard, known as the Fiber Distributed Data interface (FDDI), is ultimately aimed at high-speed communication using optical fiber exclusively. It employs a ring topology with token-passing access and baseband modulation, and, at 100M bps, is among the fastest being established. Providing high-throughput capability to host computers, peripheral controllers and high-performance workstations will be its main objective. A version of the network, called FDDI-II, handles voice traffic as well as data, thus allowing PBXs and CBXs to join the network.

NETWORKS

Because of LAN's increasing popularity, there has been an unbelievable proliferation of networks hitting the market, each with distinct advantages and disadvantages. How does one decide which network is best for their application? There isn't an easy answer to this question, but it is hoped the following section will help you in the decision process.

PCnet, a proprietary design of Sytek Inc., Mountain View, Calif., introduced by IBM for interconnecting their PCs, uses broadband technology. PCnet employs a CSMA/CD access method and bus technology, somewhat like Ethernet, but its broadband modulation transmits information at 2M bps. The network implements the OSI model up to the Session Layer. The Physical Layer is implemented in a custom RF modem; the Data Link Layer in Intel Corp.'s 82586 chip and custom VLSI circuitry; the Network, Transport and Session



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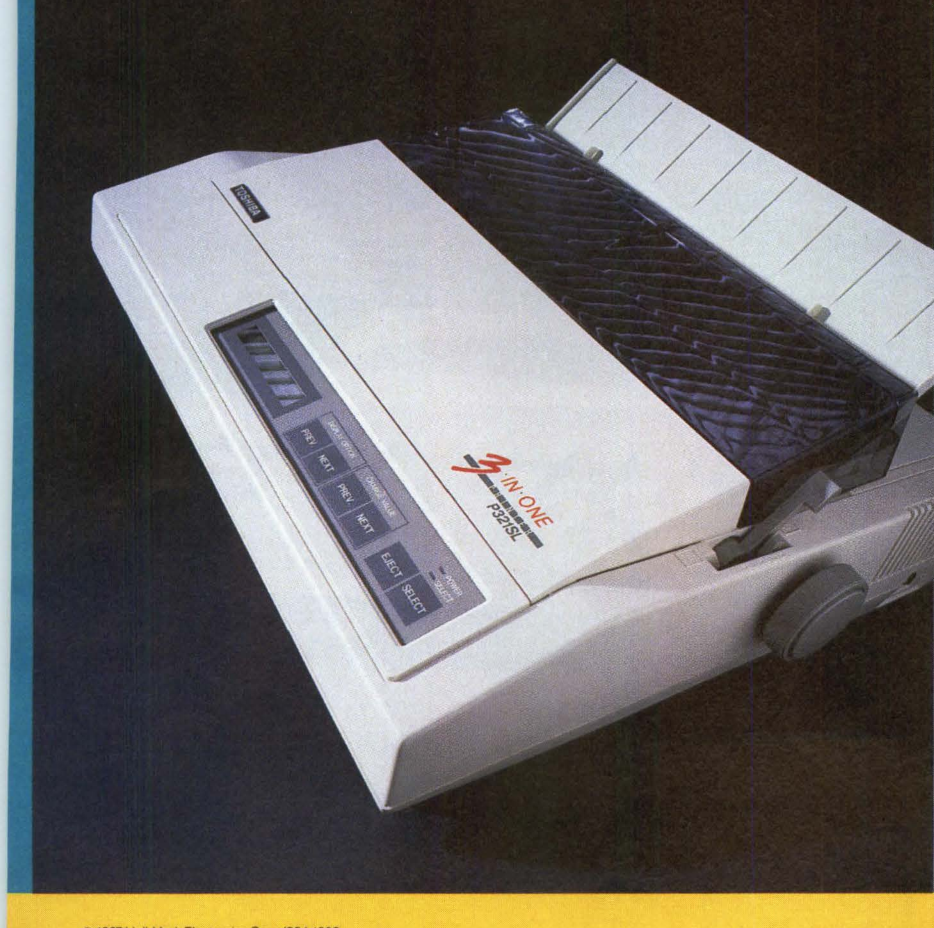

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D - Delete Record
I - Insert Record(s)
V - Verify Record(s)
T - Display Totals
M - Mass Edit
PA- Patch Append
L - Level Set
FM- Show Find Mask
FL- Find Like Level
P - Page Mode / Page Advance
FE- Find Exceptions/Errors
E - Edit Current Record
A - Append Records
Q - Quit (Exit)
VS- Locate next unverified rec
Z - Zero Total(s)
O - Display Stats
PE- Patch Edit
F - Find Record by content
FX- Enter New Find Mask
S - Save
PO- Page Mode Off
C - Clear / Reset
1:Prev 2:Next 3:Edit 4:Append 5:Find 6:Totals 7:Delete 8:Verify 9:Exit 10:HELP
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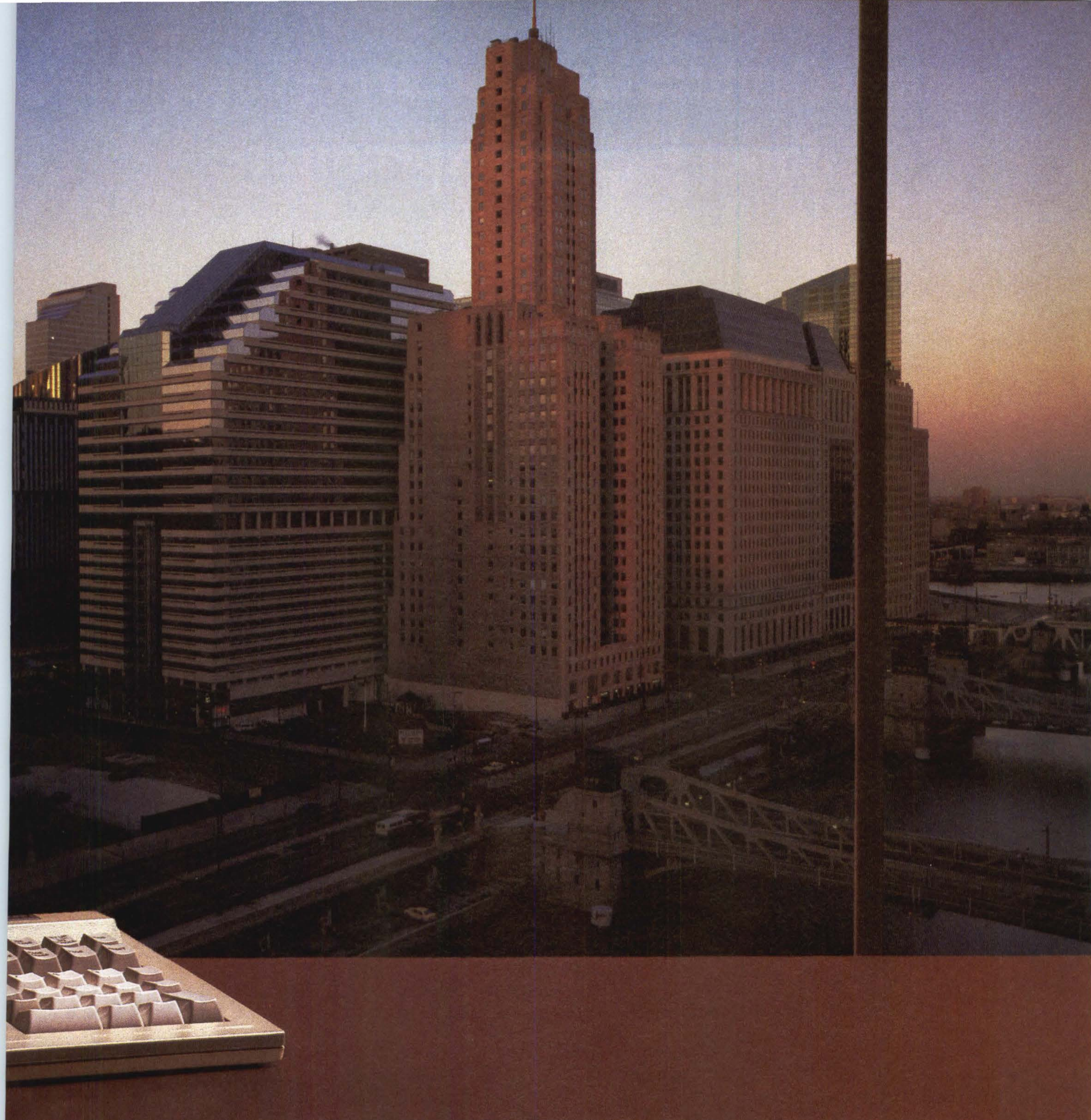

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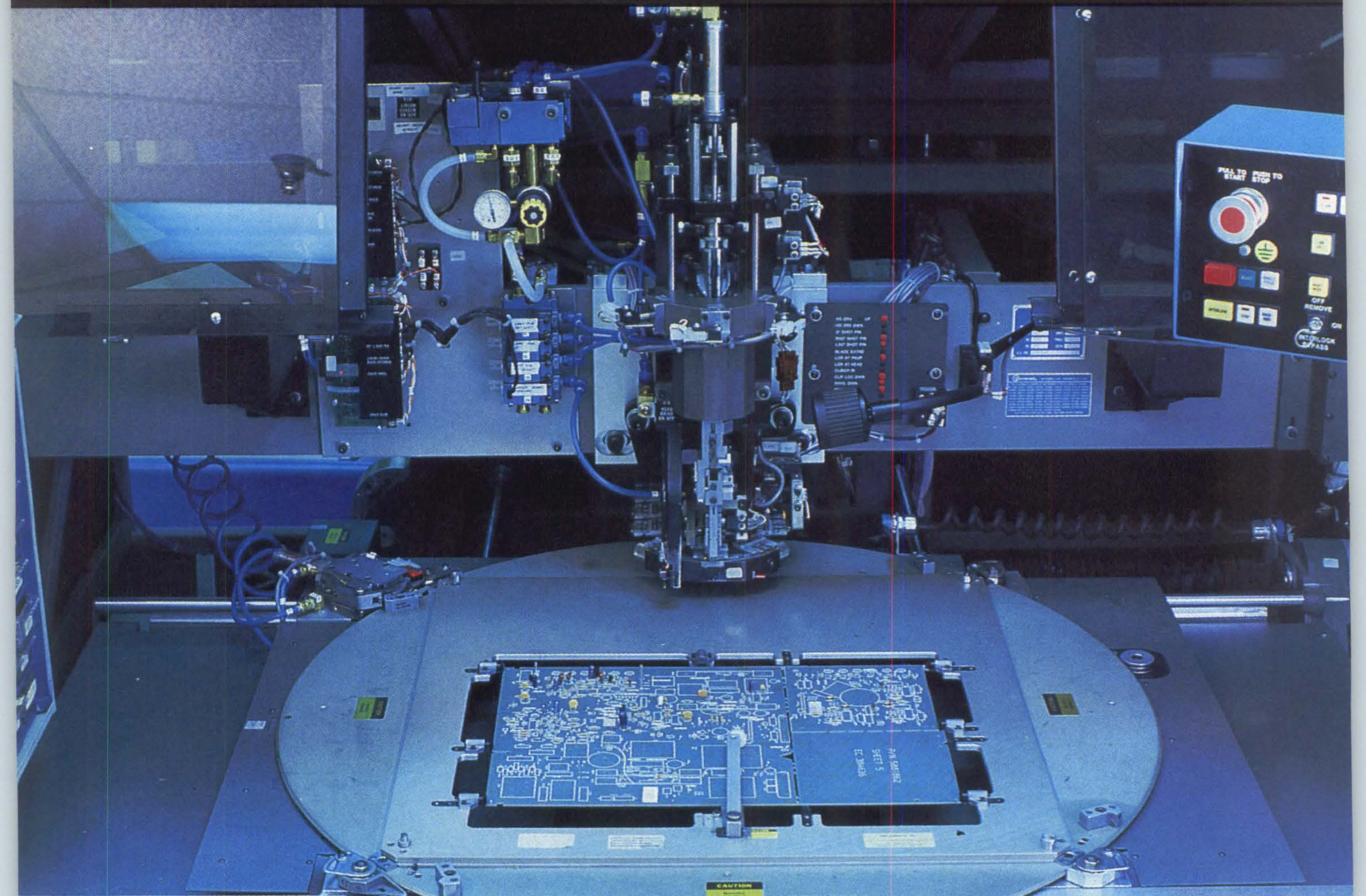

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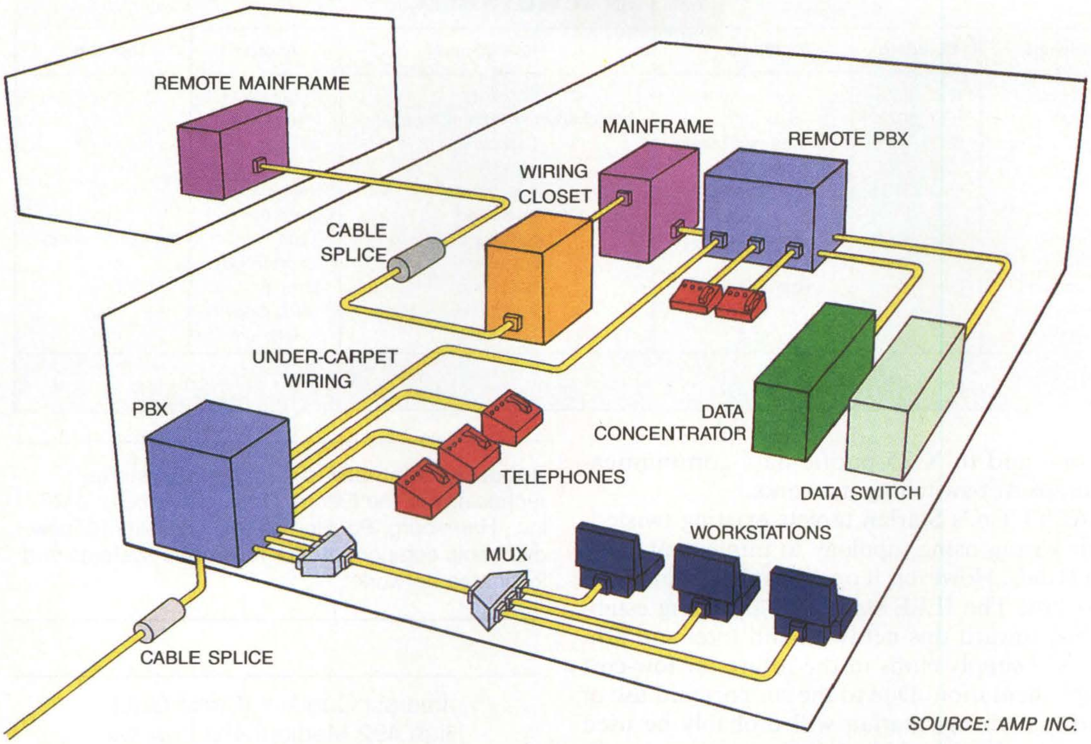
PROTOCOL WITH A HISTORY



SOURCE: AMP INC.

The veteran PBX, *still a networking workhorse, is not considered a true LAN due to the lack of uniform interfaces and protocols, and because the networks have a single point of failure. The above configuration serves both voice and data transmission.*

layers in an Intel 80188 microprocessor; and the related software driver in the PC's DOS software.

Connections to the network cost about $700, and the network requires a head end for about $600. The head end acts as a repeater and frequency shifter, because the coaxial media are unidirectionally used with different carrier frequencies for transmit and receive. A station transmits information on the bus at one RF frequency (ignored by bus receivers). This information is received by the head end, and retransmitted at a second frequency for the tuned bus. Since PCnet is fairly complex for a low-end LAN, very low-cost connections aren't likely.

Proteon Inc. of Westboro, Mass., manufactures LANs of a proprietary design. One example is a ring network operating at 80M bps using optical fiber or IBM Type 1 Twin-axial cable. This network uses star wiring for flexibility in network reconfiguration and functions as a backbone network for interconnecting slower networks, such as Ethernet or IBM's Token-Ring. According to Proteon, it can be upgraded to FDDI network standards in the future, when optical fiber is employed for network wiring. Other slower ring networks are also being offered by Proteon.

Fibercom Inc. of Roanoke, Va., offers a network using optical fiber in a ring arrangement. Although it employs a token-passing access method, one of its main capabilities is interconnecting Ethernet-type networks. Conversion from Ethernet's contention access method to the token-passing access method is accomplished by electronics in the Fibercom transceivers, and then is transported to the user.

Artel Communication Corp., Worcester, Mass., produces another type of ring. This optical-fiber ring uses a time-slot access method and operates at either 100M bps or 200M bps. In dividing up real time, 25M-bps channels are created. Thus, a digital technique apportions bandwidth like a broadband network apportions bandwidth based on frequency bands. The network will become compatible with FDDI as this standard emerges, and the network works with Ethernet, Token-Ring Network, IBM 3270-type systems and the CCITT's (ISDN) Integrated Services Digital Network. Counterrotating rings enhance network reliability.

ARCnet, from Datapoint Corp. of San Antonio, Texas, predates all other popular LANs, including Ethernet. Reportedly having over 6,000 installations and 200,000 connections, it is probably the most widely installed LAN to date. Its proprietary design employs coaxial cable, baseband modulation, token-passing access and a star or bus topology. Gateways are offered for a variety of external services, such as SNA/SDLC (Systems Network Architecture/synchronous data link control), HDLC (high level data link control), 3270, 3780 and HASP (Houston Automatic Spooling Program)—all

The various calls upon LAN *capabilities trigger diverse approaches and the consequent drive for standards.*

LANs IN A NUTSHELL

Network	Standard	Media	Modulation	Access	Topology
Ethernet	IEEE 802.3	coaxial/fiber	baseband	contention	bus
MAP	IEEE 802.4	coaxial/fiber	broadband/carrierband/baseband	token passing	bus
Token Ring	IEEE 802.5	twisted pair/coaxial	baseband	token passing	ring
MAN	IEEE 802.6	coaxial/fiber	baseband	time slot	ring
FDDI	ASC X3T9.5	fiber	baseband	token passing	ring
ARCnet		coaxial	baseband	token passing	bus
Starlan	IEEE 802.3	twisted pair	baseband	contention	bus (star wired)
PCnet		coaxial	broadband	contention	bus
Proteon		fiber/twin axial	baseband	token passing	ring
Fibercon		fiber	baseband	token passing	ring
Artel		fiber	baseband	time slot	ring

SOURCE: AMP INC.

IBM—and to X.25 public data communication, packet-switching networks.

AT&T Co.'s Starlan targets existing twisted-pair wiring using topology to implement LAN functions. However, it operates slowly, at about 1M bps. The IEEE standards are being established toward this network, and Intel and others will supply chips in the future for low-cost implementation. Due to the support and use of existing wiring, Starlan will probably be used for entry-level LAN installations. □

Robert K. Southard is manager of systems technology in the Electro-Optics Division of AMP Inc., Harrisburg, Pa. He has responsibility for new electronic components for fiber-optic systems and local area networks.

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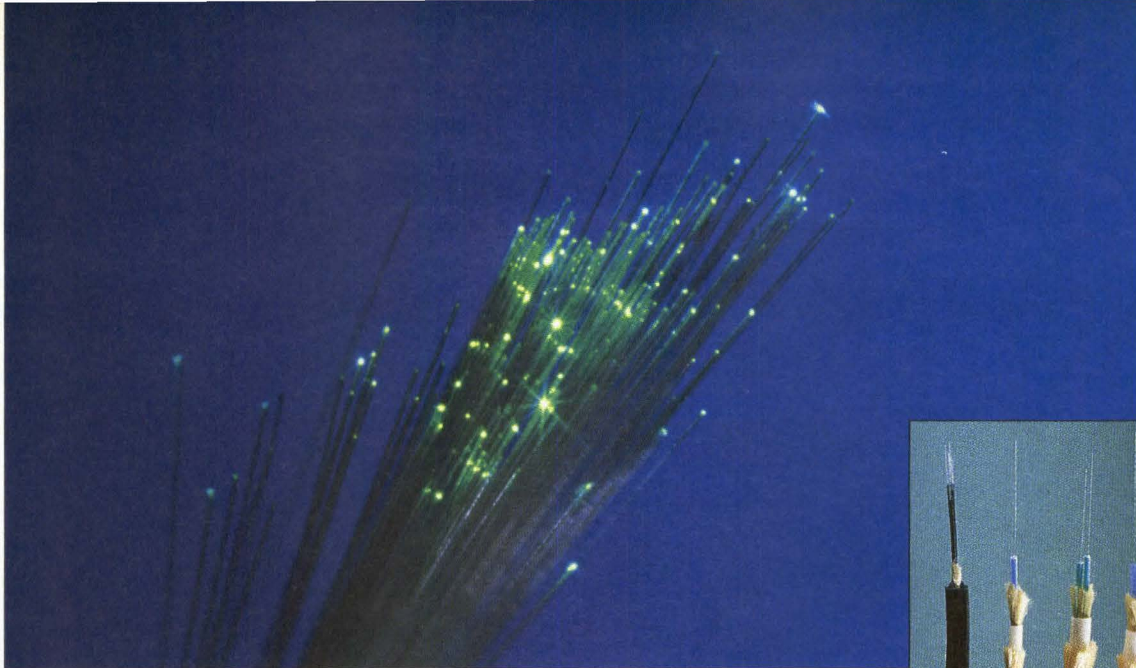
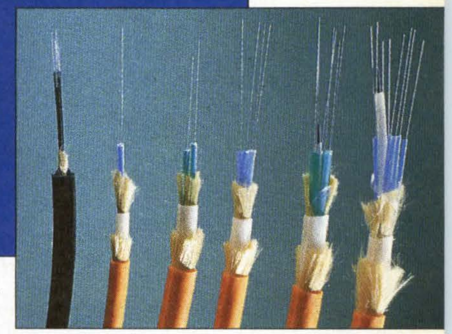




(Courtesy: Corning Glass Works)

LIGHT WORK FOR HIGH-SPEED LINKS

The declining cost of high-speed, high-capacity optical fiber fosters a broad spectrum of network products and options for system integrators

Edward R. Teja, Contributing Editor

Burying fiber-optic cable three feet underground throughout the San Bernardino mountains might seem like a dirty job. But, "There's gold in them thar hills" for the U.S. Forestry Service: critical communications links. The project's goal is to provide a complete physical connection for a network of computers that can keep service employees informed even in the harsh environment of a forest fire. In January 1988, when the physical medium is in place, SimpleNET Systems will deliver fiber-optic local area network cards that will put 16 stations in touch with each other over the 125M-bps LAN.

For less harsh environments, many companies offer fiber optics as an alternative to conventional twisted pair and coaxial networks. In fact, Corning Glass Works, one of the largest manufacturers of optical fibers, estimates that the U.S. computer market will be buying $78 million worth of fiber annually by 1990. That's just for the fiber.

Reap the fiber benefit package

As you might expect, from among the companies rushing to provide fiber-optic networks you'll find a fair mixture of prediction, proselytizing and promise.

