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BYTE

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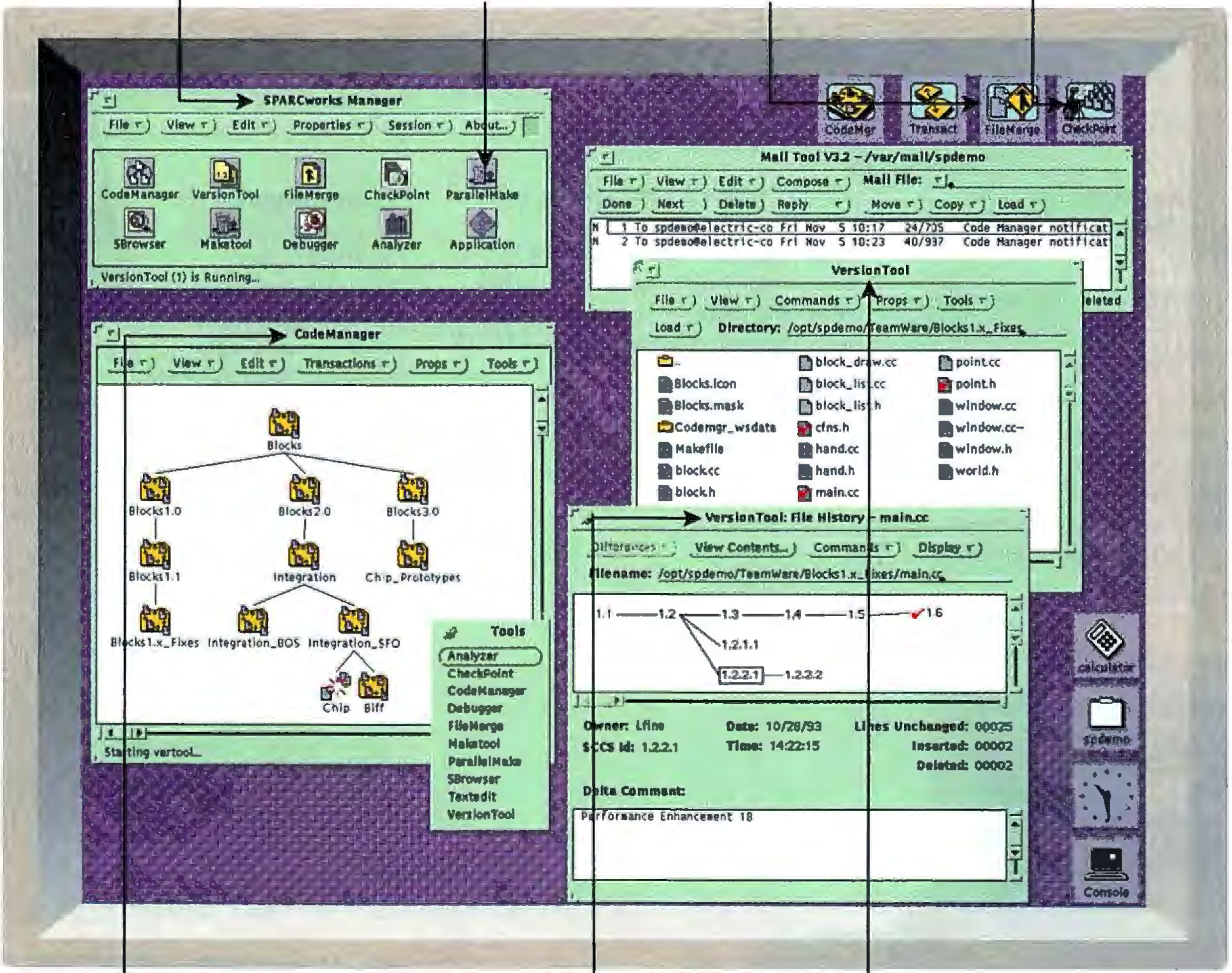

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BYTE

MARCH 1994 VOL. 19, NO. 3

Hands On

Opinions

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BYTE Contents by Platform

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The State of Computing

We are in for some big changes in power and portability, and they are for the better

Now that you've heard all the "State of the..." addresses from various world leaders, it's time to focus our attention on the computer industry. Throughout the next 12 months, three primary aspects of computing will be well worth watching: power, portability, and the enterprise-wide application of computer technology.

We will find increased power in hardware systems. Not only will we see a hefty number of Pentium-based systems this year, but RISC-based alternatives will garner more attention than ever before. The RISC movement will be led by the PowerPC, which Apple and IBM will promote heavily. No, 1994 won't be the final showdown year for Intel's 80x86 architecture against the RISC gang of Alpha, Mips, SPARC, and PowerPC CPUs. However, the stage will be set this year, and we will have to await Intel's next announcement to see just how well it can hold onto its advantage.

One thing we know for sure: Performance is being boosted big time. While some industry pundits have pooh-poohed the relatively minor gains of the Pentium over the 486, we should expect a lot more from the next generation of 80x86-compatible chips from Intel, as well as those from Cyrix and AMD.

On one side of the fence, you have the RISC gang trying to shift the CPU paradigm by offering big performance gains, and, because some of the RISC chips are fast enough to take on tasks usually done by support chip sets, they also offer simplified (i.e., fewer chips) circuit-board design. Apple's new PowerPC Macs, for example, promise to be three to four times faster than a 25-MHz 68040-based Mac Quadra 900 (see page 23). And on the other side of the fence, Cyrix and AMD are going head-to-head with Intel with their superscalar CPUs.

The CPU competition is hotter than it's ever been. The resulting performance boost in hardware will make system replacement attractive, create an installed base of more powerful platforms that software developers can write for, and—at long last—give 32-bit operating systems a place to exist.

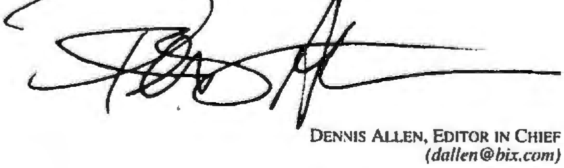
The portability aspect of computing that will change is wireless technology. During the next 12 months, most folks will hear the wireless-technology alarm bell ring loudly. While we won't see a massive adoption of wireless devices—like PDAs (personal digital assistants)—this year, we will see a mind-set change. The awareness of wireless technology and its impact on corporate computing will reach critical mass as many hardware makers and service providers roll out their answers to mobile computing. Aided by software like General Magic's Telescript, even people who do not use a portable computer today will consider using one of the new compact devices.

The real challenge will be developing plans that show companies how to deal with all those wireless computers. Right now, some information managers don't even know what a PDA is; the problem is that very soon many of their employees will be demanding access to company data with their wireless devices. And once they get that, these people using wireless computers will want to actually *update* that data. That notion ought to scare the living daylights out of any information manager who isn't already making plans accordingly.

That dilemma leads right into the third aspect to watch this year—the enterprise-wide application of computer technology. Desktop computing has come a long way, and basic computing is at an acceptable level for single users in most applications. But moving any of those applications to the whole enterprise has been extremely difficult.

The problem is not new. However, this year will be different because many large companies are so confident in their ability to solve the enterprise computing problem that they are restructuring their companies based on technology solutions.

So, the focus of computing in the workplace will change, and personal computers may become a little less, well, personal. It will also open opportunities for software manufacturers to exploit this new work environment. We will see the document-centered view of computing become more dominant as software developers strive to make whole organizations work together. We will also see LANs in organizations become linked into WANs (wide-area networks), so that workgroups can share data—the whole idea behind the empowerment-based restructuring that many companies are doing. ■



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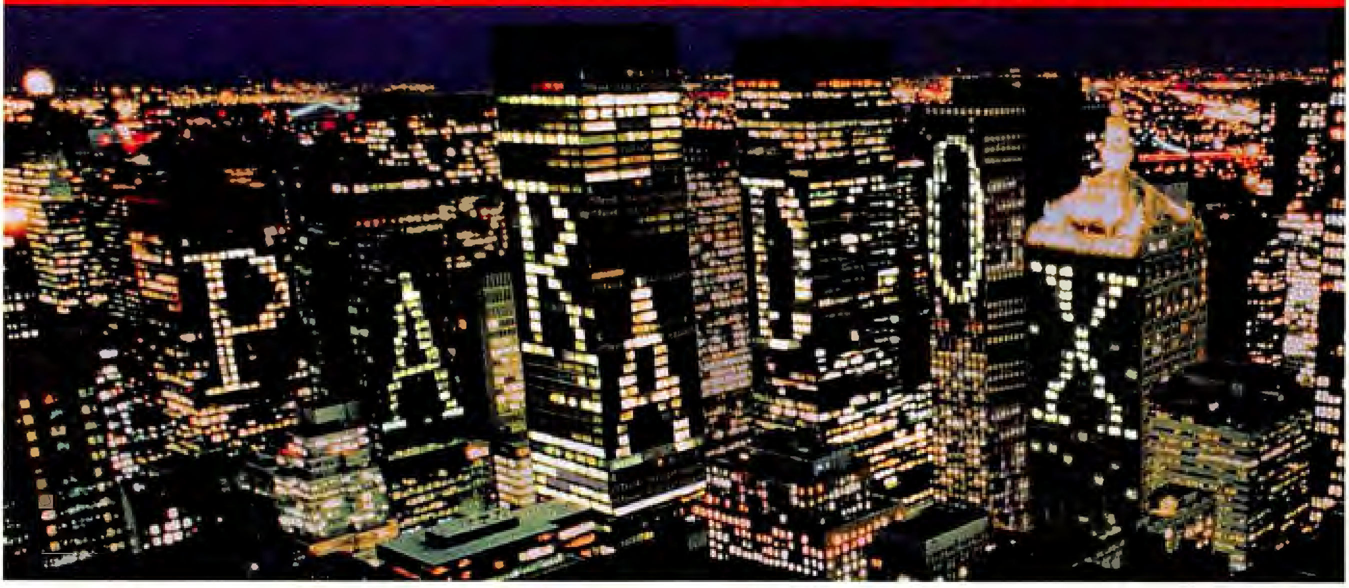
THE LEADER IN OBJECT COMPUTING



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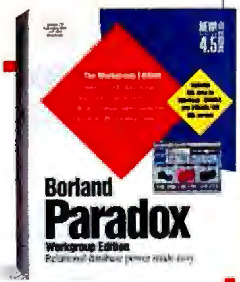

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The Apple Report On PowerPC

NUMBER 2 – RISC PERFORMANCE AND CROSS-PLATFORM COMPATIBILITY

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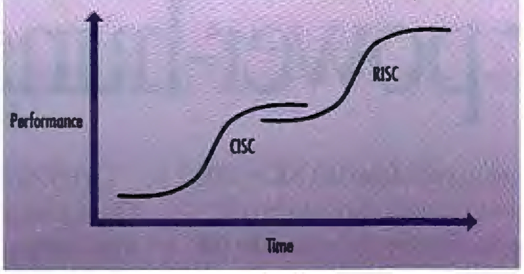
RISC vs. CISC.

Tremendous advances have been made in CISC architecture over the years. However, the physical limitations of the new, high-performance CISC design mean that CISC chips must be significantly bigger and more complex, and must run at hotter temperatures to perform the same tasks as comparable RISC chips. Consequently, the newer generation of CISC chips, like the Pentium, are much more expensive to manufacture. Which means that personal computers powered by PowerPC chips can offer a significant advantage in price as well as in performance.

Figure 1. CISC vs. RISC Performance Evolution



As you can see on the chart, RISC microprocessors offer dramatically greater potential for growth, leading us well into the next century and increasing the practicality of features like voice recognition, videoconferencing, object-oriented software and multimedia capabilities – functions that will be integral to doing business in the 21st century.

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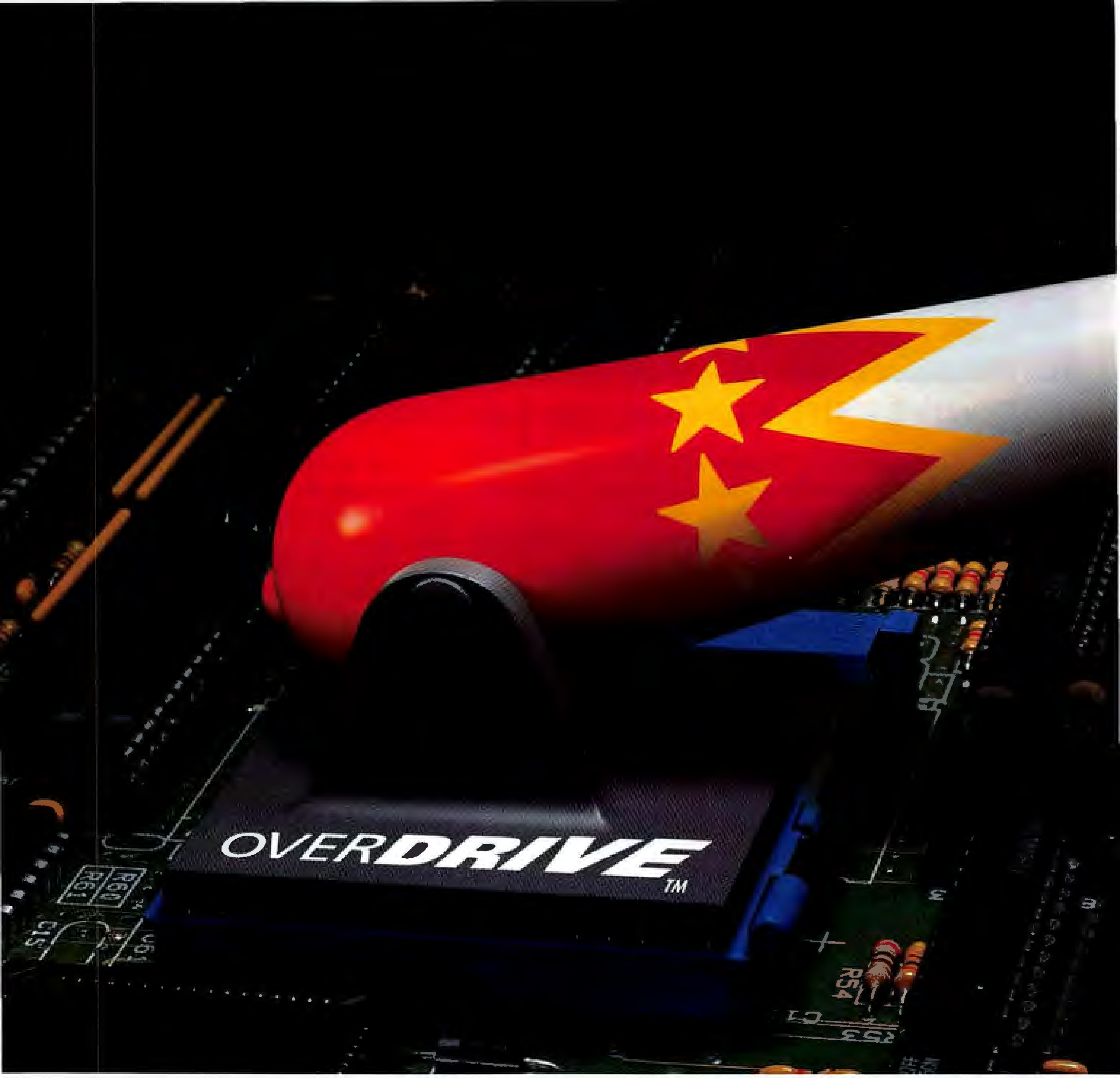
Apple



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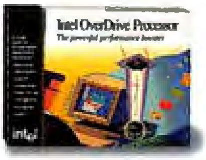

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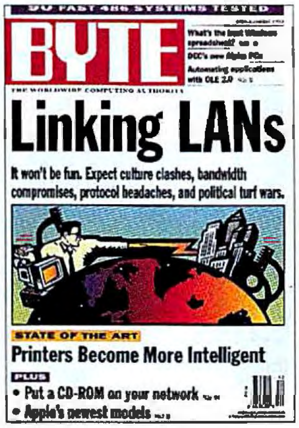
WANs in a LAN Society

I want to congratulate you on your cover story "Linking LANs" in the December 1993 issue. The article was outstanding. I have been a professional in the WAN (wide-area network) arena for quite some time, and I thought that I knew it all. Your approach has really made me look at my area from the other side of the fence, the LAN—something that I'd thought I had done before, but, just as you said, in a "culturally hampered" way.

Paul Liesenberg
Frankfurt, Germany



Regarding your cover story "Linking LANs": The article implies division of IP address space on organizational boundaries. No, no, no! Domain names reflect organizational boundaries. IP address assignment and subnetting are only related to network topology and address assignment authority (stand-alone or delegated from the NIC [network interface card]). Mismanagement of IP address space as described in this article is probably the prime cause for the rapid decrease in available addresses from the NIC.

James Cutler
Troy, MI

We can see how a reader might misconstrue the design of our examples in the text box "TCP/IP Addressing" on page 84 (December 1993). The confusion comes from the often strong relationship between the operational organization and its geographic organization. A few words specifically about network topology were called for and would have prevented anyone from being misled. Right you are about the mismanagement of IP address space being a major problem. Thank you for your insightful comment.
—Eds.

I read your article on LANs/WANs ("Linking LANs"), and I want to thank you for what was for me a very timely piece. We are just now grappling with these issues as we prepare to issue an RFP (Request For Proposal) for global X.25 and value-added data services. Your article cleared up a number of hazy areas. Thanks.

D. Dion
Rome, Italy

State of the Art or Mainstream?

I am often impressed with the thoroughness and accuracy of the articles in BYTE. However, I have some questions about "Printers in Transition" and "The Printers Talk Back," both in your December 1993 issue. I am alarmed that your magazine would have its readers believe that dumb printers and bidirectional printer communication protocols are "state of the art" when the truth is that they have been in wide use for the better part of a decade.

The fact that these things are new to DOS does not mean that they are new to the computing world. I can only conclude that no one involved with the production of these articles had any knowledge of the Macintosh. If you aim to describe the state of the art, you should make sure that you understand current mainstream practice first.

Alex Lewin
Cambridge, MA

Lying with Statistics

Your November 1993 review of subnotebooks ("Windows Under 4 Pounds") didn't say how the "overall" performance numbers were calculated, but the method that you used seems to have arrived at the arithmetic mean of the individual test results. Those results were normalized numbers, whose arithmetic mean is not meaningful. The article "How Not to Lie with Statistics: The Correct Way to Summarize Benchmark Results" by P. J. Fleming and J. J. Wallace (*Communications of the ACM*, March 1986) describes why the geometric mean, not the arithmetic mean, is the only proper average for normalized numbers.

Applying the arithmetic mean can give some pretty silly answers. Benchmark testers commonly misuse the arithmetic mean, but I hope that BYTE will not do so in the future.

Clem Dickey
San Jose, CA

In the article that you cite, we used the geometric means to compute individual subtest results, but the overall performance value was computed using an arithmetic mean. If we had used a geometric mean to compute the overall values with this particular data set, the relative rankings of systems would have remained unchanged, and magnitudes would have decreased only slightly. However, you are correct in your criticism. We are currently revising our benchmark tests, and future test suites will not use arithmetic means to compute overall performance scores.
—Eds.

Looks Like Greek . . .

As a conclusion to his Commentary "How Are You at Interfacing?" (December 1993), Edward R. Swart states that, "In the end, the distinction between natural languages and computer languages will fade away." Then you give Swart's Internet address: "Tswart@snowhite.cis.uoguelph.ca."

Limpidly clear! I was sure that evolution would go the other way, but I was wrong.

Jean-Pierre Frankenhuis
Paris, France

Refocus Response

I would like to commend you and the BYTE staff for refocusing your publication to speak more to technical issues.

Not too long ago, I was considering canceling my subscription to BYTE. Let's face it, I can get DOS and Windows coverage nearly anywhere. But the last several issues have been so good that I have kept them around for reference.

And BYTE just keeps on getting better. The Advanced Operating Systems issue (Windows vs. OS/2 Special Report, November 1993) was the best one yet.

Fred Cantwell
Trenton, NJ

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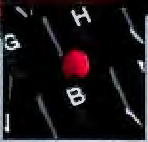

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News & Views

WINDOWS

Chicago: An Ambitious Compromise

A 4-MB RAM budget and a strict compatibility mandate forced hard choices with Chicago

JON UDELL

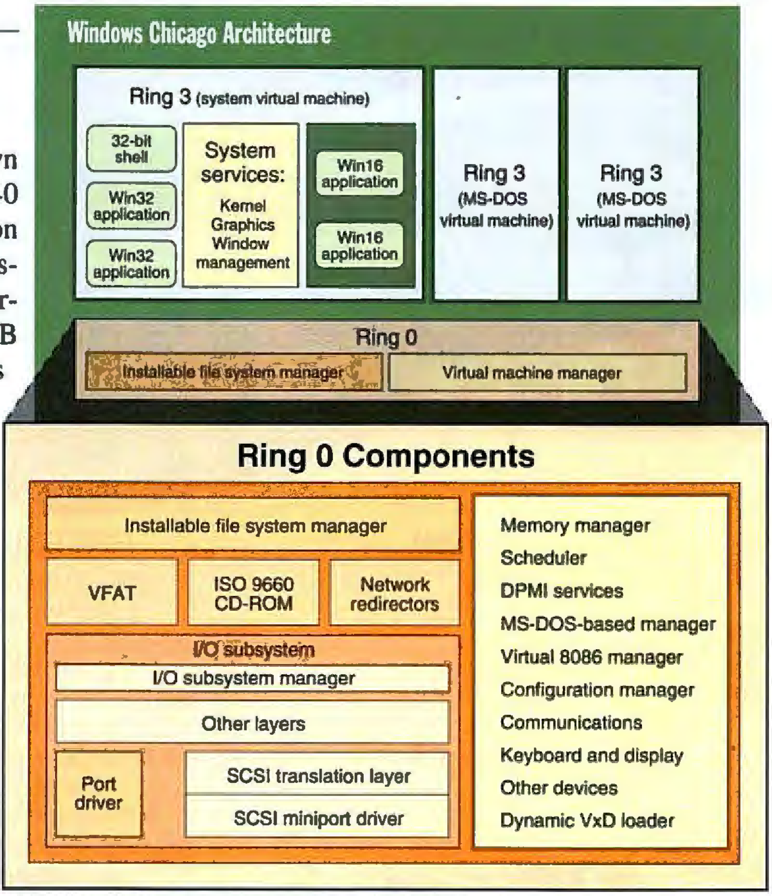
Microsoft hopes that Windows 4.0 (also known as Chicago) will upgrade many of the world's 40 million existing Windows 3.x PCs and will ship on most new PCs in 1995. For users, Chicago's mission is threefold. It must match or exceed the performance of Windows 3.x when running on a 4-MB 386. It has to work more intuitively than Windows 3.x. It must cram as much of Windows NT's robustness and multitasking muscle as will fit into 4 MB. For developers, it must also propel the Win32 API that Chicago shares with NT to the forefront of Windows programming, while introducing new messaging, telephony, and Plug and Play APIs.

Chicago's ease of use will be judged initially on the strength of a completely new (but still unfinished) shell that unifies the functions performed in Windows 3.x by Program Manager, File Manager, and Task Manager. What isn't completely new, especially if you've used Windows for Workgroups 3.11, are many of the technologies under Chicago's hood, such as virtual device driver–based disk, file, and network support.

If you've used NT, you'll find Chicago's threaded preemptive multitasking, layered device-driver model, desynchronized input queue, event-driven scheduling, and long filenames also familiar. In the latter cases, Chicago mimics NT features without sharing NT's code; there's no NTFS (NT File System) in Chicago, for example. The new long filenames are shoehorned into multiple directory entries.

Does Chicago do away with DOS? Yes and no. Chicago's boot process begins with a modified version of real-mode MS-DOS that processes AUTOEXEC.BAT and CONFIG.SYS if present (they're optional) and loads real-mode TSR programs and device drivers. But when protected-mode components like the VFAT (Virtual FAT) and CD-ROM file systems, network redirector, and 32-bit DoubleSpace driver load, they can, in many cases, unload their corresponding real-mode components from memory. DOS will then be history, unless you depend on a real-mode device driver or TSR for which you have no protected-mode replacement.

Novell's Btrieve requester and Eicon's NABIOS redirector are examples of the kinds of services that, until rewritten as DLLs or VxDs (virtual device drivers), will perpetuate DOS dependencies in Chicago. You also incur DOS dependencies



While Chicago's I/O subsystem mirrors that of Windows NT, a number of device drivers will be written as 80x86-specific VxDs.

when you launch a DOS box to run a character-mode application. But if you run only 16- and 32-bit Windows-based drivers and applications, you'll never invoke any of Chicago's MS-DOS components.

Chicago's virtual machine manager, like that of Windows 3.x, can create multiple virtual 8086-mode sessions. These share a common MS-DOS context in low memory, and their separate mapped address spaces are also visible to ring 0 components, notably VxDs (see Beyond DOS, September 1993 BYTE). Like OS/2 2.x and unlike NT, Chicago's DOS-box architecture favors compatibility (performance) over system robustness (protection from crashes), because Chicago will have to run DOS-based games without excuses.

Microsoft's design retains a large amount of 16-bit code, also for compatibility. When Win32-based applications call a 32-bit API that's implemented by a 16-bit component of the system, the function call is "thunked," or translated to its 16-bit equivalent, a process that incurs overhead. Chicago's three main modules—KERNEL, GDI, and USER—are divided into 16- and 32-bit parts. Win32 programs on Chicago will thunk down to 16 bits to access many GDI and USER services, much as Win32s programs do today. Win32 programs will image into the same 16-bit coordinate space that Win16 and Win32s programs do today, not the vastly larger 32-bit grid available to NT programs.

Chicago's Win16 support is a potential Achilles heel. Chicago's 16-bit system components are not reentrant, which means they can't be safely accessed by Win32 application or system threads. Every multithreaded operating system, including NT, uses some form of API serialization. The problem with Chicago's scheme is that a Win16 application that dawdles when processing messages can lock out other Win16 and Win32 applications. In this context, a single 16-bit Windows application is the weak link in the chain. In an environment with only Win32 programs running, programs won't be nearly as vulnerable.

If you use Chicago to run Win32 applications only, it will more closely approximate an "NT lite," which lacks NT's security, portability, scalability, asynchronous I/O, Unicode, and event logging. Chicago applications run in private address spaces, just as they do in NT. However, Chicago's memory management, scheduling, and I/O services are modeled on—but not ported from—NT.

Chicago, when running a mixture of DOS and Win16 applications, will behave much like Windows 3.x with a few improvements. As in Windows 3.1, DOS applications still multitask preemptively, while Win16 applications multitask cooperatively. To better track resource ownership and simplify cleanup when applications fail, Chicago runs each DOS and Win16 application on a separate thread. As a result, Chicago should handle DOS or Win16 crashes more cleanly than Windows 3.x.

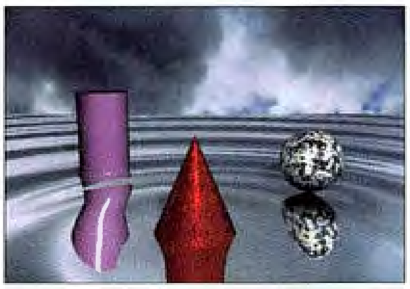
Even at its best, though, Chicago is not the pure 32-bit operating system that NT is. Instead, it is a 16- to 32-bit hybrid. At the December conference in which Microsoft distributed its second preliminary developer kits, programmers who hadn't worked yet with NT were, in general, more impressed with Chicago than those already familiar with NT.

Microsoft still lacks an operating system for the midrange RISC (i.e., $3000 8-MB PowerPC-based) systems that will hit the streets this year. But Chicago represents an ambitious Windows upgrade for the huge installed base of 4-MB PCs. If the result of Chicago's compromises is an operating system that is easier to use, more powerful, but not fatter than Windows 3.1, the payoff will be huge.

POWERPC MACINTOSH

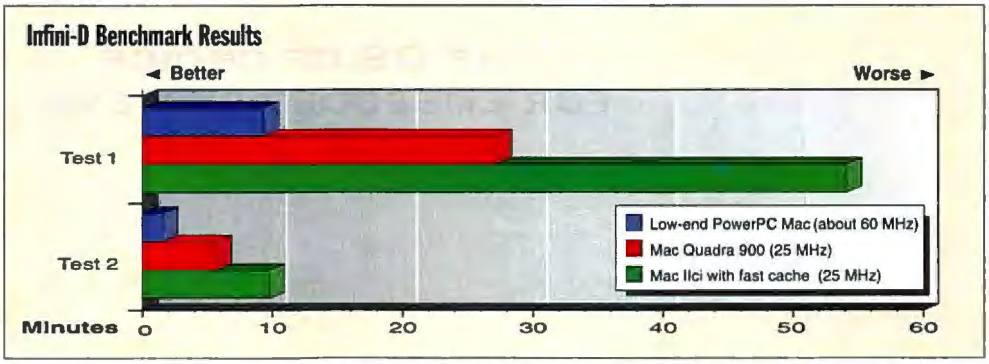
Low-End PowerPC Leaves 68040 Macs in the Dust

As Apple nears the release of its first wave of PowerPC-based Macs, preliminary test results show the least expensive PowerPC Mac completing compute-intensive tasks at least three to four times faster than a 25-MHz 68040–based Mac Quadra 900. Two separate tests using a preliminary native PowerPC version of Infini-D, Specular International's (Amherst, MA) 3-D modeling, rendering, and animation package, indicate that even the low-end PowerPC Mac—which sources say will sell for about $2000—will offer a significant performance improvement over the fastest current Macs.



Infini-D lets you quickly create 3-D wireframe models and render them using a variety of surface patterns like marble, wave, and corrosion. Once they're rendered, you can easily create professional animations.

All native PowerPC Mac applications will get a speed boost over their 68000-based cousins, but professionals who use applications that traditionally tax a processor, such as four-color desktop publishing, CAD, and video-editing programs, will see the greatest time saving in switching over to native PowerPC Mac applications. Specular ((413) 253-3100) stresses that the test results for the PowerPC Mac shown in the chart reflect performance of beta software running on a preliminary version of the Mac system software and prototype hardware. As the products near commercial release and are further refined, performance should improve even more. **—Dave Andrews**



All machines had Infini-D running under a 12-MB partition. Infini-D 2.5.2 is the current shipping version and the version used on the IIci and the Quadra. The PowerPC Mac is prototype hardware, with beta system software and a beta version of Infini-D. Test 1 (shown in the screen shot) was rendered using ray tracing and low antialiasing and with reflections, transparency, and shadows turned on. Test 2 (not shown) was rendered using phong shading with shadows turned on. Lower numbers are better.

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News & Views

THE GERMAN NEWTON PDA

Teutonizing the Newton

HAMBURG—When developing software for today's global market, developers must contend with various factors, including adding support for non-English characters, translating text strings, and supporting varying time and date formats. But in working on the German version of the Newton PDA (personal digital assistant), which was released in mid-December, Apple's Newton localization team, headed by Cindy Roberts, found that handwriting-recognition systems add a new set of factors to consider in localizing a product. Apple's programmers had to contend with major differences between American and German handwriting and the languages themselves.

When you use the Newton's dictionary-based recognition system, you get a mixture of surprisingly good—and confounding—results. The dictionary-based approach, which considers only words that you have stored or added to the system dictionary, works well for languages like English. But this system doesn't account for inflections, which are characters that change a root word's tense, case, or number (e.g., the American version of the Newton needs separate dictionary entries for *house* and *houses*). Consider the following:

the green house/the green houses
das grüne Haus/die grünen Häuser
la maison verte/les maisons vertes

The two phrases in three languages have equivalent meanings, but the German and French versions show more changes to the words. Newton would cover the English version with four dictionary entries, but it would need six entries for each of the other versions. Verbs have many more inflectional forms in German and French, so the system wouldn't require you to make as many corrections if the German version provided support for inflection rules.

But what the Newton localization team found even more haunting were those famous long German words. In English, compound nouns are written as separate words, but in German, they are written as one word. *House door key* would require three dictionary entries in English, but the German language needs a separate entry for *Haustürschlüssel*, as well as for other permutations, including *Haus*, *Tür*, *Schlüssel*, *Haustür*, *Türschlüssel*, and all their plural forms.

German-speaking Newton team member Peri Altan refined these word lists and came up with a dictionary of 17,000 words, almost twice as many as the U.S. version (the Japanese Newton, which was due to ship in January, needs 8 MB of ROM—twice the ROM capacity as that of the U.S. version). Other changes that the Newton localization team had to add to the German version are listed in the text box "From English to German."

Localizing systems that rely heavily on handwriting recognition requires much more than the simple translation of text strings, but the same is true for systems that rely on speech recognition. For developers who are worrying about the work involved in localizing their Newton applications, Apple's Roberts says that many German and other international users will be happy with a U.S. version of an otherwise satisfactory program, provided the program does not force constraints (e.g., an inflexible phone number, ZIP code, time, date, and other formats) on the user.

—Udo Flohr

FROM ENGLISH TO GERMAN

The following are but a few of the changes that Apple's localization team made in modifying the U.S. Newton to work for German-speaking users.

- **The cues for Newton's Intelligent Assistant, which interprets natural-language commands like "Fax Bob," required language changes.**
- **Date formats had to be changed. One of the less obvious ones was the calendar overview, which starts the week on Sunday in the U.S. but on a Monday in the German version.**
- **Time formats had to be changed to 24-hour mode and to handle the various ways you input time. Consider this partial list of valid time formats for handwritten entries in the date-book application (*Uhr* means *o'clock*): 3, 3 Uhr, 0, 0.00 Uhr, 0 Uhr, 22.32, 22.32 Uhr, 07, 07 Uhr, 1.15 Uhr, 6:30, 6:30 Uhr, 6:6, 6:6 Uhr, 08.03, 08.03 Uhr, 0:23, 0:23 Uhr, 13 Uhr 57, 2 Uhr 55, 02 Uhr 09, 02 Uhr 1, 02 Uhr 14, 02 Uhr 0, 1 Uhr 1.**
- **Phone numbers, which are formatted as (000) 000-0000 in the U.S., needed a more flexible format that accounts for the varying lengths of phone numbers in Germany.**
- **ZIP codes and currency symbol fields also needed to support formats of varying length.**

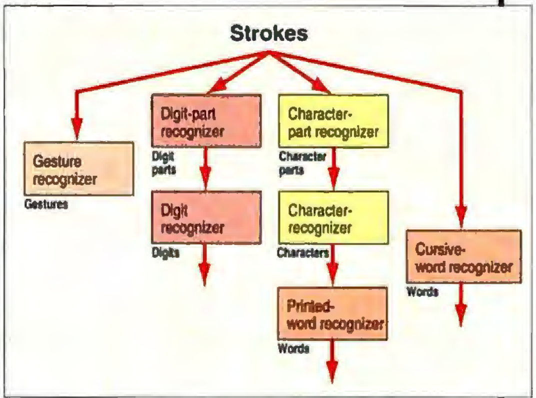
Newton Recognition Architecture

The recognition system in the American Newton uses a multiple recognizer architecture, with distinct recognizers for words, shapes (graphics), and editing and command gestures. The word recognizer uses built-in dictionaries to choose words that, with sufficient probability, match what you write.

The recognition process involves a hierarchy of recognizers that take specific types of recognition units and produce more complex units as output. Each recognizer processes its input according to a set of rules, adds interpretations to the input, and combines this more refined information in an output recognition unit that is then passed on to higher-level recognizers. To recognize a word that is made up of printed, separate characters, the strokes that make up the word are interpreted as character parts, then the parts as characters, and then the characters as a word.

This structure lets developers add new recognizers at different levels of the hierarchy. This part of the Newton operating system is only accessible through the C/C++ interface. At this point, the NewtonScript programming language and the NTK (Newton Tool Kit) don't offer tools to add recognizers to the system.

Because Americans and Germans are taught different handwriting styles at an early age, certain elements of the Newton recognition code were modified for the German version. These modifications include a combined printed and cursive handwriting recognizer, instead of two separate recognizers as for the American version. Apple declined to disclose any other modified elements. —U. F.



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Circle 159 on Inquiry Card.

NETWORKING

Tut's 10-Mbps Telephone Cord Network Could Be Small-Office King

Peer-to-peer network operating systems and network-ready computers can help reduce the aggravation that often comes with networking a workgroup or small office, but if you want to run your network at 10 Mbps, chances are you'll have to rewire your office building. Most offices today that are not yet networked do not have sufficient quality cable installed to support standard 10-Mbps networks.

Small-office users who don't want to pull data-grade wire have turned to solutions like Farallon's PhoneNet, which uses a regular telephone cord to transmit at LocalTalk (230 Kbps) speed, but this can often prove too slow a solution for any office with significant network traffic. Attempts to push data across standard telephone cable at 10 Mbps were sidelined by numerous problems, such as common-mode noise (electronic interference from other electrical devices) and signal distortion, which is why networking companies (e.g., Synoptics) had to convince users that the power of networks was worth the inconvenience and cost of pulling extra data-grade cable through their office walls.

But new developments by Tut Systems (Pleasant Hill, CA) bring the power of 10-Mbps networking to companies that previously couldn't be bothered by the complexities of network wiring. The company's Silver Streak product line provides an off-the-shelf 10-Mbps Ethernet implementation over plain old telephone (silver satin) cords. The product's ease of installation should bring a wide variety of network applications to small workgroups and home offices that have shied away from installing a 10-Mbps network.

The secret to Tut Systems' success is the company's patented new balun, a device that puts the data signals on the network wire. Tut Systems' balun attenuates noise by a ratio of 10,000 to 1 (typical baluns used in 10Base-T networks achieve a ratio of about 100 to 1), which increases network throughput and reliability. The product also meets FCC Class B emission requirements, which means it can be used in home offices.

"Small offices employ over half the workers in the U.S.," says Taylor, citing U.S. Department of Labor statistics. "The power of networking is well recognized in the corporate market, yet small offices have been very undernetworked." According to Taylor, one of the major barriers to small-office networking has been the cost of installing a network. This cost includes time needed to install the network or the actual expenses in hiring an expert to install the network. "With Silver Streak," he says, "we decided to slash that cost by creating a whole new class of installers—the users." Taylor added that with Silver Streak, you simply need to connect a $99 Silver Streak Connector to a network-ready computer and then connect the computers with telephone wire (the product also works with any level of unshielded twisted-pair cable).

