MARCH 1988

Mini-Micro Systems

FOR SYSTEM INTEGRATORS, VARs & OEMs

A CAHNERS PUBLICATION

Exploding ISDN Myths

Connectivity Strategies:

Hardware OEMs turn to third parties

The DEC/Apple alliance

C and T brings PS/2

clones home

TECHNOLOGY '88
Special Section

HAYES ANN TECHNOLOGICAL MODEMS THAT IM

It's long been thought that even the best of technology eventually becomes obsolete. A notion that we at Hayes could never really understand. And certainly never accept. So in defiance of it, we created the V-series Smartmodem 9600™ and V-series Smartmodem 2400.™ Modems that actually get better as they get older. Because they not only incorporate the most intelligent features found in modems today, they also possess the capability to provide a long-term growth path into the communications environments of tomorrow.

V-SERIES SMARTMODEM 9600

This is the fastest modem we've ever made. It can send and receive data at 9600 bps and with adaptive data compression achieve an effective throughput of up to 19,200 bps. Point-to-point error control, forward error correction and data flow control ensure that data gets there accurately.

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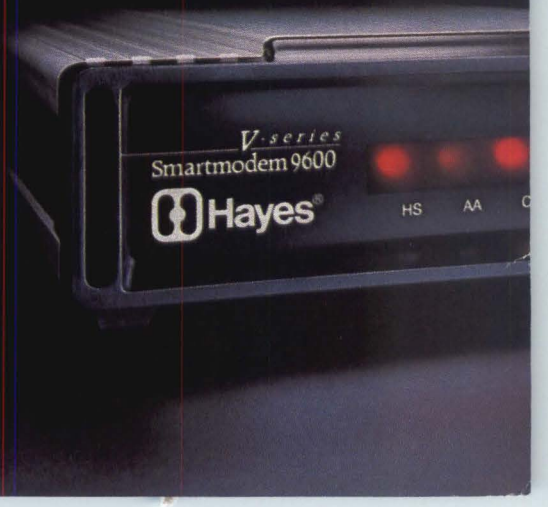


OUNCES A CONTRADICTION: PROVE WITH AGE.

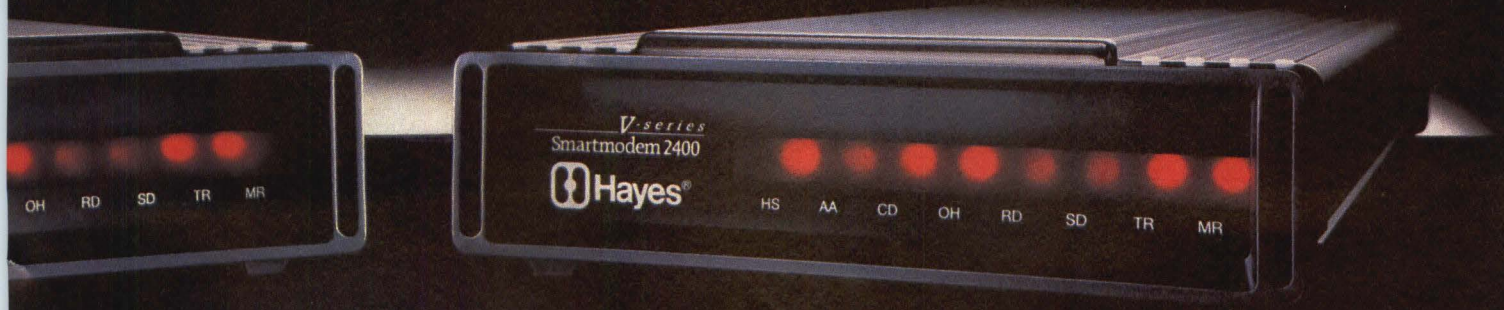
V-SERIES SMARTMODEM 2400

With adaptive data compression this modem can achieve an effective throughput of up to 4800 bps. Of course, it too offers point-to-point error control, data flow control, automatic feature negotiation and synchronous as well as asynchronous communications modes. And like the V-series Smartmodem 9600, it can link up with a wide range of networks, such as SNA, and be enhanced with an X.25 PAD option.

V-series modems come in stand-alone versions and internal versions (V-series Smartmodem 9600B™ and V-series Smartmodem 2400B™). Internal versions are bundled with our powerful new Smartcom III™ communications software.

And as yet another rebuttal to the argument for obsolescence, we developed the V-series Modem Enhancer.™ A separate stand-alone device that will upgrade current Smartmodem 1200™ and Smartmodem 2400™ external modems to the new standards set by the V-series products.

A closer look at the V-series product line will reveal to you a revolutionary technology designed to be the beneficiary of time, not its victim. So contact your Hayes Advanced System Dealer or call **800-635-1225** for the one nearest you.



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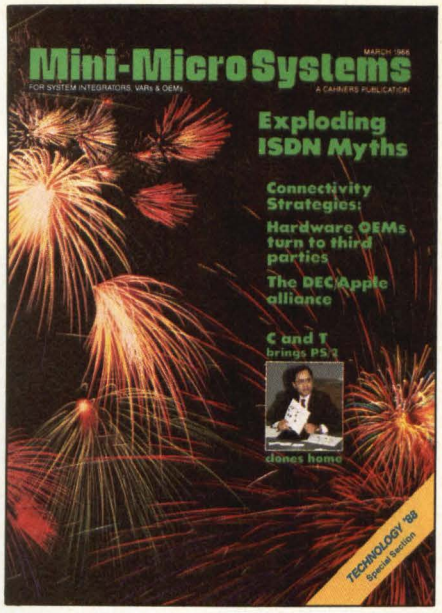

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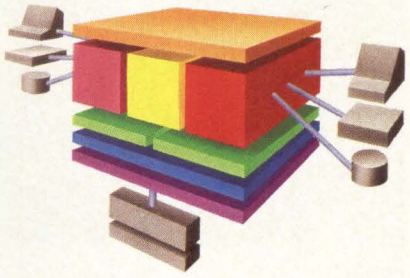
INTERPRETER

FEATURES



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TECHNOLOGY '88 PRODUCT PERSPECTIVES

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KEEPING AMERICA COMPETITIVE

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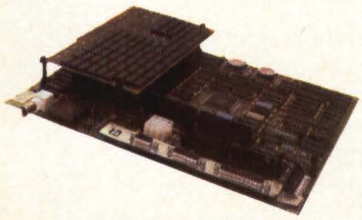
DEC

MicroVAX 2000-Compatible



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MicroVAX II-Compatible

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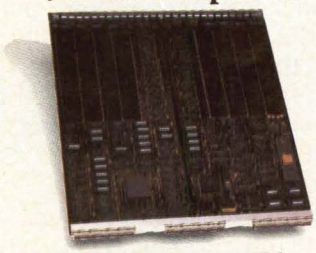
Sun 3/2XX and 4/2XX-Compatible



The **SNX2RAM/32 MB*** delivers the Sun 3/2XX system maximum on a single board. It also offers the enhanced functionality of a microprocessor-managed "on-board hotline" for local and remote diagnostics.

Sun 3/1XX-Compatible

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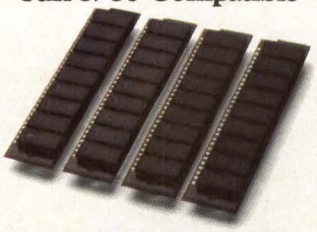
Sun 3/60-Compatible



The **SNX60**, comes in 4 MB SIMM sets that upgrade your Sun 3/60 to an expansive 24 MB. Each SIMM is one MB of reliable Clearpoint memory with a 1 megabit DRAM to support parity checking.

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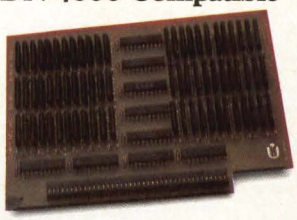
APOLLO

DN 4000-Compatible



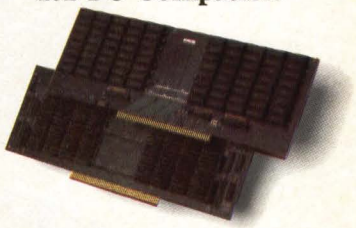
Bring your DN 4000 up to its 32 MB capacity with the **DNX4RAM*** Available in 8 MB boards, Clearpoint's cost-effective memory provides Apollo-equivalent performance with lifetime product support.

DN 3000-Compatible

The economical 1 or 2 MB **DNXRAM** memory offers Clearpoint's quality engineering and manufacturing with performance identical to Apollo.

IBM

RT PC-Compatible



Supporting the upgraded RT models 6150 and 6151, the low-cost **RTRAM** is available in 4 or 8 MB boards.

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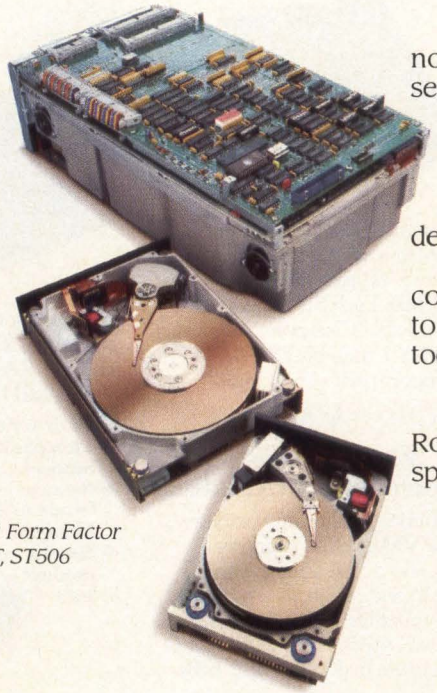

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CIRCLE NO. 5 ON INQUIRY CARD

BREAKPOINTS

SAME NAME, DIFFERENT GAME FOR VAR-ANGLED MS-DOS

Having made its mark in the PC-compatibility market with its IBM BIOS, Phoenix Technologies Ltd., Norwood, Mass., is extending its reach into the operating systems reseller arena with the acquisition of Paterson Laboratories Inc., Redmond, Wash., formerly a division of Microsoft Corp. Phoenix will this month begin distributing copies of Microsoft's MS-DOS operating system, along with the Phoenix BIOS, to independent PC VARs, corporate VARs and others who are not yet big enough to foot the multimillion dollar OEM bill tacked on by Microsoft. Paterson now ships about 20,000 copies of its DOS/BIOS each month, a number that Phoenix hopes to double with its added influence. The single-quantity price for the repackaged DOS is about $85, with discounts for multiple copies.—*Tim Scannell*

INTEL PREPARING TO SHIP OEM SYSTEMS BUILT AROUND IBM PC/AT-BUS

Watch for the OEM Systems Division of Intel Corp., Hillsboro, Ore., to get into the IBM Corp. PC/AT-compatible business. The $300 million operation sells a variety of board-level products and systems for the real-time market. The move will pit Intel against some of its biggest customers of 80286 and 80386 processors. Intel's value-added is a worldwide force of field applications engineers, a heavy industrial distribution network and extensive customer training services, according to company officials. Among the first of the new OEM systems built around the AT bus will be an 80386 system running at 25 MHz.—*Mike Seither*

APOLLO TOUTS DOMAIN/OS AS FIRST DISTRIBUTED UNIX

Apollo Computer Inc., Chelmsford, Mass., claims its Domain/OS is the first distributed version of the UNIX operating system. But VARs and OEMs are more pleased by the fact that Domain/OS incorporates three operating systems: AT&T Co.'s UNIX System V Release 3, Berkeley UNIX Version 4.2 and Aegis, Apollo's proprietary version of UNIX. "When it comes to software enhancements, nothing beats having three operating systems to give your programmers flexibility," says a West Coast VAR. Apollo says Domain/OS permits users of Apollo workstations to share files and resources across a network. Support for network functions like print serving and file sharing is included. Availability is slated for the second quarter.—*Jim Donohue*

TOSHIBA UNLEASHES 5G-BYTE OPTICAL DRIVE

When Toshiba America Inc., Irvine, Calif., announced its 12-inch WM-S500 optical disk drive at last fall's Comdex show, the write-once drive held 4G bytes. Now, the company claims 5G bytes of storage, with unit shipments scheduled for next month. The higher capacity is due to increased recording density from 13,000 to 15,000 bpi, as well as utilization of more disk space. Other key specs include a 160-msec average seek time, and a 4M- to 8M-bps transfer rate via the SCSI interface. The drive costs $13,995.—*Dave Simpson*

UNISOFT AND ADVANCED MICRO DEVICES TEAM UP, TARGET WORKSTATIONS

In a development that essentially says "move over" to Sun Microsystems Inc.'s SPARC chip, Unisoft Corp., Sunnyvale, Calif., has begun to port its UNIX System V.3 operating system, UniSoft+, to Advanced Micro Devices' (Berkeley,

Calif.) Am29000 RISC microprocessor. The two companies say the integrated hardware and software will be available during the fourth quarter. The joint agreement, according to John East of AMD's logic group, "will provide momentum for the Am29000 in the competitive engineering workstation and multiprocessing markets." As a result of this tandem, system integrators and OEMs will find another RISC-based option for the next generation of platforms.—*Doug Pryor*

NEW APPLE LASERWRITERS BOAST EXPANDABILITY

Apple Computer Inc. of Cupertino, Calif., has come out with three new upgradable versions of its pacesetting LaserWriter printers. Similar products based on the Canon USA Inc. SX print engine are upgraded by adding boards and font cartridges to an otherwise unchanged motherboard. But Apple and Canon, Lake Success, N.Y., have added a special card cage to the LaserWriter II line that permits removal of the entire motherboard. Besides adding memory, system integrators can change the architecture of the machine. Prices for the models SC, NT and NTX are $2,799, $4,599 and $6,599 respectively. —*Charles LeCompte*

NATIONAL SEMICONDUCTOR ANNOUNCES NEW MEMBER OF CHIP FAMILY

National Semiconductor Corp., Santa Clara, Calif., has announced availability of its 20-MHz CMOS-programmable DP8500 Raster Graphics Processor (RGP) for bit-mapped graphics systems. The new chip joins National's Advanced Graphics Chip Set (AGCS), a family of VLSI building blocks for video graphics and printer applications. According to Roger Reak, director of graphics marketing, "The RGP and AGCS chips provide the highest level of graphics performance and resolution available on commercial chips, yet their pricing and modular architecture make them cost effective for low- and high-end systems."—*Joseph P. Lerro Jr.*

INTERPHASE TARGETS CONTROLLER AFTERMARKET FOR SUN WORKSTATIONS

Interphase Corp., the Dallas-based manufacturer of VMEbus controllers, has started a service dedicated to providing OEMs with high-performance add-in boards for Sun Microsystems Inc. workstations and servers. The first product under that strategy is the Interphase 4400 Phoenix, a controller packaged on a standard Sun card that supports up to four SMD or SMD-E disk drives. The Phoenix 4400 uses high-speed memory FIFOs and a packetizing scheme to move data over the VMEbus at rates exceeding 30M bytes per second. Evaluation units of the 4400 Phoenix cost $3,350 and come with boot ROMS, installation software, a queuing driver and other utilities.—*Mike Seither*

PTI PITCHES 102M-BYTE, 3½-INCH WINCHESTER

Joining Connor Peripherals Inc. in the 100M-byte, 3½-inch Winchester club, Peripheral Technology Inc. (PTI), Simi Valley, Calif., next month begins shipping the PT 4102R, which has an unformatted capacity of 102M bytes. The four-platter, $829 drive has an average access time of 35 msec and an ST506/412 interface. An IBM Corp. PC/AT-compatible version (PT 4102A, $909) and a SCSI version (PT 4102S, $909) are due in May.—*Dave Simpson*

ROCKWELL MODEM TECHNOLOGY MAKES 14.4 Kbps A REALITY.

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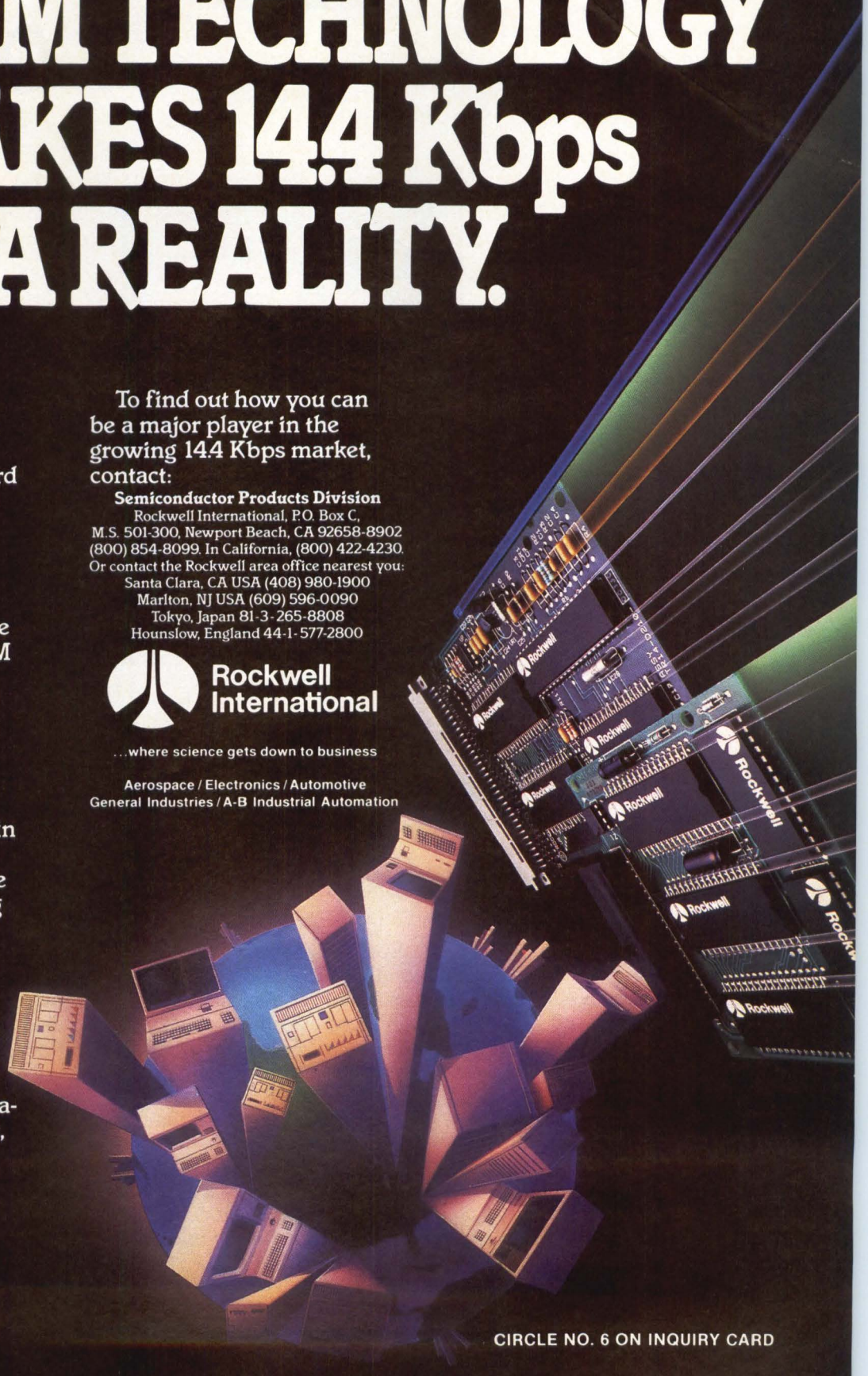

CIRCLE NO. 6 ON INQUIRY CARD

Introducing the two on earth

The new COMPAQ DESKPRO 386/20™

The world now has two new benchmarks from the leader in high-performance personal computing. The new 20-MHz COMPAQ DESKPRO 386/20 and the 20-lb., 20-MHz COMPAQ PORTABLE 386 deliver system performance that can rival minicomputers'. Plus they introduce advanced capabilities without sacrificing compatibility with the software and hardware you already own.

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Both use disk caching to inject more speed into disk-intensive applications and both will run MS® OS/2.

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COMPAQ®

KEEPING AMERICA COMPETITIVE

Chips fall into place for IBM PS/2 compatibles

Mike Seither, Senior Editor

If imitation is a form of flattery, then at least two companies in California's Silicon Valley are laying it on thick.

In January, Adaptec Inc., Milpitas, and Chips and Technologies Inc., San Jose, announced that together they have developed the key pieces that will allow OEMs to build IBM Corp. PS/2-like systems. These systems not only will be 100-percent compatible but also will offer higher performance than IBM's PS/2 models 50, 60 and 80 machines.

Both Adaptec and Chips and Technologies have worked for some time on the PS/2 compatibility project. The result: Chips and Technologies now has chip sets that mimic the core logic of the PS/2 as well as the Video Graphic Array (VGA), IBM's new analog display technology.

Adaptec has developed disk drive controllers and host bus adapters that will allow system integrators to attach drives with the small computer systems interface (SCSI) to IBM's Micro Channel, the backbone of the PS/2 machines. To date IBM has not offered SCSI support for the PS/2.

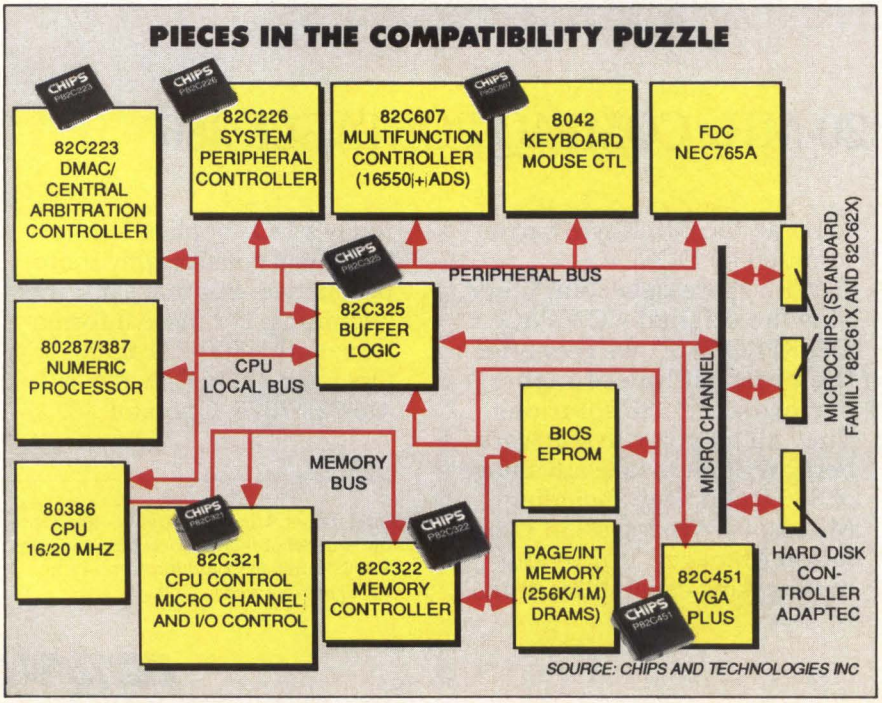
Another company that has made significant inroads into PS/2 cloning is Western Digital Corp., Irvine, Calif. Last year, the company announced CPU board-level products that mimic the PS/2 models 25, 30, 50 and 60 systems, including core logic chip sets, disk controllers and a video graphics controller. Western Digital also announced a series of add-in boards that duplicate the functions of the Micro Channel.

Also playing in the clone game with Adaptec and Chips is quasi-development partner Phoenix Technologies Ltd., Norwood, Mass. This company supplies the ROM-based basic input-output system (BIOS) for PS/2 compatibles. For the last several weeks, all these companies have been on a worldwide road trip telling OEMs and systems integrators their story. Here's what they've been saying:

The Chips and Technologies' CHIPS/250 chip set recreates IBM PS/2 models 50 and 60, but with fewer components—68 for Chips compared to 119 for IBM. While models 50 and 60 now support only the 10-MHz version of Intel Corp.'s 80286 CPU, systems using CHIPS/250 components can use the 80286 running at 16 MHz and 20 MHz.

The CHIPS/280 chip set is for companies building systems compatible with the PS/2 Model 80, which uses Intel's 32-bit 80386 processor. CHIPS/280 uses 66 components to build a motherboard, compared to 179 for the Model 80. Chips claims that this level of integration will let OEMs build compact 32-bit systems to fill the gap in the PS/2 line between the desktop Model 50 and the floor-standing Model 80.

What's more, Chips and Technologies supports "matched memory cycles" for Model 50 and Model 60 compatibles. IBM uses this scheme only in the Model 80 to get around the limitations of the 10-MHz Micro Channel while not "violating" the specifications of the bus. Add-in memory cards using this method have four additional pins that carry control signals, shortening memory access



time from 300 nsecs to 187.5 nsecs. That means OEMs can offer Model 50 and Model 60 clones that have 50 percent greater memory throughput than comparable IBM machines, according to Chips.

For PS/2 Model 80 clones, Chips says it beats IBM at the matched-memory game by a margin of 33 percent for 20-MHz machines—that is, Chips' "fast" cycle is 150 nsecs, vs. 200 nsecs for IBM. This system relies on configurable registers and most likely will be used by large OEMs who design their own memory add-in cards and bundle them in the clone.

A discrete goodbye

Both CHIPS/250 and CHIPS/280 are built around an asynchronous direct memory access (DMA) controller that Chips claims will allow OEMs to "fine tune" their I/O systems to take full advantage of the Micro Channel. According to Chips' engineers, IBM appears to have implemented a synchronous DMA scheme that runs at either the same speed as, or half the speed of, the CPU clock in order to stay within the 10-MHz bounds of the Micro Channel.

Both Adaptec and Chips and Technologies have worked for some time on the PS/2 compatibility project.

With a 10-MHz CPU, for example, IBM and Chips-based clones would have an equal DMA performance of 10 MHz. But with a 12-MHz CPU, IBM systems would have a DMA speed of 6 MHz; with a 16-MHz CPU, IBM systems run at 8 MHz. On the other hand, Chips says that its asynchronous DMA clips along at a steady 10 MHz, regardless of CPU speed.

Two other features round out Chips' value-added offerings in both of its chip sets. First are mapping registers that support the Lotus/Intel/Microsoft (LIM) Extended Memory Specification 4.0. Each task, or application, running under Microsoft Corp.'s Windows 2.0 can have its own 1M-byte register. That provides fast context switching between applications under Windows.

Second, Chips has added four programmable decoders that let OEMs avoid adding discrete logic devices to control such things as panel lights, password control and networking

INTERVIEW: CHIPS AND TECHNOLOGIES INC.

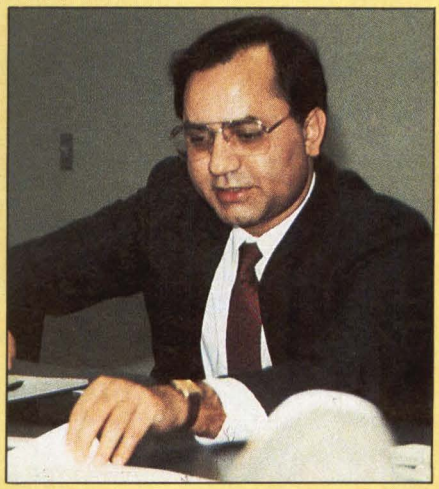
Answers in the chips for IBM PS/2 compatibility

When IBM Corp. unveiled its Personal System/2 series of computers last April, it made two things very clear to the competition.

First, because of the complexity of such things as the high-end PS/2's Micro Channel, clone-makers would find it difficult to make a less expensive duplicate system. It would also take some time, possibly a year or two, to develop such a system without getting snagged on the myriad of patents and proprietary secrets that were embedded in the new IBM series.

Second, if anyone should duplicate the PS/2 systems and the Micro Channel, then IBM would use all of its legal clout to nab those who had violated even the slightest patent, be it an IBM patent or the patent of some other manufacturer who contributed to the system design. In fact, IBM president William Lowe himself said IBM would not tolerate those who chose to illegally ride on IBM's coattails.

Despite these warning shots fired across the bows of clone makers, the PS/2 lookalikes are here. In January, Chips and Technologies Inc., Adaptec Inc. and others debuted the working



"Our design allows *OEMs to get into a lower footprint board. That's a less expensive solution compared to IBM which is using twice as many signal chips," says Sikander Naqvi of Chips and Technologies.*

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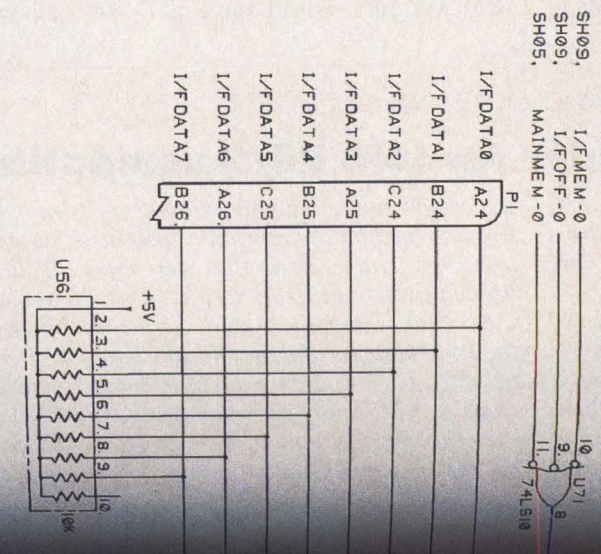

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CHIPS AND TECHNOLOGIES' PS/2 ALTERNATIVES

Function	CHIPS/250 (IBM Models 50/60)	CHIPS/280 (IBM Model 80)
System Logic	CS8225	CS8238
Graphics	82C451/2	82C451/2
COMM/FD/IO	82C607	82C607
Micro Channel Adapter Interface	82C6XX	82C6XX

Source: Chips and Technologies Inc.

support. These signal lines can be programmed from the BIOS.

Count on color

Finally, the CHIPS/450 graphics family provides two levels of support for IBM's VGA. The two controller chips in the family, the 451 and 452, are pin-compatible, allowing OEMs to design one board and upgrade it, depending on the performance requirements of their market. The 451

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pieces of a PS/2-compatible system that are available to OEMs and system integrators. At that time, they promised that functioning system would be available within a month. Not only would they be 100 percent compatible with IBM PS/2 systems but they would also be less expensive and more powerful than IBM PS/2 machines.

Recently, Mini-Micro Systems *talked to Chips and Technologies product marketing manager Sikander Naqvi about the company's PS/2 chip sets, which are the heart and soul of the new generation of IBM-compatibles. Taking part in the interview were editors George Kotelly, James Donohue, Doug Pryor and Megan Nields. Following are excerpts of that interview.*

MMS. What precautions has IBM taken with its PS/2 systems to make it difficult to copy their design?

Naqvi. If you look into the PS/2 families, they have done exactly what they did in mainframes in terms of the proprietary nature of the hardware and the software. They are also doing their own internal design at the chip level, at the software level and even at the manufacturing level. For example, PC/ATs were usually manufactured outside, but this is the first time they have integrated almost everything from chips to the operating system software all internally. This is nothing different, if you compare that to their mainframes.

MMS. What kind of problems have these proprietary roadblocks created for you?

Naqvi. Our efforts had to change, too. When we started out, we looked at the overall system and basically decided there would be two different solutions to the problem: one in the hardware, and one in the software.

They are very tightly coupled because that's how they [IBM] have developed their system. So, when we designed the system about nine or 10 months ago, we started by tying all the systems logic into the main motherboard logic. On the mass-storage side we started talking to Adaptec, Phoenix Technologies [Ltd.], and SCO [The Santa Cruz Operation] for the XENIX side, because we'd like to have XENIX on the machines.

We also had extensive discussions with Microsoft Corp., because now the operating system is very tightly coupled to the hardware. In planning the hardware, you have to understand the software, and who would know more about software than Microsoft?

MMS. Have you talked to IBM at all?

Naqvi. We have talked to IBM to the extent that they know exactly what we have been doing. We have kept them abreast of all our development activities and will address the legal issue later. In fact, we have been talking with them extensively over the last six months at every level.

MMS. Do you feel that IBM is in any way actively trying to stop systems makers from producing PS/2 clones?

Naqvi. Every indication we have is that they are not out there to stop somebody from doing it. They want to control it this time, unlike the situation they had with their PCs. And they will control it through licensing.

MMS. What exactly have you developed?

Naqvi. We have two distinct solutions, one for the Model 50 and one for the Model 80, each comprised of the graphics, systems logic and hardware. Basically, we are putting all the pieces together right now which allow compatible manufacturers to have a 100 percent compatible machine by just going to us and Adaptec.

We designed the whole system before we actually started on the actual chip design. What that means is that all the subsystems are really a collection of tightly coupled chips. For example, there are seven chips for our Model 50.

MMS. How are you positioning your system against IBM?

Naqvi. This product is really targeted toward a hole we see in IBM's product line between the Model 50 and the Model 80. Our customers will be able to come up with a Model 80 machine with the same footprint, or a lot smaller, than the Model 50. It will also be a real high-performance, 20-MHz machine.

At the same time, we are coming out with another chip set that puts the performance well above the Model 80. So, we're trying to squeeze them from both sides, one from the low end which can be put on a desktop, and one from the higher-end which is a cache-based system.

MMS. In what ways does your design benefit the OEM customer?

Naqvi. What we want to bring to our OEM customer is essentially the same as in the past. Our machine would have to clearly be a better per-

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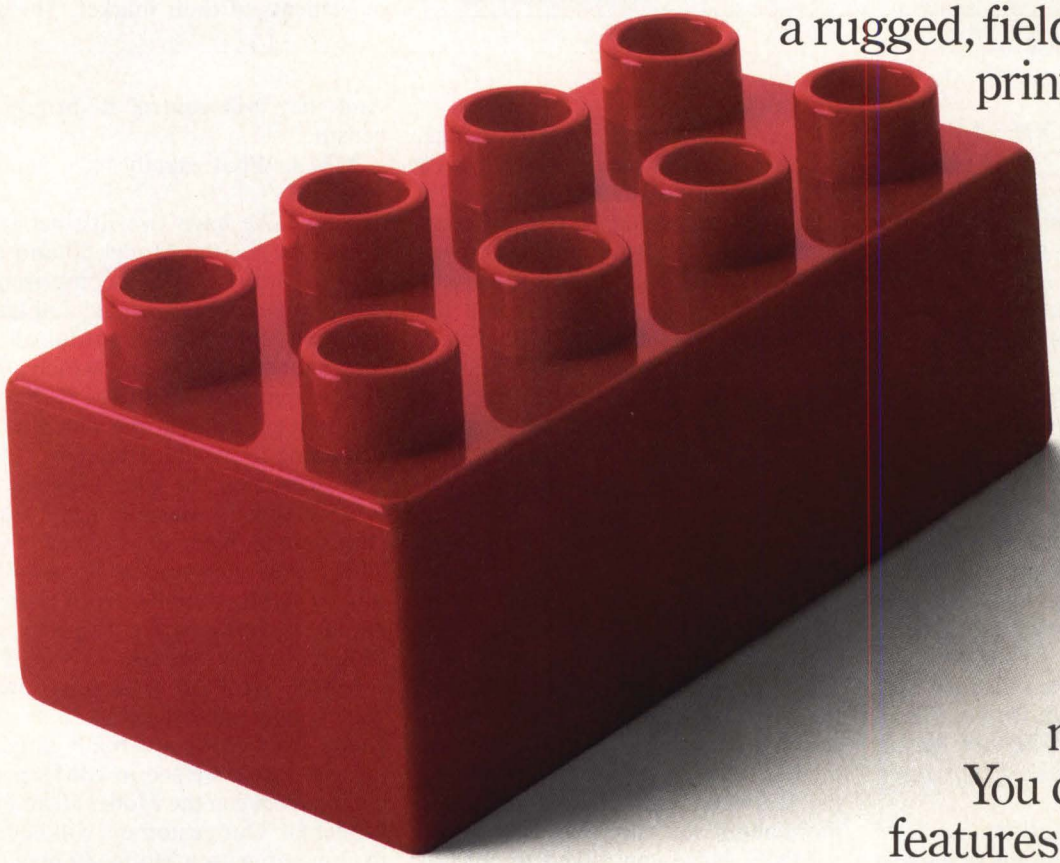

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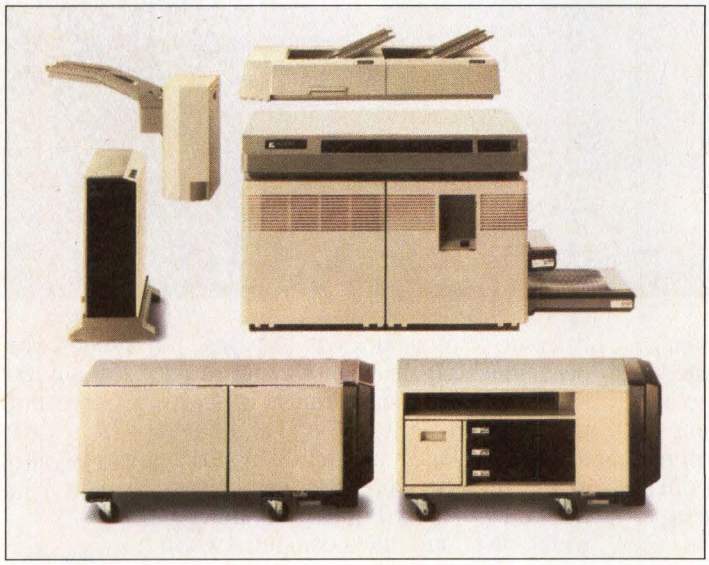

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has control signals for the IBM PC, PC/AT and Micro Channel. The 452, a superset of the 451, supports 256 colors in 640-by-480 resolution mode (IBM offers 16 colors) and 16 colors in 960-by-720 mode (IBM has four colors).

