A complete list of things to know about 2400 bps modems.

Now that you've memorized that, here's a partial list of why a Hayes® Smartmodem 2400™ is best for you.

1. The Hayes Smartmodem 2400 allows you to communicate with the vast installed-base of 300,1200 and 2400 bps “Hayes-compatible” modems. The Hayes Standard “AT” Command Set allows you to use Smartcom II® and other software that communicates.

2. Through synchronous/asynchronous technologies, the Smartmodem 2400 permits your PC to access mainframes, minis, and on-line services previously inaccessible through asynchronous-only modems.

3. The Hayes Smartmodem 2400 is efficient...it pays for itself in just 4 hours of annual use over long distance.

4. The technology of the Smartmodem 2400 allows you to transfer volumes of files with confidence across the city or across the ocean using Bell and CCITT standards.

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6. You will also get the Hayes standard 2-year limited warranty and the opportunity to extend the warranty to 4 years.

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Until now, connecting 128 terminals to your computer meant one thing. A myriad of cards taking up precious space on the backplane. And accomplishing nothing but communications. All of which could frustrate almost any self-respecting system designer into hanging up his calculator.

Well, at Systech, we understand the serial communications problems of a multi-user system. So we developed The Unplug™ asynchronous distributed multiplexer that can be used with any Multibus®, VMEbus or Multibus® II system.

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Instead of trying to figure out how to untangle all those wires.

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An outlet for your frustrations.

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That Turns Imagination
Into Reality.

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PRODUC T S S P O T L O C K

COVER STORY
HP’s new line on connectivity: customer-owned X.25 networks ....... 27

Apple opens Macintosh to system integrators .................................. 30

NCR’s platform strategy reaches to multiprocessors ......................... 33

INTERPRETER

OPTICAL DISKS
Optical memory goes multifunction—at last .............................. 41

COMPANIES
Wang hopes to rebound as the Doctor’s son steps in ....................... 45

GRAPHICS TRENDS
Major manufacturers join forces to support X Window graphics standard ................................. 49

FEATURES

Clones vs. IBM: buyer beware ........................................... 55
Personal computers compatible with IBM PCs offer significant price/performance advantages over Big Blue’s originals, but system integrators should evaluate quality and level of support.

Powerful software organizes large jobs .................................. 71
At every price level, integrated scheduling and cost accounting programs—called project management software—enable users to monitor and control complex projects.

386, graphics cards pack extra punch ..................................... 79
80386-based accelerator boards speed system processing—despite a lack of 386 software—and application-specific coprocessor boards enhance graphics and offload host processing.

Product table . . . Single-board computers .............................. 89

COMMUNICATIONS HANDBOOK . . . Table of Contents .119

*DEC DIRECTIONS
(Section begins opposite Page 108)
New Products .............................. D1

*Appearing in issues of subscribers who have DEC computers

DEPARTMENTS

Editorial Staff ........................................ 6
Editorial .......................................... 13
Letters .......................................... 16
Breakpoints ...................................... 21
New Products ................................... 109
Index to Advertisers .......................... 137
Mini-Micro Marketplace .................. 138
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A STRONG MANAGEMENT TEAM

I am pleased to announce two important additions to *Mini-Micro Systems* management personnel. First, Don Fagan assumes leadership of the sales force as vice president/publisher, replacing S. Henry Sacks, who has resigned. A well-known and respected name in the computer industry, Don served nearly 20 years with *ComputerWorld* in increasingly responsible positions. Starting as a salesman, he demonstrated proficient sales skills that quickly advanced him to vice president of sales, and then to publisher. Under his direction, *ComputerWorld* ranked first in the U.S. trade press industry in total sales and in ad pages for more than a decade.

Second, Tim Mead joins the editorial staff as executive editor. He has admirably served Cahners Publishing Co. for the past seven years in senior editorial positions. Starting at *Electronic Business* as communications editor, Tim moved rapidly to managing editor, features. His next promotion placed him as editor-in-chief of *Business Computer Systems*.

Prior to his career at Cahners, Tim worked as a field editor for Fairchild Publications and as a general assignment reporter for a New Jersey daily newspaper. He holds a B.A. degree from the University of North Carolina.

Our best wishes for future personal and professional success go to S. Henry Sacks, founder and for the past 19 years, publisher of *Mini-Micro Systems*—originally titled *Modern Data*. Under his tutelage, *Mini-Micro Systems* grew quickly to become the leading monthly computer magazine in its niche.

By integrating the achieved knowledge and experience of the past with the newly gained sales and editorial expertise, *Mini-Micro Systems* now stands positioned to meet the future challenges of the ever-changing, fast-moving, computer system marketplace.

*Introducing the new team:* George V. Kotelly, Chief Editor; Donald E. Fagan, Publisher; and Timothy G. Mead, Executive Editor.
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<thead>
<tr>
<th>Irwin BACKUP™ Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5½” FORM FACTOR</strong></td>
</tr>
<tr>
<td>Model 145 NEW</td>
</tr>
<tr>
<td>Model 125 ALREADY BEST SELLER</td>
</tr>
<tr>
<td>Model 120 NEW</td>
</tr>
<tr>
<td>Model 110 ALREADY BEST SELLER</td>
</tr>
</tbody>
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Replacing your aging VT100 terminal with our CIT 101XL is as easy as changing a 100 watt light bulb. Because from start to finish, the whole process takes only about 60 seconds.

The CIT 101XL is not only 100% compatible with your old VT100, it's compatible-plus. And that's where the CIT 101XL really starts to shine.

With some pretty bright features that C. Itoh terminals have become famous for. Like a big 14-inch tilt-and-swivel screen, large easy-to-read characters in a 7 x 11 dot matrix, multi-page memory and a choice of soft white, amber or green phosphors.

But don't think we re-invented the light bulb completely. While the CIT 101XL keyboard retains that comfortable VT100 layout and functionality, we improved it by arranging the cursor keys into an inverted "T" and adding 16 function keys.

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For more information on the CIT 101XL terminal, 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.

VT100 is a trademark of Digital Equipment Corporation.
GRAPHON UNVEILS DEC/TEK COLOR TERMINALS AT NCGA

GraphOn Corp., Campbell, Calif., invades the color market with its new G0-400 line of graphics and alphanumeric terminals. Like their monochrome cousins, these new terminals provide full 132-column emulation of Digital Equipment Corp.'s VT220, as well as Tektronix Inc.'s 4205, 4207 and 4111. Selling for $2,995 to $5,995, the G-400 line supports DEC's Remote Graphics Instruction Set (REGIS) at a resolution of 800 by 520 pixels. The terminals use Sony Corp. of America's 14-inch Trinitron monitor and the Texas Instruments TMS34010 dedicated graphics processor. GraphOn plans to show them for the first time at the National Computer Graphics Association conference March 22-26 in Philadelphia.—Mike Seither

MICROSPEED ANNOUNCES 3-D I/O DEVICE

Look this month for FastTRAP—Microspeed Inc.'s (Fremont, Calif.) 3-D pointing device that allows users to enter X-Y-Z axis data into CAD/CAE and other graphics applications. The combination mouse, track ball and third pointing-axis device emulates current mouse hardware. It features a 200-pulse-per-inch track ball and finger wheel and three input buttons for menu selection. FastTRAP will be priced at $149, with OEM discounts available. —Megan Nields

TEK TREKS INTO PC TERRITORY

Augmenting its venerable line of graphics terminals and workstations, Tektronix Inc. this month enters the high-end IBM Corp. PC graphics market with an $1,800 graphics board, a $950 high-resolution monitor and two terminal-emulation packages. The EGA-compatible PC4100 graphics board utilizes the 1-MIP, 50-MHz Texas Instruments TMS34010 processor. The 13-inch, 640-by-480-pixel monitor sports a 0.26-mm dot pitch and a cylindrical surface. Linking the system into mainframe-level graphics, the PLOT 10 PC-05 ($495) and PC-07 ($995) packages allow PC users to emulate Tektronix 4105 and 4107 terminals. The Beaverton, Ore. manufacturer aims the system—collectively called the PLOT 10 Advanced PC Graphics family—at CAD applications. —Dave Simpson

WORKSTATION VENDOR JUMPS INTO VMEBUS BOARD BUSINESS

Sun Microsystems Inc., Mountain View, Calif., is broadening its product mix beyond workstations. In late March the company is expected to announce that it is entering the VMEbus board business. Sun has been building custom boards for its customers—OEMs and the federal government—but has never sold them on the open market. The first round of products includes a 20-MHz, MC68020-based CPU card; an Ethernet controller; a video interface; and a 4M-byte memory board.—Mike Seither

MAKES A BIG EFFORT TO GET SMALL

Digital Equipment Corp., Maynard, Mass., came a step closer to attaining CEO Ken Olsen's lofty goal of down-sizing the VAX minicomputer by a factor of 100,000-to-1 recently when it unveiled its smallest system yet, the MicroVAX...
2000. Although measuring about the size of a toaster oven, the system packs up to 6M bytes of memory on a double-sided, surface-mounted board. It has a maximum disk storage of 142M bytes and 14 custom chips, manufactured by DEC, to control disk and graphics functions. The system, available for delivery within the next 30 days at a base price of about $10,000, was introduced as DEC shipped its 100,000th VAX system—to the Standard Oil Co. in Dallas.

— Tim Scannell

SKY COMPUTERS CAUGHT IN VORTEX OF ACTIVITY

On March 9, Sky Computers Inc. of Lowell, Mass., a leading supplier of board-level array processors, will make a heady claim: near supercomputer performance for IBM Corp. PC/ATs and Multibus II, NuBus and VMEBus workstations. For less than $10,000 per single-slot board (PC/AT version), system integrators and OEMs in the technical/engineering workstation market can pick an arithmetic processor from Sky's Vortex line. The boards, with vectorizing capability, boost speeds of 20 MFLOPS in 32-bit mode and 10 MFLOPS in 64-bit mode. According to the company, Vortex products, when designed into high-end workstations from Apollo Computer Inc., Digital Equipment Corp., Sun Microsystems Inc., et al, will close the performance gap between them and minisupercomputers. Vortex for the PC/AT and Multibus II and NuBus systems will be available 60 days after receipt of order; for the VME, in the fourth quarter.—Doug Pryor

PUTS MIPS MUSCLE INTO PARALLEL PROCESSING

Although barely three years old, Encore Computer Corp., Marlboro, Mass., has latched onto what president and CEO Jim Pompa calls the technical wave of the future: general-purpose parallel processing. This type of processing employs super, high-performance workstations—not laboratory tools such as connection machines and butterfly architectures. In fact, Encore recently announced its official entrance into the parallel-processing market at the Uni­forum conference. According to Pompa, Encore has been tapped by the Defense Department's Defense Advanced Research Planning Agency (DARPA) to develop a 1,000-MIPS processor within three years.—Tim Scannell

BUILDERS OF TOMORROW'S COMPUTERS SHOULD FOCUS ON STANDARDS

The future of computing can be summed up in four words, according to C. Gordon Bell, one of the architects of Digital Equipment Corp.'s VAX computer and presently with the National Science Foundation: “UNIX and open architectures.” Bell noted that, at a recent meeting sponsored by the NSF, six supercomputer manufacturers and representatives from up to 20 universities agreed to implement UNIX as a standard in large-systems design. “UNIX as a standard and not as an option is essential,” he said. “One cannot build a hierarchy without a standard.” Bell also said that the great benefit of an open-systems' standard is that, when vendors and users can agree, systems development can proceed to the next generation. Standing in the way, however, he said, are problems with security, with network speed—and with the installed base of older systems.—Tim Scannell
27 milliwatts. That's all it takes for standby mode on our FD-35 Series 3.5 inch floppy disk drives with the Power Saver option. And, in operation, they consume a mere 1.72 watts average at read/write, and 2.90 watts average at seek. These just happen to be the lowest numbers for any 3.5 inch drive.

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<table>
<thead>
<tr>
<th></th>
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<th>S/220™</th>
<th>S/320™</th>
<th>S/640™</th>
<th>S/1280™</th>
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<td>22</td>
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<td>64</td>
<td>128</td>
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<td>5 MB</td>
<td>16 MB</td>
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<td>80 MB</td>
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<td>8.8</td>
</tr>
</tbody>
</table>

*storage listed in unformatted capacities

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YOU NEVER REGRET A WYSE DECISION.
HP's new line on connectivity: customer-owned X.25 networks

Mike Seither, Senior Editor

System integrators, network managers and data center professionals charged with masterminding corporate-wide communications networks are caught between a rock and a hard place. Point-to-point connections, the rock, often mean an inflexible arrangement of costly leased lines that provides only limited connectivity. IBM Corp.’s Systems Network Architecture (SNA), the hard place, offers limited connectivity in multivendor environments.

That’s how strategic planners at Hewlett-Packard Co. view the communications options available today. Their response is a repositioning of the company’s AdvanceNet system and an array of standards-based products that will tie together an entire organization: engineering labs to manufacturing to regional sales office to business operations to branch offices.

The tune Hewlett-Packard is singing is a variation on an old theme—X.25. Like many vendors, HP has long supported the X.25 interface as a way for its computers to communicate with each other over long distances through public packet-switched networks. But now the company says it has acquired enough expertise, and developed a large enough product portfolio, that it can design, set up and maintain private X.25 networks. Compared with point-to-point connections over leased lines, private wide area networks (WANs) can cut data transmission costs 25 percent to 50 percent, HP says. Moreover, the company claims that private X.25 networks offer customers a higher degree of reliability than public telephone lines and more control over such things as recovering from errors and balancing traffic on circuits.

Perhaps most important, HP says it can put together a WAN that allows not only its computers to coexist but also those of other vendors, including IBM Corp. and Digital Equipment Corp. Such a network can be had for as little as $100,000, says Willem Roelandts, general manager of HP’s Information Networks Group in Cupertino, Calif. That kind of bare-bones system would include three switching nodes for hooking up about 60 devices and a network-management system built around an HP 9000 technical workstation. From there the sky is the limit; large corporate-wide networks can cost several million dollars.

Looking for a new image

HP unveiled its multivendor networking strategy in February just before its annual briefing for industry analysts. That announcement, which included 13 new products and services and a definitive statement about the company’s plans for connectivity, is something of a turning point for the $7 billion electronics giant. Computers and instruments—not networking—have been the stuff of HP’s reputation.

Indeed, both IBM with SNA and DEC with its DECNet have overshadowed HP in the WAN arena. That, in
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MINI-MICRO SYSTEMS SPOTLIGHT

Despite the fact that HP has an installed base of some 8,000 networks connecting 40,000 nodes through its proprietary set of Distributed Systems Network (DSN) protocols.

"HP has allowed DEC to get a reputation as the premier network vendor," says Sandy Gant, an analyst with InfoCorp., a Cupertino, Calif., market research firm. "While their approaches may be different, the deliverables are, in fact, not that far apart."

Other analysts agree about the image problem HP has built for itself. "They've certainly never been known for their networking solutions," says analyst Doug Gold of International Data Corp., Framingham, Mass. "This [X.25] strategy is very smart. It should help HP in the office-automation market, which they've been trying to break into for three or four years."

Searching for standards

Company officials seem to have no problem accepting this view of history, and in fact appear quite eager to begin writing some new chapters. John Young, HP's president and chief executive officer, calls the recent announcements the most significant ever made by HP in the area of computer interconnection. Declares Rocklandts, the man in charge of overseeing the new HP program: "We haven't had the recognition in the marketplace [for networking], but with our capabilities now, that will change."

Those capabilities, to some extent, are a result of HP's finding new ways—through product modifications and marketing programs—to sell existing equipment. At the same time, the company has marshalled a small army of networking specialists to help customers worldwide define their needs. HP is also reiterating its support for networking standards, such as the Open Systems Interconnection (OSI) model put forth by the International Standards Organization.

While the OSI specifications are still being ironed out, HP has decided to move away from its DSN protocols, although it will still support customers who use them. Instead of DSN, the company is backing ARPAnet, the networking scheme...
adopted by the Department of Defense Advanced Research Agency (DARPA) and in wide use throughout universities and military installations. HP is betting that the OSI will bear a strong resemblance to ARPA net, says Roelandts. Right now, he adds, about 70 computer vendors support ARPA net, and HP is working to support them all. The company has already made sizable inroads toward that end by being compatible with the ARPA net protocols that the Wollongong Group Inc. has ported to some 20 different vendors’ systems.

In another move towards standards, HP says it will support the Network File System which was developed by Sun Microsystems Inc. and which is quickly becoming a de facto standard.

In a few cases HP has improved older gear to make it easier for network owners to use. For instance, the HP 2334A Plus packet assembler/disassembler (PAD) and statistical multiplexor operates 25 percent faster than earlier models. Thanks to a new default mode, users can configure the system themselves and save an HP installation fee. The HP 2334A Plus lists for between $2,800 and $5,350, depending on the number of ports (four, eight, 12 or 16).

There are other examples of improving on the old for a new class of customer. With the addition of a new $350 statistical-software package, for example, the existing HP 4952A protocol analyzer can be used to troubleshoot X.25 and SNA networks at the link level. Similarly, the HP 4953A protocol analyzer can be modified for $1,200 to detect network degradation.

Not all of HP’s X.25 WAN solution comes from in-house. The company has OEM relationships with a number of other manufacturers to fill in the blanks. For X.25 switching nodes, HP is relying on M/A-COM Telecommunications Inc., Germantown, Md. For broadband to baseband conversion—getting information from workgroups into a companywide network—HP has turned to Ungermann-Bass Inc., Santa Clara, Calif. For network design tools to determine the least expensive and most efficient way to configure networks, HP uses both
IBM PC- and HP Vectra-compatible software developed by Connections Telecommunications Inc., West Bridgeport, Mass.

To tie it all together physically, HP has a newly announced Site Wire program, based on AT&T Co.'s PDS wiring scheme. This calls for a coaxial broadband cable as the networking backbone. An integral part of this approach is HP's support of Starlan, a 1M-bit-per-second local area network that runs over unshielded twisted telephone lines. HP is recommending Starlan as an inexpensive way to wire office environments. The IEEE approved the Starlan specifications (802.3) last year.

The other major pieces of HP's networking strategy revolve around four basic services: design, preparation, installation and maintenance. These services, coupled with equipment supplied by HP, in effect give large system integrators a turnkey approach to networking without a need for third-party vendors, says Roelandts.

HP believes there will be a growing market for private X.25 packet-switched networks, particularly within Fortune 100 companies. Research that HP has conducted shows that in 1985 there were 95 such privately owned networks. By 1994, the research indicates, there will be more than 1,000 networks worldwide. Hardware sales alone for PADs, switches and network control centers are forecast to be about $1 billion, says Roelandts.

Will HP succeed? Industry observer George Colony, president of Forrester Research, Cambridge, Mass., notes that HP is heading in the right direction by realizing that the technology of the 1990s will be "connectivity, not computers."

"Companies don't need a network," says Colony, "they need an application that involves a network. The biggest mistake Hewlett-Packard can make is trying to sell a technology instead of a solution."

---

**Apple opens Macintosh to system integrators**

Mike Seither, Senior Editor

System integrators, software developers and third-party hardware vendors are likely to profit now that Apple Computer Inc., Cupertino, Calif., has opened up the architecture of its Macintosh computer.

With the introduction of two new versions of the popular machine—the Macintosh II and the Macintosh SE—Apple has broken with the past in two key areas. First, Apple has built expansion slots into the machines so that resellers or users can configure the systems for specific applications. Second, both new computers feature internal rigid disk drives. Until now, Mac users have had to use external drives.

In an effort to get the machines into the hands of serious business and technical users, Apple is offering optional keyboards that will work with either the Mac II or SE. The $129 version has 81 keys; the other, with 15 additional function keys and a cursor-movement pad, costs $199.

In a separate, but related, announcement, Apple has revealed its networking strategy finally is in place. After more than a year of delays, Apple announced the availability of AppleShare software last month at the Seybold desktop communications conference in San Francisco. Priced at $799, AppleShare allows a Macintosh Plus to act as a file server for up to 25 other Mac users. The company has published its networking protocols in an effort to attract third-party hardware software developers.

**Like an IBM PC**

Getting most of the attention is the Macintosh SE, a machine that outwardly looks more like an IBM Corp. PC than the Mac of old with its one-piece monitor and CPU. The SE comes with an external 640-by-480 pixel color or monochrome monitor and a standalone central-processing unit inside a cabinet that's 9.7 inches wide and 10.9 inches deep.

The Mac SE uses Motorola Inc.'s 16-MHz MC68020 as its main processor and features six expansion slots that tie into the NuBus. The NuBus, or IEEE P1196 standard bus, is a full 32-bit bus developed at the Massachusetts Institute of Technology and acquired by Texas Instruments that uses geographical addressing. That is, four pins on each expansion slot identify a card's function no matter where it's located in the cage. This method eliminates the need for DIP switches and allows the Macintosh SE to identify where each card is, and what it does, when the computer is booted.

Delbert Yocam, Apple's chief operating officer, says that about 20 vendors are already planning to market the SE as its main product. The products range from co-processors and Ethernet local area network adapters to cards that give the SE compatibility with the DAS operating system and IBM's 3270 world.

In addition, Apple gave early versions of the computer to about 20 software developers to get new—and existing—Mac applications running on the machines. This month, Apple is releasing the SE and Mac II specifications to other vendors who want after-market business.

Apple, planning to market the SE as a workstation, has designed-in plenty of power. Main memory on the motherboard ranges from 1M bytes to 8M bytes, and can go to 2G bytes through the use of add-in memory boards. Internal rigid-disk drives that use the small computer systems interface

---

**FACT FILE**

Hewlett-Packard Co.
Information Networks Group
10250 Ridgeway Court
Cupertino, Calif. 95014
(408) 973-1919
Circle 473

**Private wide area network solution based on the X.25 interface for a typical company's sales and service, business, manufacturing and engineering operations.**

**Turnkey approach involves all equipment and services for design, installation and maintenance.**

**Network ties into IBM Corp. and Digital Equipment Corp. environments as well as those vendors who support ARPANet protocols.**

MINI-MICRO SYSTEMS / March 1987
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** Macintosh SE, a 68020-based 32-bit personal computer with six expansion slots that tie into the NuBus

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** Two optional keyboards, one with 81 keys, the other with 105, of which 15 can be programmed for specific functions

** Compatible with most applications packages written for earlier Macintosh versions, including the Mac 512 and Mac Plus

** Internal SCSI hard disks available in capacities of 20M bytes, 40M bytes and 80M bytes.

(SCSI) are available in capacities of 20M bytes (3½-inch drive), 40M bytes and 80M bytes (5¼-inch drives). Also available is a 40M-byte tape backup system. This summer, Apple expects to release for the SE its own version of the UNIX operating system, which will accommodate multi-user and multitasking applications.

A Macintosh SE configured with 1M byte of memory, an 800K-byte, 3½-inch flexible disk drive, a 12-inch monochrome monitor with video adapter (taking up one slot) and a keyboard lists for about $4,500. Adding a 40M-byte rigid disk brings the price to about $6,000.

The SE is the high end of the Mac line; the Macintosh II sits in the middle of the product family, just ahead of the current Mac 512 and Mac Plus. While the Macintosh II looks like those older machines, it's been rebuilt inside. Now there's room for an optional internal 20M-byte rigid disk. Apple has also given the Macintosh II an expansion slot, which it expects system integrators to outfit with a networking adapter. Depending on configuration, the Mac II sells for between $2,800 and $3,500.

NCR's platform strategy reaches to multiprocessors

Douglas Pryor, Senior Editor

On Feb. 25, NCR Corp. announced the Tower 32/800 and became the first well-established computer vendor to endorse a multituser supermicrocomputer architecture built around multiple Motorola Inc. MC68020 microprocessors linked by Intel Corp.'s Multibus II.

"Our approach has not been to hit a bunch of home runs. We really are trying to be steady hitters of singles," says Charles Exley Jr., chairman and president of NCR Corp., Dayton, Ohio.

Exley's corporate philosophy has influenced the computer developers in NCR's general-purpose systems division, makers of the Tower series. The company's newest product, the 32/800, bunches a number of singles that could add up to a big inning for system integrators. It means that control is shifted among microprocessors, each with local memory and a memory-management unit (an MC68461 MMU with 4G bytes of logical ad-

Housed in a Tower-like cabinet, the 32/800 measures 20 inches wide, 29 inches deep and just over 32 inches high. But its packed performance supports more than 100 users.

NCR engineers have distributed the processing chores across a number of job-specific processors in much the same way they did in the 32/600, introduced in 1985. However, they have added a twist—support for multiple CPUs, or applications processors. In fact, the design has become a full-blown, loosely coupled architecture. It means that control is shifted among microprocessors, each with local memory and a memory-management unit (an MC68461 MMU with 4G bytes of logical ad-
dress space) connected over a common bus—a Multibus II in this case. Previous Towers used Multibus I.

Building from the ground up

Each Tower 32/800 begins with a Master Application Processor module built around a 16.7-MHz 68020 CPU, 68881 floating-point coprocessor and 10K bytes of parity-checked cache.

For mass storage, a basic model could include two integrated 5½-inch, 170M-byte fixed disk drives with a small computer systems interface (SCSI) master controller and 45M-byte streaming tape drive rated at 90 inches per second. The total formatted storage for fixed disks in this configuration is 298.8M bytes. Up to five SCSI drives can be added without adding an external SCSI interface and cabinet.

Also, the basic configuration includes a file-processor module made up of a 68000, a 68010, a Multibus II interface, two SCSI device controllers, 1M byte of local memory and a maximum of 64K bytes of electrically programmable ROM. The price per user in this configuration is about $3,500.
Software support for the Tower 32/800

With the introduction of the 32/800, NCR announced support for a long list of programming languages and applications.