"What PhoneNet did for AppleTalk, Silver Streak does for Ethernet," says Don Preuss, a section chief at the National Institutes of Health (Bethesda, MD) and a beta tester of Silver Streak. "It's easy to set up; there's no need to look at the manual. And there's not much more to say about it. It works the way they say it works."

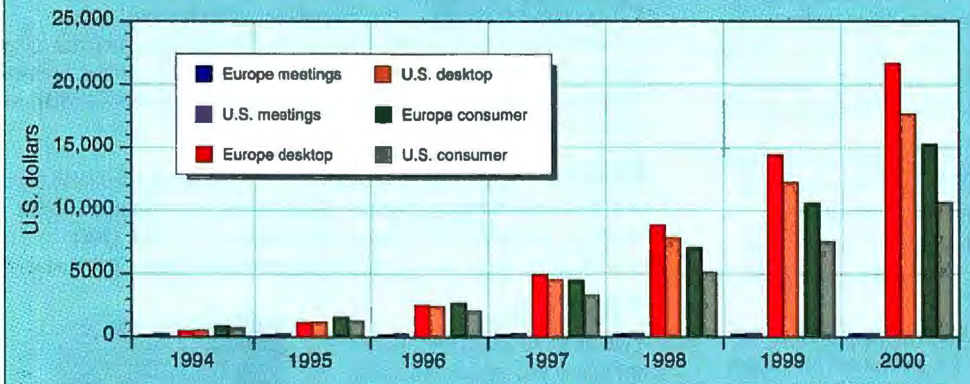
—D. A.

SILVER STREAK PRODUCTS

- **AUI/AAUI connectors that attach to a network-ready computer: $99 each.**
- **Complete Ethernet solution for IBM PC, Mac II, or Mac LC that includes NIC and Silver Streak Connector: ISA package, $199; Mac solutions, $249 each.**
- **10Base-T Converter: $199.**
- **Single UTP Converter for Tut's MH series hubs: $99.**

Tut Systems, (800) 998-4888 or (510) 682-6510; fax (510) 682-4125.

Networked Multimedia's Business Opportunity



Revenues from video-based PCs will exceed those of conventional videoconferencing equipment starting in 1996, according to consultancy Ovum (London). Companies like Apple and SGI have already released video-capable computers, and others will soon follow. Acer America expects to release a videoconferencing PC for less than $6000 in the first half of this year. Networks are the weakest link in the chain, but the situation is improving. Companies like Starlight Networks (Mountain View, CA) and ProtoComm (Trevose, PA) have developed video-server products that integrate video traffic into LANs. More recently, Novell released NetWare Video, an NLM (NetWare loadable module) for NetWare 3.x and 4.x, and IBM delivered its LAN Server Ultimedia, which adds multimedia to IBM's OS/2 LAN Server 3.0 advanced network. Work is also under way to pump up standard 10-Mbps networks to 100 Mbps. In the chart, *meetings* equals conventional videoconferencing equipment; *desktop* equals video PCs, file servers, and software; and *consumer* equals TV/CD-ROM players and TV set-top boxes.

WinBench™ 3.11 by Ziff-Davis Labs Tests Remote Windows™ Speed

This graph shows the speed of the three leading remote control programs when transferring Windows screens. As you can see, Close-Up handles more pixels, faster, meaning you spend less time waiting for Windows screens.

The industry standard test, WinBench 3.11, is perfect for testing the speed of remotes. It is an accurate measure of video throughput. Video throughput is the limiting factor in remote operations, because remote programs must transmit Windows video functions from one PC to the other.

New Remote Software Sets Windows Speed Record

Communicate Faster & Easier

Close-Up* lets you communicate faster & easier with five exciting technology firsts.

Close-Up is the only remote communications software that won both PC Magazine's coveted "Editors Choice" and PC World's "Best Buy" awards. Now Close-Up has a new faster & easier version that allows you to view and control another PC by modem as if you were there!

Technology Firsts

1. *AI Video Compression*
2. *Photographic Memory*
3. *Non-Intrusive Technology*
4. *Expert System*
5. *Video Translation*

Why Is Close-Up So Fast?

Close-Up learns as it works. It uses AI (Artificial Intelligence) to compress all Windows video function calls. That's why Close-Up does so well in Windows Benchmark tests (see WinBench 3.11 chart).

Close-Up uses its revolutionary Photographic Memory™ so that once Close-Up has seen all or part of a Windows screen, it's memorized. Then as screens change, Close-Up only transmits new unmemorized data. Incredibly, with this technology *Close-Up gets faster & faster the longer you use it.*

What Remote Companies Haven't Told You

Other remote programs permanently slow Windows and usually reduce your video resolution and depth of color, even when they are not in memory. That's because they permanently change your system.ini file. Close-Up's breakthrough Non-Intrusive Technology does not modify any of your sensitive Windows files including the system.ini. Close-Up is the only remote that when not in use, allows Windows and your PC to run at normal optimal levels.

WinBench scores (average of 10 runs):
Close-Up 1,613,118
pcAnywhere 194,093
CarbonCopy 168,397

Expert System Makes Communications Easy

You don't have to be a communications expert to get the results of one. Close-Up has an Expert System that automatically analyzes system components and configures your system for optimal speed.

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With Close-Up, dissimilar PCs can easily connect, because Close-Up senses the video capabilities of both PCs and automatically displays Windows in a video mode compatible with both sides.

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Norton-Lambert

We invite you to reproduce this test. We used two identical Gateway 4DX2-66V's with 66-MHz Intel 486DX2-66 CPUs, 16 MB RAM, 256KB RAM cache, 340 MB HD, IDE controller, no hardware disk cache. Video: Local Bus ATI Ultra Pro with 2MB VRAM, 640 by 480 pixels, 16 colors, VGA.DRV dated 3/10/92. Monitor 72 Hz. MS-DOS 5.0, SMARTDRV 2 MB cache. Modems: two 14,400 baud V.32bis. Test performed without verification by Ziff. All products are shipping versions. WinBench trademark of Ziff Communications Co. Windows trademark of Microsoft Corp.

*60 day money-back guarantee if purchased directly from Norton-Lambert. Offer expires 6/30/94. All prices in US Dollars. Prices exclude shipping.

Circle 118 on Inquiry Card.

CADVANCE, Claris CAD, VersaCAD, MacBravo! users ...

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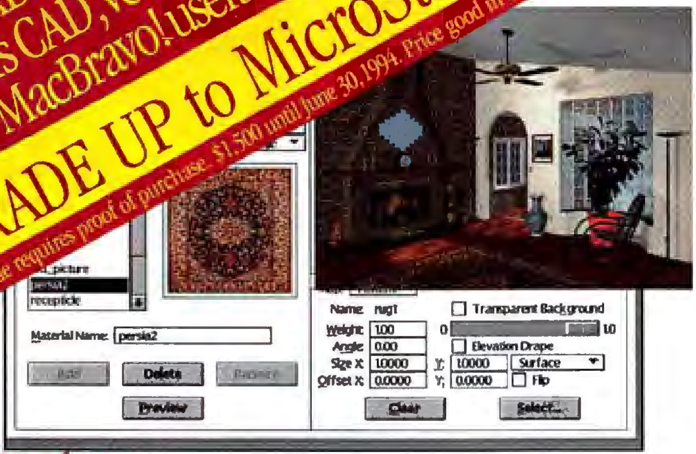

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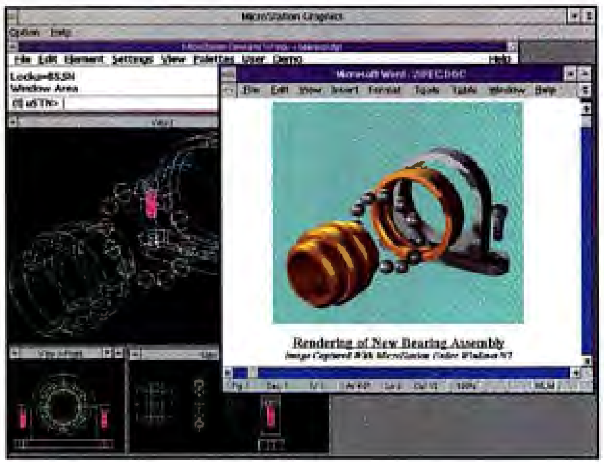
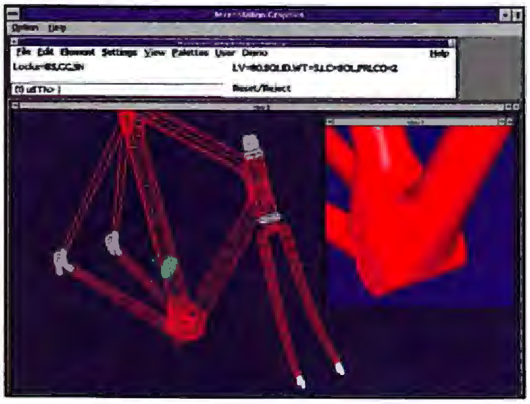


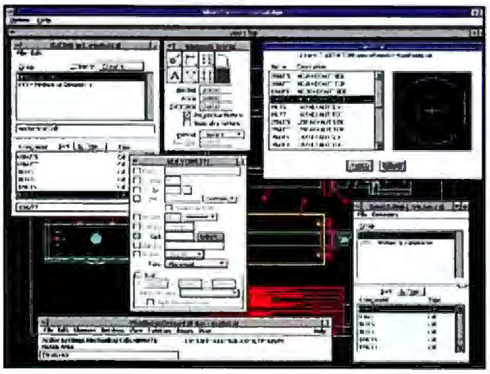
Windows. It walks and talks Windows. Behind MicroStation lies the user-responsive programming you look for in good Windows software. Version 5 gives you the ultimate in integration of CAD, engineering, and business applications.

MORE POWER TO YOU.



Modeling. Model any surface you can imagine in MicroStation. NURBS surface modeling combined with 3D Boolean operations gives you astounding flexibility in creating and modifying freeform models.

Read & write AutoCAD .dwg



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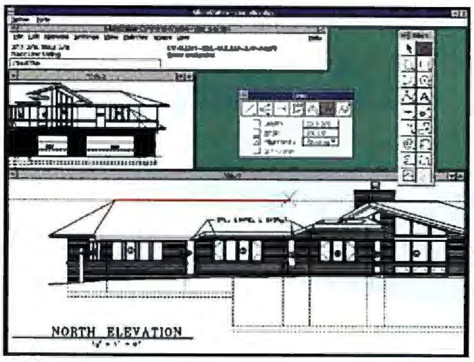

Usability. *What does computer-aided drafting have to do with the way you think? Everything. MicroStation software works for you. It understands the drafting process so well that it infers what you'll do next.*

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INTERGRAPH

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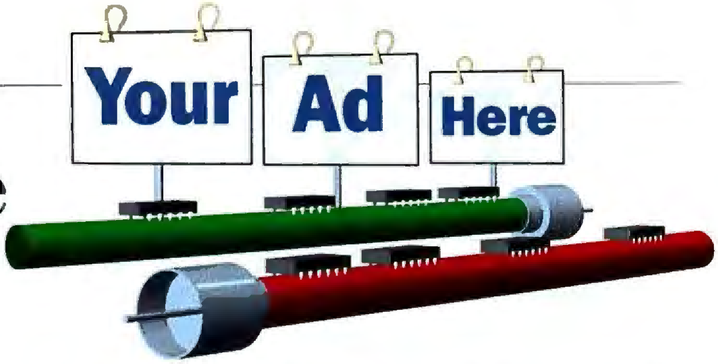
THE INTERNET

The Importance of Netiquette



So what's a data highway without billboards? Call it inevitable; advertising is now part of the Internet.

But don't expect to wade through junk mail and commercials on your computer. Internet users are divided regarding the idea of ads on-line. Even though many users enjoy (or at least don't mind) reading information about products and services, in-your-face advertising is destined to backfire severely, according to Elizabeth Lane Lawley of Internet Training & Consulting Services.

Lawley says that as federal regulations on the Internet use drop away, advertising's main barrier is users who believe that advertising is out of place on the Internet. Advertisers who don't observe the Internet's social mores, particularly those who carpet-bomb discussions with ads or send unsolicited (junk) mail, risk annoying the people they meant to entice.

Advertisers with an understanding of "netiquette" fare much better. Judith Axler Turner is an Internet veteran and director of Chronicle Information Services, the on-line arm of The Chronicle of Higher Education. Turner's on-line publication, Academe This Week, publishes 600–1200 want ads weekly. Most of the ads list jobs that are available or desired at colleges and universities. She's never received a complaint; moreover, advertisers have been pleased with the quality of applications the service has brought in.

"Passive" advertising of this type, where information is available to those interested, works. So does participation in usenets or mailing groups: Individuals affiliated with a company answer questions as knowledgeable resources on a topic (while including the name of their business in their signature).

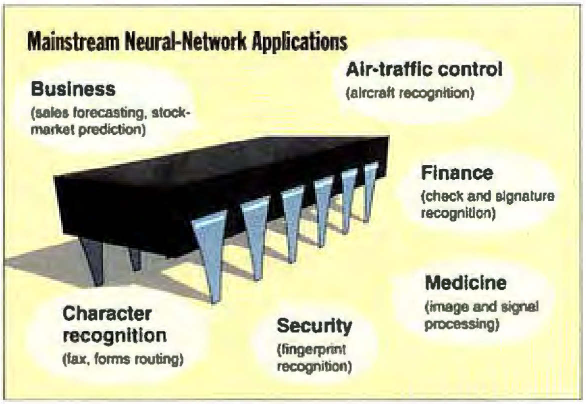
The terms of the AUP (Acceptable Use Policy) formulated by the National Science Foundation, which oversaw the Internet's backbone, excluded all advertising except for announcements of new products and services for research and education. But a second, parallel backbone run by the CIX (Commercial Information Exchange) cooperative venture is now in place, and it has no such restrictions. Most Internet public-access providers and on-line services offer service over CIX in addition to or instead of the NSFNET backbone. As the regulations change, the final word on advertising will come from its users, who will dictate acceptable tactics for reaching the thousands of microcommunities on the Internet.

—**Angela Gunn**

NEURAL NETWORKS

Intel and Nestor to Commercialize Neural-Net Chip

Neural networks, which allow computers to perform pattern-recognition functions, have so far remained on the fringe of mainstream computing. But an agreement between Intel and Nestor to commercialize the Nestor-designed Ni1000 neural chip could change that. The Ni1000, which contains over 3 million transistors, can perform high-speed pattern recognition, from handprinted characters to fingerprints to images of targets in military applications. Nestor (Providence, RI) specializes in OCR and massively parallel-processing applications and is headed by Nobel prize laureate Dr. Leon Cooper.



Intel and Nestor's Ni1000 chip could support a range of applications, as shown in this conceptual illustration.

According to Mark Holler, director of Intel's neural-network group, the Ni1000 chip performs 10 billion operations per second and is capable of recognizing 40,000 patterns per second, although other computer system bottlenecks reduce that number substantially. Holler says that some prototype systems using the chip and Nestor's OCR software, NestorReader, can recognize up to a few hundred handprinted characters per second.

Dr. Don Specht, consulting scientist at the Lockheed Research Laboratory, a beta site for the Ni1000, says that Lockheed is working on target-recognition applications using four Ni1000 chips running on a VME board and has plans for additional space-based and commercial applications. Intel's Holler says that there are eight beta sites working with the Ni1000. He sees a wide variety of industries making use of neural-network technology (see the figure).

Intel is working on reducing the cost of the silicon for the Ni1000, says Holler (pricing at press time was unavailable), and eventually, it will release an add-in card for PCs similar in cost to a "typical high-end graphics accelerator." Intel is supporting the chip with a C library and other software development tools, in addition to the NestorReader OCR software.

While neural networks are still a specialized segment of computing, commercial efforts such as Intel's and Nestor's are bound to make their application more widespread. The chip is expected to ship sometime in the first quarter of this year.

—**Nicholas Baran**

For more information, call Intel's Neural Network Hotline at (408) 765-9235.

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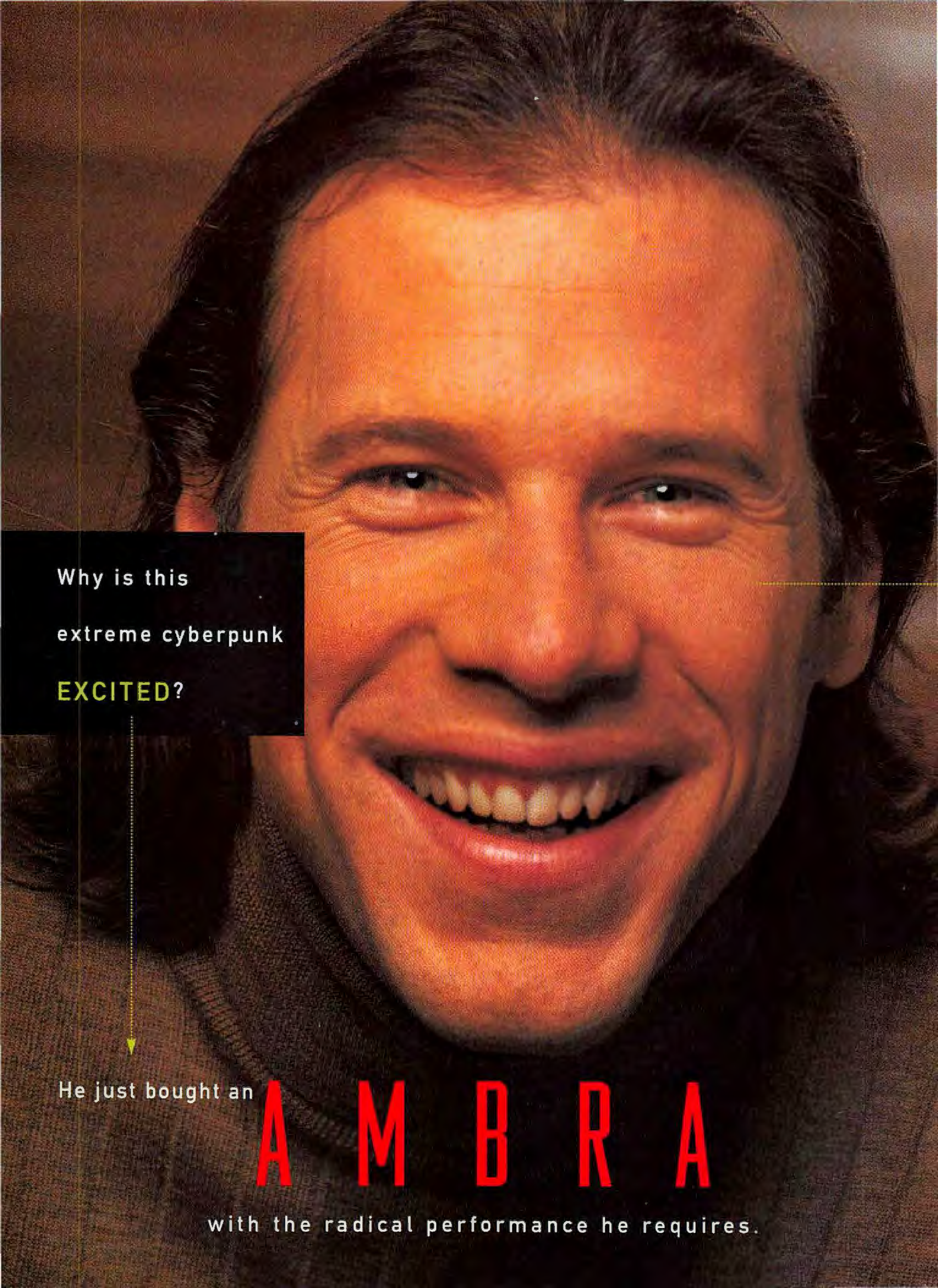

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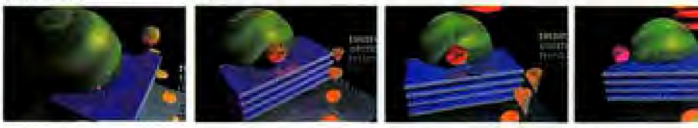

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- 4 ISA, 2 PCI, 1 ISA/PCI slot
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❷ w/ Diamond Viper video plus...
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- Lexmark PS/2-style 101-key keyboard
- MS-DOS 6.2, Windows 3.1, mouse

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- 32-bit local bus IDE controller
- 32-bit local bus graphics accelerator, 1MB
- 15" FST-NI color monitor, LR
- 3.5" 1.44MB diskette drive
- 2X CD-ROM drive
- Lexmark PS/2-style 101-key keyboard
- MS-DOS 6.2, Windows 3.1, mouse

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[1] Estimated PCI WinMarks scores based on previous Matrox testing of MGA-I using Ziff-Davis Winbench 3.11, Pentium 66 MHz, 64MB RAM, 512KB cache, 72 Hz, 1,024 x 768 x 256 colors. [2] CD-ROM drive required; may be purchased with system or separately. [3] Please call for details regarding AMBRA's money-back guarantee, limited warranty and optional IBM onsite warranty. Return shipping and insurance charges are the responsibility of the customer. Onsite service may not be available in certain locations. [4] Offerings may differ in Canada.

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- Upgradable to Pentium technology
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- 5 drive bays
- Integrated 32-bit SCSI-2 controller
- 32-bit graphics accelerator, 1MB
- 14" SVGA-NI color monitor, LR
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- Integrated Ethernet 10BaseT
- Lexmark PS/2-style 101-key keyboard
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❽ BL minitower, w/ all listed features of ❼ plus...

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- 32-bit local bus IDE controller
- 32-bit graphics accelerator, 1MB
- 14" SVGA color monitor, LR
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- Lexmark PS/2-style 101-key keyboard
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❿ 466DXA minitower, w/ all the above and:

- 8MB RAM
- 440MB (12ms) IDE hard disk
- 6 drive bays
- 8 16-bit ISA slots
- 15" FST-NI color monitor, LR

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⓫ S450DXA

- 486DX2, 50 MHz
- Upgradable to Pentium technology
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- 4MB RAM
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- 240MB (15ms) hard disk
- 3 drive bays
- 32-bit IDE controller
- 32-bit graphics accelerator, 1MB
- 14" SVGA color monitor, LR
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- Lexmark PS/2-style 101-key keyboard
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COMMUNICATIONS

Fax Gets a Face-Lift

The great things about fax are that it's easy to use and practically every business has one. However, if you need to transfer an editable word processing, spreadsheet, or image file, fax falls flat: The process of converting a bit-map fax image into a file that you can edit with your word processor or route to a network database places a heavy burden on OCR programs that usually can't approach 100 percent accuracy when recognizing a free-form document.

This spring and summer, developers will release a new wave of products that give fax a face-lift by adding binary-file-transfer capabilities, letting you send files—even files with sound and video—in their original format. "With binary file transfer, we want to take document-image communication and change that to document communication," says Richard Holder, product marketing manager at WordPerfect's consumer-products group. "We want to get rid of that whole [OCR] conversion step." But as often occurs, developers will have their pick of two standards to support, in this case one by the international ITU (formerly CCITT) standards body and the other by Microsoft.

Developers of fax software say that in many ways, the binary-file-transfer fax portion of Microsoft's At Work architecture is better defined than the ITU's evolving T.434 standard. The fax component in At Work, which is currently included with Windows for Workgroups 3.11, is more secure, supporting password and public-/private-key encryption, as well as digital-signature verification. Developers say that the At Work fax transport used for fax LAN routing and for its implementation of negotiation, in which a sending device seeks out the receiving device's capabilities and then stores it for future reference, is also more robust. "At this time, the Microsoft binary file transfer is richer," says Jennie WanMernyk, director of marketing at OAZ Communications (Fremont, CA). But vendors who choose to support Microsoft's binary fax solution in their products will also have to pay royalties to Microsoft.

The TR-29.1 committee of the Telecommunications Industry Association is working on improving the key open issues of implementing the T.434 standard, which are file-attribute negotiation and improving interoperability among different manufacturers' devices, according to James Rafferty, president of the communications consulting firm Human Communications (Danbury, CT). "T.434 will be a royalty-free solution for vendors to implement," Rafferty says. Another point in T.434's favor is that it is a multiple-platform standard, not a Windows-only solution.

"We wanted to get binary file transfer out there today, and so we implemented binary file transfer on top of T.30 [the current ITU fax standard]," says Suzan Fine, product manager at Microsoft's digital office systems group. "But T.434 will slowly be better defined. If it is widely implemented in the future and is compatible across implementations, we may support it." Most developers we surveyed said they are closely following T.434 and At Work and may support both standards in upcoming products.

Whichever standard wins in the market, however, binary file transfer could make fax even more attractive as a universal communications medium. John Willcutts, vice president of engineering at Atlanta-based Sofnet, which sells fax programs for DOS, Windows, and OS/2, says that, once widely supported, binary file transfer could upgrade fax to "the ultimate file transfer of all time." —D. A.

BINARY FILE TRANSFER IN FAX

THE GOOD

It eliminates OCR.

Fax can contain multimedia files not just bit-map images.

In-bound routing can direct a fax to its proper destination on the LAN.

THE NOT-SO-GOOD

It is more useful for computer-based fax than stand-alone fax machines.

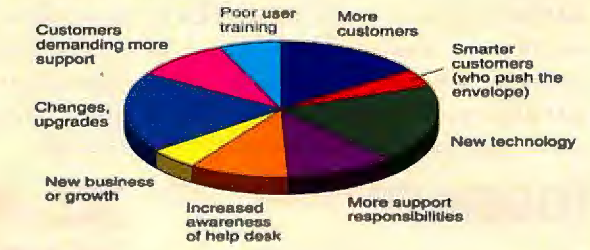
Microsoft and the ITU support different standards.

It requires error-correction support.

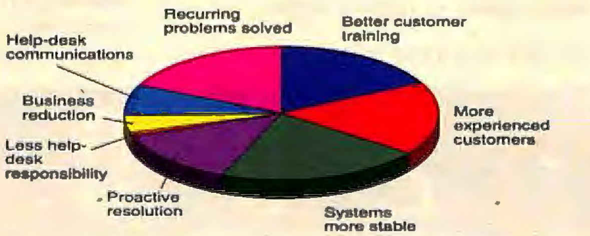
WHY USERS SOMETIMES FEAR UPGRADES

A recent survey conducted by Help Desk Institute (Colorado Springs, CO) indicates that upgrades are the most likely reason for an increase in support calls. Over 3500 Help Desk Institute members were asked to name the three most likely reasons for any increase in calls, as well as the three most likely reasons for a decrease in calls. The DMTF (Desktop Management Task Force), an organization of about 300 hardware and software vendors, is working on a variety of efforts to decrease the number of incoming calls, including the establishment of a standard set of APIs that access desktop systems, components, and peripherals to bring interoperability and management to desktop computing.

Reasons for an Increase in Support Calls



Reasons for a Decrease in Support Calls



OBJECT OPERATING SYSTEMS

Alliances Could Mean Better Integration

Following close on the heels of Sun Microsystem's deal with Next to incorporate the applications development layer of NextStep into the Solaris operating system (see January BYTE, page 148), Microsoft and DEC say they will integrate DEC's Object Broker distributed-object system with Microsoft's OLE technology. Microsoft says the agreement will let Windows- and OLE-supported Mac applications seamlessly access data and objects on a variety of platforms.

These deals reflect the growing need for seamless integration between operating-system platforms. DEC's Object Broker runs on many Unix platforms (e.g., HP-UX, SunOS, AIX, OSF/1, and Ultrix), and on Windows, Mac, and VMS. Object Broker is a development kit that lets developers write applications that can communicate with data and applications on other platforms that support the Object Broker interface.

In the agreement with Microsoft, DEC will integrate OLE into Object Broker, forming an architecture called COM (Common Object Model). For example, COM will let a Windows application running on a client PC or a Mac application supporting OLE directly access data being generated on a Unix server. Microsoft and DEC demonstrated a PC running an Excel spreadsheet being supplied with data from a stock-ticker application running on a remote Unix-based system.

Sun aims at a similar objective in its deal with Next. NextStep offers an object-oriented development environment that will be incorporated into Solaris, while Sun brings its networking and distributed-object technologies to the table. With Solaris running on Intel machines, Sun hopes to provide a similar level of integration and seamless data access across platforms as that proposed by the COM specification.

Both agreements are just that—agreements rather than working products. According to Microsoft's OLE product manager David Seres, Microsoft and DEC will distribute the COM specification in the first quarter of this year and will have an alpha version of the Object Broker–OLE product in the second quarter.

Sun declined to announce a schedule for its so-called "OpenStep" implementation. Further details will be announced in April.

One thing working in Sun's favor is NextStep's application development environment. "This is not technology under development," said Next chairman and CEO Steve Jobs about NextStep, which is already on its third release. "It's technology that's been really battle-tested and industry-acclaimed."

John Rymer, an analyst with Patricia Seybold's Group, says the Sun/Next deal is a major step forward for NextStep. HP recently announced it will integrate Taligent's Application and Development Frameworks into HP-UX and join Apple and IBM as a minority shareholder. But these frameworks won't ship until later this year. "Specifications arise from shipping products and Next has a lot more out there than does Taligent," Rymer says. "This is an important step for Next reaching industry recognition."

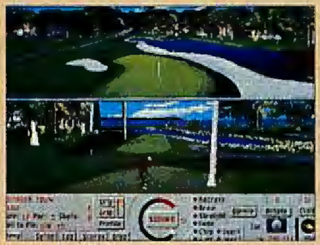
—N. B.

CODE TALK

RICK GREHAN

Phar Lap's TNT Adds Life to MS-DOS

Every time it looks like MS-DOS has overstayed its welcome and is about to be shouldered out by a bigger and better operating system, something comes along and suddenly, DOS doesn't look so bad. The latest development of this nature is Phar Lap's TNT DOS-Extender, a much-expanded version of that company's 386|DOS-Extender product. What makes TNT special (and what gives it its name) is that it's a DOS-extender injected with Windows NT's nongraphical goodies. Think of TNT as Windows NT without the Windows part: multiple processes, threads, semaphores, virtual memory, memory-mapped files, and even DLLs. Once compiled with TNT, your program can run unchanged as a DOS, Windows 3.x, or native character-mode NT application. TNT supports a subset of the NT API, so it's compatible with Microsoft's 32-bit Visual C++ compiler. Microsoft even licensed NT's floating-point emulation library to Phar Lap so that a TNT application you run under DOS will give you identical floating-point results when you run it as a native NT program.



Over 1200 applications are built with versions of Phar Lap's extender, ranging from CAD to database to games like Access Software's Links 386 Pro for DOS.

Currently, although TNT is compatible with Microsoft's 32-bit Visual C++, MetaWare's High C/C++, and Watcom's C/C++ 32 (as well as other language compilers such as Lahey FORTRAN), only Visual C++ allows access to the NT components of TNT. You can use the other compilers with TNT to create 386|DOS-Extender-compatible applications (referred to as *DOS-style* programs). Look for more compilers to provide the NT support for TNT in the near future.

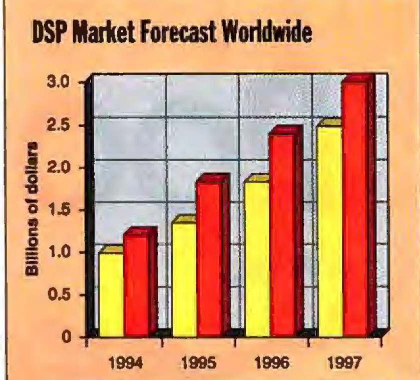
Microsoft uses TNT as the DOS-extender that drives the DOS command-line versions of its 16-bit and 32-bit Visual C++ compilers. Denis Gilbert, Microsoft's general manager of the Visual C++ business unit, sees TNT as a way for developers to hedge their bets. "Developers can build 32-bit applications that run on DOS and Windows today and will run unchanged in NT tomorrow." Furthermore, Gilbert points out that TNT allows companies to develop NT-style applications that can run on hardware (e.g., 386SX laptops) that may simply be unable to support NT.

The TNT developer's kit is $495—that gets you the extender, assembler, linker, librarian, and two debuggers (including the 32-bit version of Microsoft's CodeView). If you want to distribute your application, however, you've got to purchase the $1995 run-time kit to bind the extender into your executable file. The run-time kit also includes a license for distributing your application's first 1000 copies (Phar Lap Software of Cambridge, Massachusetts, (617) 661-1510, tells me that price is negotiable.)

Of course, it's tempting to wonder about TNT's lifespan. Couldn't the widespread acceptance of NT or the movement of advanced 32-bit features into future versions of DOS simply obviate it? Possibly, but TNT is here now, and the applications you build with it will run in 32-bit glory, immune to the evolution of DOS or NT.

DSP DEVELOPMENT

Zycad Reduces DSP Time to Market



DSPs generally come in two forms: programmable DSPs or preprogrammed FASICs.

DSP (digital signal processor) technology is showing up in products ranging from modems to cellular telephones to computers. As the DSP competition heats up, chip designers are looking for a development system that helps them get a tested design to market fast and inexpensively. A new product from Zycad (Fremont, CA) called the Paradigm RP lets DSP developers test and simulate complex DSP designs prior to committing these DSP designs to silicon.


Zycad's Paradigm RP lets DSP developers test and simulate complex DSP designs prior to committing these designs to silicon.

The Paradigm RP system, which is based on a 30,000-gate module containing high-speed, electrically reprogrammable Xilinx 4010 FPGAs (field programmable gate arrays), not only lets developers save money by not having to actually build the chip to find bugs, it also lets them test software that will run on the DSP, resulting in a faster time to market for both the chip and supporting software.

"In many cases, you can really only assess the quality of a design with a real-time test," says Johan Van Ginderdeuren, product manager at Philips ICTL (Leuven, Belgium). This is because emulating the DSP in software would have resulted in audio that sounded something like a 78-rpm record being played at 33⅓ rpm. Philips recently used a Paradigm RP to emulate a DSP-based audio system.

Ginderdeuren said that the Paradigm system could save developers the average of two to four months required to do a single redesign to fix a bug in a chip that was already manufactured.

Will Strauss, president of Forward Concepts (Tempe, AZ), said the Zycad system will have the greatest impact on preprogrammed FASICs (Function and Algorithm Specific ICs). Strauss says the Paradigm RP's ability to simulate DSP functionality in real time, combined with its ability to emulate a wide variety of DSP designs, makes it unique in the market. "It's a refreshing new approach." **—D. A.**

COMMUNICATIONS SOFTWARE

Not Just for File Transfer Anymore

Back in simpler times (in the 1980s), communications software meant programs that coaxed your modem into dialing up an on-line service or BBS. Today, it's likely to mean a good deal more. A new crop of integrated communications software is merging data, fax, file transfer, remote control, and even voice-mail functions into a single program.

To a large degree, communications software is merely following the hardware. Most of the modems sold today include fax features as well as basic data functions, and by 1997, about half of them will have voice capabilities as well, according to BIS Strategic Decisions of Norwell, Massachusetts. Not surprisingly, modem makers would like to bundle a single communications program that can manage all these functions, instead of shipping multiple packages. Meanwhile, buyers benefit from easier installation, no port conflicts, a consistent user interface across several types of communications activities, and the lower cost of buying only one program.

"Many of our customers were dissatisfied that they had to deal with multiple communication products to meet their needs," notes Mark Eppley, chairman of Traveling Software. "One customer was using seven separate programs for communication. So we put it all together in response to them."

CommWorks from Traveling Software is joined by other integrated Windows communications programs, including Delrina's Communications Suite, Bit Software's BitFax Professional, and a number of less elaborate programs, such as Smith Micro's QuickLink Gold for Windows ($99.95, (714) 362-5800), which combines data, fax, and OCR capabilities.

If this flurry of communications mergers is any indication, more such programs are on the way. "Software solutions integrating various communication media will be abundant in 1994," according to Janet Fugazzotto, a BIS senior analyst. "The next generation of packages supporting mixed media will be network products, such as a fax, voice, E-mail, and data server," she says.

The rapid development of wireless modems will no doubt prompt support for tetherless dialing and faxing, too.

—Christopher O'Malley

COMPLETE COMMUNICATIONS SOLUTIONS

BitFax Professional 3.0 for Windows ($129).
Combines fax, OCR, and data communications including terminal emulation and voice mail, if you have a modem that supports voice.
Bit Software, Fremont, California, (510) 490-2928; fax (510) 490-9490.

Delrina Communications Suite for Windows ($179).
Combines fax and data communications, including terminal emulation, with virus detection, predefined scripts for accessing eight on-line services, and optional fax broadcast through MCI Fax Broadcast Service.
Delrina Software, Toronto, Ontario, Canada, (416) 441-3676; fax (416) 441-0333.

CommWorks for Windows 1.0 ($199.95).
A combination of five separate DOS and Windows programs, including file transfer, remote access, terminal emulation, fax, and an alert utility.
Traveling Software, Bothell, Washington, (206) 483-8088; fax (206) 485-6786.

INTEL TECHNOLOGY BRIEFING

MANUFACTURING

THE ART OF BUILDING PENTIUM™ PROCESSORS

A PATTERN OF FASTER PROCESSORS.

pentium™ PROCESSOR

In 1971, Intel astounded the electronics world with the first microprocessor—the 4004 processor. It was a single silicon chip that contained 2,300 transistors and calculated 60,000 instructions per second. Today, our Pentium™ processor, only slightly larger, contains over 3.1 million transistors and calculates 100 million instructions per second!

How does Intel increasingly pack so much more computing power onto a chip the size of your thumbnail?

Advanced design techniques combined with advanced manufacturing techniques are the keys. Developing higher performance processors relies heavily on how many transistors can be integrated on a chip. So it's critical these two technologies work in unison.

Processor manufacturing is a highly complex process involving many steps, beginning with design and ending with final testing. In this Technology Briefing, we'll examine the wafer fabrication process and show you how we construct the Pentium processor from the ground up.