The 452 also runs a graphics cursor and has a scheme to move blocks of text around quickly via hardware assist. Chips claims its VGA controllers offer six to seven times the performance of IBM's. The reasons: a 16-bit VGA interface, vs. an 8-bit interface for IBM, and direct access to the CPU controller, giving Chips a 187.5-nsec cycle vs. a 300-nsec cycle for IBM.

For its part, Adaptec is bringing out three rigid disk controllers and a pair of Micro Channel-to-SCSI host bus adapters for the PS/2. For models 50, 60 and 80, Adaptec has a pair of controllers for drives with the ST506 interface. The company claims the controllers, the ACB-2610 and the ACB-2670, can burst data at transfer rates of 10M bytes per second, compared with IBM's 3.3M bytes per second.

The controllers also feature a read-ahead cache that loads a buffer with sector information beyond the original request. Adaptec believes this feature will show noticeable performance increases, not so much for single-user applications as for multi-

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forming machine than IBM's—not marginally better, but clearly a better machine than IBM's. Also, in order to compete in this marketplace, you have to make sure that the cost factor is such that they [OEMs] can come out with a machine that can be priced below IBM's. These two recipes haven't changed in the PS/2 market.

MMS. Why exactly is your system much cheaper than IBM's?

Naqvi. Our design allows them [OEMs] to get into a lower footprint board. In turn, that's a less expensive solution compared to an IBM which is using twice as many signal chips. With the reduction in chip count, and the way we have packaged them, and the way we are pricing it, we know our customers can build a system which can effectively compete with IBM.

MMS. What other benefits does your system solution offer besides a lower price tag?

Naqvi. IBM's PS/2s now have a standard clock rate of 10 MHz and offer a one-wait-state operation, and that's really much like the way they have done in the past. It's not surprising coming from IBM. However, the machine we have designed is going to operate at 16 MHz today, and the whole architecture is designed for 20 MHz. We have reason to believe that 20 MHz will eventually be a standard. We also have less than one wait-state in this system, less than IBM's.

At every level our effort has been to optimize more performance, while at the same time keep the cost factor in our minds since those are the two things that make our OEMs compete in the marketplace.

MMS. What about the design of IBM's Micro Channel? Has it presented any technical problems for you?

Naqvi. We believe the Micro Channel IBM has designed is very slow for the Model 50, so we have implemented what we call "bank memory timing." Because of this mass memory timing, our bus bandwidth is at least 60 percent faster than IBM's, even at 10 MHz. Typically their Micro Channel cycle time is 300 nsec; ours is 200 nsec. In most applications, you probably won't notice the significant improvement until you start accessing your hard disk or you try to send something over a Token Ring or an Ethernet card. Then you will see the advantage of this wider bandwidth.

Once you combine the Micro Channel bandwidth improvement and the system memory . . . the real performance benefit of our16-MHz system is twice that of the IBM Model 50. Even at 12 MHz, it's at least 30 to 40 percent better than IBM's. I don't think anyone will be designing a 10-MHz system. It has to be either 12 MHz or 16 MHz.

MMS. The obvious question, of course, concerns compatibility. Just how compatible are your PS/2 alternatives?

Naqvi. Compatibility, as far as we're concerned, is where we start. It's not something we do as another feature. We take it for granted that it will be 100 percent compatible. In this case, however, compatibility wasn't as easy as in the case of the IBM PC. IBM hasn't published any schematics for the PS/2 or for its

Mini-Micro Systems *editors team up to question Chips and Technologies about its PS/2 chip sets.*

user programs under UNIX and XENIX, where data is retrieved from storage in large blocks. The ACB-2610 uses the modified frequency modultation (MFM) scheme, while the ACB-2670 uses run-length limited (RLL), an encoding method that squeezes 50 percent more capacity from standard ST506 drives.

At the high end, Adaptec's ACB-26M20 is for drives using the enhanced small device interface (ESDI). Like its ST506 cousin for the PS/2, the ESDI controller supports a bus transfer rate of 10M bytes a second and can operate two 780M-byte ESDI drives. IBM's Model 80 top-end ESDI drive stores 314M bytes.

Adaptec hopes to makes a big splash with its AHA-1640, a SCSI host bus adapter that can run a variety of SCSI devices (magnetic and optical disk drives, tape drives, scanners and printers) off the PS/2 Micro Channel.

The AHA-1640 features a bus transfer rate of 8M bytes a second (compared to 3.3M bytes a second for IBM). According to Adaptec, in multitasking operations the host adapter can handle up to 255 tasks at a time, vs. only 3 simultaneous tasks for the IBM Model 80. In addition, the adapter supports synchronous and asynchronous peripherals concurrently. □

INTERVIEW:
CHIPS AND TECHNOLOGIES INC.

BIOS [basic input-output system], so it was difficult to know how to go about being compatible.

Our solution is to be 100 percent gate-level compatible with IBM. In fact, we are so compatible with IBM that when we build a machine, we can take the IBM PROM [programmable ROM], put in into our system and then boot it up from the IBM PROM. That's where we started. We have also added a number of enhancements that are built into our system. Since they are not there in IBM's PROM at boot-up time, the system goes through the BIOS to turn them on. Aside from these enhancements, however, the [boot-up] default is identical to IBM's, so there is no question of compatibility at boot-up time.

MMS. In designing your systems, you have had the opportunity to closely examine IBM's PS/2 design and system logic. What are some of your findings?

Naqvi. We've found some very interesting things. For example, IBM hasn't augmented and is not even using quite a few things that are there in the chips, which gives us an indication that they may have some secret development programs.

This is a benefit to us, since we have taken these unused registers and have tailored the BIOS from Phoenix [Technologies Ltd.] to take advantage of that.

MMS. Any idea what these hidden registers are being reserved for by IBM? Are they suitable for graphics or communications or database?

Naqvi. In some cases, we know that these things they are not using are suitable for graphics. And, on the logic side, they are mostly related to a bigger DMA [direct memory access] bandwidth and a larger address space for DMA. Other areas are more related to how you discover when you have a physical error in the system.

MMS. When you say you've found some undocumented DMA registers, what do you think that suggests about the addition of smart controllers and multiprocessors. Do you expect a multiprocessor machine from IBM?

Naqvi. What [IBM] has put in there are mainly some generic enhancements. But the higher DMA bandwidth would definitely be a help in multiuser applications.

MMS. What about your relationship with IBM. Is it strictly verbal or legal, or do you have some other arrangement?

Naqvi. We have been talking with IBM through our lawyers for the last six months, and we continue talking with them. They know exactly what we have done. Basically, we deal with IBM as a customer or, rather, a potential customer—even if they are not a customer. On the legal side we have worked along with IBM. Our point has been that we are not going to violate anybody's right to intellectual property.

MMS. What about recent disclosures that Computer Automation [Inc.] retains some key patents on the Micro Channel, and that IBM licenses these patents from them? Does that make things more difficult for you?

Naqvi. I think what it indicates is that all the pieces are falling into place right now. Most of it has to do with the status of these patents.

MMS. In the event you are wrong, and clone-makers make a PS/2 with your chips and IBM sues, are they going to be the one held accountable in court? More important, is there the possibility they can be found guilty of patent infringement?

Naqvi. What we're telling all our OEM manufacturers is go tell IBM what you are going to do. Tell them exactly what you are doing, and ask them what are the legal obligations before announcing anything. I don't think anyone will risk putting something on the market without first telling IBM what they are doing.

IBM will then tell them to fix it or pay up. They will be the final judge to tell if it fails or if it passes.

MMS. Do you have any plans to enhance your AT chip sets in such areas as extended I/O and extended memory since OS/2 is not Micro Channel-dependent? What specifically are you going to do in the AT area to support OS/2?

Naqvi. We had announced an AT chip set last September. If you look inside that, we have all of these built-in hooks to take advantage of OS/2. IBM has also done similar things in their PS/2 systems to take advantage of OS/2, and that's the reason that their 10-MHz PS/2 runs faster than their 10-MHz PC. We have the same things in our AT systems, and in fact they're already in production now. So, our [AT] machines can run at the same speed as the PS/2s.

As far as the EMS [extended memory specification] is concerned, we support the LIM 5.0 [the Lotus-Intel-Microsoft] standard on the chip itself.

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SYSTEM CONNECTIVITY

Apple, DEC set stage for mutual system integration

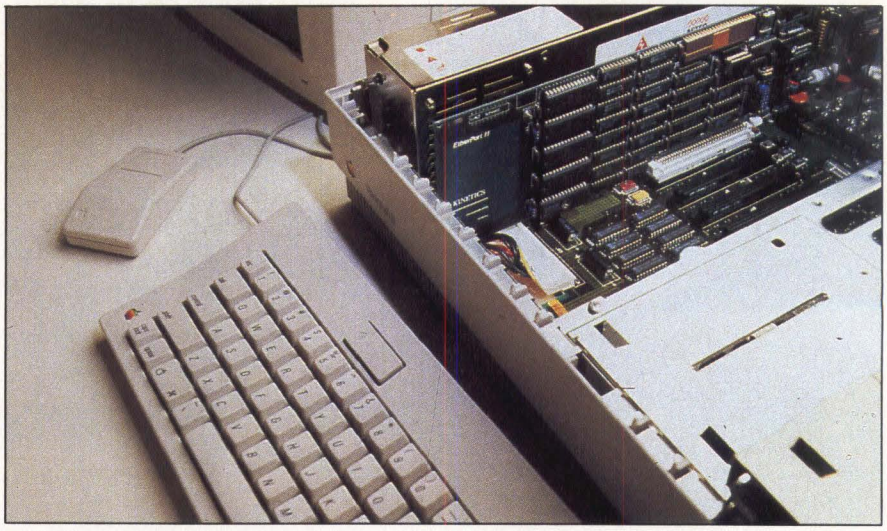
Mike Seither, Senior Editor

For the last two years a handful of pioneering vendors has doggedly pursued one goal: integrating the seemingly disparate worlds of Apple Computer Inc. and Digital Equipment Corp.

Companies that have tried include Kinetics Inc., Walnut Creek, Calif., a maker of Macintosh-to-Ethernet hardware. Others are Alisa Systems Inc., Pasadena, Calif, and Pacer Software Inc., La Jolla, Calif., with their Apple-to-VAX networking software for printing, file and mail services, terminal emulation and virtual disks.

A market for these connectivity products clearly exists. DEC estimates that Apple's Macintosh microcomputers have spread to more than a third of its 12,000 VAX minicomputer sites, which have an estimated million-plus users. So it is no great surprise that, while Apple and DEC have tacitly approved third-party efforts to link their products, they have decided to bring that effort home.

Apple Computer *chief executive John Sculley (left) and Digital Equipment CEO Kenneth Olsen agree to work toward "interoperability" among VAX and Apple Macintosh systems.*



Kinetics' Etherport II *for the Macintosh II provides networking within a work group or to a host.*

First, both Apple and DEC unveiled a joint development pact. Then DEC chief executive Kenneth Olsen made a rare appearance at a non-DEC show when he announced the agreement on Apple turf at the MacWorld Expo in San Francisco. The following week, Apple CEO John Sculley returned the favor by appearing in Boston at a DEC-sponsored conference.

Turf-swapping executives

At the Boston event, Olsen detailed plans for a wider "enterprise" networking strategy that will include not only Apple units but also computers running the OS/2 operating system from IBM Corp. and Microsoft Corp., as well as UNIX-based workstations.

Within the next few months, DEC will extend its networking reach to "selected"clone makers like Compaq Computer Corp., Ing. C. Olivetti & Co. S.p.A. and Zenith Data Systems. Right now, DEC's Network Applications Support (NAS) provides networking services to MS-DOS systems and connectivity to Big Blue's System Network Architecture (SNA) via a gateway.

Most analysts and industry watchers agree the announcement is significant and will benefit both companies. Even DEC and Apple third-party vendors are at least haltingly optimistic. David McCreery, president of Kinetics, says the joint development accord "legitimizes" what companies like his have been doing and will be good for business. However, he believes that Apple and DEC will not be able to move as fast as a smaller company to bring innovative products to market.

DEC plans to use Kinetics' Ethernet products in its 17 Advanced Technology Centers to demonstrate Macintosh-to-VAX connectivity. Whether DEC will eventually license that kind of technology is still unknown. "Buy vs. build is one of the options we always look at," says Dennis Schneider, DEC's U.S. sales manager for distributed computing products in Nashua, N.H. "But to speculate at this point would be inappropriate."

Goals now, products later

Don Cole, vice president of marketing at Alisa Systems, also is optimistic. He calls the Apple-DEC deal "wonderful, even though neither said what they plan to bring to the game. We have the window of opportunity on them now at any rate."

What the Apple-DEC alliance calls

for is a "consistent set of application programming interfaces which [independent software] developers will use to write distributed applications, leverage industry-standard networks and interchange documents," according to the joint DEC-Apple annnouncement. The specifications for those programming interfaces are scheduled for publication in August at a developers conference sponsored by Apple and DEC.

No specific products have yet been announced by the two computer giants. At this point the agreement merely outlines 10 broad goals:

- Distributed applications will be able to access VAX services.
- Macintoshes using Apple's network file protocol will be able to get to files stored on VAXes.
- Macintoshes and VAXes will be able to exchange documents using DEC's interchange format.
- Desktop publishing devices available from both companies, such as laser printers running Adobe Systems Inc.'s PostScript page description language, will be able to communicate over a network.
- Macintosh computers will have access to other hosts and networks by emulating DEC terminals and supporting ASCII characters and X Window graphics.
- Macintosh computers will have access to DEC's electronic mail services, including both ALL-IN-1 and X.400.
- Macintoshes will be able to use DEC's videotex and conferencing facilities.

VAR wars are a concern in Apple-DEC alliance

Mary Jo Foley

Even though Digital Equipment Corp. and Apple Computer Inc. have decided not to go into too much detail on their developmental partnership until August, speculation is rampant on what the long-term affects will be on value-added resellers.

Specifically, there is concern that Apple and DEC VARs will butt heads if both camps try to market their respective workstations to the same scientific and engineering VAX customers—Apple pushing its Macintosh, DEC its systems like the microVAX and VAXstation 2000.

To date, however, these VARs have almost never competed directly, even at the desktop level, says William Manning, an analyst with market researcher International Data Corp., Framingham, Mass. In fact, only a handful of resellers now carry both DEC and Apple equipment.

The new alliance, however, could dramatically change this scenario. "Apple wants to push the Mac as an engineering workstation, but DEC already sells engineering workstations," Manning says. Both parties will initially cooperate while the ink is still wet on their agreement, but this may only be for the short term, he speculates.

Currently, Apple derives between 5 percent and 8 percent of its total sales ($2.6 billion in 1987) through VARs. The $7.6 billion DEC, on the other hand, garners 27 percent to 30 percent of its revenues via VARs, Manning points out.

Industry watchers at Dataquest Inc., San Jose, Calif., say the two companies are a good fit. "Although DEC offers a very respectable line of PCs and technical workstations, the desktop device has never been its strong suit," says a Dataquest research bulletin. The addition of the Macintosh will enable DEC to rectify this shortcoming.

At the same time, "Apple's alliance with Digital opens the door for corporate buyers to include the Macintosh as part of their long-term computing strategies," Dataquest notes. With many corporate buyers confused about the availability and benefits of OS/2, the operating system for IBM Corp.'s PS/2 family, a DEC-Apple team could profit rapidly.

Zero impact on customers

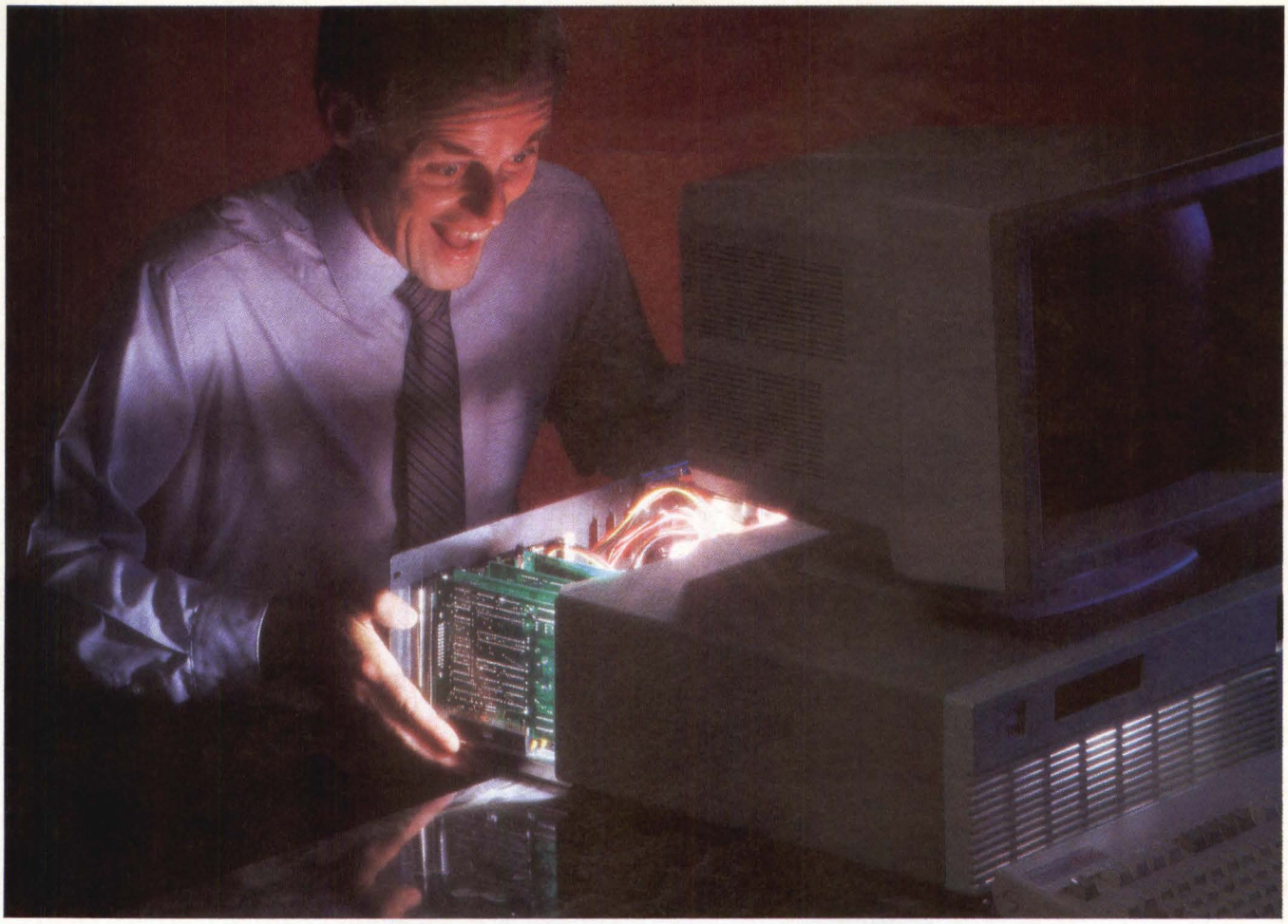
For their part, VARs, while cautious, are extremely interested in the implications of the agreement. They are generally optimistic about the partnership. Of the half dozen DEC VARs contacted by *Mini-Micro Systems,* all were well aware of the January DEC-Apple announcement, but none seemed to be concerned about the possibility of adverse effects from the relationship.

One purchasing agent of DEC equipment said that, "The two architectures (DEC and Apple) have been so different that we've never looked into Apple. So, increased connectivity in the short term will have zero impact on our customers."

More typical are reactions like that of W. Lowell Putnam, president of Video Communications Inc., a vendor of MicroVAX- and PDP-based television-station software: "In the short term, there will be no significant impact on our business. We're waiting to see any specific products that result," he says. But since the Feeding Hills, Mass., company uses Macintoshes extensively in its own offices, as well as DEC terminal emulators in its road demonstrations, it is keeping close tabs on the deal, Putnam says.

Michael Kinkead, president of one of DEC's largest VARs—The Saddlebrook Co., a $27 million Cambridge, Mass., vendor of financial services software—was perhaps the most enthusiastic of the VARs surveyed. "DEC and Apple make an outstanding team," he says. "By forming this strategic partnership, these technological leaders can meet the pressing market needs for powerful yet affordable workstation capabilities in a networking environment that's still unsurpassed for flexibility and ease of cost-effective, incremental growth."

Mary Jo Foley is a business and technology writer based in Washington.



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CIRCLE NO. 12 ON INQUIRY CARD

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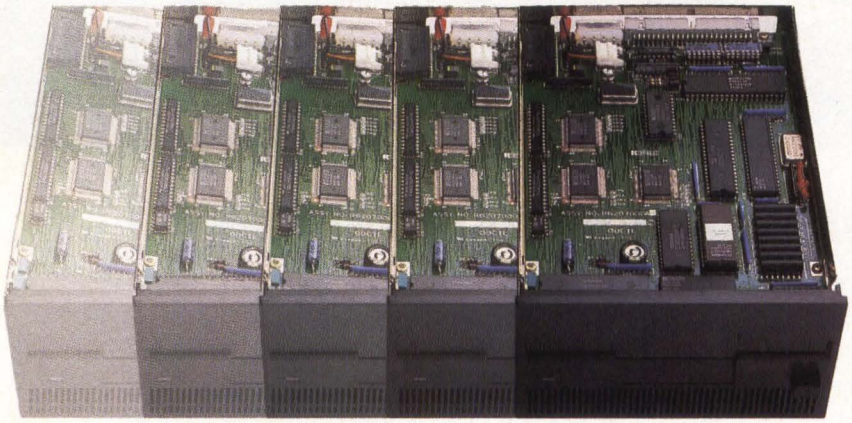

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CIRCLE NO. 13 ON INQUIRY CARD

- Jointly developed database specifications will allow Macintoshes to access data on VAXes over DECnet/OSI network protocols.
- Apple's proprietary local area networks will be able to tie into wide area networks under Phase V of DECnet/OSI.
- There will be a "unified" method to manage AppleTalk networks and DECnet/OSI.

Desktop credibility

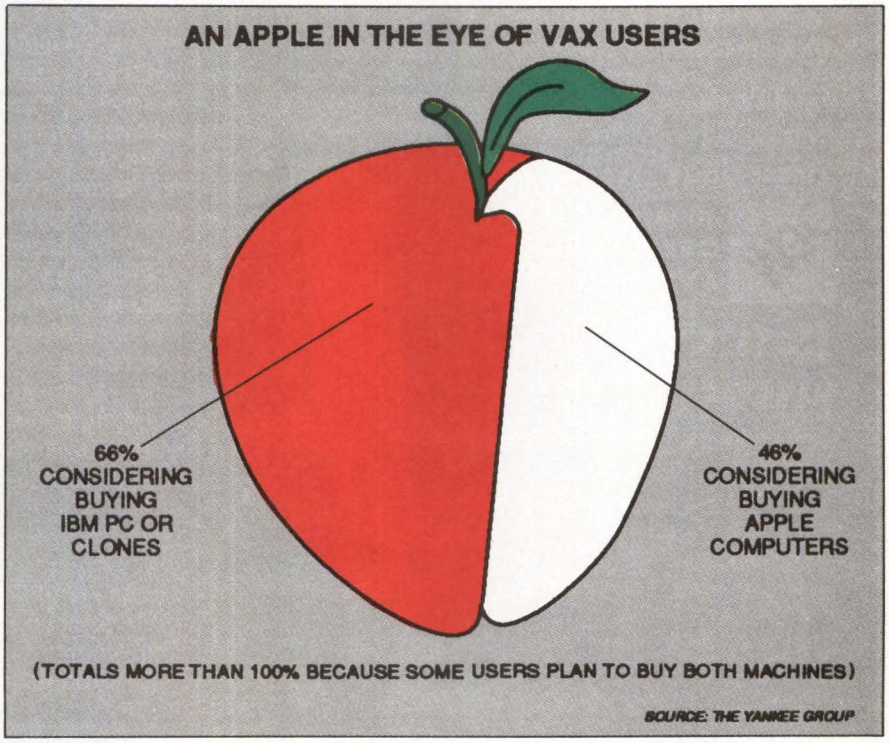
The Macintosh-to-VAX integration, as well as DEC's "enterprise" networking scheme, will be based on Open Systems Interconnection (OSI), the seven-layer communications model proposed by the International Standards Organization. Some industry observers note that DEC's recent announcements suggest that the company is getting serious about OSI.

"The issue was forced upon DEC by its customers," declares Steve Widen, an analyst with International Data Corp., Framingham, Mass. "They've been waiting for straightforward answers on DEC's commitment to OSI." By allying itself with Apple, he adds, DEC may bring to bear more influence on how the OSI standards eventually stack up.

Beyond that, the deal also helps DEC in an area where it has failed in the past—getting access to a credible desktop computing platform to compete with the IBM PC. In San Francisco, Olsen called Apple the "leader in innovative ways to interface humans and computers." He also stated that he clearly sees the Macintosh as a strategic weapon in his on-going war with IBM.

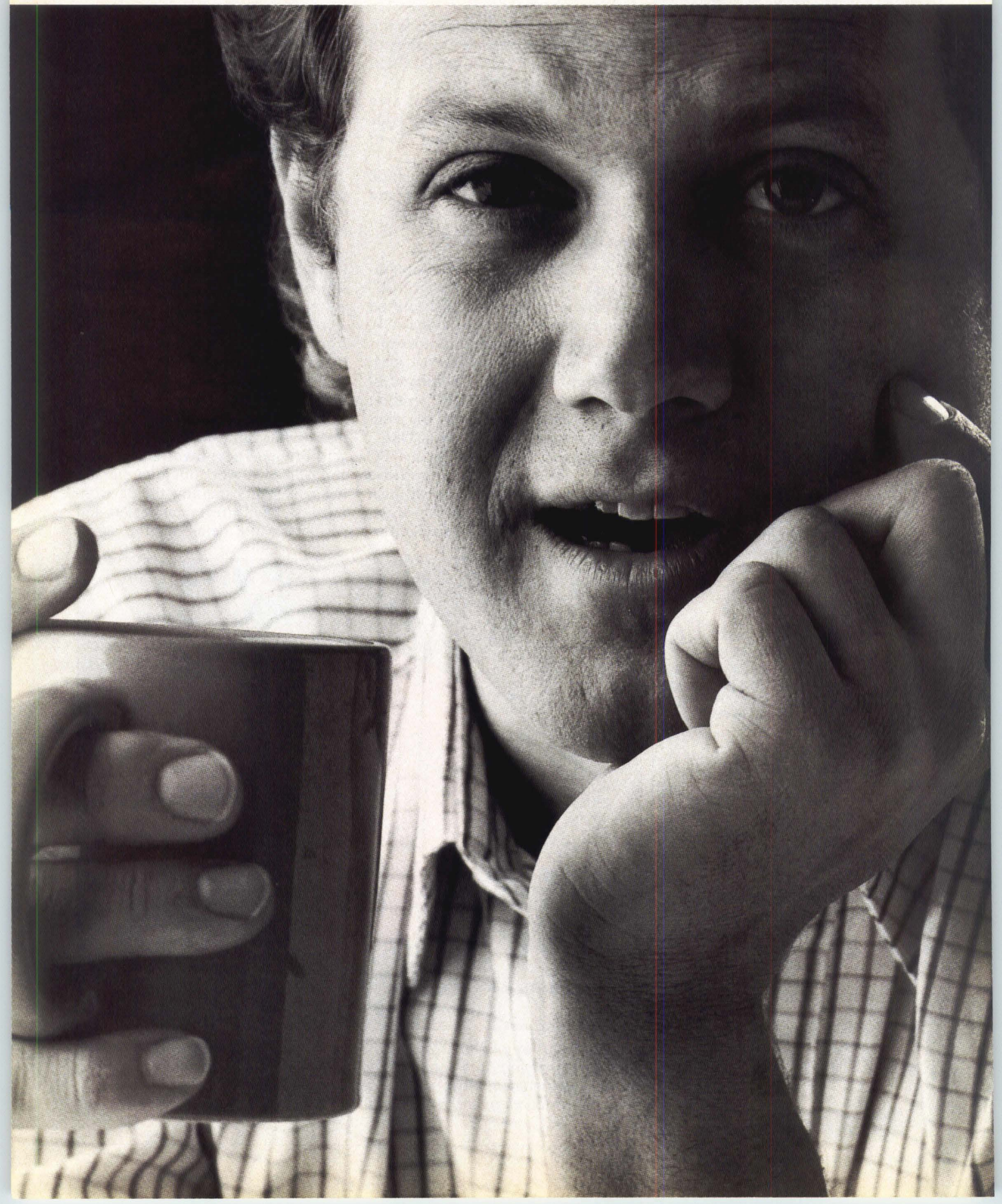
As for Apple, it too stands to gain from the joint development deal—perhaps more than DEC—since the deal will reinforce Apple's move into big-time business accounts.

Most industry observers agree the most significant announcements are yet to come. These involve how DEC and Apple will work out joint marketing agreements and how the development pact will effect their dealers and resellers. More details of the agree-



A recent survey *of 540 Digital Equipment users shows that nearly half are considering buying Apple personal computers to connect to their VAX systems. Other findings: Most employ their VAX systems in business applications like accounting, and 81 percent say IBM could not lure them away from DEC.*

"I shop the specs



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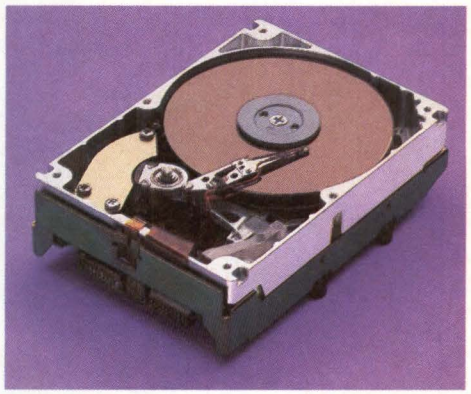

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CIRCLE NO. 14 ON INQUIRY CARD

ment and its impact on VARs and system integrators will be forthcoming at a developers' conference scheduled in August, says Olsen. □

Apple's UNIX extends the reach of Macintosh

It will be months before specifications are available from Apple Computer Inc. and Digital Equipment Corp. to unite the Macintosh and VAX computing worlds via the Open Systems Interconnection model over DECnet. But system integrators who are in a hurry to extend the reach of Apple's Macintosh II have a solution ready now—A/UX.

After numerous delays in bringing it to market, Apple finally announced the availability of A/UX at the Uniforum show last month in Dallas.

A/UX, which Apple is shipping chiefly on preconfigured 80M-byte rigid disks, contains several key characteristics. First, it includes Apple's implementation of AT&T Co.'s UNIX System V.2 operating system and meets AT&T's System V Interface Definition. In addition, it includes most of the Berkeley UNIX Version 4.2 extensions as well as an automatic recovery system.

Networking support includes Ethernet, the TCP/IP protocols and the Sun Microsystems Inc. Network File Service. The Macintosh Toolbox, which developers need to create UNIX programs with the graphical Macintosh interface, also is included.

UNIX developers have a choice of porting existing applications quickly by using the standard UNIX interfaces, such as the C, Bourne and Korn shells, and X Window Version 10.4, according to Apple. One program with a quarter million lines of code was ported in a day, according to Apple product manager Bill Jacobs.

Porting UNIX and adding the Macintosh interface will take months, he adds. However, A/UX users can still use existing Macintosh applications by switching to the Macintosh operating system. That switch takes about 60 seconds.

Apple says it is shipping A/UX on rigid disks partly because of a growing "shortage of UNIX gurus" and partly because it wants to make life easier for users. Later this year, Apple will make tape distribution an option. Users who like to torture themselves will be able to get A/UX on more than 50 diskettes.

Current Macintosh II users can buy upgrade bundles that include internal or external rigid disk drives, 4M bytes of RAM and a paged-memory management unit that requires an authorized technician to install. The internal version lists for $4,879, while the standalone drive costs $5,459. A/UX also comes bundled with a Macintosh II entry-level monochrome monitor ($8,597), color monitor ($9,396) or development system ($8,399), which has no monitor.