Fiber optic nets are well-known for four highly prized qualities:

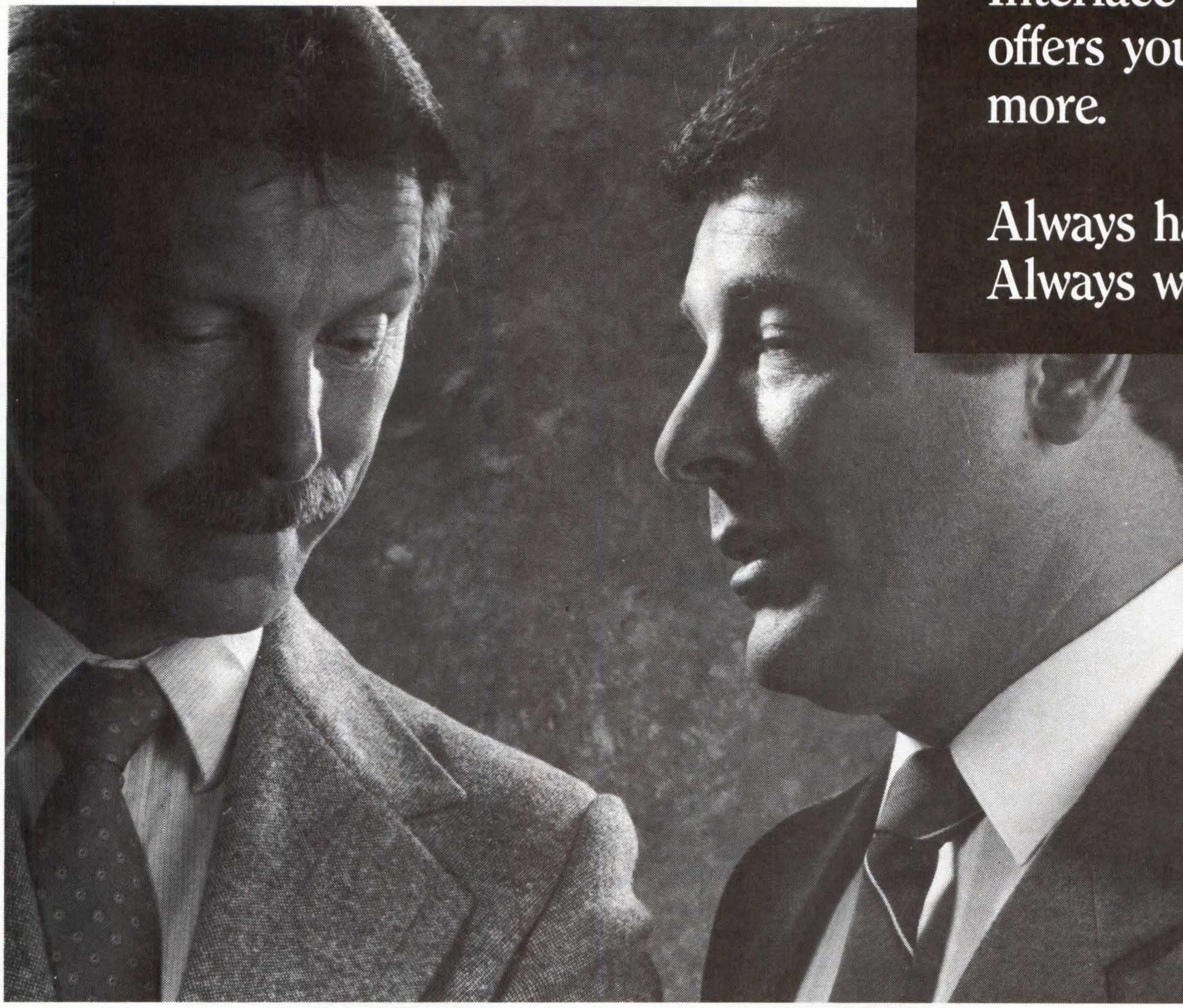
- Speed (bandwidth)
- Distance
- Immunity from electromagnetic interference (EMI)
- Security: no radio-frequency interference (RFI)

The one glitch in marketing fiber has been price. Cables of fibers and drivers have always been substantially more expensive than their copper colleagues. And the champions of copper have advocated a wait-and-see approach. They say: "The typical LAN has been underutilized anyway. Why pay more for performance you don't need?" But changes in the nature of computer applications, and cost reductions for fiber-optic components are providing compelling counterpoints. The bandwidth demands of existing applications are growing, and some of the new applications already overpower existing nets. As a result, smart system integrators are beginning to see that fiber won't long be simply an option.

The one glitch in making fiber real has been price.

Of course no one wants to toss out existing networks. But LANs must often be interconnected, and, if old nets are retained, system integrators must be able to make a twisted-pair LAN talk to a fiber-optic LAN.

For example, Fox Research Inc. offers the



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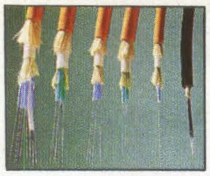
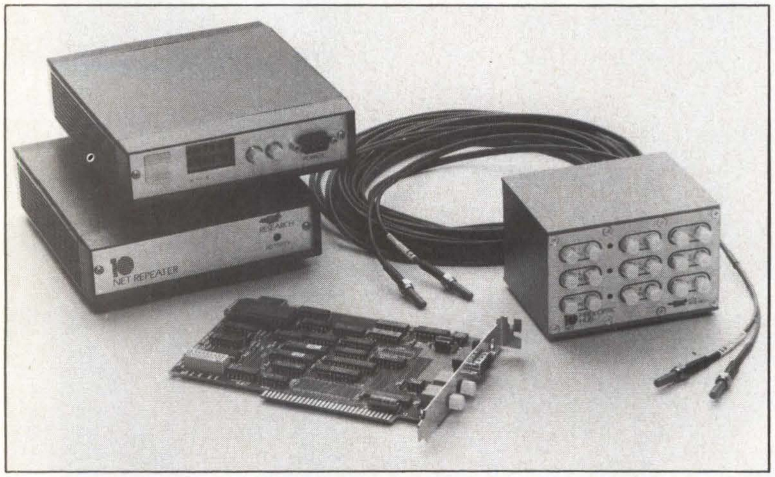


10-NET repeater to interconnect twisted pair LANs, StarLAN cable and fiber-optic cable. Priced at $1,695, the repeater links the LAN clusters together, providing a fiber-optic link between similar or dissimilar LANs.

Keep costs down

Despite fiber's bandwidth, extremely high performance isn't always the important virtue



Fox Research's 10-NET *fiber-optic boards support 1M bps communication using the Ethernet protocol; the 10-NET fiber hub (right) accommodates up to eight nodes.*

of fiber-based communications. Especially in personal computer networks, fiber-optic media play a more important role in extending the reach of networks that don't talk to the building next door and in immunizing those networks that suffer errors from EMI radiation. Cost also plays an important role.

Thus, network accessories become attractive, such as FiberCom Inc.'s $490 (per port) WhisperNet, which connects a fiber network directly to equipment compatible with Ethernet version 2.0 and IEEE 802.3 standards.

Fox Research specializes in providing components and software where cost concerns are as critical as bandwidth. Thus, the company's 10-NET LAN for personal computers comes in two incarnations: twisted pair and fiber. The two LANs are interchangeable, with the fiber-optic version costing slightly more. The 10-NET fiber-optic boards cost $895 (twisted-pair board, $695) and run at 1M bps using the Ethernet protocol. The 10-NET fiber hub ($1,995) accommodates eight nodes (a personal computer with a 10-NET fiber-optic board installed) and features a ninth port for linking hubs together.

Industrial-strength networks

Although coaxial nets have played a significant role in factory-automation systems, their life expectancy might be limited. After all, fiber optics furnish everything offered by coax in the Ethernet type network and more. So, here come the fiber-optic alternatives to Ethernet.

The FiberWay from Artel Communications Corp., a 100M-bps fiber-optic digital LAN with multiple channels, directly replaces Ethernet. Even the name of the token-passing transceiver is a challenge—Ethernet Accelerator (EXL). A Motorola Inc. MC68000 processor coupled with high-speed logic controls data transfers. Time-division multiplexing provides either two 50M-bps or four 25M-bps channels on one fiber cable.

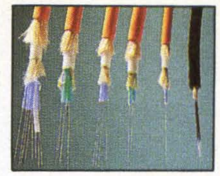
Indeed, the factory floor provides a "proof of the pudding" environment for the touted noise immunity and longer network transmission capability of fiber-optic nets. To meet that challenge, Standard Microsystems Corp. offers an ARCnet implementation using fiber cable. This baseband network uses Codenet Fiber Optic interface cards from Codenoll Technology Corp. (priced from $495 to $545) and either a two-port passive or active hub card, which can cost $395 (passive) or $800 (for an active hub). The ARCnet protocol, from Datapoint Corp., provides an interim manufacturing communication system that easily upgrades when software implementing the Manufacturing Automation Protocol (MAP) becomes available.

Graphics test the envelope

CAD/CAE systems are also constrained by short transmission lines and narrow bandwidth. To extend the installation flexibility of these products, CAD/CAE equipment vendors, such as Spectragraphics Corp., are paying an increasing amount of attention to the communications end of system development. For instance, Spectragraphics has introduced a fiber-optic communications adapter, called the CA-F, that combines protocol conversion with the chores of a fiber-optic modem. Priced at $1,050, the CA-F supports multidrop extensions, which convert Spectragraphics' own coax protocol to fiber-optic formats and provide full-duplex 1.544M bps communications for 2.3 km.

And Le Croy Corp. offers its series 5900 fiber-optic modem for operation with IEEE 802.4 media-access machines (such as those used in MAP). The 10M-bps Model 5900 is priced around $1,800. The modem operates under control of a remote network manager and can be dynamically configured to match the needs of the network.

To say the least, the graphics orientation of the engineering workstation environment proves an extremely fertile ground for fiber



optics. And the advent of optical disks presages more extensive use of graphics. Transmitting image databases will certainly "test the limits of the envelope" (push the maximum data-transfer rate) of every LAN extant. So, sophisticated vendors such as Digital Equipment Corp. are looking toward fiber as the medium for future workstation-to-workstation communications. For the moment, Ethernet LANs manage to meet the bulk of the installations' needs. But, when file transfers begin, performance degrades. FiberCom's president, Dr. Albert Bender, suggests that fast file-transfer—running at 125M bps—is vital. "Right now it is difficult to overload a network. But as more imaging and file-transfer applications are put on line, more bandwidth is needed."

Therefore, the insight has become a cliche: By the end of the decade, workstations will need more bandwidth. And all because of graphics.

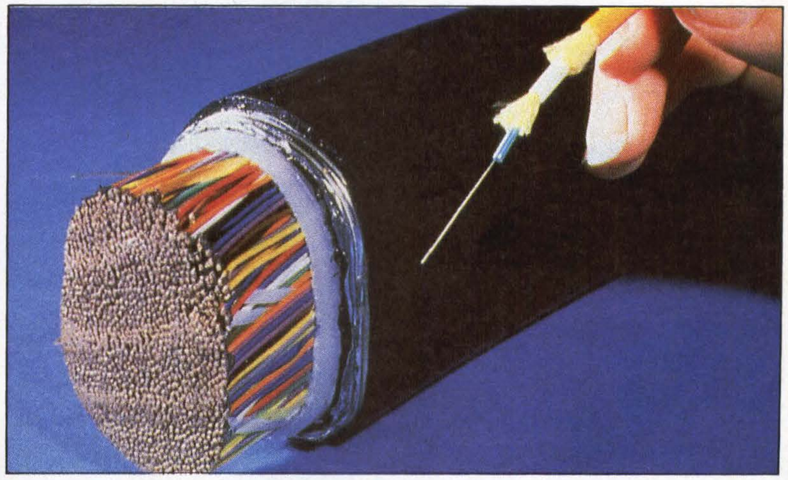
Get on board

But success in developing networks, as with other computer applications, ultimately depends on software. Much attention is being paid to protocols, such as the Fiber Distributed Data Interface (FDDI). A standard emerging under the American National Standards Committee (ANSC) X3T9.5, FDDI suits the high-speed connection of computers and peripherals using fiber-optic media. Networks using this protocol work as LAN, campus area (CAN) and wide area (WAN) networks.

The FDDI network is designed for a signaling rate of 125M bps, with an effective data-transfer rate of 100M bps, making it about 20 times as fast as IBM Corp.'s Token-Ring Network.

But this effort masks a potential misstep for users of personal computer applications. It can be difficult, if not impossible, to make existing applications run on the network. Whereas in CAD/CAE systems the network is usually designed especially for the application, personal computer networks are ad hoc constructs. And the results can be unpredictable.

The problems begin with the operating system. "DOS was never meant to run with a LAN," points out Gary Gonnella, president of CMU Systems, a systems house that specializes in creating personal computer-based multiuser LAN-based systems. "All of the DOS-based software for LANs consists of patches."



A single glass optical fiber *can carry more than 1,000 messages simultaneously. The standard copper cable needs 256 pairs of wires to reach the same capacity. (Courtesy: Corning Glass Works)*

The problem is that DOS doesn't understand file sharing; it is a single-user operating system. Thus, network server software written for DOS-based systems quickly becomes convoluted. Although this presents no problem for individual stations, bringing up a network to run a multiuser, shared-file application involves more than buying a board or two and connecting the personal computers to the fiber cable.

And, in addition to the OS problem, much of the application software isn't oriented toward either LANs or multiuser applications. Complication upon complication. Thus, in addition to

MEDIA COMPARISON

	Twisted pair	Coaxial/triaxial	Optical fiber cable
Loss (10 MHz)	useful to 2 MHz only*	20-120 dB/km	4-7 dB/km**
(100 MHz)		40-300 dB/km	4-7 dB/km
(400 MHz)		90-700 dB/km	8-18 dB/km (LED source); 4-7 dB/km (laser source)
EMI/RFI protection	weak	fair	best
Ground loop protection	none	none	excellent
Crosstalk protection	fair	good	best
Typical power budget	60-80 dB	60-80 dB	20-30 dB
Tapping ease	high	good	low
Drive electronics	conventional	conventional	special transmitters and receivers
Modulation	baseband	baseband and broadband	baseband
Cost	low	high and stable	high and falling

* Higher rates may be used for short, network attachment cables
** Multimode fiber at 850- nm wavelength

Source: AMP Inc.

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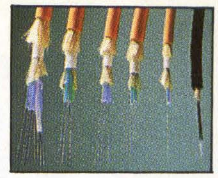


an upswing in software companies who provide packages for network-based applications, LAN vendors are joining in the effort. They want their hardware used. For instance, Fox Research offers 10-BASE DBMS (database management system), a Sequel SQL (structured query language) database ($495; $895 for multiuser) and application-language interfaces. And it has unbundled this software from its 10-NET, making it available to OEMs using other hardware. Applications will drive the winning networks, not de facto standards that substitute for effective computer communications. □

Interest Quotient (Circle One)
High 501 Medium 502 Low 503

Companies mentioned in this article

Artel Communications Corp.
93 Grand St.
Worcester, Mass. 01610
(617) 752-5690
Circle 301

CMU Systems
2249 S. Grove Ave.
Suite 105
Ontario, Calif. 91761
(714) 923-1412
Circle 302

Codenoll Technology Corp.
1086 N. Broadway
Yonkers, N.Y. 10701
(914) 965-6300
Circle 303

Corning Glass Works
Corning, N.Y. 14831
(607) 974-9000
Circle 304

Digital Equipment Corp.
199 Riverneck Road
Chelmsford, Mass. 01824
(617) 220-7207
Circle 305

FiberCom Inc.
P.O. Box 11966
Roanoke, Va. 24022-1966
(703) 342-6700
Circle 306

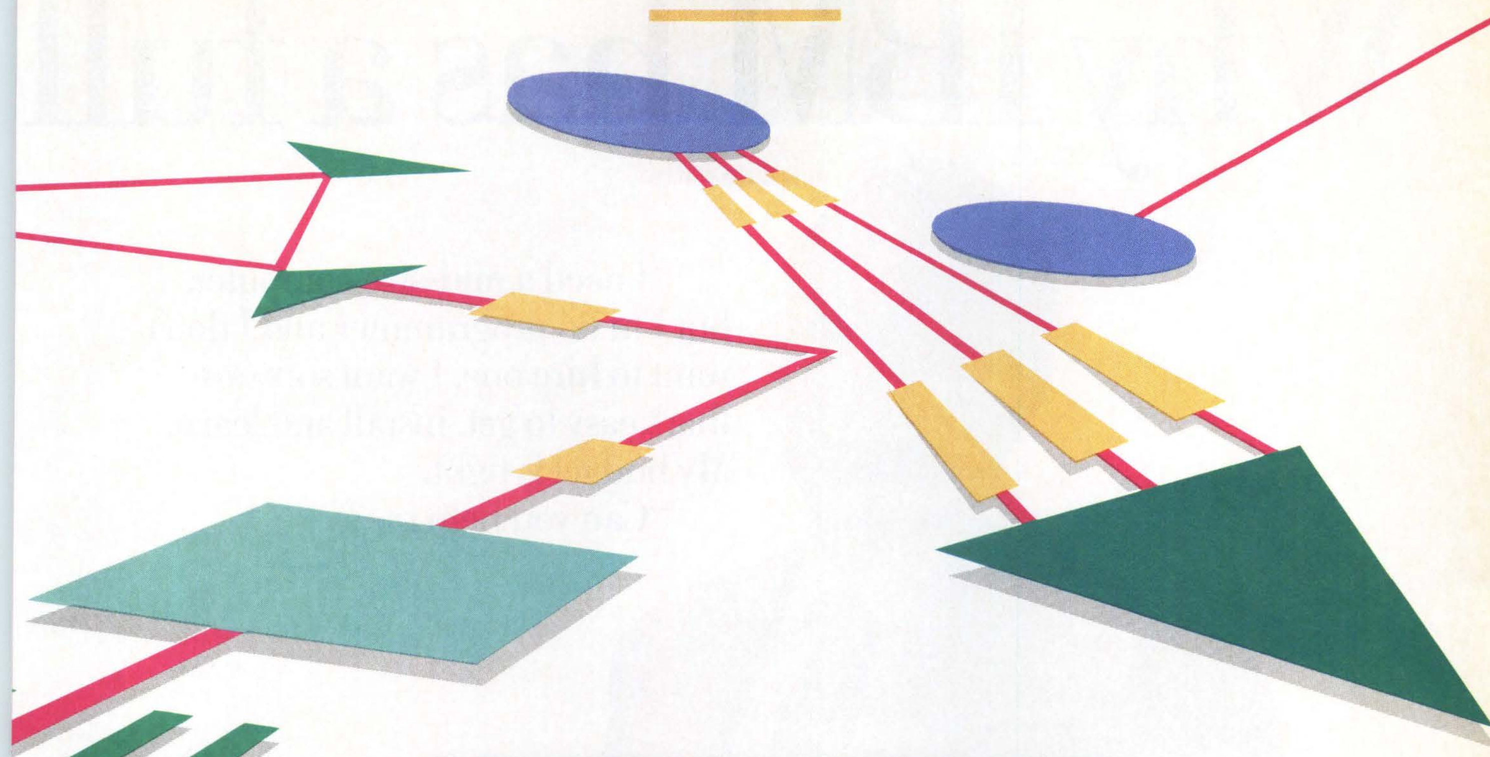
Fox Research Inc.
7016 Corporate Way
Dayton, Ohio 45459-4223
(513) 433-2238
Circle 307

Le Croy Corp.
700 S. Main St.
Spring Valley, N.Y. 10977
(914) 425-2000
Circle 308

SimpleNET Systems
Division of BCSoft Corp.
Suite A
545 W. Lambert Road
Brea, Calif. 92621
(714) 526-5151
Circle 309

Spectragraphics Corp.
9125 Rehco Road
San Diego, Calif. 92121
(619) 450-0611
Circle 310

Standard Microsystems Corp.
35 Marcus Blvd.
Hauppauge, N.Y. 11788
(516) 273-3100
Circle 311



SPEEDY RELIEF FOR CABLING HASSLES

Away from the pyrotechnics of technology, multiplexer manufacturers quietly continue to add functionality, giving users and network integrators more mux for the bucks

David Simpson, Senior Editor

Multiplexers are not the most glamorous products in the communications field, having experienced little attention-getting technological change over the past year. But they still help slash the spiralling costs of data transmission and relieve the integration headaches that can come with extensive cabling.

Despite the technological stagnancy, prices are plummetting, creating a cost-driven, cutthroat market for manufacturers, and a more-mux-for-the-buck market for buyers (see Product Table).

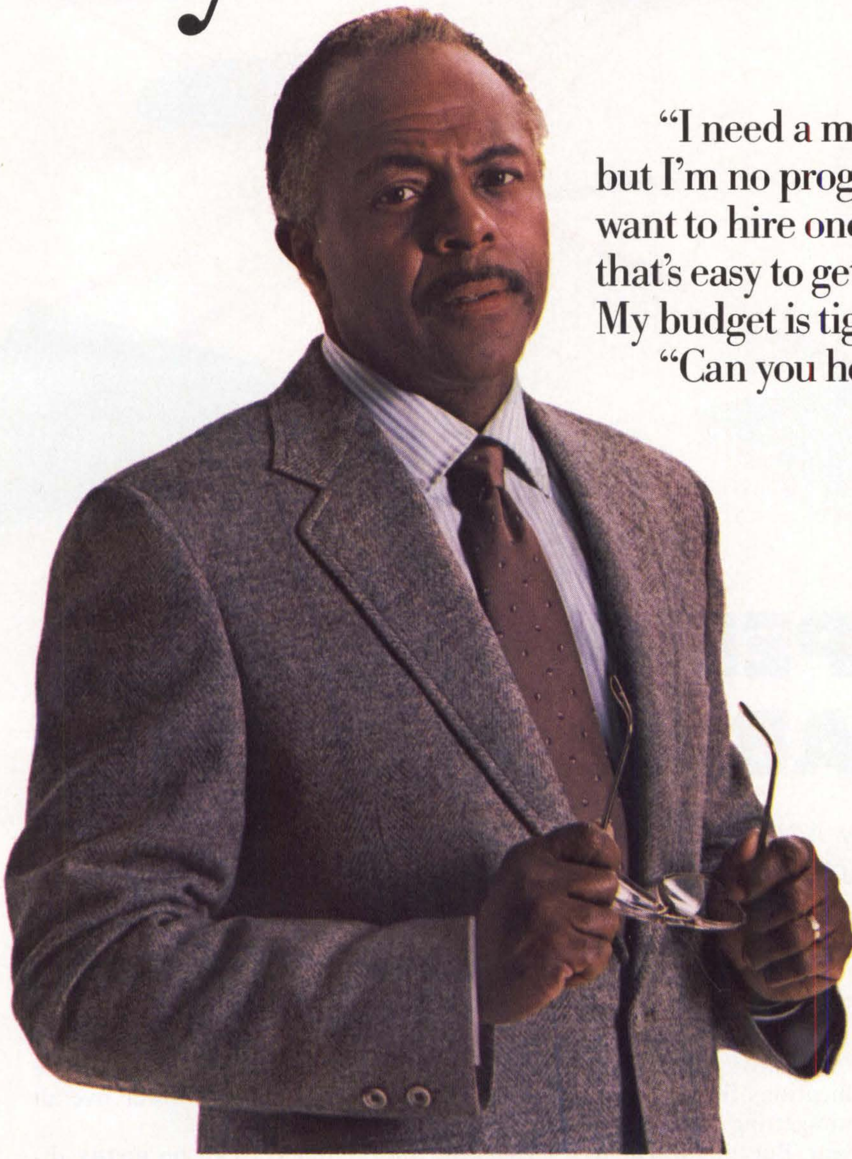
A multiplexer is a device that combines a number of low-speed or low-capacity signals into a single high-speed or high-capacity channel for transmission. Like modems, they work in pairs. The mux at the sending end concentrates (multiplexes) data from multiple lines into a combined signal that is transmitted over a single line to the mux at the receiving end. The receiving mux separates (demultiplexes) the combined signals and transmits them to the host or receiving device. The advantages of employing muxs include the elimination of a cable for each device (usually a terminal) in the configuration and the resulting lower overall costs.