WHERE IT BEGINS.

SILICON, THE PRINCIPLE INGREDIENT OF SAND, FORMS THE BASE UPON WHICH ALL PROCESSORS ARE BUILT. FIRST, THE SILICON IS REFINED TO 99.999999% PURITY, THEN MELTED AND FORMED INTO SINGLE, CRYSTALLINE INGOTS. THE INGOTS ARE SLICED INTO THIN WAFERS AND THEIR SURFACES ARE POLISHED TO A PERFECTLY SMOOTH, MIRROR FINISH. ONE SILICON WAFER CAN PRODUCE OVER 100 PROCESSORS.

BUILDING THE PROCESSOR.

EACH PENTIUM PROCESSOR IS CONSTRUCTED LIKE A MULTI-STORY BUILDING, WITH MULTIPLE LAYERS OF MATERIAL COMBINED TO CREATE A SINGLE, COMPLEX UNIT. TO CREATE A LAYER, A TECHNIQUE CALLED PHOTOLITHOGRAPHY IS EMPLOYED. PHOTOLITHOGRAPHY TRANSFERS THE TRANSISTOR AND CIRCUIT DESIGNS TO THE WAFER ONE LEVEL AT A TIME.

HOW EACH LAYER IS MADE.

1. MASKING.

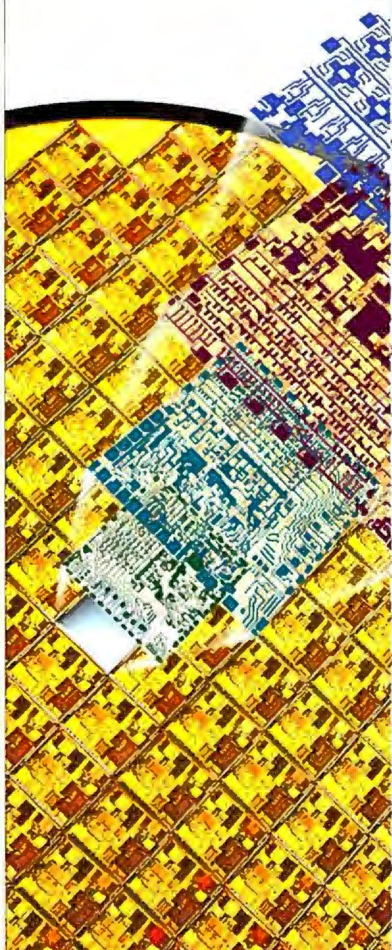
FIRST, A SMALL STENCIL-LIKE PATTERN, OR MASK, REPRESENTING THE SCHEMATIC DESIGN OF THE CIRCUIT IS CREATED FOR EACH LAYER. IT WORKS MUCH LIKE A NEGATIVE IN PHOTOGRAPHY, IMPRINTING A PORTION OF THE CIRCUIT DESIGN ONTO THE WAFER.

EXPOSURE

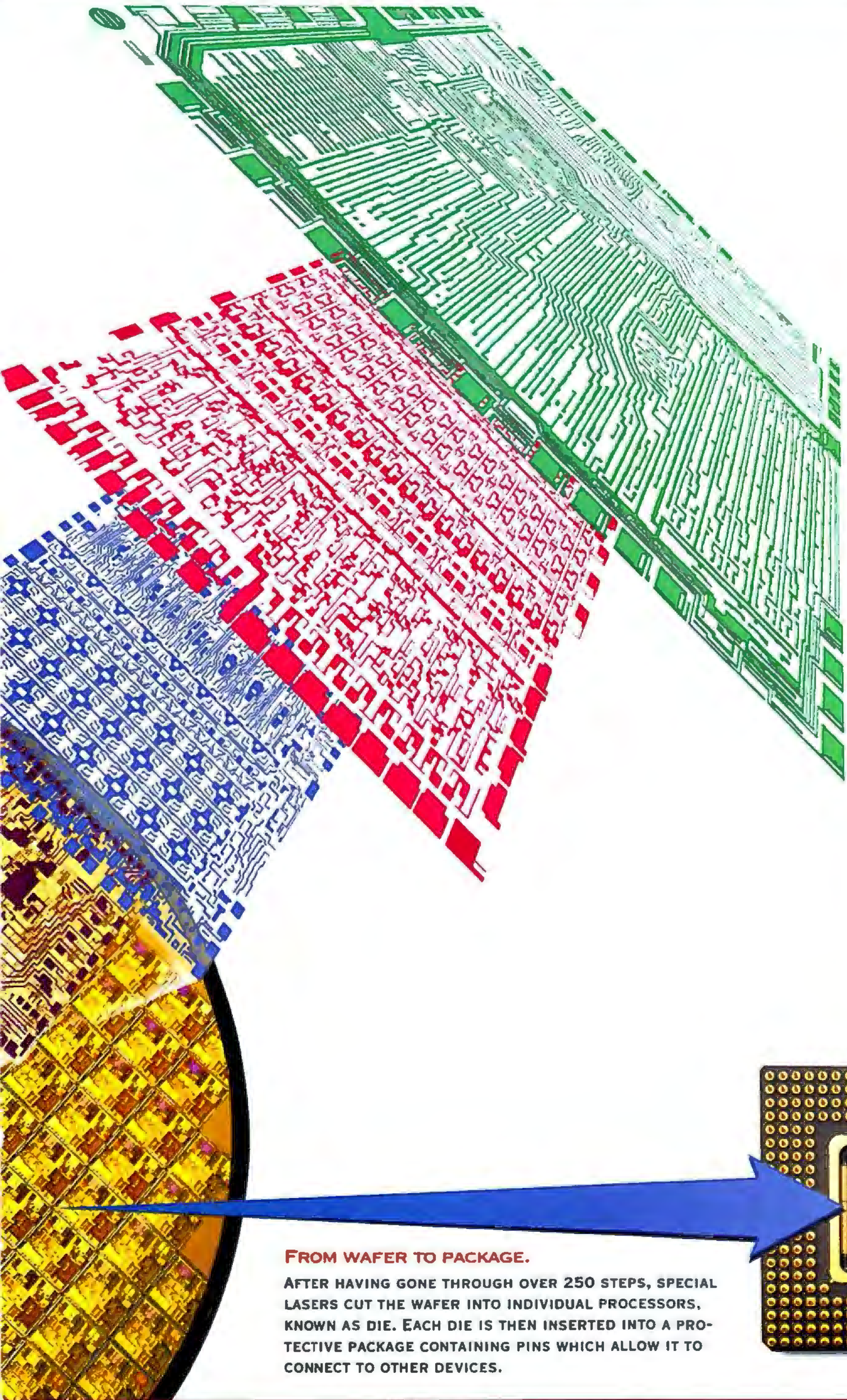
PROCESSOR MA

THE PENTIUM PROCESSOR: A CLOSER LOOK.

THE PENTIUM PROCESSOR CONTAINS 20 MICRO-THIN LAYERS OF MATERIALS SUCH AS SILICON DIOXIDE, ALUMINUM AND TUNGSTEN, ALL BUILT UPON A SILICON WAFER. EACH LAYER HAS A UNIQUE PATTERN. WHEN COMBINED WITH THE OTHER LAYERS, THEY FORM THE MILLIONS OF TRANSISTORS AND CIRCUITS THAT MAKE UP THE PROCESSOR'S ARCHITECTURE.



NUFACTURING

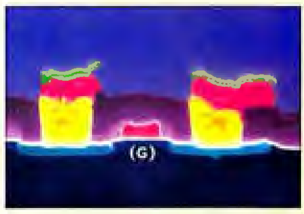


2. EXPOSURE.

DEPENDING ON THE LAYER, VARIOUS CONDUCTING OR INSULATING MATERIALS ARE THEN DEPOSITED ON THE WAFER. A MASK IS PLACED OVER THE WAFER AND ULTRAVIOLET LIGHT IS SHINED THROUGH IT, SOFTENING THE EXPOSED AREAS. (SEE PHOTO INSET, BOTTOM LEFT.)

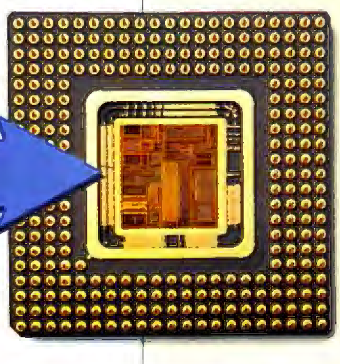
3. ETCHING.

CHEMICAL SOLVENTS THEN REMOVE ONLY THE MATERIAL THAT WAS EXPOSED TO THE UV LIGHT. THIS LEAVES RIDGES OF MATERIAL, IN THE PATTERN OF THE MASK, ON THE SILICON BASE. THIS ENTIRE PROCESS IS THEN REPEATED FOR THE REMAINING CIRCUIT LAYERS. OFTEN, THESE LAYERS ARE THE THICKNESS OF A BACTERIUM CELL!



THE TRANSISTOR: THE BUILDING BLOCKS OF PROCESSORS.

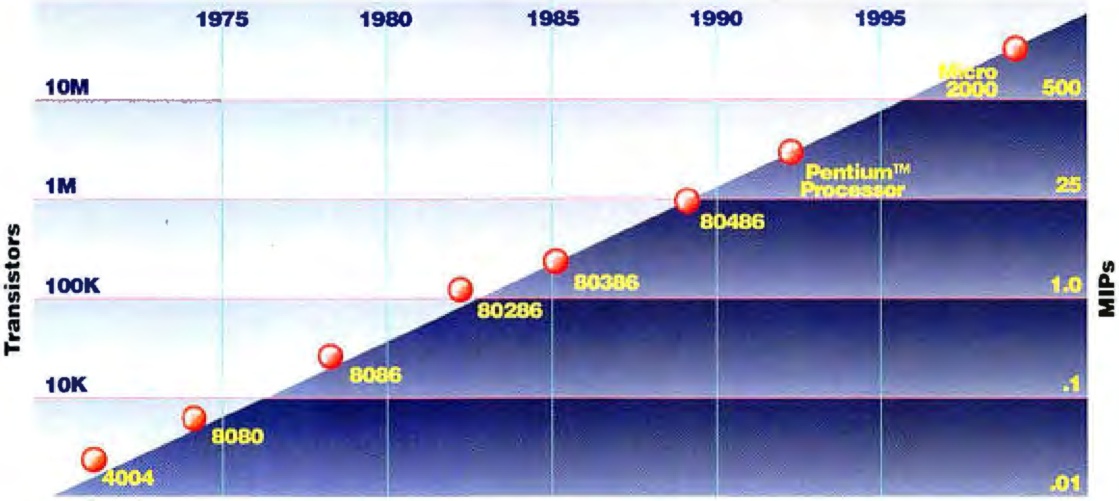
THE TRANSISTOR IS THE MOST BASIC COMPONENT OF THE PROCESSOR. THIS CROSS-SECTIONAL PHOTOGRAPH HAS BEEN MAGNIFIED 25,000 TIMES TO SHOW HOW THE MULTIPLE LAYERS (LEFT) CREATE EACH TRANSISTOR. EACH ONE IS CONTROLLED BY ITS GATE (G), WHICH ACTS LIKE AN ELECTRONIC SWITCH TURNING THE TRANSISTOR ON AND OFF. THIS ALLOWS IT TO REPRESENT BINARY 1'S AND 0'S.



FROM WAFER TO PACKAGE.

AFTER HAVING GONE THROUGH OVER 250 STEPS, SPECIAL LASERS CUT THE WAFER INTO INDIVIDUAL PROCESSORS, KNOWN AS DIE. EACH DIE IS THEN INSERTED INTO A PROTECTIVE PACKAGE CONTAINING PINS WHICH ALLOW IT TO CONNECT TO OTHER DEVICES.

MOORE'S LAW



IN 1965, INTEL CO-FOUNDER GORDON MOORE PREDICTED TRANSISTOR DENSITY ON MICROPROCESSORS WOULD DOUBLE EVERY TWO YEARS. THIS PREDICTION, SO FAR, HAS PROVEN AMAZINGLY ACCURATE. IF IT CONTINUES, INTEL PROCESSORS SHOULD CONTAIN BETWEEN 50-TO-100 MILLION TRANSISTORS BY THE TURN OF THE CENTURY AND EXECUTE 2 BILLION INSTRUCTIONS PER SECOND. TO MEET THAT CHALLENGE, INTEL IS ALREADY DEVELOPING NEW TECHNIQUES TO FABRICATE THESE COMPLEX PROCESSORS.

WHAT THE INTEL INSIDE® LOGO REALLY MEANS.

COMPATIBILITY AND RELIABILITY.

This year, Intel will produce over 30 million processors, more than one processor every second. To achieve such high levels of production and still ensure quality, painstaking steps are taken to guarantee every processor is identical, and also compatible with over 50,000 software applications.

To begin, wafers are fabricated in "clean rooms." These pristine environments prevent microscopic particles from damaging the wafers. Unlike a normal room, which contains some 15 million dust particles per cubic foot, an Intel clean room contains less than 1 dust particle per cubic foot. That's why Intel workers wear "bunny suits" in the clean rooms.

Each new processor is also designed, manufactured and tested to be backwardly compatible with every other Intel processor, all the way back to our 8086 processor.

And finally, every Intel processor undergoes over one million functional tests to make sure it meets Intel's standards for performance and reliability.

INVESTING IN TECHNOLOGY.

To ensure you're always getting the most advanced processing technology, Intel invests heavily in the latest equipment and technology available. Each fabrication plant costs over $1 billion to construct, yet is considered obsolete after just five years. That's how fast Intel is evolving its processor technology and one of the key reasons why Intel is the world's #1 semiconductor manufacturer.

FOR A CLOSER LOOK AT AN INTEL MICROPROCESSOR DIE OR FOR INFORMATION ON PAST TECHNICAL BRIEFINGS, CALL 1-800-955-5599 AND ASK FOR LITERATURE PACKET #74. WE'LL SEND IT TO YOU ABSOLUTELY FREE.

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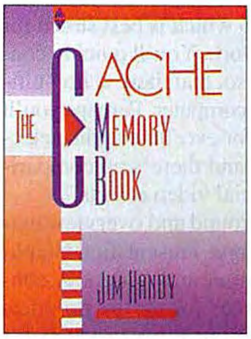
A Cache-Memory Primer



BOB RYAN

As you learn in any introduction to computer science, a computer consists of a processor and memory. The past decade has seen an order-of-magnitude increase in the speed of processors, as measured by clock speed, and a much smaller increase—on the order of two or three times—in the access speed of memory. This imbalance has a negative effect on performance because it means the processor is often idle while it waits for memory accesses to complete. Cache memories lie between the processor and memory and keep the former busy by providing very fast access to a subset of the latter.

Because of its critical role in high-performance systems, cache-memory technology is evolving rapidly. In *The Cache Memory Book*, Jim Handy, who is DataQuest's senior industry analyst for memories in its semiconductor group, tries to provide a reference for both the theory and practice of current cache-memory design. That he is doomed in the latter pursuit he recognizes early ("... this book cannot hope to keep up with all new advances.") and often ("Even as I write this section, it is becoming somewhat outdated."). The fact that its examples are a bit dated does not detract, however, from the major achievement of this book: It presents a lucid, lively look at the theory of cache memories and of the many interrelated decisions that confront cache-memory designers.

My major complaint about the book is that it is too short. Handy has written a book for systems designers, so he doesn't concentrate on some interesting issues that are out of their hands. For example, he devotes little space to cache types (i.e., whether a cache operates on physical or virtual addresses) because this issue is the province of the processor designer. Still, I wanted to see more about cache types, particularly on primary caches that mix virtual tags with physical set bits. In addition, the examples he details in the last chapter are all uniprocessor systems. With multiprocessor support showing up in more and more desktop operating systems, an example of a multiprocessing system would have increased the value of the book.

While written with the professional designer in mind, this book is easily accessible to interested laypeople. Its explanations about how caches work and the different policies that must be addressed by a cache designer (e.g., associativity, write-back versus write-through, and line size) are among the best I've ever read. If you need to know how cache-memory systems work, read *The Cache Memory Book*. ■

THE CACHE MEMORY BOOK
Jim Handy
Academic Press
ISBN 0-12-322985-5
$44.95

BYTE technical editor Bob Ryan likes to read books about microprocessors, memory, buses, and, yes, cache design. He can be reached on the Internet or BIX at b.ryan@bix.com.

MULTIMEDIA PRODUCTION

THE MULTIMEDIA PRODUCTION HANDBOOK FOR THE PC, MACINTOSH, AND AMIGA by Tom Yager Academic Press Professional, ISBN 0-12-768030-6, $35.95

In *The Multimedia Production Handbook for the PC, Macintosh, and Amiga,* Tom Yager (former director of BYTE's Multimedia Lab) provides a hands-on review of modern multimedia production. This is not a book about general concepts. You'll learn about the latest packages, explore computer hardware, and become fluent with the terminology. Yager shows that beginning with multimedia

CD-ROM FUN AT ITS BEST

MYST Broderbund Software, Inc., P.O. Box 6121, Novato, CA 94948, (415) 382-4400; fax (415) 382-4582, $60

If you like a good mystery, you'll get your money's worth from Myst. Placed abruptly in a strange, abandoned island world, you are left to discover its secrets and a way to leave. The documentation purposely gives you little guidance, except that you should try everything and look everywhere. If you get stuck, an envelope holds a few precious hints.

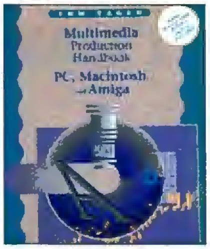
As you wander about, you pick up clues about this fantastic world; look first for a handwritten note. You have no complicated controls or menus to deal with; you simply point and click to where you want to go. The pointer turns into a hand when it is placed on an item you can pick up or grab. A zip feature lets you move more quickly from one location to another. Both the Mac and MPC Windows versions work identically.

Without giving away too much of the story, the island Myst is a base for entering and exploring other worlds. These worlds each have their own theme; there are, for instance, a water world and a mechanical world. The means by which you reach these other worlds involve a bit of science fiction and, it seems, magic.

It is easy to get hooked on Myst. Two years in the making, it features stunning, highly detailed graphics. An original sound track plays unobtrusively in the background. At certain points, video clips are seamlessly integrated into the artwork. From technical and pure entertainment standpoints, Myst sets a new standard of excellence.

—Michael Nadeau

Books & CD-ROMs



is not very difficult. All you need is perseverance.

The Multimedia Production Handbook covers the PC, Mac, and Amiga in depth, with critiques as to which is best suited for specific types of work. You'll quickly conclude, and rightly so, that there is no "ultimate" multimedia computer. Perhaps you'll decide on the PC for excellent audio selections, or the Mac for brilliant graphics, and there's no comparison for the Amiga's Video Toaster special video effects.

Aside from some introductory background and overview material, the book is grouped into four sections: Presentation Graphics, Audio, 3-D Graphics and Animation, and Video. A concluding Resource Guide provides sources for all the products mentioned in the book, as well as numerous other products for which space was not available. You can send for a videotape that provides a multimedia illustration of each chapter.

Yager's conversational writing style easily leads you through the complex decisions that proper use of multimedia requires—should you go for a simple presentation or give in to the urge for flashy graphics? does DAT (digital audiotape) or MIDI provide better sound? at what point does animation outstrip your processor's ability to cope? There's also good advice on how to gear a presentation to your audience, traveling with your computer, and designing presentations when you don't know what the display hardware will look like.

The Multimedia Production Handbook takes you step-by-step through the design, development, and delivery of multimedia presentations—whether on slides, computer screens, or videotape. Even if you're only vaguely familiar with computer technology, Yager will soon have you producing convincing and informative multimedia presentations.

—Raymond GA Côté

STRANGE PATTERNS

STRANGE ATTRACTORS: CREATING PATTERNS IN CHAOS
by Julien C. Sprott **M&T Books, ISBN 1-55851-298-5, $39.95 (with disk)**

Come on a research safari through the plains of chaos in search of strange attractors—those intriguing patterns that delight audiences and enthrall mathematicians. All you need is a personal computer, a little time, and a copy of *Strange Attractors: Creating Patterns in Chaos* by Julien C. Sprott.

Sprott has produced a veritable handbook of strangeness. You'll find Tinkerbell maps, stochastic webs, and 4-D images. Although a basic grounding in programming and mathematics will help, it is not necessary. The book is written for both the engineer and the artist. You can play as well as learn.

In addition to simply viewing existing strange attractors, the sample programs provide a system for finding new examples for your collection. Examples are provided in a mixture of BASIC, C, C++ for DOS, Windows, and Macintosh. ■

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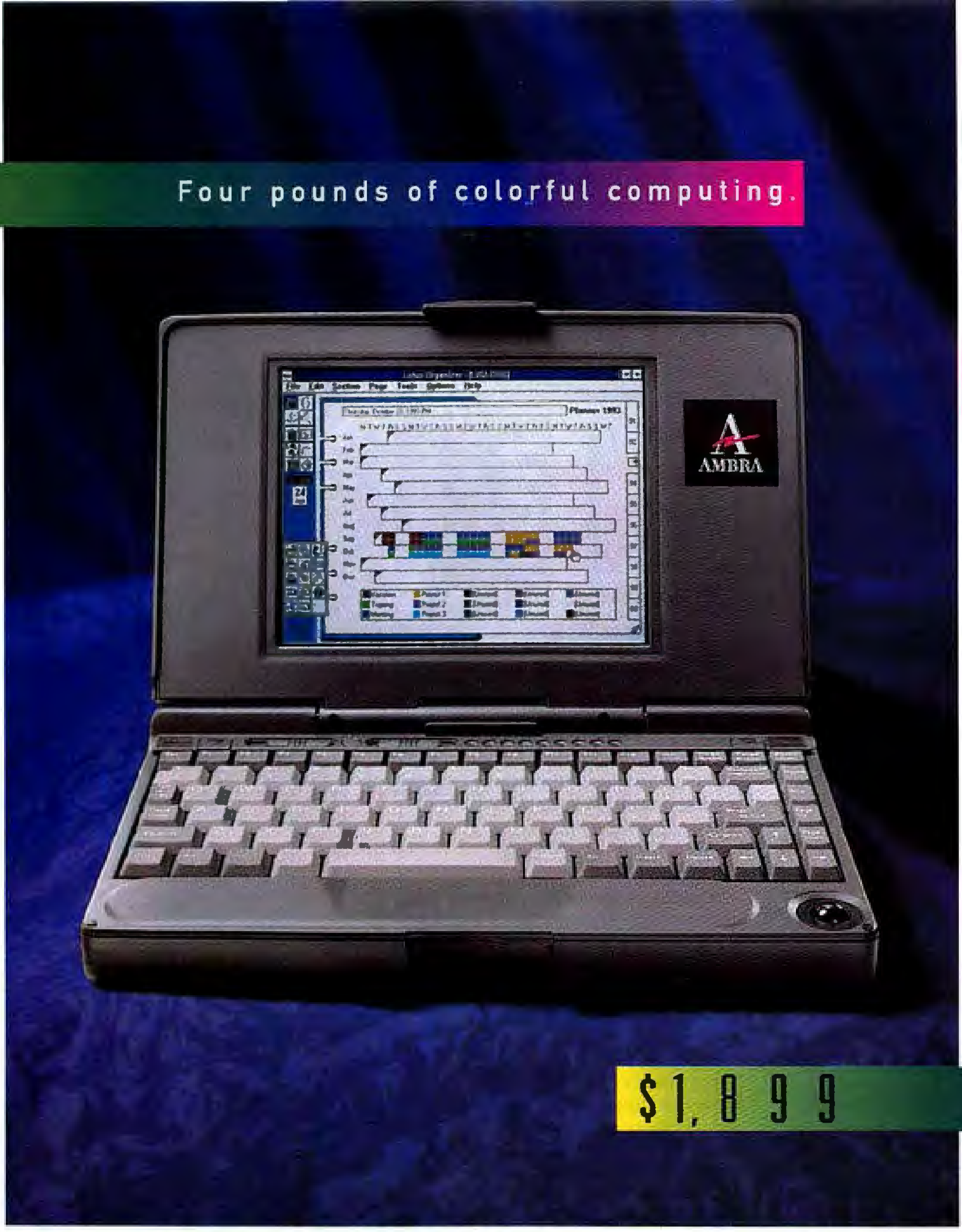

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Cover Story

BUILDING

HIGH

Many of the technologies and players needed to construct the information infrastructure are already in place. But the precise definition of the data highway is in the eye of the beholder. Who builds it could dramatically affect how it works—and how it's used.

ANDY REINHARDT

One fact must be made clear about the national information infrastructure: The government is not planning to dig a trench from New York to San Francisco, fill it with fiber-optic cables, and call it a data highway. Rather, the information highway will be privately built, owned, and operated; the Feds will encourage its development only through research funding, standards efforts, and changes in regulations.

In fact, much of the data highway *already exists* in the vast web of fiber-optic strands, coaxial cables, radio waves, satellites, and lowly copper wires now spanning the globe. What's needed now are better on- and off-ramps—that is, better and faster links from businesses, schools, and homes to the communications backbone—as well as new vehicles, more destinations, and better guidebooks on how to get there. Hundreds of billions of private and public dollars will be required over the next decade to weave together the world's communications systems and create these new software and hardware navigation tools.

What will be the benefit of all this investment? For business users, the data highway represents the holy grail of connectivity: a ubiquitous internetwork that allows them easily and inexpensively to connect with customers and suppliers, improve communications among employees, and gather competitive data. Applications facilitated by the highway, such as videoconferencing, document sharing, and multimedia E-mail, could reduce travel spending and encourage telecommuting. Businesses might also save big on reduced health-care costs if the data highway improves distribution of medical records and enables new techniques such as remote diagnostics. "We're very excited about it," says Ward Keever, the coauthor of a report on the data highway from SIM (Society for Information Management) and senior vice president for information services at the Medical Center of Delaware in Wilmington.

There's little disagreement over the grand vision of the data highway. It will be, as U.S. vice president Al Gore calls it, "a network of networks," a massive client/server and peer-to-peer mesh capable of carrying gigabits, and eventually terabits, of data per second on its trunk lines. The back-end servers, networking technologies, client devices, and software applications will be utterly heterogeneous—the most secular network ever constructed. And if it succeeds as envisioned, the data highway could help businesses find information more easily, open up new modes of research and education, and give consumers a wide choice of services.

It's in the details that opinions start to diverge, and these differences could have a profound effect on how the information infrastructure is designed and used. "Every technology company out there can define the information highway for you," joked James Abrahamson, chairman of the board at Oracle, recently. "[It's] the strate-

THE DATA WAY

gic vision for whatever the company happens to sell."

The parties vying to create the data highway—telephone companies, cable distributors, computer makers, content providers (e.g., publishers, studios, and on-line services), and the worldwide Internet community—bring to the table different technologies and points of view. Forecasting the ultimate form and function of the data highway requires examining these conflicting technical perspectives. For instance, cable companies tend to see the data highway as a distribution vehicle for video and audio; were they solely responsible for linking users to the backbone, their data highway might favor information delivery over two-way communication.

Others, including Mitch Kapor, founder of Lotus and now chairman of the Washington, D.C.–based Electronic Frontier Foundation, see the creation of the data highway as an opportunity to give citizens access to a vast wealth of information. Kapor's data highway might be less commercial- or entertainment-oriented, and its architecture would encourage individuals to become information creators, not just consumers.

In interviews with nearly 100 industry executives, engineers, analysts, users, and policymakers, BYTE has explored how the national and international information infrastructure is likely to be built. Below is a summary of those competing views, along with our own opinions of the optimal direction for the data highway of the future.

What Is It?

Oracle's Abrahamson contends that the highway is simply the logical conclusion of today's convergence of hardware, software, and networking technologies. The driving force for

Data Highway Report Card

	Telephone	Cable	Internet
Availability	A+	B+	B
Affordable	A	B-	C+
Ease of use	A+	A+	C-
Security	B-	F	C-
Billing	A+	B	D+
Information content	D	C-	A+
Openness	B-	D	A
Bandwidth	D	A-	D

Today's telephone system comes closest to meeting the criteria for a data superhighway, but its copper wiring can't currently support multiple channels of video or other high-bandwidth data. The Internet is hard to use, doesn't support billing or widespread distribution of real-time data, and can be both expensive and difficult to access. This is changing, however, with the rise of commercial Internet providers and new tools. The cable system falls in the middle, but two-way capabilities are only now being added.

this convergence is the increasing digitization of data; as Nicholas Negroponte, the head of MIT's Media Laboratory, says, "Bits are bits." Service providers are fighting over how to build the data highway. However, once video or speech or geological data becomes strings of 1s and 0s, users won't care what pipe they traverse to get from one computer to another.

The data highway's backbone will use every wide-area communication technology now known, including fiber, satellites, and microwaves, and the on- and off-ramps connecting users to the backbone will be fiber, coaxial cable, copper, and wireless. Data servers will be supercomputers, mainframes, minicomputers, microcomputers, and massively parallel machines, while a great diversity of clients will populate the end points of the network: conventional PCs, palmtops and PDAs, smart phones, set-top boxes, and TVs. Software used on the network will include operating systems, networking protocols and services, user interfaces, databases, data sources (or *content*), and a new generation of smart middleware (e.g., General Magic's agent-based Telescript) that will help users navigate the network.

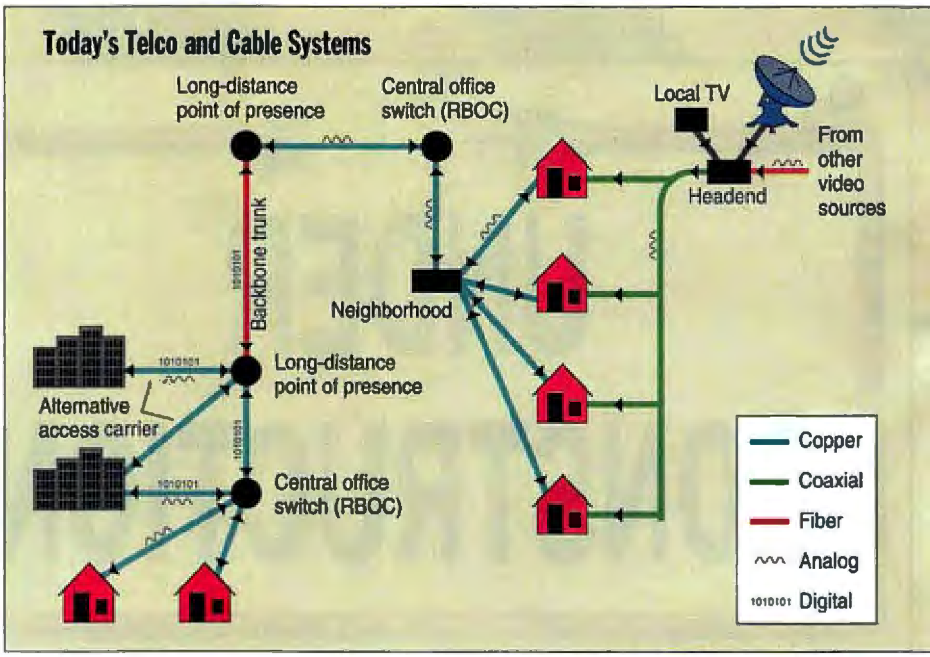
Unresolved technical arguments about the data highway's architecture boil down to two main categories: protocols and bandwidth. The protocol problem concerns the ultimate role of TCP/ IP, the lingua franca of the Internet and Unix-based LANs. Buttressed by the engineering resources of the IETF (Internet Engineering Task Force), TCP/IP has continuously evolved. But it suffers drawbacks for real-time use that could threaten its position as an internetworking standard when multimedia traffic plays a greater role on the data highway. An emerging alternative is ATM (Asynchronous Transfer Mode), a hybrid circuit-switched and packet-switched networking scheme that performs well in real-time applications but lacks TCP/IP's software base. One potential solution is to run TCP/IP over ATM.

Bandwidth equals data transmission capacity. Conventional telephones need very little, while HDTV needs large amounts—20 Mbps or more per channel. How much bandwidth is necessary to connect businesses, homes, schools, and governmental bodies to the data superhighway will depend on the applications they end up using: on-ramps will need a lot more bandwidth if users demand interactive digital video than if they use the highway to send E-mail. A yet more subtle problem is how to allocate bandwidth into and out of customer sites: A system biased to data delivery—i.e., with a high ratio of downstream to upstream bandwidth—implies information *consumption*, whereas one with symmetrical or dynamically assigned capacity implies *communication*.

The Players

To meet the needs of society, the data highway has to be ubiquitous, affordable, easy to use, secure, multipurpose, information rich, and open. If it's to be economically viable, service providers have to be able to bill customers for the time they spend on the network or for the data they use. Each of the precursors of the data highway meets these criteria with varying success. The different heritages of the players are reflected in how they define the information infrastructure.

Cable companies. Steeped in broadcasting analog video through a wire, cable companies see the data highway largely as synonymous with enhanced entertainment services. They want to layer onto the video stream new consumer offerings such as interactive TV (e.g., video-on-demand, home shopping, viewer polling, and in-



Today's phone and cable companies use different topologies and technologies to deliver their services. The phone system is switched, symmetrical, and interactive. Its backbone or "trunk" lines are typically digital fiber; analog copper wires deliver service into homes and businesses. The cable system is unswitched and distributive, built on a backbone of analog fiber and satellites, with analog coaxial cables into customer sites. In the future (far right), their local architectures will be nearly identical: Interconnected signal collection and routing points feed services via fiber to the neighborhood or the curb. From these nodes, data enters homes and businesses on a mix of coaxial cable, copper wire, and fiber to reach set-top boxes, computers, and phones. Both systems are switched and two-way, though not necessarily symmetrical or entirely digital.

formation-on-demand). But the cable companies want to provide important business services, too, such as voice telephony, data communications, and access to on-line services. Most of all, they see the data highway as a chance to exploit their primary asset: broadband coaxial cables stretching into an estimated 60 million U.S. homes and millions more around the world.

A major challenge for cable companies is that their systems tend to be proprietary and not interconnected. Constructing a nationwide network will require adopting common standards, installing giant gateways, and leasing backbone capacity from long-distance carriers (or spending big money to lay their own digital fiber trunk lines).

Telephone companies. Where the cable companies are weak, phone companies—both local and long-distance—are strong. Cable has traditionally used a one-to-many, trunk-and-branch topology with little or no provision for "upstream," or return, communications. The phone system was designed for point-to-point communications and has evolved into the world's largest switched, distributed network, capable of handling millions of phone calls simultaneously, tracking each one, and billing customers precisely for their usage. The phone system's legacy as a public utility has given it a degree of reliability and openness unmatched in the cable world.

The phone companies want to send data, especially video, over their vast networks. But the phone system suffers a bandwidth shortage: Although the trunk lines crisscrossing the country are of high-capacity fiber, the local loops into businesses and homes are typically two- or four-wire unshielded copper with limited bandwidth.

The Internet. Riding on the shoulders of the phone system is a remarkable worldwide computer cooperative, the Internet, a government-subsidized experiment in distributed computing, electronic community, and controlled chaos. The Internet doesn't own the pipes it passes through, and nobody owns the Internet, but it is growing by as many as 150,000 new users per month. If the wires and cables of the communications industry are the data highway's foundation, the Internet may provide its language, culture, and customs.

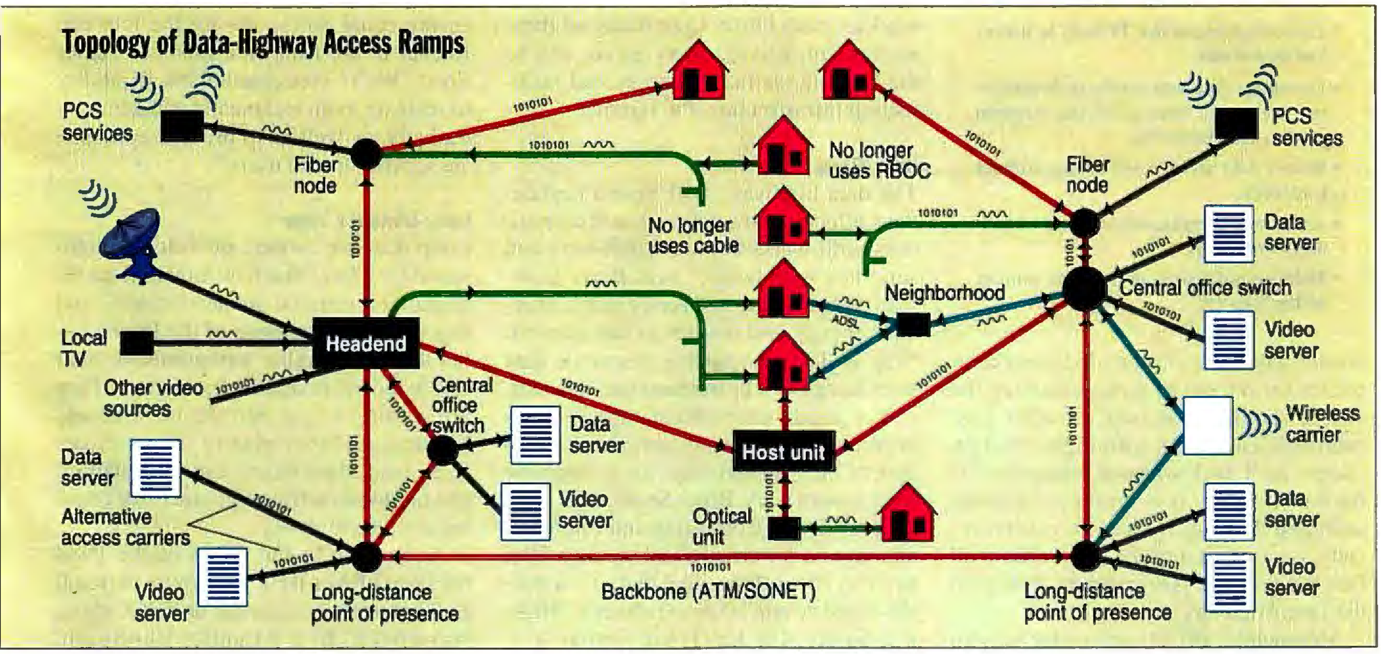
A unification of phone and cable systems could bypass the Internet and threaten its relevance, but given the Internet's rich human and informational capital, the more likely scenario is that its technology will be harnessed for the highway. A number of companies are working to make the resources of the Internet, which has a notoriously arcane interface and command structure, more accessible to businesses and individuals.