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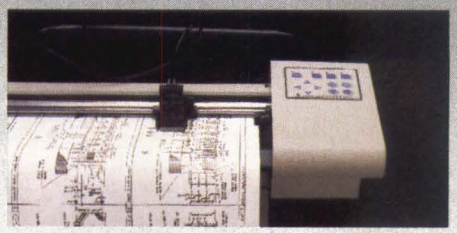

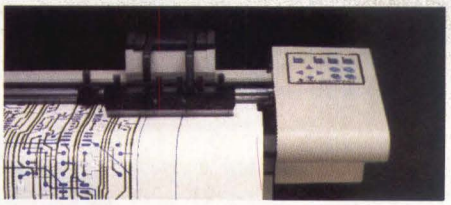

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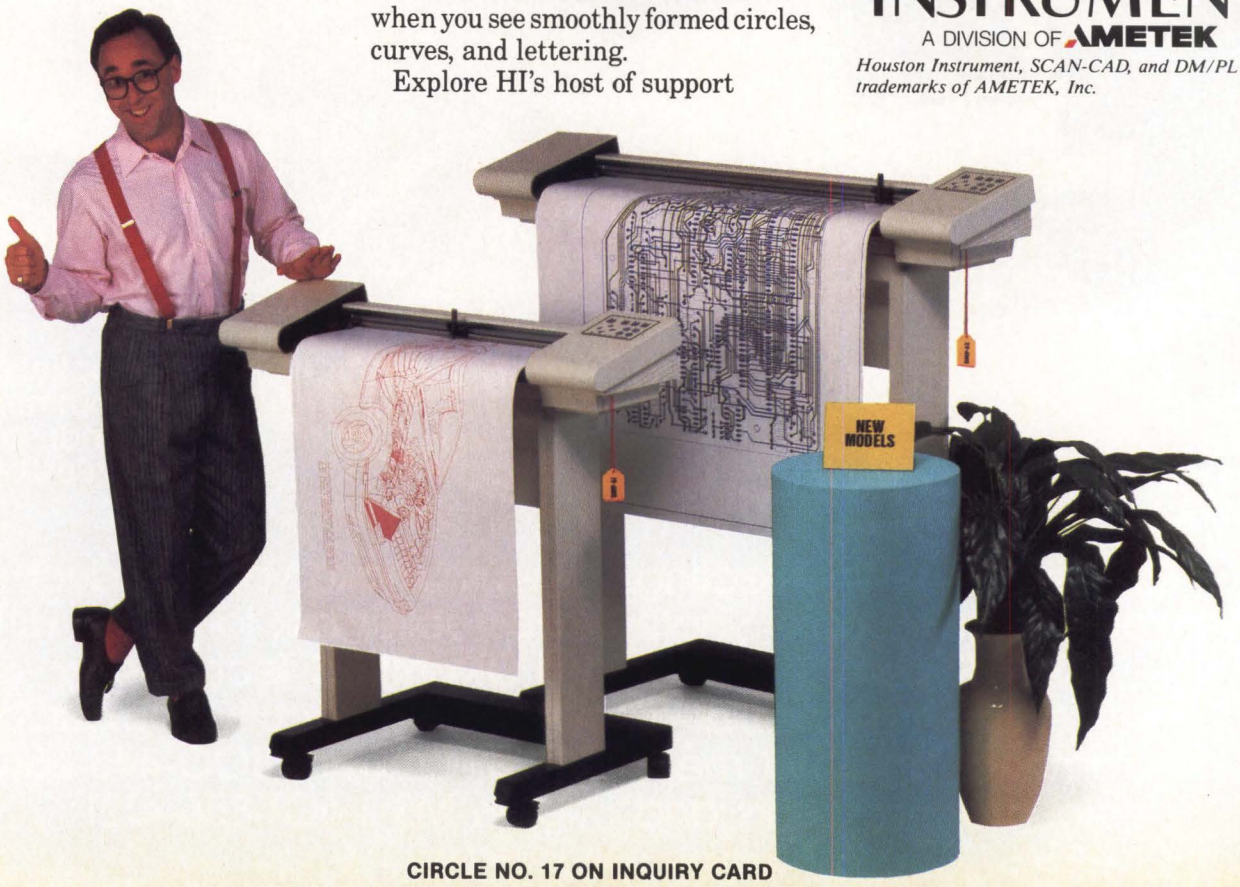


CIRCLE NO. 17 ON INQUIRY CARD

EXPLODING
FIVE MYTHS ABOUT ISDN

Don't let uncertainty about prices and international squabbling over standards confuse you. ISDN is coming. And you'll have to deal with it

James F. Donohue, Managing Editor

For many system integrators, VARs and OEMs, Integrated Services Digital Network (ISDN) is either a mysterious continent shrouded in myth or an attempt by AT&T Co. to put its hands in everybody's pocket.

In reality, it is neither. While AT&T backs ISDN—and stands to make money off it—so does, and will, every other telephone company in the world. And so will vendors of communications equipment and services. And so will system integrators, OEMs and VARs.

However, there is no doubt that confusion and doubt shroud ISDN. And that's what creates the myths you hear. ISDN is simple enough as a concept. It's an on-going, international effort to create protocols to combine circuit-switched, mostly voice service (the dial-up telephone) with packet-switched, mostly digital service (for example, local area networks) in a totally digital network that would carry voice, computer data, facsimile and video.

It's coordinating the international aspect of the project that is causing most of the trouble. That coordination means creation of standards, and many vendors of communication equipment—especially those in the United States—look on standards as ammunition their competitors will use to steal customers.

Notes Mary A. Johnston, senior consultant in the Telecommunications Consulting Group at BBN Communications Corp., Cambridge, Mass., "The goal of universal standards and limited interfaces seems out of sync with the pluralistic, competitive telecommunications scene in the United States." That won't stop ISDN, she says, but it may slow it down. "Vendors that gain competitive advantage from proprietary protocols may have little interest or motivation to hurry adoption of ISDN."

Johnston adds, "I'm becoming more and more convinced that there really will be some real value to ISDN. It's not going to be across the board, and I'm not sure it's going to be the centerpiece of a lot of people's architectures. But in selected application areas, like telemarketing, it's going to be very, very competitive and very powerful."

Here's a look at five of the more commonly heard myths you're hearing.

MYTH 1

ISDN is too controversial to ever go into effect.

What is controversial is how and when ISDN is coming, and what part American suppliers are going to play in it.

Sorry, but that's just not so. ISDN is coming. There's no real debate about that. "ISDN will eventually be widely available," says BBN's Johnston, "because the long-term survival of the regional Bell operating companies [RBOCs] hinges on widespread customer acceptance of ISDN services."

What is controversial is how and when ISDN is coming, and what part American suppliers are going to play in it.

Right now, the Europeans and the Japanese are moving with considerable speed into ISDN trials and, even, implementations. The concern is that the Japanese and Europeans, through use, will establish de facto international standards, leaving Americans out in the cold.

The European nations, led by France, Italy, the United Kingdom and West Germany, have set up aggressive plans to test and install ISDN that will be compatible across Europe.

The European Parliament has set a series of deadlines for the implementation of ISDN. An important one falls at the end of 1988, at which time the Parliament's 12 member states are to offer 64K-bit-per-second switched digital service that complies with ISDN and which can be integrated into a European network.

In Japan, Nippon Telegraph and Telephone Corp., having conducted trials since late 1984, plans to install its first commercial ISDN services this year for Tokyo and Osaka.

There's activity just north of the U.S. border as well. Recently, Bell Canada opened an ISDN demonstration center in Ottawa and identified the first three customers for its fledgling ISDN service. The customers, federal government agencies in Ottawa, will use DMS-100 digital switches manufactured by Northern Telecom Canada Ltd. for six ISDN applications, including digital telephony and wide area networking.

Meanwhile, in the United States, ISDN is stuck in often acrimonious debate among high-

Where the RBOCs have ISDN trials in progress

AMERITECH

Ameritech Information Technologies Corp, Chicago:
Trial at Oakbrook, Ill. Affiliates are McDonalds Corp. and Bellcore. Equipment suppliers include AT&T, DEC, Fujitsu America and NEC.

Bell Atlantic

Bell Atlantic Corp., Philadelphia:
Trial at Red Bank, N.J. Affiliate is Bellcore. Equipment suppliers include Siemens and Bellcore.

BELLSOUTH

BellSouth Corp., Atlanta:
Trial at Boca Raton, Fla. No affiliates have been announced. The equipment supplier is Siemens. The trial will mainly involve switch calls between Siemens and Southern Bell Telephone Co. in Boca Raton.

NYNEX

Nynex Corp., White Plains, N.Y.:
Trial at Boston and New York City. Affiliate is Bellcore. Equipment suppliers include New England Telephone Co., New York Telephone Co. and Siemens.

PACIFIC TELESIS

Pacific Telesis Group, San Francisco:
Trial at San Francisco, San Ramon and Sunnyvale, all in California. Affiliate is Bellcore. Equipment suppliers include AT&T, Northern Telecom and NEC America.

Southwestern Bell Corporation

Southwestern Bell Corp., St. Louis:
Trial at St. Louis and Dallas. Affiliate is Bellcore. Equipment suppliers include AT&T, Northern Telecom and Siemens.

USWEST

U.S. West Inc., Englewood, Colo.:
Trial at Portland, Ore. Affiliates are Bellcore and U.S. National Bank of Oregon. Equipment suppliers include Harris Corp., Hayes Microcomputer Products Inc., Northern Telecom and NEC.

Trial at Denver. No trial affiliates have been announced. NEC is the main equipment supplier

Source: *ISDN Newsletter, 214 Harvard Ave., Boston, Mass., (617) 232-3111.*

handed judges, bumbling state and federal regulators, scheming suppliers, cautious investors and users who either don't want ISDN or don't think they can afford it.

They want 'equal inefficiency'

State and federal regulators come in for a lot of criticism. "The trouble with the rulemakers," says Leonard Hyman, first vice president at Merrill Lynch Capital Markets, New York, "is that they want all the players at equal inefficiency."

Hyman told a conference on ISDN sponsored in Dallas by the International Council for Computer Communications, "Regulators do not want to let anything happen until they can predict everything that will happen. So they tend not to let anything happen."

Hyman cynically quips about regulators that "they will become irrevelant. They will end up some day doing useful work."

Regulators, of course, have a different view. Says Robert J. Keegan, a manager at the Massachusetts Department of Public Utilities, Boston, "I believe that the overall goals of the local operating companies and state regulators responsible for protecting the public interest coincide to an unprecedented degree!."

As proof of how state regulators are willing to help the telephone companies, Keegan notes that, in 1984 when the Federal Communications Commission was considering new equipment depreciation schedules for local telephone companies, the Massachusetts regulators gave New England Telephone Co. about twice the depreciation recommended by the FCC. Keegan describes this as "an effort to begin to deal with a significant ongoing problem:" helping local telephone companies control costs.

No matter who's at fault—or even if anybody is at fault—a lot of people are losing patience with what they see as bumbling, infighting and turf battles. Snaps Thomas E. Bolger, president of Bell Atlantic Corp., Philadelphia, "My God! We cannot afford to keep debating this much longer. It's been ten years. These people are bringing us, for the first time in 100 years, to the point where we're lagging in networks."

'The trouble with the rulemakers is that they want all the players at equal inefficiency.'

The U.S. telephone companies can't agree on standards for a nationwide ISDN.

It does look as if there will not be a true and transparent nationwide ISDN hookup in the United States when all the pieces are in place in the early 1990s. The seven RBOCs that replaced AT&T after its court-ordered breakup are testing and installing equipment that, to varying degrees, is incompatible with the equipment in other Baby Bell areas.

While this sounds insane on the surface, there may be a method to the madness. Bruce DeMaeyer, president of Ameritech Communications Inc., Schaumburg, Ill., a vendor of communications equipment, says the Baby Bells have set out deliberately to build little "islands" of ISDN centered on big cities like New York and Los Angeles.

In these islands, he says, the RBOCs will thoroughly test ISDN, trying out lots of hardware and software. (DeMaeyer calls these "flavor of the week ISDN.") That process is going on now, and it will continue through most of 1988.

In 1988 and 1989, he says, the RBOCs will work on expanding service across multiple exchanges, but still within the isolated islands. Finally, about 1992, will come the push for nationwide connectivity. The RBOCs will link up the islands following techniques pioneered by the local area network industry: building gateways to link one geographic area with another.

Link up the 'islands'

Some RBOCs, like U.S. West Inc., Englewood, Colo., already are working on the problems of connecting disparate equipment in different islands. U.S. West recently routed a call from a Digital Equipment Corp. VAXmate in Phoenix through a Northern Telecom Ltd. DMS-100 switch to an IBM PC in Denver.

Greg Miller, a manager at U.S. West, says of the Phoenix-Denver connection, "From a customer perspective, this means different vendor equipment can be used to send data between different ISDN switches. This is a key in developing viable customer products and services."

While AT&T backs ISDN—and stands to make money off it—so does, and will, every other telephone company in the world.

However, all is not well in ISDN connectivity, internationally or in the United States. ISDN is in such a state of flux that even the few standards for connectivity that do exist are confused in their implementation.

Notes Robert Jordan, a manager at IBM Corp.'s Rolm Systems Division, Santa Clara, Calif., "There is an X.25 standard (CCITT protocols for hooking into a public network), but at last count there were something like 400 different implementations." Jordan adds, "IBM/Rolm supports the drive for universal ISDN standards, but the key is that they be truly standard and truly universal."

MYTH 3

IBM and DEC don't support ISDN.

It's true that neither IBM nor DEC has been at the forefront, but in recent months both have been coming around to support ISDN.

IBM had been holding out against an ISDN in which a lot of intelligence was packed into the network. Big Blue had preferred to keep the intelligence at the customer site, where its computers live, not on the telephone network, where arch-rival AT&T lives.

But now, Thomas J. Pierce, program manager for interconnection with IBM's Information Systems Group, is saying that Big Blue supports ISDN, even with intelligence on the network itself. "IBM, the switch manufacturers and the carriers—all of us are in favor of intelligence being provided inside the network as well as on customer premises," Pierce says. "As far as network services are concerned, we believe that, as long as they are provided competitively, they can be provided on the network or at the customer site."

It's true that neither IBM nor DEC has been at the forefront, but in recent months both have been coming around to support ISDN.

(The telephone companies, for their part, say they also are willing to go either way. "ISDN services should be embedded *and* attached," says Ray Albers, vice president for technology planning at Bell Atlantic Corp.'s offices in Arlington, Va.)

There is another issue for IBM and ISDN: will SNA (IBM's mainframe-based networking scheme) support ISDN? According to Denis W. O'Shea, telecommunications consultant with IBM at Purchase, N.Y., "No significant structural changes will be needed in SNA" to make it compatible with ISDN.

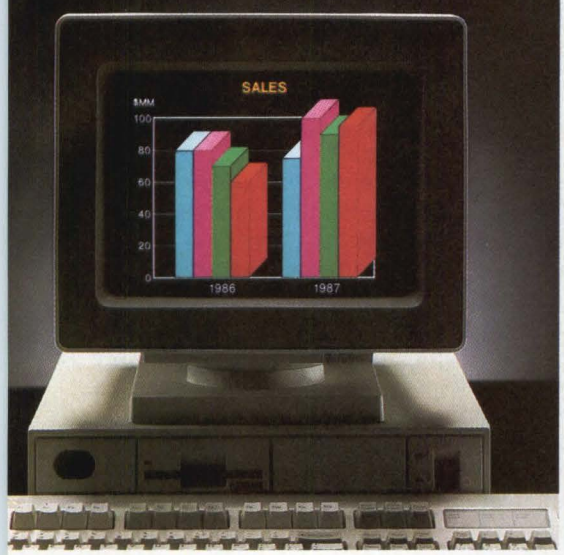
IBM plans to test prototype ISDN adapters through Nynex Corp. in New York City this April (six IBM workstations and controllers in two Nynex locations). Ed Thomas, corporate director for advanced technological development at Nynex, New York City, says about the compatibility of SNA and ISDN, "Currently, SNA lacks software to establish a 'handshake' in a switched network. But there's no question

WHERE IBM PLANS ISDN FIELD TRIALS, DEMONSTRATIONS AND STUDY PROJECTS

Nynex Corp.	
1988	first trial with U.S. carrier and first IBM trial to test workstations and controllers with experimental adapters.
Deutsche Bundepost	
1988	test basic rate access on 8751 PBX. In West Germany
Norwegian Postal Telephone and Telegraph	
1988 and 1989	test primary access on 8751, VM application.
IBM/Rolm, Santa Clara	
Mid-1988	demo basic access for workstations and controllers connected to 9751 PBX and primary access for CBX II and IBM 9750 connected to an ISDN.
BERKOM Project	
in progress	multivendor study of broadband ISDN in West Germany, applications, standards, workstation requirements, funded by Deustsche Bundepost. IBM participates primarily through its European Networking Centre in Heidelberg.
Multinational Asian Study	
in progress	study of customer benefits of ISDN and workstation requirements, coordinated by Japanese Ministry of Posts and Telecommunications.

Source: IBM Corp.

FROM CREATION TO COMMUNICATION



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CIRCLE NO. 18 ON INQUIRY CARD

Recently, DEC plunged into ISDN, offering its computers as terminals on ISDN networks, promising to build ISDN compatibility and involving itself in several ISDN trials.

that IBM has the ability to provide that software. That's one of the reasons for the trial."

Now Rolm's a division

Recently, IBM hooked up with United Telecommunications Inc. to build a data base system for an emerging technology called Signaling System 7 (SS7), which puts a great deal of intelligence on the line. And, in a move widely believed to be part of an ISDN strategy, IBM gave division status to Rolm Corp., its PBX subsidiary, changing the name to Rolm Systems Division (RSD). The action puts RSD, with headquarters in Santa Clara, Calif., under IBM's Information Systems Group.

"The story is that we're for it," says Pierce. "We feel we are in a leadership role of understanding what ISDN is and what are some of the hurdles that we have to get over. At the same time, we are actively involved in some of the field trials and standards activities. We perceive ISDN as a real potential customer benefit."

For its part, DEC had been avoiding participating in the voice industry almost entirely, pushing instead its computer-to-PBX interface (CPI) that allows computer communications through PBXs.

Recently, however, DEC plunged into ISDN, offering its computers as terminals on ISDN networks, promising to build ISDN compatibiliy and involving itself in several ISDN trials, including the Illinois Bell Telephone Co. show at the Oak Brook, Ill., headquarters of fast-food giant McDonalds Corp. And nine of the largest telephone companies are testing DEC database systems as part of SS7.

Fred Koved, DEC's telecommunications business development manager, says, "We see ISDN technology employed in the wide-area communications marketplace, providing high-speed, facility-to-facility communications. It's clear that an improvement to wide-area data communications systems improves distributed data processing and its environment."

Koved adds that support for ISDN is part of DEC's continuing support of standards. Koved, and just about everybody else working on ISDN, believes standards are key to the success of the service. "Integrating voice, data and video communications technology must be standardized," Koved says.

MYTH 4

Hardly anybody wants ISDN.

It's true that a lot of people don't want ISDN, at least not in the immediate future, and that this is putting a crimp in development and sales of ISDN equipment and services. "There does not seem to be the demand for ISDN that will lead to an early rollout," concedes Daniel E. Crawford, senior vice president for network operations at MCI Communications Corp., Washington.

Big companies, like The Travelers Corp., the insurance giant in Hartford, Conn., already have a sort of ISDN in place in the form of leased T1 lines and see no need to buy the telephone company's service. Travelers won't need ISDN, says Travers Waltrip, the company's vice president for data processing, until sometime in the future when ISDN is a nationwide network. Even then, says Waltrip, Travelers will "need it only at the interface, where we join the public domain network, to reach the small companies we do business with."

On the other hand, residential telephone users and small businesses don't think they need the speed and power of ISDN—not now, and maybe never. They're happy with plain old telephone service (POTS), especially since ISDN may be expensive.

Richard Snelling, president of Southern Bell Telephone & Telegraph Co., Atlanta, says, "ISDN will cost users about 1.5 times POTS." That's become the standard party line about pricing from the telephone companies. But Snelling adds, "We're not going to price ISDN. We're going to price service. It could be that, with value added features factored in, the price could be as much as 1.7 times POTS."

Soon after that, however, will come the "economies of scale" so familiar in the computer industry. The price of ISDN could drop to 1.2 times POTS quickly, Snelling says.

As cheap as twisted-pair

Casimir S. Skrzypczak, vice president for science and technology at Nynex, White Plains, N.Y., predicts that "by 1995 ISDN will cost no more than regular twisted-pair copper wire."

Next to worries about standards, it's this jumping and jiggling about price that has tele-

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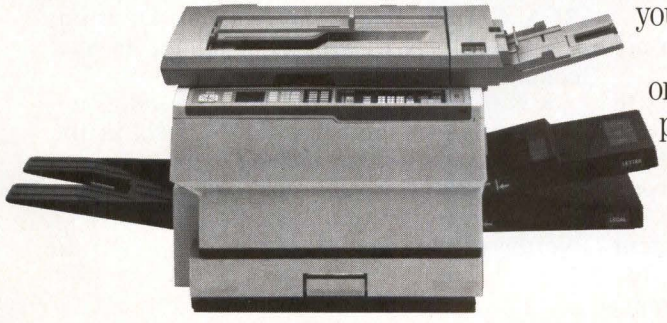

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phone users most worried about ISDN. They agree with Dr. Irwin Dorros, executive vice president for technical services at Bell Communications Research Inc. (Bellcore), Livingston, N.J., when he quips, "If you chose to go for broke on ISDN, you may go broke."

While waiting for big companies to perceive a need for ISDN and for small users to get the price they want, telephone executives like Skrzypczak think their best target markets are medium size companies and operations, like school districts, that already have some sort of advanced telephone service, especially Centrex (a public switching service).

A major problem. "AT&T is absolutely lousy at selling anything to anybody." That comes from a vendor who wants to sell ISDN gear through AT&T. He asks not to be identified. "There is no fire in the belly" at AT&T to sell ISDN, he says.

Where the RBOCs plan commericial ISDN service

Bell Atlantic Corp., Philadelphia
**Commercial service is due this year for the Commonwealth of Virginia and other unnamed customers. The locations will be in Virginia; West Virginia; Maryland; Pittsburgh, Penn.; and Washington, D.C. AT&T and Northern Telecom will supply equipment.

BelSouth Corp., Atlanta
**Commercial service starts this year in Atlanta. Customers are Trust Co. of Georgia, Prime Computer Inc., AT&T Network Systems Group and Hayes Microcomputer Products Inc. Equipment suppliers include AT&T, Northern Telecomm and Ericsson.

Southwestern Bell Corp., St. Louis:
**Commercial service is due to start about midyear for Shell Oil Co. and Tenneco Inc., both in Houston. The service contract covers ten years. AT&T will supply the central office switch; the customers will pick their own customer-premises equipment.

Source: *ISDN Newsletter, 214 Harvard Ave., Boston, Mass., (617) 232-3111.*

When ISDN becomes a reality, I'll be stuck with foreign protocols and foreign suppliers.

American companies are not likely to be shut out entirely as ISDN vendors.

As noted above, that's a real danger. Merill Lynch's Hyman tells U.S. vendors of communications equipment, "You'll develop ISDN products. You'll sell them here against foreign competition. And you won't be able to sell them overseas" because of restrictions on imports in Europe and Japan.

Nevertheless, American companies are not likely to be shut out entirely.

Expect the affiliates of the seven RBOCs to be the big players, at least at first (see boxes). The seven did about $1.7 billion in telecommunications business in 1987 and are actively involved in ISDN trials.

Another set of major players will be the four so-called independent affiliates: the SNET Telecommunications Group, New Haven, Conn.; Centel Communications Systems, Bensenville, Ill.; Contel Executone, Norcross, Ga.; and Rotelcom Inc.'s Network Systems Division, Rochester, N.Y. They did a bit more than $700 million in telecomm business in 1987.

Among the non-affiliated suppliers, Tel Plus Communications Inc., Boca Raton, Fla., seems to hold the biggest market share with about $280 million in telecomm sales in 1987. Next is RCA Corp.'s Telephone Systems Division, Cherry Hill, N.J., with $130 million in telecomm sales.

It is true, however, that foreign vendors are very active in the early ISDN trials in the United States. These include Japan's Fujitsu Ltd. and NEC Corp., Europe's Siemens AG and Ericsson Information Systems and Canada's Northern Telecom. □

Interest Quotient (Circle One)
High 517 Medium 518 Low 519

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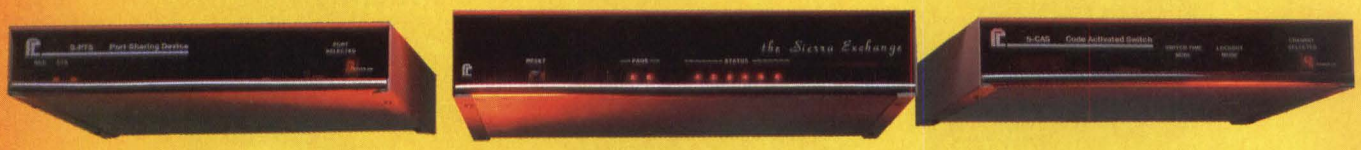

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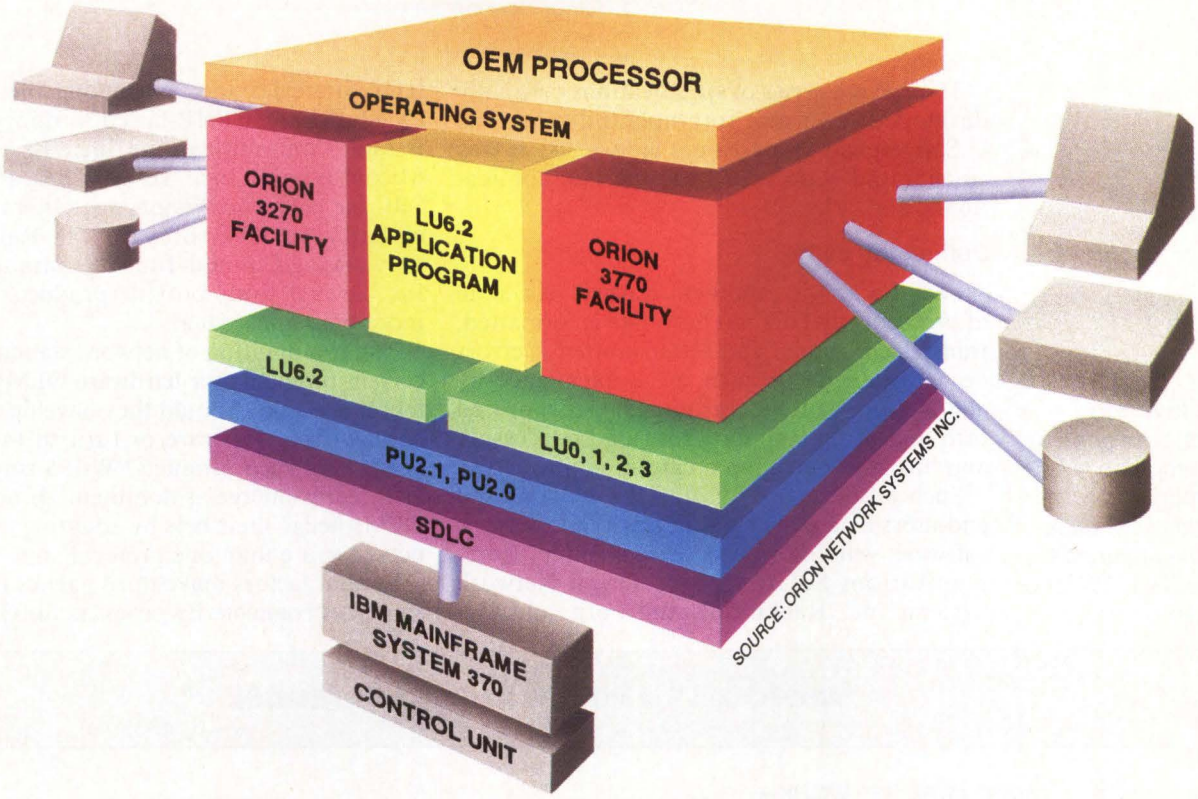


SOFTWARE LINKS MULTIVENDOR NETWORKS

SNA? OSI? TCP/IP? Hardware OEMs and system integrators turn to independent software vendors for help with multivendor connectivity

Dennis Livingston, Senior Editor

System integrators face a nettlesome problem: how to get dissimilar machines to talk to each other, even in distributed processing environments. For added complexity, these environments more closely resemble democratic New England town meetings than traditional master-slave relationships.

Many companies have found that they need a range of equipment, from supercomputers to desktop machines, to satisfy their computing and communications requirements. Naturally, they prefer to purchase such devices from vendors that offer the best price/performance deals. Thus, no one vendor is likely to capture all the computing space in the office or on the factory floor. Hence, system integrators must be ready, willing and able to put together multivendor networks, which must communicate in a way that minimizes file transfer bottlenecks, user retraining and application program rewriting.

At least three network standards—Systems Network Architecture (SNA), Open Systems Interconnection (OSI) and Transmission Control Protocol/Internet Protocol (TCP/IP)—provide the backbones that can make interoperable data communications networks out of multivendor systems.

SNA, an IBM Corp. proprietary protocol suite, has become a de facto industry standard by virtue of Big Blue's control of 80 percent of the mainframe market.

OSI is a multilayered protocol reference model promulgated by the International Standards Organization (ISO) for use in designing multivendor networks.

System integrators are increasingly called on to put together networks of machines from different vendors.

Multivendor systems *achieve interoperability through the use of network backbone standards like SNA, OSI and TCP/IP.*

TCP/IP is a series of specifications originally developed to ensure interoperability among U.S. Defense Department networks. It has since found widespread commercial application.

Defined by suite

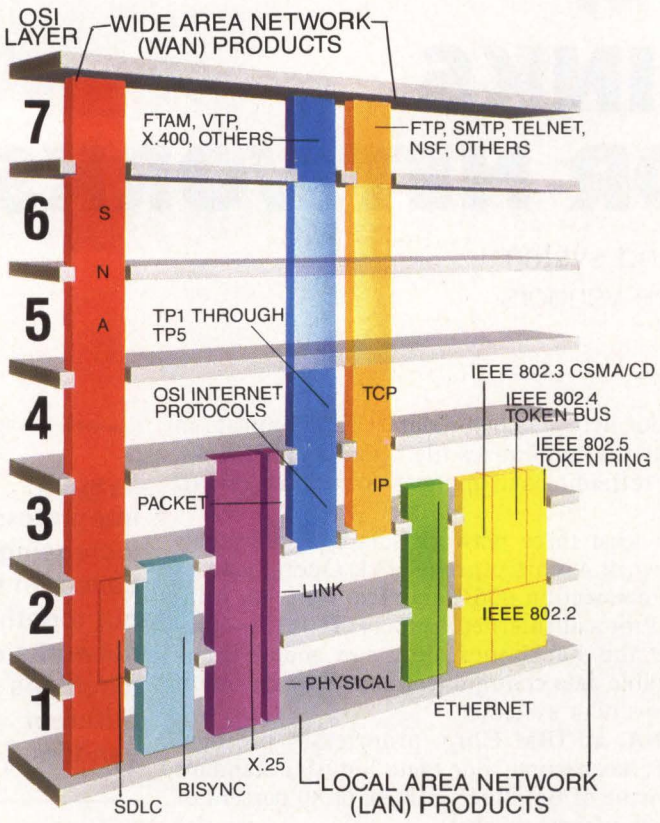
Each backbone candidate consists of a suite of protocols that defines how data is formatted, transferred, routed and retransmitted if errors occur. Protocols, in turn, are implemented by connectivity software products, incorporated into operating systems, front-end processors and board-level communications controllers.

Such products are sold to OEMs, VARs and end-users by a growing number of independent software vendors (ISVs). For example, Communications Solutions Inc., Orion Network Systems Inc., Rabbit Software Corp. and Systems Strategies Inc. are among the SNA-oriented ISVs. TCP/IP-based vendors include Bridge Communications Inc., Excelan Inc., Micom-Interlan Inc., Network Research Corp., SBE Inc. and The Wollongong Group Inc. Specializing in OSI software are Retix Internetworking Co. and Touch Communications Inc. Several firms provide products based on more than one system.

The proliferation of network standards poses certain problems for hardware OEMs and system integrators. Should they develop their own connectivity software or turn to third-party vendors of such products? Will a single standard clearly emerge as dominant? If not, should OEMs hedge their bets by adapting their products to more than one protocol suite?

Several factors make third parties the logical source of connectivity products for OEMs. For

PROTOCOLS AND OSI REFERENCE MODEL



SOURCE: SBE INC.

OSI LAYER NAMES AND FUNCTIONS

7 APPLICATION: Provides standard user functions (for example, electronic mail) and network interfaces (such as TELNET).

6 PRESENTATION: Ensures that all devices can understand each other at the Application Layer. Can include syntactical conventions such as message compression, terminal standardization and data encryption.

5 SESSION: Enables users to access processes on other machines; organizes and synchronizes the dialog between two network nodes. Validates identity and authority for communicating entities.

4 TRANSPORT: Provides a logical connection from a process on one machine to a process on another, including end-to-end flow control, error detection/correction and message sequencing.

3 NETWORK: Specifies how communications within and between networks should occur. Defines all possible routes that a message could take to its destination.

2 LINK: Provides point-to-point data transfer over physical links in a network. Establishes, maintains and releases link connections.

1 PHYSICAL: Encodes, modulates and transmits data across physical links. Defines physical signal characteristics.

one, the world of network standards is complex and ambiguous. SNA, OSI and TCP/IP compete with, yet complement, each other. Variations exist within all three protocol suites, and all are evolving. In addition, the lines between them are blurring, thanks to gateway products that connect one system with another, and to the mutual incorporation of specific protocol standards in more than one system.

In this context, "Hardware vendors just don't have the specialized expertise to understand these protocols in enough detail or to keep up with their evolution," points out consultant David Passmore of Network Strategies Inc., Fairfax, Va. Thus, it is usually desirable for an OEM to let a connectivity software vendor track the convolutions of protocol development and undertake commercialization of emerging standards.

DEFINITIONS OF TERMS IN CHART

SNA	Systems Network Architecture (IBM)
SDLC	Synchronous Data Link Control (IBM)
BISYNC	Binary synchronous protocol (IBM)
X.25	A packet-switched network protocol (CCITT)
FTAM	File Transfer Access Method (ISO)
VTP	Virtual Terminal Protocol (ISO)
X.400	A virtual terminal protocol (CCITT)
TP1-TP5	Transport Protocol, classes 1 through 5 (ISO)
FTP	File Transfer Protocol (Defense Department)
SMTP	Simple Mail Transfer Protocol (Defense Department)
TELNET	A virtual terminal protocol (Defense Department)
NFS	Network File System (Sun Microsystems; public domain)
TCP	Transmission Control Protocol (Defense Department)
IP	Internet Protocol (Defense Department)
ETHERNET	Local area network architecture developed by Xerox and others, and later incorporated into the IEEE 802.2 and 802.3 standards
IEEE	Institute of Electrical and Electronics Engineers
CSMA/CD	Carrier Sense Multiple Access/Collision Detection: multiple access method used by Ethernet and IEEE 802.3
TOKEN BUS	Multiple access method used by IEEE 802.4
TOKEN RING	Multiple access method used by IEEE 802.5 and IBM

Many OEMs also don't want to waste time reinventing the wheel. Time to market is vital, according to Ed Stevens, support manager at Systems Strategies. "We cut that time by offering products that OEMs can port to their equipment, rather than develop internally, as well as software support and maintenance services that OEMs find valuable."

Choose a protocol standard

Jim Mullen, vice president for sales and marketing at Orion Network Systems, in common with other industry watchers, feels that both SNA, because of its widespread use in the corporate world, and OSI, because of its growing international acceptance, will eventually dominate the standards field. Other backbones are expected to fall by the wayside. "We ourselves started as an SNA house," says Mullen, "but we recognized the emerging significance of OSI and are beginning to support some OSI standards."

Yet, TCP/IP, at least, is not so easily counted out of the standards sweepstakes. Virtually all major computer and network vendors support TCP/IP-based products, meeting a demand created in part by the slowness with which OSI standards have been formulated. Many end-users also see TCP/IP as providing a useful migration path to OSI.

In this light, a number of companies, including Apple Computer Inc., Apollo Computer Inc., Digital Equipment Corp., Hewlett-Packard Co. and Sun Microsystems Inc., have decided to bring their products into compliance with at least two, and sometimes all three, protocol standards to match their customers' needs.

"Our customers have current and pending investments in both consensus and de facto standards," says Sam Alunni, Apollo's IBM interconnect senior product manager. "We offer Domain/LU6.2, based on SNA software from Orion, as well as TCP/IP and OSI-derived workstation products to fit customers' diverse networking plans."