The multiplexer market can be neatly divided into time-division multiplexers (TDMs), which operate at less than T1 (1.544M bits per second) speeds; statistical TDMs (STDMs, or stat muxs); T1 multiplexers, which are TDMs that comply with AT&T Co.'s T1 digital-line transmission specifications; and fiber-optic TDMs. The fastest growing categories are T1 and fiber-optic muxs. Stat muxs, particularly those at the high end (more than 64 ports), have the most sluggish annual growth rates in unit shipments (Fig. 1).

TDMs vs. STDMs

Both TDMs and STDMs divide a combined terminal signal into increments; one for each device connected to a port on the mux. Each terminal sends data during its fraction of allotted time. A TDM allocates this fraction of time

Why IBM has a full



"I need a mid-size computer, but I'm no programmer and I don't want to hire one. I want software that's easy to get, install and learn. My budget is tight.

"Can you help me?"

Like the north and south poles, people who buy mid-range computers can be alike, yet opposite.

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But there's one thing we don't have, and neither does anybody else: a "one-size-fits-all" design that can satisfy everyone without compromise. The needs of a small law firm, a retail chain and a multi-national corporation, for example, are too diverse for one architecture to serve each equally well.

So IBM offers a choice of mid-range systems, System/3X and System/370. Neither is "better" than the other, they're just better suited for different kinds of jobs. You may even want both.

And since we give you a choice, we'll help you make the right one. Together, we'll analyze your needs for software, connectivity and training. We'll look ahead to future growth, and we'll work to protect your previous investments.

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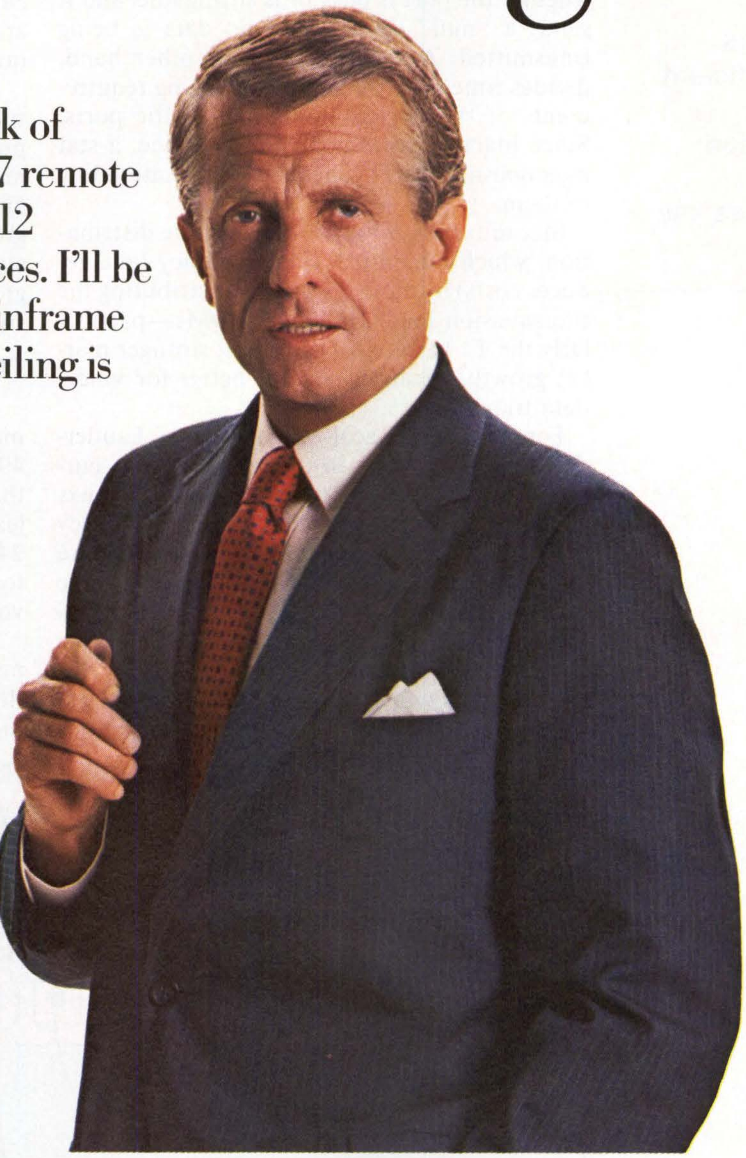
-range mid-range.



"I'm building a network of mid-range computers in 37 remote locations connecting with 12 mainframes in 5 other places. I'll be sending both data and mainframe applications. My growth ceiling is pretty much unlimited.
"Can you help me?"

extremely connectible. So a larger business can build a network of System/36s, or include them in existing networks with PCs and mainframes.

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And that's why IBM's full-range mid-range is the right idea. No matter where you fit into it, the fit feels good.

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Stat muxs boast efficient time distribution, which maximizes line usage.

whether the port is busy or is sitting idle, and it sends a "null" signal when no data is being transmitted. A stat mux, on the other hand, divides time according to the changing requirements of the devices connected to the ports. Since inactive ports don't need service, a stat mux doesn't waste "guard duty" time attending to them.

Stat muxs boast more efficient time distribution, which maximizes line efficiency (and reduces costs) by more effectively distributing the transmission load. However, TDMs—particularly the T1 variety—will exhibit stronger market growth, because they are better for voice/data transmission.

For example, Racal-Milgo of Fort Lauderdale, Fla.,—a leader in the mux market—currently ships about four times as many stat muxs as TDMs. But product manager Fred Dawsey thinks that the advent of T1 muxs—which use TDM technology—will significantly change that equation. Racal-Milgo now offers a point-to-point T1 mux but won't have a networking T1 mux until next year.

The market for TDMs that operate at less than T1 speeds is characterized by severe price cutting. This is true because many mux vendors are primarily modem vendors, and they sell muxs largely to help move modems.

The statistical multiplexer market can be subdivided into low-end units (fewer than 16 ports), midrange units (16 to 64 ports) and high-end units (more than 64 ports). Low-end and midrange stat muxs will exhibit marginal growth over the next five years, but high-end stat muxs are expected to show negative annual growth rates due to competition from packet-switching technologies and T1 muxs.

T1 takes off

T1 multiplexers represent the hottest segment of the mux market (MMS, April, Page 49). Based on AT&T's specification for service that provides 1.544M-bps transmission over leased telephone lines, a single T1 line replaces 24 analog channels. T1 allows network integrators to segment a link by channel and to mix voice and data.

The T1 market divides into simple (non-networking) and complex (networking) units, the latter being the faster growing segment. The big battle in the T1 market is between multi-

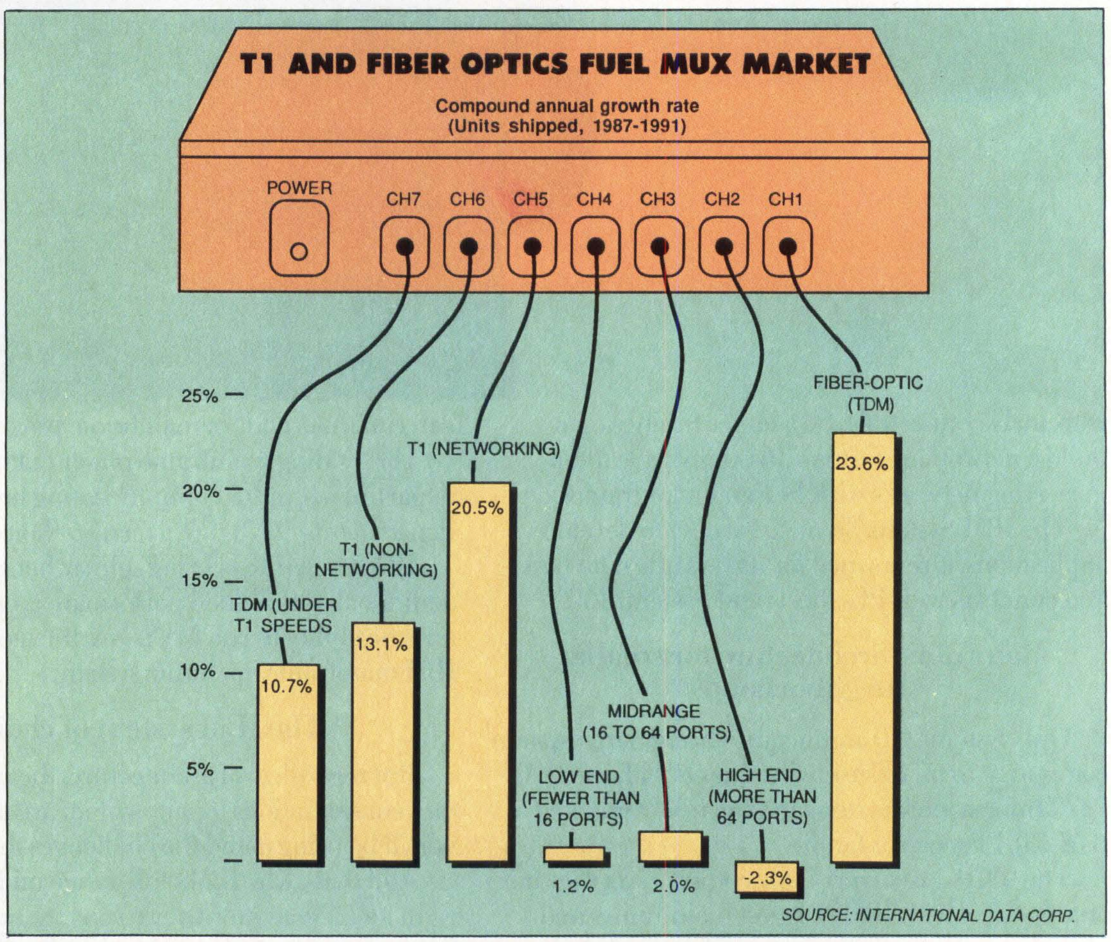

Fig.1. T1 networking muxs *and fiber-optic muxs are the fastest growing segments of the total multiplexer market. High-end stat mux growth rates are expected to decline because of stiff competition from T1 and packet-switching technologies.*

plexer manufacturers who want to put routing and management intelligence into their own boxes—thus providing a proprietary, private network—and those who prefer to use the intelligence built into public networks. Mux makers are rushing to install functions that the public carriers are trying to put into their networks. Although the T1 market is taking off at a 20 percent to 30 percent annual growth rate, with a projected market in excess of $650 million by 1989, analysts predict a swift shakeout due to overcrowding.

Advances, alliances to watch

A few trends are worth watching in the multiplexer market. For one, T3 technology is emerging, and its popularity will increase rapidly over the next three to four years, says Rick Villars, an analyst with International Data Corp., Framingham, Mass. T3 provides transmission capacity equivalent to 28 T1 channels, or 44.736M bps. T3 is not a new technology but, rather, a combination of T1 lines. "It's the next logical progression after T1," says Villars. Although few T3 muxs have been installed, major companies such as General Motors Corp. and The Boeing Aerospace Co. are using them.

Another technology trend to examine is voice compression. Voice compression techniques currently increase transmission capacity by as much as a factor of four. Voice now accounts for over 60 percent of all T1 circuit capacities, according to Villars, who predicts rapid advances in compression techniques for both voice and data.

In an attempt to broaden product lines, some vendors are entering into strategic alliances. They mostly want to have product lines include both packet-switching and circuit-switching technologies. This was evidenced just this year by: an OEM agreement between StrataCom Systems Inc. and Codex Corp., a reseller agreement between Paradyne Corp. and Spectrum Digital Corp., BBN Communications Corp.'s purchase of Network Switching Systems Inc., and the joint marketing agreement between Timeplex Inc. and Telenet Communications Corp. Most of these deals involve T1 technology.

Even the big guys saw the advantages of uniting to conquer. For example, IBM Corp.

T1 multiplexers represent the hottest segment of the mux market.

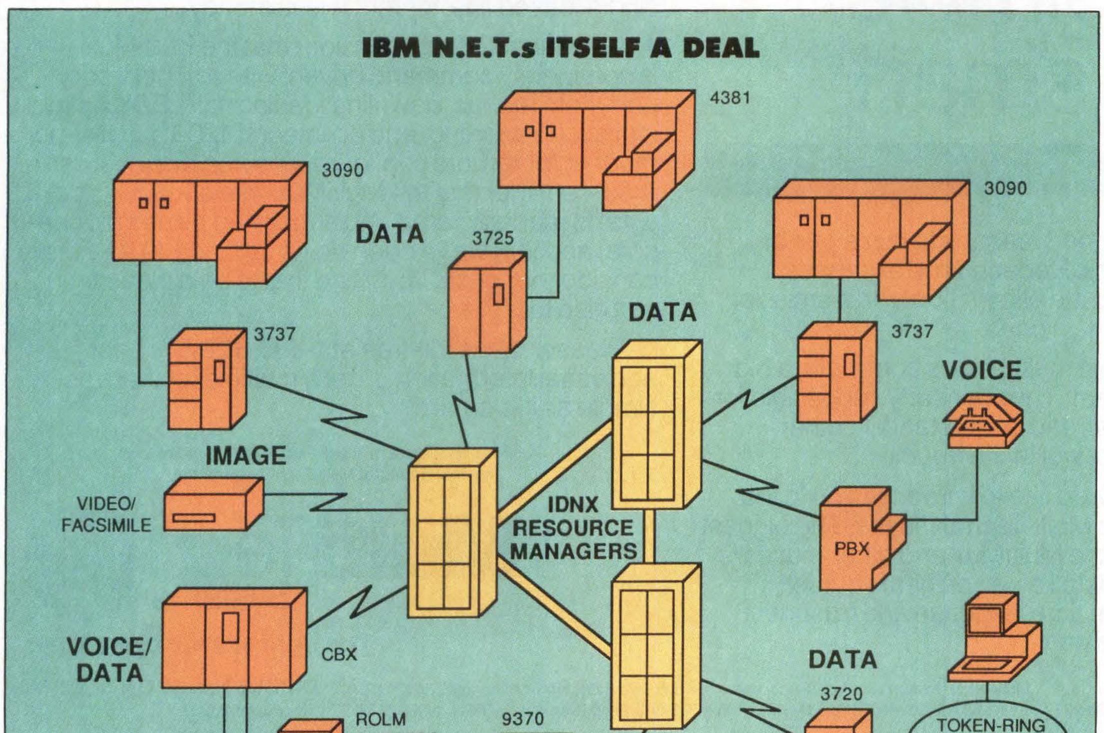

Fig. 2. Network Equipment Technologies' *IDNX resource managers serve as the heart of IBM's high-speed, wide-bandwidth digital network strategy.*

announced in June a marketing and development agreement with Network Equipment Technologies Corp., Redwood City, Calif., under which IBM will market N.E.T.'s T1 products, including the Integrated Digital Network Exchange (IDNX) voice and data transmission resource managers (Fig. 2). IBM will also contribute funding and technology to future N.E.T. product development.

Signalling more than a mere marketing agreement, IBM also announced that it would implement N.E.T.'s proprietary internodal protocol in its own products. The deal will give IBM a strong foothold in the T1 market—perhaps pushing T1 sales in general—and will enhance its NetView and NetView/PC network-management environments.

Fiber-optic muxs gain ground

Another emerging trend involves the increased use of fiber-optic links in multiplexers. IDC predicts a 24 percent annual growth rate in terms of unit shipments for this category between 1987 and 1991. However, analyst Villars is quick to assert that, in terms of revenues, the market share for fiber-optic muxs will only increase from 4.9 percent this year to 11 percent in 1991. In contrast, shipments of networking T1 muxs, which are expected to grow at 21 percent per year over the same period, should increase their revenue share of the total mux market from 25 percent this year to 46 percent in 1991.

T3 technology is emerging, and its popularity will increase rapidly over the next three to four years.

The advantages of fiber-optic muxs, explains Bob Grintz, director of marketing at Equinox Systems Inc., Miami, Fla., are noise immunity, imperviousness to lightning, wide bandwidth, and superiority in security-sensitive applications. One disadvantage, he adds, is that either users or network integrators have to install and terminate fiber cable and, simply, users are afraid of these tough tasks.

Terminating and installing the fiber is not necessarily that difficult, though. As Racal-Milgo's Dawsey explains, "If you're going into a public net, it's no different than ordering a phone line, but if you have a LAN—or an existing facility—it might be burdensome, because you have to replace the old transmission facility."

Ken O'Mohundro, president of Able Computer, Costa Mesa, Calif., expects that the use of fiber-optic muxs will be particularly prevalent in the midwest because of that region's higher incidence of lightning storms. "But," he adds, "cost is still a key impediment."

Although most observers agree that, while the use of fiber-optic muxs will grow steadily in applications that require their advantages, they will remain a niche market. For example, Tom Heimerman, marketing director at Multi-Tech Systems Inc., New Brighton, Minn., thinks that fiber-optic muxs will remain a niche market because of installation problems, high costs and competing technologies. Heimerman also sees a reluctance among users to jump into newer technologies because of the anticipation, and uncertainty of product availability, surrounding ISDN (Integrated Services Digital Network.)

Until recently, only sophisticated system integrators could cope with the complexities of hooking up muxs.

Another trend in muxs deals with ease of use. A few years ago, only sophisticated system integrators could cope with the complexities of hooking up muxs. Now, however, most end users can handle that task because of increased simplicity and modular upgrade capabilities. For example, Micom offers plug-in firmware cartridges and boards to increase channel capacity or change functionality. For instance, choosing from among six Micom Featurepack cartridges, users can tailor the MICOM BOX—a data concentrator—as a point-to-point async STDM mux, a multipoint mux or a multiplexing X.25 async PAD (packet assembler/disassembler). Plug-in boards enable upgrades from four to 16 channels and the addition of a modem.

Although price cutting eclipses other developments in multiplexers today, vendors are also adding functions, such as terminal-based switching, local and remote diagnostics, and network management and utilization reporting. "People need more and more network control information," says Mike Bissey, product line manager at Infotron Systems Corp., a Cherry Hill, N.J., supplier of a variety of network management and multiplexer systems.

Vendors are also integrating modems into their multiplexers. And because many mux manufacturers are also modem vendors, look for technological advances in modems to filter into the mux market. □

Interest Quotient (Circle One)
High 504 Medium 505 Low 506

MULTIPLEXERS

Company / Model	Input channels: Max. async (speed/bps)	Input channels: Max. sync (speed/bps)	Output channels: Max. async (speed/bps)	Output channels: Max. sync (speed/bps)	Composite link protocols	Buffer size (bytes)	Automatic bit rate detection?	Technique	Price range	Notes and Features
ABLE COMPUTER 3080 Airway Ave., Costa Mesa, CA 92626, (714) 979-7030										**Circle 511**
DHU/HS	16 (50-38.4K)					0.25K	no		$2,600-$3,250	host resident
AEG BAYLY INC. 167 Hunt St., Ajax, Ontario, L1S 1P6, Canada, (416) 683-8200										**Circle 512**
OMNIPLEXER T1	288 (2400)	288 (2400)	2 (1.544M)		transparent		no	TDM	$2,700-$10,000	drop/insert
OMNIPLEXER 2Mb	600 (2400)	600 (2400)	2 (2.048M)		transparent		no	TDM	$3,200-$30,000	drop/insert
ALGO INC. 9198-C Red Branch Rd., Columbia, MD 21045, (301) 730-7442										**Circle 513**
MC610	5 (19.2K)		5 (19.2K)		proprietary	28.3K	no	STDM	$1,495	networking
AMDAHL CORP. (COMMUNICATIONS SYSTEMS DIV.) 2200 N. Greenville Ave., Richardson, TX 75081, (214) 699-9500										**Circle 559**
Multistar II	48 (110-19.2K)	96 (300-460K)		1 (1.544M)	transparent	4K	no	TDM	$7,100-$15,000	point-to-point
Multistar III	48 (110-19.2K)	96 (1200-768K)		2 (1.544M, 2.048M)	transparent		no	TDM	$9,000-$25,600	point-to-point, networking
Multistar IV	350+ (110-19.2K)	700+ (1200-768K)		15 (1.544M)	transparent		no	TDM	$33,000-$65,000	networking
ASTROCOM CORP. 120 W. Plato Blvd., St. Paul, MN 55107 (612) 227-8651										**Circle 514**
ASIM-3	3 (9600)			1 (9600)	X.25	16K	yes	STDM	$640	point-to-point, speed and code conversion, data compression
ASIM-7	7 (9600)			1 (9600)	X.25	32K	yes	STDM	$1,195	point-to-point, speed and code conversion, data compression
ATDM/DSU		6 (19.2K)		1 (56K)	DDS		no	TDM	$1,890	built-in DSU/CSU, supports tail circuits
AVANTI COMMUNICATIONS CORP. Aquidneck Industrial Park, Newport, RI 02840, (401) 849-4660										**Circle 515**
Open Network Exchange	7400 (up to 19.2K)	7400 (up to 1.5M)		16 (2.048M)	transparent			TDM	$60,000	3-D switching, global network management
UltraMux	192 (up to 9600)	96 (up to 1.5M)		10 (1.544M)	transparent			TDM	$29,000	independent network timing, network management
UltraPac	32 (up to 9600)	16 (up to 1.5M)		1 (1.544M)	transparent			TDM	$15,000	network control
AYDIN MONITOR SYSTEMS (PRIVATE NETWORKS DIV.) 700 Dresher Rd., Horsham, PA 19044, (215) 657-7450										**Circle 516**
6248A-10		72/120 (19.2K/9600)		1	transparent	32	no	TDM	$7,500	alarm-monitoring system, diagnostics
6248A-20		72/120 (19.2K/9600)		1	transparent	32	no	TDM	$7,500	alarm-monitoring system, diagnostics
6296		30/60 (19.2K/9600)		1	transparent	32	no	TDM	$24,000-$80,000	alarm-monitoring system, diagnostics
BO-SHERREL CO. INC. 36133 Niles Blvd., Fremont, CA 94536, (415) 792-0354										**Circle 517**
MX-2	8 (19.2K)		8 (76.8K)		CCITT V.24		yes	TDM	$445	point-to-point
CANOGA-PERKINS CORP. 21012 Lassen St., Chatsworth, CA 91311, (818) 718-6300										**Circle 518**
CMX-816	16 (up to 100K)	16 (up to 76.8K)					yes	TDM	$2,750-$5,020	fiber optic, point-to-point
3124	192 (up to 9600)	120 (up to 9600)					no	TDM	$10,000-$20,000	point-to-point, ring, multipoint
3272	144 (up to 76.8K)	(76.8K)					yes	TDM	$2,350-$5,350	fiber optic, point-to-point
CASE COMMUNICATIONS INC. 7200 Riverwood Dr., Columbia, MD 21045, (301) 290-7710										**Circle 519**
DCX812	4, 8 (9600)	1 (19.2K)		1 (19.2K)	DCX ARQ	16K	yes	STDM	$1,495-$1,895	flow control conversion, point-to-point
DCX840	240 (9600)	120 (9600)		13 (80K)	DCX ARQ	64K-1M	yes	STDM	$8,400-$60,000	networking, diagnostics