PROGRAMMING LANGUAGES

<table>
<thead>
<tr>
<th>Current</th>
<th>Future</th>
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<tbody>
<tr>
<td>✓ C</td>
<td>✓ Ada</td>
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<tr>
<td>✓ Language Processors Inc. COBOL, FORTRAN*, Pascal* and Debug*</td>
<td>✓ Common LISP</td>
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<td>✓ Micro Focus COBOL</td>
<td>✓ BBX BASIC</td>
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<td>✓ Silicon Valley Software Inc. FORTRAN and BASIC</td>
<td>✓ LPI BASIC with Micro Focus Extensions</td>
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<tr>
<td>✓ RM-COBOL-85*</td>
<td>✓ Oracle 5.0 database management</td>
</tr>
<tr>
<td>*New to the Tower</td>
<td>✓ Prolog</td>
</tr>
</tbody>
</table>

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The basic model includes another design twist: a power backup unit housed in a separate cabinet. Unlike the battery backup system for previous Towers, which maintained power until systems could be shut down, the new backup senses interruptions and maintains power for 10 seconds. After this time, the system starts sav-

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ing memory and processing for up to 6 minutes at maximum load. If power returns during the 10-second period, the system resumes operation without affecting processing. "This is not fault-tolerance," says Tower program manager John Gray, "but it's certainly fault-resistance."

Optional communications processor modules make it possible for system integrators, VARs and users to connect to a variety of communications environments, including IBM Corp. Systems Network Architecture (SNA), 3270 bisynchronous and X.25 packet switching. Each module is driven by a 68010 microprocessor using a 2K-byte cache to speed I/O and program execution. Also, a local area network module option provides an 802.3 channel and runs Towernet, NCR's Ethernet implementation.

Creating value

But, without what Gray calls NCR's value-added UNIX, the hardware would suffer the problems often associated with multiuser systems. I/O bottlenecks, slow response times and low throughput. NCR's solution is to distribute the system's processing load by breaking down the System V operating system and assigning tasks to each specialized processor. For example, I/O chores are handled by kernel subsets residing in each file, terminal, communications and LAN processor. All common I/O functions are replicated on each processor. As a result, application processors are freed from a lot of time-consuming I/O.

"With the new Tower, we have platforms that can compete in medium-scale, general-purpose and commercial environments," says Khaled Marrei, assistant vice president of the general-purpose systems division. However, he suggests that NCR will announce further refinements to the 32-bit Tower family (the 32/400, 32/600 and now the 32/800), while continuing its support of the 16-bit MiniTower and Tower XP.

By midyear, NCR will announce a better than two-fold increase in connectivity, to 256 users. Also, in the near future, all Towers will use 1-megabit memory chips and faster microprocessors for applications and I/O. "We will use MC68030 chips when Motorola can deliver them in the volume we need; probably in early 1988," says Van Aggelakos, director of product management at NCR's West Columbia, S.C., manufacturing facility. When that happens, NCR could become a power hitter in the multiuser supermicrocomputer market.

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Circle 475

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**Multibus II accommodates up to 20 expansion modules
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Optical memory goes multifunction—at last

James F. Donohue
Managing Editor

This is the year that some optical storage vendors say system integrators and value-added resellers finally will see a product they can make a buck with: multifunction optical disks and drives in the 5¼-inch form factor. Multifunction optical storage disks will combine write once read many (WORM) technology and the newly developed, erasable technology. Some of the disks may include compact disk ROM (CDROM) technology as well.

A cause for cheering? You bet. This development follows more than a decade of embarrassing hype for optical storage and of agonizing starts and stops for vendors and system integrators alike.

There are estimates that venture capitalists alone have dumped $150 million into optical storage start-ups, and none of them claim to have seen a penny of profit. System integrators, like Integrated Automation, Alameda, Calif., and Unisys Corp.'s System Development Group, Camarillo, Calif., have made some business but not much money doing pilot projects for the government and for biggies like General Electric Co.

But now the promised land of profit is in sight. Vendors like Larry Fujitani, director of marketing, Optimem, Sunnyvale, Calif., and seers like Edward S. Rothchild, Rothchild Consultants, San Francisco, predict that the first commercial multifunction 5¼-inch drives will appear this year and that volume shipments will start in 1988.

Erasability is the key

What’s all the excitement about? What’s the big deal about multifunction optical storage devices?

First and foremost, they will be erasable: that is, on at least one section of the disk you’ll be able to write data, erase it, write data again, erase it—on and on, many times, depending on the media and the technology used.

Second, multifunction optical disks will have the two other optical functions: CDROM and WORM.

In CDROM, data goes on the disk when it’s manufactured, and the disk is shipped to the customer. With WORM, users write on the disks themselves, just as they would on a flexible disk. In both CDROM and WORM, the data, once written, cannot be erased.

Research into erasable media has been going on for years at companies like N.V. Philips of Eindhoven, The Netherlands. According to Dr. Gary Thomas, head of Philips’ optics department, the principal technologies under development are magneto-optic (a combination of magnetic media and laser read/write technology) and phase-transition (in which the media’s physical state is changed back and forth from amorphous to crystalline by a laser).

Sectors for each function

What will multifunction disks look like? The way vendors explain it, disks with a capacity of 200M bytes to 300M bytes will be partitioned into sectors. Each sector will have the proper media to perform one of the functions. The drives likely will have different laser configurations to write and read each sector.

Fujitani says that multifunction drives will carry price tags of $2,000 to $3,000 each at first. Then prices will move rapidly toward $1,000 a unit once volume shipments begin, he says, adding that prices will stick at about $1,000: “I don’t see prices getting into the hundreds [of dollars].”
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CIRCLE NO. 75 ON INQUIRY CARD
As multifunction drives in the 5¼-inch form factor get established toward the end of this decade, Rothchild says, you can expect the appearance of 3½-inch multifunction drives aimed at portable computers, IBM Corp. may be among the vendors.

Many industry watchers expect IBM, the only major player to have shunned optical storage so far, to come in once multifunction devices are available.

Caution and skepticism

Not everybody agrees with this rosy scenario, of course. Some vendors, like Neal Kuhn, marketing manager for disk drives at Ricoh Corp. in San Jose, Calif., are cautious. Multifunction disks and drives are coming, Kuhn says, but predictions that they'll appear this year may be too optimistic. “Some day we ought to put Ed Rothchild into a laboratory and make him build what he says is available,” Kuhn says.

Kuhn, however, agrees that development engineers—including those at Ricoh—are approaching disk/drive design from the standpoint of combining erasability and WORM on the same disk.

Industry watchers like Steven Weissman of Communications Publishing Group, Natick, Mass., are skeptical about the whole idea. Weissman looks for erasable media and drives to appear this year, but he doesn’t expect erasability to be com-

Three ways to go optical

If you’re planning to convert your data storage to optical media, here are some guidelines from Robert Castle, director of product marketing, FileNet Corp., Costa Mesa, Calif., a vendor of optical disk drives.

He says there are three ways to manage the conversion:

1. Day One Forward. You pick a day and from that on every new document goes into optical storage. Old documents (those in your system before Day One) are never converted to optical. Castle says this method works best with documents that are perishable: that is, where you don’t need the old documents at all—or at least not for very long. The drawback: Users for a time must deal with both the old and the new systems and may not know where to look for a document. They are forced to look for documents first in one system and then in the other.

2. Convert on Demand. This is like Day One Forward in that all new documents go into optical storage after a certain day. However, old documents are converted as well—but only when a user calls for them. That is, when somebody asks for an old document, it is pulled, converted to optical and then delivered to the user through the optical system. The advantage is that, unlike with Day One Forward, users must contend only with the optical system. It’s up to somebody else to keep track of what’s in each system. The disadvantage is that, early on at least, user demand for old documents can put a huge strain on the systems’ optical scanners. And delivery of documents that must be converted first can be very slow.

3. Complete Conversion. As the name implies, you convert all documents to optical over a fixed period of time. Users stay on the old system until the conversion is complete, and then they switch.

A subset of this method is Partial Conversion of only critical documents. Example: a bank’s mortgage records.

Castle says conversion costs average 11 cents to 15 cents a document. Labor and equipment account for 87 percent of the costs. The remaining 13 percent is accounted for by maintenance (7 percent), media (4 percent) and supervision (2 percent).
OPTICAL DISKS

bined with WORM and CDROM anytime soon. There's no demand for it, he says.

"There's a saying that all good ideas degenerate into hardware," he says. "Sure, theoretically you can do anything. But that doesn't mean you want to or that anybody else wants you to."

The capacity of WORM disks is so enormous—up to 2G bytes—that there is no need for erasability, he says. "Just update the info on another part of the disk and tell the computer to ignore what's been written before." Meanwhile, Weissman says, the earlier writing is still there and can be retrieved. "The beauty of write-once is that it gives you an audit trail," he says.

Another view comes from market watchers like Louis Giglio, technology market researcher at Bear, Stearns, the New York investment concern. He sees the first multifunction disks combining only CDROM and WORM, not erasability. Holding that combining optical disk technologies is a good idea. Giglio says, "A read/write drive—one that can be used with CDROMs and write-once disks—should be the first step in this direction."

Conclusion: money to be made

What conclusion can you draw from all this? It appears clear that multifunction disks and drives in just about any combination of erasability, WORM and CDROM will be available from some vendor somewhere in, probably, 1988—surely in 1989 or '90. Then you can use whatever combination will make you the most money.

No matter what the time table, few doubt that, to play in the mainstream computer business (which means on the desktop where the 5¼-inch form factor is king) optical media needs erasability. "If they can combine erasability with CDROM and WORM," says a Pennsylvania system integrator, "look out."

Look out, especially, magnetic media. "We view erasable (disks) as having the potential to replace magnetic storage over the next 10 years," says Skip Kilsdonk, director of marketing at Maxtor Corp., San Jose.


Alcatel Thomson Gigadisc Inc., Waltham, Mass.: E.I. DuPont de Nemours & Co., Wilmington, Del.; Optical Storage International, Colorado Springs, Colo.; and 3M, St. Paul, Minn., have joined Philips and many of the other drive vendors in developing optical media and probably will be among the suppliers of multifunction disks.

COMPANIES

Wang hopes for rebound as the Doctor's son steps in

James F. Donohue
Managing Editor

You can't help rooting for the Wangs: father, son and company—in order, Dr. An Wang, Frederick A. Wang and Wang Laboratories Inc. of Lowell, Mass. Fred and the company, who are the same age (36), are in a lot of trouble. Wang Labs has been leaking money like a sieve, and Fred's job as the new president is to plug up the holes. It won't be easy.

Wang Labs' fiscal year ends June 30. In the first two quarters of the 1987 fiscal year, the company lost $30 million and $79 million, respectively. Nobody thinks Wang Labs can wipe out all that red ink in six months, but Fred and others at the company look for a sharp turnaround beginning in the year's third quarter (see graph).

Supporters of this view are starting to turn up, even on Wall Street. One of these, Martin Simpson of Martin Simpson & Co., New York, believes that Wang Labs, after posting losses in 1985 and 1986, will show a profit this calendar year. Simpson sees Wang in strong contention with IBM Corp. and Digital Equipment Corp. in office automation.

"When companies are looking to buy office automation products—and we've just done a survey of over 3,000 such companies—they tend to look at only three suppliers: IBM, Digital Equipment and Wang," Simpson says. "In our survey, 64 percent of the companies responded that they would be making additional office automation purchases, which is a very high growth rate. And of these, 29 percent intend to purchase systems from Wang. That's compared with 31 percent for IBM and 17 percent for Digital."

War on two fronts

Wang Labs must attack its problems on two fronts. First, it has to cut expenses, and that's Fred's job. You hear the quip that Wang Labs is a $2.5 billion company being run as if it were an $8 billion company. The quipsters mean that Wang is full of big ideas and of waste, inefficiency and duplication. Fred, who is treasurer as well as president, says he'll cut expenses $50 million by July, largely by consolidating operations (two manufacturing plants in Massachusetts were the first), letting people go and cutting the pay of the remaining 30,000 employees 6 percent.

Second, Wang has to boost sales. That's the job of Ian Diery, the new head of U.S. operations. Diery, an Australian whose accent is a combination of outback and Oxford, is fresh from four successful years running Wang's European operations. In the last three years, Wang sales in Europe have been one of the company's few bright spots, enjoying a 40 percent compound annual growth rate.

Diery believes that Wang has been trying to sell to the United States as if it were one country when, in fact—like Europe—it is several countries:
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COMPANIES

California, the rest of the West, Texas, the rest of the Southwest, the South, the Midwest, New England, New York City and the rest of the East. So he's putting decision-making authority, and responsibility, into the hands of the company's 35 district staffs in the belief that local sales-and-service people best know the needs of local customers.

"People in Texas don't want to deal with a salesman from New York City," he says.

Customer is always right

Diery emphasized customer satisfaction in Europe (something Fred admits Wang "lost sight of" in the United States when growth was running 35 percent a year). The idea behind Diery's decentralization effort is to give one person, the project manager, total responsibility for a customer. No more passing the buck up the line to Lowell, which meant, Diery says, "that the problem never got fixed."

That's right, say customers like Philip D. Dowlin, director of information services at MidCon Services Corp., Houston. "When we started with Wang [late 1970s, early 1980s] and we had a problem, we couldn't get the attention of anybody," he says. But Dowlin confirms that Diery's passing down of responsibility already has made his Wang representatives a lot more attentive to his needs.

Wang Labs also plans, in the midst of cutting other personnel, to increase its sales force by 40 percent. Fred thinks a lot of these salespeople will come from IBM, where, he says, they'll have been fired as IBM cuts back on its own operations in the face of slumping sales. "The people they'll fire will be the people who didn't fit the IBM 'white shirt' mold," Fred says. "Those are the people we want at Wang."

Fred and Diery have taken charge like Franklin D. Roosevelt did in 1932 when the country was in about as bad a shape as Wang Labs is today. Roosevelt had his "first 100 days." Fred and Diery have their "first 45 days," their "first 100 days," and their "first six months" and so on, each segment filled with objectives.

This aggressive agenda is startling in that the company they're reforming is the one Fred's father, the venerable An Wang, 67, founded in 1951 and led as president (not counting the short reign of John F. Cunningham in 1985) until he retired for a second time in late 1986.

But the fact is that the Doctor, as the senior Wang is reverently called, let the company drift for several years in the early 1980s. Wang Labs had a lock on the booming word processing industry in those years, and nobody noticed the drift. "We were trying not to trip over our growth," Fred explains. Part of the problem was that the Doctor permitted speculation that Fred, his firstborn son, might not inherit the Wang helm when, in reality, there never was any doubt about it.

Fred has been in his father's company as an apprentice for 15 years, doing all sorts of jobs and running departments like R&D. People say that he's amiable and bright, but that he's not as smart as his father and that he wouldn't be president if he weren't his father's son.

It's certainly true that Fred became president of Wang Labs for the same reason that Robert F. Kennedy became attorney general of the United States: family connections. But, like Bobby Kennedy, Fred may have what it takes to be good at the job.

He's amiable and low key with an endearing way of discounting himself. Asked how long he'll keep the title of treasurer, he says, "Some people say until I learn the job." Despite graying hair and a three-piece suit, his demeanor is boyish: his hair is tousled and he's forever pushing it out of his eyes, and there's that famous can of Coke Classic forever in his hand.

All that, of course, makes him charming. The question is: is he tough enough to turn Wang Labs around?

So far, he looks pretty tough. In his first 60 days, Fred laid off 1,000 employees while making pay cuts. Meanwhile, Diery, who looks like an ex-prizefighter, has established his own reputation for toughness. Of him, a Wang employee says, "Fred is the boss, but woe unto thee if ye get on the wrong side of Ian."
Major manufacturers join forces to support X Window graphics standard

Tim Scannell, Senior Editor

It can reduce the cost of graphics software development and preserve investments already made in graphics hardware—particularly in expensive CAD workstations.

Those are two of the main reasons why nearly a dozen software and hardware companies—including such heavyweights as Digital Equipment Corp., Data General Corp. and Hewlett-Packard Co.—banded together recently, in an unusual show of mutual support, to commit themselves to a graphics workstation windowing system developed at the Massachusetts Institute of Technology (MIT) in Cambridge, Mass. Called X Window, the system basically allows vendors to develop high-level graphics applications in a window-oriented environment without concern for hardware compatibility. X Window is initially tailored for the UNIX operating environment, but it is expected to migrate to other operating systems—even MS-DOS—in the near future.

Other companies lending their official support to X Window include Apollo Computer Inc., Chelmsford, Mass.; Sony Corp., which sent a representative of its Super Micro Division in Tokyo; and Adobe Systems Inc. of Palo Alto, Calif., which announced plans to develop a version of its PostScript page-description language for use as an extension to high-performance graphics windowing systems. The new version of PostScript—a standard in desktop publishing—will be available sometime in the fourth quarter of this year, according to Adobe spokeswoman Anne Robinson.

The X Window System was developed as part of MIT’s Project Athena, a five-year, $50 million effort launched in 1983 to explore the use of networked, high-performance workstations in educational environments. In essence, the system virtualizes the interface to a workstation’s input and output, allowing each application to transparently handle high-level graphics data and programs over a local area network—in this case Ethernet. The arrangement also “gracefully accommodates heterogeneous computer components,” explains MIT’s Professor Steven Lerman, director of Project Athena.

The X Window System’s ability to offer a “seamless” windowed environment is key to its acceptance among different vendors, says Vicki Brown, program manager for CAD, CAM and CAE at International Data Corp., a research company based in Framingham, Mass. Presently, about 300 vendors offer about 2,400 products in the graphics market, she said, concluding “portability is a primary concern.”

Although MIT will retain ownership of the X Window System, it is nonproprietary and will be offered to any vendor for a nominal charge that covers the cost of media and documentation. MIT will continue to work with vendors to enhance the windowing system, acting more or less as a screening committee for future versions of the product and not necessarily as the primary system developer. “MIT is doing things that are important and useful and will try to convince people to adopt them,” Lerman noted. “But, we are not out to develop standards.”

The announcement of support for X Window was held in conjunction with a two-day technical conference focusing on the system. Sponsoring vendors were careful to point out that, while X Window is backed by vendors representing a combined total of more than 70 percent of the graphics workstation market, the system still had a long way to go before being completely developed. For example, in its present version, 10.4, the X Window System can only accommodate 2-D graphics. MIT does not have the resources in Project Athena to develop a 3-D version but will
emerging from MIT's developmental labs and entering the commercial world, most vendors at the announcement were quick to refer to it as at least a de facto industry standard. For example, HP added X Window to its price list in late January and expected to offer the system across its product line by the end of March, according to William G. Parzybok, vice president and general manager of the company's Design Systems Group in Fort Collins, Colo. Also, representatives from Sony of Europe and Siemens AG of West Germany pointed to their presence at the meeting as a symbol of the international importance of such a standard in the high-level graphics market.

The simple fact that major computer manufacturers have grouped together to commit their support to X Window should be a boon to companies that produce software for the third-party graphics market, observed Dr. David L. Nelson, vice president of advanced technology and chief technical officer at Apollo. "Our intent," he said, "is to limit redundancy in the industry and to send a clear signal to third-party developers and suppliers that, if they write to X, they have a ready platform to present their products."

Despite the vendors' enthusiasm, however, MIT is hesitant to tag X Window as the sole standard that is, or will be, available to the graphics community. MIT's Lerman pointed out that a number of companies already have proprietary windowing systems designed specifically for their hardware and do not see the need for a universally accepted system.

One of these companies, Sun Microsystems Inc., was invited to the MIT-sponsored press briefing and has stated it will support X Window but declined to attend and offer an official endorsement.

Also conspicuous by its absence from the MIT standards rally was IBM Corp., which reportedly supports the X Window System through Version 4.2 of its Academic Information System operating environment but apparently did not want to join DEC, DG and the other companies in a public commitment.

However, while MIT stops short of promoting X Window as the only way to fly in graphics window standards, Project Athena's Lerman does admit that its momentum, especially when driven by major companies in the computer industry, will be tough to counter.

"Once a rock starts rolling down a hill, especially if it is a big rock, you don't have to push it harder," he remarked. "My guess is that it will be harder to slow [X Window] down than to speed it up."
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CLONES vs. IBM: BUYER BEWARE

Personal computers compatible with IBM PCs offer significant price/performance advantages over Big Blue's originals, but system integrators should evaluate quality and level of support.

Andrew Allison, Contributing Editor

The IBM Corp. family of personal computers has dominated the market since the introduction of the first IBM PC on August 12, 1981. The four years following the initial PC's appearance have seen the introduction of two other extremely successful siblings, the PC/XT and the PC/AT; the birth and disappearance of the PC Jr. and the Portable PC; and the launching of the PC Convertible.

The phenomenal success of the product family as a whole has given rise to de facto status for the PC/XT and PC/AT buses and to a vast body of PC-compatible software. It has also led to the emergence of a multitude of clones: personal computers more-or-less compatible with the IBM products.

Last year the personal computer market began to exhibit such early signs of maturity as product proliferation and ferocious competition. IBM responded by starting to move away from the overcrowded, low-end, open-architecture segment as its share of the overall market fell to around 50 percent for the first time and profit-margin pressure increased.

The clone vendors are just the latest in a long line of alternative-source suppliers seeking to better the cost/performance ratios of IBM's PCs. For example, the 64K-byte basic memory of the original PC presented an irresistible opportunity to provide more cost effective memory and I/O expansion than offered by IBM. This gave birth to the first wave of
alternative-source suppliers: the add-in board manufacturers.

Simple expanded-memory modules quickly gave way to memory-based multifunction cards and a broad range of other I/O controllers. Add-in accelerator boards provide PC/AT or better levels of performance via upgrades to the PC/XT.

The enormous, and entirely unanticipated, success of the IBM PC created a demand that IBM was unable to fill (with the AT's success having similar consequences). This vacuum was filled by the first of three waves of clone suppliers.

The best known of the first-wave suppliers, Compaq Computer Corp., capitalized on its license for IBM's proprietary basic input/output system, sound financing and excellent marketing to establish itself as the pre-eminent alternate source, a position that it has succeeded in retaining. Other early participants, such as the defunct Eagle Computer and Corona Data Systems (now Cordata Technologies Inc.), were sued by IBM for BIOS infringement and lacked the strengths necessary to reach critical mass.

Vendors such as Digital Equipment Corp. and Victor Computer Corp. (now Victor Technologies Inc.) introduced Intel Corp. 8088 microprocessor-based, but not IBM-compatible products, which were doomed to failure by the overwhelming success of the IBM PC and its operating system. (Both companies have since introduced fully PC-compatible products.)

The second wave of clones came from Japan. But, as with all the previous attacks mounted on the U.S. small-computer market by Japanese suppliers, they achieved only limited success. Last year, NEC Corp., the personal computer market leader in Japan, withdrew a machine that was software-compatible with the PC/XT and redirected its focus on the high end of the PC/AT market in an attempt to establish a presence. Japan's second largest supplier, Fujitsu Ltd. threw in the towel completely.

Seiko's Epson America Inc. subsidiary is the most visible Japanese supplier in the U.S. market, with a line of mid-priced PC clones based on proprietary gate arrays and BIOS. They utilize NEC's V-series alternatives to Intel microprocessors. Matsushita Electric Trading Co. Ltd. also appears to be committed to the U.S. market through its Panasonic line.

**New Far East vendors arrive**

Last year saw the emergence of a third wave of clones: low-cost products from Korean and Taiwanese manufacturers. These come from three different types of vendors. First, Korean conglomerates such as Daewoo Electronics Co. Ltd., GoldStar Co. Ltd., Hyundai Heavy Industries Co. Ltd. and Samsung Electronics Co. and Taiwanese companies such as Tatung Co. of America Inc. The second group includes well-established electronics companies like Oriental Precision Co. Ltd. and TriGem Computer Inc., both of South Korea, and Taiwan's Multitech Electronics Inc. and American Mitac Corp. Finally, there is a bewildering array of small suppliers.

Unlike their Japanese competitors, which sell through wholly owned subsidiaries, these suppliers sell primarily through private labeling, distributors and manufacturers' representatives. Margin pressure is, however, forcing the larger suppliers to try and eliminate the middlemen. Last year also saw the beginning of serious efforts by overseas suppliers to penetrate the mass-merchandising channel.

**Consider compatibility issues**

System integrators contemplating the use of clones should consider a range of compatibility issues, including BIOS timing and capability, clock frequencies, wait states and interrupt processing.

Compatibility with IBM's PCs was rather loosely defined for the early clones: the ability to run Microsoft Corp.'s Flight Simulator and Lotus Development Corp.'s 1-2-3. As the market has matured, the definition of compatibility has changed to the point that high degrees of IBM compatibility are both required and readily available in PC clones. In fact, the leading independent BIOS suppliers guarantee that application software that runs with IBM's BIOS will run with their's. And they maintain support staffs to make good that pledge.

However, be aware that different BIOS implementations execute operating system functions at different speeds, even though their processor clock frequencies may be the same. For example, users of Award Software Inc.'s BIOS claim that it runs 11 percent faster than that of Phoenix Technologies Ltd. Hyundai
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asserts that its PC clones' Falcon BIOS runs 2 to 2.5 times faster than IBM's.

Thus, a clone's BIOS implementation can have a significant impact on system-level performance—an impact at least as important as clock frequency. In addition, there is a slight chance that a high-performance, i.e., faster, BIOS might cause compatibility problems that could not be solved by the usual expedient of dropping back to the standard clock frequency.

In addition, some clone BIOSes offer extended capability in regard to maximum addressable mass storage and networking. However, this raises the possibility that OEM software developed for use with this type of enhanced BIOS will not run under the IBM BIOS and/or other compatible BIOSes.