Policymakers. Washington is working to resolve policy issues concerning the data highway. Proposed legislation to ease regulations on cable and phone companies has the support of the Clinton administration. The most significant remaining challenge is how to ensure universal access to the information infrastructure. A principle enshrined in phone regulation since the 1934 Communications Act, *universal*

TOPOLOGIES AND PROTOCOLS

Telephone and cable systems use dramatically different communications architectures and standards. If the RBOCs, interexchange carriers, and cable companies merge into the data highway, their systems will evolve to encompass each other's advantages.

	TELCOS (VOICE/DATA)	INTERNET (VIA TELCOS)	CABLE (TODAY)	CABLE/TELCO (FUTURE)
Key users	Everybody	Government, academia, business	60 percent of U.S. homes	Everybody
Media/backbone	97 percent digital fiber optic	NSFnet (T3), other telcos	Satellite, analog fiber optic	Analog/digital fiber optic, satellite
Media/local	Copper wire, wireless	Copper wire, Switched-56, T1/FT1	Coaxial cable	Coaxial cable, fiber optic, copper wire, two-way radio
Topology	Circuit-switched, star	Packet-switched, routed	Unswitched, trunk and branch	Switched/ unswitched, star
Protocols	POTS, ISDN, ATM	TCP/IP	Proprietary analog	Analog, ADSL ATM



Topology of Data-Highway Access Ramps

BYTE's Recommendations for the Data Highway

SHORT TERM (1994–1996)

INFRASTRUCTURE

- Backbone: existing standards (T1/T3, X.25, basic-rate ISDN); increased use of frame relay, SMDS, and SONET; limited penetration of ATM; TCP/IP for internetworking
- Local loop: separate phone (POTS, ISDN, cellular) and cable (analog, pay-per-view) delivery systems; emergence of packet radio and PCS wireless
- Trials of radio- and cable-based interactive analog TV
- Trials of ADSL video-over-copper
- Trials of switched digital video
- Increasing insensitivity of "smart" backbone to end-point devices
- Increasing commercialization of the Internet
- Continued growth of commercial and business on-line services and entry of new parties
- Proliferation of easy-to-use retrieval tools and information agents

POLICY

- Lift restrictions on RBOC delivery of video content in and out of region, but retain restrictions against in-region ownership of cable companies by RBOCs.
- See more competition at local loop from interexchange carriers and alternative-access carriers; maintain restrictions on RBOCs' providing long-distance service.
- Encourage two wires into each home—coaxial cable and copper—and multiple services to business locations.
- Encourage greater penetration and tariffing of ISDN to business and residential users.
- Encourage interactive TV tests to homes and businesses.
- Encourage universal access to data-highway on-ramps: open platform, common carrier, user subsidies.
- Ensure data security and privacy without trapdoors.
- Encourage upstream/downstream bandwidth symmetry.
- Maintain multiplicity of free data sources on the Internet.

MEDIUM TERM (1996–1998)

INFRASTRUCTURE

- Backbone: primary-rate ISDN, frame relay, SMDS, SONET, and ATM; TCP/IP.
- Local loop: fiber-to-the-node, dual services (phone and cable on copper and coaxial cable) or single-provider services (via coaxial). Mix of POTS and ISDN, analog and digital cable. Some fiber to the home. Widely installed wireless.
- Bandwidth allocation remains skewed to downstream delivery.
- Greater use of analog interactive TV.
- Serious investment in switched digital video, ATM to the node.
- Early use of HDTV.
- Widespread use of personal communicators.

POLICY

- Lift restrictions on in-region cross-ownership between cable and telcos.
- Lift restrictions on RBOCs providing long-distance service.
- Increase investment in fiber to the home and desktop.
- Maintain antitrust vigilance toward infrastructure and content providers.

LONG TERM (1998–2001)

INFRASTRUCTURE

- Backbone: ATM over SONET, Broadband ISDN, SMDS over ATM, IPng
- Local loop: single coaxial cable or fiber to the home, running end-to-end ATM
- Ubiquitous bandwidth symmetry
- Switched digital video infrastructure in place
- Wide adoption of HDTV and early use of 3-D/virtual reality services

service requires telecommunications companies (or *telcos*) to cross-subsidize the cost of serving poor, rural, or other less-profitable customers with higher-margin clients such as downtown businesses. If the data highway is to become a national asset and the basis for an information society, access to it must be affordable to all (see the text box "Government Policy on the Data Highway").

Meanwhile, efforts are under way in countries outside the U.S. to build similar national networks. Canada, Germany, and Japan have major projects (see the text boxes "Data Highway Lags in Japan" and "Europe's Many Data Highways"). Many U.S. firms are rushing into foreign markets to gobble up newly privatized telecommunications franchises or to conduct technical trials of systems they hope to replicate back home. Connecting all these regional initiatives, many argue, will be the existing, de facto international information infrastructure, the Internet.

User Views

The data highway "will have a tremendous effect on how we work and do business with banks and our customers and suppliers worldwide," says Barry Coleman, senior economist for Texaco's alternate energy and resources department. "The dollars saved using electronic data interchange will be tremendous," he adds.

Yet despite the potential improvements in productivity and communications promised by the data highway, some corporate users remain wary. Bruce Smith, MIS manager for ENSR Consulting and Engineering, says he is worried about security. "I'm nervous about things like that; it's a double-edged sword." (See the text box "Highway Safety: The Key Is Encryption.")

For some users, security is of such paramount concern that they don't even outsource their communications needs today to private network providers, much less anticipate using a public backbone to exchange sensitive information. "A public information highway doesn't mean a thing to me," says Ben Fishman, LAN manager for the Wells Fargo Bank in San Francisco, California. But Fishman acknowledges that on the customer side of the bank's business, on-line banking services over the data highway could be an attractive time- and money-saver.

A SIM report examines nine areas of concern for business users of the data highway: standards for connectivity and interoperability, competitive versus regulatory forces, access, protection of rights, pace of development, funding of research, transport media, speed of data transfer, and the role of the Internet. As a rule, SIM advocates openness and competition wherever possible, but with adequate legal protections to guard against monopolies and ensure equal access. As for the Internet, Keever of the Delaware Medical Center says: "We're concerned about its ability to scale up, both technically and administratively, as well as to provide appropriate security to end users."

Long-Distance View

Long-distance carriers provide the high-speed *long lines* that now interconnect regional and national phone systems—and that form the backbone of the Internet—but they have higher aspirations for their role in the information infrastructure: They are starting to get into the local-access business, and they plan to offer services (e.g., mail, directories, and information) and hardware/software products for cruising the data highway.

According to the terms of the 1984 breakup of Ma Bell, the seven regional Bell operating companies, or RBOCs (i.e., Ameritech, Bell Atlantic, BellSouth,

Government Policy on the Data Highway

JUDICIARY

- **MODIFIED FINAL JUDGMENT, JANUARY 1984**
  Judge Harold Greene's decision broke up the AT&T Bell System and created the seven RBOCs. It forbade local telcos from manufacturing equipment, providing long-distance service, delivering video, or owning content.
- **INFORMATION SERVICES RESTRICTIONS EASED, OCTOBER 1991**
  Responding to an appeals court order, Judge Greene lifted restrictions against RBOCs' providing information services, allowing them to own news, sports, weather, and other data services distributed over their phone lines.
- **BELL ATLANTIC V. U.S., AUGUST 1993**
  U.S. District Court Judge T. S. Ellis ruled unconstitutional the provision of the 1984 Cable Act preventing local phone companies from providing TV programming in their service territories. Now on appeal. Ruling applies only to Bell Atlantic.

LEGISLATIVE

- **HIGH PERFORMANCE COMPUTING ACT OF 1991**
  Sen. Gore's bill authorized creation of the NREN (National Research and Education Network) and funded research on high-speed networking hardware and software.
- **H.R. 1757, NATIONAL INFORMATION INFRASTRUCTURE ACT OF 1993**
  Author: Boucher (D-VA). Status: Passed House of Representatives September 1993; no Senate equivalent, but portions are found in S.4, which is pending. Would expand on the High Performance Computing Act of 1991, providing coordinated federal program to develop and disseminate applications for high-performance networking and high-speed networking in education, libraries, health care, and provision of government information.
- **H.R. 3636, NATIONAL COMMUNICATIONS COMPETITION AND INFORMATION INFRASTRUCTURE ACT OF 1993**
  Sponsors: Markey (D-MA), Fields (R-TX), Boucher (D-VA), and Oxley (R-OH). Status: Introduced Nov. 22, 1993. Major restructuring of 1934 Communications Act; would permit telcos to deliver video, open local telco market to competition, provide for open platform, ensure universal service.
- **H.R. 3626, ANTITRUST REFORM ACT OF 1993**
  Sponsors: Brooks (D-TX) and Dingell (D-MI). Status: Introduced Nov. 23, 1993. Would phase out limitations placed on RBOCs by Modified Final Judgment to 1982 consent decree breaking up AT&T. Would let U.S. Attorney General and FCC grant RBOCs the right to offer interstate and interexchange services, manufacture equipment, offer burglar alarm services, and own a partial interest (up to 50 percent or 80 percent, depending on conditions) in electronic publishing ventures.

EXECUTIVE

- **THE NATIONAL INFORMATION INFRASTRUCTURE: AGENDA FOR ACTION, SEPTEMBER 15, 1993**
  The Clinton administration proposed forming IITF (Information Infrastructure Task Force), composed of federal officials, and "U.S. Advisory Council on the NII," composed of 25 public- and private-sector appointees. Among its goals: to promote private-sector investment; reform communications regulation; ensure universal service; promote applications in education, health care, manufacturing, and government information; promote standards for seamless networking; ensure security and reliability; protect intellectual property rights; and improve management of the frequency spectrum.
- **VICE PRESIDENT GORE'S ADDRESS, JANUARY 11, 1994**
  The administration voiced support for the Brooks/Dingell bill (H.R. 3626), which would allow competition between local and long-distance phone companies and proposes creation of a new, optional class of regulation for broadband interactive services, called Title VII. Three principles are paramount: private investment, fair competition, and open access. Legislation proposed by Clinton will aim to ensure universal service and open access. The administration will also support other NII measures, including networking research, applications development, and electronic delivery of government services.

Nynex, Pacific Telesis, Southwestern Bell, and US West), provide regulated local service and are concerned with the local loop—how data, voice, and video services get in and out of customer sites. Long-distance (or *interexchange*) carriers, such as AT&T, MCI, and Sprint, focus on the backbone and on value-added services. These roles, however, are starting to blur.

One job now performed by long-distance firms will remain the same in the data-highway era: They will provide the trunks, or *long lines*, that carry telephone traffic across the boundaries separating local service areas in the U.S. and into other countries. These lines are almost entirely fiber now, and most use SONET (Synchronous Optical Network), a CCITT/ITU standard that defines various levels of digital telephony service over fiber.

Trunk lines range in capacity from T1 rates (1.544 Mbps) up to OC-48 (2.4 Gbps) and beyond. Today's Internet backbone, for instance, is built on T3 (45 Mbps) lines operated by MCI. Local access from users to hosts and hosts to the backbone occurs at rates ranging from 2400 bps to 19.2 Kbps for dial-up, or via leased lines at multiples of 56 Kbps or 64 Kbps up to the T1 rate of 1.544 Mbps.

The complex telco regulatory structure permits other roles for long-distance carriers as well. They can manufacture equipment, which RBOCs cannot do. Long-distance companies also offer value-added services, such as formatted data handling; both AT&T and Sprint, for instance, have begun to sell ATM backbone service directly to customers who install private lines from their facilities to nearby long-distance points of presence, or POPs.

Most important, long-distance companies are not enjoined from offering local phone service in competition with the RBOCs. The biggest news in this context is AT&T's pending $12.6 billion acquisition of McCaw Cellular Communications; wireless technology provides a means to bypass the RBOCs and connect customers directly to long-distance POPs. To the extent that wireless communications become a key on-ramp to the data highway, the long-distance carriers—as well as wireless providers such as RAM Mobile Data and the IBM/Motorola Ardis joint venture—want a piece of the action.

AT&T has yet more irons in the fire. It now owns the Eo and Go technologies for pen-based computing, signifying its intention to compete in the market for mobile end-user devices. And it has obtained agent-based communications software from General Magic, which forms the basis for an advanced messaging service called PersonaLink that AT&T unveiled in early January.

The current regulatory environment works to the advantage of interexchange carriers, because they are freer than the RBOCs to move into new services. But with pending policy changes in Washington, telecommunications competition could turn into a free-for-all. The result for customers could be fierce price competition and an explosion of service options.

continued

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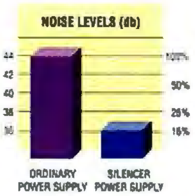

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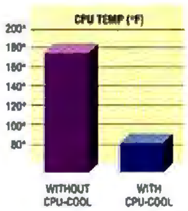

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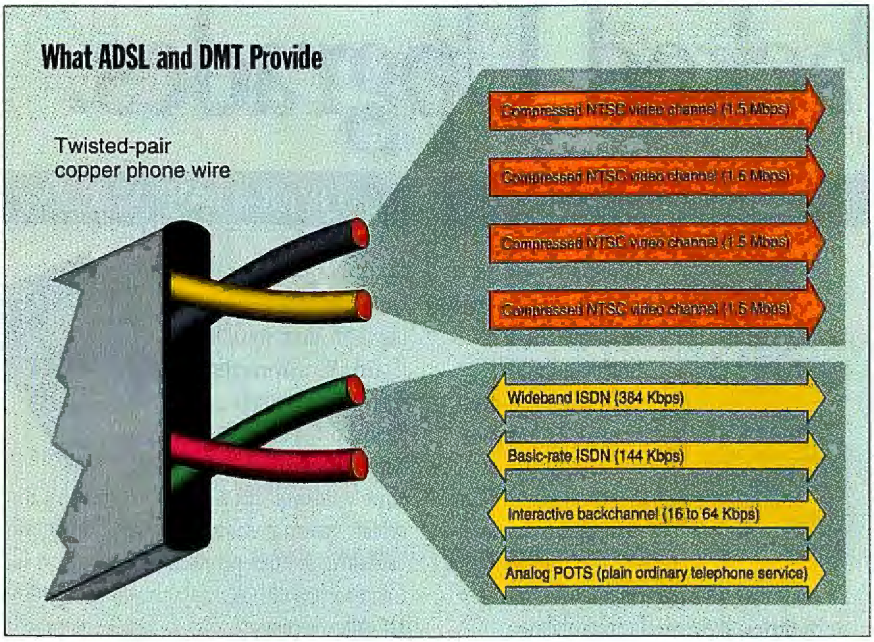

ADSL attempts to use existing copper phone wire for broadband interactive video and other high-speed digital services. An experimental variation on ADSL, known as DMT (Discrete Multi-Tone), squeezes four one-way video channels onto ordinary twisted-pair wiring, along with a two-way interactive backchannel and two ISDN channels—still leaving room for regular analog telephone service.

RBOC Realignment

The local phone companies are the vanguard of data-highway construction; their lines into homes and businesses are the access ramps to the backbone. Yet their perspective is different from that of the interexchange carriers because RBOCs have, in effect, been treated as utilities for the last decade.

Two critical restrictions imposed on the RBOCs by the 1984 breakup of the Bell system were that they could not own information services and could not deliver video content within their designated service areas. The judicial, executive, and legislative branches of the federal government are now racing to see who can lift these provisions fastest: Last August, a federal court decision on behalf of Bell Atlantic wiped out the video restriction, pending appeal; and both White House initiatives and Congressional legislation have been introduced to ease regulation.

Until new regulatory structures are in place, the RBOCs are growing by buying cable properties outside their regions; the best-known deal is the pending $25 billion merger of Bell Atlantic and Tele-Communications, Inc., or TCI, the nation's largest cable provider. At the same time, to protect themselves from expected competition from other RBOC/cable partnerships, they are retrofitting their local systems to support video.

Several approaches are being used. Bell Atlantic has conducted trials in northern Virginia and central New Jersey. The Virginia test harnesses ADSL (Asymmetrical Digital Subscriber Line), a new technology that lets conventional copper wires carry up to 1.54 Mbps of data—enough to deliver one channel of precompressed movies to a single user. The data is sent through the switched phone network to a set-top box that decompresses it and converts it back to NTSC analog video for delivery to the TV. The Virginia trial, which began with a few Bell Atlantic employees, is evolving into a market test of some 2000 consumers in northern Virginia.

ADSL is a quick-and-dirty way to pump digital video over the existing copper plant. It's no match for 50 channels of cable, but with a pair of set-top boxes and an A-B switch, customers could receive video feeds from both their cable company and their phone company. By late 1994, says Bell Atlantic vice president of technology John Seazholtz, ADSL is expected to support up to 6 Mbps of video plus ancillary services, as well as multiple users per premises and, when real-time compression arrives in 1995, live TV.

ADSL can also play a role in nonvideo applications. For instance, Bell Atlantic is considering bundling together Internet access software, ADSL compression, and ISDN service, to give customers easy, high-speed access to the Internet. The 1.54-Mbps downstream data rate would make downloading image files hundreds of times faster than over a modem, while upstream data transfers, at ISDN speeds, would be upwards of 25 times faster. This raises the interesting possibility of CompuServe or Internet ftp sites becoming multimedia service providers.

Bell Atlantic's New Jersey trial uses a much more ambitious and expensive approach, based on technology from Broad-Band Technologies (BBT) of Durham, North Carolina. BBT's system consists of several pieces. A *host digital terminal* combines telephony feeds from central phone offices and digital video feeds from cable headends and sends them over a single paired-fiber cable (for two-way transmission) to an *optical network unit.* (A *cable headend* is the central point at which TV signals downlinked from satellites and supplied by local stations are modulated onto the cable. A BBT device converts this analog video to digital.) The optical network unit, located at or near the customer site, then splits the signal back into digital video and analog telephony components and sends them, respectively, via coaxial cable to a digital set-top box and via copper wire to a standard phone. Returning signals follow the reverse path. BBT's set-top box is being developed with Philips Consumer Electronics and Compression Laboratories.

Although BBT's architecture requires installing fiber nearly to the customer site, most telecommunications and cable companies were already doing this anyway. BBT's advantage is that it uses only a single fiber for voice and video data. Furthermore, it adds star-topology switching to the video distribution system, providing customers with guaranteed but asymmetrical downstream and upstream bandwidth.

Bell Atlantic's BBT trial builds on a basic premise: that there will be two wires reaching into the home—the copper and coaxial cable already found in over 60 percent of U.S. households. Coaxial cable has ample bandwidth to support the applications envisioned so far for the data highway, especially if the backchannel is provided through the switched phone system.

Others foresee only one wire: a coaxial cable or a single fiber. Cable companies like TCI hope to provide both video and voice/data service over a single coaxial cable. Pulling fiber everywhere is too expensive to justify (estimates range as high as $400 billion to do every business, home, and school in the U.S.) until demand for broadband services is better understood and content offerings have matured.

Besides, as Seazholtz points out, all-fiber connections pose a tricky technical problem: how to keep phone service alive during a power failure. The lasers used to drive fiber optics in the office or home would have to draw AC current and thus

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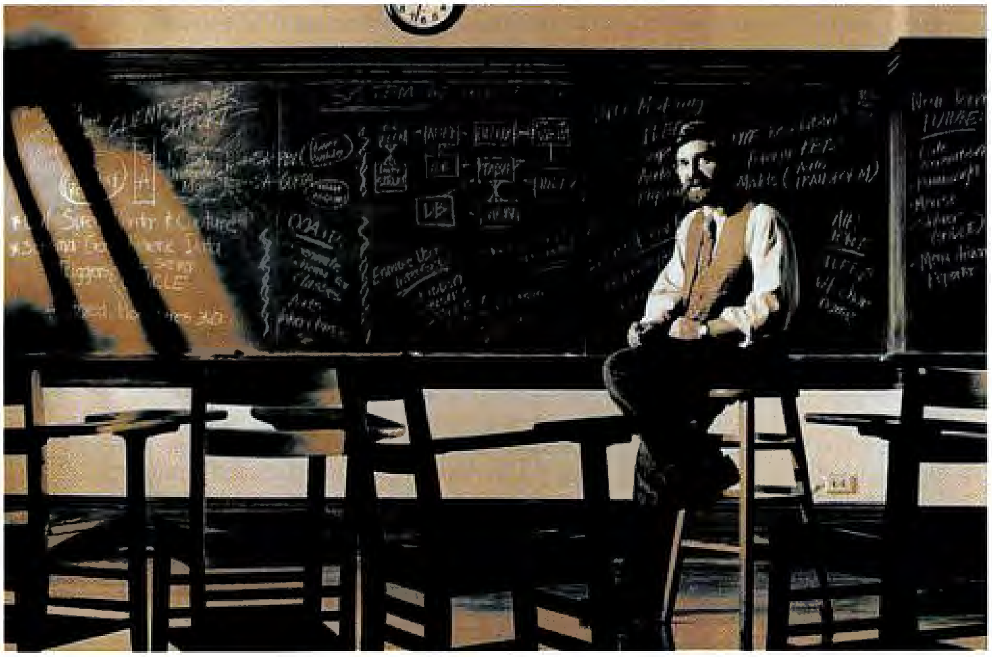

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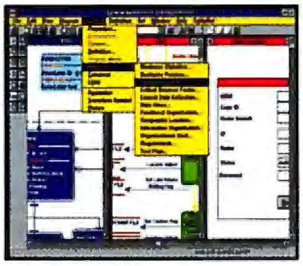

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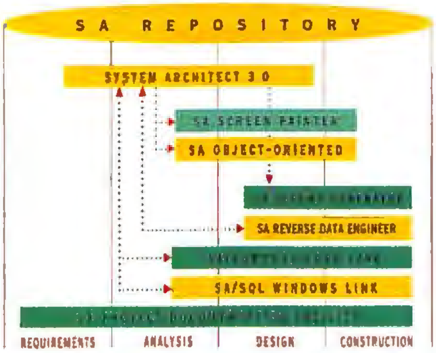

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Data Highway Lags in Japan

Asao Ishizuka

The data highway hasn't yet come to Japan. NTT (Nippon Telephone & Telegraph), Japan's largest common carrier, has a backbone that is already 65 percent fiber, and corporations are using this fiber for intra- and intercity communications. ISDN is also available—there are more than 230,000 basic-rate ISDN circuits (64 Kbps) and 3100 primary-rate circuits (1.5 Mbps).

Implementing fiber to the home, or even fiber to the curb (also known as the Next Generation Communications Infrastructure) will be a long, tough road. NTT estimates that the cost to develop the new infrastructure will be $410 billion; if $18 billion is allocated annually for this, the new infrastructure will be built by 2015.

Japan has also experienced a very slowly developing cable business. This is due in part to widespread coverage by broadcast TV, a large number of video rental shops, and the availability of alternative entertainment sources, such as Direct Broadcast Satellite, which now dishes out NTSC and HDTV signals to nearly 6.3 million subscribers.

However, some Japanese multimedia network researchers think that the real use of the information highway will be for professional and business applications, not for the home, because of its cost. The Ministry of Posts and Telecommunications decided in December 1993 to deregulate CATV and boost the integration of broadcasting and communications by repositioning cable as a core medium. Under the new rules, cable businesses will be able to provide communications services in addition to broadcasting, and foreign carriers will be able to enter the Japanese cable business. Nynex is already getting ready for experimental CATV service in Yokohama with Japanese partners, starting in the spring of 1994. And TCI is starting an advanced CATV service in Tokyo with Suginami CATV, beginning in October 1994.

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would fail during an outage. BBT's hybrid architecture, in which active optics stay at the curb while buildings remain domains of passive electronics, appears to be a safer solution for customers.

On the opposite coast of the U.S., Pacific Bell has announced an ambitious multibillion-dollar plan to go it alone, without a cable partner, and rewire California with fiber and coaxial cable. It aims to provide not just a "video dial tone" (its right to do so relying on the Bell Atlantic precedent or new FCC regulations), but video telephony and data access as well. Says Keith Cambron, Pac Bell's director of systems engineering for consumer broadband: "Video telephony, because it's symmetrical and point-to-point, requires more of a telephony model than a CATV model."

Pac Bell's design presumes, as a starting point, a heterogeneous mix of end-user devices. Cambron identifies a minimum of eight: standard analog phones; standard cellular phones; home computers linked to the network by analog modems or digital ISDN ports; RF modems that attach CATV to an individual PC (via an add-in card) or a network of PCs (via an RF-to-Ethernet converter); conventional analog set-top boxes; advanced digital set-top boxes; and plain old cable-ready TVs and VCRs. In other words, the network envisioned by Pac Bell doesn't make existing equipment obsolete, and it adds new digital services incrementally.

The architecture is similar to that of other switched systems. Central office switches communicate by digital fiber to neighborhood nodes that serve roughly 500 customers. From the fiber nodes to the customer site is shared coaxial cable, which terminates at an NIU (network interface unit) attached to the side of the building. From there, separate signals are fed by coaxial cable and copper to video and telephone devices. Cambron contends that there is enough upstream bandwidth in this design to permit video telephony.

At the back end is where Pac Bell's legacy as a common carrier becomes most evident. The central switch communicates with a video gateway, which according to Cambron still needs development. This gateway provides the user's first-level menu selections; the second-level menus are for each particular service provider. All these interfaces are open and work cooperatively. "We want to encourage as many suppliers as possible to get onto our network with gateways to their video services," Cambron says.

From Trunks to Stars

Cable companies already have the most bandwidth into American homes, but they haven't wired up many schools or businesses. They also have the most to gain from retrofitting their networks to become data-highway access roads: While holding onto their video delivery business, they could unseat the RBOCs by providing local access to long-distance carriers. The key technical need is to push fiber closer to the final delivery point. TCI and others are doing that, following models similar to the Bell Atlantic/BBT and Pac Bell projects. Time Warner is trying a more radical approach that employs ATM.

Cable systems are moving in roughly the same direction as RBOCs, which is why their partnerships seem so logical. TCI, for instance, announced in 1993 that it would spend $2 billion over the next few years to upgrade its system with fiber nodes and support for video compression. The upgrade was widely misreported to mean that TCI would supply 500 channels of cable; the truth, according to vice president of TCI Technology (TCI's technology subsidiary) Bruce Ravenel, is that TCI will have enough capacity for 500 channels for a variety of business and consumer services, including traditional broadcasts, pay-per-view or video-on-demand, videoconferencing, voice telephony, and on-line access.

Traditional cable systems use a distributive architecture antithetical to two-way communications. Area headends, or cable programming distribution points that serve thousands of subscribers, receive programming via satellite or feeds from local broadcasters and shunt them onto coaxial cables that run into neighborhoods, with cable drops to individual homes. Channels are broadcast in 6-MHz bands between the frequencies of 50 MHz and 450 MHz, although newer systems can go up to 750 MHz or higher.

The two biggest changes since cable emerged 40 years ago were the development of addressable channel selectors (i.e., set-top boxes with individual IDs that can accept messages broadcast through the cable system) and the discovery of a way to modulate analog video over fiber media. Cable systems have dramatically improved picture quality by shipping source programming around on interference-free fiber instead of coaxial cable. Their potential for two-way communications, however, is still constrained by an analog trunk-and-

Europe's Many Data Highways

BERND STEINBRINK

Having built a uniform standard for Euro-ISDN that was accepted by 26 network companies in 20 countries, France Telecom and Deutsche Telekom are now trying to establish a European standard for the next generation of high-speed networks. In cooperation with British Telecom, Spanish Telefonica, Italian STET/ASST, and Swedish Telia, the companies will build a Europe-wide, high-speed digital fiber network called the Global European Network, or GEN, that should be the precursor of a future ATM (Asynchronous Transfer Mode) network. In the mid-1990s, GEN is expected to be absorbed into the METRAN or Managed European Transmission Network, which will support data transmission at rates of up to 155 Mbps across Europe.

AT&T now cooperates with most of these state companies on national ATM projects, as well as on PEAN (Pan European ATM Network), a pilot project set up by 18 European operators to test a broad palette of communication services. By mid-1994, PEAN will have nodes in Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Norway, Spain, Sweden, and perhaps other countries; interoperability tests scheduled for then will allow transmission of video and image data across the high-speed network. PEAN members have agreed to purchase and install ATM cross-connections that meet standards and recommendations from CCITT/ITU and ETSI (the European Telecommunication Standard Institute), as well as specifications from Heidelberg-based Eurescom.

France Telecom has started yet another project with Telecom PTT Switzerland called Betel (Broadband Exchange over Trans-European Links), which began trials in September 1993 with the interconnection of several research facilities in France and Switzerland. Applications running on the Betel network include distance learning via videoconferencing and sharing supercomputers for scientific computing tasks. The platform consists of 34-Mbps fiber-optic circuits, and the different sites are equipped with FDDI (Fiber Distributed Data Interface) LANs linked to the ATM platform. Starting this year, cost-effective LAN interconnections at very high speeds via ATM networks will be offered.

Another France Telecom ATM project is Brehat, a complete communication system for videoconferencing, video transmission, LAN interconnection, and circuit emulation. The first segments of this network will be deployed in the cities of Lannion and Rennes and at several sites in the Paris region this year. Full-scale commercial launch is planned for 1995. By then, about 17,000 kilometers of fiber-optic lines will be installed in France.

Britain is a special case because it liberalized its telecommunications in 1991, allowing TV and telephone on the same network and making investment in fiber optics profitable for private companies. One of the most unusual projects involves a company called Energis, which is owned by the 12 regional electric companies in England and Wales. Energis is planning a nationwide fiber-optic network that piggybacks on the power grid. The company was granted a full telecommunications operating license last May and since then has installed 1200 km of fiber by wrapping it around the wires of overhead electrical lines. By the spring of this year, Energis's services—voice, data, image, and multimedia—will link 20 of the country's largest cities and be available to businesses and residential customers. By January 1995, Energis will extend the network to all major towns in the country.

Germany already has one of the most extensive fiber-optic networks in the world. Deutsche Telekom has installed fiber in about 80 large cities and connected them to each other via fiber. This is the basis for a network called VBN (Vermittelandes Breitbandnetz), which was first launched in February 1989. VBN allows data transfers at up to 140 Mbps for videoconferencing and is connected via satellite to international videoconferencing networks.

VBN will be the foundation for a fiber-optic network leading into customer homes. One pilot project, BERKOM (Berlin Kommunikation), has already been installed in Berlin for applications such as telepublishing, telemedicine, and city information systems.

In western Germany, the fiber-optic network will be built up through introduction of broadband communications services. A pilot ATM project called Broadband ISDN is scheduled for early this year, starting in Berlin, Hamburg, and the Bonn/Koln (Cologne) region. By 1996, the network will be made available for general use.

Group Effort

The three best-known Pan-European initiatives are RACE, ESPRIT, and IMPACT, all started by the EC (European Community) in the 1980s. RACE (Research and Development in Advanced Communication in Europe) is focused on integrated broadband communications and image/data communications. ESPRIT (European Strategic Program for Research in Information Technology) began in 1984 and is now in its third phase. Its focus is information technology, and it includes an Office and Business Systems subprogram, slated to run from 1991 to 1994, that deals with image compression techniques for interactive media.

IMPACT 1 (Information Market Policy Actions) ran from 1988 to 1990; in December 1991 the EC adopted its successor, IMPACT 2, to establish an information services market in two key areas: interactive multimedia and geographical information. At the end of 1993, another effort, Info Euro Access, was established to develop the European market for information services, especially those using broadband communications and Euro-ISDN.

Most European ATM networks will remain pilot projects until the middle of the 1990s and will likely be used for business communication afterward.

Bernd Steinbrink is a freelance journalist based in Oldenburg, Germany. He can be reached on CompuServe at 100277,3444 or on BIX c/o "editors."

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Highway Safety: The Key Is Encryption

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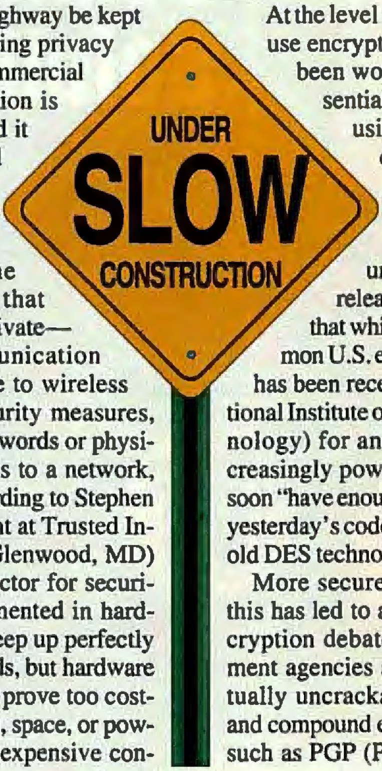


How will information sent over the data superhighway be kept safe and secure, ensuring privacy for individuals and commercial operators? This question is far from resolved, and it has provoked heated controversy about encryption regulations.

Data encryption is vital because it's the only way to ensure that data is kept strictly private—especially as communication shifts more and more to wireless pathways. Other security measures, such as requiring passwords or physically restricting access to a network, are less reliable. According to Stephen Crocker, vice president at Trusted Information Systems (Glenwood, MD) and Internet area director for security, encryption implemented in hardware will be able to keep up perfectly well with gigabit speeds, but hardware implementations may prove too costly in component prices, space, or power consumption for inexpensive consumer devices such as set-top boxes or cellular phones. On the other hand, software encryption may not be able to keep up with very high-speed applications.

At the level of technology, how to use encryption routinely has not been worked out. Yet it's essential: To feel comfortable using the data highway, consumers must be sure that information about their tastes and habits is kept private unless they authorize its release. Crocker points out that while DES, the most common U.S. encryption technology, has been recertified by NIST (National Institute of Standards and Technology) for another five years, increasingly powerful computers may soon "have enough brute force to break yesterday's code," meaning the years-old DES technology.

More secure schemes exist, and this has led to a new kink to the encryption debate: how law enforcement agencies should deal with virtually uncrackable new public-key and compound encryption techniques, such as PGP (Pretty Good Privacy). These schemes can protect people from malicious industrial competitors—or stymie law-enforcement agencies on the trail of a criminal money-laundering scheme.

The Clipper chip proposed by the U.S. government largely for telephone-based communications uses an encryption technology that provides a "back door" accessible to government agencies authorized for a wiretap. The proposal has been met with a storm of legal and technological controversy, although the government has said it is considering alternatives.

Despite Clipper, "it's not a big trick for criminals to encrypt conversations," says Crocker; they can, for instance, obtain foreign DES products. So unless the U.S. government makes Clipper mandatory on all telecommunications gear and, in Crocker's words, "outlaws stray cryptography"—two actions it has repeatedly said it will not take—there is no reason society's bad elements would use products that give law enforcement a means to entrap them.

San Francisco-based writer Paulina Borsook wrote about security in the May 1993 issue of BYTE. She can be reached on the Internet as loris@well.sf.ca.us or on BIX c/o "editors."

branch topology in which the source signal passes through 30 to 50 cascaded amplifiers before reaching each destination.

Unlike with the switched phone system, all the nodes in a given area share a common cable, as on a "shared media access" LAN such as Ethernet. In theory, with a contention access scheme like Ethernet's CSMA/CD, customers ought to be able to vie for upstream bandwidth and send messages to each other or to a server; unfortunately, each drop on the cable produces electrical noise (i.e., *noise ingress*), which is progressively magnified on its way back up the cascade to the point where it overwhelms the signal. Even without the noise problem, the thousands of customers on each cable segment would rapidly deplete the available upstream bandwidth.

According to Mario Vecchi, vice president of network design and architecture for Cable Television Laboratories (CableLabs)—the cable industry's equivalent to Bellcore, the joint research facility of the RBOCs—the solution to this problem, now being implemented by cable providers, is to reduce the number of amplifiers in the cascade and the number of drops on each segment. By pushing fiber further into a given area, each segment can serve up to 500 customers, and only 3 or 4 amplifiers come between the fiber node and the user. At the same time, new super headends connected by SONET rings will serve 100,000 or more customers. This standards-based architecture will let cable systems interconnect more easily with telcos and data services. "Point-to-point links just to serve our own needs are no longer possible," says CableLabs' Vecchi.

Existing frequencies between 50 MHz and 750 MHz will be used for downstream broadcast, while the *subsplit* frequencies from 5 MHz to 42 MHz are available for upstream data. At 6 MHz per channel, this translates into six channels of full upstream video, or many more subchannels of text or other data. The local loop will still share media, and the contention access protocol hasn't been determined, although one likely contender is DQDB, which is an IEEE standard used in MANs (metropolitan-area networks).

TCI Technology's Ravenel says TCI is implementing a scheme like Vecchi describes, with an added twist: The company will actually install two coaxial cables to each feeder, one of which will be "dark" until sometime in the future. The primary wire will be configured with asymmetrical bandwidth: downstream from 50 MHz to 750 MHz or higher, and upstream in the subsplit frequencies. Ravenel asserts—and many agree—that in the near term, information and consumer services will be heavily biased in favor of data delivery. The upstream bandwidth available on the first cable will be enough to support voice phones, two-way data, PCS (personal communications services, the new wireless spectra that will be auctioned off by the FCC this year), and video telephony,

The Tools for New TV

TOM R. HALFHILL

Think of it as the world's largest WAN (wide-area network) with the world's largest database servers at one end and the world's largest number of clients at the other: That's the vision for broadband ITV (interactive TV).

The clients, of course, are ordinary TV sets, augmented by a new generation of digital set-top boxes that will rival the processing power of today's PCs and workstations. The servers are likewise a new breed of computers that not only have enough storage for vast libraries of movies, TV shows, and multimedia applications, but also are capable of feeding that data downstream to millions of users—in real time, on demand. In between, tying everything together, is the nationwide broadband network that flawlessly switches all this traffic while ensuring that every transaction is billed to the appropriate user.