Company / Model	Input channels: Max. async (speed/bps)	Input channels: Max. sync (speed/bps)	Output channels: Max. async (speed/bps)	Output channels: Max. sync (speed/bps)	Composite link protocols	Buffer size (bytes)	Automatic bit rate detection?	Technique	Price range	Notes and Features
DCX850	240 (9600)	120 (9600)		12 (80K)	DCX ARQ	64K-1M	yes	STDM	$15,000-$85,000	switching
COASTCOM 2312 Stanwell Dr., P.O. Box 27068, Concord, CA 94527, (415) 825-7500										Circle 520
DDM-12	12 (up to 19.2K)	12 (up to 19.2K)		228 (768K)	transparent			TDM	$2,800-$7,000	diagnostics
D/I MUX-E	24 (1.544M)	24 (1.544M)	1 (1.544M)	1 (1.544M)				PCM	$4,700-$14,900	drop/insert
sTepNET	4608 (1.544M)	4608 (1.544M)	288 (1.544M)	4608 (1.544M)			yes	TDM, PCM, ADPCM	$7,900-$45,000	drop/insert, point-to-point, multipoint
CODEX CORP. Maresfield Farm, 7 Blue Hill River Rd., Canton, MA 02021, (617) 364-2000										Circle 521
6015	16 (19.2K)	16 (19.2K)		1 (19.2K)	X.25 level 2	64K	yes	STDM	$1,500-$4,000	flow control conversion, point-to-point, networking
6290		100 (1.344M)		16 (1.544M)	transparent		no		$18,000-$150,000	networking
6740	64 (19.2K)	64 (19.2K)		16 (up to 64K)	bisync, SDLC		yes	STDM	$6,000-$20,000	flow control conversion, data compression, point-to-point, networking
COHERENT COMMUNICATIONS SYSTEMS CORP. 600 Commerce Dr., Hauppauge, NY 11788, (516) 231-1550										Circle 522
DSM-64		6 (2400-56K)		1 (9600-64K)	proprietary	240		TDM	$2,300	satellite networking, diagnostics
COMDESIGN INC. 26 Castilian Dr., Santa Barbara, CA 93117, (805) 964-9852										Circle 523
RS2000	32 (19.2K)		4 (19.2K)	4 (64K)	proprietary	2.048M	yes	STDM	$3,800-$9,600	networking
TC-500A	32 (9600)		1 (19.2K)	1 (19.2K)	ADCCP ANSI	64K-320K	yes	STDM		integral modem, point-to-point
TS-1000	32 (19.2K)		4 (19.2K)	4 (64K)	proprietary	2.048M	yes	STDM	$2,100-$8,000	
COMPUTER CONCEPT 1354 McQuester Dr., #C, San Jose, CA 95122, (408) 286-1164										Circle 524
DataMux 1008	8 (9600)		1 (400K)		proprietary		yes	TDM	$450-$550	wide applications
CONCORD DATA SYSTEMS INC. 397 Williams St., Marlborough, MA 01752, (617) 460-0808										Circle 525
224 Super-duplex	3 (up to 9600)		1 (2400)		modified HDLC	8K	yes	STDM		flow control conversion, point-to-point, integral modem
DATA COMM FOR BUSINESS INC. 807 Pioneer, Champaign, IL 61820, (217) 352-3207										Circle 526
SPL	14 (9600)		1 (19.2K)	1 (19.2K)	proprietary	32K	no	STDM	$795-$2,995	point-to-point
DATAGRAM CORP. 11 Main St., East Greenwich, RI 02818, (800) 235-5030										Circle 527
DM404/408	8 (19.2K)	8 (19.2K)		2 (19.2K)	X.25 level 2	256K	yes	STDM	$4,500-$10,000	flow control conversion, data compression, point-to-point
DM700/2400	23 (9600)			1 (19.2K)	X.25 level 2	256K	yes	STDM	$1,395-$6,000	flow control conversion, data compression, point-to-point
DM4800	54 (9600)			1 (19.2K)	X.25 level 2	256K	yes	STDM	$3,650-$13,250	flow control conversion, data compression, point-to-point
DATATEL INC. Pin Oak & Springdale Rds., Cherry Hill, NJ 08003, (609) 424-4451										Circle 528
DCP5000	8/16 (50-19.2K)			1 (64K)	modified SDLC	32K-64K	yes	STDM, TDM	$2,150-$5,150	flow control conversion, point-to-point, switching, built-in CSU/DSU, integral modem
DCP9050		6 (1200-19.2K)		1 (up to 64K)	modified SDLC		no	TDM	$2,150-$2,650	diagnostics, point-to-point
DCP9100	96 (50-38.4K)	96 (600-1.536M)		1 (1.544M)	SDLC		no	TDM	$4,000-$4,400	diagnostics, point-to-point

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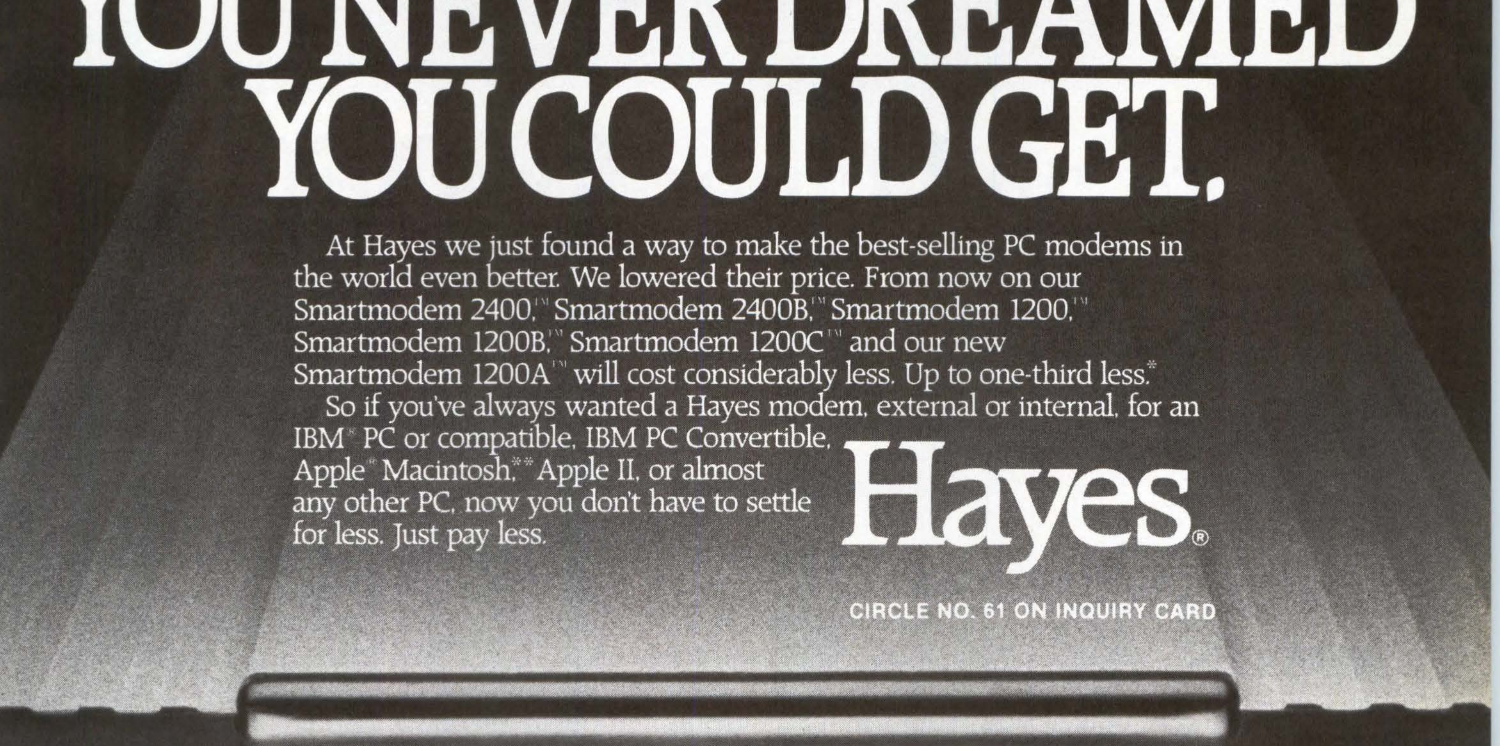
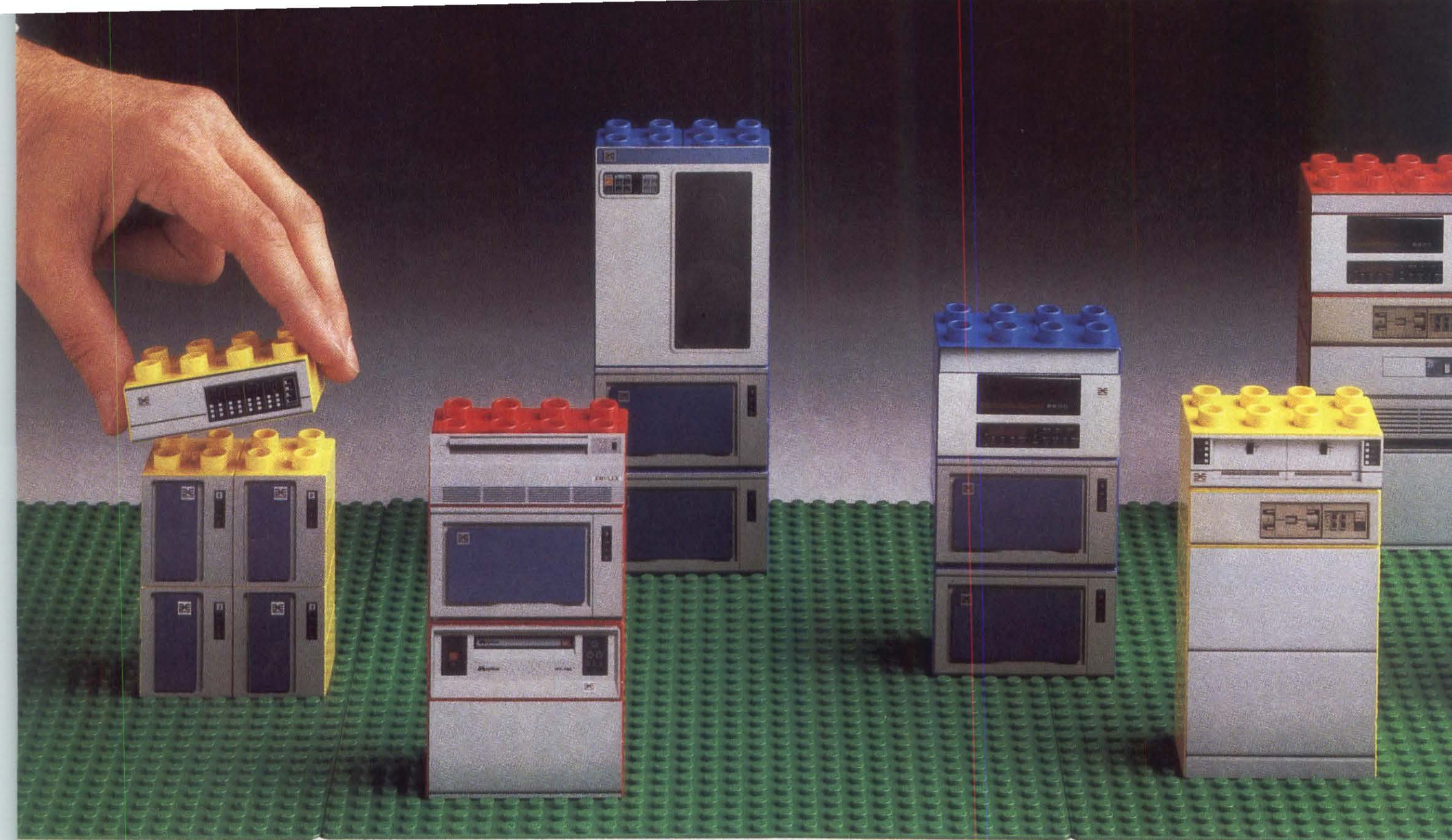


*Based on estimated retail prices. **Requires external modem.



MULTIPLEXERS

Company / Model	Input channels: Max. async (speed/bps)	Input channels: Max. sync (speed/bps)	Output channels: Max. async (speed/bps)	Output channels: Max. sync (speed/bps)	Composite link protocols	Buffer size (bytes)	Automatic bit rate detection?	Technique	Price range	Notes and Features
DOELZ NETWORKS INC.										**Circle 529**
9501 Jeronimo Rd., Irvine, CA 92718, (714) 770-1221										
ELITE ONE 2700	4 (19.2K)	4 (19.2K)	4 (19.2K)	4 (19.2K)	HDLC, SDLC, X.25	128K	yes	proprietary		flow control conversion, integral modems, networking
ELITE ONE 2800	16 (19.2K)	16 (9600)	16 (19.2K)	16 (9600)	HDLC, SDLC, X.25	128K	yes	proprietary		flow control conversion, integral modems, networking
ELITE ONE 2900	16 (19.2K)	16 (9600)	16 (19.2K)	16 (9600)	HDLC, SDLC, X.25	128K	yes	proprietary		flow control conversion, networking
EMULEX CORP.										**Circle 530**
3545 Harbor Blvd., P.O. Box 6725, Costa Mesa, CA 92626, (714) 662-5600										
CS41	144 (9600)					4K	no		$5,500-$23,000	flow control conversion, networking
EQUINOX SYSTEMS										**Circle 531**
14260 S.W. 119 Ave., Miami, FL 33186, (305) 255-3500										
LM-8	8 (19.2K)			1 (260K)	proprietary, RS422		no	TDM	$700	
LM-48	48 (19.2K)			1 (1.544M)			no	TDM	$3,100	
FIBERCOM INC.										**Circle 532**
P.O. Box 11966, Roanoke, VA 24015, (703) 342-6700										
FDM	32 (38.4K)	16 (7.8K)	32 (38.4K)	16 (76.8K)			yes	TDM		point-to-point
FMX		32 (2.3587M)		32	SNA		no			
GANDALF DATA INC.										**Circle 533**
1020 S. Noel, Wheeling, IL 60060, (312) 541-6060										
GLM 528E	128 (up to 19.2K)	128 (up to 19.2K)	2 (up to 19.2K)	2 (up to 64K)	CCITT V.24		yes	TDM	$3,475	
PIN 9106	2-4 (19.2K)		1 (19.2K)	1 (19.2K)	ASCII, HDLC	256K	yes	STDM	$900	flow control conversion, integral modem, point-to-point
MUX 2000	16 (up to 19.2K)	7 (up to 38.4K)	2 (up to 19.2K)	2 (up to 64K)	CCITT V.11, V.24, V.35; X.3; X.25; X.28; X.29		yes	STDM, TDM	$540-$4,695	
GENERAL DATACOMM INC.										**Circle 534**
Straits Turnpike, Middlebury, CT 06762, (203) 574-1118										
Kilomux 1281	12 (up to 19.2K)	16 (up to 72K)		1 (up to 384K)	transparent		no	bit-interleaved TDM	$1,780-$6,000	integral modem, CSU/DSU
MEGAMUX PLUS	54 (up to 19.2K)	54 (up to 1.152M)		1 (up to 2.048M)	transparent		no	bit-interleaved TDM	$8,500-$40,000	point-to-point
MEGA SWITCH	512 (up to 19.2K)	512 (up to 1.152M)		16 (up to 2.048M)	transparent		no	bit-interleaved TDM	$25,000-$200,000	multiple aggregate switching
INFINET INC.										**Circle 535**
40 High St., North Andover, MA 01845, (617) 681-0600										
ISM Series	640 (9600)	640 (9600)		15 (72K)	HDLC		yes	STDM	$1,450-$35,000	flow control conversion, multipoint, networking
ITM 1500 Series	144 (19.2K)	144 (1.536M)		36 (1.544M)			no	TDM	$21,600-$60,600	multipoint, networking
IXN 8400/8500	16 (19.2K)	6 (64K)		2 (64K)	X.25	up to 48K	yes	STDM	$1,725-$7,100	flow control conversion
INFOTRON SYSTEMS CORP.										**Circle 536**
Cherry Hill Industrial Center, Bldg. 9, Cherry Hill, NJ 08003, (609) 424-9400, (800) 257-8352										
990NP/992NP	640/104 (50-19.2K)	640/104 (1200-19.2K)		15 (72K)	CCITT V.24, SDLC, SNA, X.25		yes	STDM	$80,000/$30,000	
NX4600/NX3000	4000/24 (50-19.2K)	4000/24 (64K-1M)		(1.544M)	CCITT V.24, SDLC, SNA, X.25		yes	TDM	$20,000/$10,000	drop/insert, network control
Infostream 1500	128 (50-19.2K)	128 (1200-1M)		2 (1.544M-2.048M)			TDM			
LUXCOM INC.										**Circle 537**
3853 Breakwater Ave., Hayward, CA 94545, (415) 786-1200										
LC100	64 (up to 19.2K)	32 (up to 256K)	64 (up to 19.2K)	32 (up to 256K)	transparent		yes	TDM		point-to-point, multidrop, fiber optic, coax

Company / Model	Input channels: Max. async (speed/bps)	Input channels: Max. sync (speed/bps)	Output channels: Max. async (speed/bps)	Output channels: Max. sync (speed/bps)	Composite link protocols	Buffer size (bytes)	Automatic bit rate detection?	Technique	Price range	Notes and Features
MDB SYSTEMS INC. 1995 N. Batavia St., Orange, CA 92665, (714) 998-6900										Circle 538
MDB-TurboMUX-T-32M	32 (38.4K)		32 (38.4K)				no		$7,494	auto flow control
MLSI-TurboMUX-T-32M	32 (38.4K)		32 (38.4K)				no		$6,455	auto flow control
MEGADATA CORP. 35 Orville Dr., Bohemia, NY 11716, (516) 589-6800										Circle 539
SM/5X	4 (19.2K)	4 (19.2K)	1 (19.2K)	1 (19.2K)	bisync	64K	no		$900-$1,500	polling, statistics
MEGARING CORP. 80 Oser Ave., Hauppauge, NY 11788, (516) 434-1000, (516) 435-4666										Circle 540
CMX-10T	80 (up to 9600)	10/50 (56K/9600)		1 (1.544M)				TDM	$3,995-$18,000	drop/insert, point-to-point
CMX-24T	192 (up to 9600)	24/120 (56K/9600)		1 (1.544M)				TDM	$4,995-$25,000	drop/insert, point-to-point
MICOM SYSTEMS INC. 4100 Los Angeles Ave., P.O. Box 8100, Simi Valley, CA 93062-8100, (805) 583-8600										Circle 541
MB2-ESM	16 (9600)		1 (9600)	1 (19.2K)	async, X.21, DLC	64K	yes	STDM	$1,490-$5,990	integral modem, data compression, point-to-point, multipoint
MB3-ESW	16 (19.2K)	8 (19.2K)		1 (72K)	DLC	256K	yes	STDM	$1,790-$6,690	integral modem, data compression, point-to-point
MB5-ESM	32 (9600)		1 (9600)	1 (19.2K)	async, X.21, DLC	64K	yes	STDM	$3,050-$9,500	integral modem, data compression, point-to-point, multipoint
MINNTRONICS CORP. 2785 White Bear Ave., St. Paul, MN 55109, (612) 770-5247										Circle 542
MZV8-11 OCTOMUX	8 (38.4K)					0.064K			$650-$750	
MITEL DATACOM INC. 13873 Park Center Rd., Suite 553, Herndon, VA 22071, (703) 471-1000										Circle 543
4061X		4 (9600)		1 (9600)	transparent		no	TDM	$450	point-to-point
4062X		6 (14.4K)		1 (14.4K)	transparent		no	TDM	$585	point-to-point
MULTI-TECH SYSTEMS INC. 82 Second Ave. S.E., New Brighton, MN 55112, (612) 631-3550										Circle 544
MultiMux 904	4 (9600)			1 (19.2K)	HDLC	8K	no	STDM	$1,095	flow control conversion
MultiMux 908	8 (9600)			1 (19.2K)	HDLC	8K	no	STDM	$1,395	flow control conversion
MultiMux 908/96	8 (9600)			1 (19.2K)	HDLC	8K	no	STDM	$2,495	integral modem
NCR COMTEN INC. 2700 Snelling Ave. North, St. Paul, MN 55113, (612) 638-7944										Circle 545
T-203X	128 (19.2K)	128 (19.2K)			CCITT V.35		yes	bit-interleaved TDM	$11,000-$100,000	drop/insert, flow control conversion, integral modem
PARADYNE CORP. 8550 Ulmerton Rd., Lago, FL 33540, (813) 530-2785										Circle 546
2030	8 (19.2K)	8 (19.2K)		1 (19.2K)	HDLC	16K	yes	STDM	$1,500-$3,000	
DCX 825/871	32 (9600)	8 (9600)		1 (19.2K)	HDLC	16K	yes	STDM	$1,800-$7,500	
DCX 840/850	240 (9600)	120 (9600)		15 (19.2K/56K)	HDLC	up to 1M	yes	STDM	$6,000-$100,000	switching
PENRIL DATACOMM 207 Perry Parkway, Gaithersburg, MD 20877, (301) 921-8600										Circle 547
5SLOT VCX	80 (19.2K)			10 (72K)	SDLC, X.25	256-2K	yes	STDM	$4,500-$14,750	flow control conversion
19SLOT VCX	304 (19.2K)			38 (72K)	SDLC, X.25	256-2K	yes	STDM	$8,000-$45,750	flow control conversion
VCX-150	16 (19.2K)			2 (72K)	SDLC, X.25	256-2K	yes	STDM	$1,500-$3,600	flow control conversion, integral modem

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CIRCLE NO. 64 ON INQUIRY CARD