This is unlikely to occur for commercially available software, which must run on IBM PCs and strictly compatible clones. But OEMs and system integrators who develop custom packages could conceivably be locked into a specific clone by timing dependencies.

None of these issues should prevent system integrators or value-added resellers from taking advantage of the obvious cost/performance benefits offered by clones. Just make sure that the software specified (or developed) actually runs on the clone of choice.

Other compatibility issues encountered with clones include the effects on performance of clock frequency, wait states and interrupt processing. Application software with internal timing loops (fortunately a small and declining class consisting mostly of games) is obviously clock-frequency sensitive, and expansion modules (most notably enhanced graphic adapter controllers) are affected by all three parameters. In addition, programs developed for standard-clock-speed systems that directly access I/O ports (bypassing the BIOS) may cause difficulties on faster systems.

**Clock frequencies vary**

PC clones offer a variety of clock frequencies and ways of handling wait states. Most clones that operate at higher clock rates than standard IBM rates also include mechanical and/or software switches to provide 4.77-MHz operation for the PC and PC/XT and 6 MHz for the PC/AT. IBM has followed clone suppliers by (optionally) increasing the clock frequency of the PC/AT to 8 MHz. And the industrial-strength model 7552 PC/AT, announced in November, speeds along at 10 MHz.

Wait states raise another timing-related consideration. The IBM PCs impose wait states for off-motherboard operations, whereas at least some of the clones make the use of wait states optional. Although wait states are most widely employed to permit the use of slower (and less costly) main memory RAM, their use has implications for I/O controllers that have been designed around the IBM specifications.

As with software compatibility, wait-state and expansion-card compatibility should be examined early in the clone-selection process. Note in this regard that some so-called clones that are software compatible (i.e., PC-DOS and ROM-BIOS compatible) with IBM PCs nonetheless utilize incompatible I/O buses. Compatibility with expansion boards must therefore be considered in addition to the number and type of expansion slots provided.

**Implementations differ**

Clone vendors have taken a number of different approaches to implementing their products. One aforementioned alternative is the use of NEC's V-Series processors, some members of which Intel has claimed infringe upon its copyrights.

The huge market represented by IBM-compatible PCs has also encouraged the development of application-specific integrated circuits (ASICs) that replace the SSI/MSI (small- and medium-scale integration) component "glue" representing most of the non-memory components in IBM PC implementations. ASICs are also being utilized to integrate other major portions of system logic, notably graphics and disk controllers.

This high level of integration has had two main results. First, many of the functions previously implemented on expansion boards can now be incorporated within a clone's motherboard. Thus, large amounts of memory and controller logic can be integrated without suffering the delays inherent in utilizing I/O buses. The potential drawback is reduced repairability; if a controller fails, it can't simply be unplugged and replaced.

Second, at the other end of the spectrum, the basic motherboard functionality can be implemented on a standard expansion module that
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simply plugs into a (motherboard-less) PC bus backplane.

Faraday Electronics introduced the first integrated PC chip set in the spring of 1984, and was the first company to eliminate the motherboard on its PC bus products. The four-member FE30x0 AT chip-set, introduced last October, supports 6-, 8- and 10-MHz operation with no, one, or two wait states. It allows the basic AT motherboard to be replaced by an AT bus expansion module. Other suppliers of PC and PC/AT chip sets include Chips & Technologies Inc. (five chips), and Daewoo subsidiary ZyMOS Inc. (two chips plus address and data buffers).

Standard cells on the way

The first generation of these products utilized gate arrays to implement the required logic. Although the overall market is large enough to support full custom implementations, the individual market shares of the semi-custom chip suppliers probably isn't. Hence, the next significant step will be to switch to standard-cell implementations—already done by ZyMOS. It seems likely that all the major players in the ASIC business will jump on this bandwagon, with the usual downward effect on prices.

The "super-motherboard" approach has had several benefits. It frees up expansion slots, permits additional functions to be incorporated in the basic chassis and reduces the overall size of the system. Several clone suppliers have "shrunk" their products to varying degrees, and the Wyse Technology WYSEpc+, introduced in September, carries this process about as far as it can go.

This PC/XT clone incorporates a 4.77-MHz or 9.54-MHz 8088-1 processor, up to 640K bytes of RAM, a monochrome/color graphics controller, two serial ports, a parallel port, a real-time clock with battery backup and either two half-height 360K-byte flexible disk drives or one flexible-disk drive and a 20M-byte rigid disk drive. All this plus two expansion slots packs into an extremely compact (2.75-by-18.75-by-15.75-inch) chassis, which occupies only 42 percent of the area of IBM's 6-by-20-by-16-inch PC/XT box. The system unit is complemented by a 14-inch ergonomic display.

The same technique is being applied to reduce the size of the even bulkier AT systems unit. IBM's initial step in this direction, the attempt to plug the performance gap between the PC/XT and PC/AT lines with its new 286 XT, sought to limit the impact on the PC/AT product line by not supporting 16-bit, AT-style expansion modules.

This is similar to the strategy adopted with the PC RT, i.e., coupling a very powerful processor to an inadequate bus. And it is a strategy that is likely to lead to the same result: lukewarm (at best) product acceptance.

A more elegant example of PC compression is the PC/AT compatible Cordata CS4200 series clone, which, like the rest of Cordata's computer products, is manufactured by majority owner Daewoo. Although not quite as compact as the Wyse computer, the CS4200 system unit is, at 5 by 18.25 by 16 inches, much smaller than the standard AT.

The motherboard integrates the usual 640K bytes of RAM, a dual 360K-byte flexible disk drive controller, serial and parallel I/O ports and a clock/calendar. Optional 20M-byte rigid disk and monitor controllers occupy two of the four AT-style expansion slots provided. The CS4200 incorporates other attractive features, such as an 8-MHz 80286 processor and a front-panel power switch.

Ruggedized units appear

In addition to shrinking, PC clones are also being ruggedized, a trend driven by the penetration of PC family products into industrial and instrumentation applications. Thus, IBM, AT&T Co. and Hewlett-Packard Co. introduced industrial versions of PC family products during 1986. Typically rack-mountable, these systems utilize shielded enclosures and the enhanced cooling, filtering and power conditioning necessary to operate over a temperature range of zero to 55 degrees C.

Faraday Electronics' Stepstone is an example of the motherboard-less, single-board computer implementations that are penetrating industrial applications. A rackmountable PC/AT bus
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Alsys launches PC AT-TO-370 ADA Cross-Compiler at November ADA Expo; 80286 Debugger also introduced.

A new Alsys cross-compiler permitting Ada programs to be written on an IBM-PC AT and executed on an IBM 370 was introduced at the November Ada Expo in Charleston, W. VA. The cross-compiler, pre-validated to AJPO test suite 1.7, is priced at $2,995 and includes a 4 MB RAM board.

Two compilers, the Alsys validated PC AT self-hosted compiler, and the AT-to-370 cross-compiler, are offered as an option at $4,995. One RAM board serves both compilers.

The cross-compiler, and especially the two-compiler option, implements a "distributed programming" environment for which the Ada language and its "package" concept is particularly suited. The two-compiler option permits developers to program in Ada and test their results at their workstations before uploading 370 object code to the mainframe.

Alsys also introduced its PC AT debugger called AdaPROBE at the Expo. AdaPROBE combines a unique AdaVIEWER with regular debug facilities.

Ada now
industrial computer system, it combines single-board implementations of the PC and PC/AT, system monitor board, maintenance panel, modular power supply and disk drives. With its industrial-grade keyboard and a 10-slot card cage, it becomes a robust and flexible industrial controller.

Two significant changes occurred in the IBM PC and compatible market last year: the legitimization of the use of clones in professional and resale applications and the emergence of Korean suppliers. As one consequence of these developments, IBM’s share of the PC and PC-compatible market, while probably remaining above 50 percent for 1986 as a whole, slipped below 50 percent during the second half of the year. Because IBM cannot live with the low margins acceptable to clone vendors with lower overhead, new, harder-to-clone, down-sized products can probably be expected from the market leader. Indications at press time that IBM is no longer manufacturing the PC and is shipping PC/XTs in its stead may be the first reaction to this trend.

The entry of major Korean computer manufacturers into the clone market will impact the other suppliers as distribution channels develop and volume increases. At least some of the Korean suppliers have indicated their interest in other areas of the computer market, a transition facilitated by the availability of 32-bit microprocessors. This has profound implications for minicomputer and superminicomputer manufacturers.

Tandy Corp. has recently emerged as the No. 1 clone supplier in terms of units shipped, according to InfoCorp of Cupertino, Calif. That, coupled with the recent introduction of IBM PC-compatible products by Atari Corp. and Commodore Business Machines Inc., means that the market battle is truly joined.

Whatever their apparent source, most clones originate in the Far East, with few U.S. suppliers doing any manufacturing below the major
subassembly level. As a consequence, clone-related purchases were a significant contributor to the U.S. electronic trade deficit in 1986.

Although most minicomputer companies offering private-label clones get them from the Far East, some manufacture PC-compatible clones themselves. Of these, only HP and Olivetti USA are active in the OEM market.

HP is pursuing vertical applications with desktop publishing and CAD/CAE workstation systems, in addition to supplying PC-DOS-compatible workstations to its minicomputer customer base.

HP's current PC-compatible Vectra product is particularly interesting in that it is manufactured in the United States on a highly automated assembly line. In fact, Vectra incurs a direct-labor content so low that the company no longer bothers to keep track of it. Low production costs combined with Japanese, Korean and Chinese character capability enables the computer to be sold successfully in Far Eastern markets—a significant accomplishment for a U.S. manufacturer.

### Some buyer caveats

Clones have a number of attractions for OEMs and system integrators. In addition to the price differential between clones and the IBM products, quality and level of support are often more than adequate. And, in many cases, there are performance benefits to be had as well.

With the proliferation of PC/AT clones, and the resulting price reductions, you should give careful consideration to the trade-off between PC/XT and PC/AT prices and performance. Use of Intel 80386-based systems, on the other hand, remains risky until IBM establishes the standard in this area.

A few other caveats are in order for system integrators, OEMs and VARs. Some of the smaller clone suppliers offer extremely aggressive pricing, but one should carefully evaluate

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</tr>
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<td>310</td>
</tr>
<tr>
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<td>236 N. Santa Cruz Ave.</td>
<td>Los Gatos, Calif. 95030</td>
<td>311</td>
</tr>
<tr>
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<td>521 Cottonwood Drive</td>
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<td>312</td>
</tr>
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</tr>
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<td>316</td>
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<td>317</td>
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<td>Sunnyvale, Calif. 94086</td>
<td>318</td>
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<td>GoldStar Co. Ltd.</td>
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<td>319</td>
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<td>322</td>
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<td>327</td>
</tr>
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### MINI-MICRO SYSTEMS/March 1987

66
When Sun Microsystems began looking at Multibus disk and tape controllers for their high performance engineering workstations, they demanded a lot.

"We needed a fast Multibus SMD disk controller, one that could read fast drives, like the Fujitsu Eagle, at full speed," says Sun Director Jon Garman. "The boards we were evaluating simply couldn't measure up."

That's when Sun discovered Xylogics.

"Getting Xylogics' 440 controllers operational with Sun's workstations was a positive experience," Garman remembers. "What the manual said, the Xylogics boards did, and the software interface was simple to use."

"We had our first Xylogics board up and running with UNIX in just four hours. It was quite phenomenal," he says.

Next, Sun integrated the Xylogics 450 in its second-generation family of workstations because it was the fastest, most reliable Multibus board they could find.

"From the start, our number one concern has been performance," says Garman. "But just as important is the support Xylogics gives us. They've always been very responsive. They listen. And take us seriously. We have a close working relationship: engineering to engineering and management to management. They've always delivered on their promises."

Xylogics' newest product, the 751 VME controller, is now being integrated into Sun's third generation of workstations, The Sun-3 Series.

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the quality of their products, degree of compatibility, level of local support and potential longevity in the market. In any case, the minimum requirements for PC clone products are an ability to put 640K bytes (PC/XT) or 1M byte (PC/AT) of memory on the motherboard, a power supply rated for at least 190W, a guaranteed IBM-compatible BIOS and stateside technical support.

And there are other things to consider. First, the clone must have the required degree of IBM PC compatibility. This means, in addition to a compatible BIOS, the ability to select the standard clock frequencies for those products that can operate at higher clock frequencies than IBM products. A hardware reset should also be a prerequisite, as should adequate capability (slots and power supply) for systems expansion. Other features may be mandated by the application or be desirable for product differentiation.

Overall, evaluate products on the basis of quality, level of support and price—in order of decreasing importance. Ascertaining the identity of the actual manufacturer of a clone under consideration is a good first step.

The largest cloud on the clone horizon is IBM. Specifically, the big question is what the company will do about its loss of market share and the margin pressure induced by the explosive growth of the clone market. It seems clear that any IBM 80386 processor-based product will have proprietary hardware and software. And this proprietary content will migrate down in the PC family, at least to 80286 processor-based products.

However, despite these developments, and the apparent demise of the IBM PC, the market for 8088- and 80286-based, MS-DOS personal computers will not disappear. The PC, PC/XT and PC/AT are standards that will survive both the introduction of proprietary content by IBM into its new personal computers and the onslaught of 386-based products.

Andrew Allison, Los Altos Hills, Calif., is an independent consultant specializing in the evaluation of small-systems technology and its application to product and market development.

Interest Quotient (Circle One)
High 483 Medium 484 Low 485
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POWERFUL SOFTWARE ORGANIZES LARGE JOBS

At every price level, integrated scheduling and cost accounting programs—called project management software—enable users to monitor and control complex projects.

Edward R. Teja, Contributing Editor

For users who require computer systems to orchestrate work, system integrators must enter the world of what is known as "project management." Unfortunately, the bewildering array of software that falls loosely under the generic heading of project management makes specifying the best package for a particular application difficult. Adding to the confusion is the fact that not every program suitable for project management is, in actuality, project management software. There are important differences between certain management tools—such as databases and spreadsheets—and project management packages.

The common underlying characteristic of project management software is that each program applies a particular set of formalized organizational and analytical techniques to the process of estimating and measuring the performance of individual tasks that can be grouped together into a single project (see "Understanding project management"). The individual tasks may be either dependent on the completion or partial completion of other tasks or be independent, as long as all the tasks are inherently part of the project.

The various performance levels of project management software relate to the origins of a program—whether it migrated from mainframe environments or was created specifically for microcomputer environments. Although there are over 40 project management packages on the market, a look at a few examples from the various levels enables system integrators and value-added resellers to better understand the differences and similarities.

Packages control costs

Project management isn't a new concept. In fact, much interest results simply because powerful and inexpensive desktop computers are putting potent, well-understood management tools into the hands of small businesses. And no longer do software developers concern themselves with the limitations of microcomputers. They now write programs that put microcomputer-based software in head-to-head competition with mainframe software. Their programs are based on the same assumptions as traditional mainframe packages and often have similar capabilities.

Typical of the migration of project management software from computer room to desktop is Promis, from Strategic Software Planning Corp. This $2,995 package runs on a PC/XT, PC/AT or compatible with 512K bytes of memory, a CGA (color graphics adapter) or EGA (enhanced graphics adapter) and a color or monochrome display. The system connects to plotters or 132-column printers.

Promis features complete budgeting and cost control for single- or multiple-project operations. It tracks projects using several calendars (a unique calendar for each project), supports networks and exchanges data with Lotus Development Corp.'s Lotus 1-2-3 spreadsheet program.
Plantrac furnishes the standard analysis tools required for true project management software and adds earned-value analysis and project trending.

Computerline Inc.'s Plantrac is another industrial-strength package that is capable of handling an unlimited number of projects, with each project containing as many as 250,000 individual activities and using as many as 200 resources. The program runs on a PC with 256K bytes of RAM and a rigid disk drive. The main disadvantage of the microcomputer-based program over its mainframe competitors is speed. For example, time analysis of 1,000 activities takes from 2 to 6 minutes, a process that would only require seconds on a mainframe.

Plantrac furnishes the standard analysis tools required for true project management software and adds earned-value analysis and project trending. However, such capabilities cost: Plantrac carries a price tag of $3,000 for the first year and $995 for each following year. But the program is sufficiently powerful that it is being used to manage the New York City Transit Authority's more than 200 underground and surface construction projects.

Some software vendors integrate project management programs into larger software systems that run on mainframes, minicomputers and PCs. For example, SAS Institute Inc.'s SAS System combines a powerful fourth-generation language with a wide range of data-management procedures. One of the procedures in the system is SAS/OR, a project management and decision support tool. SAS/OR performs critical path analysis and linear programming and determines minimum and maximum cost flow, as well as other project management functions. The software runs on IBM mainframes and PCs, as well as mid-range systems from major minicomputer vendors.

One company that offers project management packages aimed specifically at software development environments is Expertware Inc. Its POWER management-support package helps users evaluate and monitor the software-development process. The company's CMT and DST toolkit packages increase programmer productivity by controlling and managing changes in software projects and generating documents and templates.

What to look for

Most large-system programs carry large-system price tags. However, the new generation of project management programs for PCs do a bit less than the large-scale competition, and the prices come down accordingly.

For example, Microsoft Corp.'s $395 Project is a generic project management program for microcomputer users that does exactly what you would expect a project manager to do. The program handles up to 200 activities and 255 resources.

At the beginning of a project, users can define the available resources, their costs, outline the project and milestones, and forecast the work. The calendar that the computer uses for scheduling can be customized to accommodate variables such as scheduled overtime, dead time and holidays, as well as normal workdays. Using the program is simple. You enter the data and create a forecast that can periodically be compared to the actual progress of a job. The program provides comparisons between the forecast and the actual job in terms of both cost and time (did the team meet all of its

Understanding project management

Whether a person or a computer program, a project manager must coordinate available resources with the job at hand in an efficient manner. Then, as work progresses, results must be compared to forecasts in such a way that corrective action can be taken in time to ensure that the inevitable snags don't mean missed deadlines, and that all costs are accounted for. Periodic review of the project management data should provide information that will guarantee better forecasts the next time around.

To accomplish these fundamental goals, project management software programs provide:

- Critical-path analysis—a process to determine the sequence of tasks to expedite the job
- Resource tracking—a method of knowing that materials, personnel and cash are available
- Cost accounting—procedures for separately identifying the expense of each task
- Cash-flow analysis—a means of tracking revenue.

These tools come in a variety of forms and vary from package to package. Although the tools are all required, the user must dictate the form of output. The most useful analysis might be in the form of a display of critical paths via network diagrams on a PERT chart. Such a graphical analysis shows the job flow, focusing on the order of the separate tasks and their relationship to one another. For another kind of analysis, Gantt charts might prove more appropriate. Gantt charts are time-based, rather than order-based, and provide a visual schedule of activities.

There are, in fact, myriad ways to manage—perhaps as many as there are managers. But the thing to remember is that the fundamental goals of project management are project scheduling and costing. A program that doesn't control and analyze these two factors in some fashion is less than a true project management package.
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CIRCLE NO. 45 ON INQUIRY CARD
Low-cost packages attack single tasks

Not every project management program provides tools for dealing with large and complex projects. Broderbund Software Inc., for example, has developed ForComment to deal specifically with the often disagreeable task of documentation. Treating documentation as a separate project might appear a step away from the goal of integrated project management, but Broderbund’s president, Douglas Carlston, sees documentation as the often orphaned stepchild of other projects. Thus ForComment addresses the repetitive tasks of reviewing and commenting on written documents with the idea that automating this task will produce significant management control and productivity benefits even for projects that don’t justify full-function project management software.

ForComment, an add-on package, accepts documents created with most word processors and uses data from spreadsheets (as ASCII files). The $195 package allows as many as 15 people to suggest changes, make comments and ask questions. Most importantly, the program allows users to make the changes to see how they look, without altering the source document.

For large or distributed operations, a networked version of ForComment ($995) lets users make comments and suggestions independent of others. They can also pass along comments and information via popular local area networks—including those from IBM Corp., Novell Inc. and 3Com Corp.

Although the customer may want to manage a project, classic project management software might lead to overkill.

How to select a package

As useful as generic project management programs are, their existence doesn’t provide an easy out for system integrators or VARs who don’t want to learn about project management. Certainly, you can install the package and ignore the nature of the customer’s business, but don’t count on having either satisfied customers or repeat business. To know enough to select the optimum program, you must ask three important questions:

1. Does the user’s job really require project management software?
2. What features will get users to actually employ the program?
3. What special requirements does the user’s job entail?

The first question is the most important. Although the customer may want to manage a project, classic project management software might lead to overkill. In some applications the problems can be best solved with a quality database manager, customized to the user’s task.

The answer to the second question isn’t all that obvious. Typical users do not employ a computer because of infatuation with the technology. Users most often only tolerate computers because they do the job. Many programs, such as Strategic Software’s Promis and Microsoft’s Project, try to accommodate these users.

deadlines?). You can even pull together data from several independent jobs to ensure that there is no conflict in the use of available resources.

Like the large-scale programs, Project works equally well whether the work being managed is a construction job or a software-development process. Microsoft Project Version 3.0 runs on MS-DOS (Version 2.0 or higher) machines that have at least 256K bytes of RAM and two flexible disk drives or a rigid disk drive.

An interesting benefit of Project is that, if you want more features than it offers, you can link data from the program to more powerful (and more expensive) project management systems. For example, a program called MSP3 transfers data from Project into the files of Primavera Systems Inc.’s Project Planner, a $2,500 PC-based program. Thus, a job that outgrows the capabilities of Microsoft’s Project (one that requires more than 200 activities) can migrate to the Primavera system, capable of 10,000 activities. Or, users can take advantage of resource leveling. This is a reasonably standard feature in the high-priced programs that helps even out the use of people and materials during a project.

Another reason for migrating files is to take advantage of Primavera’s Primavision graphics package ($1,500). This program supplements the output offered by either Microsoft Project or Primavera Project Planner, using cut-sheet or continuous roll plotters to create time-scaled bar charts and network logic diagrams.

If the price of the software package is a prime consideration, and the project management job is not too complex or specialized, consider Westminster Software Inc.’s $69.50 IN CONTROL! package, which can schedule and organize 75 activities. Oregon State University is using the program to design and plan projects within its forestry department. The program runs on PCs with 128K bytes of memory and outputs to Epson America Inc. or IBM dot-matrix printers. Businesses with several users involved in project management can also purchase a site license that, for $6,950, offers unrestricted duplication of both the program and documentation and 30 days of technical support.

Although the customer may want to manage a project, classic project management software might lead to overkill.
Companies mentioned in this article

Broderbund Software Inc.
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(206) 882-8080
Circle 304

Primavera Systems Inc.
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Circle 305

SAS Institute Inc.
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Strategic Software Planning Corp.
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Circle 308

Westminster Software Inc.
2701 El Camino Real
Mountain View, Calif. 94040
(800) 822-8298
Circle 308

by making their screens self-explanatory and by taking liberal advantage of a computer's special function keys. Still, Promis' price includes a one-day basic training session and both Promis and Project come with tutorials on disk. Project, in fact, comes with a 30-lesson interactive training disk that teaches both project management and system operation.

In any case, users will have to make a significant effort to learn to use these tools. Some users will run the tutorial disk; some will respond better to formal, factory-sponsored training. So, in light of the second question, part of the system integrator's evaluation of the application must include getting to know the user.

The third question—dealing with a user's special requirements—reflects the fact that many industries have unique terminologies and business practices. Knowing these can help avoid misunderstanding as well as ensure that the product the system integrator delivers is the right one for the job. A classic example of this problem arises in reporting strategies.

Reports the results

The way a program outputs information can make a significant difference in whether it suits a user's needs. For example, a user might need a variety of standard charts and reports, such as Gantt charts, network diagrams, critical-path diagrams, histograms and pie charts. The project management software must provide the type of output traditionally used in the client's business for the system to be effective. Furthermore, if the user is making bids for government contracts, the output must meet certain particular and, sometimes, unique requirements. For example, the Department of Defense requires a specialized report form, termed a "C" spec. Programs that don't include C spec output would be worthless to a company that gets a significant portion of its income from DOD contracts.

When looking at project management packages, remember that system integration itself is a project that decomposes into discrete tasks—both dependent and independent. If the number and complexity of system integration projects makes management of those tasks a chronic problem, consider making your own business a test site, thus giving you a closer understanding of the power and capability of the programs. Furthermore, by using the programs in your own operation, you'll not only get better acquainted with the products, you may gain unexpected insights about the nature of your business.

Edward R. Teja is president of Freehold Corp., Santa Cruz, Calif., specializing in marketing and writing services for high-technology companies.

Interest Quotient (Circle One)
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CIRCLE NO. 38 ON INQUIRY CARD
386, GRAPHICS CARDS
PACK EXTRA PUNCH

80386-based accelerator boards speed system processing—despite a lack of 386 software—and application-specific coprocessor boards enhance graphics and offload host processing.

Carl Warren, Senior Editor

To boost CPU processing speed, and to attack specific applications such as graphics, system integrators are pairing powerful coprocessor cards with standard CPU boards. These cards accelerate performance for general jobs like word processing, as well as increase speed for specific tasks.

Many coprocessor board manufacturers are focusing on Intel Corp.'s 80286 and 80386 microprocessors and IBM Corp. architectures. Of these, some companies provide 80286-driven coprocessor boards for older machines, such as the PC, while others—including Intel, Definicon Systems Inc., Orchid Technology and Quadram—offer 80386 coprocessor boards for the PC/XT and PC/AT buses as well.

For example, Definicon Systems, primarily known for supplying coprocessor boards based on chips from National Semiconductor Corp. and Motorola Inc. for a variety of buses, uses Intel's 80386 on its DSI-386 board. Designed for the PC/AT, the 16-MHz DSI-386 supports from 1M to 16M bytes. A 1M-byte version costs $2,495 and comes with the utilities developers need to create 80386-specific programs.