The whole system is far larger and more complex than anything that exists today. Its nearest relative is the public telephone system—a low-bandwidth network that terminates into relatively simple analog devices and is designed to deliver communications instead of content. ITV is so new that critical pieces of the hardware and software technologies are still being invented. It won't come cheap, it won't come easy, and it probably won't come as quickly as some people are predicting.

Will it come at all? No question. ITV definitely isn't a technology in search of a solution. In fact, it's the technology that's the problem.

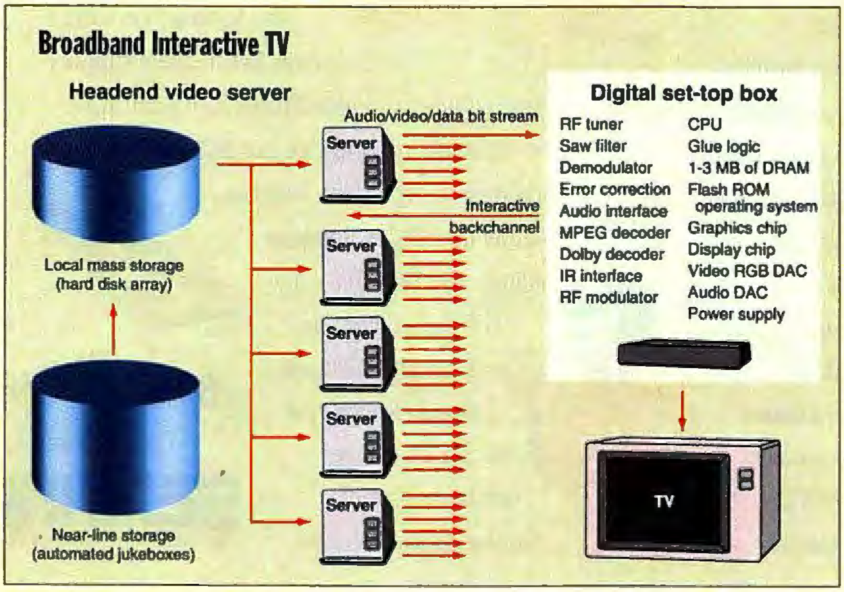
Consider, for example, the servers that will form the hub of this great network. Most of today's databases store relatively simple data (e.g., names and addresses), and their I/O model is transactional, so minor delays are common when accessing records. But headend servers on the ITV network must store full-motion video, stereo sound, and other rich data types. These "video servers" must also achieve real-time or near real-time throughput, because even brief delays will cause visible glitches on home TV screens.

Oracle (Redwood Shores, CA), which hopes to become a key player in this field, says that most of its current database customers manage 100 to 150 GB of data. Oracle's biggest customer, a credit-history company, has a database approaching 1 TB (1024 GB). But the ITV network of the future will store the world's entire movie library, estimated at 65,000 films. Each film requires 1.5 GB or more of storage when compressed in MPEG-2 format. That adds up to about 95 TB. Now add all the historical news footage and popular TV shows that will eventually be stored, too. And don't forget the other content, such as electronic catalogs and interactive encyclopedias, and things yet to be imagined.

The bulk of this material will be archived in near-line storage: banks of automated jukeboxes that can mount tape cartridges or optical disks on the video server within seconds of a user's request. The server will copy the video onto its local mass storage, probably striping the data across arrays of hard disks for redundancy and faster access. Then it will buffer the data in RAM while pumping it downstream to the user's set-top box. Frequently accessed material, such as the most popular movies and games, may be permanently maintained on local storage. Special software will track viewing habits, automatically loading *It's a Wonderful Life* in December.

Consumers will expect the same reliability from the ITV network that they do from the public phone system, so video servers will need careful maintenance. An array of 1000 hard disks will lose an average of one drive per day, according to MTBF (mean time between failure) statistics. Technicians will patrol rooms of servers and jukeboxes, hot-swapping failed drives on the spot, just as they used to keep ENIAC running by constantly replacing blown vacuum tubes.

If the storage requirements of video servers seem daunting, the I/O is nightmarish. During peak hours in major cities, thousands of people may be requesting videos. Today's broadcast model is synchronous: One "copy" of a movie is sent over cable or the airwaves to a mass audience, and everyone watches it at once. Pure video-on-demand is asynchronous: If 5000 people on Saturday night want to watch the latest hit film, only a few will punch in their orders at



To provide video-on-demand, multimedia encyclopedias, and other new services, ITV networks will need high-speed servers with vast amounts of mass storage. Material will be stored on digital tapes or optical disks in automated jukeboxes. When the network receives a user's request via the upstream backchannel, the server will retrieve the appropriate file from the jukebox and copy it to a hard disk array, from which the compressed video will be spooled downstream to the user's digital set-top box. The box will decode and decompress the video and then modulate an analog signal for the TV.

the same moment. Thus, the server must stream the same video to thousands of destinations according to different time bases, some only seconds apart.

To complicate matters still further, the video server will provide virtual VCR functions, such as pause, rewind, fast-forward, slow motion, and frame advance. So it has to update thousands of file pointers to keep pace with frequently shifting viewing patterns.

What kind of computer can do all this? "I think 'computer' may be the wrong word," says Greg Hoberg, marketing manager of the video communications division at Hewlett-Packard (Santa Clara, CA); "it's really an I/O machine." Hoberg says the problem is not computational and therefore requires an entirely new approach to hardware design. "We're trying to come up with the architecture that is appropriate to this problem. It's a problem of I/O and mass storage, not a problem of MIPS."

HP's video server, dubbed the Video Engine, is expected to be ready in about a year. Hoberg says it will be a highly scalable machine that fits into HP's vision of numerous servers distributed across a hierarchical network. Local servers will supply the most popular videos, while remote machines that serve many localities will store less-popular content. This topology could minimize headend costs without compromising access.

HP isn't alone in the scramble to gain a foothold in the high-stakes video-server market. IBM and DEC see video servers as a potential use—even a savior—for large minicomputers and mainframes. Microsoft, Intel, AT&T, Silicon Graphics, Motorola, nCube, and Oracle are a few of the other companies working on hardware and software. As with anything new, different approaches are emerging.

Unlike HP, Oracle and nCube (Foster City, CA) think video servers *do* need great computational power. They're designing servers using nCube's massively parallel computers and Hypercube architecture. In their view, symmetric multiprocessor systems have too much hardware overhead and will quickly fall victim to bus saturation if applied to large-scale video-on-demand.

To boost the server's I/O bandwidth, nCube interconnects large numbers of proprietary microprocessors comparable to a 386 but optimized for throughput. Oracle, which is writing the software, says an nCube-based video server with 1024 processors could supply video to 7000 homes. A larger nCube-2 computer supports up to 4096 processors and could serve 30,000 homes.

"No one knows for sure how these machines will be used," says Benjamin Linder, director of technical marketing for Oracle's Media Server project. "So Oracle is designing a system that's as general as possible. We're trying to create servers to act as living libraries on the data superhighway."

Linder says that the massively parallel approach is overkill for video I/O, even on this scale, but nevertheless makes sense because the server could handle tasks that otherwise would be shunted downstream to the user's set-top box.

This is a key point. New computers are needed for *both* ends of the ITV network—clients as well as servers. Digital set-top boxes are much more than simple tuners or descramblers, yet their cost must be driven down to about $300 before broadband ITV is economical.

Consider what a typical box might contain. Start with a powerful CPU, such as a 486, PowerPC, or Mips R4000. Add 1 to 3 MB of RAM; a high-speed graphics chip for screen overlays and video games; a display chip; a 1-GHz RF tuner; a demodulator; an error-correction chip; an MPEG-II decoder; logic to strip the audio soundtrack from the incoming video; a Dolby decoder; two 16-bit audio D/A converters; a video RGB converter; an RF modulator; an infrared interface for remote control; flash ROM for the operating system; a security chip to prevent theft of service; and a switching power supply.

"People have this interactive TV vision, but if the set-top box costs $1000, it's not going to be worth it," notes Roger Kozlowski, vice president and technical director for the consumer segment of Motorola (Phoenix, AZ). That's why Oracle and nCube are designing video servers that can shoulder part of the computational burden. They seem to be in the minority, however. Other companies are betting the set-top technology will be affordable by 1995 or 1996—and it'll be at least that long before the network infrastructure is ready to support it.

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which needs 384 Kbps to 1.54 Mbps of bandwidth, Ravenel says.

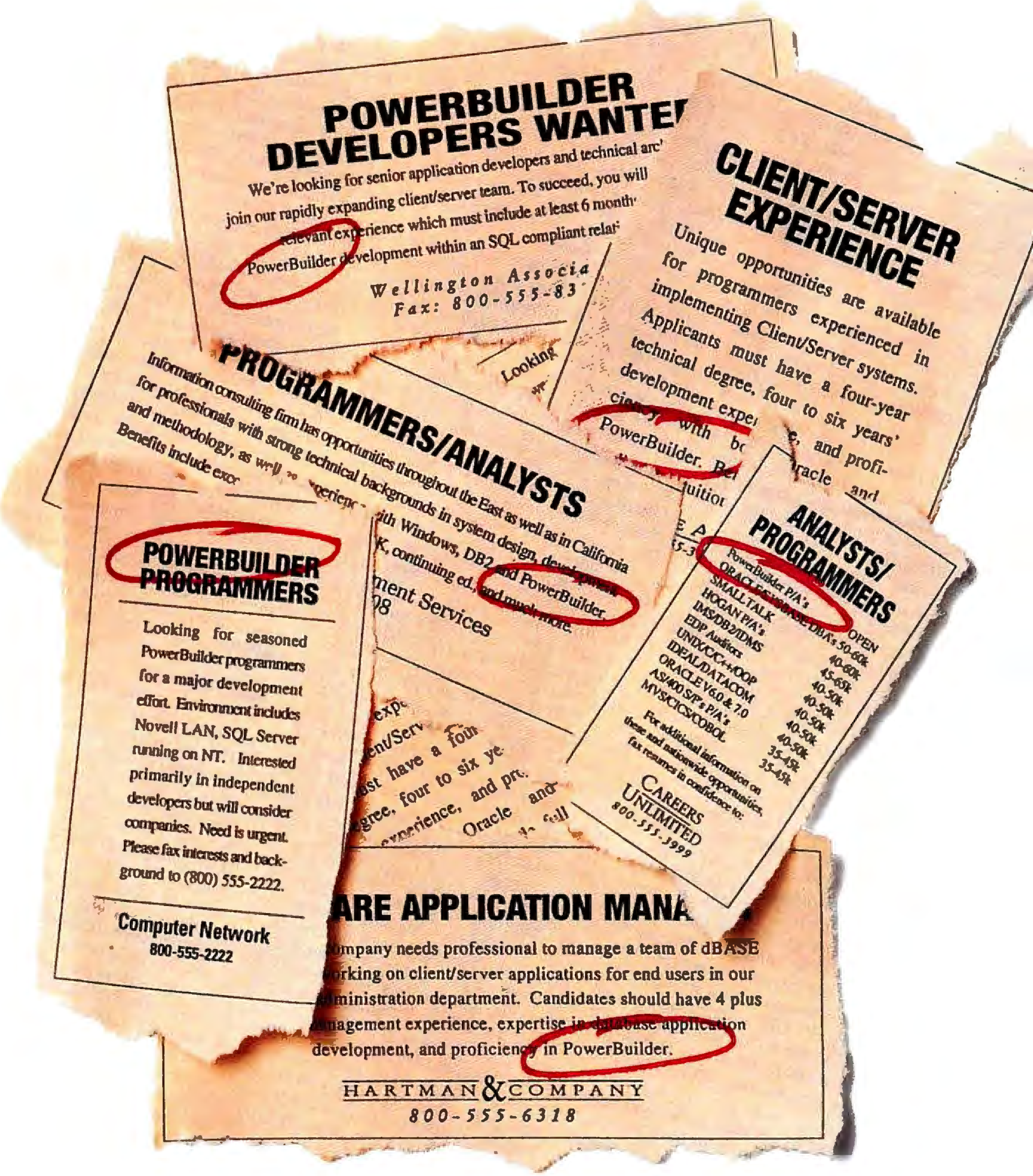
TCI's second cable will be *midsplit*, with the "free" portions of 500 MHz of bandwidth allocated in each direction (the second, digital-only, unamplified cable is subject to RF ingress). When activated, this cable would allow TCI to provide more than just telephony: It would empower subscribers to become originators, not just consumers, of content—in effect, to become broadcasters in their own right. "You're more likely to be enfranchised as a user if your cable service allows you to communicate with other users," says Allison Mankin, a researcher at the U.S. Naval Research Laboratory and a cochair of the IETF's "IP:next generation" project.

Cable companies are serious about using upstream bandwidth to compete with the RBOCs in local phone access. The top five cable firms—TCI, Time Warner Cable, Continental Cablevision, Cox Cable Communications, and Comcast—jointly own TCG (Teleport Communications Group), the leading alternative access provider, which connects local users to interexchange-carrier POPs. Large corporate customers are already contracting with TCG for primary or backup access from their phone systems directly to long-distance carriers. Now cable companies want to offer the same option to smaller businesses and individuals. Access to the long-distance network through the cable system could lower costs for customers and give RBOCs a run for their money.

Future Networks

A technology that may bring cable and phone companies even closer together is ATM, which spans the gap between packet-switched and circuit-switched technologies by using elements of each. ATM splits data into small chunks, like a packet service, but the cells are all of equal size. Then, instead of routing each cell individually, ATM sets up a virtual circuit and streams them across the network. Aside from its scalability and ultrafast switching performance (622-Mbps ATM products are available now), what makes ATM so attractive for video applications is its ability to allocate bandwidth on demand and assign priority levels to cell streams. This means ATM can guarantee nearly real-time delivery of digital video data. "ATM is the right kind of switching technology for interactive video," says TCI's Ravenel.

To test this hypothesis and to push ATM technology to its limit, Time Warner Cable is conducting an interactive TV and video-on-demand trial in Orlando, Florida, together with AT&T, Silicon Graphics, and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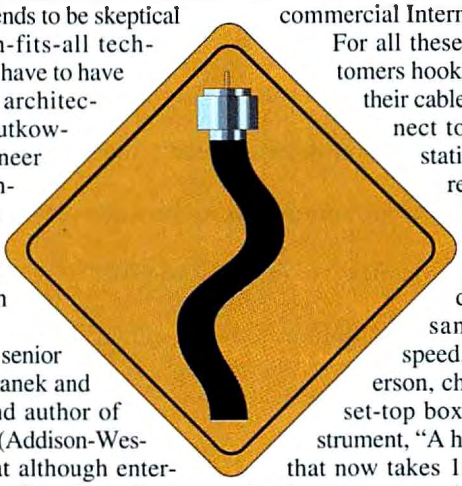
others (see the text box "The Tools for New TV"). This trial uses ATM end-to-end, from the massive video servers at the back end to the set-top boxes in subscriber homes. It's a costlier solution than TCI or Pac Bell is trying, but it may be more forward-looking. Ravenel says he's not sure ATM to the home is necessary but he's grateful to Time Warner for trying it out.

Some are even less certain about ATM, cautioning that it has been overhyped. This view is particularly found in the Internet community, which tends to be skeptical about one-solution-fits-all technologies. "We don't have to have a single, universal architecture," says Tony Rutkowski, an Internet pioneer and director of technology assessment at Sprint. "It's nonsense to think that everything will run over ATM."



Craig Partridge, a senior scientist at Bolt Beranek and Newman (BBN) and author of *Gigabit Networking* (Addison-Wesley, 1994), says that although enterprise ATM switches from Fore Systems and Lightstream (a joint venture of Ungermann-Bass and BBN) can deliver their rated 155-Mbps speeds, some high-end 622-Mbps switches have failed from a lack of adequate flow control. "ATM switches are really designed for steady, not bursty, traffic. But data communications is bursty, so they drop bits all over the floor," he says.

ATM also doesn't now support multicasting, which means that all transactions are point-to-point. This could prove very inefficient for broadcast video content, such as live news or sports events, when millions of users are watching the same source and don't need to be individually addressed. Still, cable and telco executives almost unanimously conclude that ATM will be a vital backbone technology for the data highway, weaving together the cable, telco, and data service providers.

Linking with Content

Another problem that both cable companies and telcos confront in promoting their visions of the data highway is that neither owns meaningful data content. The cable companies bring to the party lots of entertainment properties and Hollywood relationships, but these are a far cry from business-oriented information sources such as demographic databases or parts catalogs.

To gain access to this information, cable and phone companies are forging links with on-line services. In late 1993, Comcast and Viacom announced they would test delivery of Prodigy and America On-Line over cable systems in Castro Valley, California, and elsewhere. Continental Cablevision began a trial last December in Exeter, New Hampshire, that lets some home and business cable customers connect directly to CompuServe; and in early 1994, Continental will offer cable subscribers in Cambridge, Massachusetts, a direct link to Performance Systems International, or PSI (Herndon, VA), a leading commercial Internet provider.

For all these arrangements, customers hook up an RF modem to their cable and from there connect to a PC, Mac, workstation, or network. The result of using broadband coaxial cable instead of twisted-pair copper for data delivery is a thousand-fold increase in speed. Says Daniel F. Akerson, chairman and CEO of set-top box maker General Instrument, "A high-resolution image that now takes 15 minutes to download over a conventional modem will be accessible within a few seconds."

Zenith Electronics (Glenview, IL) makes one such interface, called HomeWorks, that sells for $495 and consists of an external cable modem (with Ethernet output) and a PC bus card. HomeWorks is being used for the Continental/CompuServe trial in Exeter, and Zenith is also partnering with Spry (Seattle, WA) to promote cable-based Internet access via Spry's Air Navigator, a $149 Windows-based software package.

DEC is getting into the act with ChannelWorks, a bridge that permits interconnection of Ethernet LANs over CATV systems, supporting 10-Mbps speeds at distances of up to 70 miles. According to a Datapro Information Services report, "Data over CATV," DEC has partnered with TCI, Continental Cablevision, Times Mirror Cable, and others, and is targeting ChannelWorks at businesses, hospitals, state and local governments, and educational institutions. Both the DEC and Zenith modems require two-way cable systems and support symmetrical data rates.

Start-up Hybrid Networks (Mountain View, CA) is taking a different approach with an asymmetrical architecture that uses both cable and phone lines. Its product uses RF modem technology for 10-Mbps downstream data over subsplit frequencies and sends return data over conventional phone lines at 9600 bps to 19.2 Kbps.

Hybrid has also demonstrated upstream communications over ISDN, using 2B channels, or 128 Kbps. President Howard Strachman notes that only 15 percent of U.S. cable systems are now two-way, and of those, most suffer noise ingress that makes provision of even a single 6-MHz upstream channel nearly impossible. Hybrid's product will thus serve the millions of users lacking advanced cable service.

But looking forward to the time when fiber nodes move closer to end users, Hybrid is also working with Intel and General Instrument on a device that communicates in both directions over cable. This two-way RF modem, slated to be used for the Viacom and Comcast trials this year, will be implemented on a PC add-in card, not in an external unit like HomeWorks. Strachman says the specifications for the final card aren't set but could include NTSC-to-VGA conversion; if so, he says, a single board would "cable-enable" a PC for both video reception and data I/O. Although the initial product is for the ISA bus, future versions could support other I/O buses or PCI (Peripheral Component Interconnect) or could be built directly into a set-top box.

Services such as CompuServe and Prodigy were designed around the presumption of scarce bandwidth, but with connection rates orders of magnitude higher, they will be able to offer richly detailed multimedia user interfaces and new capabilities such as interactive imaging, store-and-forward audio and video communication, and "rentals" of massive data sets. "Some believe that a good part of the required transport infrastructure [for the data highway] already exists in the cable plant," says Datapro analyst Lance Lindstrom. By adding support for data communications, he says, cable companies can leverage their bandwidth advantage over the telcos and assume the role they see for themselves as "important contributors" in building the information highway.

The Data Web

People often confuse the Internet's physical structure—its web of T3 trunks linking IBM RS/6000–based routers and its various dial-up and dedicated access lines and services—with its true identity: a set of software protocols and tools, thousands of open data servers, a community of more than 20 million users, and a process for engineering upgrades. But in theory, this identity could be divorced from today's Internet hardware and the "Net" would still exist; indeed, if the data highway turns into a melding of cable and telco infrastructures, the Internet could live on as a

Federally Funded Pilot Projects

VISTANET

Participants University of North Carolina at Chapel Hill, North Carolina State University, Bell South, GTE MCNC

Technical details Uses data-intensive files such as CAT scans and MRIs to drive tests of protocols and network performance analysis using HIPPI (High Performance Parallel Interface), ATM (Asynchronous Transfer Mode), SONET (Synchronous Optical Network), and broadband circuit switching

Goals To examine medical uses for gigabit networking, concentrating on medical imaging

AURORA

Participants IBM, Bellcore, MIT, University of Pennsylvania, MCI, Nynex, Bell Atlantic, University of Arizona.

Technical details Uses 2.4-Gbps channels from MCI to link the computer labs of the other participants. The switches are configured for both standard ATM and an alternative known as PTM (Packet Transfer Mode).

Goals To test the differences between the switching schemes and to explore the implications of hooking up a data firehose to a desktop workstation.

Comments To handle these blistering interface speeds, future desktop computers will need specialized I/O controllers with DMA and direct access to video, as well as operating-system improvements to greatly reduce context-switching time.

NECTAR

Participants Carnegie Mellon University, Bellcore, Bell Atlantic, and the Pittsburgh Supercomputing Center.

Technical details Uses ATM as an intermediate layer between SONET backbone links and HIPPI interfaces on the computers.

Goals Scalability; to link gigabit LANs and WANs to one another and to supercomputers. To overcome current I/O bottlenecks and to develop a dedicated network coprocessor to off-load protocol handling from system bus.

Comments Adding a new computer to the network only requires connecting it to the ATM switch, whereas the Casa network needs a direct SONET line between every pair of communicating computers. Nectar's approach is much closer to the architecture that will be used to link homes and businesses to the data superhighway. Since most people will want to make connections with many different computers in a day, they'll require the flexibility of a switched network. But point-to-point, switchless approaches like Casa's could be used to establish permanent links between a small number of sites, such as when a company connects computers in neighboring plants.

MAGIC

Participants Earth Resources Observation System Data Center, Lawrence Berkeley Laboratory, Minnesota Supercomputer Center, SRI International, University of Kansas, MITRE, Army High-Performance Computing Research Center, Army Battle Command Battle Laboratory, DEC, Northern Telecom, Southwestern Bell, Splitrock Telecom, Sprint, U.S. West

Technical details Will use SONET links and ATM to create a gigabit WAN interconnecting three high-speed ATM LANs and one HIPPI LAN, providing trunk speeds of 2.4 Gbps and access speeds of 622 Mbps

Goals Will use a military-terrain visualization application to study real-time interactive data exchange among diverse, geographically distributed computing and networking devices

CASA

Participants Caltech, The San Diego Supercomputing Center, The Jet Propulsion Laboratory, MCI, Pacific Bell, UCLA, US West, and Los Alamos National Laboratory.

Technical details Uses SONET fiber-optic lines running at 622 Mbps to link the different sites, but doesn't use ATM because ATM's 53-byte cell size proved inefficient for moving supercomputer-size blocks of data that routinely grow to 64 KB or greater.

Goals To explore methods for synchronizing massive distributed simulations running on supercomputers hundreds of miles apart.

Comments Even at gigabit speeds, the propagation delay introduced by networking throws off these applications, which concern problems such as modeling the global climate system.

BLANCA

Participants Lawrence Berkeley Lab, NCSA, University of California–Berkeley, University of Illinois, University of Wisconsin, AT&T, Ameritech, Astronautics, Bell Atlantic, and Pacific Bell.

Technical details The test-bed links local FDDI (Fiber Distributed Data Interface) LANs with SONET-based ATM switches.

Goals To study how voice, data, and video flow in networks.

Comments Voice is at once more forgiving and more demanding than regular data. People using a phone won't even notice if one packet containing a microsecond of conversation is lost; the ear and brain fill in the gap. However, a long pause is unacceptable. Data connections, on the other hand, are time-insensitive but cannot tolerate even a single lost packet. From a user standpoint, delayed data means sluggish performance, but not gibberish. Put another way, voice traffic is predictable and steady, whereas data communications occur in unpredictable bursts that can overflow switch buffers designed for voice traffic.

set of services and standards.

Whether you connect to the data highway by copper, coaxial cable, fiber, or radio, the key unanswered questions are *how* you will interact with the giant network and *what* you will find there. Being linked to everybody and everything in the world won't do much good if you can't use the system or locate services you need—or if there's no data on-line that you care about.

This is where the Internet comes in. Unlike experimental networks such as Time Warner's ATM trial in Orlando, the Internet is in place today, running the battle-tested TCP/IP protocol, offering global remote log-in and file transfer (telnet and ftp, respectively) to and from thousands of data servers, and supporting public domain networking standards such as SNMP, SMTP, and SLIP. To help users navigate this vast, interconnected mesh, the Internet community has created innovative searching and indexing schemes, such as Gopher, Archie, WAIS, and the hypertextual World Wide Web.

The physical Internet is quickly evolving: According to Steven Wolff, director of the networking division of the NSF (National Science Foundation), which oversees the Internet's core, "the NSFnet backbone is going away" in the next few years, to be replaced by a combination of linked commercial subnetworks and a restricted-access research backbone. One immediate effect of this is that the Acceptable Use Policy, which prohibited commercial data traffic across the NSFnet, will become even more moot than it already is.

Instead of providing universities and public institutions with free access to a government-sponsored network, Wolff says, the government will get out of the network business and offer these users vouchers or grants to buy access to commercial Internet providers. There are now nearly 50 of these regional mid-level network providers in North America (including PSInet, BARRnet, CERFnet, NEARnet, and NYSERnet), most linked under an umbrella called CIX, or the Commercial Internet Exchange. Many may merge or

Commercially Funded Pilot Projects

NIIT

(The National Information Infrastructure Testbed)

Participants	AT&T, Department of Energy, DEC, Ellery Systems, Essential Communications, Hewlett-Packard, Network Systems, Novell, Ohio State University, Oregon State University, Pacific Bell, Sandia Labs, Smithsonian, Sprint, Sun Microsystems, SynOptics, UC–Berkeley, University of New Hampshire.
Technical details	Prototyping data-highway concepts using the Internet, FDDI, frame relay, and ATM.
Goals	To create real-world demonstration projects using currently available products.
Comments	The first test, called Earth Data Sciences, distributed environmental data over disparate systems in a collaborative multimedia framework. The second test will be on medical imaging.

SMART VALLEY

Participants	3Com; Hewlett-Packard; Pacific Bell; Silicon Graphics; Network General; Stanford University; Regis McKenna; Mohr, Davidow Ventures; and others
Goals	To promote the development of the data superhighway through brokering public and private partnerships and by supporting applications development

XIWT

(The Cross-Industry Working Team)

Participants	Apple Computer, AT&T, Bellcore, Bell South, CableLabs, Citicorp, DEC, GTE, Hewlett-Packard, IBM, Intel, MCI, McCaw Cellular, Motorola, Nynex, Pacific Bell, Silicon Graphics, Southwestern Bell, Sun Microsystems, and others.
Goals	To hammer out technical issues involved in bringing gigabit technology to homes and business desktops. XIWT has four working groups—architecture, services, portability, and applications—and has assigned each to examine pertinent issues and produce white papers. XIWT's overall goals for the data highway are that it be ubiquitous, affordable, flexible, and easy to use.

COLLABORATORY ON INFORMATION INFRASTRUCTURE

Participants	Bellcore, all the regional Bell operating companies, Capital Cities/ABC, DEC, Hewlett-Packard, JCPenney, Los Alamos National Laboratory, MIT Media Lab, Microware Systems, Northern Telecom, WilTel
Goals	To find solutions to practical problems such as user interface and network navigation

be acquired by telcos, cable companies, or on-line service providers. "We won't be buying our bandwidth from people like CERFnet and PSI 20 years from now," predicts Noel Chiappa, a member of the IETF and an independent networking researcher based in Vermont.

To carry forward the Internet's original mandate as a research tool, the government will create a new backbone under the auspices of the 1991 NREN (National Research and Education Network) Act, which was sponsored in Congress by then-Senator Al Gore. This new backbone will operate at speeds of 155 Mbps (OC-3) and will not carry routine mail or file-transfer traffic; it will exist, says Wolff, to support research on protocols, RPCs (remote procedure calls), large file transfers, and other advanced applications. NSF is also co-funding research on even higher-speed networking via so-called Gigabit Testbeds.

As the Internet's backbone is changing, so are its on-ramps. Programs such as Continental Cablevision's link to PSI are opening up the Internet to a new class of users and bringing it into the same devices people will use to view videos or make phone calls. Thus, distinctions among these services will blur. The thousands of Internet data servers and news groups, offering virtual community and free information ranging from government statistics to satellite images to crop studies, will be available from your office or living room through the same user interface you use to conduct a videoconference or order a pizza.

One major problem that could hold back growth of the Internet as a commercial venue is that no provisions exist today for usage-based billing. If you log into a server with anonymous ftp, nobody charges you (by access time, packets downloaded, records passed, or some other scheme) for the data that you obtain. By comparison, proprietary on-line services such as CompuServe were designed from the beginning to track usage.

"The thought of billing is a nightmare to 90 percent of the providers on the Internet," says Susan Estrada, former managing director of CERFnet and now president of start-up Aldea (Carlsbad, CA). Unlike commercial services, she adds, many Internet nodes, such as government servers, are required to publish their data at no charge.

Some people also bemoan the inevitable change that expansion of the Internet will wreak on its unique subculture. Says Dave Farber, an Internet founder and professor at the University of Pennsylvania (Philadelphia): "Internet people believe in free goods to everybody: Give each user a straw and let him sip on the pool of wisdom." If Internet access is no longer free and users have to pay to download data sources, the Internet will lose its communal spirit.

Protocol Quandary

Aside from its highly evolved tools and wealth of data sources, the Internet's greatest contribution to the data highway may be the TCP/IP protocol. But this is debatable, because TCP/IP wasn't originally designed for real-time data delivery, which is necessary to support any meaningful volume of audio or video traffic. "Its optimal use is to hang together a great many apps, nets, and operating systems around the world," says Sprint's Rutkowski.

TCP/IP is a routed, connectionless, datagram (or packet) protocol, which means it divides network traffic into unequally sized, individually addressed chunks that are routed through the network over a dynamically assigned path. (The Internet uses several algorithms to determine the best route at any given time.) This is analogous to sending a friend a postcard every day for a month: The cards may arrive out of order or take different routes to get there, but the friend can sort them out at the other end. By contrast, connection-oriented schemes, such as voice telephony or ATM, establish a circuit between the source and destination and send all signals or packets in sequence along the same path. Each approach has its strengths and weaknesses.

TCP/IP's greatest competitor—if, indeed, they must be at odds rather than complementary—is ATM. But ATM spans different levels of the network stack, including link-layer specifications that are out of TCP/IP's purview, and not including TCP/IP's "reliable" layer, which ensures end-to-end error checking. An IETF group is working to implement IP over ATM (this requires splitting IP's variable-length packets over ATM's fixed-length cells and then reassembling them on the other side), on the premise that IP can and should remain an internetworking standard even if the underlying transport changes from a connectionless datagram to cell switching.

continued

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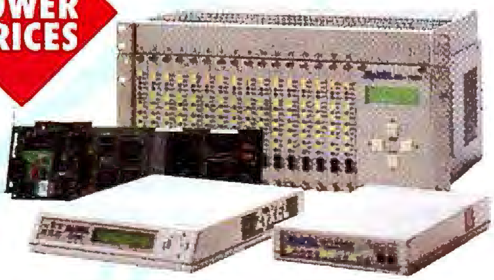

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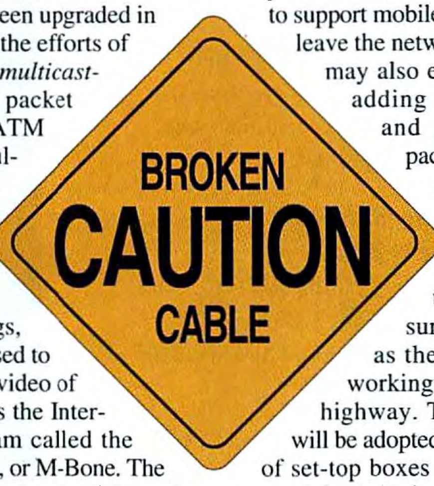
But if ATM does so well with video and other real-time data, why muck around with TCP/IP at all for the data highway? The answer is heterogeneity, says Scott Bradner of the Harvard University Office of Information Technology, and cochair of the IETF's IPng committee. "Just because a large chunk of the network of the future will be running over ATM doesn't mean it will all be," he says.

TCP/IP is widely supported in applications and routers and is unmatched in universality and reliability—significant advantages in building the information infrastructure. It has also been upgraded in recent years, through the efforts of the IETF, to support *multicasting*, or one-to-many packet broadcasting, which ATM does not support. Multicasting reduces the burden on routers by mapping packets into predefined distribution groups.



Among other things, multicasting is now used to distribute live digital video of IETF meetings across the Internet through a program called the Multimedia Backbone, or M-Bone. The program demonstrates a potential use for the Internet, but it's a far cry from the architecture required for widespread video-on-demand or video telephony. "The way they do M-Bone now is to shoot the packets through the net and pray for the best," says CableLabs' Vecchi.

Despite its shortcomings, M-Bone's real significance is symbolic: The Internet's ability to grow and adapt to changing requirements should never be underestimated. A case in point is the current effort to expand the IP address space. Concern that the explosive growth in Internet use would exhaust the remaining IP addresses has prompted a creative two-pronged effort to plan for the future. If the efforts of the IPng task force are successful, there will be enough IP addresses to give one to every computer, telephone, fax machine, and set-top box in the world, with billions more to spare.

The IP address field is now specified at 32 bits, which theoretically ought to permit 4 billion addresses. But when the Internet was set up, addresses were divided into three classes based on the size of the attached network, and now there is a shortage of the most popular (Class B) type. The first step to combat the address crunch is to eliminate classes with new technology called CIDR (Classless Inter-Domain Routing). Coupled with more aggressive efforts to reclaim unused blocks of addresses, this may buy the Internet as many as five to 10 years of breathing room, depending on growth rates, says network researcher Chiappa.

For the longer term, the IPng will consider proposals to modify IP to support at least 1 billion networks and 1 trillion nodes. Three proposals have been formulated so far, but contenders could still emerge or drop out; all three proposals include 64-bit address fields (allowing essentially unlimited addresses) and tackle the problem of auto-configuration, or how to support mobile devices that join and leave the network at will. The IPng may also examine schemes for adding resource allocation and pseudo-guaranteed packet delivery (a "good enough" solution) to better support video over TCP/IP.

The purpose of all these efforts is to ensure TCP/IP's position as the universal internetworking protocol of the data highway. This doesn't mean it will be adopted tomorrow by makers of set-top boxes and cellular phones; most of these devices will remain analog for some time, and those that are digital could use proprietary protocols on top of ISDN or ATM. But TCP/IP protocol stacks may show up in some unusual places, such as plug-and-play "cable-enabled" PCs.

IP could also face competition from experimental "lightweight" protocols, such as XTP or HighSpeed Transport Protocol, that are designed to reduce switching overhead on the backbone. TCP/IP was written to cope with an older, more unreliable network infrastructure, and it places heavy emphasis on error control and retransmission, says William Stallings of Comp-Comm Consulting (Brewster, MA). In the context of a fiber infrastructure running fast transports like ATM, IP may be too "muscle-bound to cope," he says.

According to Stallings, XTP establishes connections more efficiently than TCP/IP, supports different priority levels and multicasting, offers greater flexibility in checksums, and is the only protocol that permits selective retransmission of missing packets. By combining functions of TCP and IP into a single, streamlined protocol, XTP manages to be both reliable and fast, he says.

A Window Seat

What will be your view onto the data highway? This is the ultimate client-side battleground, pitting against one another companies that pride themselves on their user-interface design skills, such as Apple, Microsoft, and General Magic, as well as makers of devices ranging from palmtops to smart TVs. In all likelihood, no single user interface will prevail, but standards have to be developed so that set-top boxes are interchangeable among different delivery systems and software applications run the same around the country.

Microsoft aims to be a major player in defining the user interface for interactive services, whether delivered over cable or wireless, onto desktop PCs or TVs. Its first-generation product, Modular Windows, derived from the same API as Win16 (and was promoted to developers as an easy way to leverage multimedia PC development onto TV-like devices), but it fizzled after being adopted only by Tandy for its VIS player. Microsoft is trying again with new non-Windows technologies, due to appear in pilots and trials this year, says Craig Mundie, vice president of advanced consumer technologies at Microsoft.

These consumer technologies—a separate initiative from the Microsoft At Work environment for office equipment slated to be rolled out this year—will cover the gamut from back-end servers through broadband networking to end-user products, Mundie says. "Our public position now is that we don't intend to use the Windows user interface for consumer devices."

Windows will play a key role as a portal to the data highway. For example, the new Internet-In-A-Box from O'Reilly & Associates (Sebastopol, CA) runs under Windows, providing a TCP/IP stack, automatic network registration, Internet services, and navigation tools. This product and other Windows-based interfaces to on-line services (i.e., CompuServe Navigator or the America On-Line front end) will operate in conventional set-ups such as a desktop or notebook PC connected via the phone system, or in emerging schemes such as PCs connected via RF modems through the cable system.

For radically different devices, such as PDAs or set-top boxes, different interfaces will be created. Apple has already invested heavily in the Newton, which, with the addition of needed communications capabilities, could become a hand-held data highway navigator. General Magic's Magic Cap interface, slated for use in devices from Motorola, Sony, Philips, and Matsushita, may also show up under the name MagicTV in set-top boxes. Silicon Graphics is carrying its Indigo Magic media interface from the Indy desktop into the set-top boxes that it is designing for the Time

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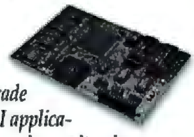

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Warner Orlando trial. And Eon (Reston, VA), formerly TV Answer, has spent more than five years developing and testing a user interface for its interactive TV system, which will be designed into a set-top box from Hewlett-Packard.