Company / Model	Input channels: Max. async (speed/bps)	Input channels: Max. sync (speed/bps)	Output channels: Max. async (speed/bps)	Output channels: Max. sync (speed/bps)	Composite link protocols	Buffer size (bytes)	Automatic bit rate detection?	Technique	Price range	Notes and Features
RACAL-MILGO 1601 N. Harrison Parkway, Sunrise, FL 33323, (800) 327-4440										**Circle 548**
Omnimux 82 Series	32 (19.2K)	32 (19.2K)		2 (72K)	modified HDLC	2K-8K	yes	STDM	$2,026-$11,209	multiple sync protocols
Omnimux TDM	16 (48K)	16 (2400)		1 (128K)			no	TDM	$1,795-$6,440	diagnostics
RACAL-VADIC 1525 McCarthy Blvd., Milpitas, CA 95035, (408) 432-8008										**Circle 549**
7400	16 (9600)			1 (19.2K)	HDLC	10K	no	STDM	$1,295-$4,780	integral modem, point-to-point, dial-up
7556		6 (19.2K)		1 (56K)	CCITT V.35		no	TDM	$1,465-$1,990	
RAD DATA COMMUNICATIONS INC. 151 W. Passaic St., Rochelle Park, NJ 07662, (201) 587-8822										**Circle 550**
FLM-1	12 (up to 38.4K)			11 (1.2288M, 2.4576M)	transparent		yes	TDM		fiber optic, integral modem, point-to-point
KiloMux	6 (up to 4800)	6 (19.2K)		1 (19.2K-128K)	transparent		no	TDM		point-to-point
Megaplex		20 (768K)		1 (1.544M)			no	TDM		point-to-point
SCITEC CORP. 850 Aquidneck Ave., Middletown, RI 02840, (401) 849-4354										**Circle 551**
BSPT-1	128 (19.2K)	128 (1.344M)		1 (1.544M, 2.048M)	proprietary		no	TDM	$5,400	integral modem, voice cards
MUX25	4 (9600)	1 (9600)	1 (19.2K)	1 (19.2K)	X.25	2K	yes	STDM	$1,000	flow control conversion, data compression, networking, point-to-point
NPX25	32 (19.2K)	4 (2400-9600)	2 (19.2K)	2 (56K)	X.25	4K	yes	STDM	$1,800	integral modem
S.I. TECH INC. P.O. Box 609, Geneva, IL 60134, (312) 232-8640										**Circle 552**
2006	8 (19.2K)	8 (19.2K)	8 (160K)	8 (160K)	transparent		no	TDM	$750-$1,500	fiber optic modem, point-to-point
2016	16 (19.2K)		16 (320K)		transparent		no	TDM	$1,900	fiber optic modem, point-to-point
SOLANA ELECTRONICS 7887 Dunbrook Rd., Suite A, San Diego, CA 92126, (619) 566-1701										**Circle 553**
SE822	8 (9600)		1 (400K)		proprietary			TDM	$495	point-to-point
TELEBYTE TECHNOLOGY INC. 270 E. Pulaski Rd., Greenlawn, NY 11740, (516) 423-3232										**Circle 554**
570	8 (19.2K)		1 (300K)		proprietary		no	TDM	$548	cables, flow control conversion
571	8 (19.2K)		1 (300K)		proprietary		no	TDM	$695	8 built-in tail circuit modems
TELEPROCESSING PRODUCTS INC. 4565 E. Industrial St., Simi Valley, CA 93063, (805) 522-8147										**Circle 555**
TP-212	2 (110-9600)		1 (110-9600)	1 (110-9600)	proprietary	16K	no	STDM	$850	flow control conversion, data compression, point-to-point
TP-214	4 (110-9600)		1 (110-9600)	1 (110-9600)	proprietary	16K	no	STDM	$1,350	flow control conversion, data compression, point-to-point
TP-218	8 (110-9600)		1 (110-19.2K)	1 (110-19.2K)	proprietary	64K	no	STDM	$1,850	flow control conversion, data compression, point-to-point
TELTONE CORP. 10801 120th Ave. N.E., Kirkland, WA 98033, (206) 827-9626										**Circle 556**
M-825	32 (19.2K)		32 (19.2K)				yes	TDM	$150-$4,800	point-to-point
TIMEPLEX INC. 400 Chestnut Ridge Rd., Woodcliff Lake, NJ 07675, (201) 930-4600										**Circle 557**
LINK/1	208 (up to 19.2K)	208 (up to 1.152M)		6 (1.544M)				TDM	$12,000-$75,000	

Company / Model	Input channels: Max. async (speed/bps)	Input channels: Max. sync (speed/bps)	Output channels: Max. async (speed/bps)	Output channels: Max. sync (speed/bps)	Composite link protocols	Buffer size (bytes)	Automatic bit rate detection?	Technique	Price range	Notes and Features
LINK/2	208 (up to 19.2K)	208 (up to 1.152M)		6 (1.544M)				TDM	$15,000-$100,000	
LINK/100	15,000 (up to 19.2K)	15,000 (up to 1.152M)		14 (1.544M)				TDM	$100,000-$300,000	
VERSITRON 6310 Chillum Place, N.W., Washington, D.C., 20011, (202) 722-8600										Circle 560
Versimux	120 (88.4K)	30 (78.6K)			proprietary		no	TDM	$4,200-$14,000	
WESTERN DATACOM 5083 Market St., Youngstown, OH 44512, (216) 835-1510, (800) 262-3311										Circle 558
Prism 3A	3 (9600)		1 (9600)			2K	no	STDM	$875	
ZETACO INC. 6850 Shady Oak Rd., Eden Prairie, MN 55344, (612) 941-9480										Circle 561
MX-420	16 (19.2K)		16 (up to 19.2K)				no		$2,295	

CIRCLE NO. 86 ON INQUIRY CARD

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5. When you need a peripheral storage device for hostile environments.

Or, for any other disk intensive application, including Data Base Management, Graphics, Process Control, or for real time processing situations such as Image Processing and Data Acquisition.

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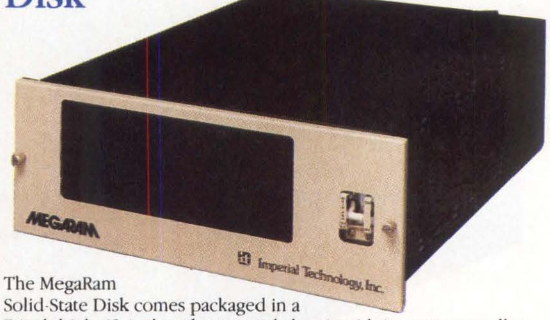
If your CPU requires faster data access and retrieval, operates in hostile environments, or demands maximum disk reliability, you'll find the MegaRam a smart, cost-effective investment. Call or write today for full details.

The MegaRam Solid-State Disk



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CIRCLE NO. 66 ON INQUIRY CARD

PERSONAL COMPUTERS

Refined NuBus opens Apple's Macintosh II

Zigurd Mednieks, MURSU Corp.

The Macintosh II is an evolutionary new Macintosh that brings sophistication, plus the computing power of a workstation, to a machine priced in the microcomputer range.

Still a Macintosh, and running the same software as a Macintosh Plus or Macintosh SE, the Macintosh II is as fast or faster than most workstation computers. It can use large graphics screens and combine several screens into one huge desktop. Also, it is easy to use, simple to install and doesn't require a resident "wizard" to maintain the correct configuration of its hardware and software.

The microprocessor is the Motorola Inc. MC68020, a 32-bit member of the 68000 family. It is object-code compatible with the 68000 used in other Macintoshes. The 68020's clock is twice as fast as the one used in the Macintosh Plus and SE models. The speed of the Macintosh II is from three to five times faster than the Macintosh Plus and SE models. Floating-point operations, with an optional floating-point processor, are between 40 and 200 times faster.

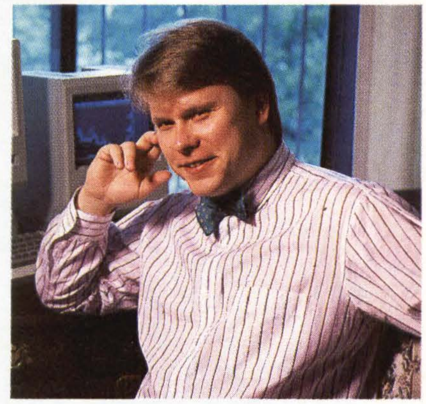
To increase flexibility, the high-performance NuBus was added to the system. Developed by the Real Time Systems group at the Massachusetts Institute of Technology as the bus for its Nu Machine, NuBus traveled a circuitous route through Zenith Data Systems, then on to Western Digital Corp. and finally to Texas Instruments. By this time, the Nu Machine was obsolete, but the bus lived on in LISP systems built by TI and LISP Machine Inc. and in UNIX systems from TI.

Zigurd Mednieks is president of MURSU Corp., a Cambridge, Mass., consulting company that engineers hardware and software for Macintosh, UNIX and LISP-based systems. He is co-author of *C Programming Techniques for the Macintosh*.

Fair interrupt arbitration

This 10-MHz synchronous bus is capable of 8-, 16- and 32-bit-wide transfers; block transfers of 2, 4, 8 or 16 words; and a maximum transfer rate of 37.5M bytes per second. It has full 32-bit addressing, requires no fixed master processor and incorporates an interrupt scheme based on bus transactions, rather than interrupt lines. That way, many intelligent peripherals can send interrupts to many processors. Arbitration is strictly fair with slots competing for bus ownership, gaining access in order. There is no inherent hierarchy of interrupt or bus-access priority. Geographical addressing gives each of the bus' slots a fixed position in the NuBus address space. A configuration ROM on each card (at a fixed offset within each slot's address space) identifies the cards. As a result, any card can be placed in any slot. NuBus has a clearly defined byte and word order: When a larger word is split in two, the most significant bits are at the lower address. Establishing this convention makes the bus independent of processor byte order.

Apple chose to implement Non-Master Request (NMRQ) lines, enabling the Macintosh II to handle interrupts from the NuBus with a VIA (Versatile Interface Adapter) chip. This approach is less flexible than the full NuBus interrupt scheme, but it is adequate and doesn't keep coprocessor systems and their peripheral cards from using the more flexible interrupt scheme. Additionally, restricting the per-slot address space to the lowest megabyte of the slot's 16M-byte address space and mapping it into a contiguous "slot space" in the 24M-byte, compatibility-mode address space of the system, permits compatibility with current Macintoshes. This restriction affects only those NuBus cards used directly by the Macintosh system, and doesn't affect coprocessor systems.



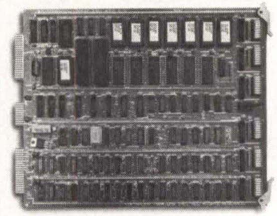
The Macintosh II is easy to use, simple to install and doesn't require a resident 'wizard.'

The first cards available for NuBus will be graphics cards, because the Macintosh II is very flexible in interfacing to graphics cards. Two or more graphics cards can be used, and they may be of different types (e.g., color and monochrome), different sizes and even different memory layouts.

Any depth from 1 bit to 32 bits per pixel is supported. Existing color displays support 256 colors from a palette of 16 million colors. In theory, the system supports 32 billion colors on a screen 65,535 pixels horizontally and vertically, or about 100 feet diagonally. The parameters of the Macintosh II's QuickDraw graphics-device standard go far beyond the ability of the human eye to resolve color, and beyond the ability of foreseeable display technology.

The Color QuickDraw software

Follow this line.



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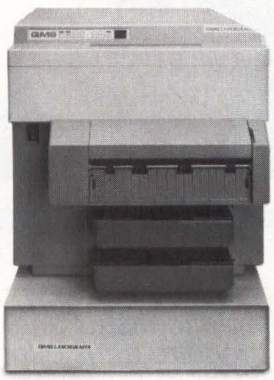

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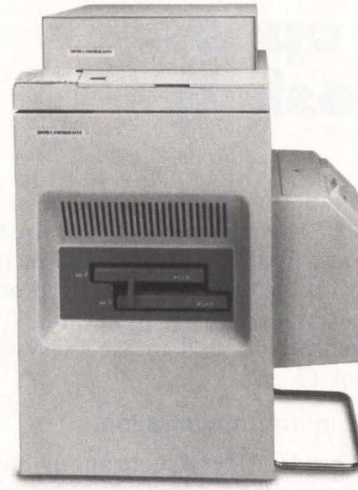
8 pages per minute. Engineering, scientific, CAD. Multi-user environments.



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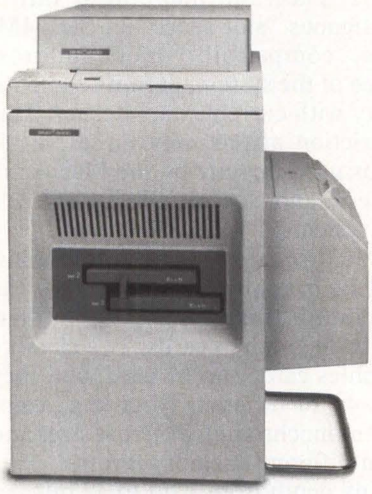

QMS-PS 2400

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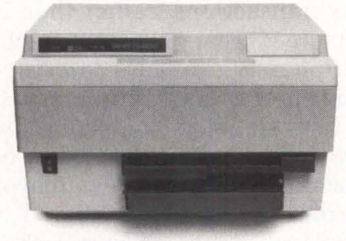

QMS-PS® 800

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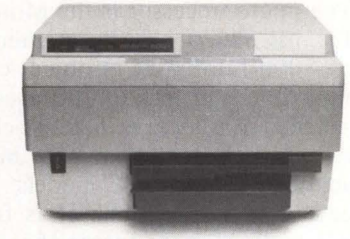

QMS-PS 800 + —New

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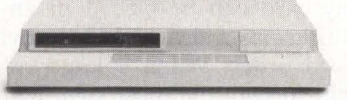

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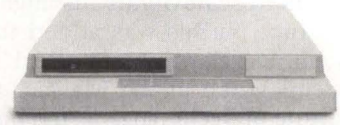
PostScript upgrade for laser printers using Canon® engines. 13 resident typefaces.



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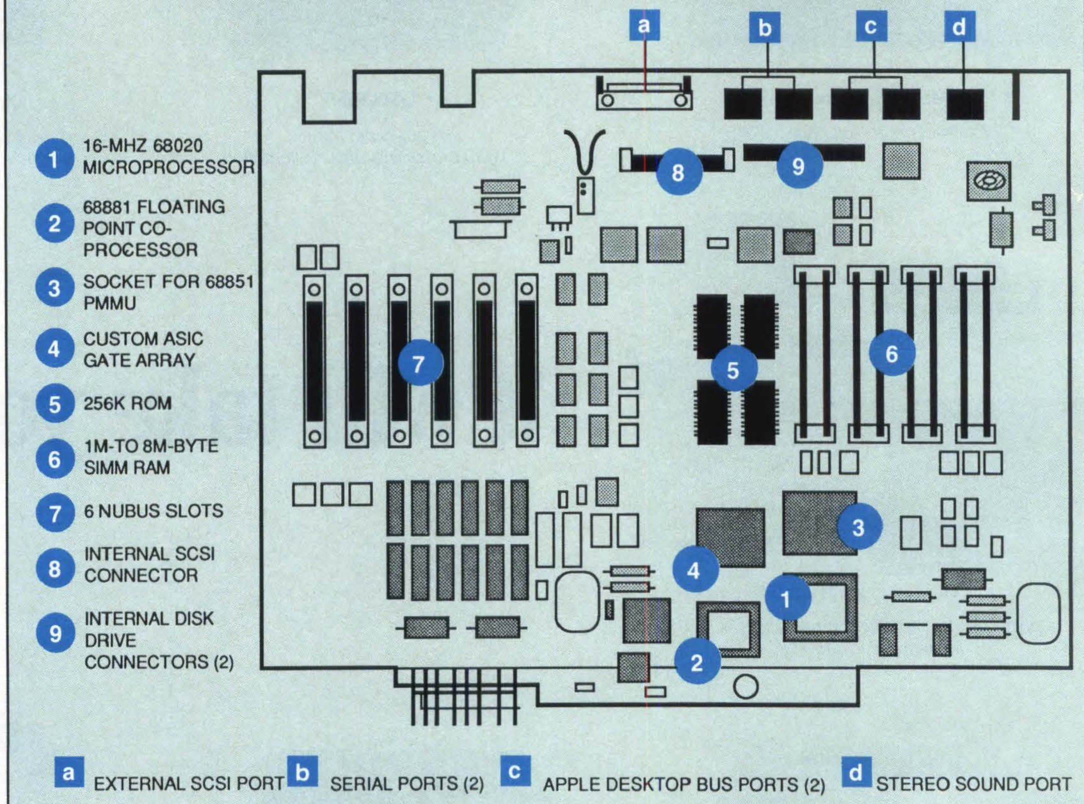
PERSONAL COMPUTERS

Residing on the Macintosh II's *motherboard, NuBus handles 32-bit addressing and serves many intelligent peripherals with a "first come, first served" interrupt scheme.*

NUBUS FINDS A HOME ON THE MAC II MOTHERBOARD



built into the Macintosh II supports two graphics memory formats: planar, with each bit-plane storing one bit per display pixel; and "chunky," where the bits for each pixel are stored contiguously. A third, "chunky-planar" format, in which red, green and blue are allocated separate memory areas (each containing "chunky" memory), is planned but not yet implemented. This last format allows graphics memory to be split among three NuBus cards.

The high performance of the NuBus makes multiple processors practical as well as possible. Therefore, a high-performance coprocessor can be added into the system without running into an I/O bottleneck. In fact, the biggest problem in selecting a coprocessor for the Macintosh II is picking one fast enough to be interesting. With a 16-MHz 68020, the Macintosh II can perform very well—it does not need an added boost for most applications. The most interesting coprocessors are those that provide either a substantial performance increase or access to a software base at less cost than the price of a whole standalone computer. For example, a vector processor card would speed up substantially many scientific calculations at a much lower cost than would a minicomputer with a vector processor. Also a Digital Equipment Corp. MicroVAX coprocessor card would provide access to the VMS software base without the cost of a VAX and its associated peripherals.

The first available cards will be graphics cards, because the Macintosh II is very flexible in interfacing to graphics.

There is an AST Research Inc. coprocessor board for running MS-DOS applications. It is unclear whether a less powerful coprocessor makes sense. The Macintosh II runs a wide variety of software, which is often more powerful than any available for the MS-DOS environment. Also, the price of a standalone IBM Corp. PC/AT-compatible computer may be, in some cases, near that of the add-in compatibility card.

The decision to interface a mass-storage device with a NuBus card must be weighed against the lower cost of interfacing it through the SCSI (small computer systems interface) bus. Only the fastest storage devices could take advantage of NuBus throughput. A high performance, mass-storage system makes sense in conjunction with a specialized processor, like a database processor or a processor for searching inverted index files. The NuBus enables the

Introducing the Mylex 386 system board... the ultimate in microcomputing power! It's the same size as an AT system board for easy integration or upgrade. Speed previously unattainable is now possible by utilizing a special section of memory (known as CACHE) to store the most frequently used code. The 386 is complete with ROM-based diagnostics and hardware setup. Backed by extensive documentation and technical support.

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PERSONAL COMPUTERS

special processor to talk to the disk without intervention from the processor. Putting such a system in the Macintosh II would reduce the cost of specialized database processors.

There will be more than one Ethernet adapter available for the Macintosh II. The two types of Ethernet adapters are intelligent and dumb. The dumb adapters merely enable the

There will be more than one Ethernet adapter for the Macintosh II.

processor to put packets on the Ethernet. The intelligent adapters are an EtherTalk card, which supports the NFS (Network File Service) protocol, and TCP/IP (Transmission Control Protocol/Internet Protocol) running on Ethernet.

Intelligent adapters can save system integrators much effort in interfacing a network adapter. Communications between the processor and adapter take place at a relatively high level, which is useful in a system deficient in software support for networks.

The Macintosh II offers workstation performance and features. Workstation manufacturers will react to the Macintosh II's pricing. Sun Microsystems Inc. has already reacted by dropping the price of its entry-level Sun 3/5OM system. Sun probably will not be hurt by the Macintosh II, but manufacturers without low-end products that can compete in price against the Macintosh II will find themselves locked out of consideration in many cases.

The Macintosh II is priced at $5,369 with a 40M-byte rigid disk drive and $3,769 with a flexible disk drive. The prices do not include monitor and keyboard.

The Macintosh II system is sold unbundled. Thus, system integrators can provide fully customized systems, including display and keyboard options, without wasting money. □

Interest Quotient (Circle One)
High 495 Medium 496 Low 497

MODEMS

OEM modems exploit latest technologies

William Conway
Rockwell International Corp.

Simple error-checking routines and redundant transmission can handle small amounts of data.

Dramatic increases in leased-line costs are driving many business users onto more economical dial-up networks for data communications at speeds of 9,600 bits per second (bps) and higher.

Overcoming the problems imposed by limited bandwidth at lower speeds was relatively easy: simple error-checking routines and redundant transmission can handle relatively small amounts of data. However, reliable high-speed data transmission over the public switched telephone network (PSTN) system is more difficult. To meet this challenge, OEM modem developers incorporate trellis-coded modulation (TCM) and echo-cancelling technologies in their latest products.

To date, high-speed modems following CCITT recommendations have employed a technique called quadrature amplitude modulation (QAM) to modulate signals over the dial-up network. Appreciating the benefits of trellis-coded modulation requires an understanding of the role QAM plays.

A CCITT, full-duplex, leased-line V.29, QAM-based high-speed modem operating at 9,600 bps uses two carriers, 90 degrees out of phase (sine and cosine), and modulates each at one of two or more levels. Using this proven technique, four bits of information, or one symbol, can be transmitted during each send interval. A 9,600-bps QAM modem transmits four bits per symbol, at 2,400 symbols per second (or 2,400 baud). At the receiving modem, each symbol is decoded to represent four bits of coded information, or one (x,y) point of a possible 16 (2^4) in a rectangular coordinate system. Spacing between the points is a function of the speed of the transmitting modem. And, at higher speeds, the complexity of the resulting pattern, or constellation, increases exponentially.

Speed without reliability is useless for data transmission. Line impairments such as phase jitter, frequency offset and impulse noise cause the position of the points to shift from where they should be. When line conditions are poor, the resulting shifts in the points make it easy to mistake a specific point for one of its neighbors.

Since there are limitations to the bits-per-second that can be sent over the phone lines, the distance between the points becomes inherently less as the number of points increase. For example, a full-duplex V.32 modem sends 9,600 bps in each direction, creating a cloud, or constellation, of 32 points over the line. Because the points are close, any distortion can cause errors.