Mike Gayowski, IBM interconnect marketing manager at DEC, echoes this sentiment. "Our networking strategy is to connect anytime, anyplace, anywhere." Toward this end, DEC, while promoting its own proprietary network, makes available DECnet-SNA gateway products (as well as VMS/SNA products), a VMS-based TCP/IP program developed from The Wollongong Group's WIN/TCP and a separate product line of OSI protocols. In addition, DEC is moving DECnet Phase V into

'Once IBM's OS/2 is installed, demand for LU6.2 on PCs and workstations should rise.'

compliance with OSI standards as they emerge.

Still, each set of standards has its own characteristics and prospects, which may lead OEMs and their customers to tilt to one or the other, at least for the next few years.

SNA becomes peer-to-peer oriented

Although SNA is an IBM proprietary standard, its implementation at approximately 25,000 sites has made SNA a de facto interindustry standard. As a result, OEMs selling into business computing environments must have a strategy for communicating with IBM machines by accessing SNA and/or by linking with an open systems network in which SNA participates.

SNA has evolved in two directions since its introduction in 1974. Traditional SNA ties together mainframes and unintelligent peripherals in a hierarchical relationship. Non-IBM devices gain SNA access through software that enables them to emulate IBM's 3270 interactive terminal and 3770 remote job entry workstation. "Many companies still need to obtain huge amounts of data stored on mainframes via dumb terminals," points out Apollo's Alunni. "We must continue to enhance old SNA products so customers can take advantage of their installed base of such machines and the wealth of database and transaction processing software written for mainframes."

IBM is transforming SNA into an architecture capable of supporting distributed processing environments.

With the proliferation of minicomputers and personal computers, IBM found it necessary to transform SNA into an architecture capable of supporting a cooperative processing environment in which remote intelligent equipment could be linked not only with mainframes but also with each other, peer-to-peer. Such Low Entry Networking (LEN), as IBM calls its concept for the new SNA, is being created through the gradual implementation of two related protocols: Logical Unit (LU) 6.2., marketed as Advanced Program-to-Program Communications (APPC), which establishes logical communications between cooperating programs, and Physical Unit (PU) 2.1, which makes posssible point-to-point physical connectivity between peer nodes without mainframe involvement.

LU6.2 solves several significant problems for SNA, according to Orion's Mullen. "Since processor hierarchy is no longer an applicable concept with LU6.2, software programs in workstations and midrange computers can exchange data directly, without logging on to a mainframe and without having to make PCs act like dumb terminals. Everyone in such a network is a peer." Moreover, with 3270-based software, IBM couldn't build networks that would run by themselves. When programs can talk to programs, less human intervention is needed for such matters as data transmission and error detection. In addition, LU6.2 makes it possible to throw remote programs into execution from any machine on the network.

However, "There's not yet a big demand for LU6.2 because 3270s are being used to access most applications that people want to use on IBM mainframes," says Network Strategies' Passmore. Few applications, in turn, have been written that use LU6.2, although this standard has been implemented within IBM's Customer Information Control System (CICS). (CICS is a mainframe-based teleprocessing monitor that facilitates transaction processing by user-written programs.)

In addition, Passmore notes that LU6.2 is very sophisticated software, occupying several hundred thousand bytes on a PC. That doesn't leave a lot of room for other applications. "What users really need is OS/2, IBM's new multitasking operating system. Once OS/2 is installed, you'll see more and more applications available that can support LU6.2, which will create demand for LU6.2 implementations on PCs and workstations."

With added functionality, PU2.1 should also extend the versatility of LEN. In particular, a superset of LEN known as Advanced Peer-to-Peer Networking (APPN) makes possible peer-based communications over networks of interlinked processors. One machine can talk to another through a third using such networks, and the network automatically reconfigures the best routing connections among its components as equipment is added to or removed from the system.

However, APPN is currently available only with IBM's System/36 minicomputer. As of January, IBM had not incorporated PU2.1 into its mainframes. Version 3, release 2 of Virtual Telecommunications Access Method (VTAM), the mainframe's host communications software, announced last fall, will support LU6.2. But the Network Control Program (NCP), software that runs on the system's communications processor, does not yet provide PU2.1 link support. (VTAM 3.2 works in conjunction with PU2.0, an older protocol.)

Inclusion of LU6.2 helps move SNA away from its traditional structure. Without PU2.1, however, true peer-to-peer connections would be lacking. A PC on one network, for example, that wanted to communicate with a PC on

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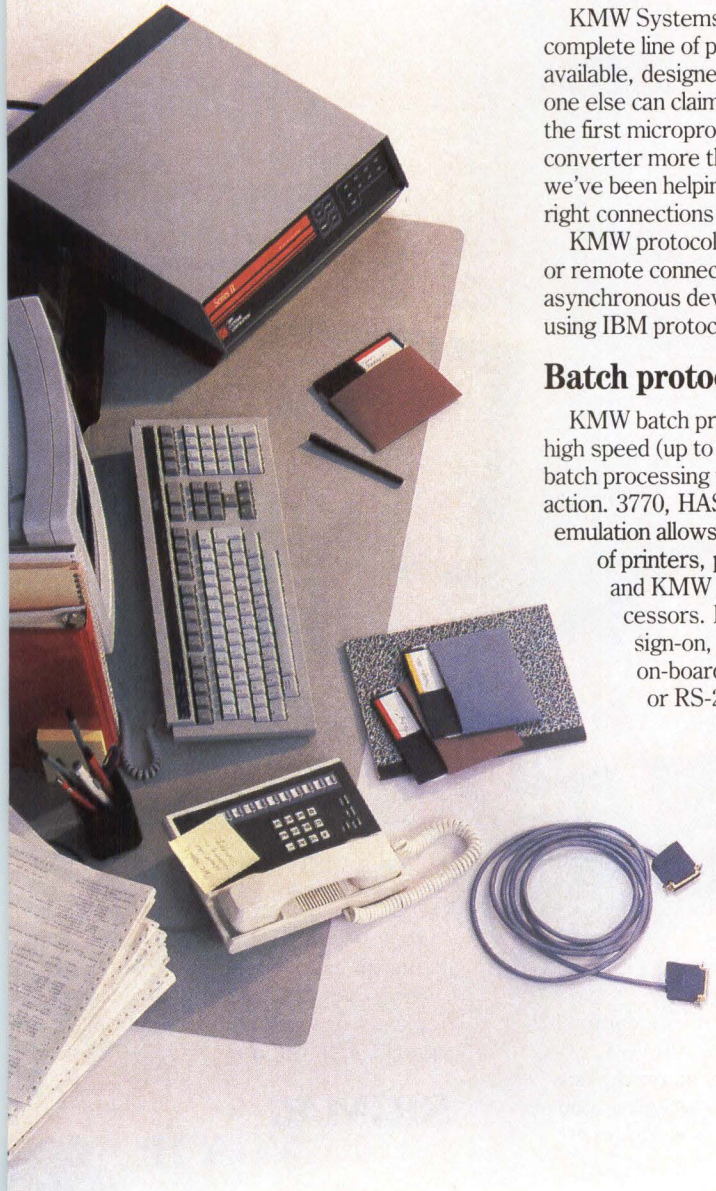

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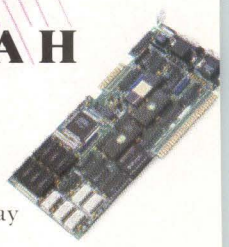

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another would still require VTAM involvement.

IBM has made clear its intention to offer a PU2.1 link in a forthcoming version of NCP. Even so, the extent to which such software will support APPN—and, therefore, the degree of integration between APPN peer-oriented and hierarchial SNA networks—is not yet certain.

SNA thus stands between the worlds of master/slave and distributed processing networks. OEMs selling into IBM environments must be prepared to cope with both—or to consider the alternatives.

Does OSI have it?

OSI is not itself a product, but an internationally recommended reference model intended as a conceptual framework for the design and comparison of multivendor network backbone systems. Each of OSI's hierarchically organized seven layers consists of protocols that guide the performance of certain data communications functions. Not every layer is complete, and each layer may offer several protocol options. (See "OSI Standards Bolster Data Communications," MMS November, 1987, Page 69.)

There is ample room within OSI for the development of more finely tuned, OSI-compatible commercial products and protocol subsets. For instance, OSI's lower layers have been dominated for some time by X.25 packet-switching standards for public data networks, established by the CCITT, and by Ethernet local area network (LAN) standards, developed by DEC, Intel Corp. and Xerox Corp. and incorporated as protocols 802.2 and 802.3 of the IEEE. In addition, users' groups associated with General Motor Corp.'s Manufacturing Automation Protocol (MAP) and Boeing Computer Services' Technical and Office Protocols (TOP) are elaborating OSI-based standards.

Still, at least in past years, it seemed as if ISO was finalizing a full suite of OSI protocols about as swiftly as molasses climbing uphill during a cold wave. The organization's travails are understandable. ISO is a complex mix of standards committees whose output must satisfy user and vendor members from many participating countries. The process has been further slowed by the pull-and-tug of competing interests when vendors attempt to insinuate proprietary standards into OSI. (IBM has tried several times to gain acceptance of LU6.2 as an OSI prospective upper layer peer-to-peer standard, so far without success.) And compliance testing of the growing range of commercial products presumably conforming to OSI remains a serious issue.

Yet, 10 years of work on OSI has created a foundation that makes possible the creation of practical products today.

Touch Communications, for example, offers host- and controller-resident versions of TOUCH OSI conforming to the MAP/TOP 3.0 specifications, along with a language-independent programming interface. These products allow users to view an entire network of dissimilar computers and resources as an extension of their local system.

A number of recent and forthcoming events also indicate progress in bringing OSI protocols to practical fruition. The Government Open Systems Interconnection Profile (GOSIP), specified by the National Bureau of Standards, requires OSI as the standard reference in bids to all government agencies for new data processing and communications systems. In addition, the here-and-now reality of OSI will be demonstrated at the Enterprise Networking Event International in Baltimore next June via an OSI network connecting three to 12 vendors in each of nine sites.

IBM, for its part, has established a somewhat ambivalent relationship with OSI. OSI, after all, can be seen as an alternative to SNA for end-users who prefer to avoid complete reliance on IBM. "Many companies feel threatened by IBM dominance," says Ed Stevens of Systems Strategies. "OSI is an outgrowth of that apprehension." Brian McGann, vice president of product strategy and alliances at Touch Communications, agrees that companies are trying to get away from being locked into sole-source vendors and proprietary solutions. He points out that OSI acts as a rallying point next to SNA around which all other suites will evolve.

Thus, IBM and, indirectly, system integrators, face a classic dilemma. How to help customers who wish to network machines from IBM and other vendors using non-proprietary standards, without thereby losing business to competitors?

IBM's solution, according to Network Strategies' Passmore, is to remain firm in supporting SNA as the protocol of choice for IBM systems, while positioning OSI as a compatible means of accessing SNA within multivendor environments. Thus, end-users can have both SNA and OSI. At the same time, IBM is selling OSI products primarily in Europe, where the demand has been strongest, while holding back to see how U.S. markets develop.

OSI acts as a rallying point next to SNA around which all other suites will evolve.

IBM's involvement with OSI takes a number of forms. The company is a member of several OSI organizations including ISO itself; the Corporation for Open Systems (COS), a MacLean, Va., forum of U.S. vendors and users that promotes and tests OSI standards; and the OSINET project, coordinated by the National Bureau of Standards to accelerate testing and use of OSI.

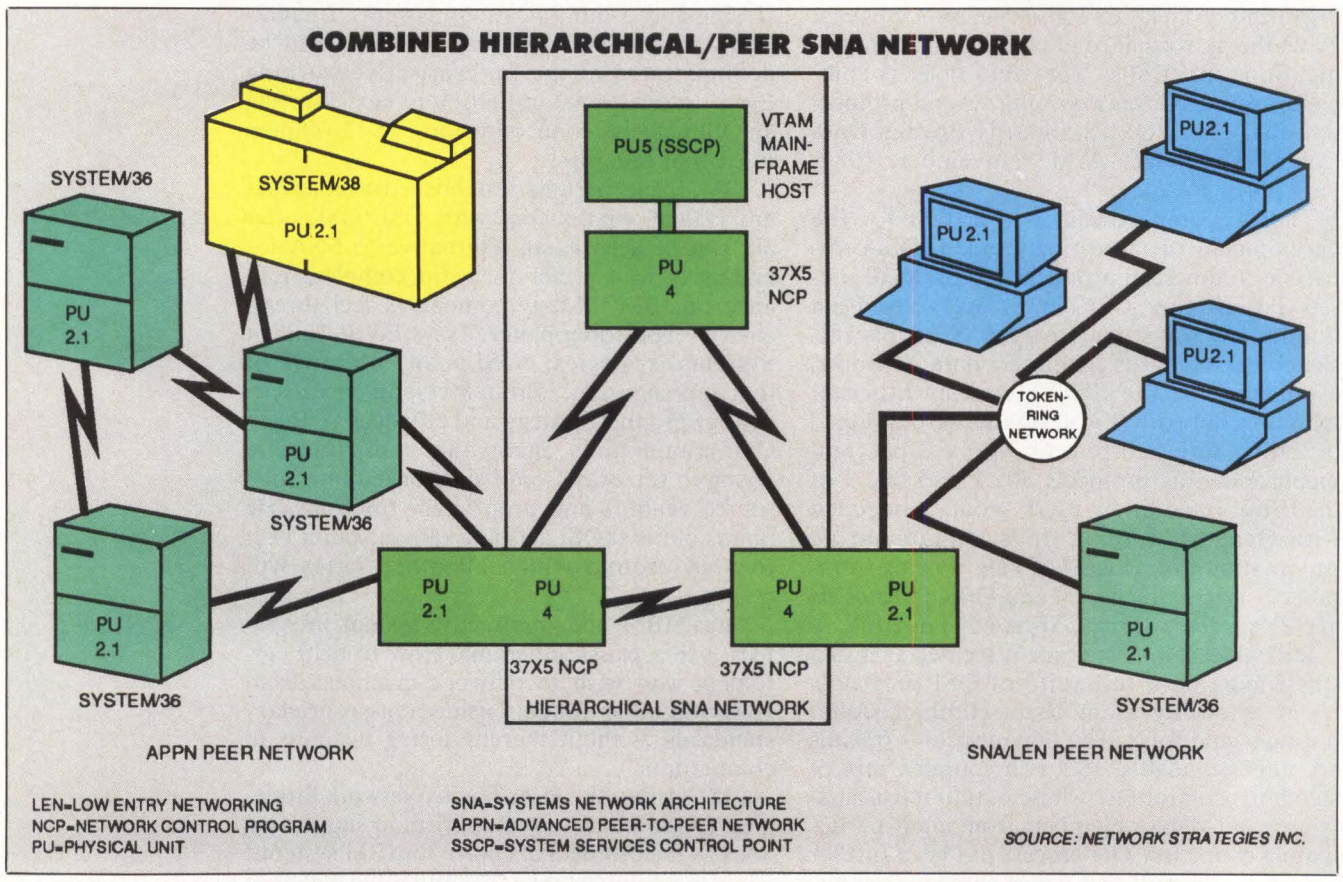
OSI products from IBM include software based on the Qualified Logical Link Control (QLLC) protocol that allows users to run SNA sessions over X.25 packet-switched networks, and programs that support X.400, an OSI upper layer protocol for message-handling applications. IBM is also developing OSI software at several European research centers.

Therefore, OSI remains promising as the one potentially all-pervasive, internationally accepted protocol suite with which all existing proprietary backbones (including SNA and DECnet) will be congruent. Whether an end-user should move to implement it now, or hold back to await further protocol specification, still remains an open question.

TCP/IP: available now

Network users reluctant to cast their fate with SNA don't have to wait for OSI to get its act together. TCP/IP already exists as a proven network standard supported by more than 100 vendors.

TCP/IP, which generally conforms to OSI layers 4 (Transport) and 3 (Network), is part of a larger grouping—the Internet protocol suite —whose Application Layer (level 7) includes standards for file transfer, virtual terminal emulation (remote login) and electronic mail capa-



Future SNA configurations *could combine the advantages of hierarchical control of thousands of nodes and devices with the peer-oriented communications capabilities of systems based on PU2.1/LU6.2 protocols. Here, a centralized SNA backbone facilitates wide-area communications between two local peer networks. The Low Entry Networking system (right) enables IBM PCs to establish point-to-point sessions on a Token-Ring Network without host involvement. The Advanced Peer-to-Peer Networking system (left) links nodes directly to each other over arbitrary network topologies.*

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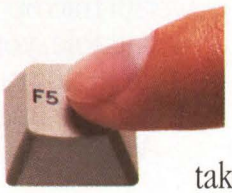

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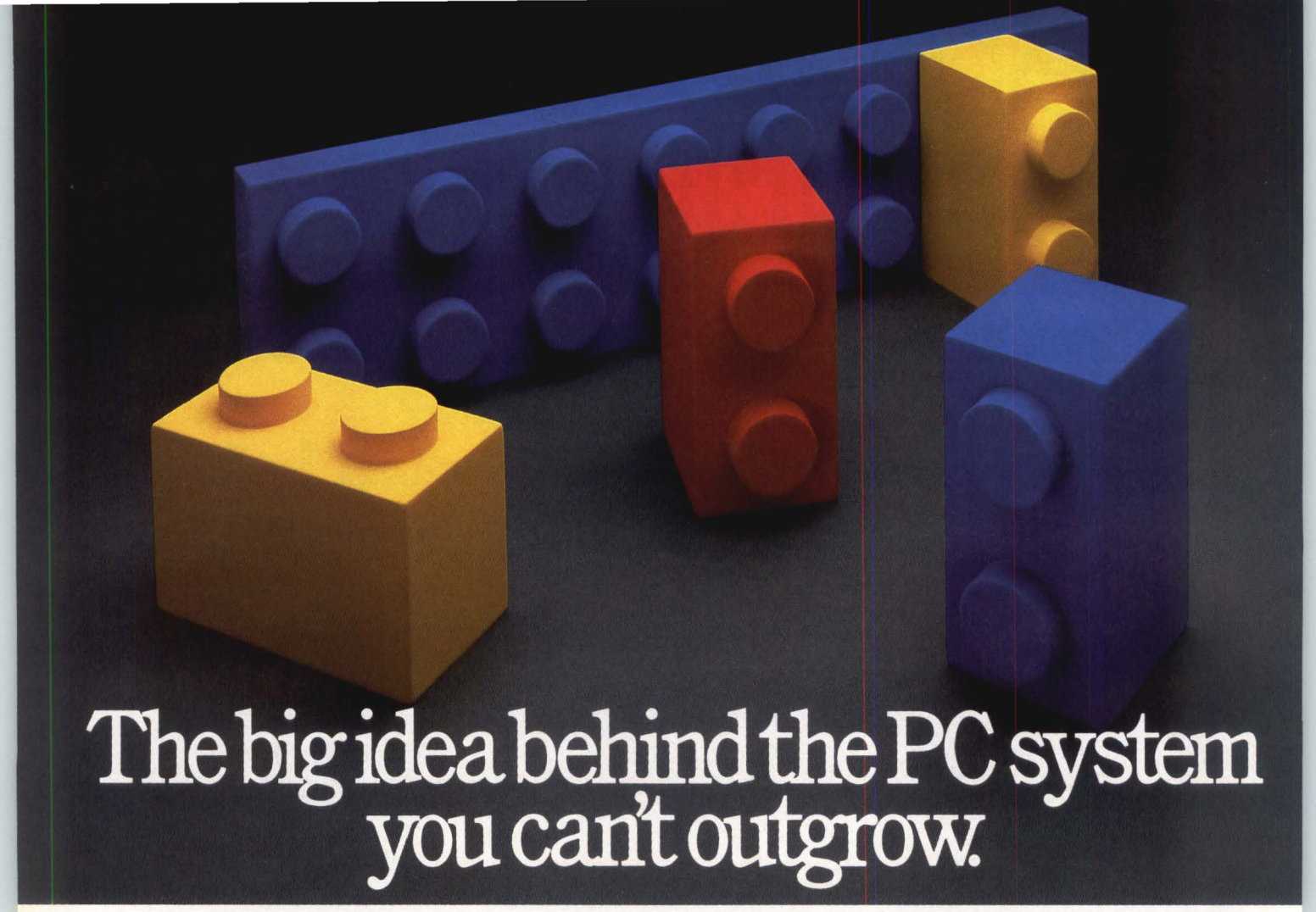

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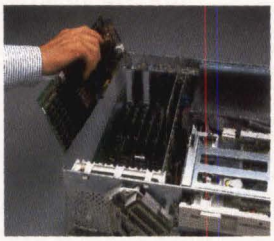

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bilities. At present, the Internet family comprises the world's most widely used set of non-proprietary network standards.

TCP/IP's origins have heavily influenced its evolution. Developed in the early 1970s by diverse researchers involved with the Arpanet system of the Defense Department's Advanced Research Projects Agency, TCP/IP in time became symbiotically joined with two other systems: Ethernet, which provides lower layer network standards for TCP/IP, and the Berkeley UNIX 4.2 operating system elaborated at the University of California.

Arpanet users included members of research and academic centers. When such individuals moved on to companies like Apollo and Sun, they carried along their enthusiasm for TCP/IP as the protocol of choice for linking engineering and technical workstations.

While still typically implemented on UNIX machines over Ethernet LANs, TCP/IP is not necessarily restricted to either. In recent years, this standard has found its way into other operating systems as its use has spread from government and academic environments to the office arena.

How should OEMs regard TCP/IP? Is it a system whose time is rapidly coming to an end, squeezed between SNA and OSI? Even the Defense Department, TCP/IP's godfather, has announced its intention to migrate to OSI. Or does TCP/IP have years of useful life left? The latter seems to be the answer. Like Mark Twain's death notice, any news of TCP/IP's imminent demise is greatly exaggerated.

"Since OSI hasn't moved as quickly as expected, TCP/IP has become a de facto OSI," states Apollo's Alunni. "It makes people comfortable who are OSI-oriented, but can't wait for ISO to roll out the protocols." Steve Spanier, technical marketing manager at Excelan, believes that it will be years before OSI approaches TCP/IP's popularity. It takes a long time to push through a set of protocols that pleases everyone, and different versions of OSI products will have to go through the same debugging process that TCP/IP programs have already faced. Alunni asks, "Since TCP/IP does what people want now at OSI levels 3 and 4, what's to gain by waiting?"

Excelan offers TCP/IP-based Ethernet LAN controller boards for UNIX, DEC's VMS, Apple's Macintosh and IBM's PC-DOS operating systems. Using a front-end communications processor takes the burden of processing protocols off the host CPU, freeing the latter for more efficient handling of its other tasks, according to Excelan. The company, however, is not putting all its eggs in the TCP/IP basket; Excelan is also developing products based on MAP/TOP protocols.

As for SNA: "In theory, an IBM environment is a little more exclusive and harder to deal with than TCP/IP specifications, which have been in the public domain for a long time," says Spanier. SNA, after all, is supported by a single vendor with its own interests at stake; TCP/IP was put together under the stimulus of a government agency with everyone's interests at stake, he notes.

TCP/IP exists as a proven network standard supported by well over 100 vendors.

Even IBM, which might prefer to deal with OSI as the only complementary system, has got religion over TCP/IP. "If they want to sell a mainframe to a shop that has a cluster of engineering workstations, they'll provide a connection to those machines," says Alunni. "It's notable that they showed up at last year's TCP/IP Interoperability Conference." At that meeting, sponsored by Advanced Computing Environments of Cupertino, Calif., IBM gave technical presentations on the use of TCP/IP in conjunction with the VM and MS-DOS operating systems.

The bottom line on TCP/IP, according to Spanier: You can build the best machine technically, but it won't sell if it can't communicate with other types of machines. TCP/IP is the best way to connect diverse systems today.

Sorting things out

So how do OEMs help their customers sort through their network standards options and, in so doing, determine what kind of connectivity software to offer them?

"Keep an eye on IBM's LU6.2," says Systems Strategies' Stevens. "It gives added flexibility to end users with an investment in machines from IBM and other vendors and could allow IBM to capture networks that might have otherwise gone to TCP/IP or OSI."

Network Strategies' Passmore stresses that a decision on what protocols to support depends primarily on what machines you are dealing with. "If you're an IBM shop, go with SNA," he says. "If you're in a multivendor environment, with a mix of equipment in which no vendor predominates, consider TCP/IP. It supports peer-to-peer communications better than SNA

Third parties are the logical source of connectivity software for OEMs.

does for now, and many TCP/IP products are available. But down the road looms OSI, which will ultimately replace TCP/IP. This is not a question of if, but when." □

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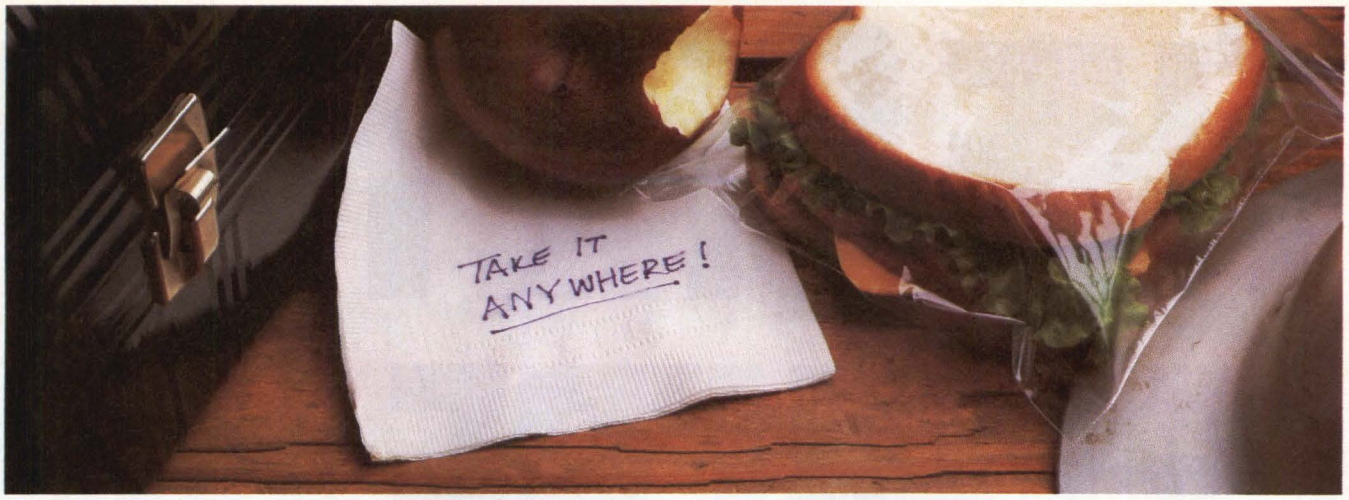

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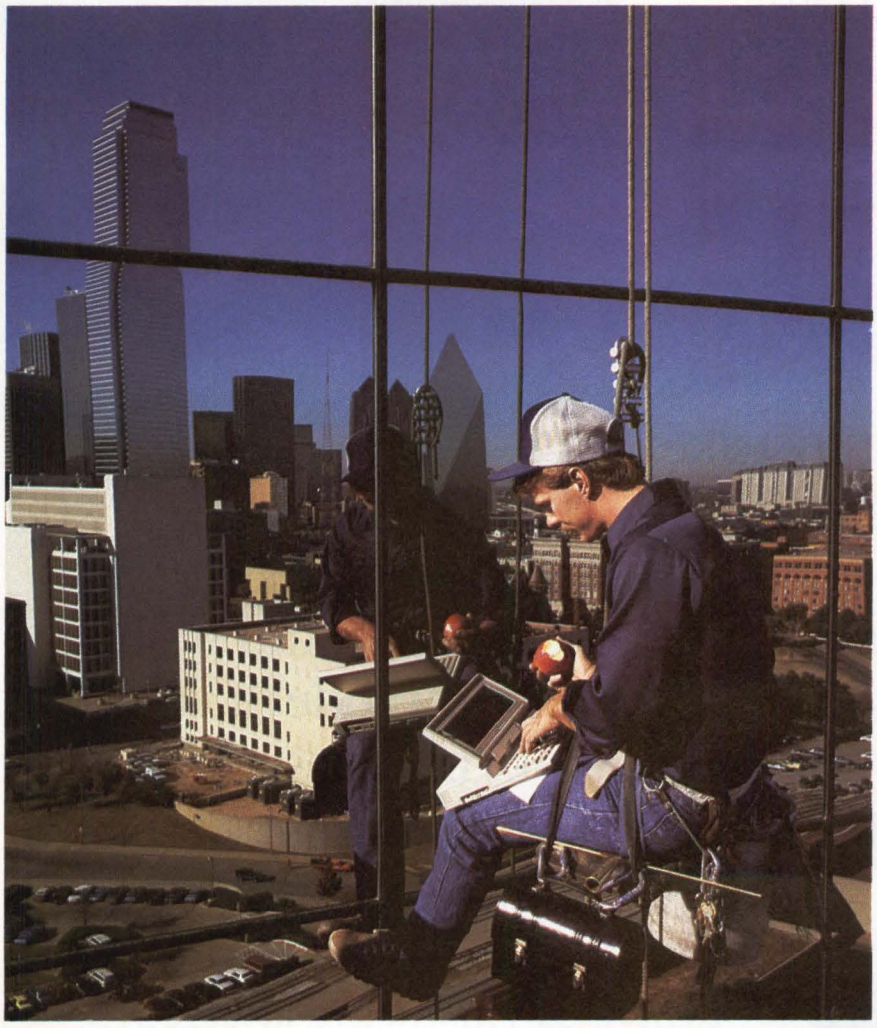

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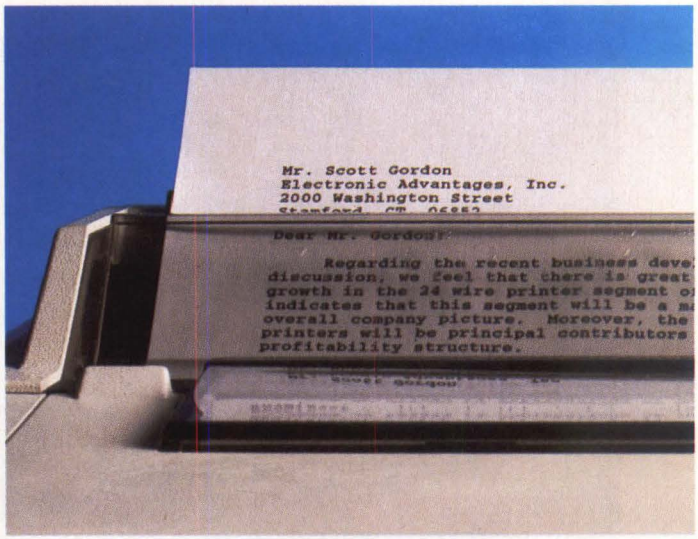

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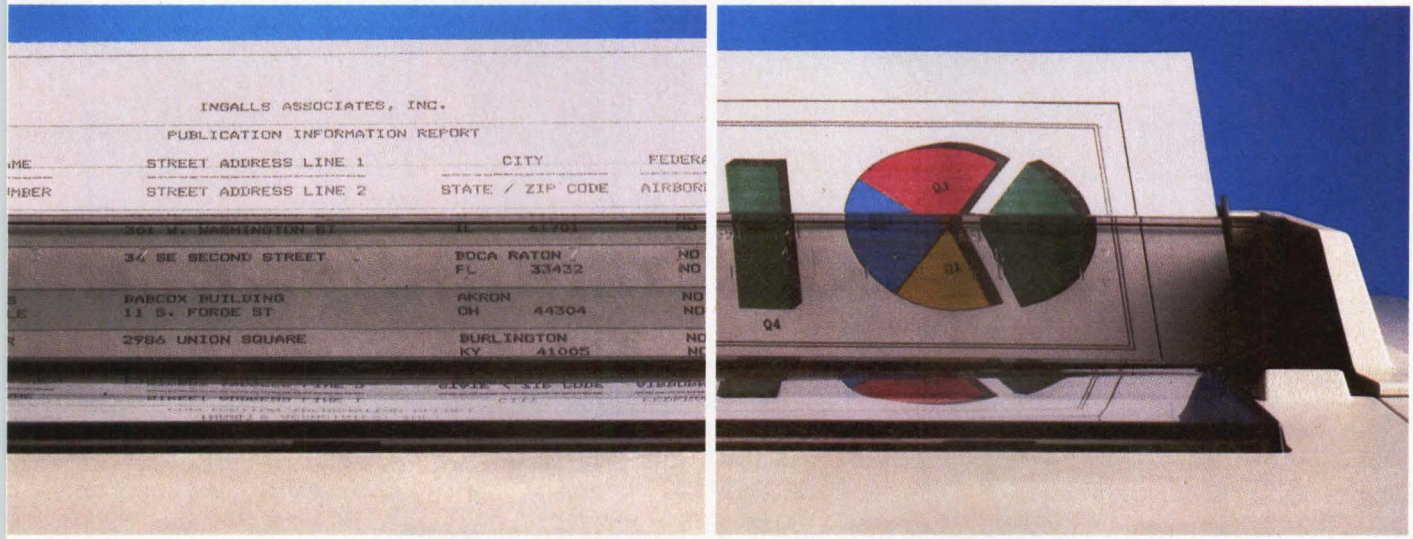

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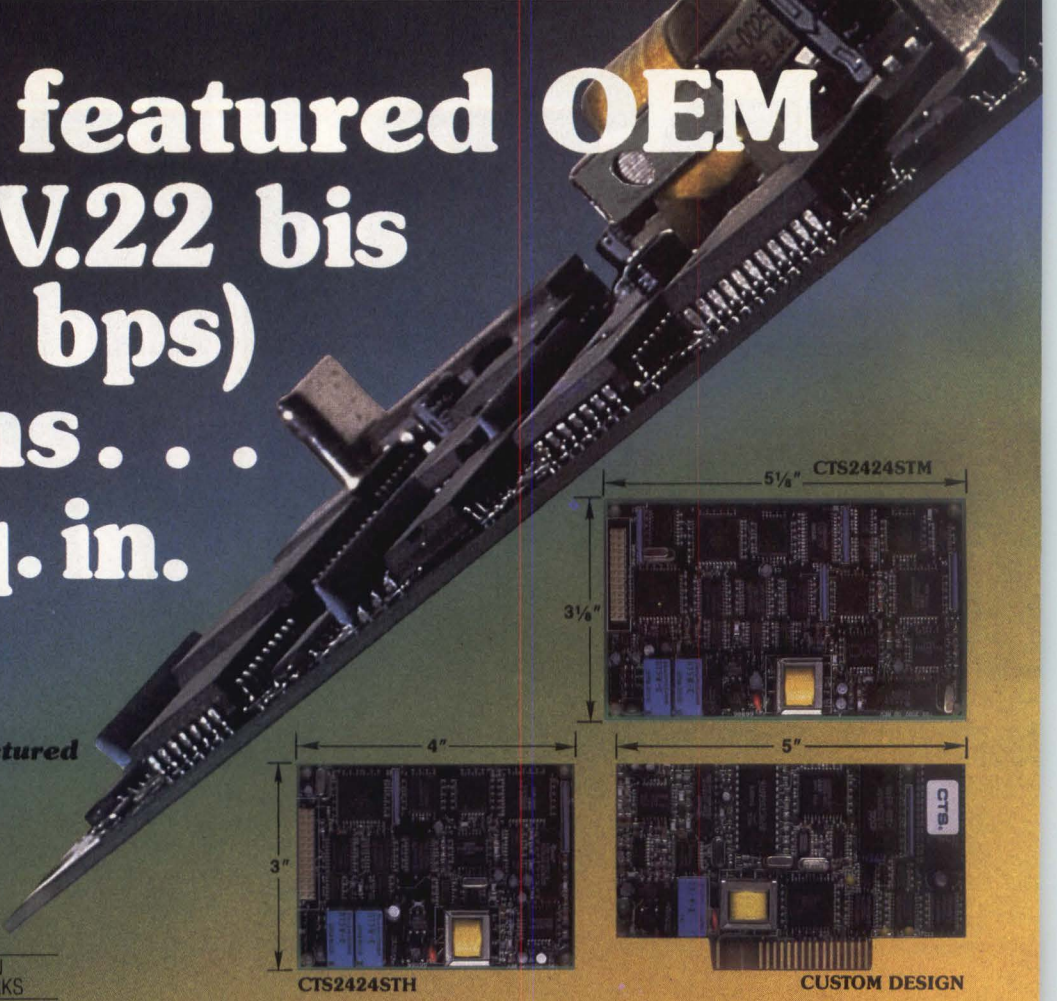

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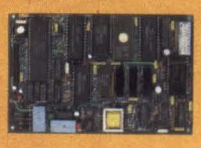

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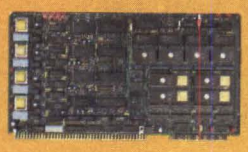

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DISPUTES SHAKE UP 2,400-bps MODEM MARKET

MNP Class 5 data compression boosts modem throughput, whereas Class 4 error correction stirs controversy

David Simpson, Senior Editor

The 2,400-bits-per-second modem market is benefitting from significant technological advances. But there's controversy. Most of the debate centers on data compression and error-correction techniques.