To make these environments truly useful to users, software tools have to run deeper than just the surface of the screen. For instance, support for General Magic's Telescript communications language is built into Magic Cap, which means that when the user selects services by pointing at screen icons, smart agents are automatically dispatched across the network to obtain those services. Similar capabilities can be imagined for any of the set-top box interfaces, which will offer home and business users a kick-off point for cruising the data highway.

One of the finest examples of data highway middleware is Mosaic, developed at the National Center for Supercomputing Applications in Illinois. Mosaic runs under Windows, the X Window System, and the Mac, acting as a client-side browser for World Wide Web servers on the Internet. The software makes visible and easily navigable the hypertext links implicit in the World Wide Web. Thus, you could click on an icon to learn about northwestern conifers and get connected to a server in Vancouver, and then hop a link in pursuit of details on pinecones and be transparently logged into a server in Oslo. "Mosaic is the most intuitive, user-friendly, attractive user interface I've ever seen," says Sprint's Rutkowski. "It's the Internet's killer app."

O'Reilly & Associates' Internet-In-A-Box makes use of the Mosaic data browser, developed at the National Center for Supercomputing Applications.

Learning to best exploit these tools will be a major challenge facing businesses in the era of the data highway. "Information access is going to be a commodity," says Joe Correira, vice president of applied technology for The Travelers insurance company (Hartford, CT). "Everyone will have access to the information, [but] those with the experience will profit from the information."

Haves and Have-Nots

All these snazzy devices and rich tools will be meaningless to average citizens if accessing the data highway is too expensive or difficult. If proper precautions are not taken, the highway could become the province of the educated and economically privileged, dragging the U.S. even farther toward being a land of information haves and have-nots.

Lowering regulatory barriers between telcos and cable companies, and the rise of yet more gigantic media empires to fill the wires with content-for-hire, could lead to fierce competition over services and prices—or to new monopolies. Will all citizens be guaranteed access to the national information infrastructure? San Francisco consultant Evelyn Pine, former managing director of Computer Professionals for Social Responsibility, says that "people take phone service for granted," where "universal service has brought about great economic and political advantages." But, she says, "it's hard to visualize universal [computer] access that's not a high-priced solution." Paying $17 per month for service (an amount more in line with the cost of discretionary cable than with basic lifeline phone service) may seem like peanuts to people in the computer business, but it could be a burden for those with lower incomes, she notes.

Pine also poses the question whether cash-starved libraries and community colleges should be charged with providing universal access to the data highway (i.e., through public centers offering subsidized accounts), or whether new public institutions should be established for granting access. While the latter approach would spare colleges and libraries a burden, it could also "siphon money away [from them]," she adds.

The cable and telco businesses are racing so far ahead of regulators, judges, and legislators that their wish to invade each other's territories may be granted before proper protections are in place for the public. But if the information highway is to fulfill the grand civic vision outlined for it by President Clinton, the government must set in stone rules that carry forth the spirit, if not the substance, of the 1934 Communications Act that bound Ma Bell to be a common carrier and provide universal service. RBOCs can't be left to carry that burden alone while the cable companies and alternative carriers skim off the best customers. Perhaps the best solution is one currently floating around Washington: to create a public trust fund into which all providers pay and from which subsidies are drawn.

Like the transcontinental railroads and interstate freeways, the data highway will profoundly alter society—perhaps in ways we can't even anticipate today. No matter who controls the wires or airwaves that reach into homes and businesses in the U.S. and around the world, major technical, legal, and economic challenges remain before the data highway is as unremarkable as telephones and TVs. But when these hurdles are surmounted, enormous opportunities will be unleashed for all providers and consumers of information. Vice President Gore put it most succinctly: "Better communication has almost always led to greater freedom and greater economic growth." ■

CONTRIBUTORS

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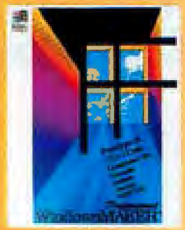

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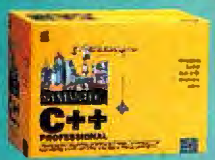

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MANAGING MASS STORAGE

As processors become more powerful, networks more ubiquitous, and data types more rich and varied, storage technologies struggle to keep pace

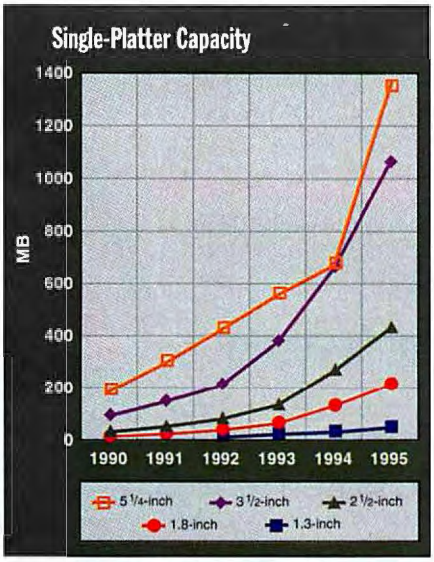
SCOTT WALLACE

Your computing environment contains many types of storage, from the registers that feed the processor pipelines to the jukeboxes that store archival data. The different types of storage in a computer system form a hierarchy, with fast, expensive devices at the top and slow, inexpensive ones at the bottom.

The best visual representation of this storage hierarchy is a pyramid. Since the early days of mainframes, computer systems engineers, managers, and users have found the pyramid ideal for depicting how data is organized and distributed across storage devices. Over the years, the simple RAM-disk-tape pyramid has evolved into a complex, distributed, hierarchical data-storage architecture populated by devices of varying capacity, performance, reliability, and price.

Today, the volume of data managed by this storage hierarchy is rising dramatically. The ever-increasing storage demands of individual applications; the migration of large database applications from the glass house onto corporate networks; and the introduction of new groupware, imaging, and multimedia desktop applications contribute to the need for more distributed-storage capacity and more effective tools to manage data. The goal is cost-effective data management that properly safeguards information while providing users with appropriate access at the lowest cost.

Fortunately, rises in storage requirements have been paced by rises in storage capacity. Recently, hard drives have shown a 60 percent annual increase in data density, a trend that shows no sign of changing (see the figure "Single-Platter Capacity"). MO (magneto-optical) drives doubled their capacity not long ago and will do so again soon; tape subsystems in several form factors have dramatically increased storage capacities and speed; and jukeboxes, or auto-loaders, have improved in price, performance, and reliability, further leveraging MO and tape drive advances. The result is a storage hierarchy that is becoming at once more flexible, more responsive, and more complex.



For the foreseeable future, *hard drive capacities will continue to advance an average of 60 percent per year, regardless of form factor. (Source: Dataquest, 1993)*

Storage Hierarchy

Every organization must create and configure its storage subsystems based on user needs and compatibility with the existing IT (information technology) infrastructure. Each organization must, in effect, design and construct its own storage pyramid. Typically, this is done by selecting products with a range of per-megabyte costs and access times that provide a price/performance continuum by mixing slower, low-cost products with faster, high-cost products (see the figure "Cost vs. Speed").

Although many storage products today have short development and life cycles, this hasn't prevented enterprises from effectively incorporating technological developments into their storage hierarchies. "For most organizations, the 'sweet spots' don't move around very much, because all components of the pyramid are improving performance more or less simultaneously," says Alex Nedzel, a consultant with Ernst & Young's Center for Information Technology and Strategy in Boston, Massachusetts.

A bigger problem is the proliferation of data, where there are two basic concerns. "First, there's the relatively straightforward problem of getting enough data online at the right cost," Nedzel says. "But the more complicated issue is how to assure the safety of that data from both a confidentiality and a disaster-recovery standpoint." While industrial-strength software to manage storage exists in mainframe environments, none exists that can manage storage in the type of heterogeneous distributed-computing environment that typifies many client/server systems.

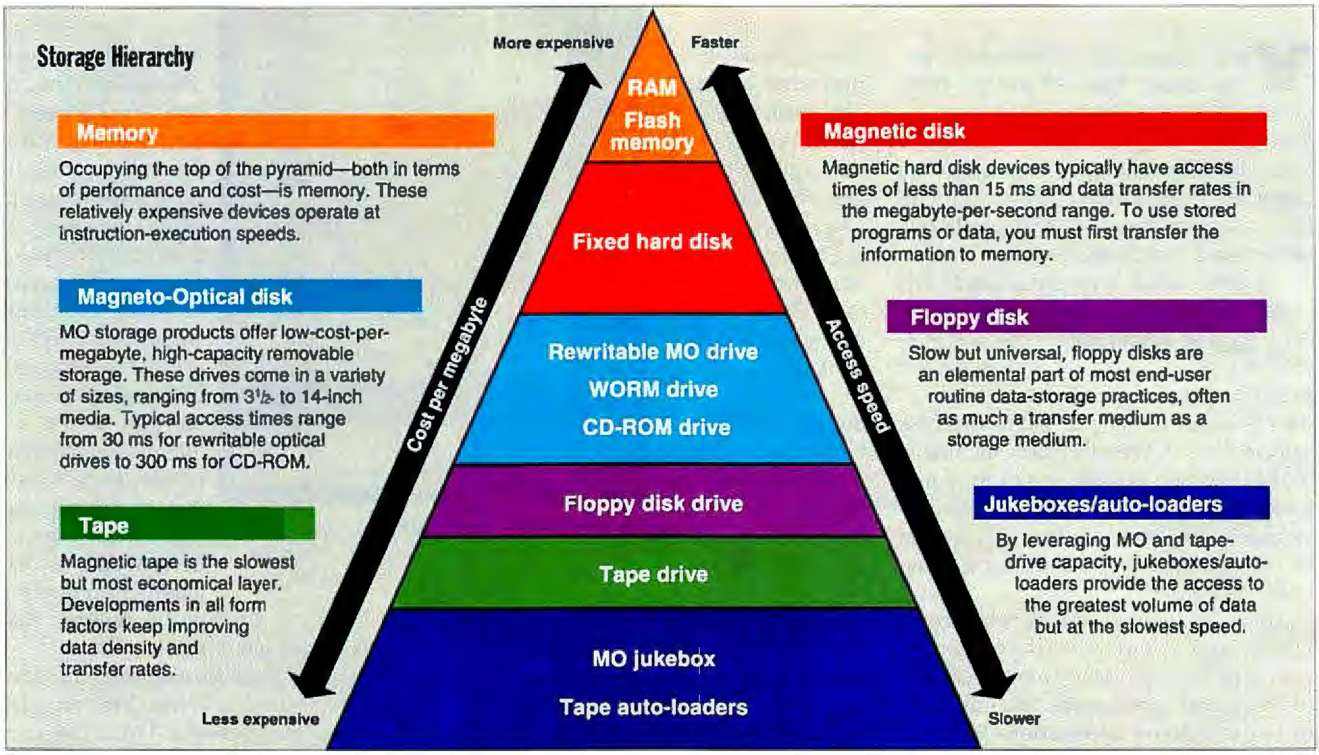
To match such an environment, contemporary storage hierarchies are also broad and heterogeneous. To confuse matters more, they often differ from platform to platform, even in a single organization. A mainframe storage hierarchy is different than a desktop hierarchy, which is different than a server, laptop, or PDA (personal digital assistant) hierarchy. A pyramid combining all platforms would have memory, magnetic disk, MO disk, floppy disk, tape, and auto-loader layers (see the figure "Storage Hierarchy").

The Persistence of Memory

The top of the storage pyramid consists mostly of DRAM and associated caches that are used for temporary storage of programs and data. As applications and operating systems become more memory hungry, you'll see the average memory of desktop systems rise to accommodate such requirements.

The real news is flash memory. Flash

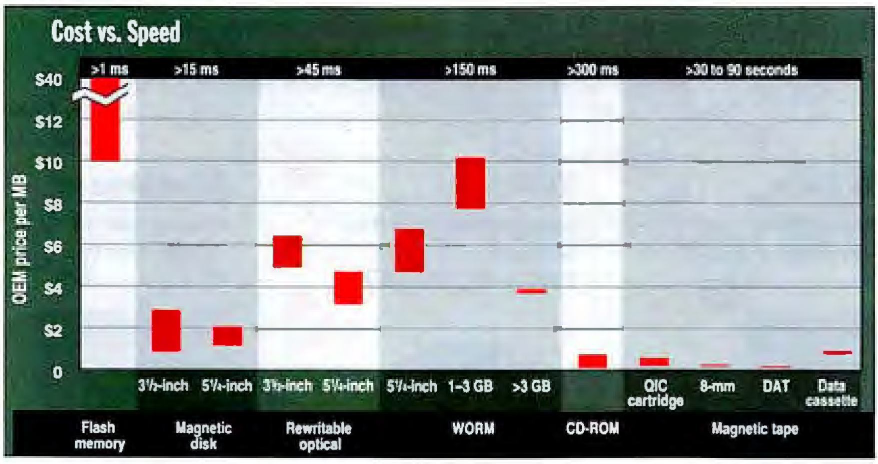
ILLUSTRATION: GEORGE SCHILL © 1994



A pyramid is ideal *for representing the relationships between different parts of the storage hierarchy. Technologies at the top are more expensive and are fielded in small capacities; technologies at the bottom are less expensive and have larger capacities.*

memory has been around for some time but is just now becoming popular. This is a result of many factors, primarily increased chip-storage capacity, reduced manufacturing costs, and demands for low-power, low-weight storage created by PDAs and other mobile-computing devices.

Flash memory is not only fast (with a less-than-1-millisecond seek time), it's extremely reliable. Because it has a lower soft-error rate than DRAM and is nonvolatile, flash memory is ideal for BIOS and critical systems applications. Flash memory today has low power consumption (e.g., Intel's 16-Mb FlashFile chip draws only 1 milliamp in static mode or 1 microamp in power-down mode). And because a flash-memory system has no moving parts, it offers survivability well beyond that of rotating media—it can survive a shock in excess of 1200 g's and operate in temperatures ranging from –13° F to +167° F. Flash storage is also small (32-Mb chips should soon provide storage of 195 MB per cubic inch) and light, and it operates silently. Flash memory today is an ideal storage medium for laptops, as well as personal and mobile digital applications.



With nonvolatile memory, *access time and cost are inversely proportional. You can pay up to $40 per megabyte for flash storage, while most forms of tape storage are well under $1 per megabyte. (Source: Freeman Associates, Inc., 1993)*

The problem with flash memory is price. An OEM can expect to pay $1200 for 40 MB of flash memory. Thus, typically, flash-memory disk purchasers buy 5- or 10-MB PCMCIA cards (at OEM pricing of $200 to $300) for portable computing environments. The relatively low storage requirements of PDA devices fit flash-memory pricing. In addition, PDA operating systems are designed from the ground up to support flash architectures. "Flash is block-erasable but byte-writable. It's not like a disk drive that has direct overwrite," explains Bruce Bonner, flash drive product-line manager for Intel in Santa Clara, California. "With flash, you want programs and data separated. Right now, desktop operating systems commingle them; they're not flash-friendly."

Desktop operating systems will exhibit flash-friendliness in the next year or two. And if what Nelson Chan, director of marketing at SunDisk in Santa Clara, California, says is correct, almost every desktop machine in the future will have a PCMCIA slot for transferring data between the desktop and portable computing devices. "We expect to bring a low-cost PCMCIA desktop card reader to market soon with a street price of under $80," says Chan. With sustained read rates of 3

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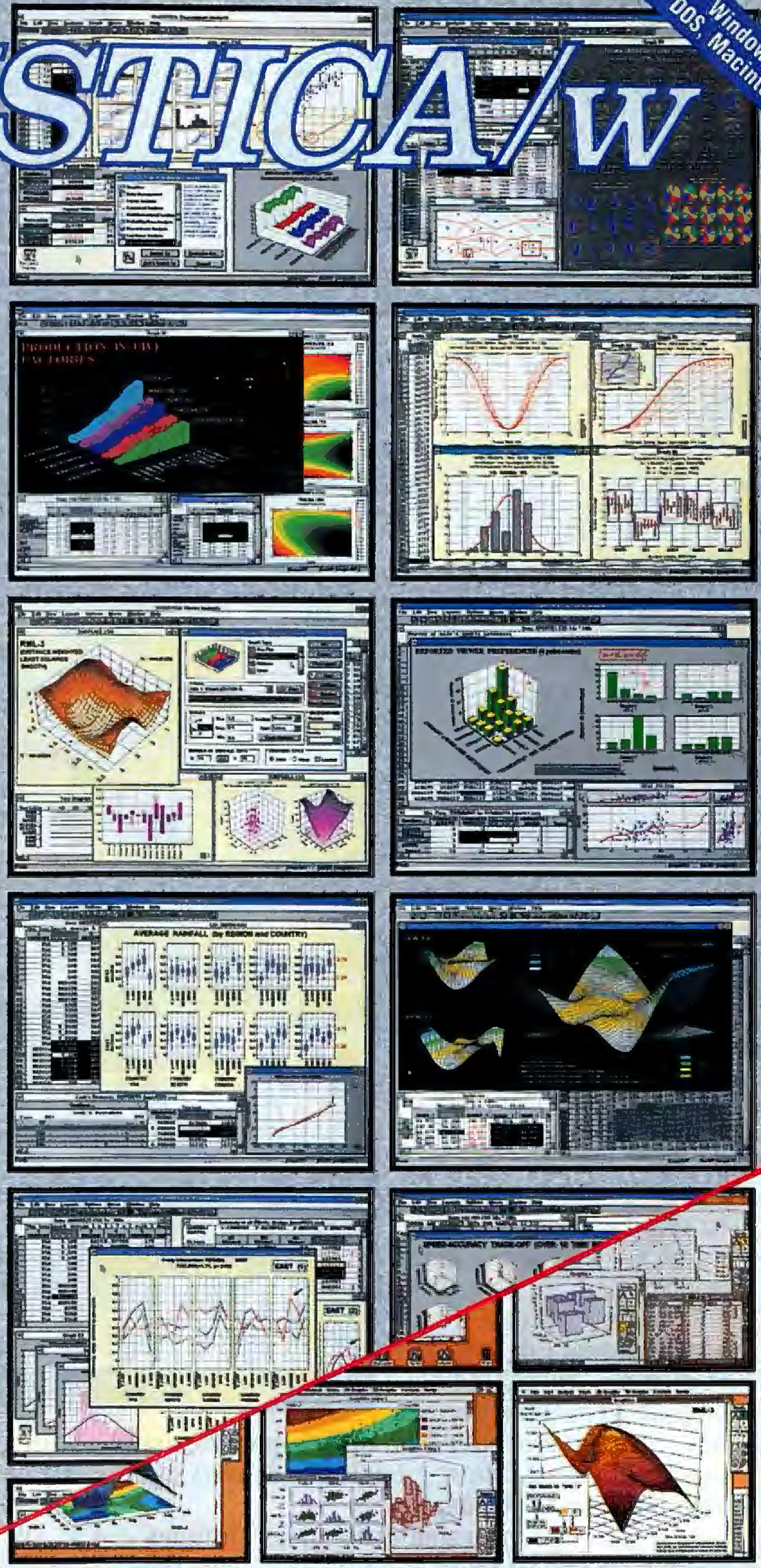

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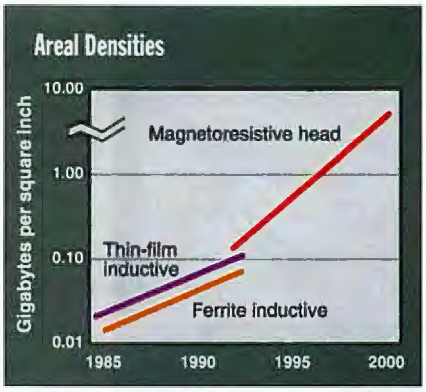
or 4 MBps (writing is slower, on the order of 200 KBps), future PCMCIA flash-memory disks—like floppy disks today—may be a key portable-to-desktop end-user link.

Spin Doctors

Hard disk technology is the most rapidly evolving storage technology, largely as a result of the size of the hard disk market, its highly competitive character, and industrywide R&D spending on rigid disks. Phil Devin, vice president of storage technologies at Dataquest in San Jose, California, foresees density improvements of 60 percent to 65 percent annually, prices falling by 12 percent per quarter, and product life cycles of less than a year. A key factor in density improvements will come from developments in MR (magnetoresistive) heads, with much of the work being done by IBM.

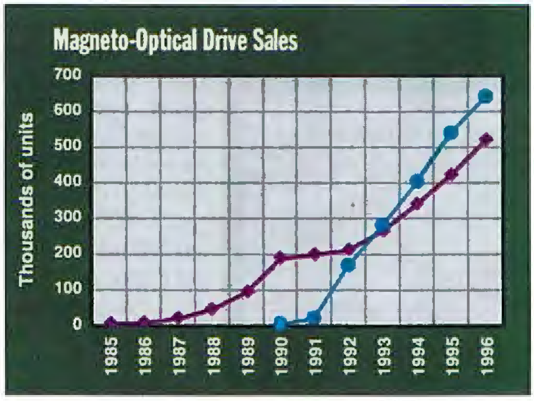
MR heads allow greater areal density than either thin-film or ferrite-inductive heads (see the figure "Areal Densities"). According to Bob Scranton, director of storage systems and technology at IBM's Almaden Research Center and director of advanced technology at IBM's San Jose, California, Storage Systems Division, MR heads will be important for maintaining a 60 percent compound annual growth rate in areal density for the foreseeable future. "With expected improvements in our MR heads, the focus will shift more toward the electronics," says Scranton. IBM is just one of many companies pursuing research into the data-recording, digital-read-channel, and interface technologies that will help keep areal-density growth at historic levels (see "Digital Hard Drives" on page 91).



Head technology *is one of the driving forces behind hard drive capacity increases. Magnetoresistive heads are expected to accelerate capacity increases, partly because they work so well with newer digital read technologies. (Source: IBM Corp., 1992)*

Data density isn't the only good news: Drive latency, a function of rotation speed, is getting better, too. "We've seen an increase in spin speed from 5400 rpm to 7200 rpm," says Paul Wasenberg, product-line marketing manager for Micropolis of Chatsworth, California. Spindles spinning 33 percent faster means data is available sooner. Combined with increased areal density (which also means an increase in linear density), the effect is a higher data rate. The trade-off is noisier, hotter, and more power-hungry drives.

IBM's DFMS and DFHS families of high-performance 3½-inch drives rotate at 7200 rpm. These 1-, 2.1-, and 4.3-GB drives feature an industry-leading areal



As capacities increase, *so will the popularity of MO technology. The plateau in 5¼-inch shipments from 1990 to 1992 reflects the effects of the standards turmoil in that market. (Source: Disk/Trend, Inc., 1993)*

density of 564 Mb per square inch, a seek time of 8.6 ms, and the industry's highest media rate of 12.2 MBps. The Barracuda, another 7200-rpm drive from Seagate Technology (Scotts Valley, CA), offers 8-ms seek times and a capacity of 4.1 GB. With lower seek times, improvements in caching, and higher spin speeds, access times will only get better.

Focus on Optics

The principal advantages optical disks (rewritable and WORM) have over hard disks are removability and greater bit density. These combine to make optical storage ideal for library and archive applications. In the past, the optical-storage market was primarily focused on large 12- and 14-inch drives, but the emphasis today is on smaller products (see "Optical Advances" on page 107). Projections for 5¼-inch and 3½-inch rewritable optical drives indicate strong market growth (see the figure "Magneto-Optical Drive Sales").

The 5¼-inch form factor is attractive for desktop applications. "In 1993, we saw the introduction of the double-capacity 5¼-inch drives, which significantly improved the cost per megabyte of optical storage over the earlier 650-MB models," says Stan Corker, director of removable storage research at IDC (San Diego, CA). And things are likely to get better. Hitachi, outpacing optical-drive manufacturers Hewlett-Packard, Sony, and IBM, has released its triple-density 2-GB 5¼-inch drive.

Rewritable optical drives in the 3½-inch "rigid floppy" form factor are also becoming more capacious and attractive. "The momentum is with the 3½-inch drive," says Patty Chan, optical-storage analyst with Dataquest. "It's a smaller form factor, the entry cost is much lower, and it can be used in many more applications. We expect 1993 figures to show 3½-inch drives surpassing 5¼-inch drives in unit shipments, and in 1995 we anticipate some 3½-inch drives in excess of 500 MB."

Because optical is a removable storage medium, there is a strong demand for interchangeability standards. "The development of standards probably tends to throttle back the rate of technological improvement," comments IBM's Scranton, referring to the disparity in bit-density improvements between magnetic and optical storage over the past several years. "CD-ROM players, for instance, have been at the same density for many years. The reason is media interchange standards."

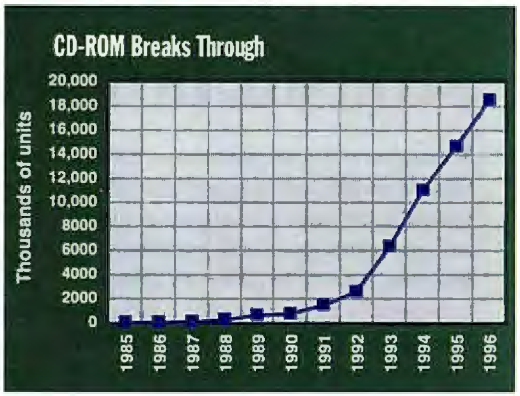
In terms of unit shipments, however, CD-ROM is the fastest-growing segment of the optical marketplace (see the figure "CD-ROM Breaks Through"). Until recently, CD drives were strictly aftermarket products, typically oriented toward publishing and data-distribution applications rather than storage. "CD-ROM has graduated from an aftermarket item to an option in the standard configuration," notes Dataquest's Chan.

End-user and OEM interest in CDs is being driven primarily by pricing, but functionality helps. "Over the next two years, the price of CD-R [CD Recordable]—now around $5000—will drop fast. In that same time frame, we can expect to see erasable CDs," says Chan. These developments will likely push CD-ROM drive prices lower.

Tale of the Tape

Magnetic tape products are growing quickly in capacity and, despite impressive improvements in hard disk storage, are keeping pace with magnetic drives. A critical end-user issue with tape is storing data faster, particularly in server environments where the window for backing up data is constrained, but the amount of data to be backed up keeps growing.

QIC (quarter-inch cartridge) drives account for 76 percent of the installed base of all computer tape drives, according to Robert Abraham, an analyst with Freeman Associates in Santa Barbara, California. "This momentum—coupled with a strong desire for backward compatibility, well-defined performance migration paths, and low costs—has discouraged many users from defecting to helical-scan or optical technologies," he says.



After years of slow growth, *CD-ROM players are starting to be considered standard equipment on desktop PCs. (Source: Disk/Trend, Inc., 1993)*

QIC tape products can be configured to compatibly serve a range of computing environments, from mainframes to laptops. "The highest growth area is the QIC 3½-inch format, and that's being driven by PC users," says Fara Yale, tape market analyst at Dataquest. Yale estimates 1993 shipments of QIC 3½-inch floppy interface products at more than 2 million units, mostly for stand-alone PC backup. Desktop penetration, however, remains low, at less than 10 percent of desktops.

Arguably the fastest-growing tape market segment is parallel-port interface tape systems; these products can support

STORAGE HOT SPOTS

Perhaps more than any other product, the jukebox is an enabling technology with a potent multiplier effect; it allows improvements in optical- and tape-storage drives to be multiplied many times over. Because the price of the jukebox robotics remains the same, doubling drive capacity in a jukebox has the effect of halving the cost per megabyte. Hewlett-Packard, a leader in the growing 5¼-inch optical jukebox market, found that the release of its 1.3-GB optical drives caused a flood of jukebox sales.

But price and capacity aren't the only issues. "The challenge of optical drives and jukeboxes is to help smooth the pyramid, so it's not an ugly transition between on-line data and off-line data, and to help make network administration a natural act," says Pam Ingmire, product marketing manager at HP's Greeley, Colorado, storage-systems division.

Capacity, security, and availability are the critical buyer issues. Performance, though less critical, is still important. "On our 5¼-inch library, the worst-case time to access data is 15 seconds or so," Ingmire says. "We're looking to improve that by 50 percent or more with a 'double-picker'—robotics that can handle two cartridges at once rather than just a single disk."

SQUEEZE PLAY

Data compression, once a rarity, is now commonplace and is even bundled into many storage products. Compression can be accomplished either by hardware (which is faster) or software (which is less expensive and more flexible) and with absolutely no loss of data and lower compression ratios (lossless) or with no appreciable degradation of data and higher compression ratios (lossy).

The data compression market is fairly mature, and desktop products like PKZip from PKWare (Brown Deer, WI) and Aladdin Systems' (Watsonville, CA) StuffIt are tried and true, widely used, and inexpensive. Typically, these utilities operate at the archive or directory level, which means that they can compress segments of a disk, keeping directories and file structures intact. "For archive-level compression, the goal is efficiency, not speed. That's where the compression-ratio wars are happening today," says David Schargel, president of Aladdin Systems. Real-time compression services, such as those embedded in MS-DOS 6, are faster but result in less compressed files than archive-level products.

Images, motion video, and multimedia will become commonplace on the desktop only if there are price and performance improvements for silicon-based products that support JPEG and

MPEG compression. "Until you compress video or still-image data, it's just too voluminous for a PC to handle," says Eric Hamilton, manager of microcode for C-Cube Microsystems and chair of the ISO JPEG committee. C-Cube is developing a chip to support H.261 video, as well as MPEG and JPEG compression and decompression. By the end of 1994, volume pricing for the chip is projected to be under $100.

DEALING WITH DISASTER

Disk arrays designed to increase the reliability and performance of disk-storage subassemblies are also leveraging the improvements made in drive and interface technologies. "High data-rate applications—like multimedia PCs and audiovisual software—are growing," says Joel Hagberg, Raidion product manager at Micropolis. "At the same time, mission-critical applications are migrating down to the network. The result is storage requirements that are going sky-high and an increase in the need for fault-tolerant storage."

The demand for fault-tolerant storage is paced by users' growing awareness of the value of their data. Different solutions provide different degrees of security, and users must select their solution and its risks. "There are many different levels of fault tolerance, going all the way to on-line transaction-processing systems where everything is paralleled," notes Jim Porter, president of Disk/Trend in Mountain View, California.

Redundancy, as exemplified by RAID technology, is one popular approach to creating fault-tolerant storage (see "Disk Arrays Explained," October 1992 BYTE). But, as storage components become more bulletproof (IBM's DFMS and DFHS drives sport 1-million-hour MTBFs [mean times between failures]—that's 114 years of uninterrupted use), fault-tolerant storage should become less expensive, more manageable, and more available. "We've just seen the tip of the iceberg in terms of the kind of confidence we'll have in a file server, say, five years from now," concludes Porter.

not only desktop systems but laptops as well. A variety of manufacturers, including Colorado Memory Systems, Conner Peripherals, and Tandberg Data, offer parallel-port interface products.

DAT (digital audiotape)—because of its storage density and small form factor—is popular for data-intensive storage applications at the desktop, the workstation, and the server level. Products by Conner Peripherals, HP, Sony, and others are making inroads into the tape-storage market.

At the high-end, DEC's DLT (Digital Linear Tape) offers capacity, speed, and extreme reliability. The design allows for a head life of 10,000 hours (nearly five times that of previous drives), a recommended average of 10,000 reads/writes per cartridge, and an MTBF (mean time between failures) of 80,000 hours.

The Storage Boss

Managing the storage hierarchy—whether for a PDA, laptop, workstation, server, or mainframe—is getting more complex, and the consequences of mismanagement are getting more expensive. A survey of 450 information systems executives at Fortune 1000 companies found computer downtime cost an average of $78,191 per hour and occurred, on average, nine times a year. A typical "outage" cost $330,000, including the costs of recovering or reconstructing data. Clearly, users must prepare themselves and their data for the inevitable.

In the client/server environment, this preparation can be complicated, and hierarchical storage management systems are being called on to automate backup and recovery, manage file migration, and oversee volume and library management services. The goal is to create a high-reliability, high-access, high-performance data management environment. "Hierarchical storage management comes from the mainframe world, and users migrating to client/server are looking for the same kind of management tools they had on their mainframes," says Barbara Goldworm, product-line manager for management services at Novell in Provo, Utah.

NDMS (NetWare Distributed Management Services), Novell's management strategy, supports the utilities and functions to allow decentralized management of storage and data across distributed environments. Within NDMS today, HCSS (High-Capacity Storage System Services) supports hierarchical management across the magnetic disk and optical disk layers. "The Novell strategy is to provide key management services within NDMS, plus APIs to development partners for extended or specialized additional services," Goldworm notes. HCSS lets users set "watermarks" on disk capacity and trigger transparent data migration to and from magnetic and optical storage.

Hierarchical storage management comes from the mainframe world, and users migrating to client/server are looking for the same kind of management tools they had on their mainframes.

Conner Software Products (Lake Mary, FL) offers hierarchical storage management software called Conner HSM. The Conner system is designed specifically for automated data management on Novell NetWare networks. It manages three of the storage pyramid layers: magnetic disk, optical disk, and tape. Conner HSM, which is typically configured with a dedicated storage server running as its primary task, has three logical components: the network interface, migration and data management software, and analysis and reporting to support assessment of migration thresholds. "From the user's perspective and from the network administrator's perspective, Conner HSM is just one large storage pool," explains Rick Luttrall, product marketing manager for Conner's advanced network products. "They really don't know where the files reside within the hierarchy; that's transparent."

One of the problems confronting prospective storage management customers is an uncertainty about their true storage needs. With individual desktop applications expanding data requirements, mainframe applications migrating onto networks and desktops, and altogether new applications emerging, it's difficult to project storage needs. "We provide a tool, HSM Planner, that helps users analyze operations across the enterprise—all the servers on the network—and determine what their storage requirements are and are likely to be within the next three years," says Luttrall.

Storage Directions

What can we expect in the future? Flash memory will become less expensive and smaller and increase in capacity. As desktop and laptop operating systems become "flash friendly," look for operating systems on a chip. Also, solid-state disks, such as DEC's new 580-MB DRAM ESP580, can be expected to penetrate specialty markets like high-speed, high-value transaction-processing applications, where data integrity is paramount and I/O storage is the bottleneck for high-value transactions.

In hard drives, you should look for big-drive capacity (i.e., 500 MB) on small drives and lower per-megabyte cost everywhere. Also, advances in interface technology will make it easier and less expensive to use these large-capacity drives (see "IDE Takes Off" on page 97). MO storage will experience faster density increases than it has in the past, while in CD-ROM, prices will continue to fall and multispeed drives will proliferate, with triple- and quadruple-speed drives from companies such as NEC and Pioneer becoming increasingly common.

On the cutting edge, look for holographic storage products to come to market within the next year. Tamarack Storage Devices of Austin, Texas, a spin-off of MCC, expects to ship its holographic product, called MultiStore, in the second quarter of this year. MultiStore will provide 30 GB of removable WORM storage at an initial end-user cost of $6000, dropping to $3500 with volume. Media cost is projected to be $5 per gigabyte. The device is essentially an auto-loader for 30 2½-inch disks, each of which stores a gigabyte of data on a Du Pont photopolymer material similar to that used in holographic art.

On the software side, hierarchical storage management software will get more robust, address more layers of the pyramid, and better manage storage devices. In the next three years, you'll see capable, multiplatform products that offer mainframe-quality data-storage management in distributed environments.

All these improvements will be necessary, as the future will bring more and more data that's increasingly critical to success in a wide variety of businesses and industries. "Keeping your detailed manufacturing data on-line so you can optimize production efficiency and products, for instance, is a competitive investment," notes IBM's Scranton. "If it produces improved quality and reduced cycle time, then more companies will be using data as a competitive weapon." The result is an accelerating demand for products to ease the management of that data. ■

Scott Wallace is a BYTE technical editor. He can be reached on BIX c/o "editors."

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State of the Art

DIGITAL HARD DRIVES

Older analog read technologies are giving way to DSP-based digital read channels, which let you pack more data on your hard disk

PETER WAYNER


GEORGE SCHILL © 1994

Over the next several years, most hard drive manufacturers will abandon purely analog recording technology and begin shipping drives that use digital techniques. The new technology, called digital read channel, will at least double the amount of information that can be packed into each square inch of a hard drive platter, and there's no reason to doubt that further advances will produce even greater improvements in density. Such improvements in density are necessary as desktop machines move to applications that employ such rich data types as voice and video.

The key to the transition is a collection of low-cost drive controllers from companies such as Cirrus Logic (Fremont,CA), IBM Storage Systems Division (San Jose, CA), and Adaptec (Milpitas, CA) that incorporate digital signal processing to digitally process the signals from the disk fast enough to sustain the data rates needed by the main computer. These controllers use a digital signaling technique known as PRML (partial-response maximum-likelihood) that was originally used for communications with deep space probes, such as the Viking Lander. If the technique helped keep data clear through all the background interference from space, there is no reason why it can't help keep the data from disk drives clear, too.

PRML lets you pack more information into each track of a drive, because the algorithm allows the drive hardware to filter out the noise associated with densely packed data. The algorithms use knowledge of how nearby bits can blur together in order to clean up the signal and detect spurious signals. The new chips also pack more tracks on each platter by using digital techniques to align the drive head over the correct track. When these two improvements are combined, they can lead to a doubling in the amount of data stored per disk. That means the cost of hard disk storage per byte will be cut in half.