Pointing the way

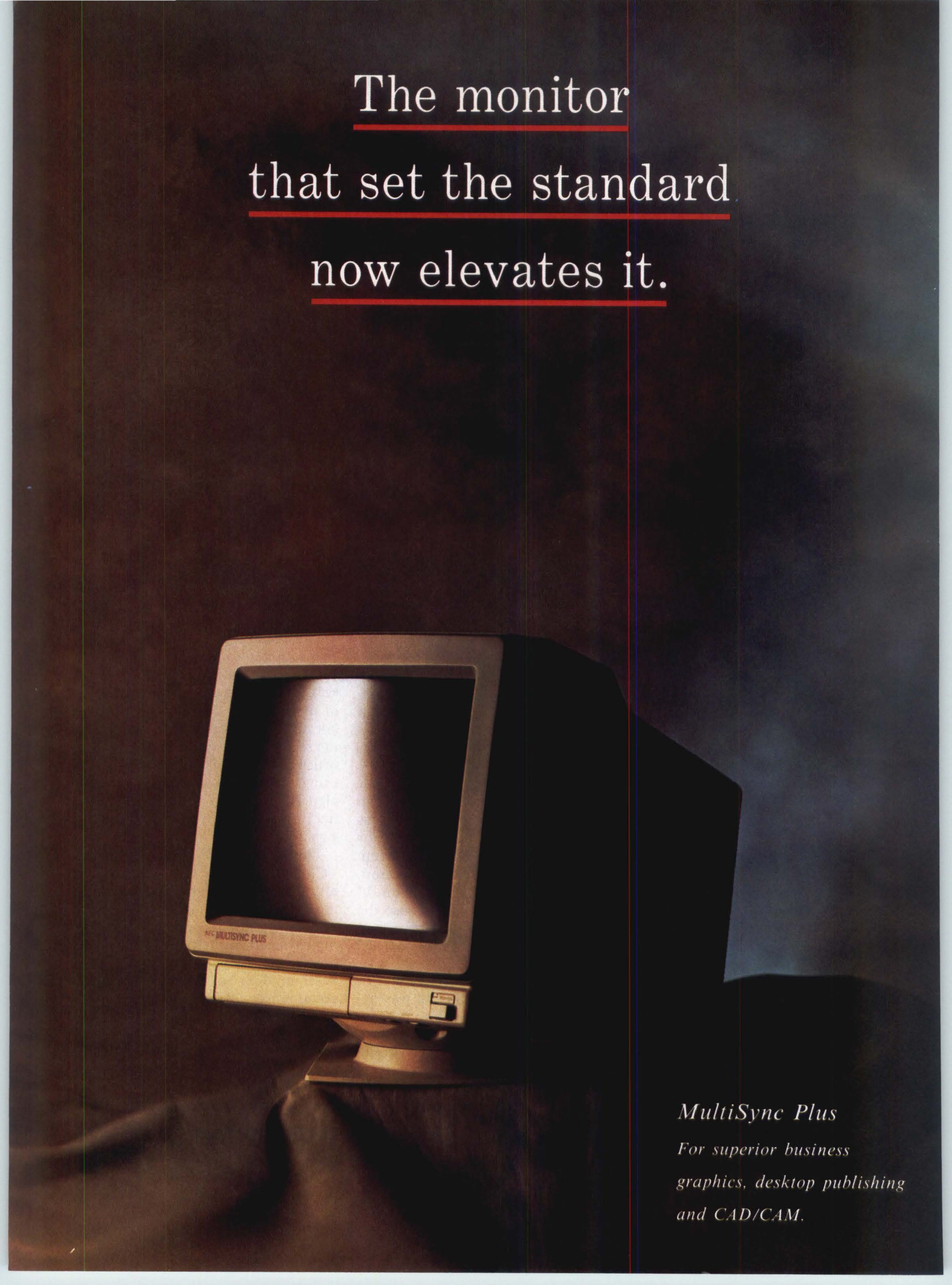
Trellis-coded modulation was developed to help eliminate "confusion" among the points and so reduce the number of errors. With TCM, an algorithm in the transmitter selects the positions in the constellation that are permitted for the next data point. These positions are selected to give the greatest distance possible between points, so that confusion is reduced. Of course, the receiver at the other end must be able to decode the signal and apply the same algorithm in reverse to recover the original data.

Considerable processing horsepower is required to perform TCM. Basically, because the receiver doesn't know if there have been any mistakes in the past, the decoder must calculate all possible valid points, compare the received data to each, then decide which is closest. This is usually done using a procedure called the Viterbi algorithm, which selects the most likely points out of a sequence of signals.

The benefits of TCM are clear. TCM considerably improves immunity to noise compared with a QAM modem without trellis coding. There's at least a 3 dB performance improvement in a V.32 modem that uses TCM compared to a non-TCM V.29 modem, or an error rate of about three orders of magnitude lower.

However, speed and noise are not the only problems to overcome in the design of a high-speed dial-up modem. With full-duplex V.32 operation at 9,600 bps, there is insufficient bandwidth for separate data channels in each direction. This presents difficulty in distinguishing between incoming weak signals and any reflections, or echoes, of stronger outgoing

William Conway is a product manager in the semiconductor products division of Rockwell International Corp., Newport Beach, Calif.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signals. The echoes are caused by mismatched impedances and delays inherent throughout the dial-up network—PBX (private branch exchange), central office equipment, etc. These echoes can be further subdivided into those occurring almost immediately upon transmission (called near-end echoes), and those from farther along the data stream (called far-end echoes). Near-end echoes may, in fact, be even stronger than signals originating from the remote modem.

Most often, echo-cancelling involves discovering what the echo is, and then creating another signal which, when added to the echo, will cancel it out. Since the echo is not stable, and varies with time, the task is formidable.

Signals by the numbers

Generally, solutions are based on a mathematical technique that takes a portion of the known output signal and delays it for a short time and then compares it to the incoming signal. By shifting the delay, and subtracting one signal from the other, you can tune the system for a minimum echo result. This is perhaps an oversimplification of the mathematical processes, but it suffices as a basic model. Of course, this process must apply to both near-end and far-end echoes, and modern applications over global lines should have the ability to program the echo-canceller to cover the spectrum as necessary to meet specific conditions.

To meet these conditions, advanced modems under development by Rockwell International Corp. include a built-in, programmable bulk delay, to accommodate satellite links over longer distances. These delays are usually 500 to 600 msec per "hop" from the earth station and back.

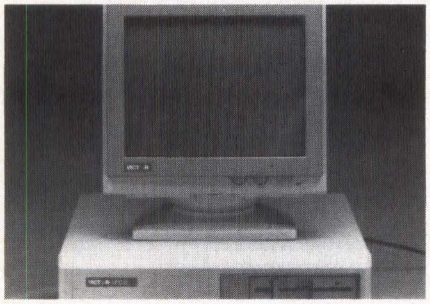
As costs, convenience and technology continue to drive users into higher speed transmission, TCM and echo-cancellation techniques will become even more widely employed, and their use will foster new applications in the near future. □

Interest Quotient (Circle One)
High 498 Medium 499 Low 500

NEW PRODUCTS

SYSTEMS

Megan Nields, Staff Editor



PC system offers up to 1M byte of RAM

- Six expansion slots
- 30M-byte disk drive
- Serial, parallel ports

The IBM PC/AT-compatible VPC III 286 supplies 512K bytes of RAM, expandable to 1M byte. It is configured with six expansion slots, one serial port and one parallel port. A 30M-byte, 3½-inch rigid disk drive is supplied. The unit is compatible with AutoCAD, dBASE III and Lotus 1-2-3 software. $2,500. **Victor Technologies Inc.,** 380 El Pueblo Road, Scotts Valley, Calif. 95066-0001, (408) 438-6680.

Circle 326

PC/AT compatible uses 80286 processor

- 1.2M-byte flexible drive
- Three configurations
- 640K bytes of memory

An IBM PC/AT-compatible microcomputer, the pc286 aims at spreadsheet, word processing and personal computer graphics applications. The unit uses a 16-bit 80286 processor running at 10 MHz. It is available in three configurations. A base system consists of 640K bytes of memory, serial and parallel ports and a 1.2M-byte flexible disk drive. The system runs software such as Lotus 1-2-3, dBASE III Plus, WordStar and WordPerfect. $3,195 and higher. **Harris Corp.,** National Accounts Division, 16001 Dallas Parkway, Dallas, Texas 75248, (214) 386-2000.

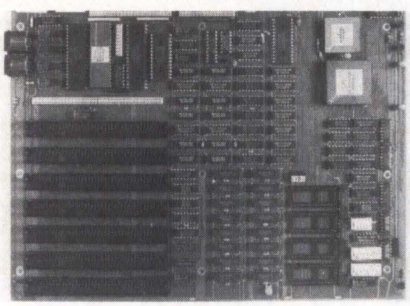
Circle 327

Superminis support up to 22 users

- Two configurations
- 68020 processor
- 5M bytes of RAM

The S/221 and S/222 superminicomputers support up to 20 users. Both systems use a Motorola MC68020 processor running at 12.5 MHz and supply up to 5M bytes of RAM. The 32-bit units offer a quarter-inch streaming tape drive, four system slots and a VMEbus. Options include an MC68881 floating-point coprocessor and a communications controller. $16,000, S/221; $17,5000, S/222. **Convergent Technologies Inc.,** 2700 N. First St., P.O. Box 6685, San Jose, Calif. 95150-6685, (408) 434-2848.

Circle 328

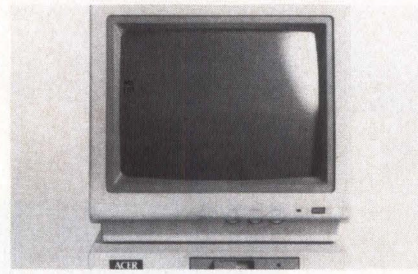


Computer system runs at 12.5 MHz

- 14.5M bytes of RAM
- 20M-byte disk drive
- Two RS232C ports

An MC68020-based microcomputer, the QT 20x operates at 12.5 MHz. The system supplies 0.5M bytes of RAM, expandable to 14.5M bytes. It consists of a 20M-byte rigid disk drive, a 720K-byte flexible disk drive, two serial ports and a parallel port. A SCSI interface with DMA is furnished. Options include an MC6881 math coprocessor, a graphics board and programming languages. $3,695. **Frank Hogg Laboratory Inc.,** 770 James St., Syracuse, N.Y. 13203, (315) 474-7856.

Circle 329



Desktops furnish IBM PC compatibility

- Two models
- Up to 1M byte of RAM
- 8088, 80287 processor

The Intel 8088-based 710 and the 80287-based 910 are IBM PC/XT- and PC/AT-compatible desktop computers. The 710 provides 768K bytes of RAM, two 360K-byte flexible disk drives, a 20M-byte rigid disk drive and runs twice as fast as the PC/XT. The 910 offers 512K bytes of RAM, expandable to 1M byte, a 1.2M-byte flexible disk drive and six expansion slots. Space is allotted for three 5¼-inch disk drives. Both systems feature a monochrome monitor. $1,195, 710; $1,895, 910. **Acer Technologies Corp.,** 1012 Stewart Drive, Sunnyvale, Calif. 94086, (408) 773-8400.

Circle 330

Graphics system suits CAE

- IBM PC/AT compatible
- 256-color monitor
- Proprietary software

Based on the IBM PC/AT, the AT1100 ConceptStation suits desktop CAE applications. The system furnishes a 32-bit graphics engine and a 256-color monitor with a 1,024-by-770-dpi resolution. A three-button mouse and proprietary software are offered. The system supports C and FORTRAN-77 compilers, Ethernet communications and IBM color graphics. It performs interactive, 3-D solids modeling and assembly modeling. $21,850. **Aries Technology Inc.,** 650 Suffolk St., Lowell, Mass. 01854, (617) 453-5310.

Circle 331

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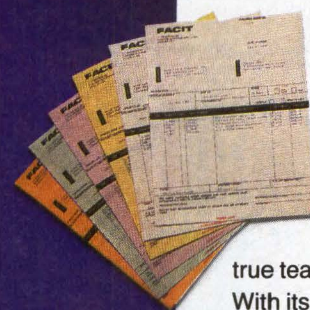

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Six-part forms can be a six-part headache. That's because many ordinary printers don't fully penetrate multi-part forms or keep them aligned. And they lack true tear-off capability, wasting forms.

With its unique, flat platen and V-shaped top, our new DocuMate gives you perfect feed-through and immediate tear-off.

A Bar Code Shouldn't Make Waves.

Our straight path keeps bar codes in line with unmatched precision and readability. And because bar coding is software resident, you can choose from 11 different bar code configurations.

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Printing 10,000 labels in succession could get sticky for an ordinary printer. DocuMate prints them without peel-off. You can even mix in bar codes and variable size characters up to 9.5″ tall.

There's no end to what you can demand from DocuMate. Like front load and bottom feed for true counter-top convenience. Plug-in font cards that make type style changes a snap. And a rugged, easy-to-load—quick-to-service clamshell case. The silence inside is unheard of. So is the price.

For more information, write Facit, Inc., 9 Executive Park Drive, PO Box 334, Merrimack, New Hampshire, U.S.A., 03054. Or call (603) 424-8000.

Facit DocuMate 3000 Demand Document Printer—features 11 resident bar codes, immediate paper tear-off, text and graphics, label printing, and up to six-part forms.

Facit P7080—A Laser Printer—For high-volume workloads with multiple emulations, face-down stacking, and optional PostScript emulation and bar codes.

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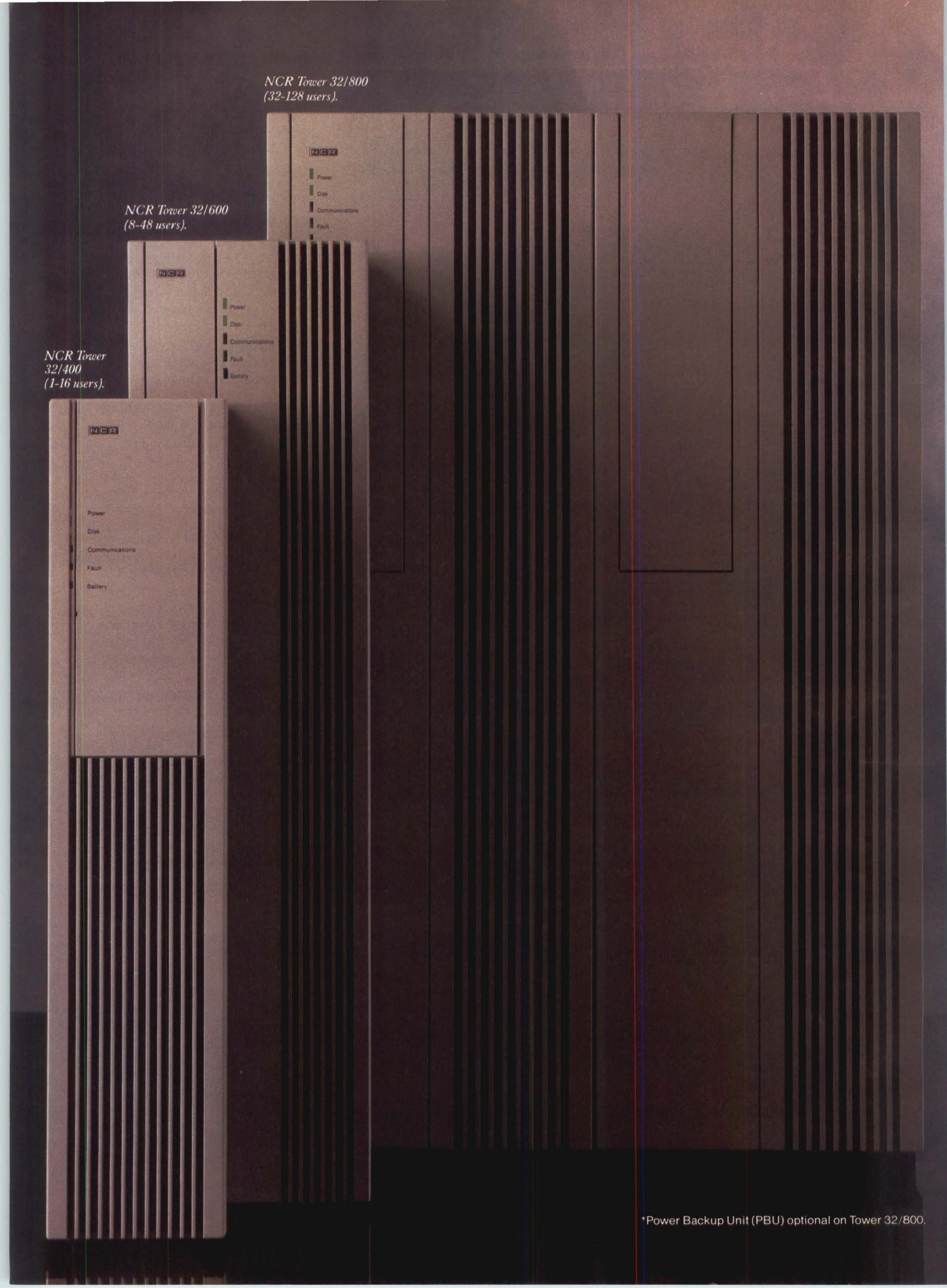
CIRCLE NO. 75 ON INQUIRY CARD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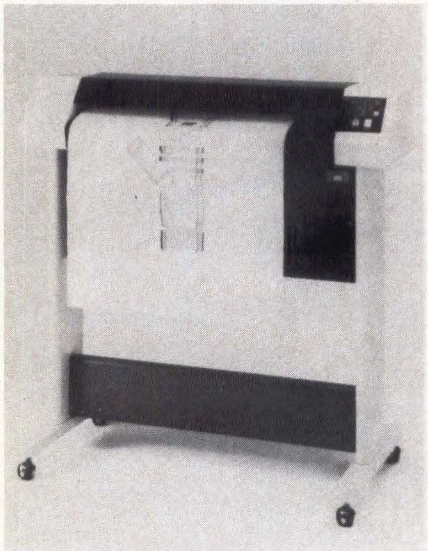
(1-16 users).
*Power Backup Unit (PBU) optional on Tower 32/800.

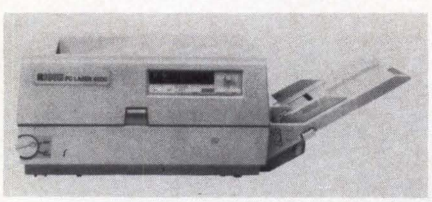


Plotter draws on eight pens

- 128K-byte buffer
- RS232C port
- 20 ips

An eight-pen digital plotter, model RV5200 produces A-, B-, C- and D-size drawings. It operates at 20 ips and supplies 0.001-inch resolution. Features include a 128K-byte buffer memory expandable to 256K bytes and an RS232C interface. The plotter language is HP-GL-compatible. Firmware functions include linear motions, curves, circles and graphics. $6,000. **RDK Instruments Inc.,** P.O. Box 14864, Austin, Texas 78761, (512) 835-0330.

Circle 332



Laser printer yields 6 ppm

- 2M bytes of RAM
- 300 dpi
- Two interfaces

The PC Laser 6000 printer produces 6 ppm with a 300-dpi resolution. Equipped with up to 2M bytes of RAM, the unit targets CAD/CAM, word processing and business applications. It has a proprietary graphics command set which includes Diablo 630 emulation. Optional emulation cards for the Epson FX-80, HP LaserJet Plus and IBM Proprinter are available. The IBM PC/XT and AT-compatible product comes standard with parallel and serial interfaces. $2,395. **Ricoh Corp.,** 5 Dedrick Place, West Caldwell, N.J. 07006, (201) 882-2000.

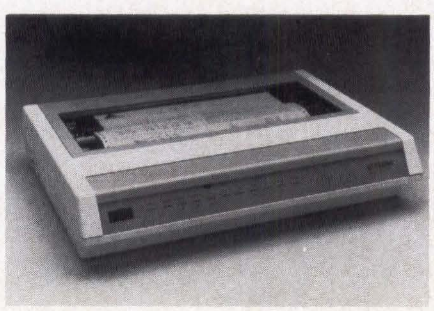
Circle 333

Dot-matrix prints 216 cps

- 32K bytes of memory
- 54 dBa
- Built-in tractor

The P321SL dot-matrix printer furnishes 72 cps in letter-quality mode and 216 cps in draft mode. It offers 32K bytes of memory, two font-card slots and a built-in tractor. Resolution is 180 by 180 dpi or 180 by 360 dpi. $749. **Toshiba America Inc.,** Information Systems Division, 9740 Irvine Blvd., Irvine, Calif. 92718, (714) 380-3000.

Circle 334

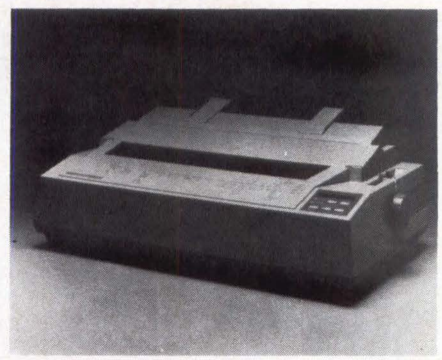


Serial printer spouts 400 cps

- 6,000-hour MTBF
- 58 dBa
- DEC, IBM emulation

A 400-cps serial matrix printer, the TriPrinter/4000 handles graphics, barcoding and data-processing applications. MTBF is 6,000 hours. The unit offers a noise level of less than 58 dBa and an 87.5-cps letter-quality mode. It emulates Apple, DEC, Epson and IBM printers. Print options include boldface, slanting and double-size characters. Single-bin and dual-bin sheet feeders are available. $1,995. **CIE Terminals Inc.,** 2505 McCabe Way, Irvine, Calif. 92714, (714) 660-1421.

Circle 335



Dot-matrix runs at 428 cps

- Under 55 dBa
- Nine resident fonts
- Epson emulation

A 24-wire dot-matrix printer, the NP-2405 outputs 250 to 428 cps in draft mode and 80 to 144 cps in letter-quality mode. The unit prints up to six-part forms. It supplies Epson LQ-1500 emulation, nine resident fonts and a 30K-byte buffer. Parallel and serial interfaces are standard. Noise level is less than 55 dBa. Options include seven additional fonts and Diablo 630 emulation. $1,295. **Nissho Information Systems,** Suite 100, 10855 Business Center Drive, Cypress, Calif. 90630, (714) 952-8700.

Circle 336

The perfect PC takes bigger bytes.

Now here's a design dilemma that's hard to swallow.

On one hand, the market demands a PC with a smaller footprint to take up less space on a desk. On the other, the market demands high-capacity disk drives with ultra-pronto access to stored data.

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Our 3.5″ micro-Winchester hard drives are available in capacities from 20 to over 57 MB, and standard (MFM) or run length limited (RLL) configurations that offer more usable formatted storage space than comparable drives.