To boost throughput, many modem manufacturers are adding data-compression algorithms to their devices. To preserve compatibility, some companies are using the algorithms included in MNP (Microcom Networking Protocol, developed and promulgated by Microcom Inc.) Class 5—the fifth performance level of MNP (see "MNP: A class-y act").

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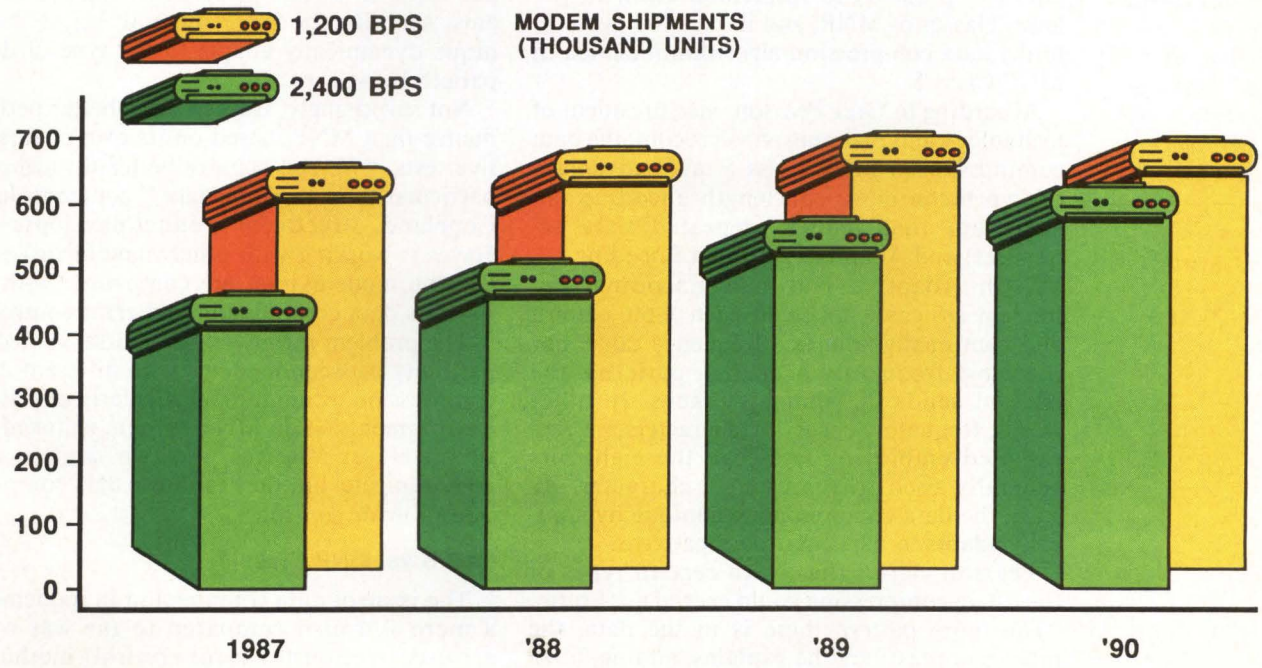
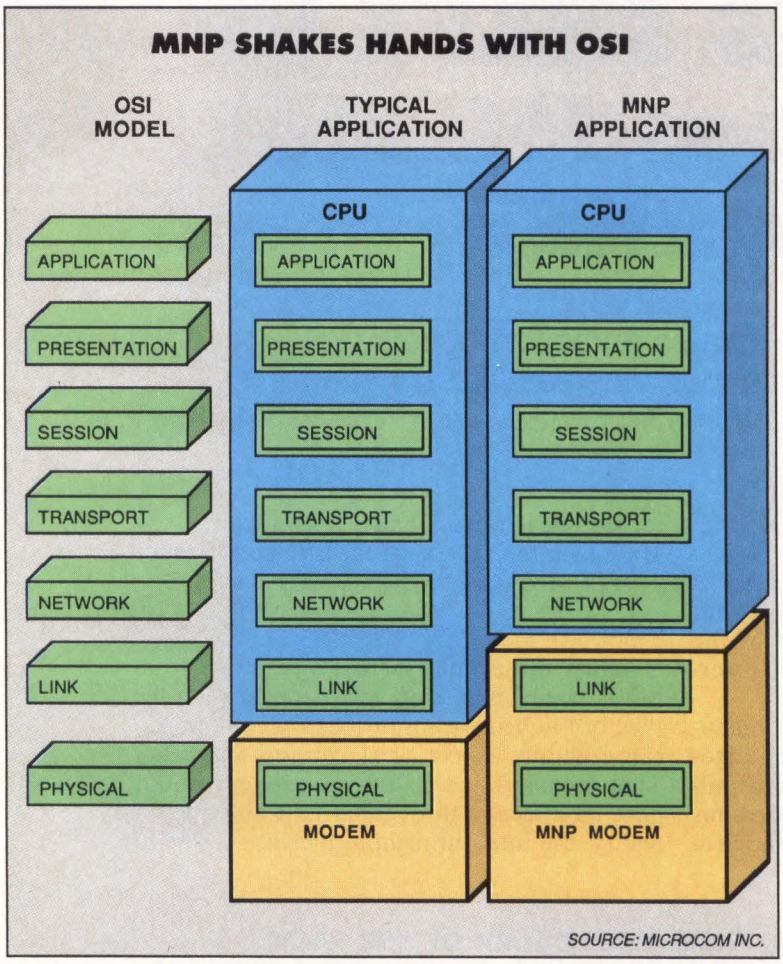


SOURCE: INTERNATIONAL DATA CORP.



MNP conforms *to the OSI network reference model. Error detection and control take place at the Link Layer.*

part (37 percent) to implementation of the lower classes of MNP, and in part (63 percent) to the data compression algorithm included in MNP Class 5.

According to Greg Pearson, vice president of technology and planning at Microcom, the data compression in MNP Class 5 takes advantage of two techniques: run-length encoding (an algorithm that reduces repeated data sequences) and Adaptive Huffman Encoding.

With Adaptive Huffman Encoding, the modem assigns a token to each 8-bit pattern and continually adjusts a frequency table. For the most frequently occurring patterns, the modem sends the shortest tokens. In other words, frequently occurring characters are represented employing less than the eight bits generally used to represent a character. As such, the data-compression technique dynamically adapts to particular data patterns.

Pearson claims that, with certain types of files, data compression could exceed a 2:1 ratio. "The more pattern there is in the data, the more compression," he explains, adding, however, that "if the data is very random, it might actually slow down throughput."

Microcom claims that performance advantages range from 1.3 to 1.0 and 2.0 to 1.0, depending on the compressibility of the file being sent. The hardest types of files to compress are .COM or .EXE files, followed by spreadsheet files. The easiest types to compress are word processing and print files.

All classes of MNP are in the public domain —available to any vendor—but Microcom licenses Class 5 for a one-time fee of $2,500. Licensees do not get code from Microcom, but they do get a complete specification on how the data-compression technique works.

Look for manufacturers of 2,400-bps modems to enhance their units with MNP Class 5 data compression over the next few months. Some manufacturers—such as Concord Data Systems Inc., Microcom, MultiTech Systems Inc. and U.S. Robotics Inc.—shipped MNP Class 5 modems as early as last year.

Beat of a different baud

However, not all major modem manufacturers are boarding the MNP bandwagon. One notable absentee is Hayes Microcomputer Products Inc., which prefers its own proprietary method of data compression—called Adaptive Data Compression—in its V-series modems.

Like Microcom, Hayes claims a possible 2:1 data compression ratio, and effective throughput rates of 4,800 bps on its 2,400-bps modems. And like the MNP method, Hayes' technique dynamically adapts to the type of data pattern being sent.

Not surprisingly, Hayes claims better performance than MNP, based on its own comparative tests. "We can achieve better throughput, particularly on random data," contends John Copeland, director of product development. Hayes is working with other manufacturers to develop modems that are compatible with its V-series data compression and error control.

The problem for buyers, of course, is incompatibility between modems with different data compression techniques, particularly in dial-up environments. If an MNP modem is linked to, say, a Hayes V-series, the two devices can communicate, but they can't use data compression or error control.

LAP-B vs. MNP Class 4

The issue of data compression in modems is a mere skirmish compared to the war over error-correction (or error-control) methods.

The warring factions? Proponents of LAP-B vs. proponents of MNP Class 4.

LAP-B (Link Access Procedure-Balanced) is the link layer protocol used in the CCITT X.25 standard and is an international standard for error correction. Proponents of LAP-B, such as Hayes, argue, among other points, that X.25/LAP-B is a standard (MNP is a proposed standard); changes to it are publicly controlled (Microcom reserves the right to change MNP); it's compatible with X.25 networks; has support for multiple virtual circuits; and has a standardized negotiation scheme.

More important, argue LAP-B proponents, ISDN (Integrated Services Digital Networks) protocols compare closely with X.25, making

MNP: A CLASS-Y ACT

The Microcom Networking Protocol (MNP), a communications protocol that supports interactive and file-transfer applications, divides into six classes, or performance levels. According to Microcom Inc., the MNP performance ladder includes the following rungs:

Class 1, the lowest performance level, uses an asynchronous byte-oriented half-duplex method of exchanging data. The protocol efficiency of a Class 1 implementation is about 70 percent; in other words, a 2,400-bps modem using MNP Class 1 will have a 1,690-bit-per-second (bps) throughput.

Class 2 uses asynchronous byte-oriented full-duplex data exchange. The protocol efficiency of a Class 2 modem is about 84 percent (a 2,400-bps modem will realize 2,000-bps throughput).

Class 3 uses synchronous bit-oriented full-duplex data exchange. This approach is more efficient than the asynchronous, byte-oriented approach, which takes 10 bits to represent 8 data bits because of the "start" and "stop" framing bits. The synchronous data format eliminates the need for start and stop bits. Users still send data asynchronously to a Class 3 modem, but the modems communicate with each other synchronously.

The protocol efficiency of a Class 3 implementation is about 108 percent (a 2,400-bps modem will actually run at a 2,600-bps throughput).

Class 4 adds two techniques—Adaptive Packet Assembly and Data Phase Optimization. In the former technique, if the data channel is relatively error-free, MNP assembles larger data packets to increase throughput. If the data channel is introducing many errors, then MNP assembles smaller data packets for transmission. Although smaller data packets increase protocol overhead, they concurrently decrease the throughput penalty of data retransmissions—more data is successfully transmitted on the first try.

Data Phase Optimization is a technique for eliminating some of the administrative information in the data packets, which further reduces protocol overhead.

The protocol efficiency of a Class 4 implementation is about 120 percent (a 2,400-bps Class 4 modem will effectively yield a throughput of 2,900 bps).

Class 5 adds data compression, which uses a real-time adaptive algorithm to compress data. The real-time capabilities of the algorithm allow the data compression to operate on interactive terminal data as well as file-transfer data. The adaptive nature of the algorithm refers to its ability to continuously analyze user data and adjust the compression parameters to maximize data throughput.

The effectiveness of data compression algorithms depends on the data pattern being processed. Most data patterns will benefit from data compression, with performance advantages typically ranging from 1.3 to 1.0 and 2.0 to 1.0, although some files may be compressed at even higher ratios. The following types of user files are listed in increasing compressibility: .COM or .EXE files, spreadsheet files, word processing files and print files.

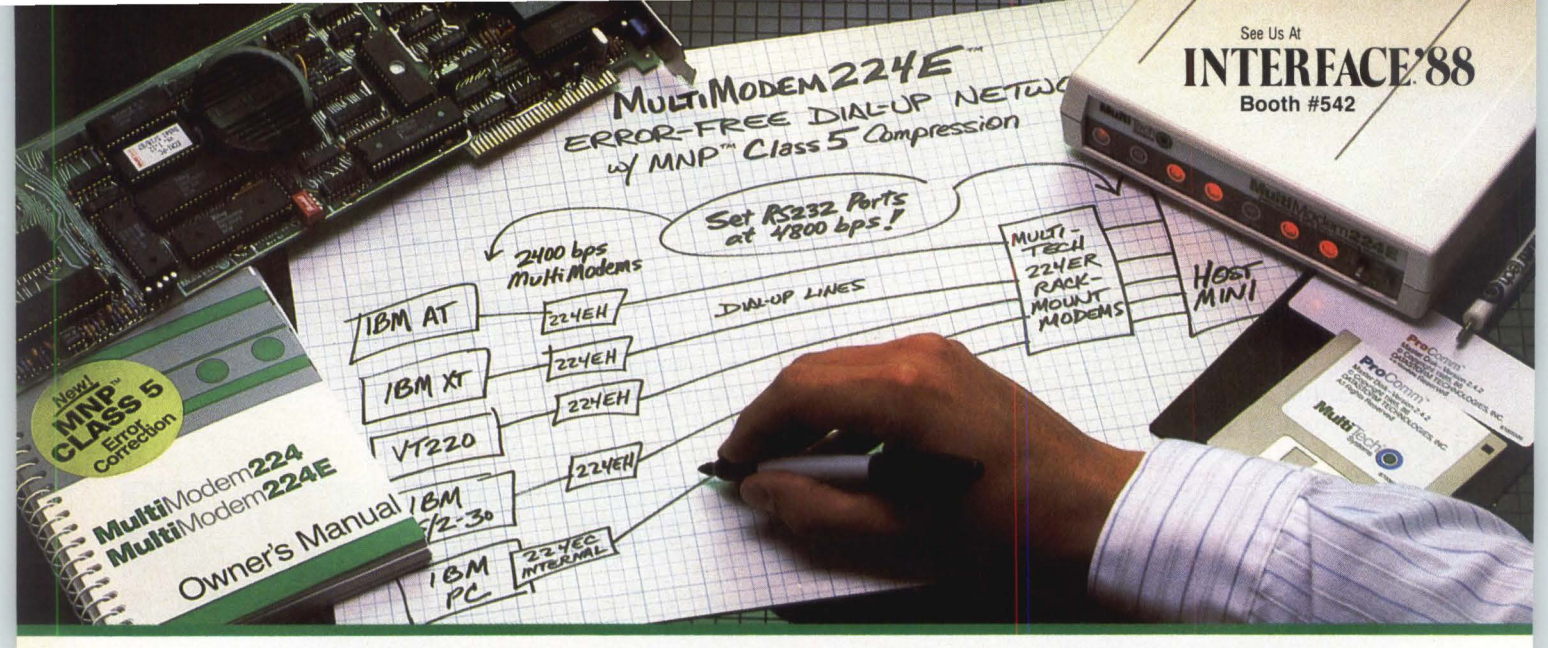
A realistic estimate of the overall compression factor is 1.6 to 1, or 63 percent. This is equivalent to having a net protocol efficiency of 200 percent; in other words, a 2,400-bps modem can achieve a 4,800-bps throughput.

Class 6 applies mainly to 9,600-bps modems, and adds two features: Universal Link Negotiation and Statistical Duplexing.

High-speed V.29 and V.32 modems do not provide compatibility with each other or with the lower speed modulation techniques found in 212A and V.22 bis modems. To overcome this problem, Universal Link Negotiation allows MNP modems to begin operations at a common slower speed and to negotiate the use of an alternate high-speed modulation technique.

If the high-speed carrier technology uses half-duplex modulation, MNP Class 6 provides Statistical Duplexing. This algorithm monitors the user data traffic pattern to allocate utilization of the half-duplex modulation dynamically to deliver full-duplex service.

With Class 6 modems based on V.29 technology, up to 19.2K bps throughput is possible on dial-up circuits in most applications. MNP Class 6 incorporates the Class 5 data compression algorithm.



MNP™ Class 5 Data Compression Modems from Multi-Tech Systems:

When it has to be as *fast* as it is good

- In the dial-up modem world, Class 3 MNP is the hands-down choice for hardware-based error correction. With its 100% error-free transmission, the MNP protocol is used in dozens of manufacturers' 1200 & 2400 bps modems, and our MultiModem224E modems have been recognized as the best of their kind (see box).
- Well, the best just got better. Multi-Tech modems now offer MNP *Class 5* data compression along with error-correction. Class 5's 2-to-1 compression and serial port speed conversion means that you can buy a 2400 bps modem from Multi-Tech and run it at speeds of up to 4800 bps*. Error free!
- Multi-Tech Class 5 modems will communicate automatically with MNP Class 4 and Class 3 modems, as well as non-MNP modems. And if you wish, you can even upgrade your present Multi-Tech Class 3 & 4 modems to Class 5 (call us for details).

PC MAGAZINE EDITOR'S CHOICE

In the May 12, 1987 edition of PC Magazine where 87 modems were reviewed, only three were awarded *Editors Choice*: "For a high-performing 2,400-bps modem with a slew of extras, check out Multi-Tech Systems' MultiModem224E... with [its] high immunity to line noise and the extra advantage of MNP error correction, [this modem] should do a fine job of managing fast, error-free data communications."

- Our Class 5 modems incorporate all of the features of our Class 3 versions. Features like phone number & configuration memory, auto-repeat dial and "AT" command compatibility. And Multi-Tech's seventeen years of modem manufacturing experience.
- Please call us toll-free at **1-800-328-9717**, for additional information... get a modem that's as fast as it is good!

* The compression throughput of MNP Class 5 is, like all compression schemes, dependent on the type of data being sent. The more "compressible" the data, the greater the throughput. For example, a typical text file transfer at 2400 bps should yield a throughput of between 4400 and 4900 bps. And the MultiModem224E's speed conversion and flow control features let you set your modem's RS232C port at 4800 or even 9600 bps, to take full advantage of the Class 5 compression.

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adaptation of X.25 products to ISDN a relatively simple task. ISDN uses a protocol very similar to LAP-B for communication on its D channel. This protocol—LAP-D— provides multiple virtual circuit capability at the link layer, in addition to supporting the X.25 packet layer.

LAP-D is the basic user-network signalling protocol for ISDN and is an extension of LAP-B. ISDN includes specific provisions for carrying X.25 packet layer logical data connections on the ISDN D channel on top of the LAP-D link layer protocol and also for carrying X.25/LAP-B connections on the higher speed ISDN B channel.

"We went with it," explains Hayes' Copeland, "because we could develop products that would work modem-to-modem using error control as well as being able to work with X.25 networks."

Nevertheless, other modem suppliers are going with MNP Class 4 error correction. MNP's strong suit lies in its large installed base.

However, it appears that both LAP-B and MNP Class 4 will survive, at least for the time being. Some companies offer support for either error-correction method, and some, such as Cermetek Microelectronics Inc. and General Datacomm Inc., plan to offer modems with both types of error correction built in.

Copeland admits that "if there appears to be a real need for the so-called 'dual-mode' modems, Hayes would develop one. But the problem we have with MNP is that it's not a CCITT standard, and it's not as well-documented."

Last October, the CCITT convened to resolve the LAP-B vs. MNP debate. But, the standards body left the issue unresolved, suggesting that the industry should find a way to incorporate both protocols in a new standard, to be called LAP-M.

Groups that want to retain compatibility with the installed base of MNP modems are demanding that the new standard have both LAP-B and MNP protocols in it. The more zealous LAP-B proponents would prefer that MNP was not mentioned at all. Other groups are arguing for LAP-M as a primary protocol, with MNP as an "appendix" to the standard. Finally, it's possible that no standard at all will evolve.

If it comes at all, the new standard will probably not arrive until 1989; the next plenary session of the CCITT takes place this November. Meanwhile, users can't wait: demand for error-correction modems is rising steadily (although currently less than 3 percent of the world's installed base of modems has any form of error control).

However, buyers should not despair. The final standard may be compatible with, or include, both error-correction methods. And for applications that demand both protocols, dual-mode modems will be available. On the downside, modems with both MNP and LAP-B will cost more. □

The problem for buyers is incompatibility between modems with different data compression techniques.

Interest Quotient (Circle One)
High 526 Medium 527 Low 528

VOICE GRADE DDD MODEMS

Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
ACER TECHNOLOGIES CORP. 401 Charcot Ave., San Jose, CA 95131, (408) 922-0333							**Circle 622**
1212/PC	300, 1200	FSK, PSK	full duplex	asynch	auto dial/ auto answer	$149(Q1)	Bell 103, 212A, CCITT V.21, V.22B compatible; plugs into PC compatible
2400/SA	300, 600, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$329(Q1)	Bell 103, 212A, CCITT V.22A, V.22 bis compatible
2400/PC	300, 600, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$260(Q1)	Bell 103, 212A, CCITT V.22B, V.22 bis compatible; plugs into PC compatible
ANCHOR AUTOMATION INC. 20675 Bahama St., Chatsworth, CA 91311, (818) 998-6100							**Circle 623**
1200E	300, 1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$189(Q1)	Bell 103J, 212A compatible
1200i	300, 1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$149(Q1)	Bell 103J, 212A compatible; plugs into IBM PC bus
2400i	300, 1200, 2400	FSK, PSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$199(Q1)	Bell 103J, 212A, CCITT V.21, V.22 bis compatible; plugs into IBM PC bus

VOICE GRADE DDD MODEMS

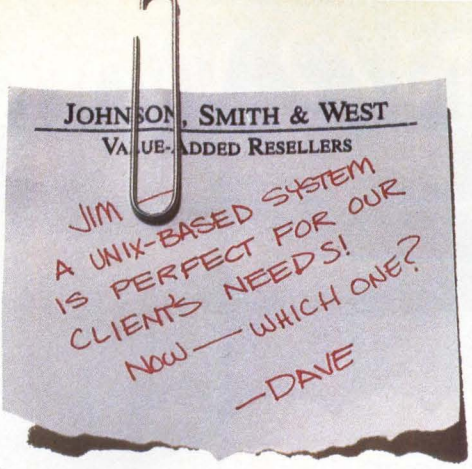
Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
ANDERSON JACOBSON INC.							**Circle 624**
521 Charcot Ave., San Jose, CA 95131, (408) 435-8520							
AJ 2412-AD3H	300, 1200, 2400	FSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$695(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
AJ 2412-STH	300, 1200, 2400	FSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$495(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
AJ 2441-1	300, 1200, 2400	FSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$695(Q1)	Bell 103, 212A, CCITT V.21, V.22, V.22 bis compatible
APPLE COMPUTER INC.							**Circle 625**
20525 Mariani Ave., Cupertino, CA 95014, (408) 996-1010							
Personal Modem	300, 1200		full duplex	asynch	auto dial/ auto answer	$399(Q1)	
AT&T							**Circle 626**
295 N. Maple Ave., Basking Ridge, NJ 07920, (800) 247-1212							
2024A	2400	DPSK	full duplex	synch		$1,960(Q1)	
2224CEO/2224G	300-2400	FSK, DPSK, QAM	full duplex	asynch, synch		$650/$695(Q1)	Bell, Hayes, CCITT V.32 compatible; standalone/ multi-mounted version
4024	up to 2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$475(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
BIZCOMP CORP.							**Circle 627**
532 Mercury Dr., Sunnyvale, CA 94086, (408) 733-7800							
2110	300, 1200	FSK, DPSK	half, full duplex	asynch	auto dial/ auto answer	$429(Q1)	Bell 103, 212A, Hayes compatible; plugs into IBM PC or compatible
4120	300, 1200	FSK, DPSK	half, full duplex	asynch	auto dial/ auto answer	$449(Q1)	Bell 103, 212A, CCITT V.22, Hayes compatible
4124	300, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$599(Q1)	Bell 103, 212A, CCITT V.22 bis, Hayes compatible
BLACK BOX CORP.							**Circle 628**
P.O. Box 12800, Pittsburgh, PA 15241, (412) 746-5500							
MD797B	300, 1200, 2400	FSK	half, full duplex	asynch, synch	auto dial/ auto answer	$350(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis, Hayes compatible
MD815B	300, 1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$250(Q1)	Bell 103, 212A, Hayes compatible
BYTCOM							**Circle 629**
2169 Francisco Blvd., Unit H, San Rafael, CA 94901, (415) 485-0700							
24/12 Contac	300, 1200, 2400	FSK, PSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$389(Q1); $249(Q100)	Bell 212, CCITT V.22 compatible; plugs into IBM
CASE COMMUNICATIONS INC.							**Circle 630**
7200 Riverwood Dr., Columbia, MD 21046-1199, (301) 290-7710							
4624/VS	2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$695(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; standalone or plugs into IBM PC
4648/VS	2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$795(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; standalone or plugs into IBM PC
CERMETEK MICROELECTRONICS INC.							**Circle 631**
1308 Borregas Ave., Sunnyvale, CA 94088-3565, (408) 752-5000							
1200SPC	300, 1200	FSK, PSK	full duplex	asynch	auto dial/ auto answer	$265(Q1); $193(Q100)	Bell 103, 212A compatible; plugs into IBM PC/AT/XT
2400R	300, 1200, 2400	FSK, PSK	full duplex	asynch, synch	auto dial/ auto answer	$545(Q1); $382(Q100)	Bell 103, 212A, CCITT V.22 bis compatible
2400SPC	300, 1200, 2400	FSK, PSK	full duplex	asynch	auto dial/ auto answer	$395(Q1); $277(Q100)	Bell 103, 212A compatible; plugs into IBM PC/AT/XT
CODEX CORP.							**Circle 632**
Maresfield Farm, 7 Blue Hill River Rd., Canton, MA 02021-1097, (617) 364-2000							
2219	1200	FSK	half, full duplex	asynch	manual orig./ auto answer	$475(Q1)	Bell 202S, 202T compatible
2220	1200, 2400	PSK	half, full duplex	synch	manual orig./ auto answer	$685(Q1)	Bell 201B, 201C compatible
2233	300, 1200, 2400	FSK, QAM	full duplex	asynch, synch	manual orig./ auto answer	$445(Q1)	Bell 103, 212, CCITT V.22 bis compatible

VOICE GRADE DDD MODEMS

Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
COMPUTER COMMUNICATIONS SPECIALISTS INC. 6683 Jimmy Carter Blvd., Norcross, GA 30071, (404) 441-3114							**Circle 633**
Audiomodem II	1200	FSK	half duplex	asynch	auto dial/ auto answer	$2,495(Q1)	Bell 202S compatible, verbal response to inputs from touch-tone phone or hand-held terminal
Audiomodem III	1200	FSK	half, full duplex	asynch	auto dial/ auto answer		Bell 103, 202 compatible; plugs into IBM PC/AT; verbal response to inputs from touch-tone phone or hand-held terminal
CONCORD DATA SYSTEMS INC. 45 Bartlett St., Marlborough, MA 01752, (617) 460-0808							**Circle 634**
224 Autodial Plus	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$425(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
224 Series II	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$695(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; standalone or plugs into IBM PC
212 Autodial	300, 1200	FSK, DPSK	full duplex	asynch, synch	auto dial/ auto answer	$295(Q1)	Bell 212A, CCITT V.21, V.22 compatible
CTS FABRI-TEK INC. (DATACOMM PRODUCTS DIV.) 6900 Shady Oak Rd., Eden Prairie, MN 55344, (612) 941-9100							**Circle 635**
2424ADH	110-2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$395(Q1)	Bell 103, 113, 212A, CCITT V.22 bis, V.22 A/B compatible
2424AMH	110-2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$395(Q1)	Bell 103, 113, 212A, CCITT V.22 bis, V.22 A/B compatible
Half-Pak #24	110-2400	FSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$395(Q1)	Bell 103, 113, 212A, CCITT V.22 bis, V.22 A/B; plugs into IBM PC/AT/XT or compatible
DATAGRAM CORP. 11 Main St., East Greenwich, RI 02818, (401) 885-4840							**Circle 636**
DCE-224	300, 600, 1200, 2400	FSK, DPSK, PSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$695(Q1); $500(Q100)	Bell 103, 202, 212A, 224, CCITT V.21, V.22, V.22 bis, V.23 compatible
DATEC INC. 2300 Englert Dr., Suite C, Durham, NC 27713, (919) 544-6433							**Circle 637**
212SD	300, 1200	FSK	half, full duplex	asynch, synch	auto dial/ auto answer	$590(Q1); $418(Q100)	Bell 103, 113, 212A compatible
FASTCOMM DATA CORP. 12347-E Sunrise Valley Dr., Reston, VA 22091, (703) 620-3900, (800) 521-2496							**Circle 638**
FASTCOMM 2400	300, 1200, 2400	FSK, DPSK		asynch	auto dial/ auto answer	$619(Q1)	Bell 103, 212A, CCITT V.22 bis compatible; plugs into IBM PC
FRANKLIN TELECOMMUNICATIONS CORP. 733 Lakefield Rd., Westlake Village, CA 91361, (805) 373-8688							**Circle 639**
Bright Modem	300, 1200	FSK, PSK			auto dial/ auto answer		Bell 103, 113, 212A compatible; plugs into IBM PC/AT/XT, Portable
FM2400e	300, 1200, 2400	FSK, DPSK, QAM		asynch, synch			Bell 103A, 212A, CCITT V.22, V.22 bis compatible
FM2400i	300, 1200, 2400	FSK, DPSK, QAM		asynch			Bell 103A, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC and compatible
GANDALF DATA INC. 1020 S. Noel Ave., Wheeling, IL 60090, (312) 541-6060							**Circle 640**
ACCESS Series 24A	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$510(Q1)	Bell 103, 212A compatible
ACCESS Series 24S	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$595(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
ACCESS 24V	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$695(Q1)	Bell 103, 212A compatible
GENERAL DATACOMM INDUSTRIES INC. Straits Turnpike, Middlebury, CT 06762, (203) 574-1118							**Circle 641**
AccuLine 224	300, 1200, 2400	FSK, PSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$595(Q1); $425(Q100)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
DataComm 224+	300, 1200, 2400	FSK, PSK, QAM		asynch, synch	auto dial/ auto answer	$580(Q1); $420(Q100)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
DeskTop 201	2400	DPSK	half, full duplex	synch	manual orig./ auto answer	$690(Q1); $510(Q100)	Bell 201C compatible

VOICE GRADE DDD MODEMS

Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
HAYES MICROCOMPUTER PRODUCTS INC.							**Circle 642**
P.O. Box 105203, Atlanta, GA 30348, (404) 449-8791							
Smartmodem 1200	1200	PSK, DPSK	half, full duplex	asynch	auto dial/ auto answer	$399(Q1)	Bell 103, 212A, CCITT V.22 compatible
Smartmodem 2400	2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$599(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
V-Series Smartmodem 2400	2400	QAM	full duplex	asynch, synch	auto dial/ auto answer	$899(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
IBM Corp.							**Circle 676**
900 King St., Rye Brook, NY 10573, (914) 934-4000							
5853	1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$690(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
5842	1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$719(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
PC2400	1200, 2400	FSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$569(Q1)	Bell 103, 212A, CCITT V.22 bis compatible; plugs into IBM PC/XT/AT
IDEASSOCIATES INC.							**Circle 643**
29 Dunham Rd., Billerica, MA 0l821, (617) 663-6878							
IDEAcomm 1200S	1200	FSK, PSK, QAM	full duplex	asynch	auto dial/ auto answer	$345(Q1)	Bell 103, 212A compatible; plugs into IBM PC/AT/XT; includes software
IDEAcomm 2400	2400	FSK, PSK, QAM	full duplex	asynch	auto dial/ auto answer	$645(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC/AT/XT; includes software
INFINET INC.							**Circle 644**
40 High St., North Andover, MA 01845, (617) 681-0600							
224 Dial	1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer		Bell 103, 212A, CCITT V.22, V.22 bis compatible
IDM 2400	1200, 1800, 2400	PSK	half, full duplex	asynch, synch	auto dial/ auto answer	$1,550/ $1,650(Q1); $1,240/ $1,320(Q100)	CCITT V.26 compatible, rackmount or standalone
INFOTRON SYSTEMS CORP.							**Circle 645**
Cherry Hill Industrial Center, Bldg. 9, Cherry Hill, NJ 08003, (609) 424-9400							
INM 2400	1200, 2400	QAM	half, full duplex	synch	auto dial/ auto answer	$1,550/ $1,650(Q1)	Bell 201, CCITT V.22 bis compatible; rackmount or standalone
LEADING EDGE HARDWARE PRODUCTS INC.							**Circle 646**
225 Turnpike St., Canton, MA 02021, (617) 828-8150							
Model "L" Series 1200B	300, 1200	FSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$149(Q1)	Bell 103, 212A, CCITT V.22 compatible; plugs into IBM PC/AT/XT or compatible; includes Bitcom software
Model "L" Series 2400B	300, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$289(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC/AT/XT or compatible; includes Bitcom software
MICOM SYSTEMS INC.							**Circle 647**
4100 Los Angeles Ave., Simi Valley, CA 93063, (805) 583-8600							
3124EH	2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$599(Q1)	Bell 212A, CCITT V.22 bis compatible
MICROCOM INC.							**Circle 648**
1400 Providence Highway, Norwood, MA 02062, (617) 762-9310							
AX/1200c	1200	FSK, DPSK, QPSK	full duplex	asynch	auto dial/ auto answer	$499(Q1)	Bell 212A, CCITT V.22 compatible
AX/2400	2400	FSK, DPSK, QPSK	full duplex	asynch	auto dial/ auto answer	$699(Q1)	Bell 212A, CCITT V.22 bis compatible
MITEL DATACOM INC.							**Circle 649**
13873 Park Center Rd., Suite 553, Herndon, VA 22071, (703) 471-1000							
4122ACX	1200	DPSK	full duplex	asynch, synch	auto dial/ auto answer	$700(Q1)	CCITT V.22 compatible
4123X	1200	FSK	half, full duplex	asynch	auto dial/ auto answer	$480(Q1)	CCITT V.21, V.23 compatible
4242X	2400	QAM	full duplex	asynch, synch	auto dial/ auto answer	$900(Q1)	CCITT V.22 bis compatible



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CIRCLE NO. 35 ON INQUIRY CARD

COLORSCAN®/2 Workstation

VAX access and PC applications. Hmmm!

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The COLORSCAN/2 color graphics workstation "is an idea whose time has come," reported *Digital Review*. It fits two capabilities - VAX™ access and the ability to run PC applications - into one very small, low-profile enclosure with quiet, diskless operation.