Orchid Technology's $1,499 80386-based coprocessor board, the JET 386, is also designed for the PC/AT. This 16-MHz board fits into a slot on the system motherboard; a cable connects to the existing 80286 microprocessor socket. The 80286, in turn, is plugged into an adapter socket on the cable. A 64K-byte cache on the JET 386 speeds program execution, but the board still relies on existing 16-bit system memory and 8-bit I/O.

Look over product choices

An unusual coprocessor board is Quadram's $595 Quad386 XT, an 80386-based card designed for the 8-bit I/O slots on the PC/XT backplane. Although this design would seem to limit the board's performance, the company claims the Quad386 delivers the expected 80386-level performance because of its onboard 32-bit memory.

Aimed at the PC/AT, Intel's Inboard 386/AT coprocessor card delivers 16-MHz speed and up to 2M bytes of memory for $1,145. For an extra $495, system integrators get a 10-MHz 80287 math coprocessor.

Of course, not everyone is interested in the raw power of the 80386. Qualogy Inc., for example, offers the $1,245 QPC-5101, which is essentially an IBM PC/XT on a plug-in card. The board uses a Harris Semiconductor CP80C88 CMOS processor, has room for a math coprocessor and includes both a graphics controller and a small computer systems interface (SCSI) controller. The board is designed for PC backplanes that have sufficient line drivers and receivers on each address and data line.

Computer Peripherals Inc. has a different way of mining the growing coprocessor market. Although it offers the RACER 80286-based accelerator card, the company's approach to the 80386 environment is through increased memory. Its 386 Memoire card, priced at $745 for 1M byte of memory and $1,095 for 2M bytes, matches Compaq Computer Corp.'s Deskpro 386 memory-expansion add-on connectors. Asif Kahn, CPI's director of interna-

Graphics software packages benefit from the high resolution (1,024 by 1,024) obtainable with graphics coprocessor boards. This screen was created using T & W Systems Inc.'s VersaCAD Advanced software and Vectrix's PEPE graphics coprocessor board.
COPROCESSOR BOARDS

Built for the VMEbus, Force Computer's CPU-386 coprocessor board uses a pipelined architecture to avoid memory cycle wait states and to set up I/O addresses on the VMEbus.

Software lags behind

Softguard Systems Inc.'s vice president of marketing, Joseph Diodati, contends: "When you add an 80286 coprocessor card to an XT system, or an 80386 coprocessor card to an AT-type system, you get little more than blazing speed and not much extra functionality. There is nothing to take advantage of what these processors offer."

Specifically, today's system-level software (e.g., operating systems and development tools) isn't using the ability of the 80286 and 80386 to operate in protected mode and to manage large arrays of memory in the 4G-byte to 4-terabyte range.

"The coprocessor," says Mike Knox, software engineer for West Coast Consultants, San
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Diego, "is basically a way of optimizing the work load in a system. But right now with the 80386, there really isn't any software that lets you take advantage of all that power."

However, Softguard Systems recently introduced VM/386, an under-$300 software package that provides users with a multitasking environment and the ability to manage the virtual capability of the 386. VM/386 allows an 80386 computer to perform like several virtual 8086/8088 machines. Softguard claims that, with VM/386, users can plug in an Orchid JET-386 board, for example, and establish as many virtual machines as they want. The virtual machines can run concurrently, each with its own operating system, and all resources available to the 80386 machine are available to each virtual machine.

The VM/386 environment is managed by a central control program that determines how each device is allocated in the system and supervises the memory by handling real and virtual pages, system timers and tasks. Because the program provides the linkages to real and virtual devices, any number of "virtual machines" can be established at boot time. Thus, a single AT with an 80386, or a Compaq Deskpro 386, can be set up as "n" machines. Hot keys are used to switch between each machine. In the VM/386 software architecture the existing host DOS (i.e. MS-DOS or PC-DOS 3.2) is still used for basic file management and I/O.

Works side-by-side with DOS

In operation, a host system can be established as several machines, each responsible for a variety of tasks. VM/386 allocates available memory to all the tasks and determines which machine is idle and which isn't. VM/386 keeps tabs on the location of various system elements and is able to get data from the proper virtual device and put it into executable memory. Multiple operations can take place in the VM/386 environment while DOS executes single-threaded operations.

To assist system integrators, Softguard also offers a $2,000 DOS developer's package that consists of MetaWare Inc.'s C and Pascal compilers, Phar Lap Software Inc.'s assembler and Softguard's 32-bit linker and loaders. The entire kit gives developers the ability to create 32-bit code and load and link it in the 4G-byte memory space while the DOS manages the I/O.

Other companies also are jumping on the 80386 software bandwagon. Theo's Software Corp., for example, recently introduced the THEOS 386 operating system, which addresses up to 16M bytes of memory and supports as many as 32 units in a multiuser environment. The company expects to add other enhancements, such as full virtual operation, by mid-year. Pricing depends on licensing arrangements and CPU implementation.

The company that was expected to be the biggest supplier of software for the 80386 may be the last to ship product. Although Microsoft Corp. has plans to provide (possibly as early as this month) a DOS 4.0 that will support the virtual mode of the 80286, company designers at a Windows development conference held late last year told independent software vendors not to expect a 386 version of DOS until 1988.

Graphics chips offload host

An exciting trend in coprocessor boards is the development of powerful graphics chips; specifically, the Intel 82786 graphics coprocessor, Motorola 6845 CRT controller, NCR Corp.'s 7300 series and Texas Instruments' 34010 graphics system processor.

Intel's 82786 graphics coprocessor, a dedicated microprocessor that is about equal in processing power to an 8086, employs a graphics-specific instruction set. The graphics instructions are maintained in ROM built into the 82786 and are activated by assembly language routines triggered by the host computer. Therefore, the host system needs only to send a single instruction to draw, for example, a circle or a polygon. The 82786 takes over and issues instructions to the on-board video controller to perform the action on the screen.
Employing bit-slice technology, Tech-Source's GDS-3800 graphics coprocessor boards support Multibus or VMEbus systems.

Besides managing the graphics primitives, video interface and general graphics housekeeping, the 82786 can address up to 4M bytes of RAM video memory—which increases the resolution and number of colors that can be displayed. For example, managing 4,096 colors on a 2,000-by-2,000-pixel resolution would be possible using the Intel chip.

Number Nine Computer Corp. uses the Intel chip in its $999 Pepper graphics board. The board comes with 256K bytes of memory (expandable to 4M bytes) and can manage up to a 1,280-by-700-pixel resolution. The company makes it easy for system integrators to add value via software by employing the virtual device interface (VDI), which eases device driver design.

Texas Instrument's 34010 processor achieves a still higher performance level. The 34010 is based on a 32-bit reduced instruction set computer roughly equivalent to the processor for IBM's RISC, the RT PC. The 34010 can manage high-level language routines, such as those written in C, and can operate completely independent of the host computer.

Conographic Corp. uses the TI chip in its raster image processor (RIP) board. "We process images—specifically, fonts—based on the concept of curves," says company president Luis Villalobos. He continues: "The goal is to create 'what you really see is what you really get.' Right now, you only see almost what you will get. This means that we have to aim for an increase in apparent resolution of about 8-to-1." By employing the 34010 and sophisticated algorithms, the Conographic RIP system provides 1,280-by-1,024 resolution, and drives laser engines at double the typical resolution. For example, using the Conographic board, resolutions of 300-by-600 dpi can be achieved on a Hewlett-Packard Co. Laserjet Plus.

NCR's approach to graphics processors is similar, but it uses chip sets. Its 7300 chip set is designed to replace all the glue logic typically found on a graphics board. Like the Intel and TI processors, the 7300 chips manage graphics functions and provide lookup-table capability. Graphics functions are managed by the 7300 color graphics controller, while the 7301 memory interface controllers serve as memory multiplexers and raster operations processors that can support two bit planes. If more resolution is required, NCR recommends adding additional 7301 chips and frame buffer memory.

Some terminal manufacturers, such as Wyse Technology, are using the Motorola 6845 CRT controller to support resolutions as high as 1,280 by 800, and to emulate all the popular PC operating modes. Wyse packages the display controller with a 15-inch monochrome monitor as the Wyse 700, a display subsystem that costs $995.

Besides providing end users with full-page display capability, the subsystem also gives integrators and VARs a base to build on. Although the 700 comes with a built-in character set in ROM, new character sets can be added, along with more display memory than the 128K bytes found on the basic card.

Some board manufacturers prefer proprietary processors. For example, Vectrix Corp.'s $2,750 PEPE professional graphics board uses a proprietary bit-slice processor to achieve 1,024-by-1,024 pixel resolution. The basic model supports 16 colors and four bit planes. For an additional $200, system integrators can add lookup-table capability to manage 4,096 colors. The product comes in five models.

Of course, the IBM PC isn't the only game in town, and companies such as Matrox Electronic Systems Ltd. are providing high-performance color display processors for Multibus II systems. The Matrox MMG-640 employs the Hitachi America Ltd. 63484 ACRTC controller, combined with a 16- or 32-bit microprocessor and a memory-management unit, to support a 640-by-480-by-8 display resolution; with an increase to 1,024 by 1,024 due later this year. The company expects the board to fit into high-speed imaging applications where standalone graphics capability is an important feature.

Another company making inroads into the high-speed graphics business is Tech-Source Inc. The GDS-3800 graphics display system uses a bit-slice microprocessor on a VMEbus or Multibus II card to provide developers with a
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The Series 3000 is a remarkable piece of design. No other terminal can offer such elegant ergonomics allied to such a comprehensive range of user benefits.

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CIRCLE NO. 253 ON INQUIRY CARD
could be major conflicts. To avoid these potential conflicts, developers and system integrators have banded together to set bus and BIOS standards for devices like the 80386 and the newer graphics processors.

Nevertheless, Greg Resnick, Video-7 Inc.'s director of marketing, believes that standards will be used primarily to achieve backward compatibility to support existing software. "You want to upgrade the coprocessor with little or no impact on the system as a whole. This ability comes about by having a level of transparency built in, and this comes from establishing common operating environments such as the direct graphics interface specification (DGIS) and the virtual device interface (VDI) to simplify integration," says Resnick.

"The goal, at least in software," says John Butler, Microsoft's marketing director, and developer of the Windows environment, "is to decouple the application from the hardware—that's the purpose of the graphics device interface (GDI)—Microsoft's version of VDI." Butler believes that, by making the system flexible for application developers, hardware devices such as coprocessor boards can be richer in functionality.
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## SINGLE-BOARD MICROCOMPUTERS

**ALCVON CORP.**
5010 Shoreham Place, San Diego, CA 92122, (619) 587-1155

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>CPU-Type</th>
<th>Operating System</th>
<th>RAM, ROM (KOM)</th>
<th>Dimensions (FW-X)(WOM)</th>
<th>Price &amp; Quantity</th>
<th>Notes &amp; Features</th>
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<tbody>
<tr>
<td>A68VME</td>
<td>MC68010</td>
<td>VMEbus processor</td>
<td>REGULUS</td>
<td>C, FORTRAN, Pascal</td>
<td>1M (128K)</td>
<td>3,095(1Q1)</td>
<td>SCSI bus controller, 2 serial ports, clock/calendar, interrupts</td>
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<tr>
<td>A68VME-020</td>
<td>MC68020</td>
<td>VMEbus processor</td>
<td>REGULUS</td>
<td>C, FORTRAN, Pascal</td>
<td>1M (128K)</td>
<td>4,500(1Q1)</td>
<td>2 serial communication ports, clock/calendar, battery backup</td>
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**ALLEN SYSTEMS**
2151 Fairfax Rd., Columbus, OH 43221, (614) 488-7122

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<th>Memory Type</th>
<th>Processor</th>
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<th>Notes &amp; Features</th>
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<tr>
<td>FX-11</td>
<td>68HC11</td>
<td>CMOS</td>
<td>Assembly, BASIC</td>
<td>60K (60K)</td>
<td>4X6X0.5</td>
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<td>FX-97</td>
<td>6807</td>
<td>NMOS</td>
<td>Assembly, BASIC</td>
<td>16K (16K)</td>
<td>4X7X0.5</td>
<td>375(1Q1)</td>
<td>2 serial, 4 parallel ports; 1 counter/timer</td>
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**ALLOY COMPUTER PRODUCTS INC.**
100 Pennsylvania Ave., Framingham, MA 01701, (617) 875-6100

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<th>Company</th>
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<th>Memory Type</th>
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<td>Bi-TURBO NE-20</td>
<td>NEC V20</td>
<td>IBM PC</td>
<td>MS-DOS</td>
<td>1M 3.875X13.25</td>
<td>995(1Q1)</td>
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<tr>
<td>PC-SLAVE/15</td>
<td>NEC V20</td>
<td>IBM PC</td>
<td>MS-DOS</td>
<td>1M 3.875X13.25</td>
<td>995(1Q1)</td>
<td>2 serial ports</td>
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**AMPRO COMPUTERS INC.**
67 E. Evelyn Ave., Mountain View, CA 94041, (415) 962-0230

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<th>Company</th>
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<td>Little Board/186</td>
<td>8018N</td>
<td>NMOS</td>
<td>CP/M-86, ConcurrenT DOS, PC-DOS</td>
<td>BASIC, C, 89FORTH, PASCAL</td>
<td>512K (128K)</td>
<td>7.75X7.5X0.75</td>
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<tr>
<td>Little Board/PC</td>
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<td>Little Board PLUS</td>
<td>280A</td>
<td>NMOS</td>
<td>CP/M</td>
<td>BASIC</td>
<td>64K (32K)</td>
<td>289(1Q1)</td>
<td>flexible and rigid disk controllers; 2 serial, 1 Centronics port(s)</td>
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**APPLIED BUSINESS COMPUTER**
765 S. State College Blvd., Suite F, Fullerton, CA 92631, (714) 738-8131

<table>
<thead>
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<th>Company</th>
<th>Model</th>
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<td>ASBC-8</td>
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<td>Assembly, BASIC, FORTH, PL/65</td>
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<td>6.5X9.75X0.5</td>
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<td>DT 6000</td>
<td>68EO9</td>
<td>NMOS</td>
<td>ADOS</td>
<td>Assembly, FORTH</td>
<td>64K (30K)</td>
<td>8X9X0.5</td>
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**AT&T TECHNOLOGY SYSTEMS**
555 Union Blvd., Dept. KB, Allentown, PA 18103, (800) 372-2447

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<th>Notes &amp; Features</th>
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<tr>
<td>WE 3215B</td>
<td>AT&amp;T WE 32100</td>
<td>CMOS</td>
<td>UNIX, System V/VME</td>
<td>BASIC, C, FORTRAN, PASCAL</td>
<td>1M (256K)</td>
<td>6.3X9.2</td>
<td>3,800(1Q1); 2,900(1Q1)</td>
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**CARINT LTD.**
One Waters Park Dr., Suite 101, San Mateo, CA 94403, (415) 345-4040

<table>
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<tr>
<td>XK-186</td>
<td>80166</td>
<td>CMOS</td>
<td>MS-DOS</td>
<td>C Compiler, Lattice, Mark Williams, Microsoft</td>
<td>512K (10)</td>
<td>8X10X0.5</td>
<td>599(1Q1); 469(1Q1)</td>
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**CENTRAL DATA CORP.**
1602 Newton Dr., Champaign, IL 61821, (217) 359-8010

<table>
<thead>
<tr>
<th>Company</th>
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<tr>
<td>CD21/8286</td>
<td>80288</td>
<td>NMOS</td>
<td>Multibus</td>
<td>RMX-86, RMX-286, XENIX-266</td>
<td>1M (128K)</td>
<td>6.75X12X0.5</td>
<td>2,200(1Q1); 1,600(1Q1)</td>
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<td>CD21/8630</td>
<td>8086 (5, 8, 10)</td>
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<td>Multibus</td>
<td>MS-DOS, RMX-86</td>
<td>256K (526K)</td>
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<td>Company</td>
<td>Model</td>
<td>Core Type</td>
<td>Clock Rate/MHz</td>
<td>CMOS or NMOS</td>
<td>Bus</td>
<td>Type of board</td>
<td>Operating System</td>
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<tr>
<td>--------------------------</td>
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<tr>
<td>COMARK CORP.</td>
<td>CAT 286</td>
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<td>DATAVUE TECHNICAL SYSTEMS</td>
<td>MV15000</td>
<td>CMOS Multibus</td>
<td>2800 AL5</td>
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<td>processor</td>
<td>AOS/VS</td>
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<td>DATRICON CORP.</td>
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<td>NMOS SASI</td>
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<td></td>
<td>LSI-11/73</td>
<td>CMOS O-bus</td>
<td>J11 (15)</td>
<td>386 MHz</td>
<td>100-pin DIP</td>
<td>processor</td>
<td>RST/S/E, RSX, RT, ULTRIX-11</td>
</tr>
</tbody>
</table>
The choice is yours... promises or product.

Any company can make great promises about their products. At Siemens, we make great products – and promise immediate delivery now.

Around the world, OEM professionals depend on Siemens for the finest storage technology available. Our customized robotic production line guarantees extremely high yield and consistent standards of manufacturing excellence. A sophisticated control system insures precise, repeatable quality.

310 The 310 megabyte capacity MegaFile Series offers a wide range of design and performance features for high capacity, high performance 5¼” hard disk drives.

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Memory Products Division
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Westlake Village, California 91362
818-706-8872
Three New 68020 VME Processor Boards from Plessey!

32-BIT PERFORMANCE AT 16-BIT PRICE— the PME 6823: real-time 32-bit performance at low cost; multi-processor capability; tons of on-board support functions and unrivaled versatility.

COMPLETE 32-BIT SINGLE BOARD COMPUTER—the PME 6822: 16 or 20 MHz 68020, 68881 paged MMU, 8 Mbytes dual port RAM and SCSI interface.

SUPERFAST NUMBER CRUNCHER—the PME 6821: high speed up to 25 MHz, no wait state plus VSB interface and prefetch cache!
### SINGLE-BOARD MICROCOMPUTERS

<table>
<thead>
<tr>
<th>Company Model</th>
<th>Company Name</th>
<th>CPU Type</th>
<th>RAM (MB)</th>
<th>BIOS</th>
<th>Type of Board</th>
<th>Operating System</th>
<th>Programmer Language Support</th>
<th>RAM (MB)</th>
<th>Price (In)</th>
<th>Notes and Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUAL SYSTEMS CORP.</td>
<td>DUAL SYSTEMS CORP.</td>
<td>68020 (16.7)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>UNIX System V 2.2</td>
<td>BASIC, C, COBOL, FORTRAN, Pascal</td>
<td>1M</td>
<td>6.3 x 9.2</td>
<td>4,450(Q1)</td>
</tr>
<tr>
<td>DVME-104</td>
<td>DVME-104</td>
<td>MC68010 (12.5)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>UNIX System III, Harmony Real-Time</td>
<td>C, RM/COBOL, FORTRAN, Pascal</td>
<td>1M (256K)</td>
<td>8.7 x 9.2</td>
<td>2,230(Q100)</td>
</tr>
<tr>
<td>DVME-107</td>
<td>DVME-107</td>
<td>MC68010 (10)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>P-DOS, M-DOS, FORTRAN, Pascal</td>
<td>512K (128K)</td>
<td>8.7 x 9.2</td>
<td>2,496(Q1)</td>
<td>1 serial communications port, 7 interrupt levels</td>
</tr>
<tr>
<td>DVME-134</td>
<td>DVME-134</td>
<td>MC68020 (12.5, 16.7)</td>
<td>CMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>UNIX System V, Harmony Real-Time</td>
<td>C, FORTRAN, Pascal</td>
<td>1M (64K)</td>
<td>8.7 x 9.2</td>
<td>4,361(Q1)</td>
</tr>
<tr>
<td>ENTERPRISE SYSTEMS CORP.</td>
<td>ENTERPRISE SYSTEMS CORP.</td>
<td>6809 (1, 2)</td>
<td>NMOS</td>
<td>STDbus</td>
<td>processor</td>
<td>up to 24K (up to 24K)</td>
<td>6.5 x 4.5</td>
<td>250(Q1); 185(Q100)</td>
<td>power fail detect, serial port, 4 programmable timers</td>
<td></td>
</tr>
<tr>
<td>FARADAY ELECTRONICS INC.</td>
<td>FARADAY ELECTRONICS INC.</td>
<td>6809 (1, 2)</td>
<td>NMOS</td>
<td>STDbus</td>
<td>processor</td>
<td>up to 24K (up to 24K)</td>
<td>6.5 x 4.5</td>
<td>250(Q1); 185(Q100)</td>
<td>power fail detect, serial port, 4 programmable timers</td>
<td></td>
</tr>
<tr>
<td>BUS AT</td>
<td>BUS AT</td>
<td>80286 (6, 8)</td>
<td>NMOS</td>
<td>PC AT bus</td>
<td>processor</td>
<td>CP/M-86, MS-DOS</td>
<td>BASIC, FORTH, Pascal</td>
<td>512K (64K)</td>
<td>13.2 x 4.8</td>
<td>15 interrupts; 2 DMA controllers, keyboard, reset, speaker ports; CMOS clock/calendar</td>
</tr>
<tr>
<td>BUS PC</td>
<td>BUS PC</td>
<td>8088 (4.77)</td>
<td>NMOS</td>
<td>PC bus</td>
<td>processor</td>
<td>CP/M-86, MS-DOS</td>
<td>BASIC, FORTH, Pascal</td>
<td>256K (64K)</td>
<td>13.15 x 4.2</td>
<td>8 interrupts; 2 serial, 1 parallel port(s); 3 timers</td>
</tr>
<tr>
<td>CMOS Micro PC</td>
<td>CMOS Micro PC</td>
<td>80C88 (4.77)</td>
<td>CMOS</td>
<td>PC bus</td>
<td>processor</td>
<td>CP/M-86, MS-DOS</td>
<td>BASIC, FORTH, Pascal</td>
<td>256K (64K)</td>
<td>6.2 x 4.2</td>
<td>8 interrupts; 8087 coprocessor, 3 timers; keyboard, speaker ports</td>
</tr>
<tr>
<td>GENERAL MICRO SYSTEMS INC.</td>
<td>GENERAL MICRO SYSTEMS INC.</td>
<td>GMSV06</td>
<td>VMEbus</td>
<td>processor</td>
<td>OSS, P-DOS, pSOS, UNIFLEX, UNIX, VERSAdos</td>
<td>BASIC, C and FORTRAN Compilers; Pascal</td>
<td>128K</td>
<td>1,995(Q1); 1,496(Q100)</td>
<td>68881 math coprocessor; 2 multiprotocol serial, parallel port(s); 4 timers; real-time, battery-backed clock/calendar</td>
<td></td>
</tr>
<tr>
<td>GMSV06/020</td>
<td>GMSV06/020</td>
<td>MC68020 (16)</td>
<td>VMEbus</td>
<td>processor</td>
<td>OSS, P-DOS, pSOS, UNIFLEX, UNIX, VERSAdos</td>
<td>BASIC COMPILER, Pascal</td>
<td>up to 2M (128K)</td>
<td>2,995(Q1); 2,246(Q100)</td>
<td>68881 math coprocessor; 2 multiprotocol serial, parallel port(s); 4 timers</td>
<td></td>
</tr>
<tr>
<td>GMSV07</td>
<td>GMSV07</td>
<td>MC68020 (16, 20, 24)</td>
<td>VMEbus</td>
<td>processor</td>
<td>OSS, P-DOS, pSOS, UNIFLEX, UNIX, VERSAdos</td>
<td>BASIC, C and FORTRAN Compilers; Pascal</td>
<td>128K</td>
<td>1,995(Q1); 1,496(Q100)</td>
<td>2 coprocessor; 2 multiprotocol serial, parallel port(s); 2 expansion connectors</td>
<td></td>
</tr>
<tr>
<td>GESPC INC.</td>
<td>GESPC INC.</td>
<td>8088 (8)</td>
<td>NMOS</td>
<td>G-64</td>
<td>processor</td>
<td>OSS, P-DOS</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal</td>
<td>64K (128K)</td>
<td>4 x 6 x 0.8</td>
<td>395(Q1); 316(Q100)</td>
</tr>
<tr>
<td>GESMPU-4B</td>
<td>GESMPU-4B</td>
<td>MC68000 (8)</td>
<td>NMOS</td>
<td>G-64</td>
<td>processor</td>
<td>OSS, P-DOS</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal</td>
<td>64K (128K)</td>
<td>4 x 6 x 0.8</td>
<td>1,170(Q1); 936(Q100)</td>
</tr>
<tr>
<td>GESMPU-20</td>
<td>GESMPU-20</td>
<td>MC68020 (16)</td>
<td>NMOS</td>
<td>G-64</td>
<td>processor</td>
<td>OSS</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal</td>
<td>64K (128K)</td>
<td>4 x 6 x 0.8</td>
<td>595(Q1); 476(Q100)</td>
</tr>
<tr>
<td>GESSBS-5</td>
<td>GESSBS-5</td>
<td>8088 (8)</td>
<td>NMOS</td>
<td>MS-DOS</td>
<td>processor</td>
<td>GENESCOPE</td>
<td>64K (64K)</td>
<td>4 x 6 x 0.8</td>
<td>595(Q1); 476(Q100)</td>
<td>2 RS232C serial ports; real-time clock/calender, 10 (8-bit) timers</td>
</tr>
</tbody>
</table>
### SINGLE-BOARD MICROCOMPUTERS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>CPU Type</th>
<th>Clock Rate(MHz)</th>
<th>CMOS or NMOS</th>
<th>Bus</th>
<th>Type of board</th>
<th>Operating System</th>
<th>Programming Languages Supported</th>
<th>MMU/Operating System</th>
<th>Manufacturer/OS</th>
<th>Price &amp; Quantity</th>
<th>Notes and Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>GMX INC.</td>
<td>Micro-20</td>
<td>MC68020</td>
<td>(12.5, 16.67, 20)</td>
<td>(12.5, 16.67, 20)</td>
<td>processor</td>
<td>OS9, UNIFLEX</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal, Sculptor</td>
<td>2M (256K)</td>
<td>flexible disk controller, 68881 math coprocessor, 4 serial ports, battery-backed day clock, I/O expansion connector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Micro-20 MMU</td>
<td>MC68020</td>
<td>(12.5, 16.67, 20)</td>
<td>processor</td>
<td>OS9, UNIFLEX-VM</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal, Sculptor</td>
<td>3M (256K)</td>
<td>flexible disk controller, 3 serial ports, battery-backed day clock, up to 8M bytes of memory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEURIKON CORP.</td>
<td>HK68/M220</td>
<td>MC68020</td>
<td>(up to 24)</td>
<td>NMOS</td>
<td>Multibus II</td>
<td>processor</td>
<td>OS9, pSOS, UNIX System V, VRTX</td>
<td>BASIC, C, COBOL, FORTRAN, Pascal</td>
<td>4M (256K)</td>
<td>flexible disk controller, 2 serial ports, 68881 math coprocessor, SCSI interface, MMU</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HK68/V10</td>
<td>MC68010</td>
<td>(10, 12.5)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>OS9, pSOS, UNIX System V, VRTX</td>
<td>BASIC, C, COBOL, FORTRAN, Pascal</td>
<td>4M (128K)</td>
<td>flexible disk controller, 2 serial ports, battery-backed day clock, VMEbus processor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HK68/V20</td>
<td>MC68020</td>
<td>(up to 24)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>OS9, pSOS, UNIX System V, VRTX</td>
<td>BASIC, C, COBOL, FORTRAN, Pascal</td>
<td>4M (128K)</td>
<td>flexible disk controller, 80287 math coprocessor, serial port, MMU, VXBus memory bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDOCMP INC.</td>
<td>IND-68011</td>
<td>MC68010</td>
<td>(8, 10, 12.5)</td>
<td>CMOS</td>
<td>proprietary</td>
<td>processor, I/O</td>
<td>MTOS-68K, MTOS-UX 68K Assembly, C, Pascal</td>
<td>up to 128K (up to 128K)</td>
<td>15x9.5 x 0.5</td>
<td>3.125(Q1); 2.500(Q100)</td>
<td>interrupts, up to 3 serial ports, real-time clock, 16 analog inputs, 4 analog outputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IND-68021</td>
<td>MC68010</td>
<td>(8, 10, 12.5)</td>
<td>CMOS</td>
<td>proprietary</td>
<td>processor, I/O</td>
<td>MTOS-68K, MTOS-UX 68K Assembly, C, Pascal</td>
<td>up to 128K (up to 128K)</td>
<td>15x9.5 x 0.5</td>
<td>2.448(Q1); 1.958(Q100)</td>
<td>interrupts, up to 3 serial ports, real-time clock, 5 counter/timers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IND-68041</td>
<td>MC68010</td>
<td>(8, 10, 12.5)</td>
<td>CMOS</td>
<td>proprietary</td>
<td>processor, I/O</td>
<td>MTOS-68K, MTOS-UX 68K Assembly, C, Pascal</td>
<td>up to 128K (up to 128K)</td>
<td>15x9.5 x 0.5</td>
<td>2.100(Q1); 1.774(Q100)</td>
<td>interrupts, up to 3 serial ports, real-time clock, 16 analog inputs, 2 analog outputs, 2 counter/timers</td>
<td></td>
</tr>
<tr>
<td>INTEGRATED SOLUTIONS</td>
<td>VME-68K10</td>
<td>MC68010</td>
<td>(11.2)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>Berkeley UNIX Version 4.2</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>16K (64K)</td>
<td>2.000(Q1); 1.320(Q100)</td>
<td>2 serial ports, MMU</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VME-68K20</td>
<td>MC68020</td>
<td>(16.67)</td>
<td>NMOS</td>
<td>VMEbus</td>
<td>processor</td>
<td>Berkeley UNIX Version 4.2</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>16K (64K)</td>
<td>2.500(Q1); 1.650(Q100)</td>
<td>2 async serial ports, MMU</td>
<td></td>
</tr>
<tr>
<td>INTEL CORP.</td>
<td>ISBC 186/xxx</td>
<td>80186</td>
<td>Multibus, Multibus II</td>
<td>processor</td>
<td>RMX, UNIX, XENIX</td>
<td>up to 16M</td>
<td>2.1000-2.0000/Q1</td>
<td>2.000-1.0000/Q1</td>
<td>8087-1 coprocessor, built-in self-test, advanced DMA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>iSBX 286/xxx</td>
<td>80286</td>
<td>Multibus, Multibus II</td>
<td>processor</td>
<td>RMX, UNIX, XENIX</td>
<td>up to 16M</td>
<td>2.000-1.7900/Q1</td>
<td>80287 coprocessor, built-in self-test, advanced DMA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>iSBX 386/xxx</td>
<td>80386</td>
<td>Multibus, Multibus II</td>
<td>processor</td>
<td>RMX, UNIX, XENIX</td>
<td>up to 16M</td>
<td>4.000-1.2000/Q1</td>
<td>80287 coprocessor, built-in self-test, advanced DMA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERCONTINENTAL MICRO SYSTEMS CORP.</td>
<td>CPS-MS</td>
<td>NEC V40</td>
<td>S-100</td>
<td>processor</td>
<td>PC-DOS, TurboDOS</td>
<td>BASIC, C, FORTH</td>
<td>640(K)</td>
<td>5.1x10 x 0.65</td>
<td>395(Q1); 587(Q100)</td>
<td>flexible disk controller, power/reset circuit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPS-PC</td>
<td>NEC V40</td>
<td>PC bus</td>
<td>processor</td>
<td>NetWare 86, PC-DOS, TurboDOS</td>
<td>BASIC, C, FORTH</td>
<td>768(K)</td>
<td>4.2x10.5 x 0.75</td>
<td>795(Q1); 477(Q100)</td>
<td>flexible disk controller, power/reset circuit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPZ-186</td>
<td>80186</td>
<td>S-100</td>
<td>processor</td>
<td>TurboDOS</td>
<td>BASIC, C, FORTH</td>
<td>1M</td>
<td>5.5x10 x 0.56</td>
<td>1.195(Q1); 717(Q100)</td>
<td>flexible disk and DMA controllers, MMU</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
INTERPHASE PULLS A FAST ONE