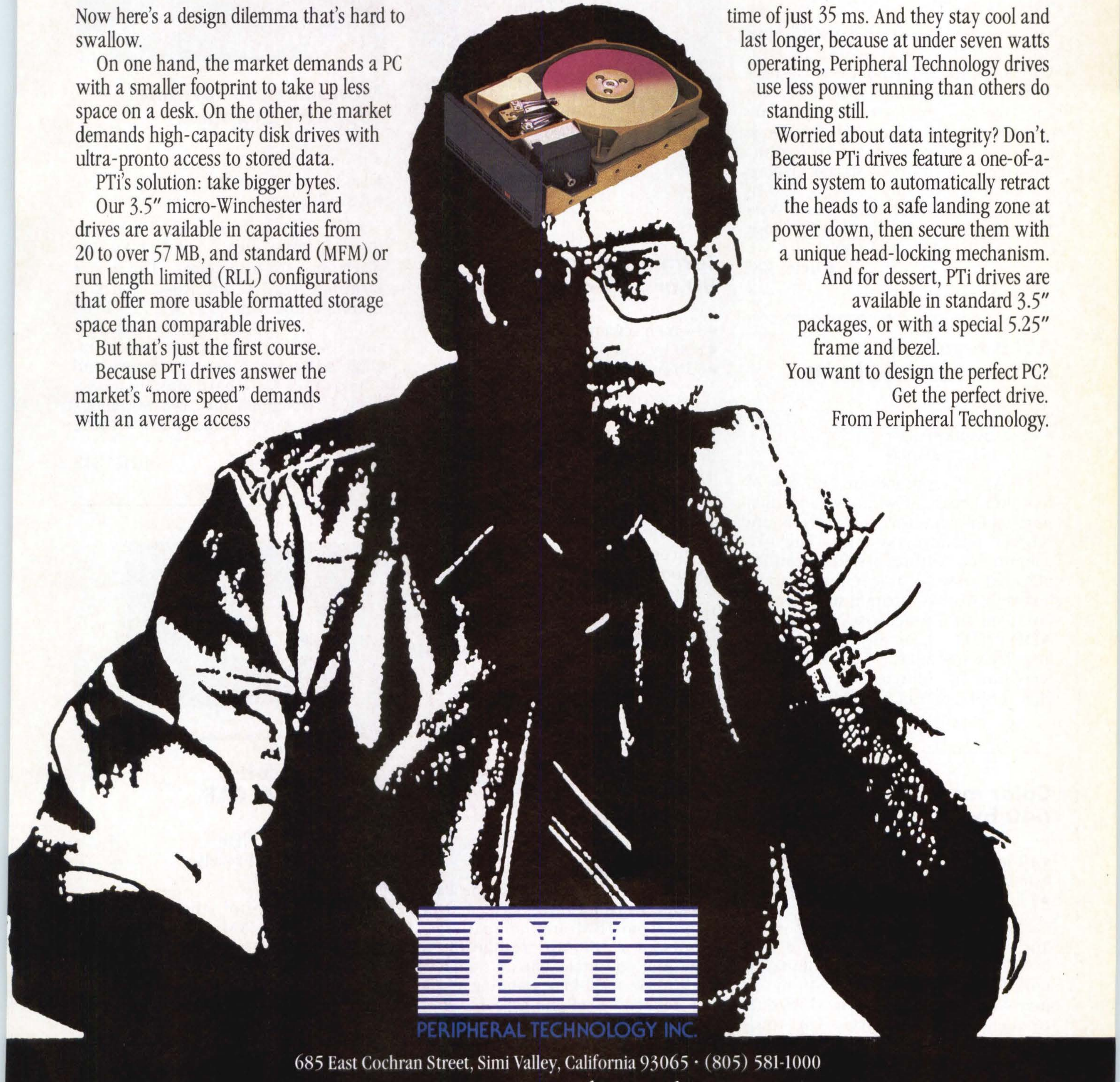
But that's just the first course.

Because PTi drives answer the market's "more speed" demands with an average access time of just 35 ms. And they stay cool and last longer, because at under seven watts operating, Peripheral Technology drives use less power running than others do standing still.

Worried about data integrity? Don't. Because PTi drives feature a one-of-a-kind system to automatically retract the heads to a safe landing zone at power down, then secure them with a unique head-locking mechanism.

And for dessert, PTi drives are available in standard 3.5″ packages, or with a special 5.25″ frame and bezel.

You want to design the perfect PC? Get the perfect drive. From Peripheral Technology.



PTi

PERIPHERAL TECHNOLOGY INC.

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We've got the drive.

CIRCLE NO. 78 ON INQUIRY CARD

Terminal combines ANSI, ASCII features

- 14-inch screen
- DEC, IBM compatibility
- 800 by 312 dpi

Combining ANSI and ASCII functions, the WY-99GT works in DEC VT220 and Tektronix 4010/4014 modes. It is compatible with IBM CGA and Hercules graphics. The unit runs programs such as AutoCAD, AutoDesk, Lotus 1-2-3, Plot-10 and Xerox Ventura Publisher. The 14-inch screen displays resolutions of 800 by 312 dpi, 720 by 348 dpi and 640 by 200 dpi. $649. **Wyse Technology,** 3571 N. First St., San Jose, Calif. 95134, (408) 433-1000.

Circle 337

ASCII terminal connects to two hosts

- Dual ports
- Three windows
- 132-column display

An ASCII terminal, the OPUS 4 offers three types of windows and dual-port technology for Pick, UNIX and XENIX operating systems. The 132-column unit features a split-screen format that allows it to communicate via hot keys to two separate hosts or two ports on the same host. It emulates ADDS, DEC, Lear Siegler, TeleVideo and Wyse terminals. $565. **Esprit Systems Inc.,** 100 Marcus Drive, Melville, N.Y. 11747, (516) 293-5600.

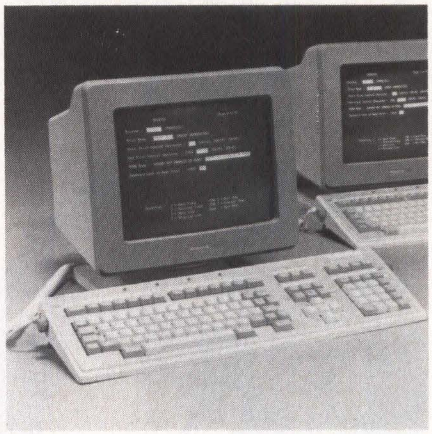
Circle 338

Color monitor displays 640 by 240 pixels

- 19-inch screen
- 350 lines
- 15.75 kHz

A color, touch-screen monitor, the TurboTouch 1910 accepts RGB and NTSC signals. The IBM PC-compatible unit displays 350 lines and 640 by 240 pixels on a 19-inch screen. Horizontal frequency is 15.75 kHz. The touch screen interfaces to an RS232C port. $1,595. **Personal Touch Corp.,** 4320-290 Stevens Creek Blvd., San Jose, Calif. 95129, (408) 246-8822.

Circle 339



Terminal displays 80 or 132 characters

- 14-inch screen
- 800 by 350 dpi
- 12 function keys

An asynchronous display terminal, the HDS 5 furnishes RS232C or RS422A interfaces, baud rates from 300 to 9,600 bps, parity and flow control. The unit's 14-inch, 800-by-350-dpi screen displays 80 or 132 characters per line. It supports smooth scrolling and up to five partitions. Features include 12 programmable function keys and composite video for driving large-screen devices. $995. **Honeywell Bull Inc.,** 300 Concord Road, Billerica, Mass. 01821, (617) 671-2517.

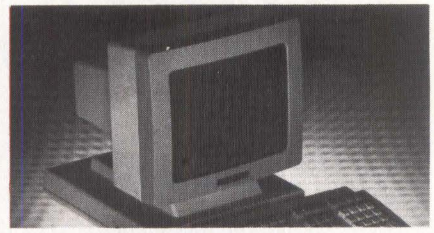
Circle 340

Monitor operates with CGA and EGA cards

- 19-inch screen
- 900 dpi
- 15.75 kHz, 22 kHz

A 19-inch color monitor, the Patriot Enhancer operates with CGA and EGA cards from IBM and compatibles. It furnishes a 900-dpi resolution and 0.31-mm dot pitch. The unit adjusts to 15.75-kHz or 22-kHz scanning frequency, depending on the card resolution. Applications include CAD/CAM, CAE, and factory automation. $2,550 and higher. **Aydin Controls,** 414 Commerce Drive, Fort Washington, Pa. 19034, (215) 542-7800.

Circle 341

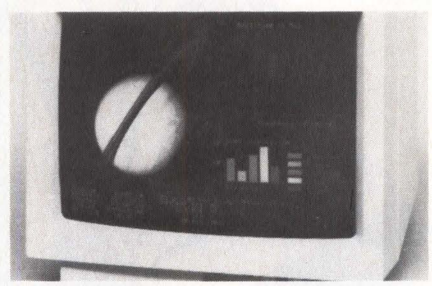


Monochrome terminal supports graphics

- 15-inch screen
- 1,024 by 780 pixels
- RS232C port

A monochrome graphics terminal, the GX-2000 displays 1,024 by 780 pixels on a 15-inch screen. The device furnishes RS232C and RS422 ports. It is compatible with DEC VT52, VT100 and VT220 alphanumerics and Tektronix 4010/4014 graphics. Options include additional graphics memory and a Tektronix 4631 hardcopy interface. $1,495. **Modgraph Inc.,** 149 Middlesex Turnpike, Burlington, Mass. 01803, (617) 229-4800.

Circle 342



Monitor suits CAD/CAM, CAE

- 0.31-mm dot pitch
- 1,280 by 1,024 pixels
- Up to 75 Hz

A color monitor, the HG-6905BK aims at CAD/CAM and CAE applications. The unit supplies a 40-kHz to 67-kHz horizontal scan range, a 50-Hz to 75-Hz vertical scan range and 0.31-mm-dot pitch. Resolution is 1,280 by 1,024 pixels, non-interlaced. $3,790. **Mitsubishi Electronics America Inc.,** Computer Peripherals Division, 991 Knox St., Torrance, Calif. 90502, (213) 515-3993.

Circle 343

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access my data
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Toshiba's T1100 PLUS and T3100 Portable Personal Computers.

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Weighing less than 10 pounds, the T1100 PLUS has 640K of RAM with the serial, parallel and CRT ports as standard built-in features. The 80C86 microprocessor allows for faster speed, and it runs on built-in rechargeable batteries.

The T3100 is designed for serious users, with the same 80286 microprocessor as a full-sized IBM PC-AT in a readily portable, 15-pound package. You get a 10MB internal hard disk, full-sized keyboard, expansion capabilities and a dual-voltage power supply which allows you to plug in and work almost anywhere.

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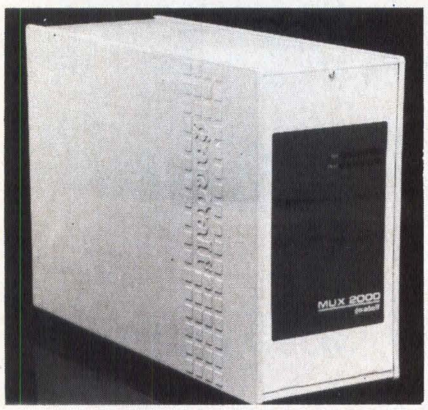
CIRCLE NO. 79 ON INQUIRY CARD

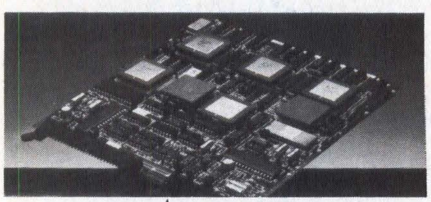


System provides data, voice transmissions

- Two multiplexers
- Assembler/disassembler
- Up to 64K bps

The MUX 2000 system supplies statistical and time-division multiplexing for high-speed digital services and digitized voice transmission. It consists of an ,X.25 packet assembler/disassembler (PAD) and two multiplexers. The XMUX PAD provides access to networks for up to 16 asynchronous devices operating at up to 19.2K bps. The KMUX seven-channel synchronous TDM furnishes up to 64K bps; the two-channel VMUX voice and data TDM digitizes and compresses speech into a 32-bit data stream. $950, VMUX; $2,195 to $4,695, XMUX; $2,595, KMUX. **Gandalf Data Inc.,** 1020 S. Noel Ave., Wheeling, Ill. 60090, (312) 541-6060.

Circle 344

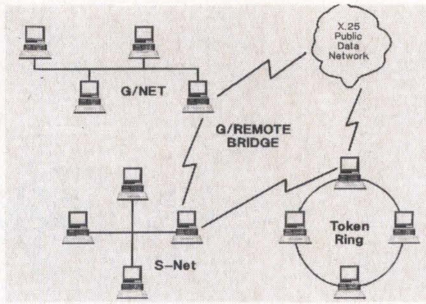


Modem boasts 19.2K bps

- Full-duplex unit
- Ten watts
- Proprietary interface

The Fujitsu Core Card modem boasts speeds ranging from 9.6K bps to 19.2K bps. The full-duplex unit occupies only 56 square inches and uses less than 10W of power. Features include trellis coding and a proprietary interface form factor. $3,550. **Fujitsu America Inc.,** 3055 Orchard Drive, San Jose, Calif. 95134-2017, (408) 946-8777.

Circle 345



Bridge connects up to 32 LANs

- X.25 protocol
- Up to 19.2K bps
- IBM PC compatible

G/REMOTE Bridge is an IBM PC-compatible, X.25-based Netware LAN-to-LAN remote bridge. The device connects up to 32 LANs simultaneously while supporting Netware's IPX communications protocol. It provides transmission speeds of up to 19.2K bps for over 37 different networks. $2,990. **Gateway Communications Inc.,** 2941 Alton Ave., Irvine, Calif. 92714, (714) 553-1555.

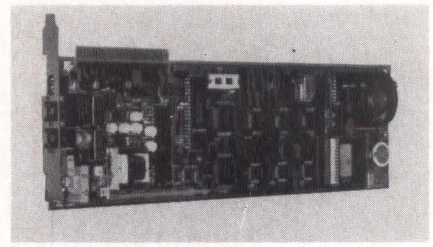
Circle 346

Communications controller supports SNA/SDLC

- Up to 19.2K bps
- 1M byte of memory
- RS232C port

A communications controller, the IBM-compatible H174-04 supports SNA/SDLC operation at speeds up to 19.2K bps and BSC operation at speeds up to 9.6K bps. The device offers 1M byte of system memory, an RS232C port and a 3½-inch flexible disk drive. Features include IBM 3179-G graphics support and on-line diagnostics. $3,350. **Harris Corp.,** National Accounts Division, 16001 Dallas Parkway, Dallas, Texas 75248, (214) 386-2000.

Circle 347



Pair of modems speed at 2,400 bps

- Two configurations
- Hayes compatible
- 50,000-hour MTBF

Supplying 2,400 bps, the Okitel 2400 and 2400b are external and internal modems, respectively. The Hayes-compatible units feature auto-dial/auto-answer capabilities, non-volatile memory and a 50,000-hour MTBF. Software is included. $599, 2400; $549, 2400b. **Okidata,** 532 Fellowship Road, Mount Laurel, N.J. 08054, (609) 235-2600.

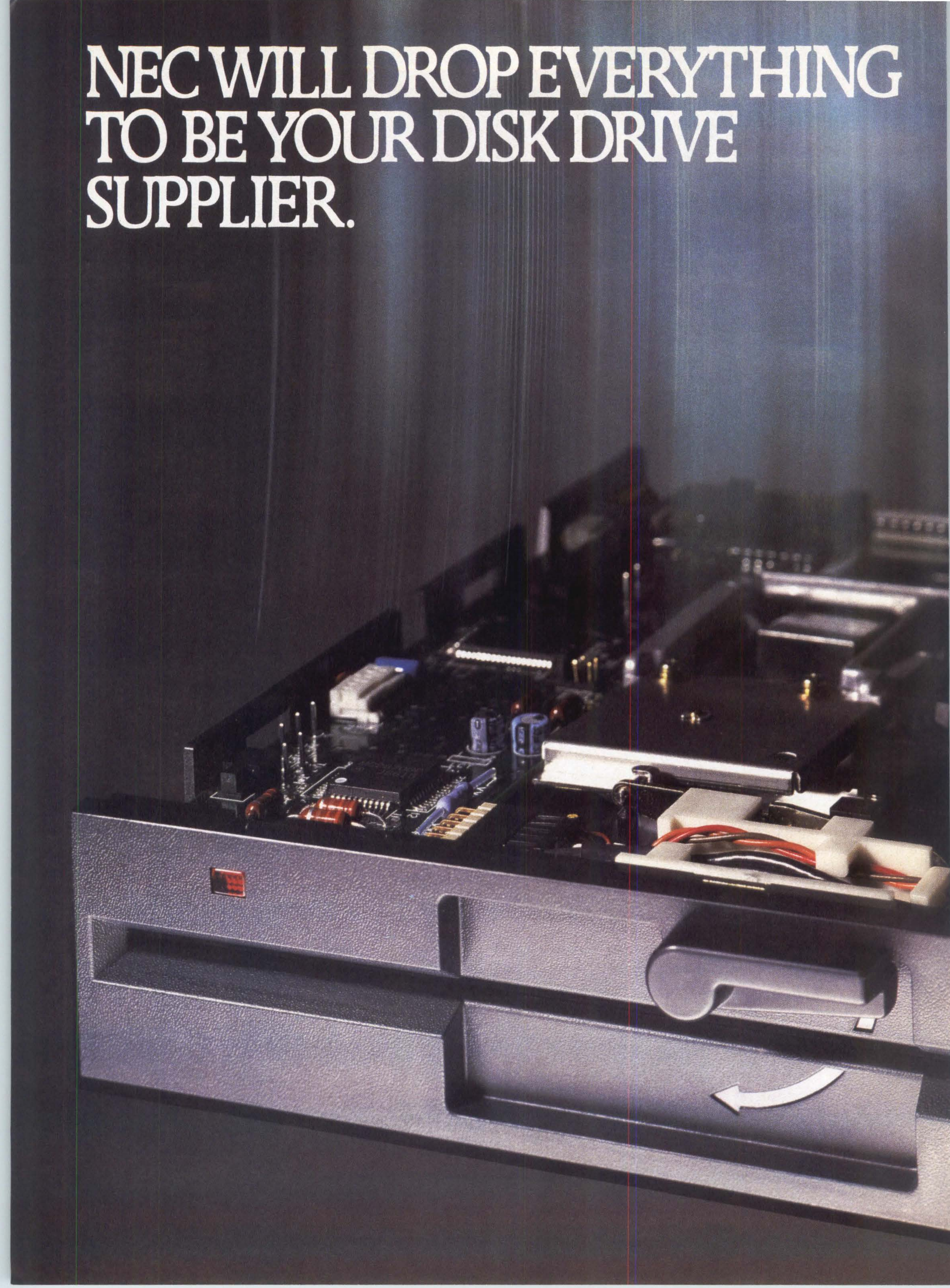
Circle 348

Modem runs at 9.6K bps

- CCITT V.32
- Full-duplex
- Internal/external

A 9.6K-bps full-duplex modem, the FDX 9600 is based on CCITT V.32 error-correction techniques. The unit operates in mainframe, minicomputer and personal computer environments. It runs over dial-up or leased lines and is available in internal or external configurations. Features include MNP error control with data compression, auto-dial/auto-answer and full diagnostics. $1,195. **Fastcomm Data Corp.,** 12347-E Sunrise Valley Drive, Reston, Va. 22091, (703) 620-3900.

Circle 349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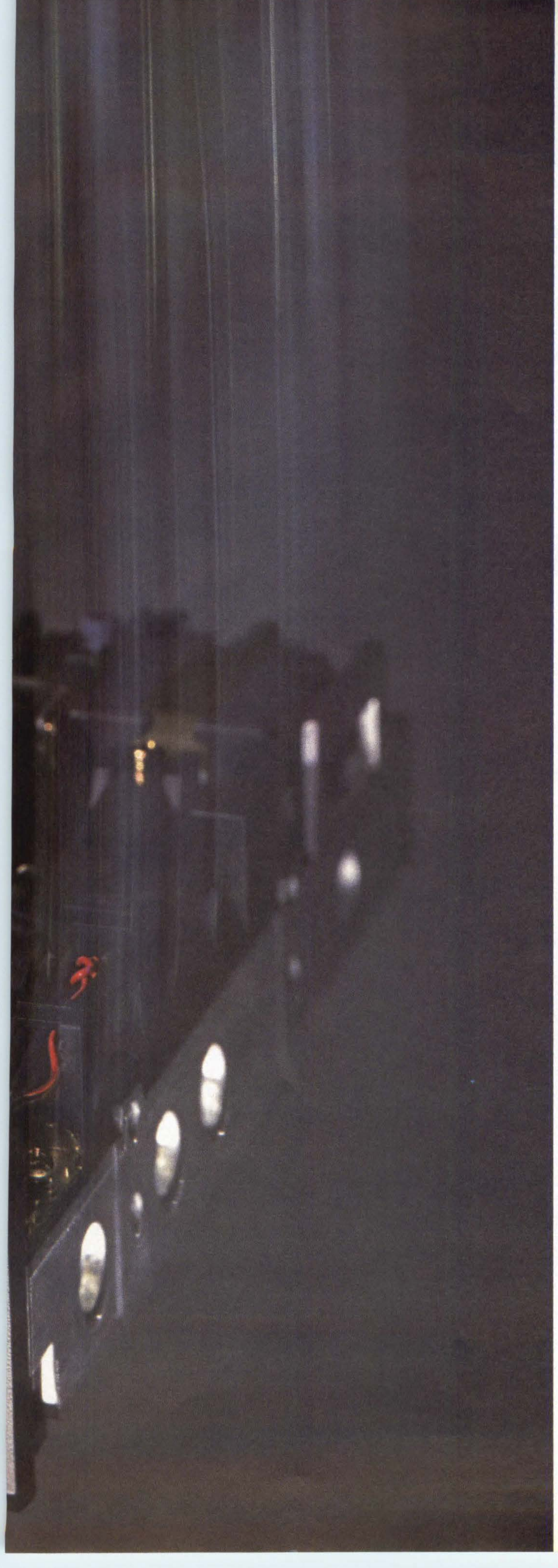

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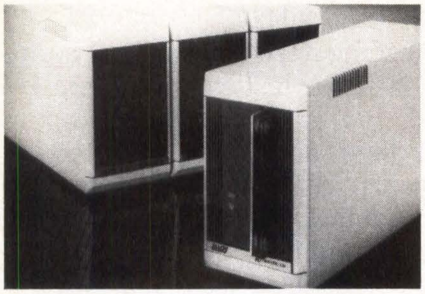
CIRCLE NO. 110 ON INQUIRY CARD

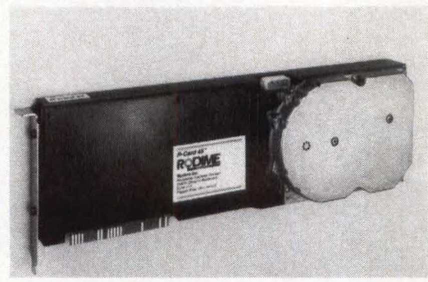


Tape backup offers error correction

- 120M bytes of storage
- Proprietary software
- Compaq, IBM compatible

The Retriever tape backup system stores 120M bytes of data. It is compatible with the Compaq 386 and IBM's PC/XT and PC/AT. Multiple units can be attached to a system, supplying up to 480M bytes. Features include proprietary software and error-correction capabilities. $1,695. **Alloy Computer Products Inc.,** 100 Pennsylania Ave., Framingham, Mass. 01701, (617) 875-6100.

Circle 350



Disk drive sits on card

- IBM compatible
- 45M bytes of storage
- 28-msec access time

An internal rigid disk drive for the IBM PS/2 Model 30, PC/XT and PC/AT, R-Card 45 comes with proprietary software. The unit offers 45M bytes of storage and a 28-msec access time. MTBF is 18,000 hours. Features include automatic head parking and locking in a dedicated landing zone. $1,495. **Rodime Inc.,** Peripheral Systems Division, Suite 214, 29525 Chagrin Blvd., Pepper Pike, Ohio 44122, (216) 765-8414.