It's a built-in plug-compatible VT™200 text/color graphics terminal for all your VMS™ and UNIX® information access. And it's a high-performance MS-DOS® personal computer for today's business applications. All in one sleek ergonomically-designed desktop workstation.

There's more, too. Parallel VT200 and MS-DOS operations. ReGIS™, Sixel, Tektronix™ and EGA plus-compatible color graphics (640 × 480 × 16 resolution). Built-in cut and paste. Full 132-column display.

In other words, "The COLORSCAN/2," according to Frank J. Derfler, Jr., editor of *PC Magazine*, "is an excellent solution to desktop clutter for any combination of PC, LAN-based and host-based applications."

To find out more, call Datamedia at 1-800-DMC-INFO.

Unretouched screen
10 × 15 × 2.5-inch base unit

DATAMEDIA CORPORATION
The Positive Response™

11 Trafalgar Square, Nashua, NH 03063

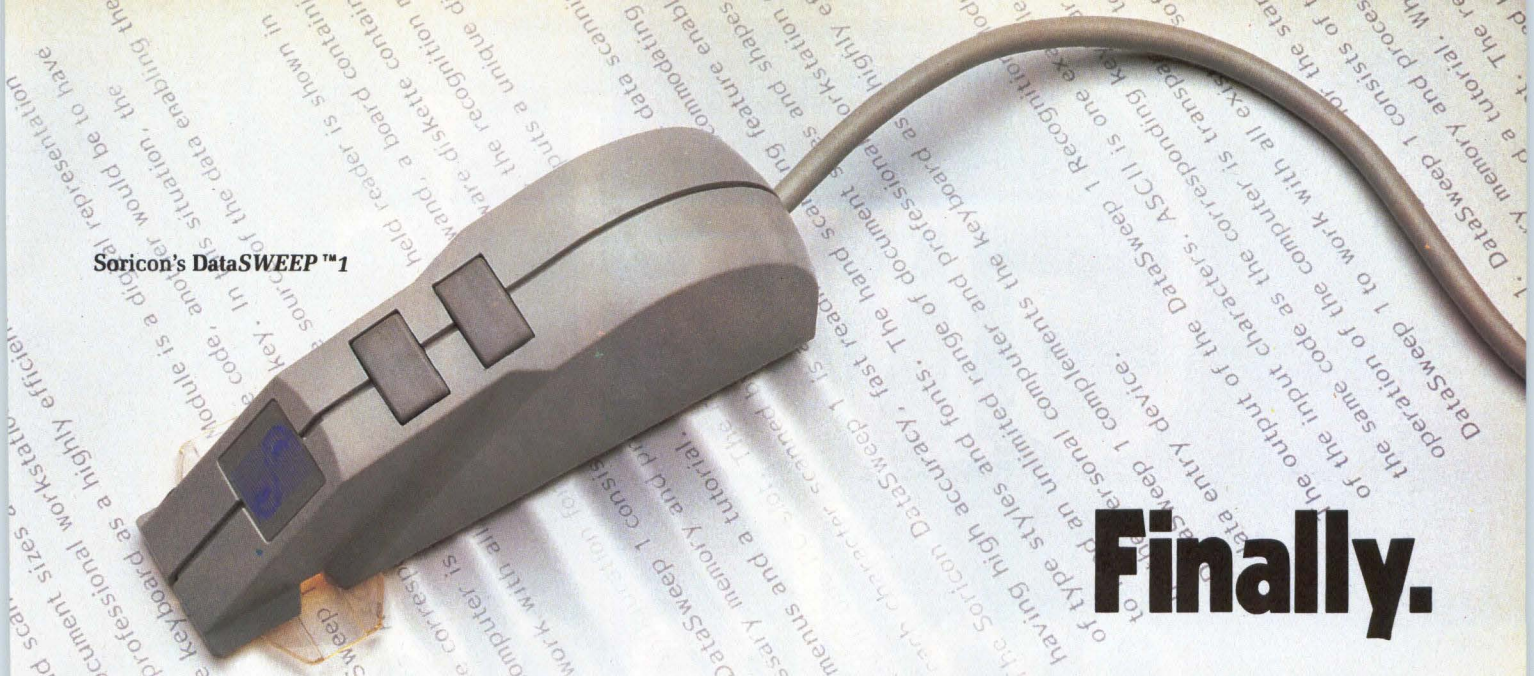
CIRCLE NO. 36 ON INQUIRY CARD

VOICE GRADE DDD MODEMS

Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
MULTI-TECH SYSTEMS INC. 82 Second Ave. S.E., New Brighton, MN 55112, (612) 631-3550, (800) 328-9717							**Circle 650**
MT212EH	300, 1200	FSK, PSK, DPSK	half, full duplex	asynch	auto dial/ auto answer	$399(Q1)	Bell 103, 113, 212A, Hayes compatible
MT224EC	300, 1200, 2400	FSK, PSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$499(Q1)	Bell 103, 212A, Hayes compatible
MT224EH	300, 1200, 2400	FSK, PSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$649(Q1)	Bell 103, 212A, Hayes compatible
NEC HOME ELECTRONICS (U.S.A) INC. 1255 Michael Dr., Wood Dale, IL 60191, (312) 860-9500							**Circle 677**
PC-16-61	300, 1200	FSK, DPSK	half, full duplex	asynch	auto dial/ auto answer	$399(Q1)	Bell 103A, 212A compatible; plugs into MulitSpeed
PC-16-63	300, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$499(Q1)	Bell 103A, 212A, CCITT V.22, V.22 bis compatible; plugs into MultiSpeed
NOVATION INC. 21345 Lassen St., Chatsworth, CA 91311, (818) 998-5060							**Circle 651**
490510	300, 1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$299(Q1)	Bell 103, 212A compatible
490605-2	300, 1200, 2400	FSK, PSK	full duplex	asynch, synch	auto dial/ auto answer	$750(Q1)	Bell 103, 212A compatible
490700	300, 1200	FSK, PSK	full duplex	asynch	auto dial/ auto answer	$119(Q1)	Bell 103, 212A compatible
OMNITEL INC. 3500 W. Warren Blvd., Fremont, CA 94538, (415) 490-2202							**Circle 678**
Encore 2400HB	2400	QAM	half, full duplex	asynch	auto dial/ auto answer	$399(Q1)	Bell 103A, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC/AT/XT, PS/2 Model 30
Encore 2400PS	2400		half, full duplex	asynch	auto dial/ auto answer	$399(Q1)	Bell 103A, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PS/2 Model 50, 60
Encore 2400SD	2400	QAM	half, full duplex	asynch	auto dial/ auto answer	$499(Q1)	Bell 103A, 212A, CCITT V.22, V.22 bis compatible
OKIDATA 532 Fellowship Rd., Mount Laurel, NJ 08054, (800) OKIDATA							**Circle 652**
Okitel 1200/1200B	1200	FSK, PSK, DPSK	full duplex	asynch	auto dial/ auto answer	$339/$319(Q1)	Bell 103, 212A compatible; standalone or plugs into IBM PC/AT/XT, PS/2
Okitel 2400/2400B	2400	FSK, PSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$549/$499(Q1)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; standalone or plugs into IBM PC/AT/XT, PS/2
PARADYNE CORP. 8550 Ulmerton Rd., Largo, FL 33540 (813) 530-2000							**Circle 653**
FDX 2400 Plus	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$595(Q1); $565(Q100)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible
FDX/PC	300, 1200, 2400	FSK, DPSK, QAM	half duplex	asynch, synch	auto dial/ auto answer	$495(Q1); $465(Q100)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC/XT or compatible
PATTON ELECTRONICS CO. 7958 Cessna Ave., Gaithersburg, MD 20879, (301) 975-1000							**Circle 654**
612	1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$175(Q1); $140(Q100)	Bell 103, 212A compatible
624	2400	FSK, PSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$295(Q1); $236(Q100)	Bell 103, 212A, CCITT V.22 compatible
PENRIL DATACOMM 207 Perry Parkway, Gaithersburg, MD 20877, (301) 921-8600							**Circle 655**
Cadet 1200	300, 1200	FSK, DPSK	half, full duplex	asynch	auto dial/ auto answer	$289(Q1)	Bell 103, 212A compatible
Cadet 2400	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$535(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
Datalink 2400	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$595(Q1)	Bell 103, 212A, CCITT V.22 bis compatible

VOICE GRADE DDD MODEMS

Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
PRACTICAL PERIPHERALS INC.							**Circle 656**
31245 LaBaya Dr., Westlake Village, CA 91362, (800) 641-0814							
1200SA	1200	FSK, PSK,	half, full duplex	asynch	auto dial/ auto answer	$169(Q1); $84(Q100)	Bell 103, 212A compatible
2400SA	2400	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$239(Q1); $143(Q100)	Bell 103, 212A, CCITT V.22 compatible
PM2400	2400	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$199(Q1); $120(Q100)	Bell 103, 212A, CCITT V.22 compatible; plugs into IBM PC or compatible
PROMETHEUS PRODUCTS INC.							**Circle 657**
4545 Cushing Parkway, Fremont, CA 94538, (415) 490-2370							
ProModem 1200T	300, 1200	FSK, PSK	full duplex	asynch	auto dial/ auto answer		Bell 103, 212A compatible; plugs into Toshiba
ProModem 2400	300, 1200, 2400	FSK, PSK	full duplex	asynch, synch	auto dial/ auto answer		Bell 103, 212A compatible
ProModem 2400B/2	300, 1200, 2400	FSK, PSK	full duplex	asynch	auto dial/ auto answer		Bell 103, 212A compatible; plugs into IBM
QUADRAM CORP.							**Circle 658**
One Meca Way, Norcross, GA 30093, (404) 923-6666							
Quadmodem II	300, 1200, 2400	FSK, PSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$795(Q1)	Bell 103, 212A compatible; plugs into IBM PC/AT/XT compatible
RACAL-VADIC							**Circle 659**
1525 McCarthy Blvd., Milpitas, CA 95035, (408) 432-8008							
1200VP	300, 1200	FSK, DPSK	full duplex	asynch, synch	auto dial/ auto answer	$295(Q1); $236(Q100)	Bell 103, 212A compatible
2400PA Model 2	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$795(Q1); $636(Q100)	Bell 103, 212A, CCITT V.22 bis compatible
2400VP	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$595(Q1); $452(Q100)	Bell 103, 212A, CCITT V.22 bis compatible
RAD DATA COMMUNICATIONS INC.							**Circle 660**
151 W. Passaic St., Rochelle Park, NJ 07662, (201) 587-8822							
DLM-300	300	FSK	full duplex	asynch	manual orig.		Bell 103, CCITT V.21 compatible
DLM-HD	1200	FSK	half duplex	asynch	manual orig.		CCITT V.23 compatible
DLM-VJ	1200	FSK	full duplex	asynch	manual orig.		CCITT V.23 compatible
ROCKWELL INTERNATIONAL CORP.							**Circle 661**
4311 Jamboree Rd., P.O. Box C, Newport Beach, CA 92658, (714) 833-4700							
R212AT	300, 1200	FSK, DPSK	full duplex	asynch	auto dial/ auto answer	$20(Q1000)	chip set; Bell 103, 212A compatible
R1212DS	300, 600, 1200	DPSK	full duplex	asynch, synch	auto dial/ auto answer	$30(Q1000)	chip set; Bell 103, 212A, CCITT V.22A/B compatible
R2424DS	300, 600, 1200, 2400	QAM	full duplex	asynch, synch	auto dial/ auto answer	$47(Q1000)	chip set; Bell 103, 212A, CCITT V.22A/B, V.22 bis compatible
TANDY CORP. (RADIO SHACK)							**Circle 662**
1800 One Tandy Center, Fort Worth, TX 76102, (817) 390-3011							
25-1013	300, 1200	FSK, DPSK	full duplex	asynch	auto dial/ auto answer	$199(Q1)	Bell 103, 113, 212A compatible; plugs into Tandy 1000, 3000, 4000
TDT GROUP INC.							**Circle 663**
444 Brickell Ave., Suite 902, Miami, FL 33131, (305) 372-9332							
UnderCover Modem 201C	2400	DPSK	full duplex	synch	auto dial/ auto answer	$650(Q1)	Bell 201 compatible, plugs into IBM PC bus
TEK-COM CORP.							**Circle 664**
120 Charcot Ave., San Jose, CA 95131, (408) 435-9515							
TC24AD	300, 1200, 2400	QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$459(Q1); $371(Q100)	Bell 103, 212A, CCITT V.22, V.22 bis compatible
TC24EC	300, 1200, 2400	QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$595(Q1); $446(Q100)	Bell 103, 212A, CCITT V.22 bis compatible
TC24PC	300, 1200, 2400	QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$345(Q1); $259(Q100)	Bell 103, 212A, CCITT V.22, V.22 bis compatible; plugs into IBM PC/AT/XT, PS/2



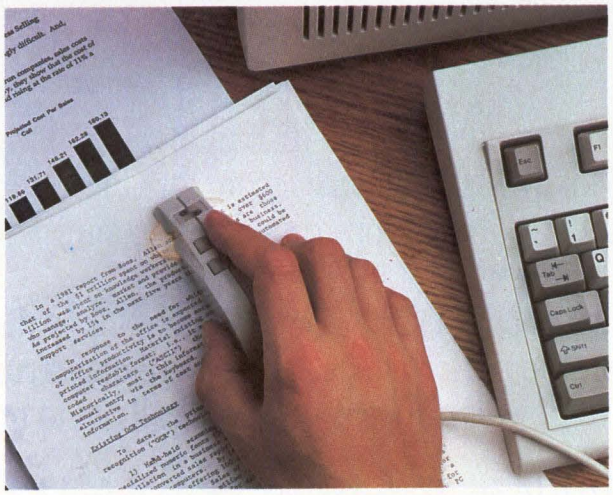
Finally.
DATA ENTRY has been made DATA EASY.

With Data*SWEEP*™*1* from Soricon. An intelligent, hand-held character reader/data entry system that provides the OEM,VAR and System Integrator with a solution-oriented system peripheral for ***selective,*** high-speed data input.

Provide your personal computer customers with the enhanced productivity of Soricon's OCR/ICR technology. With the continuing rise in keyboard data entry costs, **Data*SWEEP 1*** is a must for increasing data entry accuracy and productivity.
Ergonomically designed, it's the ideal price/performance solution for keyboard users in a wide variety of industries such as banking, insurance, securities, legal, medical and general office workplaces.

When you consider the **Data*SWEEP 1*** features and compare them to typical keyboard data entry, it becomes clear that intelligent character recognition (ICR) technology will become the standard method to efficiently and cost-effectively execute data entry.

- Scanning speed: 170 effective wpm
- Accuracy: Typically 99.3%
- Easy and quick to install and operate
- Requires very little host memory



The Soricon **Data*SWEEP 1 "A Better Way"***

- Multi-font capability: Most office fonts from typewriters, laser printers, daisy wheels, near letter quality dot matrix printers and some typeset text and proportionally spaced type
- Automatically compensates for variations in user technique
- The system adjusts automatically to the specific type style
- Works with the IBM PC, XT, AT and 100% compatibles

Data*SWEEP 1* comes complete with the hand-held intelligent character reader, interface board (uses one full- size expansion slot), software diskette, user manual plus full service and manufacturer support.

Soricon's proprietary character recognition technology is not limited to **Data*SWEEP 1.*** It can be customized ***(in fact, that is our business)*** to function with other hosts, non-intelligent terminals, etc.

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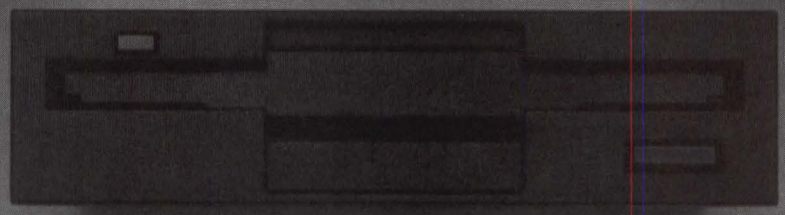
CIRCLE NO. 37 ON INQUIRY CARD

Give Us an Inch.



FD-135 shown actual size.

The TEAC FD-135 Series of 3½-inch micro floppy disk drives need only one inch in height. A mere 25.4mm. But they're not short on capacity. Switchable from 1 to 2 megabytes of storage, the FD-135 Series fit in with today's emerging standard.

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To over 9 million users of our FD-55 Series 5¼-inch floppy disk drives, the distinctive TEAC arrow stands for precision performance and proven long-term reliability. Now, with our line of 3½-inch micro floppy disk drives, we're going all out to repeat ourselves.

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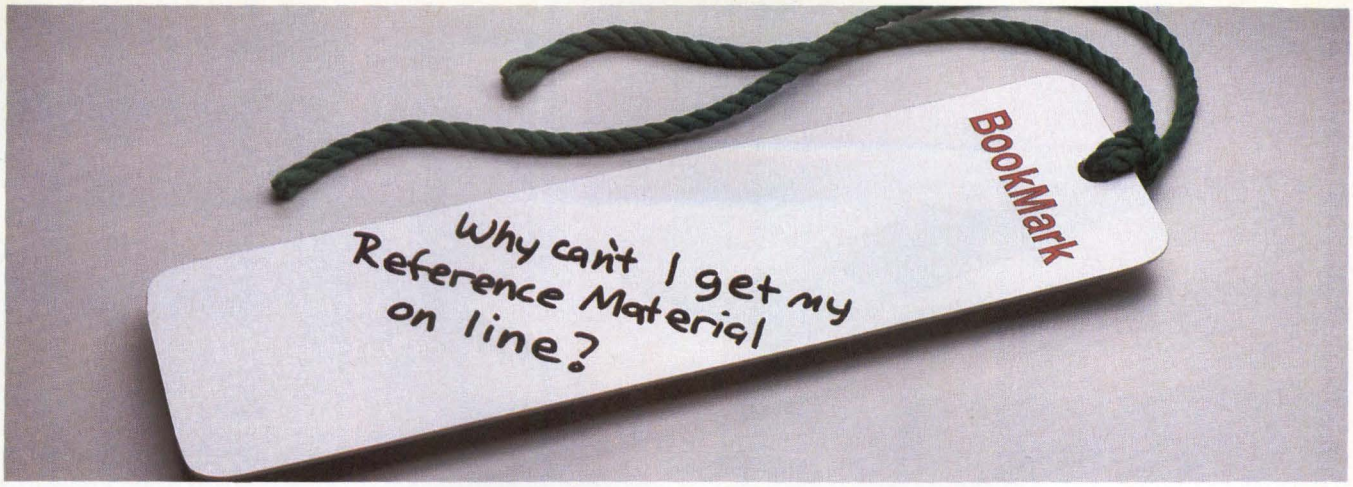
CIRCLE NO. 38 ON INQUIRY CARD

VOICE GRADE DDD MODEMS

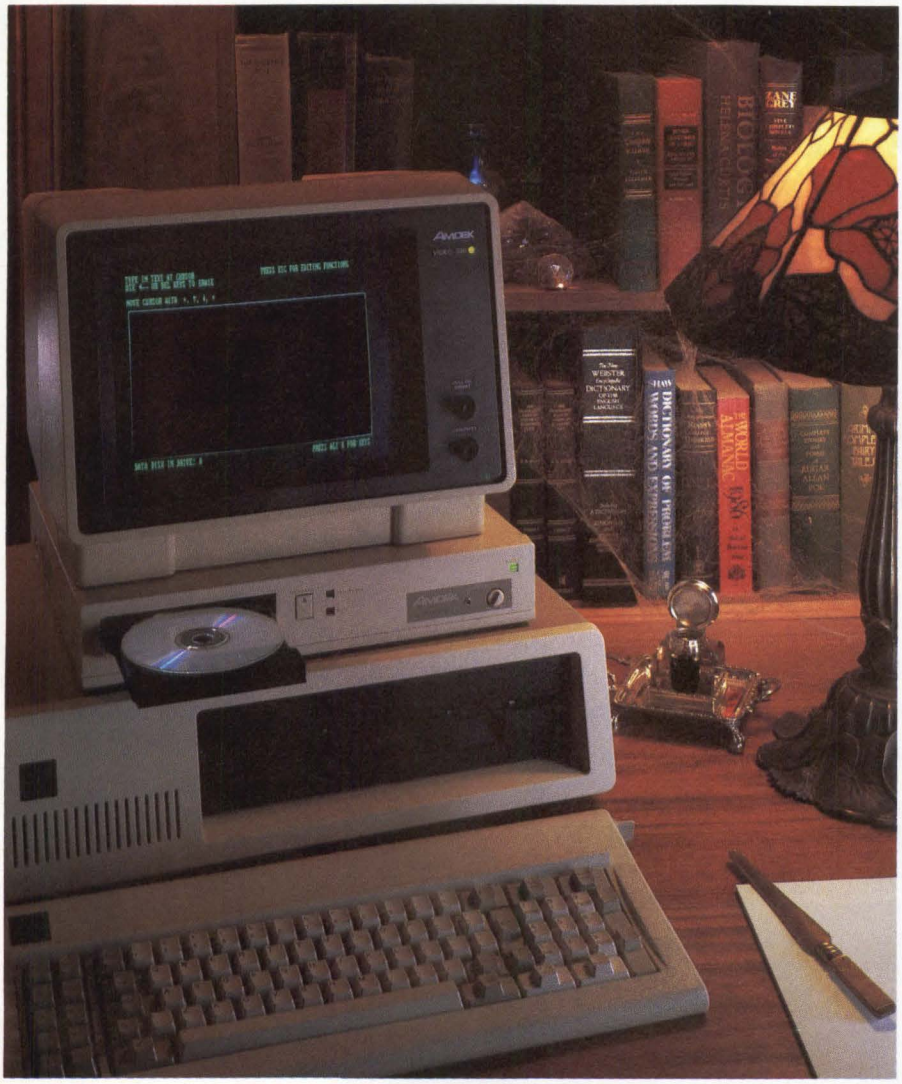
Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
TELCOR SYSTEMS CORP.							**Circle 665**
12 Michigan Dr., Natick, MA 01760, (617) 653-3995							
2424MA	up to 2400	FSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$795(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
2496DA	up to 2400	FSK, DPSK. QAM	full duplex	asynch	auto dial/ auto answer	$1,095(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
2496MA	up to 2400	FSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$995(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
TELEBYTE TECHNOLOGY INC.							**Circle 666**
270 E. Pulaski Rd., Greenlawn, NY 11740, (516) 423-3232							
1200BS	300, 1200	FSK	full duplex	asynch	auto dial/ auto answer	$150(Q1); $112(Q100)	Bell 212A, CCITT, Hayes compatible; plugs into IBM PC
TELENETICS CORP.							**Circle 667**
895 E. Yorba Linda Blvd., Suite H, Placentia, CA 92670, (714) 524-5770							
TC921I, PS/2	300, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$595(Q1)	Bell 103, 212A, CCITT V.21, V.22, V.22 bis, V.32 compatible; plugs into IBM PC bus
TC921S	300, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$695(Q1	Bell 103, 212A, CCITT V.21, V.22, V.22 bis, V.32 compatible
TOUCHBASE SYSTEMS INC.							**Circle 668**
160 Laurel Ave., Northport, NY 11768, (516) 261-0423							
WorldPort 1200	300, 1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$199(Q1)	Bell 103, 212A, CCITT V.21, V.22, Hayes compatible
WorldPort 2400	300, 1200, 2400	FSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$359(Q1)	Bell 103, 212A, CCITT V.21, V.22, V.22 bis compatible
TRANSEND CORP.							**Circle 669**
884 Portola Rd., Portola Valley, CA 94025, (415) 851-3402							
PCM1200	300, 1200	DPSK	full duplex	asynch	auto dial/ auto answer	$159(Q1); $100(Q100)	Bell 212A compatible, plugs into IBM PC
PCM2400	300, 1200, 2400	DPSK	full duplex	asynch	auto dial/ auto answer	$289(Q1); $220(Q100)	Bell 212A, CCITT V.22 bis compatible; plugs into IBM PC
TRI-DATA SYSTEMS INC.							**Circle 670**
1450 Kifer Rd., Sunnyvale, CA 94086, (415) 746-2074							
OZ Guardian Model 533	110, 300, 1200	FSK, PSK	full duplex	asynch	auto dial/ auto answer	$750(Q1)	Bell 103, 212A compatible
TYMNET (MCDONNELL DOUGLAS NETWORK SYSTEMS CO.)							**Circle 671**
2650 N. First St., San Jose, CA 95161, (408) 922-7595							
933	2400	DPSK, QAM	full duplex	synch	auto dial/ auto answer	$549(Q1); $467(Q100)	Bell 212A, CCITT V.22 bis compatible
934	2400	DPSK, QAM	full duplex	synch	auto dial/ auto answer	$1,295(Q1); $1,126(Q100)	Bell 212A, CCITT V.22 bis compatible; supports up to 3 terminals or PCs over same dial-up line
972	2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$749(Q1); $599(Q100)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible
UNIVERSAL DATA SYSTEMS							**Circle 672**
5000 Bradford Dr., Huntsville, AL 35805, (205) 721-8000							
212A LP	300, 1200	FSK, PSK	full duplex	asynch	manual orig./ auto answer	$195(Q1)	Bell 103J, 212A compatible
EC224A/D	300, 1200, 2400	FSK, PSK, QAM	full duplex	asynch	auto dial/ auto answer	$1,995(Q1)	Bell 103J, 212A, CCITT V.22 compatible
FasTalk 2400	300, 1200, 2400	FSK, PSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$495(Q1)	Bell 103J, 212A, CCITT V.22, V.22 bis compatible; standalone or plugs into IBM PC compatible
U.S. ROBOTICS INC.							**Circle 673**
8100 N. McCormick Blvd., Skokie, IL 60076, (312) 982-5001							
Courier 2400	300, 1200, 2400	FSK, PSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$599(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
Courier 2400e	300, 1200, 2400	FSK, PSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$699(Q1)	Bell 103, 212A, CCITT V.22 bis compatible
Courier 2400e/PS	300, 1200, 2400	FSK, PSK, DPSK, QAM	full duplex	asynch	auto dial/ auto answer	$699(Q1)	Bell 103, 212A, CCITT V.22 bis compatible; plugs into IBM PS/2 Micro Channel bus

VOICE GRADE DDD MODEMS

Company / Model	Data rate (bps)	Modulation method	Transmission mode	Synchronization	Calling mode	Price (quantity)	Notes and features
VEN-TEL INC.							**Circle 679**
2121 Zanker Rd., San Jose, CA 95131, (408) 436-7400							
2400-33	300, 1200, 2400	FSK, PSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$749(Q1)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible
2400-34	300, 1200, 2400	FSK, PSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$649(Q1)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible
2400 Plus	300, 1200, 2400	FSK, PSK, DPSK, QAM	half, full duplex	asynch, synch	auto dial/ auto answer	$599(Q1)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible
VISIONARY ELECTRONICS INC.							**Circle 674**
141 Parker Ave., San Francisco, CA 94118, (415) 751-8811							
Visionary 1200XT	300, 1200	FSK, PSK	half, full duplex	asynch	auto dial/ auto answer	$495(Q1); $223(Q100)	Bell 103, 212A, CCITT V.21, V.22, Hayes compatible; 8K-byte RAM
WESTERN DATACOM CO.							**Circle 675**
P.O. Box 45113, Westlake, OH 44145, (216) 835-1510							
424 Class 5	300, 1200, 2400	FSK, DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$695(Q1); $615(Q100)	Bell 103, 113, 212A, CCITT V.22, V.22 bis compatible
MESA424	300, 1200, 2400	DPSK, QAM	full duplex	asynch, synch	auto dial/ auto answer	$995(Q1); $915(Q100)	Bell 212A, CCITT V.22, V.22 bis compatible
WorldCom 223	300-1200	FSK, PSK, DPSK, QAM	half, full duplex	asynch	auto dial/ auto answer	$545(Q1); $485(Q100)	Bell 103, 113, 202A, CCITT V.21, V.22, V.23 compatible
WINSYSTEMS INC.							**Circle 680**
P.O. Box 12136, Arlington, TX 76012, (817) 274-7553							
MCM-Modem	300, 1200	FSK, PSK	full duplex	asynch	auto dial/ auto answer	$395(Q1)	Bell 103, 212A, Hayes compatible; plugs into STD bus



The Hall-Mark solution:



The Amdek Laserdek

With Amdek's new Laserdek, you can access volumes of reference material easily through your computer keyboard. Connect the Laserdek to your IBM or compatible system, insert the compact disc and you are all set to select from a library that would normally take hours to accumulate.

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CIRCLE NO. 41 ON INQUIRY CARD

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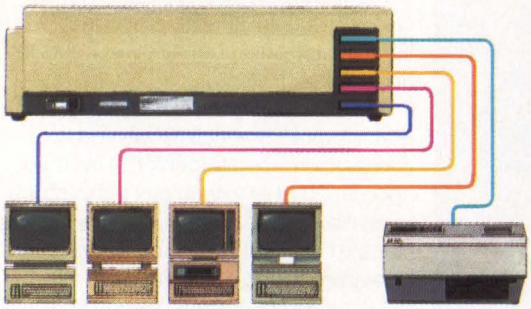

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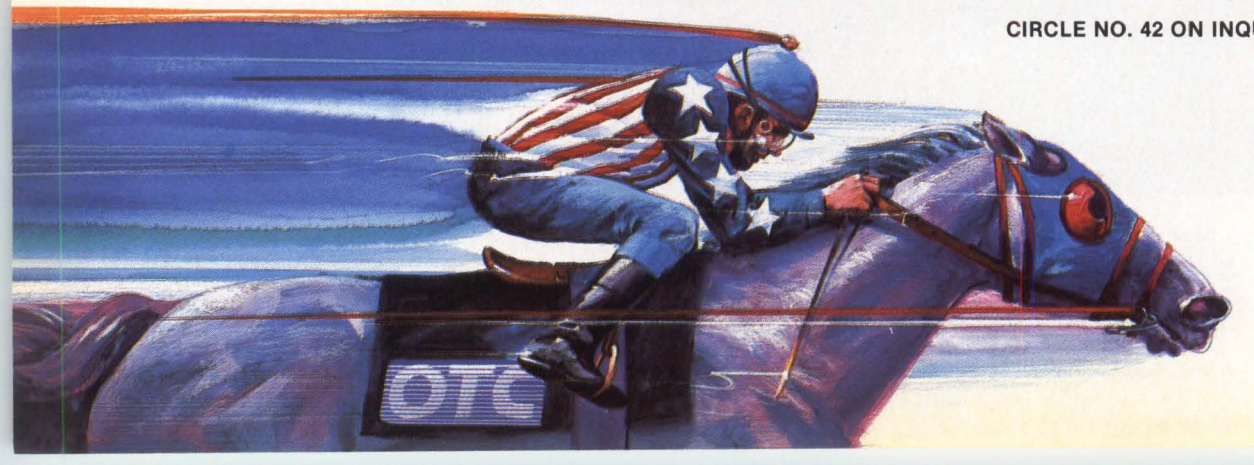


NELSON BENCHMARK TELLS THE WHOLE STORY

The Neal Nelson Business Benchmark yields results for each test, rather than distilling results into a single 'magic' number

Ralph Barker
Ralmar Business Systems

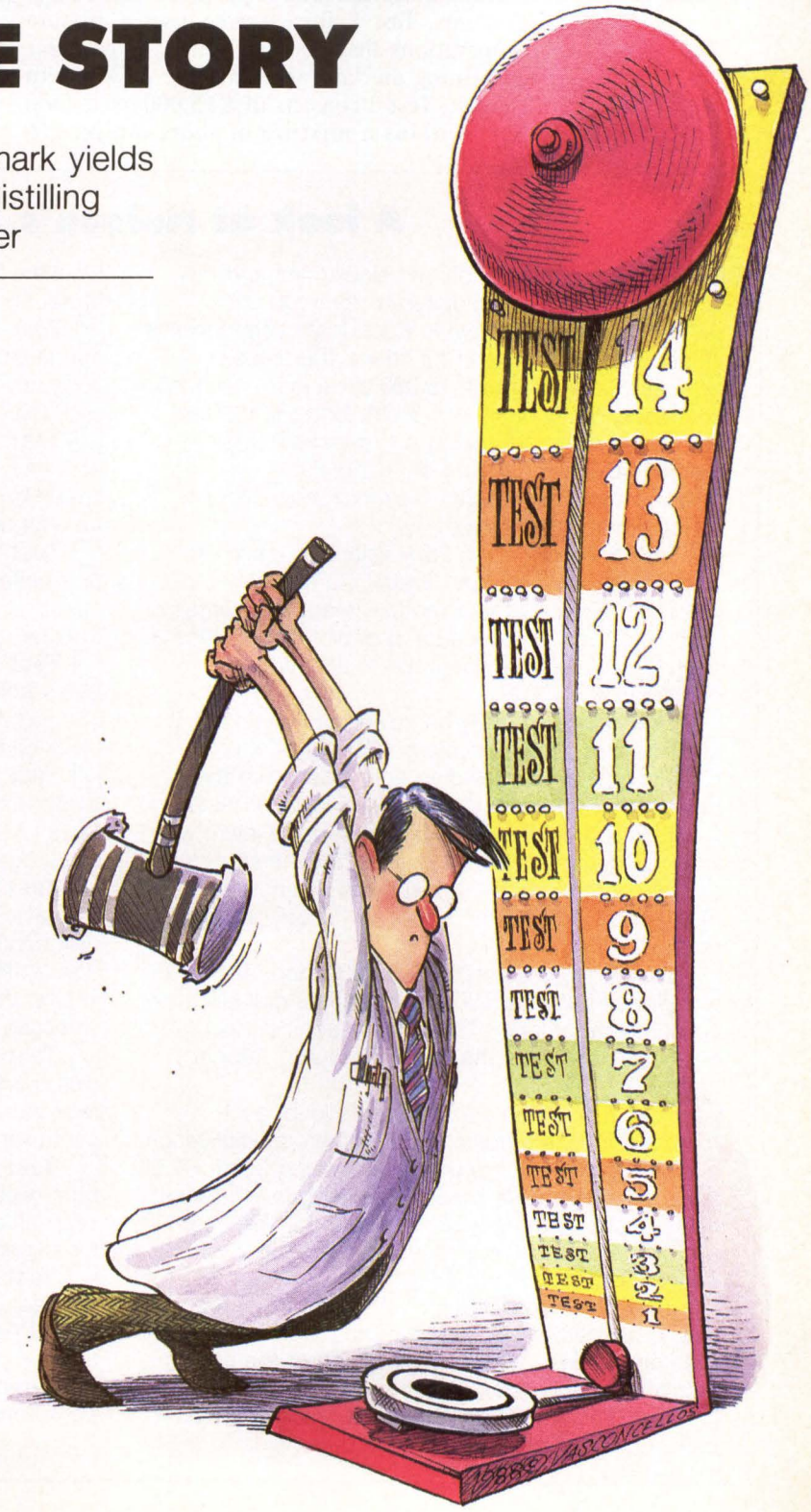
The Neal Nelson Business Benchmark, in contrast to traditional benchmarks, measures multitasking system performance over a range of system loads. Additionally, the test results depict how the machine's performance degrades as the system load increases.

Nelson developed the tests to solve his own benchmarking needs as a VAR. Now he sells them, and the reports they produce, for use by others. Because of the approach taken by the tests, VARs and system integrators who place systems into a variety of user environments should find them particularly interesting.