30 MBytes/s on VMEbus

INTERPHASE® shatters the old speed limits of the VMEbus with its second generation of VME disk controllers boasting 30 megabytes per second bus speeds and above. Using a new INTERPHASE technology breakthrough called the BUSpacket InterfaceSM ... the new V/SMD 4200 Cheetah and V/ESDI 4201 Panther triple existing VMEbus speeds and approach the VMEbus theoretical bandwidth of 40 megabytes per second!

SIMPLY THE FASTEST
The combination of the BUSpacket Interface and a large (128 KBytes) cache memory provide the V/SMD 4200 and V/ESDI 4201 with unequaled speed, and make them the fastest SMD and ESDI controllers by a factor of three. No one even comes close!

In simple terms, the new INTERPHASE technology preformats packets of data to go across the bus before acquiring it. The INTERPHASE BUSpacket approach unharnesses the VMEbus from slow devices through deep, high-speed bus FIFOs and an asynchronous delay line-based state machine, which controls bus transfers. Data is emptied onto the bus in packets at speeds 30 megabytes per second and above.

STICK WITH THE WINNERS
The V/SMD 4200 and V/ESDI 4201 also incorporate the proven INTERPHASE features of the multitasking Virtual Buffer ArchitectureSM, Intelligent Caching, and zero latency operation found on other popular INTERPHASE products. The four drive V/ESDI 4201 Panther even adds an integral SCSI port for easy addition of back up devices.

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For more information about Fujitsu's ½" cartridge, or other tape drives, call (408) 946-8777. Or write Fujitsu America, Inc., Storage Products Division, 3055 Orchard Drive, San Jose, CA 95134-2017.

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Need a High Resolution Graphics Controller?

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<table>
<thead>
<tr>
<th></th>
<th>Prism</th>
<th>Performer I</th>
<th>Performer II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>800×600, 1024×768</td>
<td>640×480, 800×600</td>
<td>1024×768, 1280×1024</td>
</tr>
<tr>
<td>Vendor</td>
<td>NEC 7220A</td>
<td>Hitachi ACRTC</td>
<td>Hitachi ACRTC</td>
</tr>
<tr>
<td>Colors</td>
<td>16 Color (4096)</td>
<td>16 Color</td>
<td>256 Color (4096)</td>
</tr>
<tr>
<td>Interface</td>
<td>Analog/TTL</td>
<td>TTL (RGBI)</td>
<td>Analog</td>
</tr>
<tr>
<td></td>
<td>RS-232 Port</td>
<td></td>
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</tr>
</tbody>
</table>

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### SINGLE-BOARD MICROCOMPUTERS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>CPU Type (Clock rates MHz)</th>
<th>CMOS or NMOS</th>
<th>Bus</th>
<th>Type of board</th>
<th>Operating system</th>
<th>Programming languages supported</th>
<th>Memory/Bus (KHz, No of MB)</th>
<th>Display (H/W/Dio)</th>
<th>Price &amp; Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERPHASE CORP.</td>
<td>MC68010</td>
<td>VMEbus processor</td>
<td>UNIX</td>
<td>C</td>
<td>512K</td>
<td>14x11.5</td>
<td>2.995(Q100) disk controller: serial, parallel ports; 5 expansion slots</td>
<td></td>
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</tr>
<tr>
<td>IRONICS INC.</td>
<td>MC68010</td>
<td>VMEbus processor</td>
<td>pSOS, UNIFLEX, UNIX System V.2</td>
<td>512K</td>
<td>1.995(Q1)</td>
<td>2 multiprotocol serial, 2 parallel I/O ports</td>
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<tr>
<td>IV-1602</td>
<td>MC68010</td>
<td>VMEbus processor</td>
<td>pSOS, UNIFLEX, UNIX System V.2</td>
<td>256K</td>
<td>2.445(Q1)</td>
<td>4 dual channel I/O controllers, 8 multiprotocol serial I/O ports</td>
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<tr>
<td>IV-3201</td>
<td>MC68020</td>
<td>VMEbus processor</td>
<td>pSOS, UNIFLEX, UNIX System V.2</td>
<td>1M</td>
<td>3.395(Q1)</td>
<td>programmable counter/timer, real-time clock/calendar</td>
<td></td>
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<tr>
<td>ISKRA VME TECHNOLOGIES</td>
<td>f3286</td>
<td>NMOS VMEbus processor</td>
<td>IRMX-86, MS-DOS, XENIX</td>
<td>512K</td>
<td>6.3x9.2</td>
<td>2.280(Q1); interrupt controller, 80287 coprocessor, reset circuit, 2 serial ports, real-time clock</td>
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<tr>
<td>VMEx86</td>
<td>DCJ-11</td>
<td>NMOS VMEbus processor</td>
<td>RSX-11</td>
<td>512K</td>
<td>4.3x9.2</td>
<td>2.395(Q1); interrupt controller; reset circuit; 1 serial, 1 parallel port; real-time clock; 3 timers</td>
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<tr>
<td>JF MICROSYSTEMS</td>
<td>4012</td>
<td>NMOS STDbus I/O processor</td>
<td>IRMX-86, MS-DOS</td>
<td>2K</td>
<td>4.5x6.5</td>
<td>460(Q1); 3-channel timer, interrupt controller</td>
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<td>IV-1624</td>
<td>IV-3201</td>
<td>CMOS VMEbus processor</td>
<td>pSOS, UNIFLEX, UNIX System V.2</td>
<td>8K</td>
<td>4.5x6.5</td>
<td>400(Q1); 3-channel timer, parallel I/O processor, interrupt controller</td>
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<td>IV-3201</td>
<td>IV-3201</td>
<td>CMOS VMEbus processor</td>
<td>pSOS, UNIFLEX, UNIX System V.2</td>
<td>256K</td>
<td>6.7x12</td>
<td>2.000(Q1); 3-channel timer, master interrupt controller</td>
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<tr>
<td>LAPOLE SYSTEMS INC. /LCA-NY</td>
<td>8086</td>
<td>NMOS STDbus processor</td>
<td>CP/M-86</td>
<td>32K</td>
<td>4.5x6.5</td>
<td>500(Q1); 3-channel timer, master interrupt controller</td>
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<tr>
<td>LPU-68K: 1M-D10</td>
<td>MGB8000</td>
<td>Multibus processor</td>
<td>CP/M-86, OS, REGULUS</td>
<td>C, FORTH, FORTRAN, Pascal</td>
<td>1M</td>
<td>6.76x12</td>
<td>2.100(Q1); 1.400(Q100) DMA controller, 16-bit counter/timer; 2 ISA expansion connectors</td>
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<tr>
<td>LPU-DAC</td>
<td>HD64B180</td>
<td>Multibus processor</td>
<td>CP/M-80</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>256K</td>
<td>6.76x12</td>
<td>2.000(Q1); 1.350(Q100)</td>
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<tr>
<td>LITTLE MACHINES INC.</td>
<td>80286</td>
<td>NMOS Multibus processor</td>
<td>CORTEX, IRMX-286, UNIX System V, XENIX</td>
<td>Assembly, C, PL/M</td>
<td>512K</td>
<td>12x6.75</td>
<td>2.200(Q1); 3 RS232C or RS422/423 ports; 1 parallel, 1 Ethernet ports; Centronics interface</td>
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<tr>
<td>LOGICRAFT INC.</td>
<td>8086</td>
<td>NMOS Unitbus processor</td>
<td>MS-DOS, RSX, RSX-11M-PLUS, RT-11, TIX, VMS</td>
<td>MD-DOS languages</td>
<td>768K</td>
<td>8.5x15.625x6.350(Q1); 3.492(Q100) RS232C port</td>
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<tr>
<td>HCP-11</td>
<td>80286</td>
<td>NMOS Serial bus processor</td>
<td>MS-DOS, RSX, RSX-11M-PLUS, RT-11, TIX, VMS</td>
<td>DS-DOS languages</td>
<td>768K</td>
<td>8.5x5.18</td>
<td>2.22(Q1); 1.223(Q100) RS232C port</td>
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<tr>
<td>LIGHTNING 286</td>
<td>80286</td>
<td>NMOS S-100 processor</td>
<td>Concurrent DOS, CP/M-86, MS-DOS</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>5x10x0.5</td>
<td>1.095(Q1)</td>
<td>8 vectored interrupts, IEEE 696 bus expansion, 80287 math coprocessor</td>
<td></td>
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</table>

MINI-MICRO SYSTEMS/March 1987
<table>
<thead>
<tr>
<th>Company/Model</th>
<th>CPU/Type (Clock rate)</th>
<th>CMOS or NMOS</th>
<th>Bus</th>
<th>Type of Board</th>
<th>Operating System</th>
<th>Programming Languages Supported</th>
<th>Memory/Bus Type</th>
<th>Component</th>
<th>Component Price ($/each)</th>
<th>I/O Port(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thunder/Plus</td>
<td>80186 (10)</td>
<td>NMOS</td>
<td>S-100 processor</td>
<td>Concurrent DOS, CP/M-86, MS-DOS</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal</td>
<td>1M (128K)</td>
<td>5x10x0.5</td>
<td>1195(Q1)</td>
<td>flexible disk controller; 8087 math coprocessor; 2 serial, 1 parallel port(s)</td>
<td></td>
</tr>
<tr>
<td>COM16A</td>
<td>8086 (8)</td>
<td>Multibus</td>
<td>communications</td>
<td>UNIX System V</td>
<td>Assembly, C</td>
<td>128K-512K (256K)</td>
<td>6.75x12 x0.5</td>
<td>1450(Q1); 950(Q100)</td>
<td>DMA channel, 8 serial ports, iSIX expansion connector, UNIX Terminal I/O</td>
<td></td>
</tr>
<tr>
<td>GPC68020</td>
<td>MC68020 (12.5, 16.67)</td>
<td>Multibus</td>
<td>processor</td>
<td>UNIX System V, VRTX</td>
<td>Ada, Assembly, C</td>
<td>1M-8M (256K)</td>
<td>7.75x12 x0.4</td>
<td>2785(Q1); 1950(Q100)</td>
<td>dual serial I/O ports; 7 interrupt levels; 5 (8-bit) counter/timers</td>
<td></td>
</tr>
<tr>
<td>MT68020</td>
<td>MC68020 (12.5, 16.67)</td>
<td>Multibus II</td>
<td>processor</td>
<td>UNIX System V, VRTX</td>
<td>Ada, Assembly, C</td>
<td>1M-4M (256K)</td>
<td>9.2x0.78 x8.9</td>
<td>3490(Q1); 2443(Q100)</td>
<td>dual serial I/O ports; 7 interrupt levels; 5 (8-bit) counter/timers</td>
<td></td>
</tr>
<tr>
<td>MICRO-LINK CORP.</td>
<td>STD-203</td>
<td>STDbus</td>
<td>processor</td>
<td>CP/M-68K, OS9, P-DOS</td>
<td>BASIC, Lattice and Alcyon C, FORTH, Absoft FORTRAN</td>
<td>(4K)</td>
<td>4.5x6.5 x0.5</td>
<td>425(Q1); 340(Q100)</td>
<td>Z80 vectored interrupts</td>
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<td>STD-206</td>
<td>STDbus</td>
<td>processor</td>
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<td>256K (64K)</td>
<td>4.5x6.5 x0.5</td>
<td>475(Q1); 380(Q100)</td>
<td>2 serial, 1 parallel port(s); iSIX expansion connector</td>
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<tr>
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<td>STD-247</td>
<td>STDbus</td>
<td>processor</td>
<td>CP/M 2.2</td>
<td>BASIC, C, FORTH, FORTRAN, Pascal</td>
<td>64K (32K)</td>
<td>4.5x6.5 x0.5</td>
<td>285(Q1); 228(Q100)</td>
<td>1 RS232C, 1 parallel ports; battery-backed, real-time clock/calendar; 2 timers</td>
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<tr>
<td>MICRO/SYS INC.</td>
<td>SB8020</td>
<td>Z80 (4)</td>
<td>NMOS STDbus</td>
<td>processor</td>
<td>CP/M 2.2</td>
<td>C</td>
<td>32K (32K)</td>
<td>4.5x7.0 x0.5</td>
<td>395(Q1); 290(Q100)</td>
<td>2 serial, 1 parallel port(s); battery-backed clock/calendar; 4 counter/timers</td>
</tr>
<tr>
<td></td>
<td>SB8082</td>
<td>NEC V20 (5, 8)</td>
<td>NMOS STDbus</td>
<td>processor</td>
<td>PC-DOS</td>
<td>C</td>
<td>32K (32K)</td>
<td>4.5x7.0 x0.5</td>
<td>395(Q1); 290(Q100)</td>
<td>2 serial, 2 parallel ports; 5 counter/timers</td>
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<tr>
<td></td>
<td>SB8088</td>
<td>8088 (5, 8)</td>
<td>NMOS STDbus</td>
<td>processor</td>
<td>PC-DOS</td>
<td>C</td>
<td>32K (32K)</td>
<td>4.5x7.0 x0.5</td>
<td>345(Q1); 225(Q100)</td>
<td>1 serial, 2 parallel port(s); 5 counter/timers</td>
</tr>
<tr>
<td>MILLER TECHNOLOGY INC.</td>
<td>647 N. Santa Cruz Ave., Los Gatos, CA 95030, (408) 395-2032</td>
<td>Z80A (4)</td>
<td>NMOS STDbus</td>
<td>processor, I/O</td>
<td>CP/M</td>
<td>Assembly, BASIC, C</td>
<td>64K (16K)</td>
<td>7x4.5x0.5</td>
<td>645(Q1); 535(Q100)</td>
<td>serial port, memory mapping</td>
</tr>
<tr>
<td></td>
<td>Z80A (4)</td>
<td>NMOS STDbus</td>
<td>processor, I/O</td>
<td>CP/M</td>
<td>Assembly, BASIC, C</td>
<td>64K (16K)</td>
<td>7x4.5x0.5</td>
<td>795(Q1); 735(Q100)</td>
<td>flexible disk controller; serial, printer port; 3 counter/timers, memory mapping</td>
<td></td>
</tr>
<tr>
<td>MOTOROLA INC. (MICROCOMPUTER DIV.)</td>
<td>2900 S. Diablo Way, Tempe, AZ 85282, (602) 438-3501</td>
<td>Z80A (4)</td>
<td>NMOS STDbus</td>
<td>processor</td>
<td></td>
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<tr>
<td></td>
<td>Z80A (4)</td>
<td>NMOS STDbus</td>
<td>processor</td>
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<tr>
<td></td>
<td>Z80A (4)</td>
<td>NMOS STDbus</td>
<td>processor</td>
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<tr>
<td>MMVE105</td>
<td>MC68010 100</td>
<td>NMOS VMEbus</td>
<td>processor</td>
<td>VERSAdos</td>
<td>C, FORTH, Pascal</td>
<td>512K (256K)</td>
<td>9.2x0.8 x6.3</td>
<td>850(Q100); 995(Q1);</td>
<td>2 serial, 8-bit parallel port(s); 4 timers</td>
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</tr>
<tr>
<td>MMVE133A</td>
<td>MC68020 20</td>
<td>HCMOS VMEbus</td>
<td>processor</td>
<td>VERSAdos, VRTX</td>
<td>C, FORTH, Pascal</td>
<td>1M (256K)</td>
<td>9.2x0.8 x6.3</td>
<td>4200(Q1); 31880(Q100)</td>
<td>math coprocessor; 2 multiprotocol serial ports; 3 (8-bit) timers; real-time clock</td>
<td></td>
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<tr>
<td>MMVE135</td>
<td>MC68020 16.67</td>
<td>HCMOS VMEbus</td>
<td>processor</td>
<td>UNIX System V, VERSAdos</td>
<td>C, FORTH, Pascal</td>
<td>1M (128K)</td>
<td>9.2x0.8 x6.3</td>
<td>5245(Q1); 3934(Q100)</td>
<td>math coprocessor; 2 serial ports; 2 (16-bit) timers</td>
<td></td>
</tr>
<tr>
<td>OCTAGON SYSTEMS CORP.</td>
<td>6510 W. 91st. Ave., Westminster, CO 80030, (303) 426-8540</td>
<td>8088 (5.12)</td>
<td>STDbus</td>
<td>processor</td>
<td>ROBASIC</td>
<td>16K (64K)</td>
<td>4.5x7 x0.468</td>
<td>545-595(Q1); 366-406(Q100)</td>
<td>8-level interrupt controller, 2 RS232C serial ports, real-time clock, 5 counter/timers; includes ROBASIC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8088 (5.12)</td>
<td>STDbus</td>
<td>processor</td>
<td>ROBASIC</td>
<td>ROBASIC</td>
<td>32K (64K)</td>
<td>4.5x7 x0.468</td>
<td>645(Q1); 446(Q100)</td>
<td>1 RS232C serial port, 5 counter/timers, 8 analog inputs; includes ROBASIC</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Company/Model</th>
<th>CPU Type (clock rate/MHz)</th>
<th>CMOS or NMOS</th>
<th>Bus</th>
<th>Type of Board</th>
<th>Operating System</th>
<th>Programming Languages Supported</th>
<th>Memory/Memory Support</th>
<th>Dimensions (HxWxDinches)</th>
<th>Price ($)(Monthly)</th>
<th>Notes and Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS-2Z</td>
<td>Z80A (4)</td>
<td>CMOS proprietary processor</td>
<td>OEM BASIC</td>
<td>OEM BASIC</td>
<td>9K (16K)</td>
<td>4.5 × 7 × 0.468</td>
<td>345-380 (Q1); 236-264 (Q100)</td>
<td>1 RS232C serial port, 8 analog inputs, digital I/O, includes OEM BASIC</td>
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<tr>
<td>OMNIBYTE CORP.</td>
<td>Circle 446</td>
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<tr>
<td>OB88K1A</td>
<td>MC68000 (10)</td>
<td>Multibus processor</td>
<td>IDRIS, C, Pascal</td>
<td>128K-512K (256K)</td>
<td>6.75 × 12 × 0.062</td>
<td>1,295 (Q1); 971 (Q100)</td>
<td>2 RS232C serial, 2 (16-bit) parallel ports</td>
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<tr>
<td>OB88K/V8BC1</td>
<td>MC68000 (12.5)</td>
<td>VMEbus processor</td>
<td>IDRIS, C, Pascal</td>
<td>512K (256K)</td>
<td>6.3 × 9.19 × 0.062</td>
<td>1,695 (Q1); 1,271 (Q100)</td>
<td>up to 4 serial ports</td>
<td></td>
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<tr>
<td>OB88K/V8BC20</td>
<td>MC68020 (16.7)</td>
<td>VMEbus processor</td>
<td>IDRIS, C, Pascal</td>
<td>1M-4M (128K)</td>
<td>6.3 × 9.19 × 0.062</td>
<td></td>
<td>up to 4 serial ports</td>
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<tr>
<td>ONSET COMPUTER CORP.</td>
<td>Circle 447</td>
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<tr>
<td>199 Main St., P.O. Box 1030, N. Falmouth, MA 02556, (617) 563-2267</td>
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<tr>
<td>CPU-8086</td>
<td>80C86 (4)</td>
<td>CMOS C-44 processor</td>
<td>monitor</td>
<td>Assembly</td>
<td>256 (8K)</td>
<td>5.25 × 4.5 × 0.5</td>
<td>552 (Q1); 380 (Q100)</td>
<td>real-time clock, 14-bit timer</td>
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<tr>
<td>Tattletale</td>
<td>6303Y (4.91)</td>
<td>CMOS process control</td>
<td>TT3 BASIC</td>
<td>Assembly, TT3 BASIC</td>
<td>256K (32K)</td>
<td>2.9 × 5.0 × 0.8</td>
<td>595 (Q1); 410 (Q100)</td>
<td>on-board voltage regulator, 8-channel A/D converter</td>
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<td>Model II</td>
<td></td>
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<tr>
<td>Tattletale</td>
<td>6301 (4.91)</td>
<td>CMOS process control</td>
<td>TT3 BASIC</td>
<td>Assembly, TT3 BASIC</td>
<td>32K (16K)</td>
<td>2.25 × 3.725 × 0.8</td>
<td>395 (Q1); 275 (Q100)</td>
<td>lithium battery backup, on-board voltage regulator, 11-channel A/D converter</td>
<td></td>
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<tr>
<td>Model IV</td>
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<td>PEP MODULAR COMPUTERS INC.</td>
<td>Circle 448</td>
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<td>600 N. Bell Ave., Pittsburgh, PA 15106, (412) 279-6661</td>
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<tr>
<td>MPM68008</td>
<td>MC68000B (8.10)</td>
<td>NMOS intelligent I/O channel processor</td>
<td>OS9, BASIC, C, Pascal</td>
<td>64K (256K)</td>
<td>4 × 6.25 × 4.0</td>
<td>498 (Q1); 400 (Q100)</td>
<td>2 serial, 2 parallel ports; 2 timers; power fail detect</td>
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<tr>
<td>VMPM68KB</td>
<td>MC68010, MC680100 (10)</td>
<td>CMOS, NMOS VMEbus processor</td>
<td>OS9, P-DOS, VERSAdos, BASIC, C, Pascal</td>
<td>128K (128K)</td>
<td>4 × 6.25 × 1.05</td>
<td>1,095 (Q1); 895 (Q100)</td>
<td>2 serial, 1 parallel port(s); 2 timers; power fail detect</td>
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<tr>
<td>VMPM68K2</td>
<td>MC68020 (12.16.20)</td>
<td>CMOS, NMOS VMEbus processor</td>
<td>OS9, VERSAdos, BASIC, C, Pascal</td>
<td>1M (256K)</td>
<td>4 × 6.25 × 0.8</td>
<td>4,000 (Q1); 2,500 (Q100)</td>
<td>2 serial ports, power fail detect</td>
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<tr>
<td>PERFORMANCE TECHNOLOGIES INC.</td>
<td>Circle 449</td>
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<td>435 W. Commercial St., East Rochester, NY 14445, (716) 586-6727</td>
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<tr>
<td>PT-VME100</td>
<td>MC68010 (10)</td>
<td>VMEbus processor</td>
<td>UNIPlus +, UNIX System V</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>64K (256K)</td>
<td>9.2 × 6.3 × 0.8</td>
<td>2,700 (Q1); 1,995 (Q100)</td>
<td>dual MMU</td>
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<tr>
<td>PT-VME102</td>
<td>MC68010 (10)</td>
<td>VMEbus processor</td>
<td>P-DOS</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>2M (256K)</td>
<td>9.2 × 6.3 × 0.8</td>
<td>1,995 (Q1); 1,500 (Q100)</td>
<td>7-level interrupts, battery backup, 68811 math coprocessor</td>
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<tr>
<td>PT-VME103</td>
<td>MC68010 (10)</td>
<td>VMEbus processor</td>
<td>DEBUG, Monitor</td>
<td>Assembly</td>
<td>64K (120K)</td>
<td>9.2 × 6.3 × 0.8</td>
<td>2,750 (Q1); 2,050 (Q100)</td>
<td>MMU</td>
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<td>PERIPHERAL TECHNOLOGY</td>
<td>Circle 450</td>
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<td>1480 Terrell Mill Rd., Suite 870, Marietta, GA 30067, (404) 984-0742</td>
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<tr>
<td>PT68K-1</td>
<td>MC680008 (10)</td>
<td>NMOS processor</td>
<td>OS9, SK*DOS</td>
<td>BASIC, C, FORTRAN, Pascal</td>
<td>768K (64K)</td>
<td>5.75 × 8 × 0.8</td>
<td>595 (Q1); 350 (Q100)</td>
<td>flexible disk controller; 2 RS232C, 2 (8-bit) parallel ports; real-time clock</td>
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<tr>
<td>PT69-3</td>
<td>6809 (1)</td>
<td>NMOS processor</td>
<td>OS9, STAR-DOS</td>
<td>BASIC, C, Pascal</td>
<td>59K (4K)</td>
<td>5.5 × 6.5 × 0.8</td>
<td>269 (Q1); 180 (Q100)</td>
<td>flexible disk controller; 2 RS232C, 2 (8-bit) parallel ports; real-time clock</td>
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<tr>
<td>PT69-5</td>
<td>6809 (2)</td>
<td>NMOS processor</td>
<td>OS9, SK*DOS</td>
<td>BASIC, C, Pascal</td>
<td>60K (8K)</td>
<td>5.75 × 7 × 0.8</td>
<td>349 (Q1); 235 (Q100)</td>
<td>flexible disk controller; 4 RS232C, 2 (8-bit) parallel ports; real-time clock</td>
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<tr>
<td>PERSONAL MICRO COMPUTERS INC.</td>
<td>Circle 451</td>
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<td>275 Santa Ana Court, Sunnyvale, CA 94086, (408) 737-8444</td>
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<tr>
<td>PC-101</td>
<td>Z80A (4)</td>
<td>processor</td>
<td>CP/M 3.0</td>
<td>CBASIC</td>
<td>128K (4K)</td>
<td>5.7 × 11.7 × 0.5</td>
<td>325 (Q1)</td>
<td>flexible disk controller; 2 RS232C, Centronics ports(s); real-time clock</td>
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<tr>
<td>PLESSEY MICROSYSTEMS</td>
<td>Circle 452</td>
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<td>One Blue Hill Plaza, Pearl River, NY 10965, (914) 735-4661</td>
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<tr>
<td>PKE 68-14</td>
<td>MC680000 (10)</td>
<td>NMOS VMEbus, GPIB processor</td>
<td>P-DOS, pSOS, VERSAdos, BASIC, C, FORTRAN, Pascal</td>
<td>2M (512K)</td>
<td>6.3 × 9.2 × 0.8</td>
<td>2,081 (Q1)</td>
<td>2-channel DMA controller, dual serial I/O ports, programmable real-time clock</td>
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</table>
### SINGLE-BOARD MICROCOMPUTERS