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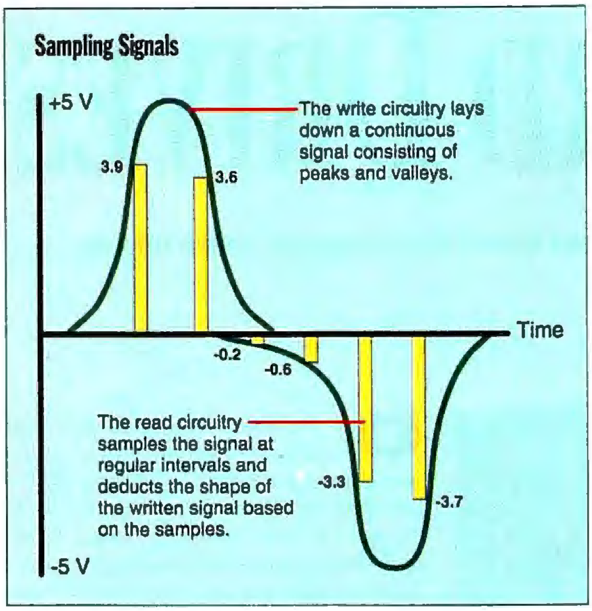


As laid down by the write circuitry, *1 bit on a hard drive corresponds to magnetized spots on the surface of the disk, while 0 bits corresponds to the absence of magnetization. The signal on the disk resembles a smooth curve. The read electronics, however, doesn't see a smooth curve. Rather, it samples the signal at discrete points. Interpreting these samples gets tricky as increasing bit densities pushes the peaks closer together.*

Hard Drive Basics

To understand this approach, you need to begin with the physics of building a hard drive. A drive uses electromagnets to store data on the magnetically sensitive coatings of the platter. When the electromagnet is turned on, it generates a magnetic field. The molecules in the coating align themselves in the direction of the field in the same way that a compass turns to align itself with the magnetic field of the earth. Current can pass through the electromagnets in two directions, which means that resultant magnetic fields can have one of two opposite orientations. When you flip the polarity of the electromagnet, it will leave a similar pattern in the coating.

You read the data from the disk using the reverse of the write process. The magnetic fields in the coating generate tiny electrical currents in the coils of the electromagnets as they pass under the read/write head. The presence or absence of an induced current determines the value of the spot.

At this level, both analog and digital hard drives and analog and digital tape drives operate in the same manner. The main difference is that the disk drives record bits as spots where the magnetic field saturates the coating and completely aligns all molecules. Old analog cassette decks stored the sound in the strength of the field that created larger and smaller magnetic patches. This technique is not generally used in disk drives because saturated blips are easier to read and write at high speed. This ease is also why digital tape players are making such inroads in the consumer audio world.

For years, drive manufacturers have continued to use tried-and-true analog read techniques while concentrating on other technologies to increase disk capacity. One major target has been reducing the distance between the head and the platter. The closer the head, the smaller the magnetic spot and consequently, the more data that can be packed into one place. Of course, small spots also mean weaker induced fields when reading, so researchers have also concentrated on the development of more sensitive thin-film coatings. Research certainly continues in these two areas, but manufacturers are turning to PRML because the electronics necessary to do the more complicated digital calculations are finally becoming inexpensive enough to make digital drives a commercial possibility. Digital techniques let disk makers achieve significantly larger packing densities without investing the money in building physically more precise mechanisms or developing more sensitive recording media.

Encoding Data

The process of converting bits into magnetic marks on a disk involves at least three different layers of algorithms. On the highest level is the operating system, which writes the file (which may already have been compressed by software) to the disk electronics. When these bits are handed to the drive, the drive electronics then encodes them with ECCs (error-corrected codes), such as Reed-Solomon codes. ECCs have redundant bits that let the hardware reconstruct the original data when errors occur. The codes are a well-studied branch of mathematics. They often amount to constructing overdetermined systems of equations where m equations and n unknowns exist, and m is greater than n.

This resulting bit stream is then converted into RLL codes, which add redundant bits to guarantee that not too many 1s or 0s fall in a row. The process for writing to the disk generates a new magnetic mark for every time a 1 occurs. If a 1 doesn't occur often enough, the clock that tries to count the position along the drive starts to drift, and the drive may drop a bit. Cirrus Logic uses an RLL in which every 1 is separated by at least one 0 and no more than seven 0s. During the course of this process, the bits increase in number by 50 percent. This loss of packing density is necessary to guarantee the accuracy of the data.

The effects of writing bits on a disk can be seen in the figure "Sampling Signals." The curve represents the strength of the magnetic mark at a particular point on the track. Some of the peaks point up and others point down. Drive controllers usually alternate positive and negative peaks to help distinguish them.

The old generation of technology used two peak-detection circuits to determine whether a peak occurred. One circuit would check to see if the signal was above a preset level, and the second would take the derivative of the signal and look for a 0. This worked well if the peaks were spread apart, but as they grew closer, the mingling of two peaks would often add false peaks.

READ TECHNOLOGY

Analog

- **Is simple to implement**
- **Needs clean samples**
- **Can't handle closely packed bits**

Digital

- **Requires fast processors**
- **Can filter noise and other interference**
- **Allows denser packing of bits**

The Role of PRML

The main problem with crowded signals is that the read electronics do not see the smooth curves as shown in the figure "Sampling Signals." The heads can only provide a few samples for each peak. Thus, as you crowd more bits into a smaller area, you need some method of determining to which peak a sample belongs. This is the role of the PRML algorithms in digital read channels. The algorithms determine whether each pair of samples belong to the same peak or to two different peaks. More important, the algorithms adjust themselves when errors occur, because it is not uncommon for noise to skew samples and add false peaks.

The PRML algorithms used in digital-read-channel controllers are similar to the algorithms that were developed in the sixties and used to process convolutional codes. These codes built in a certain amount of redundancy and error correction by writing each bit down as the sum of several of the previous bits. For instance, one simple convolutional code might write bit *i* as the sum of bit *i*, bit *i*-1, and bit *i*-3. Bit *i* can be recovered at read time by subtracting out the values of bit *i*-1 and bit *i*-3. Normally, these convolutional codes will store each bit as the result of two or more different polynomial equations based on the previous *n* bits. The more complex the polynomials, the more resistant the code can be to error.

If there is no noise, these convolutional codes can be decoded by reversing the equation and subtracting out the values of the previous bits that have already been decoded. But if there is noise, the algorithm can use the extra information present to determine which bits were flipped. It tries to identify the most likely bit that caused the error. The algorithms for doing this are often known as *Viterbi algorithms*. In the simplest form, they amount to checking all possible errors and looking for the best match to the data in question. This technique is useful if you are using a small polynomial involving only a few bits that could go wrong. In the most complex cases, the algorithms perform like dynamic programming algorithms.

Convolutional codes are good models for disk drives where tightly packed data may create peaks that overlap. The tail of one bit can often interfere with the signal of another. More important, each peak can contain several sample points. The algorithm's job is to determine when and how noise skews some of the sample points (see the text box "PRML at Work").

Embellishing PRML

Some manufacturers have developed proprietary approaches to these PRML algorithms. Cirrus touts its SofTarget feature that allows the electronics to tune itself on various drives. The electronics can use a range of different polynomials in the convolutional codes and also set the expected values for each peak. Each drive can tune itself and choose the best values. One drive might decide that its peaks normally generate ±3.7 for the first sample and ±3.4 for the second sample after it writes and reads a calibration pattern. Another might choose the pair ±3.2 and ±3.5.

Cirrus believes that the SofTarget technology gives drive manufacturers the ability to relax their tolerances on the magnetic media and the heads. The heads and the media do not have to perform in as narrow a range as before.

The Electronics

Companies such as IBM, Cirrus, and Adaptec like to characterize digital-read-channel systems as using digital signal pro-

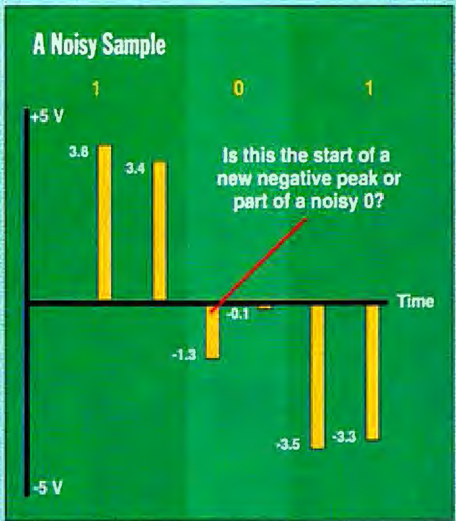
PRML at Work

PRML (partial-response maximum-likelihood) comes into play when noise skews one of the samples of the signal from the disk. In the figure "A Noisy Sample," the signal should properly decode to bit pattern 101, but the third sample is hard to interpret. It could be the beginning of a negative peak that was attenuated, or it could be a peakless point that was amplified by a glitch or by interference with a neighboring peak.

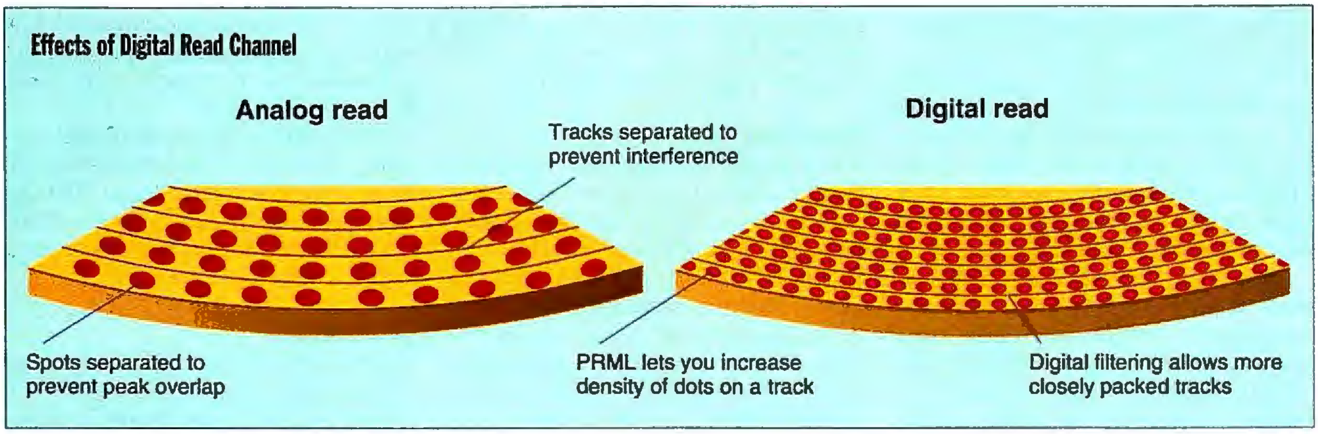
A peak-detection algorithm could be confused by the noise in this signal. It might detect an extra negative peak in the 101 bit pattern. This weakness in peak detection is one reason drive makers can't pack too many peaks close together unless they resort to technology that yields a more intelligent interpretation of the samples.

Under PRML, the drive electronics doesn't try to interpret the third sample until later samples arrive. In fact, PRML tracks both interpretations and then computes the partial error that would occur with each interpretation. Assume that the standard assumed value for a peak is ±3.5 and a flat section is 0. Interpreting the 101 pattern as a 110 would generate 12.8 total units of error. The correct interpretation, however, would only generate 2.0 units of error. Thus, the PRML can make the correct choice for the interpretation.

Although it is possible to make the decision after the fourth sample, a PRML algorithm might wait until the fifth and sixth samples arrive before choosing the interpretation with the smallest amount of error. This is one reason why drive controllers alternate between positive and negative peaks. The fact that two peaks of the same polarity can't follow each other disallows certain interpretations and makes it easier to weed out bad choices.



The third sample *in this example signal is an anomaly—it doesn't correspond to a 1 bit or a 0 bit. Using PRML, the read electronics use the value of follow-on samples to correctly interpret the anomalous sample as part of a 0 bit.*



Digital technology *lets disk makers pack bits more closely on individual tracks and also pack tracks more closely. The advent of magneto-resistive heads will further increase the packing density of hard disk platters.*

cessing. While this is true, the use of these words can cause some confusion because the electronics built into the drive hardly resemble the DSP (digital signal processor) chips that are common today. The standard DSP is a stand-alone computer with some beefed up circuitry for doing simultaneous multiplication and addition.

On the other hand, these drive controllers can do only one thing—interpret the signals coming off the disk. The electronics are hard-wired circuits that can only be reprogrammed in small ways. The circuits must be simple because they have to process the data at high rates. The Cirrus CL-SH4400, for instance, can put out data at up to 64 Mbps at channel frequencies of up to 96 MHz.

The work that the CL-SH4400 does can be broken up into five basic steps. First, a companion chip, the VM6400 from VTC (Bloomington, MN), converts the raw signal from analog into 6 bits of digital representation. When this arrives at the

CL-SH4400, the signal is equalized and smoothed before the PRML algorithm attempts to filter out the errors. This is because the response of the head to the magnetic field is often not smooth. Finally, the chip removes the RLL codes and presents the result in ordinary form.

In addition, Cirrus makes the CL-SH3300, a one-chip version of the CL-SH4400/VM6400 pair that performs at a slower rate of 40 to 48 Mbps. A 64-Mbps derivative of the CL-SH3300 will be available soon, and Cirrus plans to push the two-chip version to even higher rates. Both packages are made in CMOS.

The Future

The emergence of PRML drives is likely to be responsible for major gains in price/performance of hard drives over the next several years. At this point, Cirrus claims that new drives can increase in capacity by up to 50 percent if the company uses the CL-SH4400 SofTarget technology with conventional heads and magnetic media.

In the future, further gains will come when drive manufacturers can build magneto-resistive heads. These heads contain special resistors that change their resistance as they pass through the magnetic field caused by a magnetic mark on the disk platter. These heads are better tuned for PRML algorithms because they generate smoother signals. When these heads become common, drives should be able to pack twice as much information again into each platter.

The simple PRML algorithms used in this first round of drives is just the beginning. More complicated coding algorithms can result in greater densities of data. IBM's Almaden Research Center (San Jose, CA) is experimenting with a trellis-coded PRML system that uses a more sophisticated coding algorithm that is commonly used in high-speed modems. Its system uses a technique called Matched Spectral Nulls that more accurately tunes the coding algorithm to the read-head response. The algorithm knows which types of errors are more likely to happen, and it can recover those better. IBM is reporting that experiments show that at least 15 percent more information can be packed into each track, and more important, off-track performance is improved, allowing narrower track widths.

These algorithms promise to reduce the amount of error correction that is built into the system. At this time, the three levels of codes—ECC, RLL, and PRML—significantly increase the number of actual bits that are written to the disk. If the coding process can be more properly tuned to the channel, then more data can be written.

The future drives will no doubt include even more innovations in coding technology. Digital disk electronics was not possible until recently; you couldn't fabricate chips with enough transistors to do the necessary computations. Now that this technology has arrived, there will be plenty of room in the future for new systems that incorporate better algorithms and more robust codes. ■

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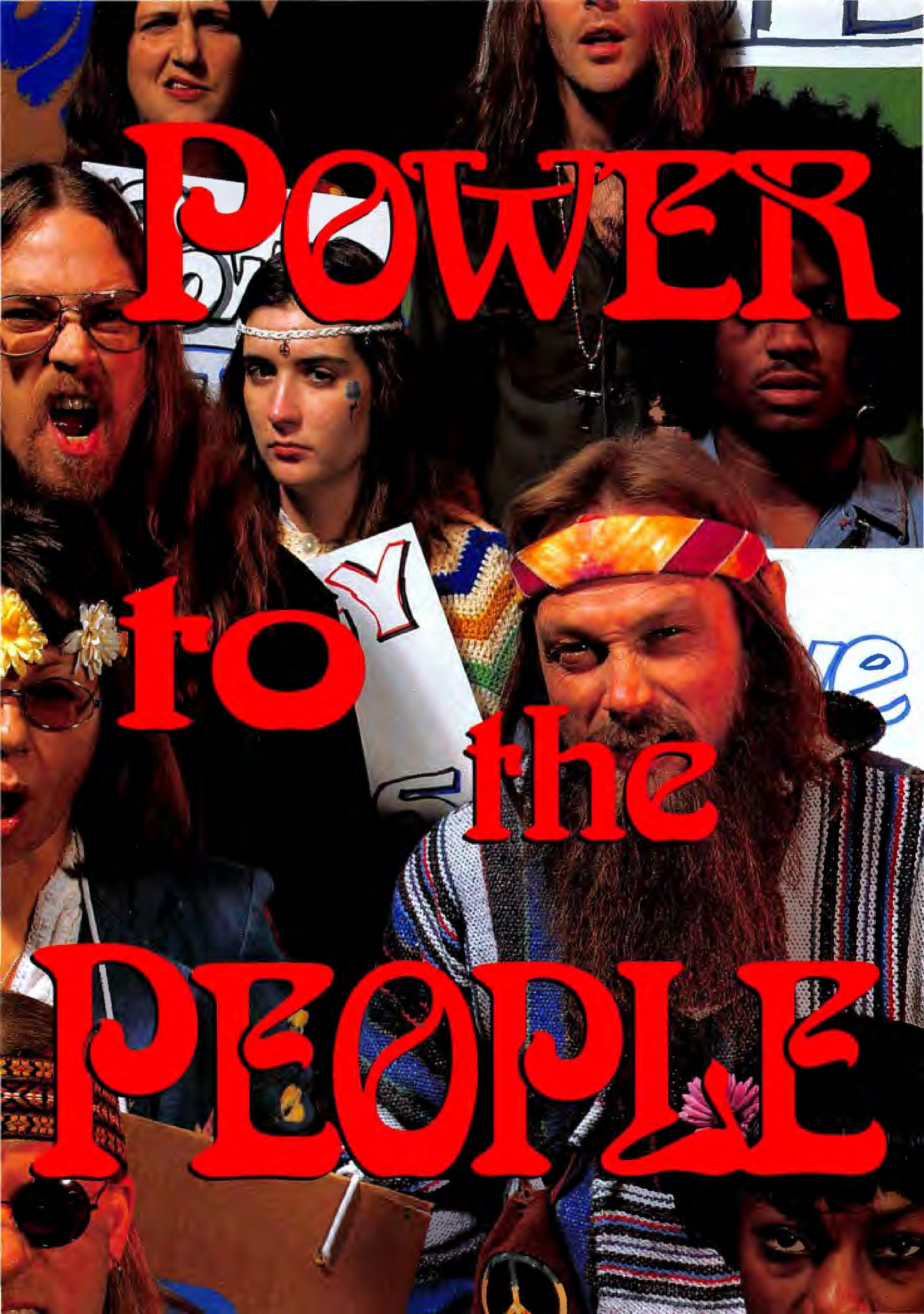
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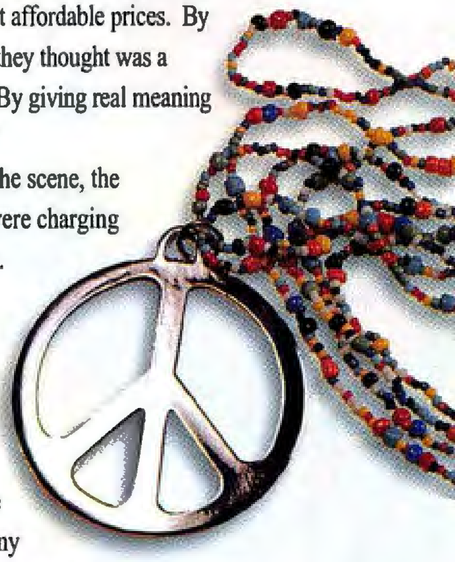

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intel inside

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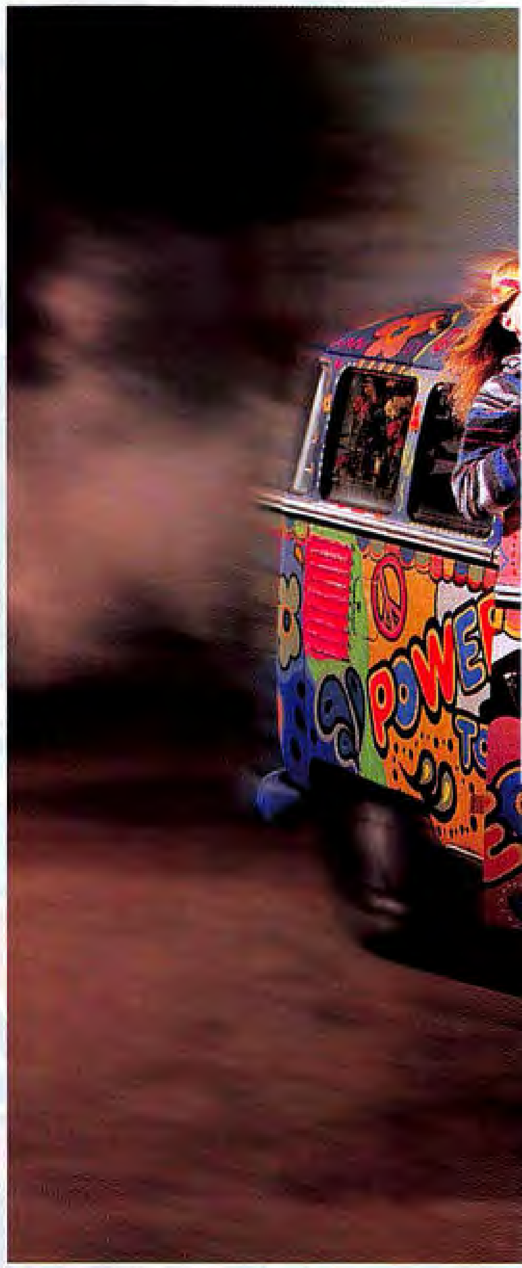

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IDE TAKES OFF

The most popular method of connecting hard drives to PCs has just gotten a whole lot better

JOHN BRYAN

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IDE (Integrated Drive Electronics) is the number-one disk interface in the PC environment for two good reasons: First, it is insanely easy to use, and second, it's inexpensive to implement. This is a hard combination to beat. But as CPUs get faster and applications and environments get more complex, IDE's limitations begin to show.

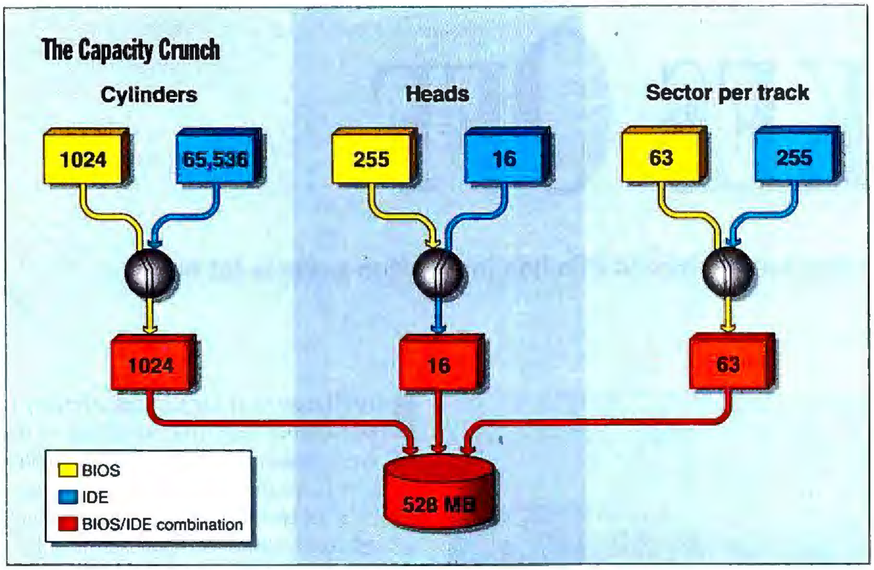
IDE was developed by Western Digital and Compaq Computer. It was a natural outgrowth of the original IBM AT disk interface—the ST-506—which was introduced in 1984. The ST-506 uses the PC BIOS INT 13h to interact with the system, and IDE is set up the same way. IDE also borrows from its ST-506 heritage in the number and type of drives it supports.

This latter feature is one of the major limitations of IDE as we know it today: IDE currently supports two drives, and without some sort of proprietary modification, those two drives must be magnetic disks. Up to now, these limitations have not been crippling, but today's high-end multimedia systems need to be able to control a mix of hard disk, tape, and CD-ROM products. IDE isn't up to the task. Also, IDE is limited in the size of the disks you can attach to it and in the data transfer rates you can get out of it. Western Digital's response to these problems is its proposed enhanced IDE, which is designed to take IDE into the twenty-first century.

Increasing Capacity

A popular feature of IDE is its transparency. You don't need a special driver for an IDE drive, because IDE is defined and supported in your system's BIOS and IDE interface. You pay for this transparency, however—most notably in capacity limitations.

The capacity of IDE drives is constrained not by the BIOS or IDE interface individually but by the combination of the two. IDE identifies a drive and determines its capacity by determining the number of



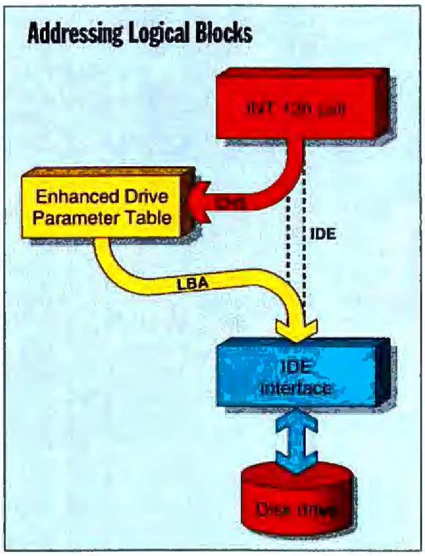
Both the standard PC BIOS and the IDE *interface support large-capacity drives. However, when they're combined, they can't support drives over 528 MB due to the different number of bits each reserves to define the different characteristics—cylinders, heads, and sectors per track—of a drive.*

heads, cylinders, and sectors per track that it contains. Because DOS specifies that there are 512 bytes per sector, the capacity of a drive is the number of heads times the number of cylinders times the number of sectors times 512.

The drive lookup table, which the PC BIOS INT 13h accesses, supplies only a specific number of bits for maintaining information about the characteristics of a drive. Similarly, the IDE interface has a set number of bits for storing this information. Either of these methods provides for large drives. The PC BIOS uses enough bits to recognize up to 1024 cylinders, 255 heads, and 63 sectors per track in its CHS (cylinder-head-sector) format. The BIOS can thus support drives with capacities of up to 8.4 GB. IDE can recognize up to 65,536 cylinders, 16 heads, and 255 sectors per track or drives up to 136.9 GB. Unfortunately, drive capacity in a BIOS/IDE setup is determined by the lowest common denominator of the corresponding drive characteristics, resulting in a limit of 528-MB for PC-based IDE drives (see the figure "The Capacity Crunch").

While 528 MB isn't small, it isn't exactly spacious in a high-end environment or for multimedia, where storage requirements for sound and video applications can really eat up disk space. As disk prices fall, too, there will be more and more motivation to move to larger capacities.

Western Digital's proposal for enhanced IDE provides two methods for solving the capacity problem. You choose between the two in CMOS setup. The first method, called auto-configure, is designed for operating systems, such as NetWare and Unix, that bypass the BIOS in accessing disk drives. It uses the standard DPT (Drive Parameter Table) to pass information about drive capacity from the IDE drive to the operating system.



Rather than the straightforward transfer *of cylinder, head, and sector information, enhanced IDE uses information in its Enhanced Drive Parameter Table to translate INT 13h CHS information into either IDE CHS or IDE LBA. In the case of LBA, only the drive need provide the final logical-to-physical translation. The operating system, file system, and device drivers can use logical information exclusively.*

The second method—for DOS and Windows—is called auto-translate. Selecting this drive type tells the BIOS to create an EDPT (Enhanced Drive Parameter Table) during its POST (power-on self test). The initialization process fills this table with the appropriate values for all the drive characteristics, along with a checksum value to ensure the accuracy of the parameters.

The EDPT contains two sets of drive parameter information: one that comes from the Identify Drive command, and another that the BIOS gives to the operating system. The information presented to the operating system is not simply a copy of that taken from the drive, but a translation that isn't dependent on how the CHS and IDE bit fields match up. The BIOS supports two types of translations based on information returned by the Identify Drive command. The first, called IDE CHS, provides a straightforward translation of BIOS CHS information to IDE CHS information.

The second translation requires more drive firmware changes but has wider-ranging implications. It translates the CHS information that is passed to the BIOS into a 28-bit LBA (logical block address). The BIOS then sends the LBA information to the drive's task-file register and sets bit 6 of the drive's SDH (select drive head) register to indicate that the information in the task registers is LBA rather than CHS. The drive then uses the LBA value to fetch the appropriate physical block from the disk.

The EDPT lets enhanced IDE access drives with sizes up to the CHS limit of 8.4 GB. The advantage of the EDPT is that it doesn't require software or operating-system changes to support high-capacity drives. The IDE CHS and the IDE LBA translations are transparent to the operating system, except in the case of Windows 3.1 in its 32-bit address-on mode. In this case, you need a new driver. Western Digital's IDE LBA–enabling driver is called FASTDISK. It will be available for all Western Digital Caviar drives with capacities greater than 528 MB.

The advantage to IDE CHS is that the BIOS changes required to implement it are minimal. LBA requires more extensive BIOS changes as well as changes in the drive firmware, but you get advantages with this added complexity. Many current operating systems use LBA to access hard drives. LBA lets you use a single consistent access scheme across the operating system, device driver, and drive interface. Looking ahead, LBA is also compatible with the INT 13h Functional Extension specification as defined by Microsoft and IBM, which specifies "packets" that contain LBA rather than CHS addresses.

Faster and Faster

Current IDE drives outperform the data transfer rate capabilities of the ISA bus, making a faster bus mandatory if you want to increase the data transfer rate of IDE systems. EISA and Micro Channel architecture are options, but increasingly, local-bus technology—VL-Bus and PCI (Peripheral Component Interconnect)—is the preferred solution to higher sustained throughput. Enhanced IDE offers a series of solutions designed to meet escalating levels of performance expected from local-bus technologies over the next few years.

You should consider several issues when looking at data transfer between a system and a peripheral. First is the speed at which the peripheral can handle the data that moves on and off it. Also important is the delivery cost of the subsystem, especially in the personal computer market. If cost were no object at all, drives with huge read/write cache systems could deliver and accept data at practically any speed.

IDE drives transfer data in two ways: PIO (processor I/O) depends on the processor to handle the data transfer, and DMA lets the drive itself handle the transfer after the processor performs an initial setup. IDE's traditional method of data transfer is PIO because when IDE was introduced, PIO was faster than DMA, which was dependent on the speed of the ISA bus.

The introduction of faster buses, however, has resulted in faster DMA, and enhanced IDE supports several types. Type B DMA offers a transfer rate of 4 MBps, while Type F, supported by the PCI local bus, extends this to either 6.67 MBps or 8.33 MBps, depending on the PCI/ISA bridge chip set in the system. Both Type F and Type B DMA requires device drivers (or BIOS changes).

PCI also makes available to the PC a new type of DMA transfer called Scatter/Gather. Operating systems that use virtual memory management schemes may find that a requested block of memory is scattered across a variety of physical disk locations. With Scatter/Gather support, four 4-KB blocks that make up a single 16-KB block of memory can be fetched with a single I/O request, rather than with the four I/O requests and DMA instructions that would normally be required. The result is greatly improved performance for the operating systems, such as Windows 3.1, OS/2 2.1, and NetWare 3.1 and 4.0, that support this mode. Windows NT does not currently support Scatter/Gather, but future releases will.

VL-Bus designs use PIO or BPIO (block PIO) data-transfer methods. BPIO works in exactly the same fashion as standard PIO, except that where PIO transfers a single block of 256 words (512 bytes), BPIO transfers *n* blocks of 256 words. The support of BPIO requires BIOS changes and device-driver support, and Western Digital has device drivers that provide this

SCSI vs. IDE

SCSI dates from a time when a small computer was roughly the size of your father's Oldsmobile. Its adaptation to the personal computer market has been slowed by complexity, independent standards development, and relatively low demand for its special features.

Only on the Mac has SCSI been a great success, mainly because Apple rigorously controls every aspect of the development of peripherals for the Mac. The SCSI experience on PCs has been quite the opposite, with different vendors implementing their own version of SCSI communication.

SCSI is a separate bus structure rather than a connector like IDE, so it offers many features that IDE cannot. First, SCSI is extremely flexible in the type and timing of the devices attached. Everything from disks and other storage media to scanners and printers can be attached to the same SCSI host adapter. Up to seven devices can be connected to each adapter.

In addition, the SCSI connector cable can be up to 6 meters long, which means that peripherals can reside outside the host computer system. In fact, SCSI is the only interface used with large drive arrays or optical jukeboxes that support network servers. In contrast, enhanced IDE offers a maximum cable length of 18 inches, which means that it is a strictly internal solution. SCSI also offers speed that standard IDE can't match, and Fast/Wide SCSI offers sustained data rates (20 MBps) that even enhanced IDE can't achieve.

But there is a cost, literally. From host adapters to peripherals, SCSI is more expensive than IDE. Part of the reason for this is the amount of logic required on both ends of the cable. All devices on the SCSI bus are intelligent; each has its own ROM that contains the basic operating parameters of the device. The host adapter is also an intelligent device.

But the bigger cost is that incurred by the development of software to support all the possible combinations of hardware, software, and operating systems that a peripheral is likely to encounter in the diverse and, at times, chaotic world of the PC. Rich Rutledge, marketing manager of storage products for Western Digital, explained it this way: "SCSI has a single command set (per peripheral), but at the chip level, each product has a different register set, requiring a different hardware device driver. The result is that everyone has to produce different drivers for each and every operating-system type and release."

Western Digital believes that with the emergence of enhanced IDE, SCSI will be largely constrained to the server market and external systems. Of course, SCSI proponents see things differently. Adaptec, which developed the EZ-SCSI software that has taken much of the anguish out of implementing SCSI on a PC, believes that ATAPI (AT Attachment Packet Interface) and SCSI combined will squeeze proprietary interfaces out of the CD-ROM market. The company also sees SCSI's performance advantages and flexibility becoming increasingly important as multimedia applications come to the fore.

Both viewpoints have merit. Enhanced IDE will be the interface of choice where ease of use and value are imperative and will take a good deal of midrange business away from SCSI. Where performance is the determinant, however—and performance is a big determinant in multimedia—SCSI retains advantages that should ensure its position as the interface of choice for high-end desktops and workstations.

support for Windows 3.11, MS-OS/2 1.31, and NetWare 3.11.

While the system's CPU controls standard PIO and BPIO, local bus and enhanced IDE have made possible a method of PIO that the device controls. The ATA (AT attachment) specification of I/O Channel Ready was too fast for the ISA bus to implement; however, VL-Bus can handle it, and it pushes the data transfer rate up to 6.67 MBps, or 10 MBps for a cache-hit burst.

Gang of Four

To overcome the limitation of two devices, Western Digital's proposal for enhanced IDE specifies that BIOS and system manufacturers actively support the use of both the primary and secondary controller addresses that have always been in the IBM AT system hardware map. The primary address, which is universally supported by BIOS and operating systems, uses IRQ (interrupt request) 14 and task-file address 1F0h-1F7h/3F6h-3F7h. Virtually all of today's BIOS and operating systems also support the secondary address, which uses IRQ 15 and task-file address 170h-177h/376h-377h, but this support does not generally extend to chip sets or Super I/O devices. As a result, you have to install a second controller with a jumper-selectable IRQ and address to attach more than two IDE devices to your system.

Western Digital is pushing system and controller suppliers to build in hardware support—including a connector—for the second channel, so four IDE devices can coexist in the same system. Dataquest says that four devices would meet the expansion needs of an overwhelming majority of the PC market, especially if those devices can be nondisk.

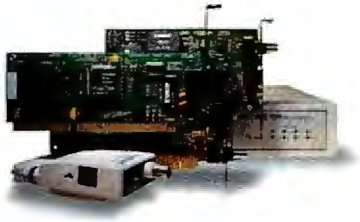
Diverse Connections

In addition to extending the number of devices IDE can support, enhanced IDE also extends the types of devices. CD-ROM has become an essential part of many personal computer setups, especially in the multimedia environment. Until recently, most CD-ROM drives used either a SCSI connection or a proprietary interface and command set.

Western Digital's proposal for supporting CD-ROM with IDE is called ATAPI (ATA Packet Interface). ATA is the protocol used to transfer data and status and control information between a PC and a hard drive. ATAPI is an extension of the ATA protocol formulated to bring a single command set and single register set to CD-ROMs, and it can also be easily adapted to other devices, such as tape. The goal is ease of connectivity and command implementation for OEMs and the end-user market.

ATAPI depends on a minor BIOS modification. When the BIOS performs its POST, the POST uses an `Identify Drive` command to poll the IDE interface and determine the type of devices attached. If the device isn't a disk drive, the command will abort, and the ATAPI-aware BIOS will then issue an `ATAPI Identify Device` command. This will automatically switch support for that device to the device driver, which initiates Packet Command, as defined in the ATAPI proposal that is now before the Small Form Factor Committee.

Once Packet Command is in effect, new rules will apply to the device, because the



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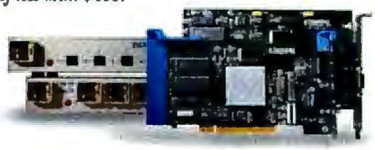

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standard IDE rules for disks don't all work with other types of devices. Under Packet Command, the device execute command is padded out to 12 bytes and sent via the data register rather than the task file. When the device interrupts, the DRQ bit in the status register is matched with the interrupt reason registers to determine the actual interrupt type. The amount of data sent at each DRQ (device interrupt request) is determined by a byte count, and after data has been transferred, status is returned to the host as a new interrupt. Data transfers can occur via DMA or PIO modes, depending on the indicator in the ATAPI features register. The commands of Packet Command are based on SCSI-2, making it easier for peripheral manufacturers to create ATAPI drivers.

ATAPI includes several commands that are specific to CD-ROM devices. These include the Read CD family of commands and a CD speed-select command. Play Audio commands are optional to the specification. A standard command set has not yet been established for tape.

The Big Picture

Not all disk vendors implement the features that enhanced IDE offers. At Fall Comdex, however, many disk vendors—including Western Digital, Conner, and Seagate—stated that they will release IDE drives greater than 528 MB in capacity with some type of support for high-speed data transfer rates. Western Digital, particularly, will be extending its Caviar line of drives to include models from 540 MB (already available) to 1.2 GB (available soon).