A complete exercise program

Almost all good benchmarks exercise a system through a mixture of memory management, calculation and disk I/O tests. Having been misled by benchmarks that simply exercise the hardware, Nelson designed the Business Benchmark to approximate the system load created by actual applications software. Although application programs typically comprise a broad mixture of memory management, calculation and disk I/O operations, the mixture tends to vary with each general classification of application software, such as word processing, spreadsheet or database operations. Having benchmark results that depict each of these functional areas, in detail, can be critical when targeting a system for a particular user environment.

Additionally, the benchmark provides detailed results for each of the 18 tests in the suite (in both numerical and graphical form), rather than distilling the test results into a single "magic" number as many benchmarks do.



Thus, the Business Benchmark can be used in a variety of performance measurement roles.

Three of the tests provide an overview of the system's performance for particular user environments. Test 1, for example, uses a mixture of operations that simulate an "average" user performing an "average" mixture of work. In contrast, Test 2 consists of a 15,000-cycle loop that contains a mixture of short-integer (16 bit), long-integer (32 bit) and double-integer (64 bit) math, along with function calls, memory allocation and other operations. Test 2 simulates calculation-intensive tasks like word processing or spreadsheet operations.

Test 3 consists of a 250-cycle loop that contains a mixture of disk I/O functions, including sequential and random reads and writes of both short and long records. Thus, Test 3 depicts

A look at Nelson's 18 tests

☑ **Test 1** provides a mix of calculations and disk access functions to simulate an "average user" performing "average" work. Each test cycle consists of looping through these functions 100 times.

☑ **Test 2** consists of a 15,000-cycle loop, each loop containing a mix of short (16 bit), long (32 bit) and double (64 bit) math, along with function calls, memory allocation and so on. It simulates calculation-intensive tasks like word processing or spreadsheet operations.

☑ **Test 3** consists of a 250-cycle loop, each of which contains a mixture of disk I/O functions, including sequential and random reads and writes of both short and long records. It depicts disk-intensive applications such as database or accounting software.

☑ **Test 4** is essentially an "overhead checker". It consists of a 250,000-cycle null loop (no internal calculations), thus providing an indication of the overhead of the looping logic used in other tests.

☑ **Test 5** provides a 250,000-cycle loop, each with four calculations (addition, subtraction, multiplication and division) of short (16 bit) fields against short (16 bit) fields. It reflects the speed of "short" integer math.

☑ **Test 6** provides a 250,000-cycle loop, each with four calculations (addition, subtraction, multiplication and division) of long (32 bit) fields against long (32 bit) fields. It reflects the speed of "long" integer math.

☑ **Test 7** provides a 25,000-cycle loop, each with four calculations (addition, subtraction, multiplication and division) of double-precision floating point (64 bit) fields against double-precision floating point (64 bit) fields. It shows the speed of "floating point" math, and will reflect the operations of a floating point coprocessor chip.

☑ **Test 8** consists of a 500,000-cycle loop, each loop calling an empty function (no parameters, no data allocation). It reflects the speed of the system's function call routines.

☑ **Test 9** is a 100,000-cycle loop, each of which calls a function and passes nine data fields to the function. This test shows the speed with which the system evaluates data passed to functions.

☑ **Test 10** checks character-oriented memory operations through a mix of initializing, moving and comparing a total of 2 million characters. It shows the speed of text handling in memory.

☑ **Test 11** consists of a 5,000-cycle loop with one disk read of 16 bytes in each loop. It reflects the speed of sequential disk I/O and the associated data transfer rate with disk reads.

☑ **Test 12** consists of a 5,000-cycle loop with one disk write of 16 bytes in each loop. It reflects the speed of sequential disk I/O and associated data transfer rate with disk writes.

☑ **Test 13** is a 500-cycle loop with one read of 512 bytes from the disk in each loop. It reflects the disk I/O and data transfer rate when doing sequential block-oriented disk read operations.

☑ **Test 14** is a 500-cycle loop with one write of 512 bytes from the disk in each loop. It reflects the disk I/O and data transfer rate when doing sequential block oriented disk writes.

☑ **Test 15** is similar to Test 14, except that each loop also includes a "sync" instruction, forcing the disk controller to physically write the data held in the disk buffers onto the disk. It reflects the performance impact of sync instructions within application software.

☑ **Test 16** reads the same 512-byte record from disk 5,000 times, thus testing the efficiency of the microprocessor and the cache manager on the disk controller.

☑ **Test 17** reads the same two records alternatively from disk 5,000 times, testing if the disk controller will keep at least two different records in cache memory for a given process.

☑ **Test 18** provides a 500-cycle loop in which widely spaced, non-sequential records are read from disk files. It provides a general indication of such functions as disk I/O speed and access time when doing random disk reads typical of a "live" multiuser environment.

disk-intensive applications such as database or accounting software. The balance of the tests check other, specific areas of system performance.

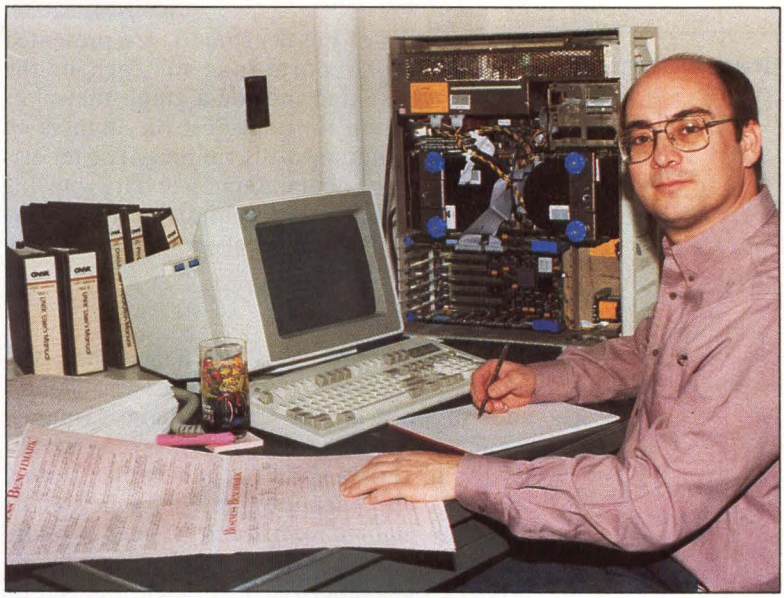
To determine a system's calculation performance, the Business Benchmark provides three separate tests. Short-integer (16 bit) and long-integer (32 bit) math operations are each tested with a 250,000-cycle loop. This loop performs four calculations (addition, subtraction, multiplication and division) using integers of the same size. The floating point test consists of a 25,000-cycle loop that does similar calculations with double-precision floating-point (64 bit) fields. The suite also contains a 250,000-cycle null loop so that the test's looping logic overhead can be separately determined for more detailed analysis.

Individual results are represented by the elapsed time necessary to complete the test at each load level.

In the areas of testing memory operations and function call efficiency, the Business Benchmark examines the speed of processing empty functions and processing functions, which includes data parameters. In the test for function call efficiency (a 100,000-cycle loop), the nine data fields are passed to each function call. The "empty" function test provides useful information about the inherent overhead of function-call processing on the system. Text manipulation in memory is tested by the benchmark through a mixture of initializing, moving and comparing a total of two million characters.

Reading and writing

Although the average access time and the latency data supplied by disk manufacturers provide a starting point for analysis, data throughput is the real key to a system's disk-related performance. Data throughput is a combination of the raw disk performance and efficiency of any disk caching scheme that may be present. A total of eight tests are provided by the Business Benchmark for disk I/O and disk cache management operations. Even though these tests vary according to the number of test-loop iterations, they do provide a good cross section of the disk I/O functions typically encountered.



Neal Nelson runs *the OS/2 version of his Business Benchmark on an IBM Corp. PS/2 Model 80. The suite of tests approximates the system load created by actual applications software.*

Individual tests read and write short-integer (16 byte) and block-oriented (512 byte) records, in both sequential and random-access patterns. The random-access test's widely spaced records provide a general indication of the disk I/O and access speed typically encountered in a "live" multiuser environment. The efficiency of the microprocessor and cache management on the disk controller is also examined by repeatedly reading the same (512 byte) record from a disk.

Another test alternately reads the same two long records to determine if the cache manager will keep at least two different records in cache. By comparing the individual test results with the disk operations anticipated in the user environment, a balanced view of the test system's likely performance can be obtained.

Each of the areas examined by the previously described tests is important. The acceptability of a system for a specific client's use, however, is determined by the machine's real multitasking performance.

This performance criterion is determined within the Business Benchmark by simultaneously running multiple copies of each test. Although a range of 0 to 100 simultaneously executing copies of each test can be selected when the benchmark is started, the typical range is zero to 20. Individual test results are represented by the elapsed time (in seconds) necessary to complete the test at each load level. As the multitasking aspect of the benchmark follows the functional separation provided by the individual tests, the results can be closely related to specific user environments.

Ralph Barker is president of Ralmar Business Systems, a San Jose, Calif., VAR specializing in UNIX systems, consulting and training for non-technical users. Before establishing Ralmar, Barker was president of the Systems Development division of Team Solutions Corp., a software company in San Jose, Calif.

The results of the benchmark are presented in a series of reports (one for each of the eighteen tests), and include a graph that plots actual execution times against the number of test copies simultaneously running. The reports also include the actual numerical data showing the execution times at each load level and the percentage difference between the two machine's execution times.

Individually tailored

When running the Business Benchmark, Nelson's C language source code is downloaded and compiled on the target system. Compiler options may be specified, thus allowing the test results to reflect code optimization or other special compiler features present on the system. (Some specialized architectures, such as multiprocessor systems, may require certain options.) Unless otherwise instructed, the Nelson staff will use the standard portable C compiler with the -O option.

Additionally, the range of multitasking can be specified at run time. A higher than normal range may be required to obtain meaningful results on extremely fast machines. The total run time for the suite can range from approximately an hour on "fast" machines to over 24 hours on a personal computer.

The Business Benchmark can be used in many applications. Most companies leasing source code for the benchmark use it for internal system testing, as well as product positioning.

Many of these companies also use the benchmark reports directly with prospective customers, as part of their sales presentation. Showing a non-technical customer the performance graphs is often easier and more effective than trying to explain the significance of a particular benchmark's "magic" number.

Companies can use benchmark results to determine the cost/benefit ratio of adding additional memory, math coprocessors or other system enhancements. By running the related test before and after the addition of the proposed enhancement, they can easily determine the cost justification for the enhancement.

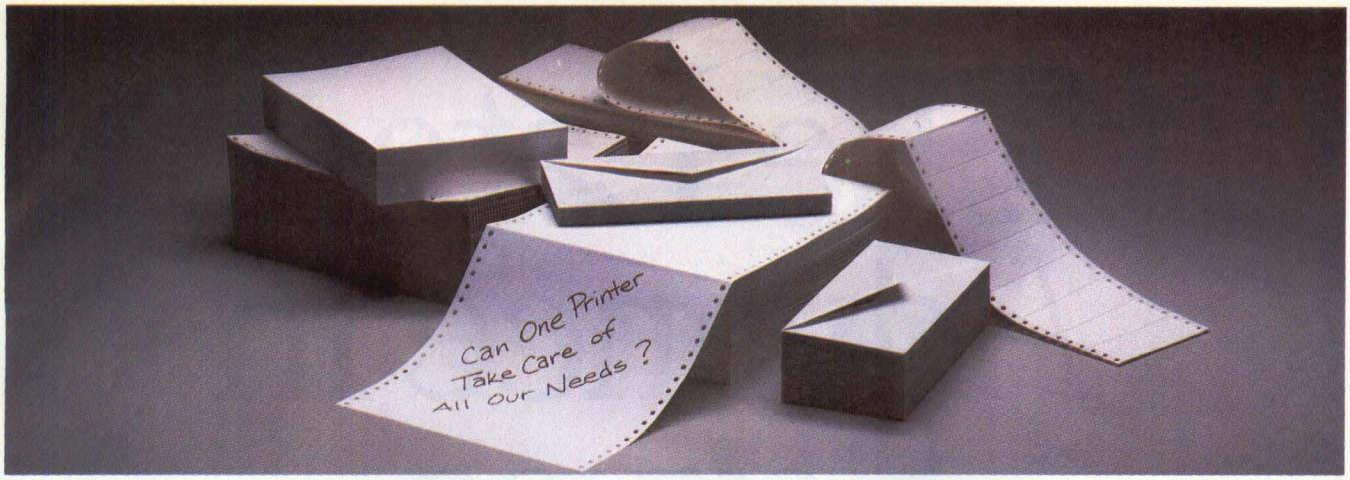
Neal Nelson & Associates also maintains a database of test results for various commercial systems (currently over 130). Reports can be ordered that compare any two machines (or configurations) within the database. Exhaustive benchmarking of specific system configurations may be difficult to cost justify when dealing with departmental or small business machines. In such cases, the test results that are already in Nelson's database may provide the company with sufficient data. □

BENCHMARKING THE BENCHMARKS

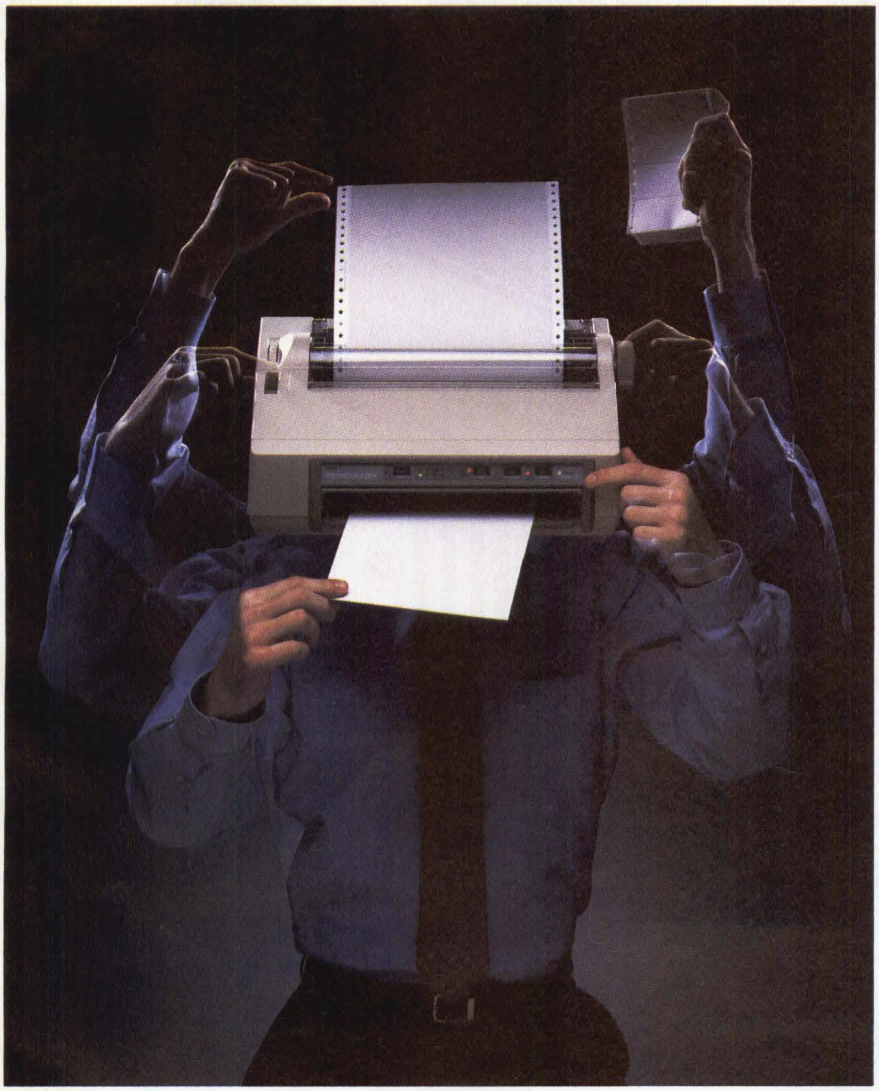
Here's a checklist of what tests are most useful for what applications

Word processing	Spreadsheet	Accounting, DB management	Scientific/ engineering	Programming application development	Test number	Test description
		✓			1	Mixed, average user
✓	✓		✓	✓	2	Calculation intensive average user
		✓			3	Disk intensive average user
					4	Test overhead check
			✓		5	Short integer math
	✓		✓		6	Long integer math
	✓		✓		7	Floating point math
			✓	✓	8	Function call, no parameters
			✓	✓	9	Function call, nine parameters
✓			✓	✓	10	Text manipulation in memory
		✓			11	Sequential disk reads, 16-byte records
		✓			12	Sequential disk writes, 16-byte records
				✓	13	Sequential disk block reads (512 bytes)
				✓	14	Sequential disk block writes (512 bytes)
					15	Write and sync, flush buffers
					16	Disk controller cache management
					17	Multiple records in cache per process
		✓		✓	18	Random disk reads

Source: Neal Nelson & Associates



The Hall-Mark solution:



The NEC Pinwriter 2200

Now there is one printer that can handle everything from continuous forms to envelopes and labels. NEC's Pinwriter 2200 can do it all!

This 24-pin pinwriter features the sharpest resolution in the industry — 360 x 360 dpi. Multiple built-in paper handling features make it possible for you to print envelopes and single sheets through the front slot on the printer without ever removing the already-installed continuous forms. And, for real print variety, the P2200 has six built-in typestyle families capable of up to 128 font variations.

The P2200 adapts easily to every environment. It has an industry-standard parallel interface for easy compatibility with all IBM PC or PC compatible computers. The P2200 is also fully compatible with NEC's other popular pinwriters which are supported by over 450 of the most popular software packages — more than any other 24-pin printer.

NEC offers all these features on one affordably priced printer — the P2200. Call Hall-Mark today for NEC — the answer to all your printing needs. Hall-Mark has solutions to all your computer systems and peripherals needs.

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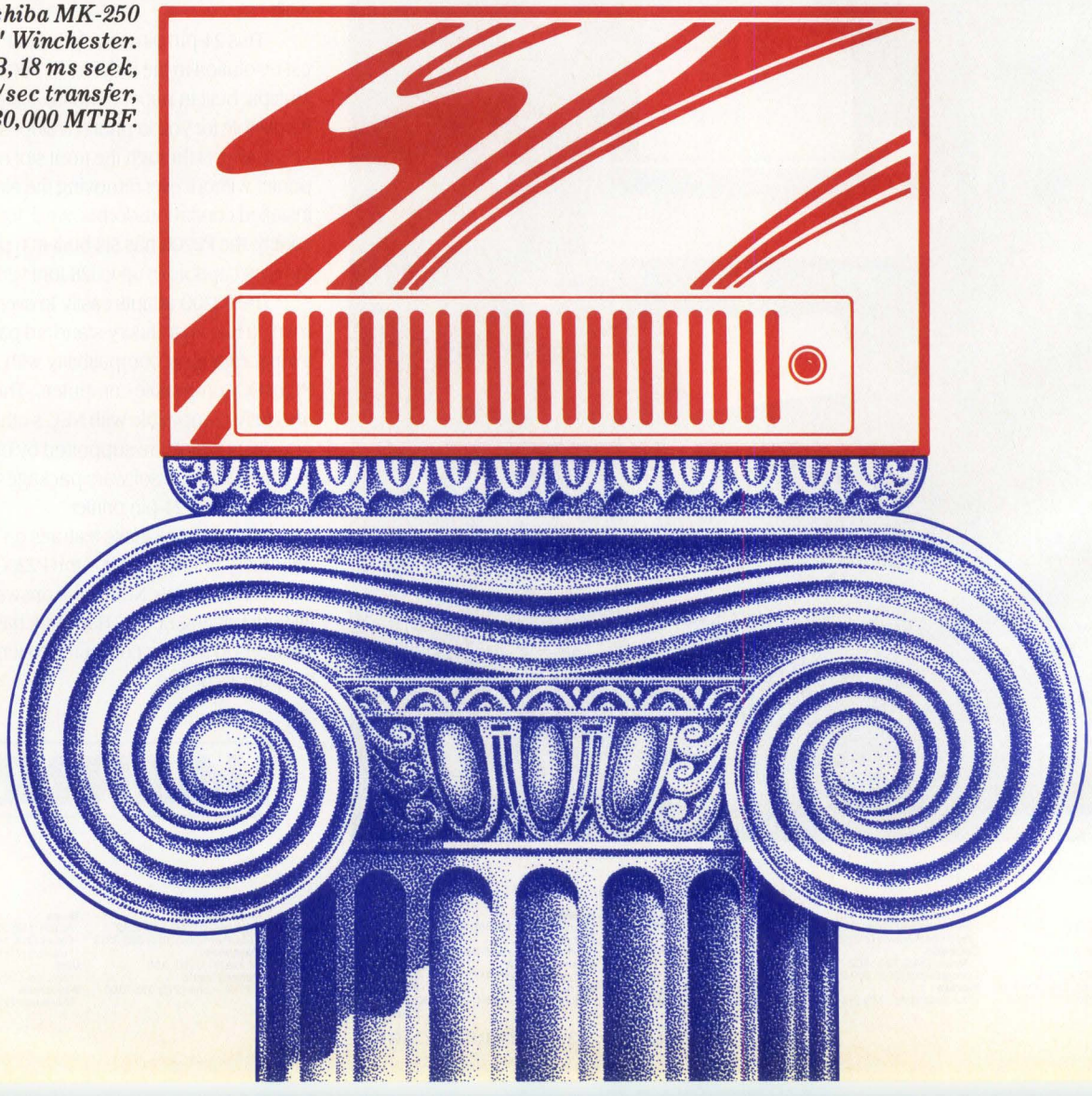
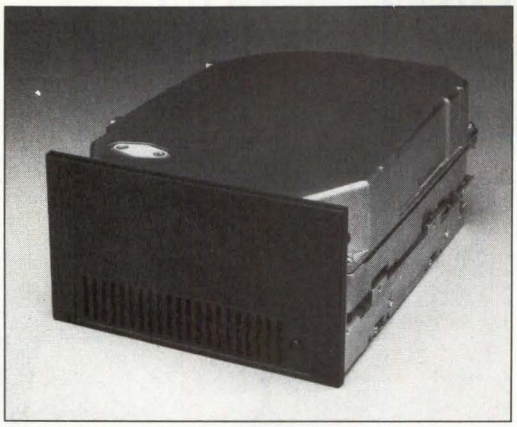
30,000 MTBF.





The new Toshiba MK-250 may look like your average 5.25" Winchester drive, but looks can be deceiving. Because you can't really see the 15Mb/sec transfer rate or 18 ms access time that make it the perfect drive for UNIX™ and graphics applications.

Nor can you see what makes it one of the most advanced Winchester drives ever produced. And that's our new Hybrid-Servo. An innovation that allows us to provide the 382 MB capacity you need but with fewer platters and heads in the drive. Which, in turn, gives you other benefits. Like the fast transfer rate. Higher reliability. And more tolerance across the range of operating environments.

But one of the best things about our new servo is the support it gives our position as a leader in disk drive technology. Because the Hybrid-Servo concept is a fundamental requirement in pushing 5.25" Winchester capacities toward the gigabyte level. All of which means Toshiba is well on the way to where the rest of the industry will be going.

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In Touch with Tomorrow

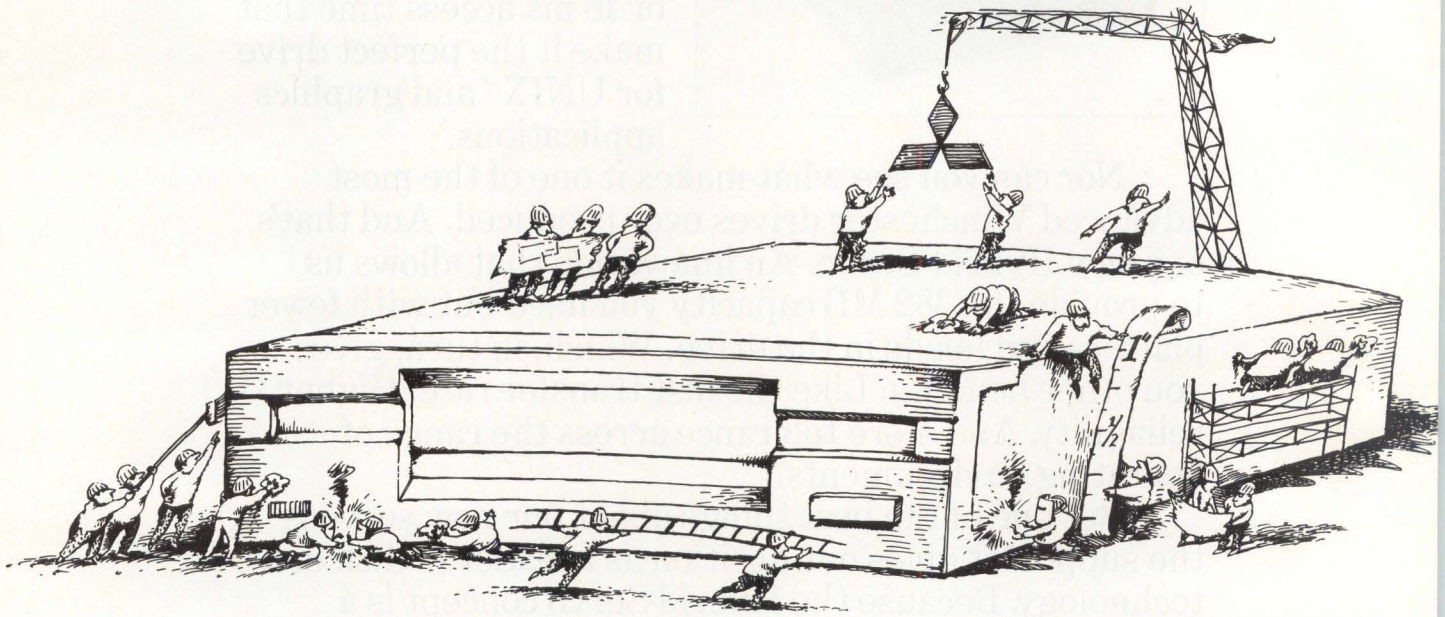
TOSHIBA

TOSHIBA AMERICA, INC.

Disk Products Division, 9740 Irvine Boulevard, Irvine, CA 92718

CIRCLE NO. 44 ON INQUIRY CARD

Introducing The Only 1" High Microfloppy Disk Drive Big Enough To Be A Mitsubishi.



At just 1" high, our new MF353C and MF355C 3½" microfloppy drives are designed to give your system a giant edge in performance and reliability.

Developed by Mitsubishi—a $13 billion dollar corporation with resources worldwide—the MF353C and MF355C integrate easily into today's small, lightweight PC designs.

When it comes to features, our microfloppies offer sizable advantages.

Unformatted memory is an impressive 1.0MB on the MF353C; 2.0MB on the MF355C. HCMOS-based LSI architecture with fewer parts and single 5V power requirements reduce power consumption while providing unsurpassed dependability and longer product life. Another big advantage from Mitsubishi: The MF355C is downwardly compatible with the MF353C.

A complete family of floppies.

Whether 3½", 5¼" or 8" form factor, Mitsubishi has just the floppy drive you need and available in quantity. Representing over two decades of design and manufacturing expertise, each Mitsubishi drive is vertically integrated to include our own ICs, read-write heads, motors, and other critical components.

It all comes down to quality.

The result is unparalleled Mitsubishi quality from top to bottom, inside and out. A reputation for product innovation, proven performance and reliable, on-time delivery has made Mitsubishi the supplier of choice among the biggest OEMs in the business.

Model No.	Size	Height	Memory Capacity (Unformatted)	Power Requirements
MF353B	3½"	1.26"	1MB	+5V and +12V
MF355B	3½"	1.26"	1MB/2MB	+5V and +12V
MF353C	3½"	1"	1MB	+5V
MF355C	3½"	1"	1MB/2MB	+5V
MF501B	5¼"	1.61"	0.5MB	+5V and +12V
MF504B	5¼"	1.61"	0.5MB/1MB/1.6MB	+5V and +12V
M2896	8"	2.25"	1.6MB	+5V and +24V

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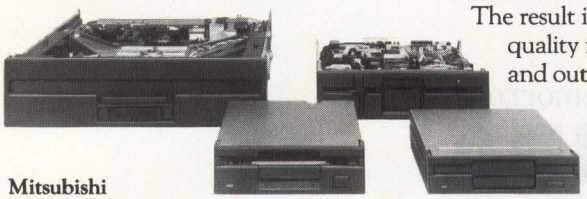

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Perpendicular recording increases data density

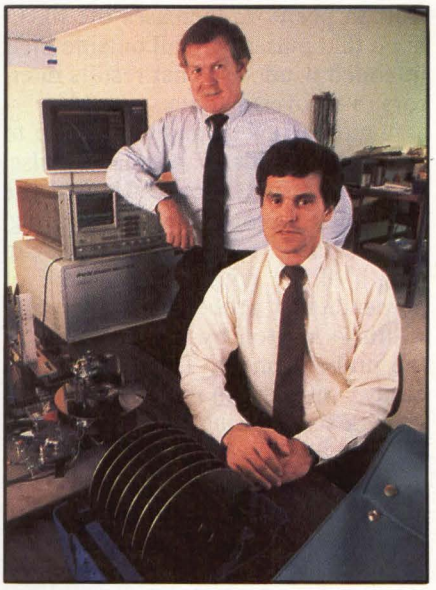
Eric Katz and Richard Brechtlein
Censtor Corp.

Since the early 1960s, improvements in the capacity, cost, performance and size of rigid disk drives using traditional longitudinal-recording methods have proceeded at a remarkable pace. Today, for example, high-end 5¼-inch Winchester disk drives are approaching capacities of 1G byte at a cost of $5 per megabyte. Larger, 8-inch rigid disk drives with higher data-transfer rates sell for as little as $10 per megabyte.

Improvements have been made in both head and media technology. For example, new slider designs continue to reduce the flying height of heads. In addition, the critical geometric structure of the gap in the ring head used for longitudinal recording has been reduced to tens of microinches, posing a demanding challenge for large-volume, low-cost component manufacturing.

Meanwhile, there has been a shift away from oxide media toward sputtered-metal thin film, which supports substantially higher bit densities. As bit density increases, the data-bit transitions get closer together, requiring higher values of coercivity. Coercivity is the measure of the strength of a magnetic field required to switch the magnetic domain patterns in a material. Thin films show much higher coercive values than oxides. Today, thin film allows areal densities in the range of 15 million to 30 million bits per square inch. (Areal density is determined by multiplying the linear bits per inch on the innermost track by the number of tracks per inch.)

However, availability of parts for this upper range is sometimes a problem because manufacturing yields tend to be low. By comparison, typical non-contact heads and disks now being manufactured by Censtor Corp. using perpendicular recording technology achieve areal densities from 30 million to 60 million bits per square inch. Censtor accomplishes this with linear densities of 20,000 to 40,000 bits per inch, with tracks laid down at between 1,000 and 2,000 per inch.



Eric Katz (front) is principal physicist with Censtor Corp., San Jose, Calif. **Richard Brechtlein** is Censtor's vice president of marketing.

Vertical vs. horizontal

In longitudinal recording, the direction of magnetization of the individual bit cells lies along the direction of the track, that is, in the plane of the media. In vertical recording, the magnetization is oriented perpendicularly to the surface of the media. Both methods allow storage and retrieval of data, and both function the same way. However, implementing perpendicular recording with a single probe head and a thick-film metal media offers significant benefits: Performance characteristics are better, and the physical structure of the head and media is simple to manufacture.

To obtain the ever-higher recording densities needed for tomorrow's high-performance disk drivers, either the linear bit density or the track density must be increased substantially. Each has its own unique and complex set of challenges that must be overcome before it's possible to produce cost-effective products.

Linear bit density. During the recording process, the read/write head records data on written tracks through a series of magnetic reversals on the disk media. During playback, the magnetization pattern in the media generates a series of positive and negative voltage pulses in the head. The user's data is contained in the time-interval relationships between the pulses, which are written in integer multiples of a basic clocking frequency. Pulses that are present or absent in the various clock intervals, or "data windows," determine the sequence of ones and zeroes.

Toward a sharp pulse

There is a practical limit to how densely these pulses may be packed along the track. The limiting factor is

the characteristic width of each pulse. Overlap of pulses causes a loss of signal amplitude, as well as a shift in the apparent positions of the individual pulses. The loss in amplitude and the corresponding loss in signal-to-noise ratio increases the timing jitter of the pulses. This, along with the shift in position, increases the likelihood that pulses will fall outside their intended windows. That results in errors in recovering data.

A number of factors contribute to the overall width of an isolated pulse. First, there is the resolution of the head itself. In longitudinal recording, pulse width is limited by the gap length of the ring head. In case of perpendicular probe heads, the pulse width is limited by the thickness of the probe element. This thickness is easily controlled in manufacturing by using a semiconductor wafer process step.

Pulse width and amplitude are also affected by the "transition zone"in the media. The direction of magnetization in the media does not generally change abruptly at the written transition. Rather, the change takes place gradually over a finite distance. In longitudinal recording, this zone can broaden even further by what is known as self-magnetization. A transition in the media generates magnetic fields. While these fields are ultimately responsible for generating the read-back signals in the head, they also demagnetize the media.

Beyond 2,000 tracks

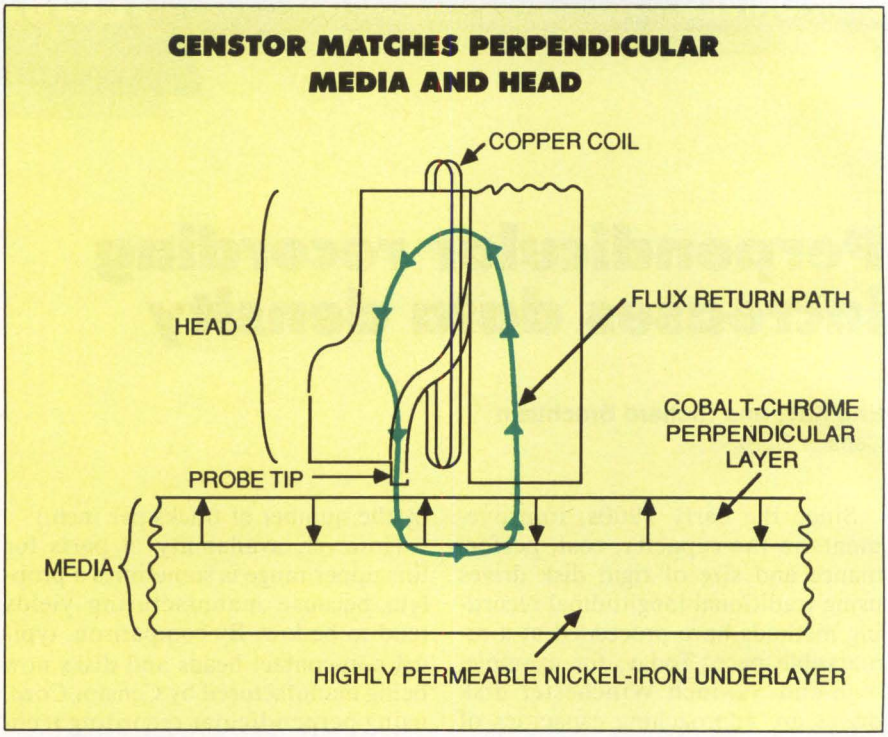
Perpendicular recording, on the other hand, tends to reduce the magnitude of the remnant magnetization itself, especially in regions far from the center of the transition. This occurs because the strength of the demagnetizing fields grows weaker as the size of the zone increases. These fields continue to increase the size of the transition zone until an equilibrium is reached, a point at which no further demagnetization takes place and the maximum demagnetizing field just equals the coercivity of the media.