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>CPU Type (Clock rate MHz)</th>
<th>CMOS or NMOS</th>
<th>Bus Type</th>
<th>Type of Board</th>
<th>Operating System</th>
<th>2M (64K)</th>
<th>Price ($100)</th>
<th>Notes and Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>PME 68-21</td>
<td>MC68020 (16, 20)</td>
<td>NMOS</td>
<td>VMEbus, VSB</td>
<td>processor</td>
<td>P-DOS, psOS, VERSAdos, BASIC, C, FORTRAN, Pascal</td>
<td>6.3±9.2x10.8</td>
<td>5,635(Q1)</td>
<td>dual serial I/O ports, programmable counter/timer</td>
<td></td>
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<tr>
<td>PME 68-22</td>
<td>MC68020 (16, 20)</td>
<td>NMOS</td>
<td>VMEbus, 5CSI</td>
<td>processor</td>
<td>P-DOS, psOS, UNIX System V, VERSAdos, BASIC, C, FORTRAN, Pascal</td>
<td>6.3±9.2x10.8</td>
<td>4,495(Q1)</td>
<td>dual serial I/O ports, programmable counter/timer, real-time clock</td>
<td></td>
</tr>
<tr>
<td>PRO-LOG CORP.</td>
<td>Circle 453</td>
<td>2560 Garden Rd., Monterey, CA 93940, (800) 538-9570</td>
<td>7808</td>
<td>Z80 (6.144)</td>
<td>NMOS</td>
<td>STDERRbus</td>
<td>processor</td>
<td>Assembly, BASIC</td>
<td>128K (64K)</td>
</tr>
<tr>
<td>QNP COMPUTER SYSTEMS INC.</td>
<td>Circle 454</td>
<td>23632 Mercantile Rd., Beachwood, OH 44122, (216) 464-6600</td>
<td>SCS-I</td>
<td>Z80B (6)</td>
<td>NMOS</td>
<td>S-100</td>
<td>processor</td>
<td>TurboDOS 1.3</td>
<td>all</td>
</tr>
<tr>
<td>QUALOLOGY INC.</td>
<td>Circle 455</td>
<td>2241 Lundy Ave., San Jose, CA 95131, (408) 434-5200</td>
<td>QPC-5101</td>
<td>8088 (4.77)</td>
<td>CMOS</td>
<td>PC bus</td>
<td>processor</td>
<td>MS-DOS, PC-DOS, BASIC, C, FORTRAN, Pascal</td>
<td>640K (64K)</td>
</tr>
<tr>
<td>R.J. B. R. BRACHMAN ASSOCIATES INC.</td>
<td>Circle 458</td>
<td>19083, (800) 228-7264, (215) 622-5455</td>
<td>QED 11/85CPU</td>
<td>J-11 (15)</td>
<td>CMOS</td>
<td>Unibus</td>
<td>processor</td>
<td>RT-11, RSX-11, RSTS, UNIX</td>
<td>PDP-11</td>
</tr>
<tr>
<td>R.L.C. ENTERPRISES</td>
<td>Circle 459</td>
<td>1117 Hillview Dr., Milpitas, CA 95035, (408) 946-7471</td>
<td>SBC-188</td>
<td>80188 (5, 8, 10)</td>
<td>NMOS</td>
<td>STDERRbus</td>
<td>processor</td>
<td>MS-DOS, Assembly, C, FORTRAN, Pascal</td>
<td>96K (256K)</td>
</tr>
<tr>
<td>SBE INC.</td>
<td>Circle 460</td>
<td>2400 Bisso Lane, Concord, CA 94520, (415) 680-7722</td>
<td>COM-2</td>
<td>MC68000, MC68001 (10)</td>
<td>NMOS</td>
<td>Multibus communications</td>
<td>REGULUS</td>
<td>ASM, BASIC, C, FORTRAN, 77, PROBUG</td>
<td>128K (256K)</td>
</tr>
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</table>
Sure, most 5600 terminals can scrunch 132 columns onto a 14" screen. But you need a magnifying glass to read them.

Not so with the TeleVideo 955. That's because we redesigned the proportion of our characters and put more space between them. And then put them on a high contrast, super dark screen. The result is the most readable 132 column ASCII display available.

But there's more to the 955 than meets the eye. Take our tilt-and-swivel positioning, for example. The screen rotates through a full 270° right and left, and from −5° to +15° up and down. (Which makes backs and necks feel a lot better.)

Then we put all this in a machine with an incredibly small footprint, measuring just 9" x 12". The result is a terminal that meets all the human factors standards recommended for adoption by the American National Standards Institute.

For more information about the TeleVideo 955, call the nearest TeleVideo regional office listed below, and we'll give you the name of your nearest distributor. The TeleVideo 955. It's a real eye-opener.

<table>
<thead>
<tr>
<th>TELEVIDEO 955 VS. WYSE WY-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEATURES</td>
</tr>
<tr>
<td>Screen Color</td>
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<tr>
<td>Optional Graphics model</td>
</tr>
<tr>
<td>Dynamically allocated non-volatile function key memory</td>
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<tr>
<td>Maximum non-volatile bytes per function key</td>
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<tr>
<td>High contrast super dark Matsushita screen</td>
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<td>List price</td>
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<td>Company/Model</td>
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<td>MPU-20</td>
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<td>SKY COMPUTERS INC.</td>
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<td>SOLARCOM TECHNOLOGY INC.</td>
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<td>SPURRIER PERIPHERALS CORP.</td>
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<td>SYSTEC CORP.</td>
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<td>SYSTEMEK</td>
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<tr>
<td>TEXTINTEK ENTERPRISES INC.</td>
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### SINGLE-BOARD MICROCOMPUTERS

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<tr>
<th>Company</th>
<th>Model</th>
<th>CPU Type/Chip (Clock rate, MHz)</th>
<th>CMOS or NMOS</th>
<th>Bus</th>
<th>Type of Board</th>
<th>Operating System</th>
<th>Programming language supported</th>
<th>Memory/Byte RAM (ROM)</th>
<th>Dimensions (W x H x D)</th>
<th>Price &amp; Quantity</th>
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<tr>
<td>VESTA TECHNOLOGY INC.</td>
<td>TMS 9900</td>
<td>IBM PC bus</td>
<td>NMOS</td>
<td>TM 990</td>
<td>processor</td>
<td>P-DOS</td>
<td>Assembly, BASIC, FORTH, Pascal</td>
<td>128K (16K)</td>
<td>7.5 x 11 x 1</td>
<td>1,350(Q1)</td>
</tr>
<tr>
<td>VESTA TECHNOLOGY INC.</td>
<td>TMS 99105</td>
<td>IBM PC bus</td>
<td>NMOS</td>
<td>TM 990</td>
<td>processor</td>
<td>P-DOS</td>
<td>Assembly, BASIC, FORTH, Pascal</td>
<td>64K (64K)</td>
<td>7.5 x 11 x 1.95</td>
<td>1,350(Q1)</td>
</tr>
<tr>
<td>WINSYSTEMS INC.</td>
<td>LPM-SBC3</td>
<td>IBM PC bus</td>
<td>CMOS</td>
<td>Z80</td>
<td>processor</td>
<td>Z80</td>
<td>Assembly, BASIC, C, FORTH</td>
<td>64K (64K)</td>
<td>7.5 x 4.5 x 0.5</td>
<td>295(Q1)</td>
</tr>
<tr>
<td>WINSYSTEMS INC.</td>
<td>LPM-SBC8</td>
<td>IBM PC bus</td>
<td>CMOS</td>
<td>80C88 (8, 5)</td>
<td>processor</td>
<td>80C88</td>
<td>Assembly, BASIC, C, FORTH</td>
<td>32K (64K)</td>
<td>7 x 4.5 x 0.5</td>
<td>495(Q1)</td>
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<tr>
<td>WINTEK CORP.</td>
<td>LPM-SBC50</td>
<td>IBM PC bus</td>
<td>CMOS</td>
<td>NEC V50 (8, 5)</td>
<td>processor</td>
<td>NEC V50</td>
<td>Assembly, BASIC, C, FORTH</td>
<td>512K (512K)</td>
<td>7 x 4.5 x 0.5</td>
<td>695(Q1)</td>
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<tr>
<td>ZIATECH CORP.</td>
<td>MCH68</td>
<td>IBM PC bus</td>
<td>NMOS</td>
<td>68009 (1)</td>
<td>processor</td>
<td>Z80</td>
<td>Assembly, C</td>
<td>24K (8K)</td>
<td>4.5 x 6.5 x 0.5</td>
<td>282(Q1); 169(Q100)</td>
</tr>
<tr>
<td>ZIATECH CORP.</td>
<td>MCV45</td>
<td>IBM PC bus</td>
<td>NMOS</td>
<td>68000 (1)</td>
<td>processor</td>
<td>Z80</td>
<td>Assembly, C</td>
<td>512 (4K)</td>
<td>4.5 x 6.5 x 0.5</td>
<td>188(Q1); 113(Q100)</td>
</tr>
</tbody>
</table>

### Specifications
- **990/102-3**: TMS 9900 (12) NMOS TM 990 processor P-DOS Assembly, BASIC, FORTH, Pascal 128K (16K) 7.5 x 11 x 1 1,350(Q1) 16 interrupt levels: 2 RS232C ports(s)
- **990/103-1**: TMS 99105 (24) NMOS TM 990 processor P-DOS Assembly, BASIC, FORTH, Pascal 64K (64K) 7.5 x 11 x 1.95 1,350(Q1) 16 interrupt levels: 2 RS232C, 1 (16-bit) parallel port(s)
- **OEM188**: 80188 (8) NMOS IBM PC bus processor CP/M, MS-DOS languages 256K (64K) 8 x 8 x 0.5 329(Q1); 269(Q100) 16 interrupt levels: 2 RS232C serial port(s)
- **SBC88**: 8088 (4, 5, 8) CMOS, NMOS processor, I/O Vesta Basic, Vesta Forth BASIC, FORTH 32K (32K) 5 x 6 x 0.5 199(Q1); 139(Q100) real-time clock; 8-channel, 8-bit analog to digital converter
- **WINTEK CORP.**
  - **MCH68**: 6809 (1) NMOS Wintek processor Assembly, C 24K (8K) 4.5 x 6.5 x 0.5 282(Q1); 169(Q100) power-on reset; 2 RS232C, 4 parallel ports; real-time clock
  - **MCV45**: 68000 (1) NMOS Wintek processor Assembly, C 512 (4K) 4.5 x 6.5 x 0.5 188(Q1); 113(Q100) 1 serial, 4 parallel port(s)
- **ZIATECH CORP.**
  - **ZT 8806/8807**: 8086 (5/8) NMOS STDbus processor FORTH, PC-DOS, VRTX BASIC, C, FORTH, Pascal 128K (320K) 4.5 x 6.5 x 4 345/425(Q1) interrupt controller; 5 (8-bit) counter/timers
  - **ZT 8814/8815**: 80188 (5/8) NMOS STDbus processor PC-DOS, VRTX BASIC, C, FORTH, Pascal 32K (64K) 4.5 x 6.5 425/555(Q1) interrupt controller, 2-channel DMA, 3 counter/timers
  - **ZT 8816/8817**: NEC V50 (5/8) NMOS STDbus processor PC-DOS BASIC, C, FORTH, Pascal 512K (256K) 6.5 x 4.5 x 0.79 995/1,025(Q1) interrupt controller, power fail detect, 2 serial ports, real-time clock, 3 counter/timers, 16K-byte battery-backed RAM

**Notes and Features**
- **MINI-MICRO SYSTEMS/March 1987**
- **Page 107**
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CIRCLE NO. 59 ON INQUIRY CARD
NEW PRODUCTS

SYSTEMS

Megan Nields, Staff Editor

Computer emulates IBM PC/AT

• 80286 processor
• 640K bytes of RAM
• 1.2M-byte disk drive

An IBM PC/AT-compatible computer, the 365/AT utilizes an 80286 microprocessor. The system offers a 30M-byte rigid disk drive with a 40-msec access time, a 1.2M-byte flexible disk drive and 640K bytes of RAM. A Western Digital disk controller and a Hercules-compatible video controller are standard. Features include a parallel printer port and a 12-inch amber monitor. An 80287 coprocessor is available. $2,395 to $4,695; OEM prices available. Computer Components Corp., P.O. Box 12017, Research Triangle Park, N.C. 27709, (800) 843-7012.

Portable computer weighs 6 pounds

• 64K bytes of RAM
• 80-by-25 display
• Serial, parallel ports

The 6-pound, PC-8500 portable personal computer supplies an 80-column-by-25-line display and 64K bytes of internal RAM. A parallel printer port and RS232C port are standard. The unit targets VARs and features built-in software. An RGB monitor or a 1,200-baud modem can be supported, and proprietary software packages are included. $999. NEC Home Electronics (U.S.A.) Inc., 1255 Michael Drive, Wood Dale, Ill. 60191-1094, (312) 860-9500.

Publishing system suits IBM PC/AT

• 300-dpi scanner
• 8-ppm laser printer
• 200-font software

The Epsilon AT+ Publishing System is compatible with the IBM PC/AT. It includes an 8-ppm laser printer, a 300-dpi scanner and a 13-inch display. A PC/AT-compatible rigid disk drive and a scanner and printer controller are also supplied. The system’s software has over 200 fonts and a 70-page capacity per document. $7,995. Epsilon Graphics Systems, 1370 E. Edinger Ave., Santa Ana, Calif. 92705, (714) 558-1288.

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8-12-1 Nishinshijuku, Shinjuku-ku
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NEW PRODUCTS

PRINTERS

Printer emulates Diablo, Epson, IBM, Toshiba

- 19.2K baud rate
- Two interfaces
- Seven colors

The ProWriter C-715 is a seven-color, 24-pin dot-matrix printer that emulates the Diablo 630, Epson LQ-1000, IBM Proprinter XL and Toshiba 351. The unit prints 100 cps, letter quality and 300 cps, draft mode. RS232C and Centronics interfaces are standard. Features include a 19.2K baud rate, a 32K-byte buffer, proportional spacing and automatic paper loading. $1,295. C. Itoh Digital Products Inc., Suite 220, 19750 S. Vermont Ave., Torrance, Calif. 90502, (213) 327-2110.

Circle 360

Printer changes type with font cards

- 250 cps
- RS232C, Centronics ports
- IBM resident commands

The B3350 general purpose printer uses font cards to change type styles. It produces 250 cps at 12 cpi, 200 cps at 10 cpi and 90 cps, at near-letter quality. An RS232C serial and Centronics parallel interface are standard. Resident commands such as Epson FX/JX, Facit and IBM ProPrinter are supplied. Options include single-bin and dual-bin sheet feeders and color printing. $1,195. Facit Inc., 9 Executive Drive, Merrimack, N.H. 03054, (603) 424-8000.

Circle 362

Dot-matrix printer achieves 324 cps

- 10, 12 cpi
- 24-pin unit
- 55 dB(a) noise level

The model 7200 is a 24-pin dot-matrix printer with front and rear paper-loading capabilities. It prints 90 cps at 10 cpi and 108 cps at 12 cpi in letter-quality mode, and 270 cps at 10 cpi and 324 cps at 12 cpi in draft mode. Noise level is less than 55 dB(a), and MTBF is 4,000 hours. Features include a 7K-byte buffer memory, expandable to 15K bytes, and RS232C or Centronics interfaces. $2,445. Juki Office Machine Corp., Printer Division, 20437 S. Western Ave., Torrance, Calif. 90501, (800) 325-6134.

Circle 363

Four-pen plotter handles 100 sheets

- Desktop unit
- 18 ips
- A-, B-sized paper

A four-pen desktop plotter, the PD 9311/F features an automatic paper feed that handles up to 100 sheets of A- and B-sized paper. The device generates 18 ips with 0.0002-inch resolution. It is compatible with AutoCad, VersaCad, Lotus 1-2-3 and Symphony. Two command protocols are available. $3,295. Western Graphtec Inc., 12 Chrysler St., Irvine, Calif. 92718, (800) 854-8385.

Circle 361

The Sun 3-Series

The SNXRAM is the first 12 MB Sun 3-compatible memory card that delivers the full 16 MB address space using a single slot. Replacing up to 3 Sun memory cards, it frees two VMEbus slots for expansion.

- Available in 2, 4, 8, or 12 MB capacities.
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- Using the 32-bit wide private memory bus, the SNXRAM frees the system bus from processor-memory transfers.

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WHERE
The Doubletree Hotel on Great American Parkway in Santa Clara, California

WHEN
May 12-14, 1987

WHO
Engineering, Planning, Marketing and Management Personnel of companies using SCSI, or considering its use, should not miss this conference.

SCSI BUSINESS AND TECHNICAL PROGRAM

This two-day program (May 13-14) consists of the following sessions:
- A User's Perspective of SCSI
- SCSI Market Structure, Size and Trends
- Interface Alternatives: A Business Perspective
- Future SCSI Directions
- SCSI Performance Issues
- SCSI Test and Evaluation Issues
- SCSI Firmware and Software Issues
- SCSI Hardware Issues
- Storage Technology — The Driving Force Behind SCSI
- SCSI for Tape

SCSI TUTORIAL

On Tuesday, May 12, 1987 an Introduction to SCSI and SCSI Protocol will be covered in the morning, and SCSI Commands and SCSI Variants will be covered in the afternoon. Attend the 1-day SCSI Tutorial, or with the SCSI Business and Technical Program as part of the 3-day SCSI Forum Program.

SCSI EXHIBITORS PROGRAM

Exhibitors Workshops will be held on May 12-14. On the evening of May 13, an Exhibitors Reception will provide delegates and guests with the opportunity to see SCSI products.

KEY ISSUES
- Is high performance SCSI an oxymoron?
- Is the copy command useful or useless?
- Should SCSI remain a configurable standard?
- Who really needs multihost support?
- Who's using search?

FEATURED SPEAKERS
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- Roger Johnson, Western Digital, President, Chairman and C.E.O.
- Bill Frank, InfoCorp, Senior Vice President, Director of Mass Storage Services

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CIRCLE NO. 66 ON INQUIRY CARD
DATACOM

Software emulates DEC VT52, VT100

- Graphic communications
- Data compression
- Electronic mail

A graphics communications software package for personal computers. Tele-Vision enables images and text to be sent and received through electronic mail systems. The software utilizes data compression and encoding techniques that can reduce transmission times by a factor of 10. Graphics can be captured from Lotus 1-2-3 and enhanced before being transmitted. The product emulates DEC VT52 and VT100 terminals. $99. LCS/Telegraphics Inc., 261 Vassar St., Cambridge, Mass. 02139, (617) 547-4738.

Circle 364

Modems operate at up to 2.4K bps

- Bell 212A compatible
- 40-character buffer
- Half full duplex

An intelligent internal and external modems, the Starcom 1200 and 2400 transmit data at 1.2K and 2.4K bps, respectively. The units are compatible with Bell 103 and 212A. The first model is a half-card device. Features include full- and half-duplex operation, automatic answer and a 40-character command buffer. $249 and higher. $599 and higher, 2400. Scoa Systems, Suite 100, 2100 Golf Road, Rolling Meadows, Ill. 60008, (312) 640-8782.