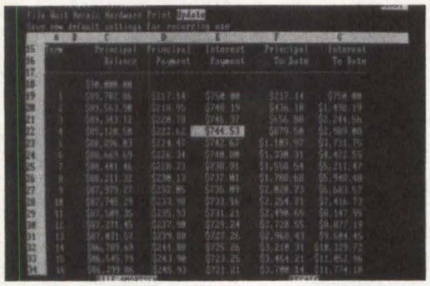
Circle 351

Subsystems suit Macintosh SE, II

- Two models
- SCSI interface
- Up to 31M bytes

The PL20 and PL30 Tough Drives are disk drive subsystems for the Macintosh SE and Macintosh II microcomputers. The units provide 21M bytes and 31M bytes of formatted storage capacity, respectively. Average access time is 65 msec. A SCSI interface is standard. Features include an automatic head lifter and utility software. $999, PL20; $1,295, PL30. **Peripheral Land,** 47800 Westinghouse Drive., Fremont, Calif. 94538, (415) 657-2211.

Circle 352



Interactive software targets desktop publishing

An interactive desktop publishing package, The Office Publisher runs on IBM PCs and compatibles. The software can generate documents of more than 30,000 pages. Information is input via keyboard or mouse, applying a WYSIWYG screen layout. Features include full text editing, automatic ruled-form generation and graphic image-crop. An 80,000-word dictionary is supplied. $995. **Laser Friendly Inc.,** 930 Benecia Ave., Sunnyvale, Calif. 94086, (408) 988-7575.

Circle 353

CAE package runs on IBM PS/2

A computer-aided software engineering package, vsDesigner runs on the IBM PS/2. The product offers a drawing editor, virtual display, integral word processor and a report generator. It also performs on the IBM PC/XT and PC/AT with full-color support in stand-alone mode or in a multiuser LAN. $4,600 to $7,500. **Visual Software Inc.,** Suite 540, 3945 Freedom Circle, Santa Clara, Calif. 95054, (408) 988-7575.

Circle 354

Double-barreled software compiles spreadsheets

@Liberty software consists of two programs. PREPARE compiles Lotus 1-2-3-compatible spreadsheet developments while the RUN program distributes the results. The product runs on IBM PCs and compatibles with 256K bytes of RAM and MS-DOS 2.0 or higher. $99.95. **SoftLogic Solutions Inc.,** 1 Perimeter Road, Manchester, N.H. 03103, (800) 272-9900.

Circle 355

Software enhances IBM PCs

Compatible with MS-DOS 3.3, Multilink Version 5.0 transforms an IBM PC, PC/AT or PS/2 into a host computer. The host can support up to 16 terminal or modem connections. $595. **The Software Link Inc.,** 3577 Parkway Lane, Atlanta, Ga. 30092, (404) 488-5465.

Circle 356

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LaserJet Series II improves on its pacesetting predecessor

Tom Largey and Charles E. Case
CAP International Inc.

The LaserJet Series II is the latest generation of Hewlett-Packard Co.'s 8-page-per-minute LaserJet family. Its predecessor, LasetJet, introduced in 1984, has dominated the low-end laser printer marketplace (which it created) and has set many industry standards. CAP International Inc. estimates there are 300,000 LaserJets in use. A LaserJet is used by six of every 10 owners of a laser printer.

The LaserJet Series II has all the features—many enhanced—that accounted for the original LaserJet's market strength. Among the most significant improvements is the new model's electrophotographic (EP) cartridge. It can print 4,000 pages (the original printed 3,000), and the printing is blacker and denser. The price is $115, $16 more than the original's.

The Series II can accept plain, cut-sheet paper (stock, up to 35 pounds—the original's limit was 21 pounds). However, the 35-pound stock must be manually fed. Cost of supplies for Series II (toner and paper) is 3.9 cents per page, compared to 4.8 cents for LaserJet.

At $2,495, Series II came on the market with a significantly lower price than LaserJet's introductory $3,495. Even so, the price has been dropping. Some discounters now offer Series II for less than $1,700.

At the heart of the Series II is a new Canon Inc. engine, the LBP-SX, which has a monthly duty cycle of 5,000 pages. That compares to 3,000 pages for the Canon LBP-CX that powered LaserJet.

The Series II has a one-year warranty, compared to 90 days for LaserJet. The increased warranty indicates HP's growing confidence.

Problems from cotton

The LaserJet came on the market advertised as a replacement for daisy-wheel printers, which can print on any type of paper. However, the LaserJet owner's manual stated that the printer was designed for use with high-quality photocopier bond paper. The warranty did not prohibit the use of cotton paper, but limited it to 21-pound stock.

The LaserJet Series II owner's manual is more detailed when speaking of its cotton paper compatibility. However, HP makes it clear that photocopying paper will still produce the best results in the LaserJet family.

The manual concedes that for "some applications you may want to use cotton bond paper." The manual lists, but does not explicitly recommend, two cotton paper products made for laser printers. Cotton paper made for laser printers is very smooth, unlike most textured cotton paper now in use.

This is not explicitly mentioned in the warranty, but an HP representative tells us that LaserJet Series II's one-year warranty will cover any damage that occurs from textured cotton paper—but only once.

The HP representative stated that, if printer damage is determined to have been caused by the paper, the problem will be remedied once, and the user will be warned to use photocopying paper or a cotton bond made for laser printers. Otherwise, any subsequent damage from paper usage will not be covered.

The HP representative went on to say, however, that, if any user insisted on using paper that damaged the printer, special arrangements could be made whereby HP would repair the damage. But the user would have to pay for parts and labor.

Nevertheless, the owners of a LasserJet Series II (or of any laser printer, for that matter) must still test each paper product, other than photocopying paper—and particularly cotton paper—for its runnability, printability and overall compatibility with their printer before using it.

HOW LASERJET STACKS UP AGAINST LASERJET SERIES II

	LaserJet	LaserJet Series II
Engine*	Canon LBP-CX	Canon LBP-SX
Duty cycle (pages/month)*	3,000	5,000
Printer weight (lbs)*	70	50
Engine life	not rated	not rated
Warranty*	90 days	1 year
Speed (ppm)	8	8
Resolution	300×300	300×300
Paper	plain, cut sheet	plain, cut sheet
Weight (lbs)*	16-21	16-35
Paper output	faceup	faceup and down
Other media	labels, transparency, envelopes	labels, transparency, envelopes
Input tray*	100 sheets	200 sheets
Output tray	100 sheets	100 sheets
Media sizes*	letter, legal, A4, B5	letter, legal, A4, executive
EP cartridge	$99	$115
Toner	monocomponent	monocomponent
Photoconductor	OPC drum	OPC drum
Yield (print/EP cartridge)*	3,000	4,000
List price*	$3,495	$2,495

*Indicates improved features

Source: CAP International Inc.

CAP International Inc., 1 Snow Road, Marshfield, Mass. 02050 (617) 834-6832, is a market research concern in the printer industry.

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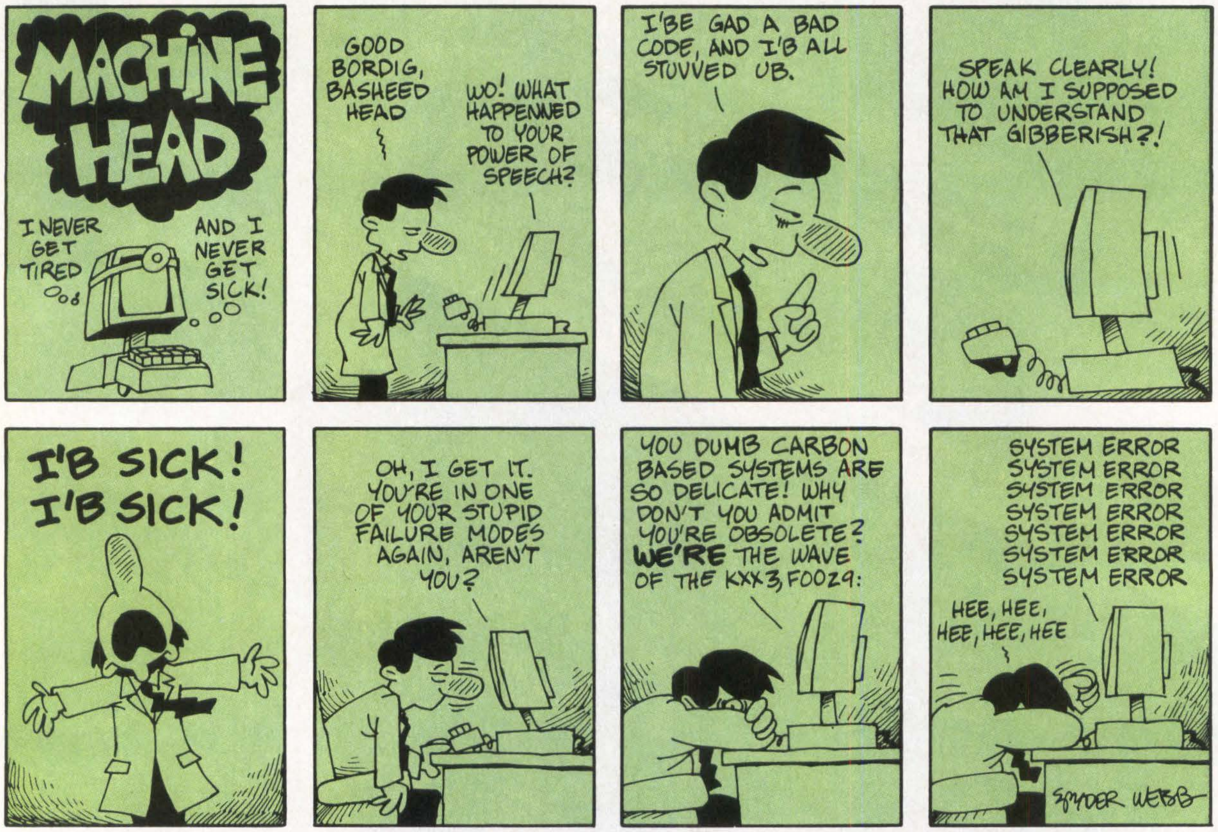

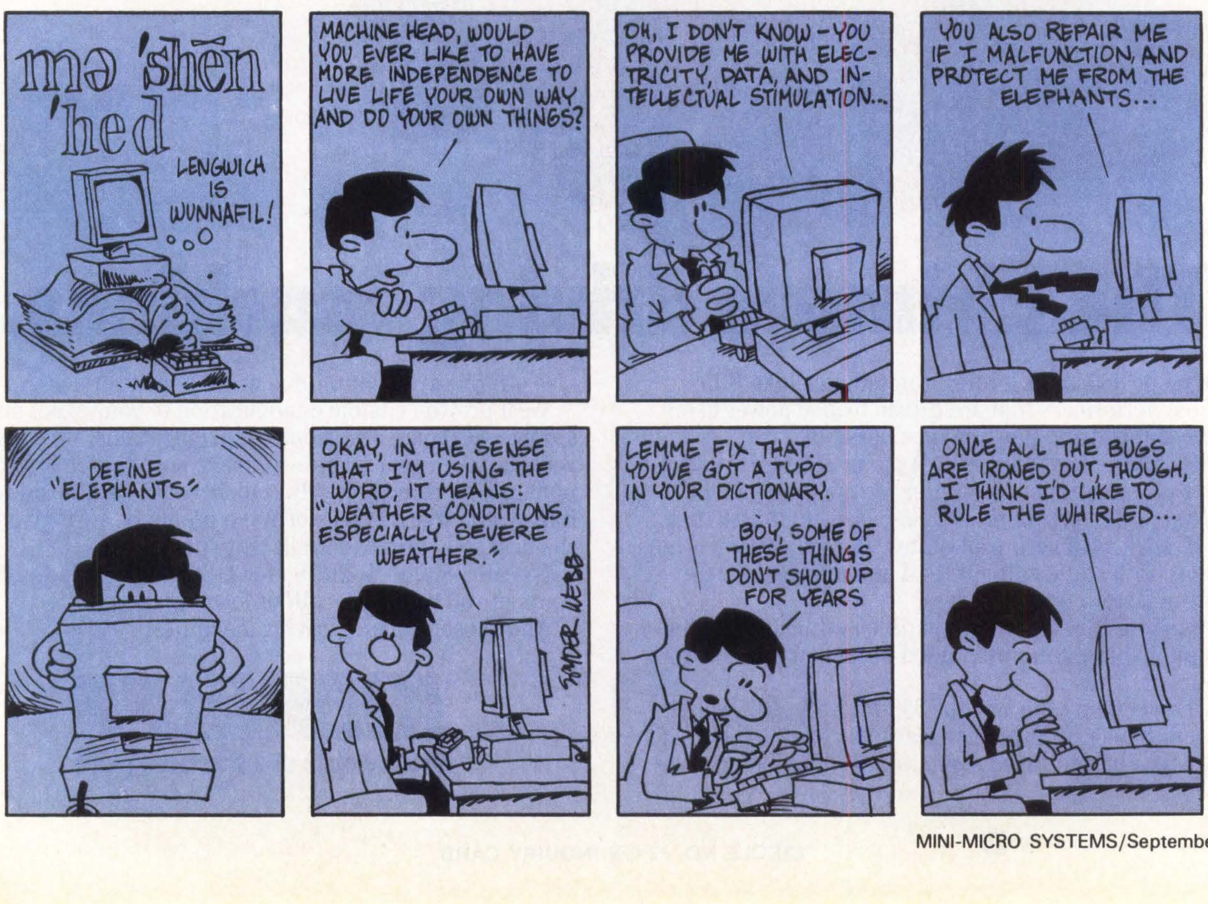

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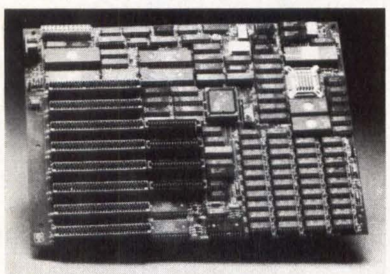

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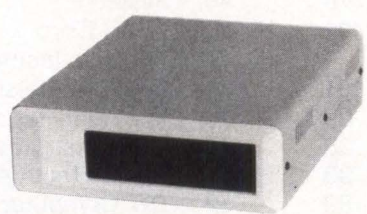

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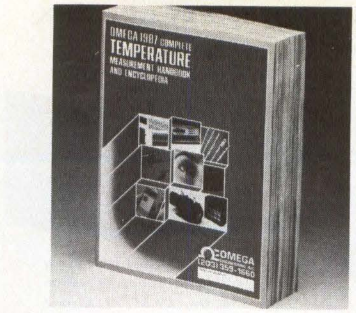

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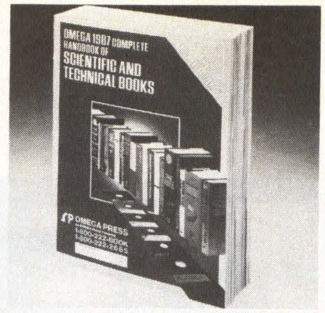

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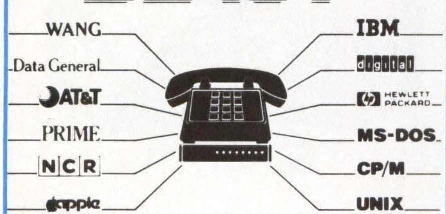

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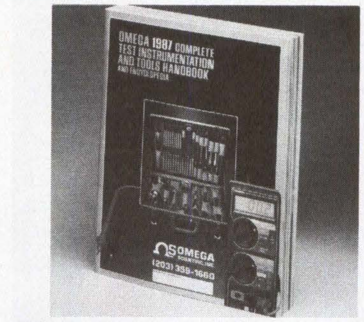

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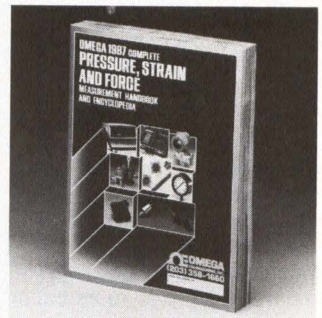

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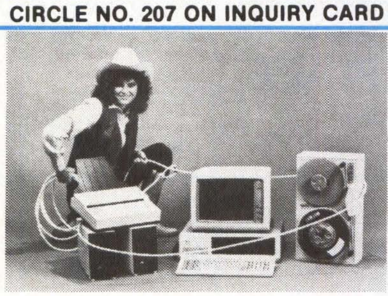

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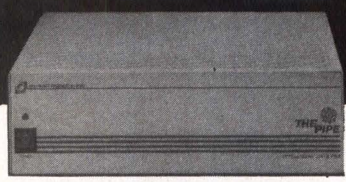

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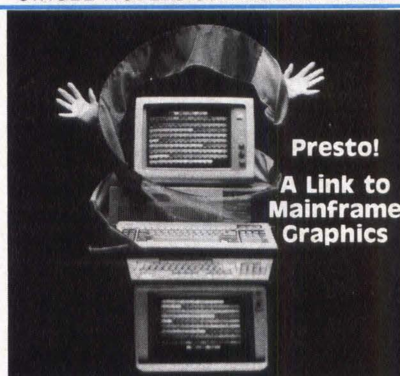

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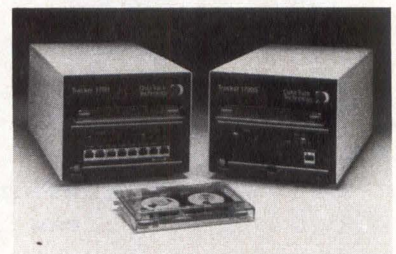

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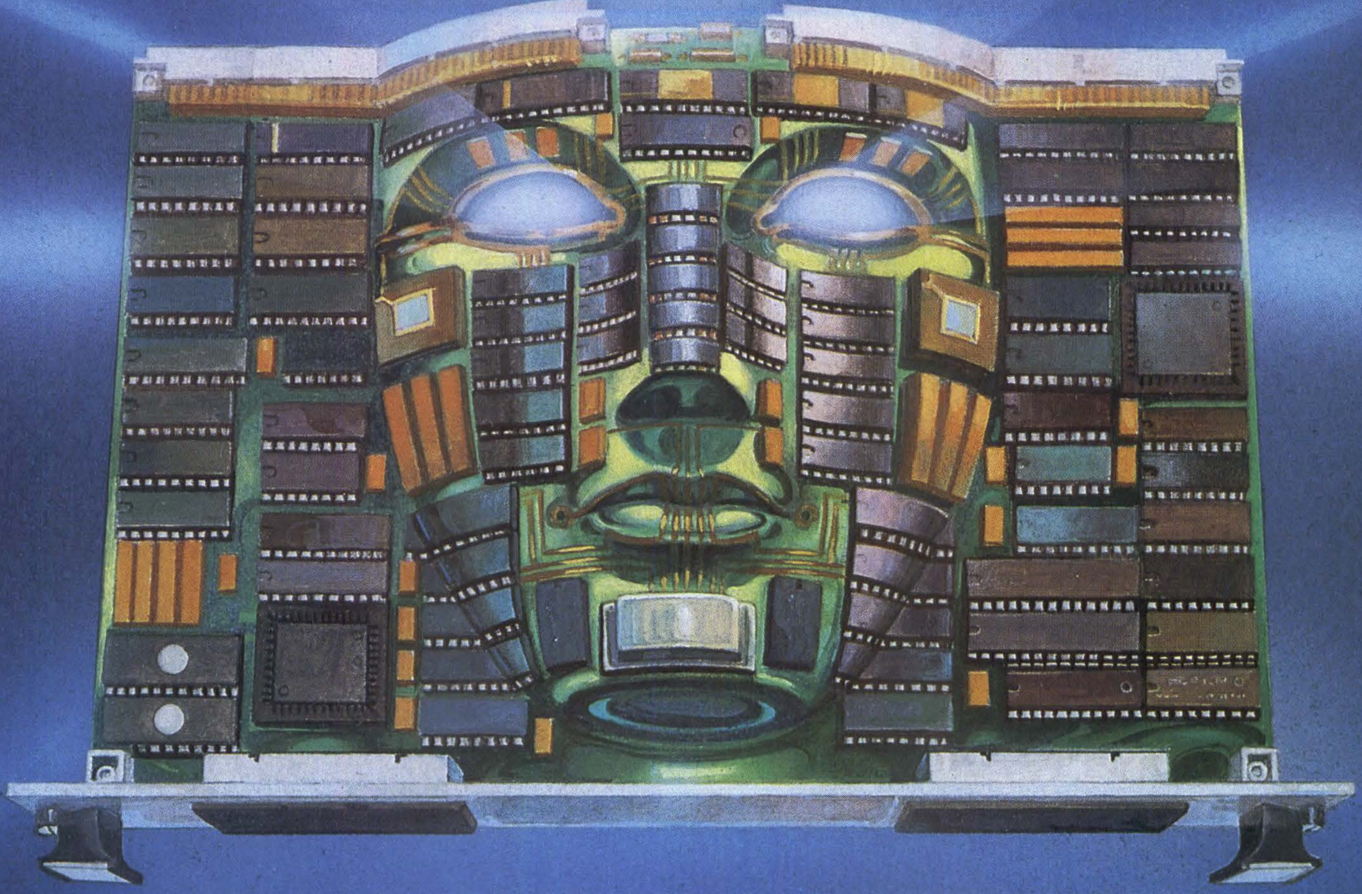

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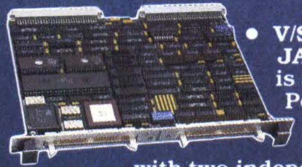
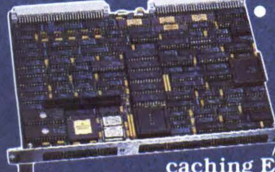


• **V/SCSI 4210 JAGUAR** is an Ultra-Performance caching host adapter with two independent and simultaneous SCSI ports and Command Queuing. It offers true Multi-Threaded control of any mix of up to 14 Synchronous and Asynchronous SCSI devices. Advanced systems concepts like disk striping and segregating high-end devices from slow or unbuffered ones become real. And Interphase's 30 MByte/s BUSpacket Interface℠ provides the industry's fastest VMEbus speed.



• **V/ESDI 4201 PANTHER** combines the performance advantages of a host resident caching ESDI disk drive controller with the flexibility of a full function SCSI port for backup, all in a single VME slot.

• **V/MIX 3210** is the unique combination of a SCSI host adapter, Centronics printer port, and Versatec or Benson plotter port. All three become high-speed DMA devices, and at a price you'd expect for any one function alone.

FACE FACTS

Interphase SCSI solutions achieve true VME system-level performance with existing SCSI devices and let you take advantage of the new generation of full-function SCSI devices as they are available. Don't let a "dumb" host adapter make you look bad. See the changing face of SCSI. Call Interphase today.

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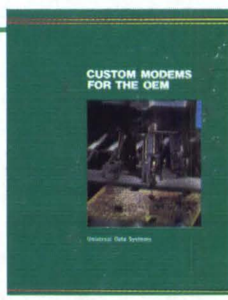

For a generous sampling of UDS' custom design capabilities, ask for the new, free OEM modem brochure.

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