Thus, media with higher coercivity generally yield narrower pulses and better resolution. Perpendicular recording has an inherent benefit in that self-demagnetization is much smaller in the vicinity of the magnetic transition. This allows for the possibility of much sharper pulses than those attained from longitudinal recording media.

Track density. Track density can be increased by reducing the track width of the heads, but this can lead to several problems. The head signal is approximately proportional to track width. Reducing track width reduces signal level, while much of the electronic noise remains the same or is reduced more slowly than the signal level. The reduction in the signal-to-noise ratio causes more random jitter of the read-back pulses, increasing the number of bits in error. Because of their geometry, perpendicular heads can have a large number of coils that provide better signal levels compared to longitudinal ring heads with equivalent track widths.

Higher track densities also require improved mechanical tolerances that will maintain head registration over the track. These mechanical tolerances must be held on the manufactured heads as well as on critical drive components such as the spindle. Advances such as ferrofluidic spindle bearings, which can keep the spindle from wobbling more than two one-thousandths of an inch, and new embedded servo techniques for guiding heads now allow track densities well in excess of 2,000 per inch.

Another challenge to track density is "side-fringing." The head not only reads and writes onto the media directly below it, but it also reads (and to a lesser extent writes) on media on both sides of the track. Signals picked up from adjacent tracks, or from previously written but slightly misregistered portions of the same track,



A probe-type head *passes an electromagnetic flux through an upper layer of cobalt-chrome, causing the magnetic material on the disk to polarize vertically. A lower layer of highly permeable nickle and iron provides a return path for the flux. This technique provides a symetrical read-back pulse similar to those obtained in traditional longitudinal recording.*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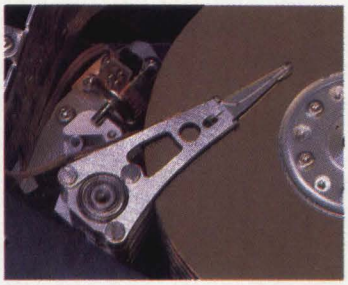

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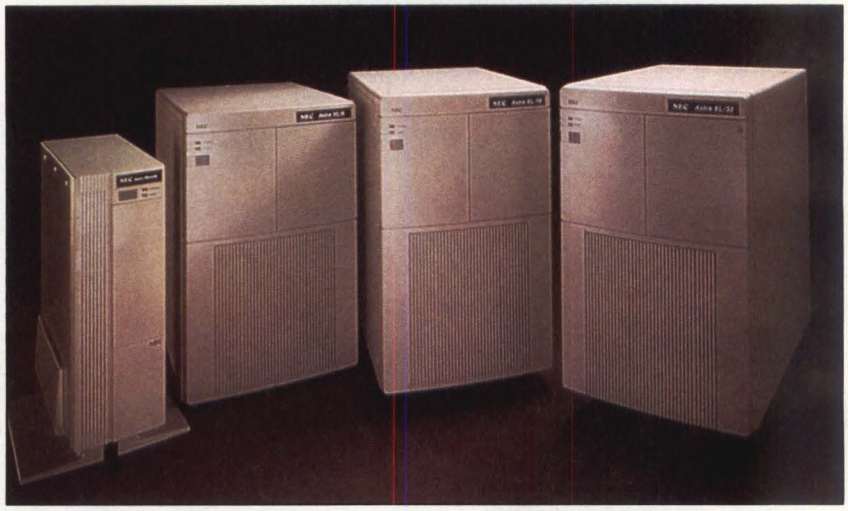
Model	Capacity (Mbytes)	Avg. Seek (ms)	Interface	Transfer Rate (MHz)
Wren V	574	16	SCSI	10-15
Wren V	442	16	ESDI	10
Wren V	383	14.5	ESDI	10
Wren V	344	16.5	SCSI	10-15
Wren V H.H.	190	18	SCSI	10-15
Wren IV	307	16.5	SCSI	10-15
Wren III	182	16.5	ESDI	10
Wren III	160	16.5	SCSI	10
Wren III H.H.	106	18	ESDI	10
Wren III H.H.	91	18	SCSI	10
Wren II	96	28	ST506,ESDI	5
Wren II H.H.	51	28	ST506	5

H.H. = Half High Models
SCSI models list usable capacity formatted in 1024 Byte sectors.
Wren III, IV, V-344 Mb SCSI models have 40,000 Hr. MTBF (others: 30,000 Hr. MTBF).

CONTROL DATA

CIRCLE NO. 47 ON INQUIRY CARD

HOW TO XL IN BUSINESS.



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Or write: NEC Information Systems, Dept. 1610, 1414 Massachusetts Ave., Boxborough, MA 01719.

CIRCLE NO. 48 ON INQUIRY CARD

can interfere with the primary signal being read back. This results in an increased error rate.

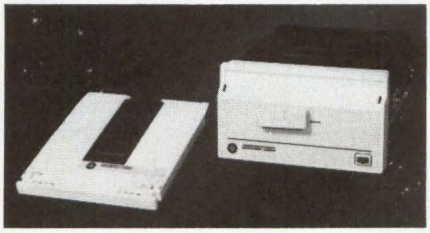
A significant benefit of perpendicular probe-type heads is that they tend to create small side-fringing fields. Such heads are critical to the 2,000-track-per-inch density.

Evolution in revolution

From the standpoint of design, the move from longitudinal to perpendicular recording can be an evolutionary process. Probe heads and double layer media, like those available now from Censtor, are mechanically compatible to those used in conventional drives. Platters come in standard Winchester diameters and use the same substrate as drives do today.

Heads incorporate mini-Winchester slider design modified for improvements in flying height, wear, stiction (a propensity of the head to stick to the media) and start-stop performance. The sliders can be mounted lengthwise or transversely to take advantage of current linear and rotary acuator designs. Track widths, currently ranging from 1,000 to more than 2,000 tracks per inch, can be varied using different masks. Readback pulses are generally symetric in shape and similar to those obtained with ferrite heads on longitudinal media. These pulses do not have the "undershoots" characteristic of thin-film ring heads. Finally, front-end integrated circuits optimized for perpendicular recording are available from a number of sources.

As densities are increased, mass storage designers are faced with practical limitations resulting from the requirements for higher performance. Historically, higher densities have required lower flying heights, smaller gap lengths, tighter mechanical tolerances and better cleanliness and defect control in the media as the bit cell grows smaller and smaller. Perpendicular-recording technology holds the promise of increasing performance and tolerance. □



Optical drive aims at system integrators

A 654M-byte WORM optical disk drive designed for OEMs and system integrators is now available from Laser Magnetic Storage International Co.

The LMS LaserDrive 510 uses double-sided removable media that offers 327M bytes of storage on each side. The 5¼-inch drive sustains a data transfer rate of 600K bytes per second and possesses a 75-msec average access time.

The product comes with an embedded SCSI interface that permits up to eight drives to be daisy-chained.

Price: $2,880; media, $95.

Laser Magnetic Storage International Co., 4425 ArrowWest Drive, Colorado Springs, Colo. 80907-3489, (303) 593-7900. 599-8713. Telex: (910) 920 4908. Fax: (303).

Circle 551

RLL scheme enhances small-form Winchesters

A 3½-inch rigid-disk drive with a formatted capacity of 87M bytes is now being shipped by C. Itoh Electronics Inc. The YD-3082 uses four platters and the run-length-limited (RLL 2,7) encoding scheme for increased capacity and boasts an access time of 26 msec.

The company aims the drive at manufacturers of laptop and portable computers. The drive has a "shipping zone" aside from the data area, where the read/write head lands when power is turned off, and an embedded SCSI controller for one-to-one interleave. The controller supports 15 of the SCSI specification's common command options as well as arbitration and disconnect/reconnect.

Price: $1,195.

C. Itoh Electronics Inc., 19300 S. Hamilton Ave., Torrance, Calif. 90248, (213) 327-9100. **Circle 552**

Parallel disk drive operates with VMEbus

IBIS Systems Inc. broadens the reach of its high-end disk drives with the introduction of a VMEbus host adapter.

IBIS' model 1012, a 14-inch, 2G-byte, parallel transfer disk drive, moves data at 12M bytes per second via a pair of 6M-byte-per-second recording channels. The drive comes equipped with the IBIS-1/VME host adapter to operate on any VMEbus system. The 1012 also uses a proprietary controller, intelligent standard interface (ISI) or storage module device-extended (SMD-E) interface.

The VMEbus host adapter is priced at $3,170 in OEM quantities; the 1012 drive with an SMD-E interface, $17,000.

IBIS Systems Inc., 5775 Lindero Canyon Road, Westlake Village, Calif. 91362, (818) 706-2505. Telex: 472-0228.

Circle 550

Optical drive boasts 12G-byte capacity

Toshiba America Inc. is expected to begin shipments in April of a 12-inch write-once optical disk drive that stores 14G bytes.

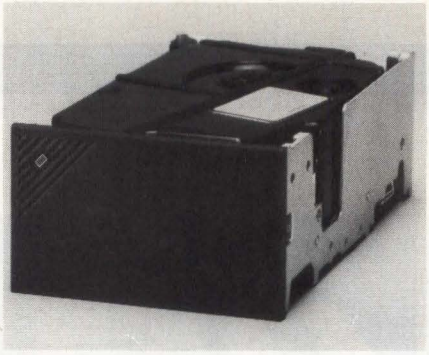
The WM-S500 achieves an average seek time of 150 msec by keeping the spindle speed at 615 rpm to minimize average latency. Meanwhile, the data transfer rate varies from 4M bytes to 8M bytes per second. A 32K-byte X2 buffer speeds data transfers.

The drive fits inside a standard 19-inch rack and comes with a built-in power supply and SCSI interface.

Price: $11,495.

Toshiba America Inc., Disk Products Division, 9740 Irvine Blvd., Irvine, Calif. 92718, (714) 583-3108.

Circle 554



Winchester boasts 777M-byte capacity

Siemens Information Systems Inc. has introduced a 777M-byte, 5¼-inch Winchester disk drive to occupy the high end of its MegaFile line. The company plans to begin shipping evaluation units in the second half of this year.

The Series 5000 will be available in both SCSI and ESDI versions. The drives are said to consume less than 30W and achieve an average access time of 16 msec. The MegaFile uses both thin-film media and read/write heads. The eight-platter drive has a recording density of 30,825 bits per inch. Track density is 1,476 per inch.

Price: $3,795.

Siemens Information Systems Inc., Memory Products Division, Suite 325, 5655 Lindero Canyon Road, Westlake Village, Calif. 91362, (818) 706-8872.

Circle 553

Subsystem stores up to 2.8G bytes

U.S. Design Corp. targets OEMs and system integrators with a 2.8G-byte Virtual Information Processor 3000 storage subsystem.

The VIP 3000 measures 5.25 by 19 by 25 inches and holds up to four peripheral storage devices, including tape and optical drives. It offers 2.86G bytes, formatted, when loaded with four of Maxtor Corp.'s 5¼-inch rigid disk drives. A peripheral backplane allows integration of both SCSI and ESDI devices.

Interface kits to connect the VIP 3000 to Apple Computer Inc.'s Macintosh personal computers are available. Kits for Digital Equipment Corp. VAX computers are expected to be shipped in the second quarter of 1988.

Prices begin at $2,095.

U.S. Design Corp., 4311 Forbes Blvd., Lanham, Md. 20706, (301) 577-2880. TWX 710-826-0417.

Circle 555

Drive boosts data rate to 4M bytes per second

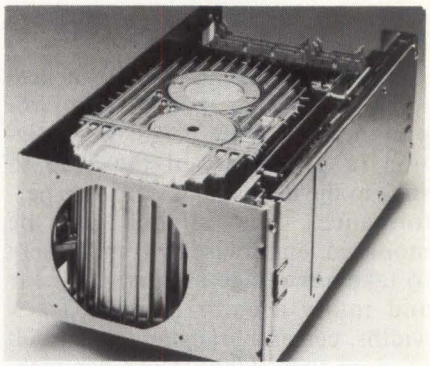
Hewlett-Packard Co. has pushed the data-transfer rate of its 5¼-inch rigid disk drives to 4M bytes per second with the introduction of the HP 97530D disk drives.

In addition to faster data transfer rates, new differential drivers on the HP97530D drives allow OEMs to place storage devices up to 25 meters from the host.

The drives come in unformatted capacities of 136M bytes, 204M bytes, and 408M bytes and include an embedded SCSI controller. HP claims that the drives—which are targeted at the OEM market—have less than one msec of SCSI overhead. Average access time is 17 msec.

Pricing for the 408M-byte version is $2,100 in OEM quantities. **Hewlett-Packard Co.,** 3000 Hanover St., Palo Alto, Calif. 94304, (415) 857-1501

Circle 556



Winchester notches 600M bytes

Hitachi America Ltd. designers have packed 13 5¼-inch disks into an 8-inch form factor to create a 600M-byte Winchester, the DK711S. Target customers include system integrators who are building workstations and superminicomputers

By using smaller platters than usual for an 8-inch assembly, Hitachi claims it has been able to increase the rotational speed to 4,876 rpm—about 25 percent faster than normal—to achieve an average access time of 12 msec. The drive uses an ESDI interface and boasts a data transfer rate of 2.46M bytes per second.

Price: $5,500 in OEM quantities.

Hitachi America Ltd., Computer Division, 950 Elm Ave., San Bruno, Calif. 94066-3094, (415) 872-1902. Telex: 176308. Fax: (415) 872-1907.

Circle 558

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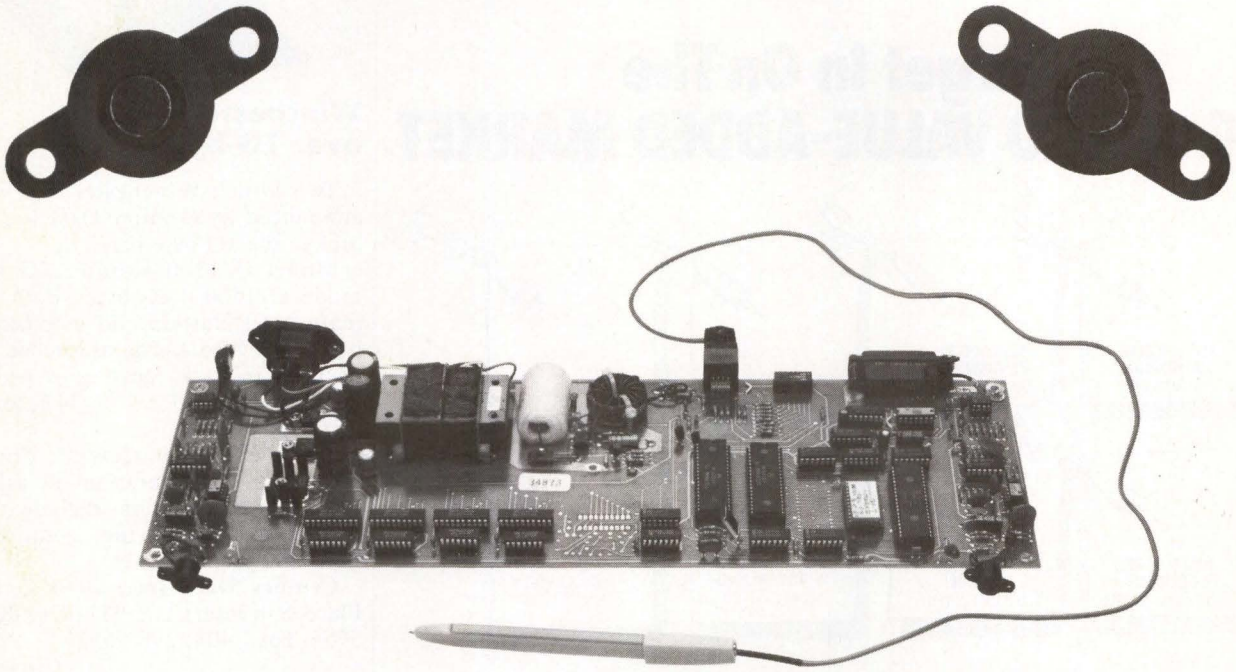

The Science Accessories Corporation GP-7 Mark II sonic digitizer is totally integratible, by using the point microphones and controller board, a workstation manufacturer can insert this digitizer into a workstation design without taking up any work space. The possibilities are unlimited because there are no bulky tablets to include in your design.

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8-inch drives feature built-in diagnostics

Targeting the replacement market for large rigid-disk drives, Toshiba America Inc. has announced 720M-byte 8-inch Winchesters. The MK-388FA is said to have built-in diagnostics that do not require external test equipment.

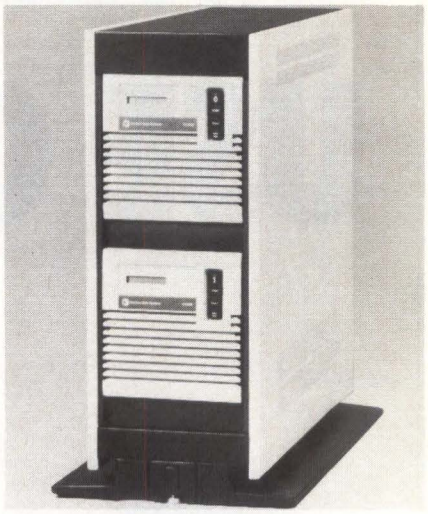
The drive comes with a standard power supply for 8-inch drives. Toshiba claims this allows system integrators to upgrade drives of lower capacity without changing existing power supplies.

The drive has an average access time of 18 msec and a data transfer rate of 2.4M bytes per second.

Price: $3,995, OEM quantities. A rack subsystem containing one drive (two can be mounted in it) is priced at $8,335.

Toshiba America Inc., Disk Products Division, 9740 Irvine Blvd., Irvine, Calif., 92718, (714) 583-3108.

Circle 563



Winchesters hold over 1G-byte

Two 8-inch Winchester disk drives announced by Century Data Inc. have broken the 1G-byte barrier.

Model C21200 stores 1.2G bytes; model C21500, 1.5G bytes. Both drives feature 10 platters and use thin-film heads and media. The difference in capacity is in track densities of 1,115 tpi for the C21200 vs. 1,347 for the C21500.

The company markets the drives in rack-mount configurations or as desk-side units. Applications include on-line transaction processing, communications and graphics.

Century Data Inc., 2055 Gateway Place, San Jose, Calif. 95110, (408) 298-5756, Fax: (408) 298-5553.

Circle 559

Micropolis furnishes 765M-byte drive

Sample quantities of two 765M-byte 5¼-inch rigid disk drives are expected to be available during the second quarter this year from Micropolis Corp.

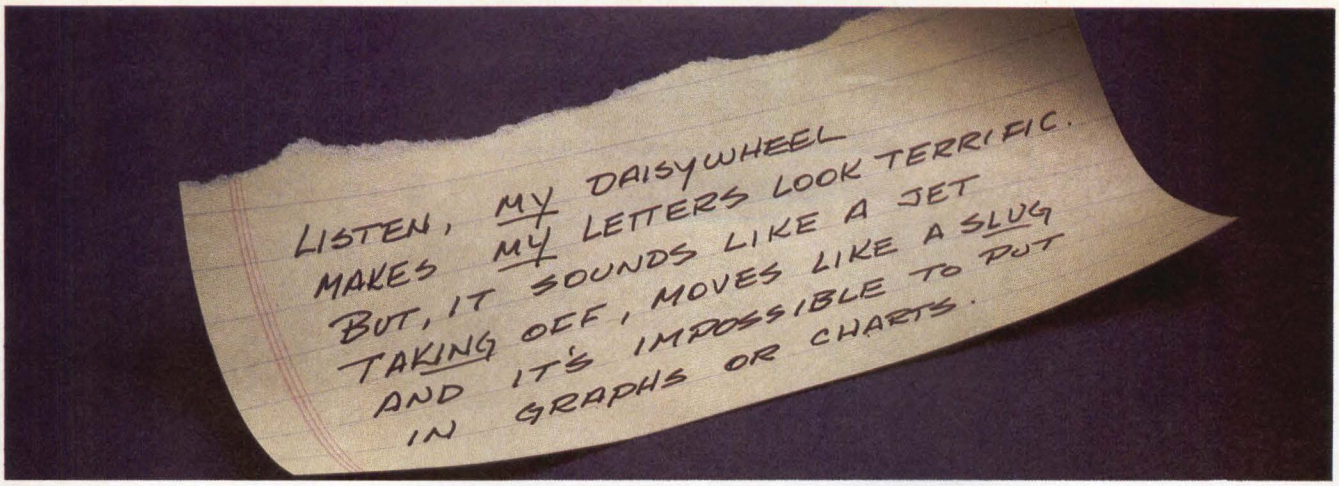
Model 1560 uses the ESDI interface; model 1580 is equipped with a SCSI interface. Both supply an average access time of 16 msec.

The drives contain eight platters and 15 read/write heads. The ESDI version has a data transfer rate of 1.88M bytes a second. The SCSI drive, in synchronous mode, is capable of burst transfers of 4M bytes per second.

In quanties of 2,500, the ESDI drive is $2,295; the SCSI version, $2,395.

Micropolis Corp., 21123 Nordhoff St., Chatsworth, Calif. 91311, (818) 709-3305.

Circle 557



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The Okidata Laserline 6.

Okidata's Laserline 6 uses today's most advanced technology to give you quiet, fast, high-quality printing at a price that may surprise you. For what you would pay for a good daisy wheel, you can own an Okidata laser printer.

The Laserline 6 is a feature-rich alternative to laser printers costing twice as much. It's extremely fast — printing six pages per minute while still retaining perfect letter quality, 300 dpi. Standard features include 15 built-in typeset quality fonts using true boldface and italic for exceptional quality.

Call Hall-Mark today for a demonstration of the Okidata Laserline 6. It's so easy to use it will amaze you. All supplies are replaceable and feature snap-in installation — no tools required. Plus, it's compatible with a wide variety of software including Hewlett-Packard's Laserjet and Laserjet Plus.

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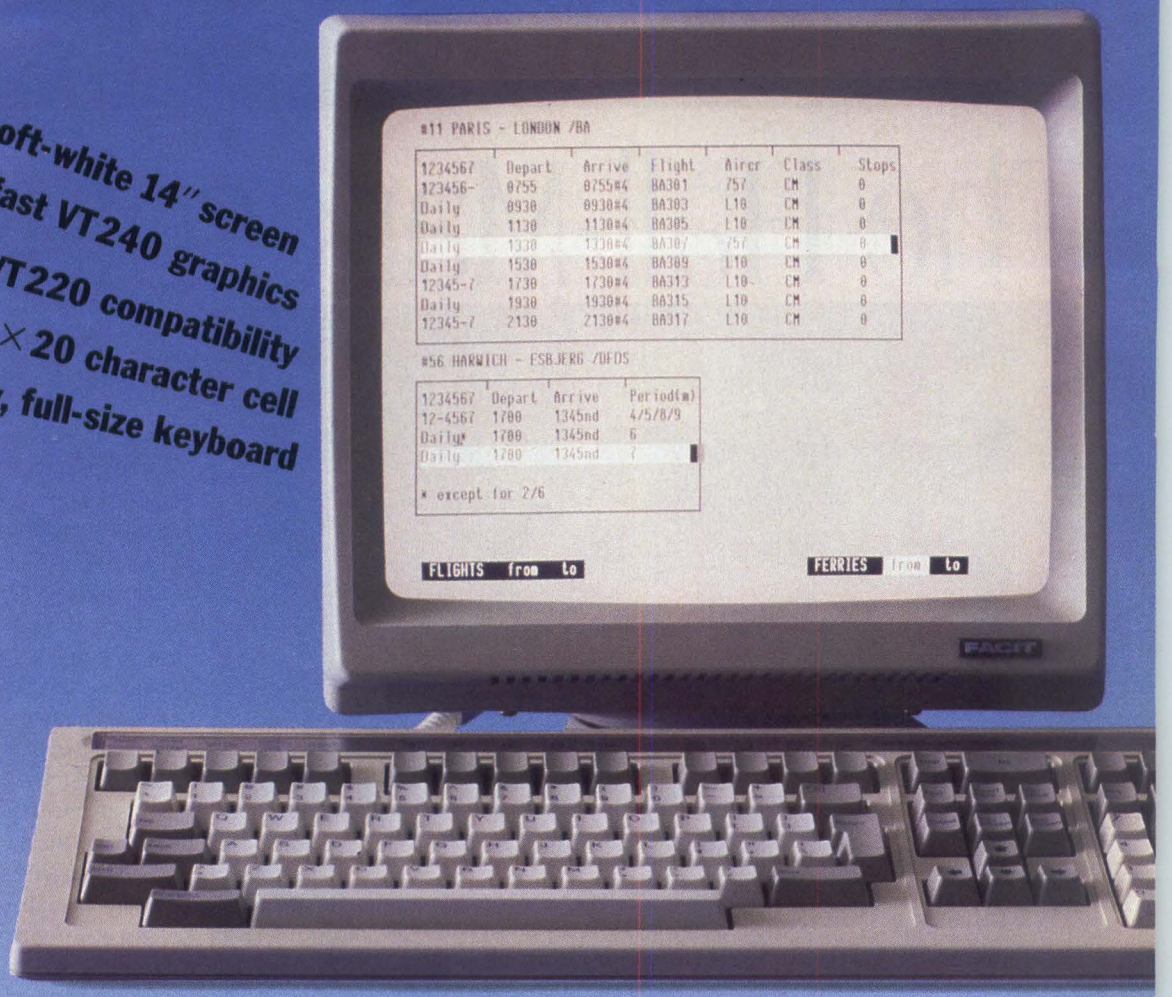
Proven DEC VT220 compatibility
Letter quality 20 × 20 character cell
105-key, full-size keyboard



With excellent ergonomics, high reliability, proven compatibility and easy upgrading to graphics operation, the Facit A2400 video terminal really enhances the VT220 concept.

The ergonomic design extends all the way from the letter quality text on soft-white background to the tilt and swivel base and functional keyboard layout.

And unlike the standard VT220 terminal, the A2400 is easily upgraded to VT240 graphics operation, complete with full DEC ReGIS and Tektronix 4010/4014 emulations as well as very fast drawing times. Just add a graphics circuit board.

Furthermore, you will have no trouble installing the terminal. Its VT220 emulation has been proven compatible in numerous applications worldwide.

However, we would like to show you the performance and compatibility of the Facit A2400 in real black-on-white. Please call your nearest Facit representative for a demonstration in your system and with your application software.

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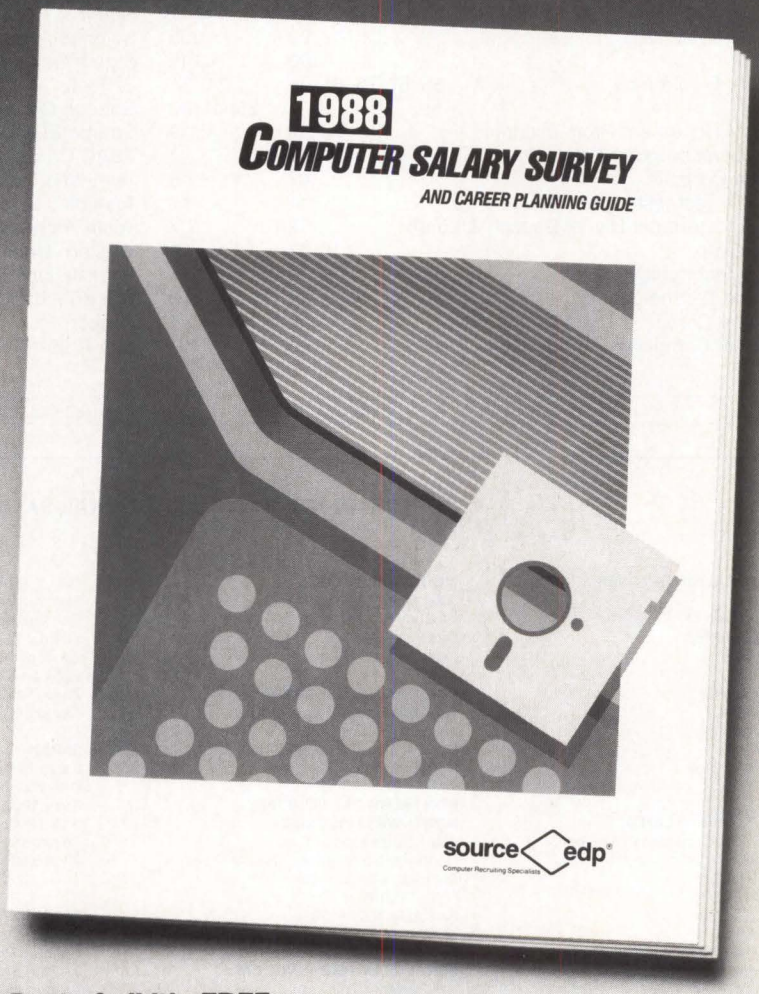

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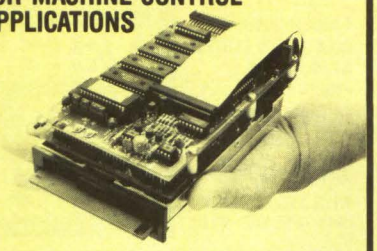

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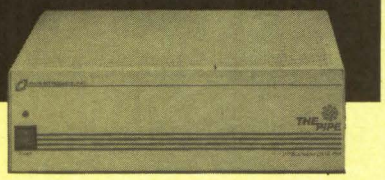

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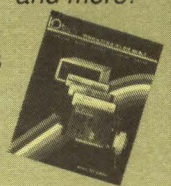

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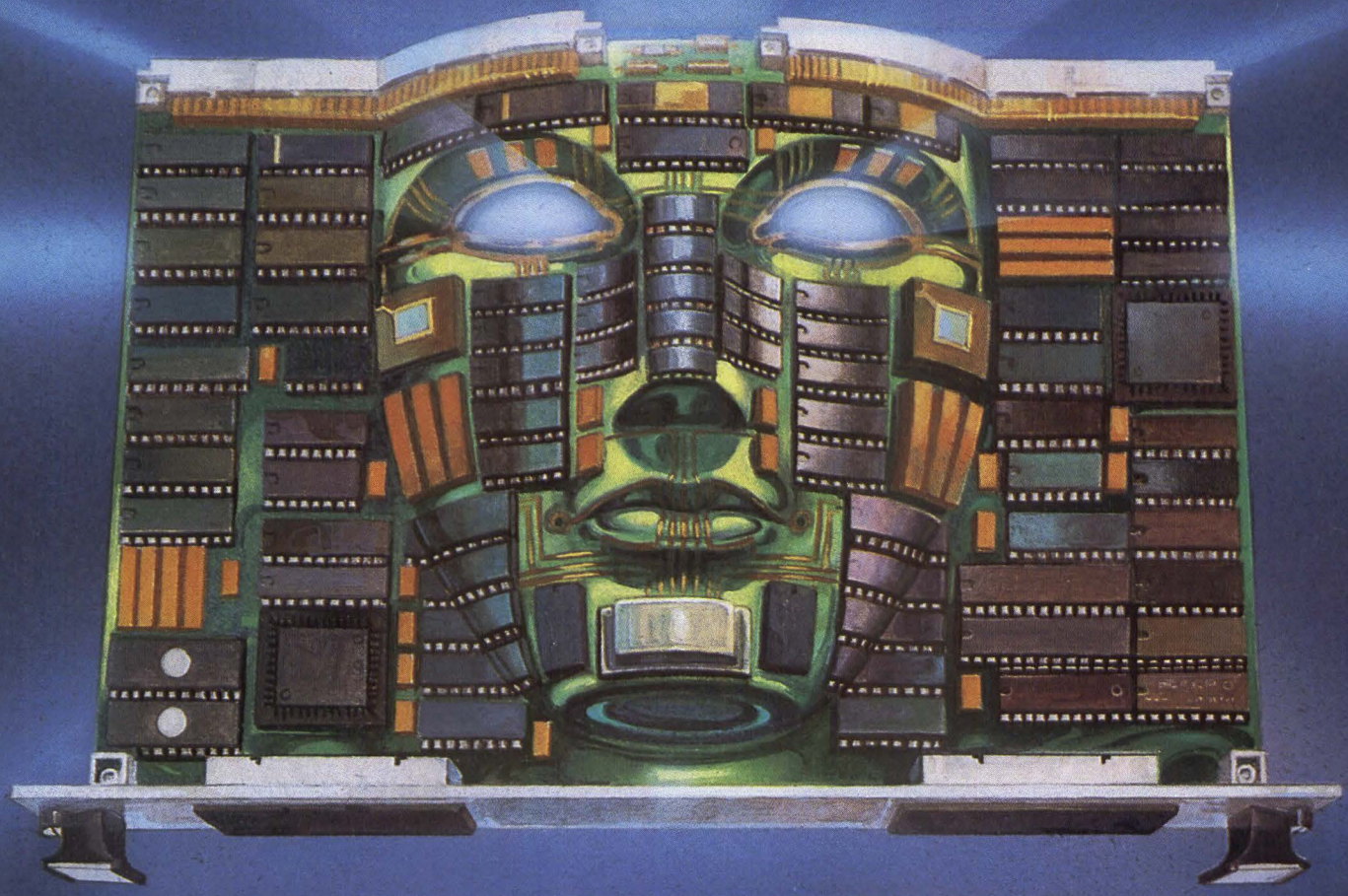

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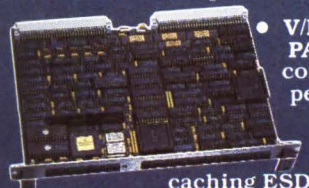

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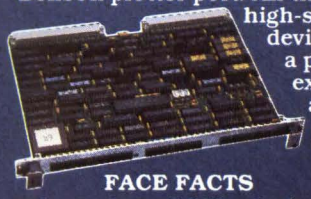

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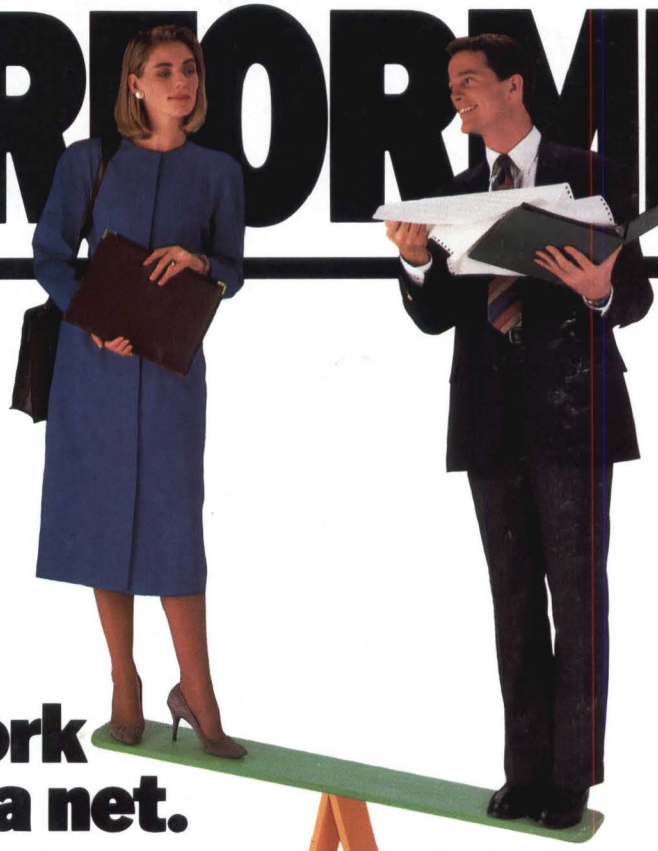

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