Circle 365

Datacom board furnishes 4, 8 serial ports

- Onboard coprocessor
- 80188 processor
- Four or eight ports

IBM PC/XT- and /AT-compatible communication boards, the COM/4i and Com/8i provide four or eight serial ports, respectively. The units utilize 10-MHz 80188 microprocessors and 256K bytes of dual-ported RAM. Proprietary software includes an MS-DOS device driver that allows the system to access up to 32 ports per system. An onboard coprocessor is supplied. $969, COM/4i, $1,195, COM/8i. DigiBoard Inc., 6751 Oxford St., St. Louis Park, Minn. 55426, (612) 922-8055.

Circle 366

Full-card modem operates at 2,400 bps

- Bell-212A compatible
- Hayes command set
- Full-duplex operation

A full card internal modem, the Lightning I/f operates at 300, 1,200 or 2,400 bps and complies with Bell 212A and V.22 bis specifications. It suits the IBM PC, PC/XT, PC/AT and compatibles and uses the Hayes Smartmodem command set. Diagnostics such as power-up self-test are provided. Features include full-duplex operation, automatic answer and error correction. $599. Anchor Automation Inc., 6913 Valjean Ave., Van Nuys, Calif. 91406, (818) 997-6493.

Circle 367

Controller suits VMEbus-based systems

- Six serial channels
- 64K bytes of RAM
- Self-test

An intelligent communications controller, the VME XC targets VMEbus-based systems. The device includes six serial channels, 64K bytes of RAM and self-test capabilities. It supports Digital Equipment Corp., IBM and Sperry communications protocols. In asynchronous mode the unit can be configured with baud rates of up to 38,400. Features include an optional token ring LAN controller or X.25 port. $1,495. Iskra VME Technologies, 222 Sherwood Ave., Farmingdale, N.Y. 11735, (516) 753-0400.

Circle 368

Multiplexers connect up to 14 terminals

- 300 to 9,600 bps
- X-on/X-off, CTS
- Full duplex

Operating at 300, 1,200, 2,400 and 9,600 bps, the SPL family of statistical multiplexers concentrates up to 14 asynchronous terminal ports over one composite communications channel. The devices support full-duplex operation, X-on/X-off and CTS protocols. Models are available in two- to four-port increments. $2,995. DataComm for Business Inc., 807 Pioneer, Champions, Ill. 61820, (800) 637-1127.

Circle 369

Multiplexers connect up to 14 terminals

- 300 to 9,600 bps
- X-on/X-off, CTS
- Full duplex

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Circle 369

MINI-MICRO SYSTEMS/March 1987
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CIRCLE NO. 76 ON INQUIRY CARD
NEW PRODUCTS
SOFTWARE

Spreadsheet transfers files to Lotus 1-2-3

The C-Calc Plus spreadsheet and analysis system transfers entire work sheets to and from Lotus files, allowing for integration of minicomputer and personal computer information management. The software runs on Digital Equipment Corp.'s VMS, ULTRIX, and UNIX systems. A proprietary graphics drive is supplied. Features include user-definable select codes. $3,500 and higher.

DSD Corp., 10632 N.E. 37th Circle, P.O. Box 2669, Kirkland, Wash. 98083-2669, (206) 822-2252.

Circle 370

Window software interfaces with UNIX

Software for the UNIX operating system, the Directory Shell features a windowing interface for asynchronous terminals. The package replaces many UNIX commands with a visual approach. It includes "plain language" error messages, a multilevel help system and a full-screen editor. $300. OEM discounts available.


Circle 371

Multiuser software targets LANs

A multiuser software package, DataEase LAN provides a common database to a network. The product offers both automatic and manual record- and file-locking for users linked in the network. Features include transparent access. $700.

Software Solutions Inc., 12 Cambridge Drive, Trumbull, Conn. 06611, (203) 374-8000.

Circle 372

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MINI-MICRO SYSTEMS/March 1987
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CIRCLE NO. 69 ON INQUIRY CARD
NEW PRODUCTS

SUBASSEMBLIES

Graphics board furnishes 16 colors

• 640 by 480 pixels
• 256K bytes of RAM
• Standard parallel port

Targeting CAD/CAM, business graphics and desktop publishing applications, the MultiSync Color Graphics Board model GB-I furnishes a 640-by-480-pixel resolution. The device offers 256K bytes of display RAM and 16-color graphics. Features include hardware zoom and scrolling and screen drivers that access software programs such as Lotus 1-2-3 and Microsoft Windows. A parallel port is standard. $700.


Circle 373

Adapter turns PC/AT into VMEbus processor

• Two circuit cards
• Three addressing modes
• Dual-port RAM

The Adapter turns an IBM PC/AT into a VMEbus processor via direct, page-mode and dual-port, RAM-shared memory addressing. It consists of two printed circuit cards: One fits in the PC/AT and one in the VMEbus card cage. Up to 14M bytes of VMEbus memory can be mapped onto PC/AT memory-address space. Both the PC/AT and VMEbus devices can use optional 32K-byte and 128K-byte dual-port RAM. $1,280. Bit 3 Computer Corp., 8120 Penn Ave. S., Minneapolis, Minn. 55431, (612) 881-6955.

Circle 374

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

"I need 10-NET."

With 10-NET RS232 you can tie entire networks, or individual PCs to networks, via phone lines. 10-NET is your key to economical, easily installed PC communications, unsurpassed in speed and transparency. Once you add up 10-NET advantages, you'll see why over 50,000 installations are already in place worldwide.

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CIRCLE NO. 64 ON INQUIRY CARD
Storage Technology's New 2925 Tape Accelerator.

It goes with unsurpassed speed.
It comes with unsurpassed features.

StorageTek's Model 2925 gives you the speed you need, and the features your customers demand. The 2925's Accelerator (Cache) feature dynamically adapts to system requirements and the host's capability... at transfer rates ranging from 100 kilobytes per second up to 1.25 megabytes per second. The 2925 goes with speed indeed; but what it comes with is even more remarkable.

Error correction codes are built into the cache's 256k of multi-record memory; so your data is checked both as it enters cache and as it is written onto tape. Data can be retrieved directly from cache—should defective media be encountered. The 2925 allows OEM systems integrators to attach ANSI-compatible 1600/6250 bpi capability to systems ranging from micros to minis... without software modification. For ease of integration, the 2925 is available with either StorageTek- or Pertec-compatible interfaces.

That's still only the beginning—be sure to read the accompanying list of features. You'll understand at a glance that 2925 performance is not only speed... but reliability, flexibility and ease of operation. StorageTek's experience with GCR 6250 bpi technology includes a full 11 years of pioneering, proving and perfecting. Our 2920 Series includes the 2921 (50 ips start/stop), the 2922 (50 ips start/stop with 100 ips streaming) in addition to the 2925 subsystem.

Take a drive in our 2920 Series... and experience performance you'll be proud to call your own.

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Modems accelerate capabilities

To meet the needs of high-volume data communications, dial-up modems push beyond 9,600 bps, and special-purpese devices adapt to SNA, fiber-optic and coaxial networks...... pg.121

Product Table: MODEMS

Covers over 130 modems from more than 50 companies. Specs include data rate, modulation method, transmission mode, synchronization, calling mode and price..... pg.131
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MODEMS ACCELERATE CAPABILITIES

To meet the needs of high-volume data communications, dial-up modems push beyond 9,600 bps, and special-purpose devices adapt to SNA, fiber-optic and coaxial networks.

Jesse Victor, Associate Editor

Consider these data-communications scenarios:
- Automatically polling hundreds of geographically dispersed point-of-sale terminals after business hours and transmitting sales data back to the host while simultaneously updating inventory numbers on the terminals;
- Transmitting screens of CAD/CAM bit-mapped 3D modelling data to and from a minicomputer or mainframe;
- Transferring high-density synchronous data streams with minimal error between host computers and attached personal computers or terminals;
- Sending messages over multiple satellite, fiber-optic, and/or microwave links between San Francisco and New York or Paris;
- Handling data communications in the harsh environment of a factory or nuclear power plant.

To make these and other sophisticated data transmission applications possible, mid-range and high-end dial-up modems have evolved far beyond basic modulator/demodulator functions. Today’s 4,800-bit-per-second (bps) and faster devices offer a panoply of automatic transmission and reception capabilities and methods of telephone line modulation, monitoring, conditioning and testing. All this is for one purpose only: to speed the transmission of digital data over the analog public switched telephone network (PSTN) with minimal or no error. However, dial-up modems transmitting at 9,600 bps or higher rates have become embroiled in controversy regarding compatibility, the necessity for trellis-coded modulation (TCM) and the role of international CCITT standards.

Software cuts costs

Specialized modems and communications packages can interact with devices under IBM Corp. systems network architecture (SNA) and exchange data over fiber-optic cable or coaxial cable networks. For example, if you want to communicate between an IBM PC, PC/XT, PC/AT or Convertible and a remote System/34, 36 or 38 minicomputer and save the cost of an external modem, communications card and cable, consider IDEAssociates Inc.’s IDEA-comm 5250/Modem software. Used with Universal Data Systems Inc.’s Sync-Up model 208.

The V.32 9,600- bps RM-9632 dial-up modem from Racal-Milgo employs trellis-coded modulation, an automatic adaptive equalizer and local and remote adaptive echo cancelling.
With hooks into SNA networks, Network Software Associates' synchronous AdaptModem eliminates the need for a separate SDLC adapter and a telephone handset.

4,800-bps (or model 201 2,400 bps) internal synchronous modem card, it emulates the IBM 5251 model 12 terminal controller and model 5294 cluster controller as well as all 5250 terminals, and accesses nine concurrent 5250 sessions.

The package configures both serial and parallel printers to emulate IBM 5256 model 1, 5224 model 1 and 5225 model 1 printers, allowing a remote PC to use a PC printer as a system printer or to direct output to a system printer. File-transfer package support includes IBM's PC Support/36 or 38 and a documented programmatic interface for custom implementations. Advanced error detection and recovery and hot keying between PC-DOS and 5250 sessions are also provided.

"The 5250/Modem eliminates interfacing problems, a hefty 5250 cable to an external modem and the potential problem of servicing a communications card from another vendor," asserts Tom Cotton, IDE Associates manager of modem development. "We are also working on a 4,800-bps remote IBM 3278-emulation product. The emulation market is growing. People want to get information from a remote mainframe or a mini to the PCs on their desks and share resources."

Network Software Associates Inc.'s synchronous AdaptModem also has hooks into SNA networks. A plug-in board for IBM PCs and compatibles, the 4,800-bps (Bell 208 A/B compatible) or 2,400-bps auto-dial/auto-answer unit eliminates the need for a separate SDLC (synchronous data link control) adapter as well as a telephone handset. The automatic call control (ACC) software module dials up to 180 numbers.

Used with the company's AdaptSNA 3270 software, the modem and ACC furnish autodial micro-to-mainframe links; with AdaptSNA APPC, they provide LU (logical unit) 6.2 protocol and advanced program to program communications (APPN) functions.

GammaLink Synchronous Communications claims substantial cost savings in SNA/SDLC service for its 9,600-bps half-duplex GammaComm modem compared to full-duplex 2,400-bps devices. According to the company, transferring 250K-byte files from 100 locations, five times in a 12-hour period using a 2,400-bps modem requires 15 synchronous front-end-processor ports at the host, if the dialing-in PC is to experience a busy signal less than 5 percent of the time. It also incurs $32,000 in monthly phone charges (based on zone 5, nationwide, lowest rate 800 service). In contrast, operating at its effective 7,200-bps rate over a micro-to-mainframe link, the GammaComm modem needs only six synchronous ports and incurs only $11,000 in monthly phone charges, a savings of $21,000.

Combining a 9,600-bps synchronous modem with an SNA/SDLC protocol converter on one plug-in card, DecaTek Inc.'s auto-dial ZIPmodem PC, when used with the mainframe ZIPmodem/FM, furnishes 3270 and 3770 (batch-transmission) emulation for IBM PCs and compatibles. Packaged with communications software and compatible with V.29 and V.27ter, in interactive 3278 mode, it emulates SNA Physical Unit (PU) 2 with LU 2 terminals or LU 1 or 2 printers.

Modems from AT&T Technology Systems and Allen-Bradley Co. suit demanding applications and harsh environments. Claimed to be the first optical data link that provides full-duplex transmission over one single-fiber optical cable, AT&T's ODL RS232-2 fiber-optic modem saves the cost of another cable plus associated connectors. Plugging into an RS232C port and offering CCITT V.24 compatibility, the 25-pin device affords secure asynchronous data rates of DC to 19.2K bps over 1 km with a bit-error rate not greater than 10⁻⁹. Transmission is immune from EMI/RFI (electromagnetic interference/radio-frequency interference), crosstalk and ground loops.

A 1.2K-bps secondary data line, multiplexed in each direction, can transfer handshaking signals. The modem complements the ODL RS232-1, which can time division multiplex data (and clock signals) on six full-duplex data channels. It allows asynchronous rates to 100K bps and synchronous rates to 64K bps.

"RS232 lines normally extend a maximum of 80 feet," notes Mitch Bloom, senior product planner at AT&T. "You can cause interference if you extend them further, especially in factory-automation applications. With the RS232-2
PC COMMUNICATION NEEDS FOR:

X-25  RS422/485
TCP/IP  MIL-STD-188-114
DDN       MIL-STD-188C
MAP
VRTX
SNA/SDLC

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modem, you can go to 1 km, and you won't have trouble with ground loops.”

Radio-frequency VistaModems from Allen-Bradley target high-speed data transport using broadband coaxial cable over long distances in harsh environments. Employing frequency-shift-keyed modulation of a crystal-controlled carrier frequency, they can be configured in point-to-point networks or for multidrop applications at rates to 100K bps.

“VistaModems replace large bundles of wires where people have many terminals connecting to one host,” explains Tom Holmes, manager of the company’s VistaLAN product line. “With a well-designed site plan, you can just move your terminal and plug it into the next office outlet without having to install a new hardwired connection. The move-and-change cost for a hardwired star network can be between $1,000 and $4,000 a node.”

Reduce line problems

The problems of implementing near-error-free data transmission at 2,400 bps or 4,800 bps rise by orders of magnitude at 9,600 bps, mainly because the PSTN is subject to a host of transmission problems. These include impulse noise, phase jitter, phase or gain hits, dropouts, attenuation distortion, envelope distortion and nonlinear distortion (clipping).

Local telephone companies’ conditioning of private lines can eliminate some of these impairments, enabling leased-line modems to reach 16.5K bps or higher rates, while dial-up modems struggle to attain 9,600 bps. For example, C levels of conditioning can control envelope or differential-delay distortion. This type of distortion subjects signals to a greater delay at high frequencies. It either distorts the shape of a pulse or causes successively transmitted characters to overlap.

Vendors of 9,600-bps dial-up modems designed to operate over unconditioned lines have adapted several responses to these problems, including TCM, multiple carriers, adaptive equalization and echo cancellation. For example, Codex Corp.’s 2260 modem uses 32-state TCM to speed data over two-wire dial-up or leased lines at 9,600 bps. In accordance with CCITT V.32 recommendations, it provides synchronous and asynchronous operation, communicates with non TCM modems at 9,600 bps and can fall back to a 4,800-bps rate if line conditions deteriorate.

The modem has other features found on many 9,600-bps units. An automatic adaptive equalizer dynamically adjusts the modem to compensate for differential delay and other types of line distortion. Nonvolatile memory stores four sets of user-defined modem settings or a phone log of nine 40-character entries. The auto-dial/redial unit responds either to the Hayes Microcomputer Products Inc. AT command set, a de facto standard, or Codex’s own.

Echo-cancellation choices

V.32 requires some form of echo cancellation but leaves the precise form unspecified. The 2260 substitutes for full-duplex transmission the echo cancellation normally supplied by the phone company for half-duplex voice transmission.

“A 9,600-bps modem must be capable of cancelling multiple echoes of the same signal, occurring at different times, with various degrees of distortion under different line conditions,” asserts Rick Arena, Codex product manager for V.32 modems. “Our scheme is one of the best out there in cancelling both local and remote echoes. TCM is necessary for 9,600-bps modems to be competitive in today’s market.” The modulation method furnishes, on the average, a 4-db improvement in signal-to-noise (S/N) ratio.

“A V.32 modem with TCM is more immune to line noise,” he maintains. “A 3-db improvement in the S/N ratio supplies double the noise power. Thus you can double the noise on the line and the TCM modem will perform as well or better than one without TCM at a lower noise level.”

Racal-Milgo’s RM-9632 V.32 9,600-bps modem also employs TCM and automatic adaptive equalizing. Its adaptive echo canceling for local and remote echoes can cope with delays of up to 2.2 seconds for multihop satellite links. The auto-dialer stores up to 10 32-digit numbers in nonvolatile memory. The RS-366/V.25 parallel interface accepts an external
MODEMS

MULTIPLE CARRIERS ATTAIN 18K-BPS RATE
(Simplified snapshot of transmission, approximately 1/7th of a second)

Using a maximum of 500 carriers, a low 7.5-baud rate and up to 6 bits per usable carrier, Telebit's TrailBlazer modem overcomes differential delay distortion to speed data at 18K bps over dial-up phone lines.

Bell 801 auto-dialer; the RS232C interface supports the Racal-Vadic 831 command set and the Concord Data Systems Inc. set.

"TCM allows fewer bits to send more information," contends Tom Casey, Racal-Milgo's product line manager, RM Series modems. "It increases immunity to noise, reduces the necessity for call-back and reduces errors on the line."

Concord Data claims a 3-dB increase in immunity to line noise for its CDS V.32 9,600-bps TCM modem. It also offers full autodialing capability, remote configuration mode and automatic transfer to a dial-up line if the leased line degrades.

Fast modems from Anderson-Jacobson Inc., Infinit Inc. and Universal Data Systems Inc. furnish the expected auto-dial features and extensive diagnostics. Anderson-Jacobson's V.32 AJ 9631-S full-duplex 9,600 bps modem also provides automatic dial-line backup for leased-line operation, as well as TCM, nonvolatile storage of eight 43-digit numbers, three levels of access security and continuous on-line monitoring of S/N ratio. Local and remote echo cancelling allows for a 2-second delay for double satellite hops.

Infinit's TCM V.32 9,600-bps modem operates in full-duplex mode over two-wire dial lines, with fallback to 4,800 bps. The device provides automatic adaptive equalization with echo cancelling and soft strapping for modem configuration via an asynchronous control port.

Economies found with V.29

The UDS 9,600A/B from Universal Data Systems furnishes synchronous transmission at 9,600 bps as well as fallback to 7,200 bps and 4,800 bps using CCITT V.29 signal-point methods, and automatic adaptive equalization.

USRRobotics Inc. retains TCM but dispenses with V.32 compliance in its 9,600-bps Courier HST modem. "V.32 makes for a much more complex and expensive product than the market will bear," asserts Mark Smith, director of marketing. "You can purchase seven of our modems for the price of two competitive V.32 modems."

An asymmetric-modem design, the Courier provides simultaneous 9,600-bps and 300-bps data or error-control channels, with the direction of the high-speed channel automatically assigned according to data-flow demand. A proprietary error- and flow-control protocol—an enhanced version of MNP (Microcom networking protocol)—allows the error-free transmission of up to 1,000 characters per second over a variety of dial-up line conditions, claims Smith. At fallback data rates, the modem is compatible with CCITT V.22 bis at 2,400 bps, Bell 212A at 1,200 bps and Bell 103 at 300 bps.

"V.32-compatible modems are generally expensive to produce and cost in the $3,000-to-$3,500 range. We can sell our 9,600VP 9,600-bps modem for approximately half that price," asserts Mark Passell, senior sales applications engineer at Racal-Vadic.

The auto-dial, auto-answer asynchronous or synchronous device offers four types of flow control, is compatible with the expanded Hayes AT command set and implements a superset of the MNP Level 4 error-control protocol with 3:1 data compression.

"Our adaptive packet-assembly technique varies the packet size to maximize throughput," Passell says. "We also have selected ARQ (automatic request repeat). If retransmission is necessary, we can go back to a particular frame and send that frame only."

Several 9,600-bps modem vendors emphasize fast-train features that maximize throughput by reducing the training time required for local and remote modems to synchronize, adjust line speed and line equalization prior to transmission. For example, Penril DataComm's Datalink 9,600 Fast Train modem reduces to 23 msec the training (or retraining) time required for remote modems on a multidrop link. It also features a bar-graph display of S/N ratio, automatic dial-line backup from leased-line operation and multidrop message broadcast, which can send commands simultaneously to all modems on a multidrop line.

Rockwell International Corp. also claims a training time of 23 msec at 9,600, 7,200 or 4,800 bps on its R96FT synchronous modem. Operating in full-duplex mode over four-wire
lines and half duplex over two-wire links, the unit can transfer data serially via its CCITT V.24, RS232C-compatible interface or in parallel over an 8-bit microprocessor bus. The R96FT/SC version offers a 75-bps secondary channel. CMOS and TTL compatible, both 100-mm-by-160-mm units interface via a 64-pin DIN connector.

Telebit Corp. utilizes a unique modulation technique to push its TrailBlazer dial-up modem past the competition’s 9,600 bps to a blazing 18,000 bps. In contrast to conventional modems that use only one or two data carriers, this modem can employ up to 512 carriers spaced 7.8 Hz apart to transmit data, increasing the usable line bandwidth by 50 percent.

TrailBlazer automatically measures the S/N ratio at each of the possible carriers and simultaneously sends data packets of 2, 4 or 6 bits at each usable frequency, approximately every one-seventh of a second. “Modem vendors have always assumed that the baud rate has to be very high for high-speed transmission,” explains Mary Schaller, marketing director. “But the lower the baud rate, or number of symbols transmitted each second, the more data carriers you can have in the telephone bandwidth. With an average of 400 usable data carriers and 6 bits per carrier, the modem can transmit a packet of 2,400 bits approximately every one-seventh of a second (7.5 baud) for an 18,000-bps data rate.”

Telebit claims 100 percent error-free transmission with its ARQ and CRC-16 error-correcting scheme. “Because we predict very closely the S/N ratio at each of the frequencies, we are already transmitting fairly accurately,” Schaller claims. “If we reach a bit error rate of less than 10^-13, the modem automatically reconfigures the carriers.”

Both TrailBlazer and Digital Communications Associates Inc.’s version, Fastlink, are bundled with Microstuf Inc.’s Crosstalk-Fast communications software.

**Compression attains 14,000 bps**

Data Race Inc. uses proprietary data-compression and error-correction techniques and V.29 modulation on its RACE-BMX block-mode-transmission modem to attain a basic rate of 9,600 bps and maximum throughput of 14,000 bps in simulated-full-duplex mode (high-speed line turnaround). It functions with Hewlett-Packard Co. and Unisys Corp. terminals.

An asymmetric-modem implementation, the RACE-IM or RACE-AF employs V.27 techniques, buffering, synchronous transmission and 2.5:1 compression on its main 4,800-bps line and 200-baud transmission on its return line. Depending on compression, effective throughput runs from 6,500 bps to 10,000 bps. The modem appears to the host computer and attached terminals as though it were an asynchronous device. The AF and IM versions are Hayes AT command set compatible.

**Lack of compatibility could deter users**

The multiplicity of modulation methods and error-correction techniques used on 9,600-bps and faster modems and their compliance or lack of compliance with CCITT V.32 standards...
“Look! That’s ALL-IN-1 on my PC screen….and a couple of minutes ago we looked at DATATRIEVE graphs…tomorrow Fred’s going to show me how to put my LOTUS files into a VAX library!”

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CIRCLE NO. 72 ON INQUIRY CARD
makes it risky to assume that devices from two different modem vendors will talk to each other. The resulting confusion of product specifications and lack of firm standards may impede users' migration from 2,400 bps or 4,800 bps devices.

As a partial remedy for this problem, some modem vendors test their devices with competitive products and issue lists of compatible software. Telebit, for example, certifies approved Fastlane software for its TrailBlazer, and Codex has tested its products for compatibility with modems from several other vendors.

However, despite problems, the cost and transmission-time savings from 9,600 bps and faster modems constitute powerful lures for system integrators and end users. A 1M-byte file, for example, which takes 3 hours to transmit at 1,200 bps speeds along in 22 minutes at 9,600 bps and in only 11.6 minutes at 18,000 bps. Transmitting data from an IBM PC 360K flexible disk between New York and San Francisco can cost $26.69 at 1,200 bps but only $3.59 at 9,600 bps.

A new standard from the CCITT may offer at least a partial solution to compatibility problems. CCITT Study Group 17 is currently working on an asymmetrical-modem standard that will provide data rates greater than or equal to 9,600 bps on the PSTN for high-speed personal computer and Group 4 facsimile communications. It will also furnish a reverse-transmission channel for error control and accommodate half-duplex operation as a fallback mode to overcome problems caused by echo suppressors. Modems following the standard will also have to accommodate the use of adaptive differential pulse-code modulation (ADPCM) compression to be employed on the new TAT-8 transatlantic cable. The CCITT has set a target year of 1988 for adoption of the full standard.

Until the full implementation of the integrated services digital network (ISDN) eliminates the need for modulator/demodulators, the only certainty in the high-speed-modem market is users' continuing need for greater device compatibility and ever faster data-transmission speeds.

Interest Quotient (Circle One)
High 498 Medium 499 Low 500
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# Voice Grade DDD Modems

<table>
<thead>
<tr>
<th>Company/Model</th>
<th>Data Rate (bps)</th>
<th>Modulation Method</th>
<th>Transmission Mode</th>
<th>Synchronization</th>
<th>Calling Mode</th>
<th>Price &amp; Quantity</th>
<th>Notes/Features</th>
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</thead>
<tbody>
<tr>
<td><strong>ANCHOR AUTOMATION INC.</strong></td>
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<tr>
<td>Express</td>
<td>300, 1200</td>
<td>FSK, DSK, DPSK</td>
<td>half, full</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>299(Q1)</td>
<td>Bell 212A, Hayes compatible; plugs into IBM PC/AT/XT; includes LYNC software</td>
</tr>
<tr>
<td>Lightning 24</td>
<td>300, 1200, 2400</td>
<td>FSK, PSK, DPSK, QAM</td>
<td>half, full</td>
<td>asynch, sync</td>
<td>auto dial/ auto answer</td>
<td>499(Q1)</td>
<td>Bell 212A, 1224, CCITT, V.22 bis compatible</td>
</tr>
<tr>
<td>Voiksmodem 12</td>
<td>300, 1200</td>
<td>FSK, PSK, DPSK</td>
<td>half, full</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>199(Q1)</td>
<td>Bell 212A, Hayes compatible</td>
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<tr>
<td><strong>ANDERSON JACOBSON INC.</strong></td>
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<td>AJ 2412-STH</td>
<td>300, 1200, 2400</td>
<td>FSK, QAM, TCM</td>
<td>half, full</td>
<td>asynch, sync</td>
<td>auto dial/ auto answer</td>
<td>395(Q1)</td>
<td>Bell 103, 212A, CCITT V.22, V.22 bis, Hayes compatible</td>
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<tr>
<td>AJ 2441-1</td>
<td>300, 1200, 2400</td>
<td>FSK, QAM</td>
<td>half, full</td>
<td>asynch, sync</td>
<td>auto dial/ auto answer</td>
<td>695(Q1)</td>
<td>Bell 103, 212A, CCITT V.21, V.22, V.22 bis compatible; rackmount or standalone</td>
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<td>AJ 9631-5</td>
<td>4800, 9600</td>
<td>QAM, TCM</td>
<td>full duplex</td>
<td>sync</td>
<td>auto dial/ auto answer</td>
<td>2,995(Q1)</td>
<td>CCITT V.32 compatible, rackmount or standalone</td>
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<td><strong>ASHER TECHNOLOGIES INC.</strong></td>
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<td>Quadrmodem II</td>
<td>300, 1200, 2400</td>
<td>FSK, QAM</td>
<td>half, full</td>
<td>sync</td>
<td>auto dial/ auto answer</td>
<td>425-695(Q1); 276-450(Q100)</td>
<td>Bell 103, 212A, CCITT V.22 bis compatible; plugs into IBM bus compatible; includes CROSSTALK XVI software</td>
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<td><strong>AT&amp;T INFORMATION SYSTEMS</strong></td>
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<td>One Speedwell Ave., Morristown, NJ 07960, (800) 247-1212</td>
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<td>4024</td>
<td>2400</td>
<td>FSK, QAM</td>
<td>half, full</td>
<td>asynch, sync</td>
<td>auto dial/ auto answer</td>
<td>750(Q1)</td>
<td>Bell 103, 212, CCITT V.22 bis compatible</td>
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<td>4112</td>
<td>1200</td>
<td>FSK</td>
<td>full duplex</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>489(Q1)</td>
<td>Bell 103, 212, CCITT V.22 bis compatible; plugs into PC 6300, IBM PC compatible; includes SoftCall software</td>
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<td>4112V</td>
<td>1200</td>
<td>FSK</td>
<td>full duplex</td>
<td>sync</td>
<td>auto dial/ auto answer</td>
<td>599(Q1)</td>
<td>Bell 103, 212, CCITT V.22 bis compatible; plugs into PC 6300, IBM PC compatible; includes Communications Manager software</td>
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<tr>
<td><strong>BIZCOMP CORP.</strong></td>
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<td>532 Mercury Dr., Sunnyvale, CA 94086, (408) 733-7800</td>
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<td>2110</td>
<td>300, 1200</td>
<td>FSK, PSK, DPSK</td>
<td>half, full</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>449(Q1); 225(Q100)</td>
<td>Bell 212, Hayes compatible; plugs into IBM PC or compatible</td>
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<td>4120</td>
<td>300, 1200</td>
<td>FSK, PSK, DPSK</td>
<td>half, full</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>499(Q1); 249(Q100)</td>
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<td>4124</td>
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<td>half, full</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>599(Q1); 349(Q100)</td>
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<td><strong>BYTCOM INC.</strong></td>
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<td>2169 Francisco Blvd., San Rafael, CA 94901, (415) 485-0700</td>
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<td>24/12 CONTAC</td>
<td>300, 1200, 2400</td>
<td>FSK, PSK, QAM</td>
<td>half, full</td>
<td>asynch, sync</td>
<td>auto dial/ auto answer</td>
<td>389(Q1)</td>
<td>Bell 103, 113, 212, CCITT V.22 bis compatible; plugs into IBM PC or compatible</td>
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<tr>
<td>PLUS</td>
<td>24/72 FASTLINK</td>
<td>FSK, PSK, QAM</td>
<td>half, full</td>
<td>asynch, sync</td>
<td>auto dial/ auto answer</td>
<td>899(Q1)</td>
<td>Bell 103, 113, 212, CCITT V.22 bis compatible</td>
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<td>212PC CONTAC</td>
<td>300, 1200</td>
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<td>half, full</td>
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<td>auto dial/ auto answer</td>
<td>299(Q1)</td>
<td>Bell 103, 113, 212 compatible; plugs into IBM PC or compatible</td>
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<td><strong>CERMETEK MICROELECTRONICS INC.</strong></td>
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<td>1308 Borregas Ave., Sunnyvale, CA 94088-3565, (408) 752-5000</td>
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<td>1200SM</td>
<td>300, 1200</td>
<td>FSK, PSK</td>
<td>full duplex</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>595(Q1)</td>
<td>Bell 103, 212A compatible</td>
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<td>1200SPC</td>
<td>300, 1200</td>
<td>FSK, PSK</td>
<td>full duplex</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>345(Q1)</td>
<td>Bell 103, 212A compatible; includes software</td>
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<td>2400 SPC</td>
<td>300, 1200, 2400</td>
<td>FSK, PSK, QAM</td>
<td>full duplex</td>
<td>asynch</td>
<td>auto dial/ auto answer</td>
<td>445(Q1)</td>
<td>Bell 103, 212A compatible; includes software</td>
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</table>

**MINI-MICRO SYSTEMS/MARCH 1987**
<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Data rate (bps)</th>
<th>Modulation method</th>
<th>Transmission mode</th>
<th>Synchronization</th>
<th>Answering mode</th>
<th>Price $ (Quantity)</th>
<th>Notes Comments</th>
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<tr>
<td>CODEX CORP.</td>
<td>224 Series</td>
<td>300, 1200, 2400</td>
<td>QAM</td>
<td>full duplex</td>
<td>asynch</td>
<td>auto dial/</td>
<td>Bell 103, 212, CCITT V.22, V.25 compatible</td>
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<tr>
<td></td>
<td>2300 Series</td>
<td>4800, 9600</td>
<td>QAM</td>
<td>full duplex</td>
<td>asynch</td>
<td>auto dial/</td>
<td>CCITT V.27 bis, V.29 compatible; point-to-point</td>
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<td>2600 Series</td>
<td>19200-19.2K</td>
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<td>full duplex</td>
<td>asynch</td>
<td>auto dial/</td>
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<td>COMDATA CORP.</td>
<td>212E-32</td>
<td>1200</td>
<td>PSK</td>
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<td>auto dial/</td>
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<td>CCITT V.29 compatible, multipoint</td>
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© MINI-MICRO SYSTEMS/March 1987
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<th>Model</th>
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<th>Modulation method</th>
<th>Transmission mode</th>
<th>Synchronization</th>
<th>Calling mode</th>
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<th>Notes, features</th>
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<td>(DIV. OF DOWYT RL INDUSTRIES INC.)</td>
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<td>3055 Orchard Dr., San Jose, CA 95134, (408) 946-8777</td>
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<td>synch</td>
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<td>2452 Embarcadero Way, Palo Alto, CA 94303, (415) 856-7421</td>
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<td>1020 S. Noel Ave., Wheeling, IL 60090, (312) 459-6630</td>
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<td>Rt. 63, Middlebury, CT 06762, (203) 574-1118</td>
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<td>P. O. Box 105203, Atlanta, GA 30348, (404) 449-8791</td>
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## VOICE GRADE DDD MODEMS

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<th>Model</th>
<th>Data rate (Bps)</th>
<th>Modulation method</th>
<th>Transmission mode</th>
<th>Synchronization</th>
<th>Calling mode</th>
<th>Price $ (quantity)</th>
<th>Notes / features</th>
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<td>2400B</td>
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<td>IDEAccom 1200</td>
<td>300, 1200</td>
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<td>Rainbow 2400 PC</td>
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<td>INFINET INC.</td>
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<td>289(Q1)</td>
<td>Bell 103, 212A compatible; plugs into IBM PC/AT/XT or compatible; includes Bitcom software</td>
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<td>auto dial/ auto answer</td>
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<td>549(Q1); 439(Q100)</td>
<td>Bell 103, 212A, CCITT V.22, V.22 bis compatible; MNP error correction</td>
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<td>LEADING EDGE HARDWARE PRODUCTS INC.</td>
<td>Microcom 1200</td>
<td>1200, 2400</td>
<td>FSK, QSK, QAM</td>
<td>half, full</td>
<td>asynch,</td>
<td>auto dial/ auto answer</td>
<td>399(Q1)</td>
<td>Bell, CCITT, Hayes compatible</td>
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<td></td>
<td>IDM 144</td>
<td>9600, 12K, 14.4K</td>
<td>QAM, TCM</td>
<td>full duplex</td>
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<td>289(Q1)</td>
<td>Bell 103, 212A compatible; plugs into IBM PC/AT/XT or compatible; includes Bitcom software</td>
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<td>MICOM SYSTEMS INC.</td>
<td>M3124EH-S1</td>
<td>300, 1200, 2400</td>
<td>FSK, DPSK, QAM</td>
<td>full duplex</td>
<td>asynch,</td>
<td>auto dial/ auto answer</td>
<td>399(Q1)</td>
<td>Bell, CCITT, Hayes compatible</td>
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<td>Multi-Tech SYSTEMS INC.</td>
<td>300, 1200, 2400</td>
<td>FSK, QSK, QAM</td>
<td>half, full</td>
<td>asynch,</td>
<td>auto dial/ auto answer</td>
<td>699(Q1)</td>
<td>Bell, CCITT, Hayes compatible; plugs into IBM PC/AT or compatible; MNP error correction</td>
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<td>NCR COMTEN INC.</td>
<td>7164, 9600, 14.4K</td>
<td>FSK, QAM</td>
<td>full duplex</td>
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<td>2,995(Q1)</td>
<td>IBM 3864 compatible</td>
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<td>NOVATION INC.</td>
<td>1200X, 1200</td>
<td>FSK, PSK</td>
<td>half, full</td>
<td>asynch,</td>
<td>auto dial/ auto answer</td>
<td>299(Q1); 249(Q100)</td>
<td>Bell 103, 212 compatible</td>
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<td>PARADYNE CORP.</td>
<td>2400</td>
<td>FSK, PSK</td>
<td>full duplex</td>
<td>asynch,</td>
<td>auto dial/ auto answer</td>
<td>555(Q1); 565(Q100)</td>
<td>Bell 103, 113, 212A, CCITT V.22 bis compatible; plugs into IBM PC, MNP error correction</td>
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## VOICE GRADE DDD MODEMS

<table>
<thead>
<tr>
<th>Company/Model</th>
<th>Data Rate (bps)</th>
<th>Modulation Method</th>
<th>Transmission Mode</th>
<th>Synchronization</th>
<th>Pricing (Monthly)</th>
<th>Notes/Features</th>
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<tbody>
<tr>
<td>HDX 9600/208B</td>
<td>4800, 9600</td>
<td>QAM</td>
<td>half duplex</td>
<td>synch</td>
<td>1,995(01); 1,495(Q100)</td>
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<td>Bell 208A/B compatible, plugs into IBM PC</td>
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<tr>
<td>207 Perry Parkway, Gaithersburg, MD 20877-2197, (301) 921-8600</td>
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<tr>
<td>Datalink 2400</td>
<td>300, 1200, 2400</td>
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<td>synch</td>
<td>695(01)</td>
<td>Bell 103, 212A, CCITT V.22 bis compatible</td>
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<td>Datalink 4800</td>
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<td>synch</td>
<td>1,395(01)</td>
<td>Bell 208A/B, CCITT V.27 bis/ter compatible</td>
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<td>Datalink 9600</td>
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<td>QAM</td>
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<td>CCITT V.27 bis/ter, V.29 compatible</td>
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<tr>
<td>266 Caspian Dr., Sunnyvale, CA 94088, (408) 734-9810</td>
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<td>P-208A/B</td>
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<td>595-695(01)</td>
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<td>One Quad Way, Norcross, GA 30093, (404) 923-6666</td>
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<td>Quadmodem II</td>
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<td>synch</td>
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<tr>
<td>1601 N. Harrison Parkway, Sunrise, FL 33323, (305) 476-5609</td>
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<td>9600VP</td>
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<td>synch</td>
<td>1,495(01); 1,271(Q100)</td>
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<td>RM-1822D</td>
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<td>synch</td>
<td>2,395(01); 2,036(Q100)</td>
<td>Bell 103, 212A, CCITT V.22, V.22 compatible; minimal failback</td>
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<td>RM-9632</td>
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<td>QAM, TCM</td>
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<td>synch</td>
<td>3,500(01); 2,975(Q100)</td>
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<tr>
<td>1525 McCarthy Blvd., Milpitas, CA 95035, (408) 946-2227</td>
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<tr>
<td>9600VP</td>
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<td>synch</td>
<td>595(01); 488(050)</td>
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<td>half duplex</td>
<td>synch</td>
<td>1,295(01); 1,100(050)</td>
<td>Bell 208B, CCITT V.27 ter compatible</td>
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<td>9600VP</td>
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<td>FSK, DPSK, QAM</td>
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<td>1,495(01); 1,270(050)</td>
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<td>TEK-COM CORP.</td>
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<tr>
<td>120 Charcol Ave., San Jose, CA 95131, (408) 435-9515</td>
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<td>TC212AD</td>
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<td>359(01)</td>
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<td>TC2400 PC1</td>
<td>300, 1200, 2400</td>
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<td>half, full duplex</td>
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<td>499(01); 374(010)</td>
<td>Bell 103A, 212A, CCITT V.22 bis compatible; plugs into IBM PC or compatible</td>
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<tr>
<td>895 E. Yorba Linda Blvd., Suite H, Placentia, CA 92670, (714) 524-5770</td>
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<td>synch</td>
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<td>300, 1200, 2400</td>
<td>FSK, PSK, DPSK, QAM</td>
<td>full duplex</td>
<td>synch</td>
<td>495(01); 347(010)</td>
<td>Bell 212A, CCITT V.22 bis compatible; plugs into IBM PC or compatible</td>
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<td>24s</td>
<td>300, 1200, 2400</td>
<td>FSK, PSK, DPSK, QAM</td>
<td>full duplex</td>
<td>synch</td>
<td>695(01); 487(010)</td>
<td>Bell 212A, CCITT V.22 bis compatible</td>
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<td>TOUCHBASE SYSTEMS INC.</td>
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<tr>
<td>16 Green Acre Lane, Northport, NY 11768, (516) 261-0423</td>
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<td>WorldLink 1200</td>
<td>300, 1200, 2400</td>
<td>FSK, PSK</td>
<td>full duplex</td>
<td>synch</td>
<td>199(01)</td>
<td>Bell 103, 212A, CCITT V.21, V.22, Hayes compatible</td>
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<td>TRANSEND CORP.</td>
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<tr>
<td>884 Portola Rd., Portola Valley, CA 94025, (415) 851-3402</td>
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<td>PCM 1200</td>
<td>300, 1200, 2400</td>
<td>DPSK</td>
<td>half, full duplex</td>
<td>synch</td>
<td>159(01); 140(010)</td>
<td>Bell 212A compatible, plugs into IBM PC</td>
</tr>
<tr>
<td>TRI-DATA</td>
<td>505 E. Middlefield Rd., Mountain View, CA 94043, (415) 969-3700</td>
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<td>OZ Guardian 533</td>
<td>110, 300, 1200</td>
<td>FSK, PSK</td>
<td>half, full duplex</td>
<td>synch</td>
<td>750(01)</td>
<td>Bell 103, 212A compatible</td>
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MINI-MICRO SYSTEMS/March 1987
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<tr>
<th>Company Model</th>
<th>Data rate (bps)</th>
<th>Modulation method</th>
<th>Transmission mode</th>
<th>Synchronization</th>
<th>Settling mode</th>
<th>Price $ (quantity)</th>
<th>Notes / Features</th>
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<td>DPSK, QAM</td>
<td>full duplex</td>
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<td>auto dial/</td>
<td>495(Q1); 455(Q100)</td>
<td>Bell 212A, CCITT V.22 bis compatible</td>
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<td>asynch</td>
<td>auto dial/</td>
<td>795(Q1); 652(Q100)</td>
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<td>asynch</td>
<td>auto dial/</td>
<td>1,295(Q1); 1,115(Q100)</td>
<td>Bell 212A, CCITT V.22 bis compatible; X.PC error correction; supports up to 3 terminals or PCs over same dial-up line</td>
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<td><strong>UNIVERSAL DATA SYSTEMS</strong></td>
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<td>half, full</td>
<td>synch</td>
<td>manual orig./ auto answer</td>
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<td>Bell 208A/B compatible</td>
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<td>QAM</td>
<td>half, full</td>
<td>synch</td>
<td>manual orig./ auto answer</td>
<td>1,995(Q1)</td>
<td>Bell 208A/B, CCITT V.29 compatible; diagnostics</td>
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<td>V.33</td>
<td>9600, 12K, 14.4K</td>
<td>QAM, TCM</td>
<td>full duplex</td>
<td>synch</td>
<td>manual orig./ auto answer</td>
<td>2,995(Q1)</td>
<td>CCITT V.29, V.33 compatible</td>
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<td><strong>US ROBOTICS INC.</strong></td>
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<td>Courier 2400e</td>
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<td>half, full</td>
<td>synch</td>
<td>auto dial/</td>
<td>699(Q1)</td>
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<td>half, full</td>
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<td>auto dial/</td>
<td>995(Q1)</td>
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<td>half, full</td>
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<td>auto dial/</td>
<td>499(Q1)</td>
<td>Bell 103, 212A, CCITT V.22 bis compatible; plugs into IBM PC bus</td>
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<td><strong>VEN-TEL INC.</strong></td>
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<td>2400 Plus</td>
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<td>synch</td>
<td>auto dial/</td>
<td>695(Q1)</td>
<td>Bell 103, 212A, CCITT V.22, V.22 bis compatible</td>
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<td>half, full</td>
<td>synch</td>
<td>auto dial/</td>
<td>549(Q1)</td>
<td>Bell 103, 212A compatible; plugs into IBM PC/AT/XT or compatible; includes CROSSTALK XVI software</td>
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<td>half, full</td>
<td>synch</td>
<td>auto dial/</td>
<td>695(Q1)</td>
<td>Bell 103, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC/AT/XT or compatible; includes CROSSTALK XVI software</td>
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<td>auto dial/</td>
<td>495(Q1); 223(Q100)</td>
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<td>synch</td>
<td>auto dial/</td>
<td>645(Q1); 419(Q100)</td>
<td>Bell 103, 113, 212, CCITT V.22 bis, Vadic compatible; MNP error correction</td>
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<td>synch</td>
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<td>Bell 103, 113, 212, CCITT V.22 bis compatible</td>
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<td>synch</td>
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<td>495(Q1); 321(Q100)</td>
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<td>91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ampex</td>
<td>63</td>
<td>48</td>
<td>NEC Information Systems Inc.</td>
<td>42-43</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ampro</td>
<td>69</td>
<td>7</td>
<td>Newbury Data</td>
<td>36-37, 86</td>
<td>252, 253</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog &amp; Digital Peripherals</td>
<td>140</td>
<td>217</td>
<td>Plessey Microsystems</td>
<td>92</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avco TeXtron</td>
<td>108</td>
<td>59</td>
<td>Polycon</td>
<td>128</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bizcomp</td>
<td>54</td>
<td>35</td>
<td>Princeton Graphic Systems</td>
<td>52-53</td>
<td>34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP Microsystems</td>
<td>139</td>
<td>208</td>
<td>RTE Deltec</td>
<td>39</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles River Data Systems</td>
<td>77</td>
<td>47</td>
<td>Radio Shack (Tandy Corp.)</td>
<td>51</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chrislin Industries, Inc.</td>
<td>16</td>
<td>12</td>
<td>Ricoh Systems, Co.</td>
<td>102</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIE Terminals</td>
<td>20</td>
<td>16</td>
<td>Sequel Data</td>
<td>32</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clearpoint</td>
<td>111, 113</td>
<td>60, 61</td>
<td>Si Tech</td>
<td>138</td>
<td>202</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ComDesign</td>
<td>124</td>
<td>71</td>
<td>Siemens Corp.</td>
<td>91</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communications Research Group</td>
<td>139</td>
<td>212</td>
<td>Sigma Designs</td>
<td>31</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concurrent Computer</td>
<td>17</td>
<td>14</td>
<td>Simpact Assoc. Inc.</td>
<td>120</td>
<td>67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convergent Technologies</td>
<td>24-25</td>
<td>18</td>
<td>Softronics</td>
<td>138</td>
<td>204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSSL</td>
<td>50</td>
<td>80</td>
<td>Storage Technology</td>
<td>118</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CYB Systems</td>
<td>6</td>
<td>5</td>
<td>Sun-Hill Nic</td>
<td>139</td>
<td>207</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Access Corp.</td>
<td>116</td>
<td>69</td>
<td>Systech</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Engineering</td>
<td>140</td>
<td>218</td>
<td>TEAC Corp.</td>
<td>23</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Datasouth Computer Corp.</td>
<td>82</td>
<td>50</td>
<td>Technology Forums</td>
<td>112</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Datavice Corp.</td>
<td>138</td>
<td>202</td>
<td>Tektronix Inc.</td>
<td>18-19, Cov. 3</td>
<td>15, 77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic Specialists</td>
<td>139</td>
<td>206</td>
<td>Telebyte Technology</td>
<td>129</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equinox Systems</td>
<td>12</td>
<td>10</td>
<td>Televideo/Computer Div.</td>
<td>60-61</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excelan</td>
<td>28, 29</td>
<td>22, 23</td>
<td>TeleVideo/Terminals</td>
<td>105</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ExpoConsul International</td>
<td>110</td>
<td>65</td>
<td>Toshiba</td>
<td>14</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facit</td>
<td>8</td>
<td>251</td>
<td>Universal Data Systems Inc.</td>
<td>Cov. 4</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fox Research</td>
<td>115, 117</td>
<td>63, 64</td>
<td>Versatec Inc. (a Xerox Co.)</td>
<td>68</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frontier Technologies</td>
<td>123</td>
<td>68</td>
<td>Vesta Technology</td>
<td>139</td>
<td>210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fujitsu America Inc. — Data Products Division</td>
<td>38</td>
<td>25</td>
<td>Viziflex Seels</td>
<td>139</td>
<td>211</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fujitsu America Inc. Storage Division</td>
<td>96</td>
<td>57</td>
<td>Wells American</td>
<td>57</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genicom</td>
<td>58</td>
<td>37</td>
<td>Wyse Technology</td>
<td>26</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMX</td>
<td>138</td>
<td>201</td>
<td>Xylogics Inc.</td>
<td>67</td>
<td>40</td>
<td></td>
<td></td>
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<tr>
<td>Grafpoint</td>
<td>139</td>
<td>209</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Hayes Microcomputer Products</td>
<td>Cov. 2</td>
<td>1</td>
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<tr>
<td>Hewlett-Packard Co.</td>
<td>98</td>
<td>27</td>
<td></td>
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<tr>
<td>Hewlett-Packard Co./Mfg</td>
<td>10-11</td>
<td>9</td>
<td></td>
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<td></td>
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<tr>
<td>Hitachi America Ltd.</td>
<td>46-47, 70</td>
<td>29, 43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honeywell Test Instrument Div.</td>
<td>4, 34-35</td>
<td>4, 32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBI Systems</td>
<td>139</td>
<td>214</td>
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<td>IBS</td>
<td>76</td>
<td>46</td>
<td></td>
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</tr>
<tr>
<td>Imperial Technology Inc.</td>
<td>74</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Interface Group</td>
<td>9, 101</td>
<td>8, 58</td>
<td></td>
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</tr>
<tr>
<td>Interphase Corp.</td>
<td>95</td>
<td>56</td>
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<tr>
<td>Ioline Corp.</td>
<td>140</td>
<td>219</td>
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<td>Irwin Magnetics</td>
<td>15</td>
<td>28</td>
<td></td>
<td></td>
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<tr>
<td>Iskra VME</td>
<td>88</td>
<td>53</td>
<td></td>
<td></td>
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<tr>
<td>JDL</td>
<td>78</td>
<td>38</td>
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<tr>
<td>KMW Systems Corp.</td>
<td>40</td>
<td>24</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Liberty Electronics USA</td>
<td>85</td>
<td>51</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Maxtor Corp.</td>
<td>7</td>
<td>6</td>
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<tr>
<td>Melard</td>
<td>140</td>
<td>216</td>
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</tr>
<tr>
<td>Microsoft</td>
<td>81</td>
<td>49</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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