ATAPI, the IDE CD-ROM standard, has been endorsed by every significant CD-ROM vendor and a large number of system vendors as well, including IBM, Compaq, and Dell. Software giant Microsoft is on board, and BIOS vendor Phoenix Technologies is behind the standardization effort.

Focused on the mainstream, enhanced IDE represents an excellent low-cost solution for most users and offers significant performance improvement over standard IDE. The fact that it is low cost doesn't mean that this solution doesn't offer significant performance improvement over standard IDE; it does. But it also offers a no-hassle peripheral-connection method that everyone can like. ■

John Bryan is a freelance technology writer and consultant based in San Jose, California. You can reach him on BIX c/o "editors."

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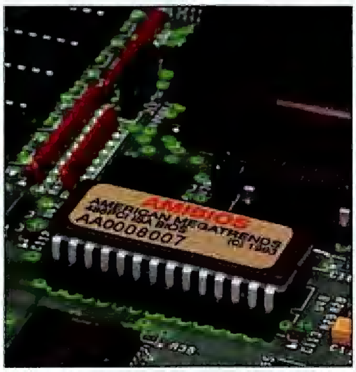

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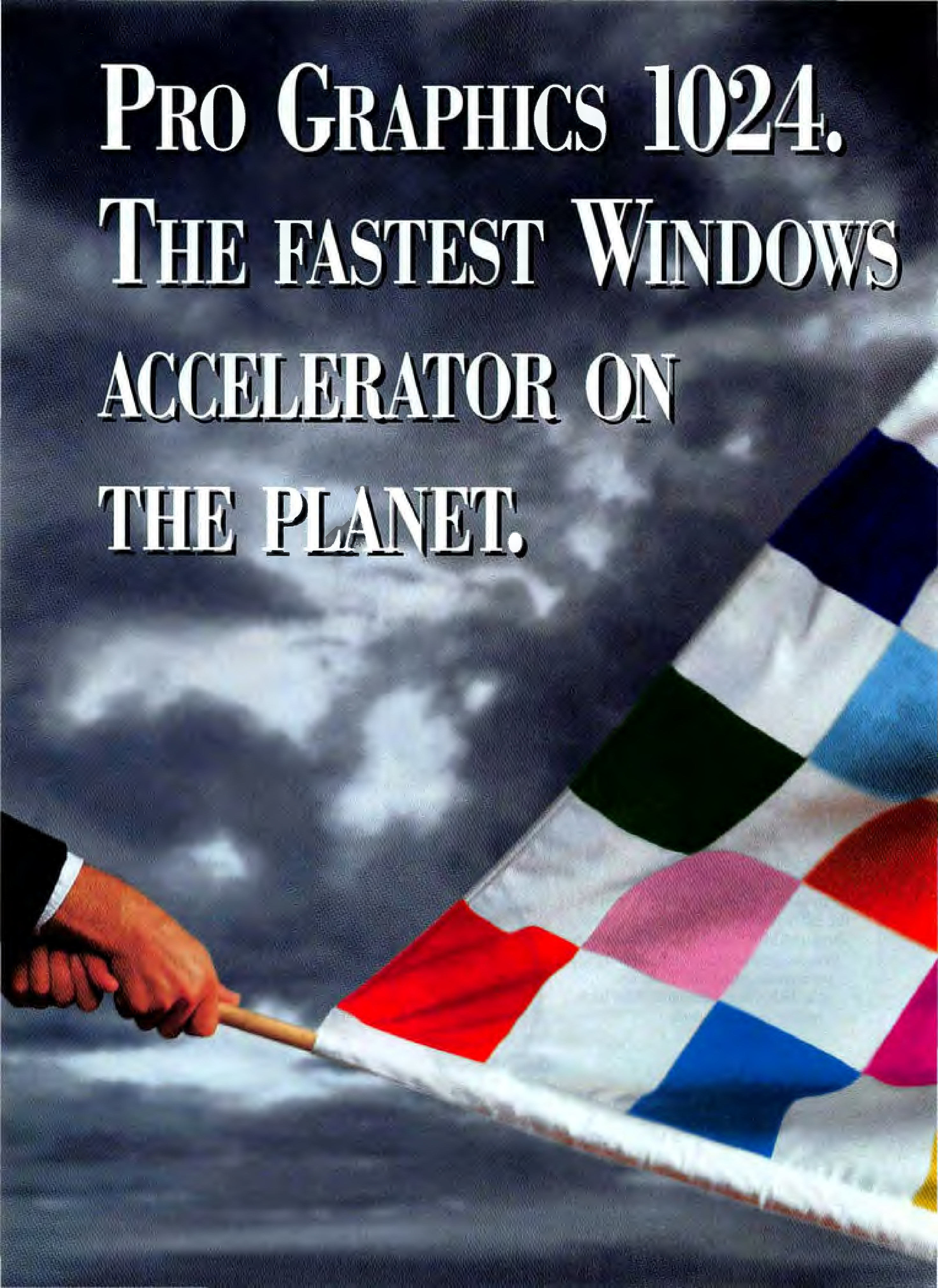
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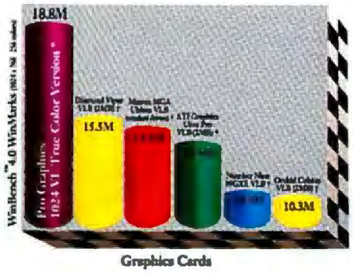

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In fact, most other Windows accelerators can't even come close to giving you 16.7 million colors and 1024 x 768 resolution at the same time. Nor can they give you a photo-realistic display with command of a larger Windows desktop. And a 76Hz refresh rate that makes "flicker" a thing of the past.

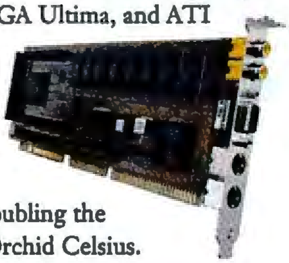
And superior speed and power.

Plus, Pro Graphics 1024 is multimedia upgradeable. So by adding a Media Vision video daughter card you can display video from any source, capture it, and play it on your screen, T.V. or record it on your VCR. Bottom line, Pro Graphics 1024 adds a whole new dimension to your multimedia experience.

Moreover, the Pro Graphics 1024 includes FastFilm™, a unique hardware feature that accelerates Video for Windows playback and eliminates missed frames and jerky AVI replay. Pro Graphics 1024 is also VGA and Super VGA compatible. It comes complete with display drivers for Windows 3.1, Windows NT, OS/2 and AutoDesk ADI which makes Pro Graphics 1024 compatible with all your applications, right from the start.

So what does this all mean when you put Pro Graphics 1024 up against other Windows accelerators? Well, we did a comparison test to answer that question.

The results? Pro Graphics 1024 performance emerged with an unprecedented WinBench® 4.0 Graphics WinMarks™ of over 18 megapixels per second. Blowing past the former champion Diamond Viper VLB, and all other competitors including Matrox MGA Ultima, and ATI Graphics Ultra Pro. And even coming close to doubling the speed of Orchid Celsius.



So as you can see, Pro Graphics 1024 not only outperforms other Windows accelerators, it pushes your graphics over the line. The finish line, that is.

MEDIA VISION

Now, that's multimedia!

Test performed using Ziff Davis Labs' WinBench® V4.0. * Test conducted by Media Vision without independent certification from Ziff Davis. Based on Micronics VL motherboard, Intel 486DX2/66 CPU, 8MB RAM, 256K cache, Western Digital Caviar 2250 IDE hard drive, MS-DOS 5.0 and Windows 3.1 enhanced mode. All products are shipping versions. † Benchmark results as published by Ziff-Davis in PC Magazine December 7, 1993 issue. Based on Micronics EISA/VL motherboard, 486DX2/66 CPU, 8MB RAM, 256K cache and 153MB hard drive. All products are shipping versions. , 47300 Bayside Parkway, Fremont, CA 94538. (510) 770-9592. Pro Graphics 1024 is a trademark of Media Vision, Inc. Any other trademarks and registered trademarks are owned by their respective holders.

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OPTICAL ADVANCES

With new laser, media, and signal-processing technologies, magneto-optical storage is primed for capacity growth rates rivaling that of magnetic disks

DAVID K. CAMPBELL AND KRAIG PROEHL

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Magneto-optical storage, or MO, is a rewritable storage technology that offers far better cost per megabyte than does magnetic storage. This is primarily because MO disks are removable and interchangeable with one another. However, because the standard storage capacity associated with MO technology remained steady at 650 MB (per 5¼-inch platter) for the first four years after its commercial introduction, most people viewed MO technology as slow moving, especially when they compared it to magnetic disk technology, which experiences major capacity gains at least once every year. In fact, it was only last year that 1.3-GB MO drives hit the market.

Today, MO technology is poised to shake off its "slow-moving" image. It has taken time for the researchers and developers behind MO technology to gain a complete understanding of the technology, its tolerances, and how to push the technology in a way that allowed for commercialization. This learning curve has been absorbed, which means you will see dramatic capacity increases for MO technology in the next four years.

In addition, the companies selling MO technology are attacking a similar learning curve. They are providing more drivers and applications that exploit the high density and removability that MO drives and media provide. The removability aspect of MO technology has spawned an entire new market for auto-changers and robotic library systems, which will only require more and more storage in the future. MO technology is poised for explosive capacity increases, which will satisfy those needs.

In fact, today's 1.3-GB capacity for 5¼-inch MO technology is expected to double before 1995, again before 1996, and once more before 1998. The upshot is that in a period of four years, MO storage capacity will probably increase from today's 1.3

GB per 5¼-inch platter to 10.4 GB. That's what absorbing a learning curve will do for a technology.

Short-Term Improvements

The next logical step in the evolution of MO technology is to double the capacity of the current drives and media to 2.6 GB of storage. The exciting aspect of this jump is that it can be accomplished fairly easily with current technologies and methods.

The key factor for the initial capacity jump from 650 MB to 1.3 GB was the implementation of ZBR (zone-bit recording) or ZCAV (zone constant angular velocity). ZBR is a method in which more sectors are recorded at the outer radius of the disk to maximize bit density. This method has been used extensively in magnetic recording over the last three to four years. MO devices will continue to use this method for the 2.6-GB drives and beyond and will leverage the programmable equalizers and frequency synthesizers already developed for this method.

The major advance that will allow MO recording to make the next capacity jump to 2.6 GB is PWM (pulse-width modulation) recording. Current 650-MB and 1.3-GB products use a recording method known as PPM (pulse-position modulation). In PPM, the information (i.e., data) is contained in the time between the positive peaks of the readback signal. The positive peaks correspond to the center of the written domain. With PWM, the information is contained in the time between the transitions (edges) of the readback signals (see the figure "Dots vs. Edges"). It is the length of the domains and the time between the domains that are important here.

MO APPLICATIONS

- ARCHIVAL STORAGE
- DOCUMENT MANAGEMENT
- DOCUMENT IMAGE PROCESSING
- LARGE-CAPACITY DATABASES
- TEXT INFORMATION REFINING

In optical PWM recording, the big challenge is the precise control of the domain edges. Writing an MO disk is primarily a thermal process with the laser serving as the heat source. Care must be taken to control the laser power accurately to write consistent, well-defined domains. The change to a PWM system alone will double disk capacity.

Other changes, however, will likely steal some of the capacity. The biggest change will probably be from the current RLL 2,7 encoding scheme to an RLL 1,7 encoding scheme. The change is necessary to buy back some bit-window margin for the read channel systems. The new encoding will sacrifice about 12 percent of the capacity improvements gained with PWM.

Fortunately, there are other means to return this lost capacity. The first method is to reduce the track pitch on the media. *Track pitch* is the distance between adjacent tracks on the disk. By reducing this distance, more tracks (and thus, more data) can be contained on the media. First-generation media (650 MB) had a track pitch of 1.6 microns. Second-generation media (1.3 GB) reduced this number to 1.39 microns, and the next generation of media (2.6 GB) will most likely go to 1.15 microns.

The Wavelength Issue

The final evolutionary changes to the MO system that are needed to double capacity to 2.6 GB involves the optics of the drive. The bit density you can achieve on a disk is directly related to the spot size of the focused laser beam on the disk. Although elementary physics explains that coherent light passing through a lens can be focused to an infinitesimally small point, there is a physical limit to how small the spot can be, based on the diffraction properties of the optics. The size of the spot is directly related to the laser wavelength and the NA (numerical aperture) of the objective lens. (NA can be easily defined as the inverse of the "f-number" that is on cameras and telescopes.) Spot size is proportional to the wavelength divided by NA, so by decreasing the laser wavelength and increasing the NA, the spot size—and therefore, the bit size—can be significantly decreased. Current 1.3-GB drives typically use a laser with a wavelength of 780 nanometers and an NA of 0.55. Future drives will incorporate 670-nm lasers and objective lenses with an NA approaching 0.60, which will allow the density to reach 2.6 GB with room to spare.

Because of the removability of MO media, interchangeability standards are an important part of bringing higher-capacity products to market. Early in the life of MO technology, the standards process was excruciatingly slow and inefficient. As the market has expanded and the knowledge base has increased, drive, media, and component manufacturers have worked together to eliminate much of the cycle time in defining standards.

Beyond 2.6 GB

Numerous methods are already under development for even further increases in disk capacity. These methods will allow capacities of 5.2 GB per 5¼-inch platter; that's eight times the capacity of the pre-1993 650-MB drives. Some of the methods such as optical and magnetic superresolution are unique and revolutionary.

continued

After a slow beginning, *the capacity of standard MO drives is expected to top 10 GB by the end of the decade. Some companies—such as Hitachi, with its 2-GB drive—are already exceeding the ISO standard 1.3-GB drives, although it's not known whether the market will support a lot of different formats.*

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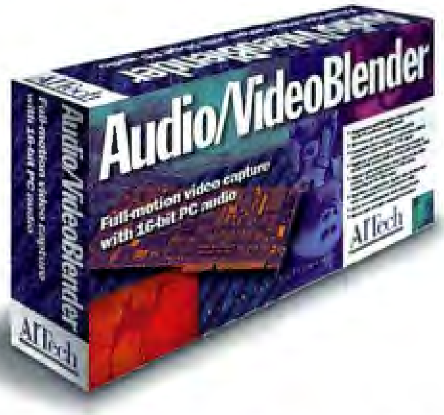

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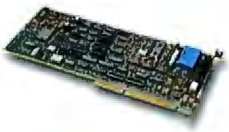

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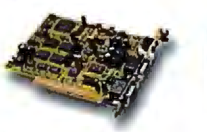

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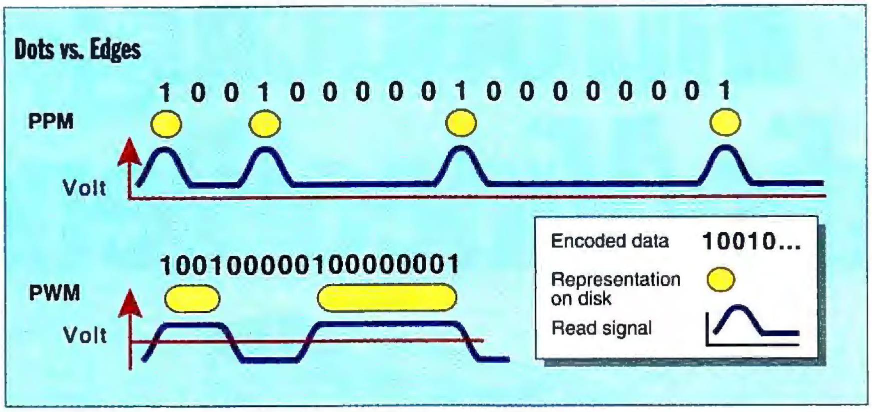


With pulse-position modulation, *each 1 bit has a corresponding spot written to the disk. With pulse-width modulation, it isn't the spot that is significant but the leading and trailing edge of spots. Each transition corresponds to a 1 bit, with the time between corresponding to a 0 bit.*

Others will be leveraged from new methods being applied to magnetic disk drives.

As described earlier, decreasing the size of the laser spot focused on the MO media allows for increased capacity. This spot, rather than being infinitesimally small, is limited by optical diffraction. Extrapolating from current trends, we expect laser wavelengths may drop to 640 nm, and NAs may increase to 0.65 by 1998. This, unfortunately, will give only a 12 percent reduction in spot size and only a 30 percent potential capacity increase from the 2.6-GB generation.

Further advances are needed, such as the shorter wavelength blue and green laser diodes just now operating in research labs and not likely to be commercialized until 1997 or 1998. Other techniques expected to be important for 5.2-GB products are optical superresolution and magnetic superresolution, which can provide capacity increases.

Optical superresolution modifies the optical power distribution of the beam focused on the optical disk. Power is shifted away from the center of the beam toward the edges, producing—through diffraction—a smaller focused spot. This smaller spot can resolve smaller features on the disk, allowing increased capacity without increases in NA or decreases in wavelength.

In many ways, optical superresolution is analogous to an electronic filter that boosts high frequencies and suppresses low frequencies. Unlike the electronic filter, however, optical superresolution boosts the high spatial-frequency amplitude response but does so with no change in phase response. Some demonstrations of optical superresolution have given 20 percent to 30 percent in track density increases. (See references 1 and 2.)

Submicron Dots

Magnetic superresolution, or MSR, is an even more promising, superresolving technique for MO drives. Rather than changing the optical power distribution in the focused laser beam, MSR produces a submicron-size aperture, or window, at the focused spot. The size of this window is what determines the resolution of the MO drive, rather than the size of the focused laser spot. While the focused laser spot may have a diameter of 1 micron, this magnetic window can have a size of much less than a micron, on the order of 0.3 microns in size.

This amazing discovery was first demonstrated by researchers at Sony, who created the MSR window by adding an extra MO layer to the standard MO disk (see the figure "Magnetic Superresolution"). With MSR media, data bits are stored in a buried memory layer. During readout, the focused laser beam heats the memory layer and a readout layer. Through magnetic-exchange coupling, the bits are copied from the memory layer to the readout layer and are visible to the laser beam. Since only a submicron area is heated, only data in a submicron area is seen and resolved. Once the data is read and passes from beneath the laser beam, the films cool and pass through a magnetic field, erasing the domains in the readout layer but leaving the data intact in the memory layer. (See reference 3.)

Another promising technology is the use of PRML (partial-response maximum-likelihood) channels that employ digital filtering techniques to allow the readback system to adapt to the many variables that contribute to ISI (intersymbol interference) among the recorded bits. ISI is the tendency of one bit to interfere with, or distort, adjacent bits. It imposes a practical limit to how closely bits can be spaced on the media. Adaptive PRML channels allow the bits to be placed closer together because the filtering technique is better able to find the data in the midst of all the ISI (see "Digital Hard Drives" on page 91). In addition, PRML channels incorporate a sampled detection scheme, rather than a traditional continuous-time, zero-crossing detection. In this technique, the channel samples the filtered analog readback signal once per bit time. It then looks at each sample and the adjacent samples and makes a decision whether the sample is a 1 or a 0. It is this "intelligence" and its ability to adapt to different heads, media, and environmental conditions that give the PRML channel so much power.

Reductions in track pitch typically contribute to increased capacity. Unfortunately, as tracks are pushed closer together, interference, or cross talk, from adjacent tracks can become significant and result in unacceptable loss of margin. This is a problem for optical and magnetic drives. Fortunately, under development for MO technology are techniques that eliminate cross talk and will allow track spacing of 0.6 microns or less.

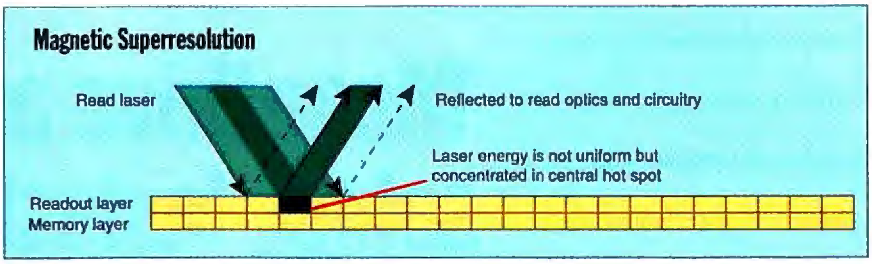
The first technique for eliminating cross talk is the previously mentioned MSR. With MSR, only bits from the desired track are copied to the readout layer; all adjacent tracks are invisible to the readout beam and thus contribute no signal or cross talk to the desired signal.

A second technique called cross-talk cancellation requires no changes in the thin-film structure for MO media but takes advantage of the parallelism of optics (i.e., the ability to read or write multiple tracks at one time through the same optical system). Cross-talk cancellation incorporates a diffraction grating and additional photo detector elements into an MO drive so that three tracks can be read at one time. The desired data track is read, as well as both neighboring tracks.

Then, in a custom cross-talk cancellation IC, the unwanted signal from the neighboring tracks is subtracted electronically from the desired signal. Tracks can be placed closer together without the deleterious effects of adjacent track cross talk causing data corruption. (See reference 4.)

Media Changes

Semiconductor diode lasers, LSI circuits, and low-cost, environmentally stable MO media are the technologies that enable and,



The read layer *heats only a submicron area to a temperature high enough to copy data from the memory layer to the readout layer, letting you use spots smaller than the laser beam diameter.*

for the most part, pace the development of MO drives. Of these, it is the media—that seemingly simple combination of thin-film coated polycarbonate housed in a plastic cartridge—that is unique to MO technology. R&D in MO media fuels future MO drive developments. Today's media research is focusing on four key areas: lower noise media for higher density, short wavelength-response MO materials, magnetic superresolution constructions, and media that will allow single-pass direct overwrite of data.

The control of noise sources in MO drives is critical to higher-density storage, and central to this is understanding and minimizing media noise. Media noise comes from two sources: writing noise and readback noise. Writing noise is evident in irregularities in the written magnetic domains. For example, even with perfect control of the laser-writing pulse, the resultant domain has submicron irregularities in the domain shape. The causes of these irregularities are micromagnetic variations in properties of the MO RETM (rare earth transition metal) films, such as domain wall motion, domain anisotropism, and thin-film defects. Improved materials and thin-film deposition processes are under development to reduce these effects.

Readback noise includes all the effects that contribute to noise, or jitter, in the detection of the domain edges from the disk. Electronic noise and laser noise are the dominant drive sources. Media readback noise results from interference sources such as polycarbonate substrate birefringence, tracking groove irregularities, thin-film reflectivity variations, and thin-film variations in MO Kerr effect. (The MO Kerr effect causes the polarization of the readback laser beam to be rotated in either a positive or negative direction, depending on the polarization of the domains on the disk. The direction of the rotation determines whether the bit is 1 or 0.) Techniques are being developed to separate these different effects, and substrate and thin-film materials and processes are being improved to minimize these readback noise sources. (See reference 5.)

Development of media for use with short wavelength lasers is a critical research topic for increased capacity MO storage. Modification of today's (RETM) films and transparent polycarbonate substrates will suffice through 5.2-GB capacity drives. However, 10.4-GB capacity drives—16 times the original MO capacity—will likely use either blue- or green-wavelength laser diodes, and media must be matched with those wavelengths.

Unfortunately, today's RETM films have little, if any, MO response at blue or green wavelengths. For this reason, research into new MO materials, such as cobalt-platinum multilayers, neodymium-iron-cobalt films, and bismuth doped garnets, is active. IBM researchers recently demonstrated read/write operations on a newly developed MO media at 2.5 Gb per square inch using a blue wavelength, 428-nm laser. (See reference 6.)

Writing Without Erasing

DOW (direct overwrite) MO media will let the drive write data using a single pass of the focused laser beam, rather than the two-pass erase-then-write process used today. Two forms of DOW media and drives are being researched and developed. The first uses fairly conventional MO media but coats the back side of the disk to allow a small magnetic head to either contact or fly above the MO films, as shown in "Magnetic Superresolution." This magnetic head is small enough to allow it to switch its magnetic field at the data rate of the recording process. This process is being used in Sony's MO Mini Disc for digital-audio recording and will likely be adopted into 3½-inch and 2½-inch MO drives.

DOW technology for 5¼-inch MO drives will likely use exchange-coupled MO media. This media is similar to MSR media in that it incorporates additional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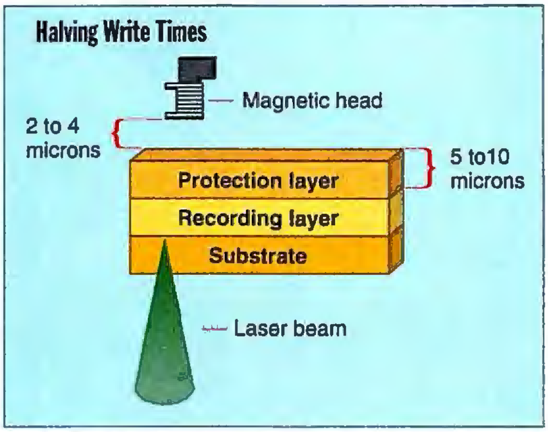

Media designed for magnetic-field modulation *DOW includes a protection layer that permits a small magnet to contact or fly just above the media surface. The magnet is small enough so that it can change its orientation at the data rate of the drive. Its small size—and thus low power—make necessary its close proximity to the disk.*

MO layers into the disk construction. One MO layer acts as the memory layer, storing the data; another acts as a magnetic reset layer, eliminating the need for a switching magnetic field. Exchange-coupled DOW MO media is written by driving the laser diode among three power levels, a low-power P_{read} for reading the data, a P_{lo} for writing 0s, and the highest-power P_{hi} for writing 1s (see reference 7). Because the temperature dependent coercivity of the memory layer is different from that of the bias layer, these varying power levels allow direct overwrite of MO data. The advantage of exchange-coupled DOW media and the reason it will likely appear in 5¼-inch drives is that it doesn't preclude the use of double-sided disks. Also, the data rate of this type of recording is limited only by the laser-diode modulation frequency, rather than by a magnetic coil modulation frequency, as is the case for magnetic-field modulation DOW.

The Changing Laser

One common thread for much of the higher-capacity technology is the need for improved power control of the diode laser during the writing and reading process. PWM recording, PRML channels, magnetic superresolution, the control of disk writing noise and direct overwrite media require more precise laser-power control. Fortunately, the advent of digital signal processor–controlled servo systems in MO drives gives this higher degree of control and, more important, provides adaptive control of the laser power. DSP-adaptive control adjusts the laser-power levels for reading and writing to adapt to variations in drive and media temperature, media sensitivity, and data-writing patterns. MO drives from Hewlett-Packard and others are being shipped with full DSP-based servos, which will become the norm for all future drives.

Reductions in laser wavelengths have and will be an important pacing item in MO drive capacity increases. One exciting aspect of shorter wavelength lasers is that the time from research samples at a particular power and wavelength to full commercial production has been decreasing. With green and blue laser diodes being produced in research labs today, it is quite likely that these devices will become commercial before the end of the decade.

Two techniques for producing short wavelength lasers are being explored. The first takes the output from a high-power 830-nm laser diode and injects it into a nonlinear crystalline material to produce frequency-doubled radiation at a 415-nm wavelength. Power outputs as high as 54 mW have been achieved. Commercial development of a compact, frequency-doubled laser diode is under way at Coherent in Palo Alto, California. Other companies are also developing these frequency-doubled lasers.

An even more exciting but riskier prospect is the development of direct-output blue and green diode lasers using Group II-VI materials such as zinc selenide. These lasers will likely be less expensive and smaller and require less power than frequency-doubled lasers. 3M researchers have demonstrated room-temperature pulsed operation of these devices but only with lifetimes of several hours. Researchers are optimistic that lifetimes and output powers will be improved, and these lasers will be commercialized by the end of the decade. (See reference 8.)

The Need for MO

As mainframes give way to distributed-computing environments, organizations need a cost-effective and dependable way to handle enormous amounts of secondary storage. Furthermore, the advancements in MO storage capacity mean that the technology will keep pace with customers' storage requirements, as well as an even lower per-megabyte cost.

continued

State of the Art

The bottom line is MO technology has made the transition from an "interesting technology" to a reliable solution that's part of mainstream computing. For storage-hungry applications (e.g., image management, network data management, on-line archives, and unattended backups) MO delivers an ideal solution. Given the capacity advances on the horizon, the uses of MO technology will only expand with time. ■

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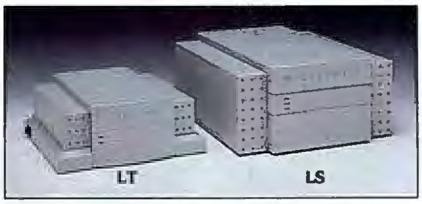

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Three Suite Deals

Office suites sell for bargain-basement prices, but whose bundle—Microsoft's, Lotus's, or Borland's—gives the most bang for the dollar?

BILL LAWRENCE

Office application suites are a runaway hit. According to a recent Dataquest survey, an office bundle, Microsoft Office, was the top software seller for the first time ever, generating $762 million in worldwide revenue in 1993. Meanwhile, Lotus pulled in $68 million from sales of office suites, while Borland took in another $14 million. All told, sales for the category grew more than 200 percent, for a total revenue of $844 million. What started as a simple marketing strategy has blossomed into a full-scale war for your entire desktop.

The success of office suites is in part due to the outstanding bundles offered by the three major providers of Windows software: Borland Office 2.0, Lotus's SmartSuite 2.1 for Windows, and Microsoft Office 4.0. In this review, I'll take a look at these bundles and determine which one does the best job of delivering an integrated set of desktop applications.

Dollars, Yes; Sense, Maybe

Cost alone makes each of these office suites a head-turning temptation. While each bundle is officially priced in the high-three-figure range, as of this writing upgrade offers are available (for which virtually everyone qualifies—you only need to own a single competing application) that reduce your purchase price to between $200 and $300. For about what you'd pay to buy an upgrade for a Windows word processor and spreadsheet, you get a box full of software.

Obviously, the office application bundles are a very good financial deal. But Microsoft, Lotus, Borland, and WordPerfect want to convince you that a suite of applications from a single vendor provides you with functionality that somehow makes the whole much greater than the sum of the parts.

If having a consistent interface among your applications is important to you, buying an office bundle will deliver instant results. In varying degrees—depending on which bundle you choose—your applications will have consistent icons and menu commands as well as shared tools,

One advantage of an office suite is interface consistency across the bundled applications. Microsoft Office's three flagship applications provide the same first 11 icons, as well as menus that are identical in all but one command. Lotus's SmartSuite ranks second in consistency, offering similar—but not identical—patterns of icons and menu commands. Borland and WordPerfect have combined icon palette styles to achieve interface similarities between Quattro Pro and WordPerfect, but the common look has not yet extended to Paradox.

such as spelling checkers and charting modules. If you've invested a lot of time in becoming an expert with a particular bundle's word processor or spreadsheet, you can make use of that experience as you tackle the bundle's other applications. Office bundles are particularly appealing to corporate software buyers who need to manage sparse training and support resources.

When it comes to advanced interapplication and workgroup-exchange tools, having a same-vendor application suite today is only nominally better than having your own selection of full-featured Windows applications. Standard Windows tools such as DDE and OLE do much to keep the playing field level. New tools, such as Microsoft's OLE 2.0 and VBA (Visual Basic for Applications), Lotus's Notes FX, and Borland's Object Exchange, show considerable promise, but for now they are implemented unevenly and in rudimentary ways.

However, these new tools do portend a very interesting picture for a few release cycles from now. Our applications may ultimately become so integrated that we stop thinking in terms of individual programs, such as word processors, spreadsheets, and database managers, and instead regard our digital desktops as "information processors" that we build and fine-tune by mixing and matching our favorite software components.

Meet the Office Staff

Without a doubt, word processors and electronic spreadsheets are the two most popular desktop applications, so it's not surprising that each of the three suites is anchored by a world-class word processor and spreadsheet. Microsoft Office includes Word 6.0 and Excel 5.0, while Lotus's SmartSuite offers 1-2-3 for Windows 4.01 and Ami Pro 3.01. Borland Office provides Quattro Pro for Windows 5.0 and WordPerfect for Windows 6.0.

Naming the best of breed among these titans is a futile exercise. The most recently released word processor or spreadsheet is guaranteed to be the most feature-rich (and the most bug-laden) in its category, and each new release is sure to leapfrog its competition. As Daniel Gasteiger aptly put it when evaluating the latest round of Windows spreadsheets (see "The Big Three Square Off," December 1993 BYTE), "If you like a feature in one of the Big Three's programs, wait a bit and it will be in everyone's software." Competition is wonderful.

The suites begin to differentiate themselves when you consider the third most popular application category: the database manager. Borland Office takes the prize for giving you the most database management capability by including Paradox for Windows 4.5 as a standard offering. Microsoft's flagship Windows database manager, Access, is available only if you purchase the Microsoft Office Professional Edition (which costs $149 more). Both Paradox and Access are full-featured, fully relational databases that let you build sophisticated applications. Both also feature a comprehensive programming language.

Lotus's SmartSuite includes Approach, a database manager that is best described as a personal query and data management program. It focuses on making basic personal database management tasks—such as producing form letters, mailing labels, and reports—easy, but in the process it leaves out advanced development tools, such as a programming language.

Lotus and Microsoft also bundle popular presentation-graphics packages, Freelance 2.01 and PowerPoint 4.0, respectively. With either of these products, you can produce first-rate on-screen slide shows and printed presentation graphics. For its part, Quattro Pro has some excellent presentation features.

By weighing in with five bundled applications, Lotus's SmartSuite wins by a nose the race to provide the most software that you can use right out of the box. SmartSuite's fifth member is Organizer 1.1, a PIM (personal information manager) with one of the best interfaces around. Organizer's super interface enables you to get up to speed in minutes. Over the long haul, however, you may find it a bit too basic. The program has the right mix of features, but each one will only take you so far. The appointment scheduler, for example, does not let you log two appointments for the same time period.

Microsoft Office also includes an additional application, Microsoft Mail 3.2, but to use it you must own the program's Server Edition and have a Microsoft Mail post office installed on your network. The program is obviously included to entice corporate buyers to make the mail package their standard. Lotus originally included cc:Mail in SmartSuite but made a decision to take it out, because the company claims its customers evaluate and purchase communications products separately from desktop applications.

Summing the Parts

A key to evaluating an office suite is determining how well the applications work together. Each of the three office bundles comes with basic tools that help you integrate program features and switch among applications with a few mouse-clicks and keystrokes.

One of the cleverest is SmartSuite's collect-and-copy feature, an interesting extension of Windows' copy-and-paste capability. From within Ami Pro, you click on an icon that transfers you to 1-2-3, where you can highlight and paste multiple cell ranges into Ami Pro in one step. This process is much more efficient than copying and pasting multiple ranges one at a time. In addition, you can select another icon to quickly tile two SmartSuite applications side by side to make the collect-and-copy feature even easier to use.

You can also type text in Ami Pro's outliner and click on an icon to automatically convert the outline to a series of bullet slides in a Freelance presentation. Or you can click on an icon to build an attractive month-at-a-glance calendar within Ami Pro, based on a schedule created with Organizer.

Conceptually similar features in Microsoft Office let you do tasks such as typing the text for a presentation in Word and transferring it into a PowerPoint graphical presentation with one click. With Borland Office, you can press a button within Quattro Pro to launch WordPerfect's text-art tool and place curved text in a spreadsheet.

Lotus's SmartSuite includes the longest list of these simple but clever application integration tricks, but it builds them on the weakest foundation. For the most part, SmartSuite's tools are constructed using Ami Pro macros. While the tools are certainly a tribute to the capability of Ami Pro's scripting language, as macros they run sluggishly and are not as bulletproof as they should be.

In each application bundle, you can employ a special icon palette at the top of your Windows display to easily launch and switch among programs. The palettes from Microsoft and Borland, affectionately dubbed MOM (Microsoft Office Manager) and DAD (Desktop Application Director), respectively, are stand-alone programs to which you can add icons to launch nonmembers of Microsoft Office or Borland Office. Lotus's LAM (Lotus Application Manager) is an Ami Pro macro that includes a fixed group of icons. Microsoft's MOM also includes the Find File feature included in Word and Excel. With Find File you can build advanced queries that locate and list files on your hard disk according to the criteria that you specify. These queries can be named and saved for reuse.

Crossing Applications

Thanks to standard Windows tools like the Clipboard, DDE, and OLE, exchanging information between two Windows appli-

OLE 2.0: Death to Monoliths?

Microsoft's launch of OLE 2.0 could change the way we work with software. The vision promised by OLE 2.0 is one of many vendors delivering small, functional software components to create an integrated, customized environment for the user. In a way, application suites fly in the face of this vision. They are, after all, a return to the monolithic approach: one vendor supplying a set of huge, multifeatured applications. It's reminiscent of the way software was sold when mainframes and minicomputers were king.

Clearly, major vendors are now committed to OLE 2.0 as a mechanism to more tightly integrate their application bundles. Therefore, OLE 2.0 may fuel, somewhat ironically, the phenomenal success of office suites, rekindling the notion of a monolithic model of software development.

Using classic object-oriented programming methodology, OLE 2.0–aware applications can browse each other to discover usable objects. Instead of launching an entire application à la OLE 1.0, you can work with an application's component parts. OLE 2.0 could call up your spreadsheet's @function engine from within your word processor, for example, to sum a table's rows of numeric information.

Office bundles can use this same approach to streamline the software architecture and make the bundled applications interact more efficiently. For instance, applications in Microsoft Office share a spelling checker, conversion filters, a graphing component, an organizational chart tool, an equation editor, and Microsoft Query.

Microsoft plans to implement OLE 2.0 on three platforms: Windows 3.1, Windows NT, and the Macintosh. In a networked environment, this would allow you to build custom networked applications, using local software components when necessary and perhaps even sharing components across the network and across platforms.

At some point, you'll probably buy and build software the same way that an audiophile today puts together a home entertainment system—by mixing and matching the very best interconnectable components from a variety of suppliers. You would lay the foundation by buying your favorite bare-bones text, table, and graphics editors (which may be offered as a bundle with your PC's operating system/graphical desktop).

You would then add some separately purchased tools. You'd probably begin with a spelling checker and a thesaurus, an E-mail module, and perhaps other specialized tools, such as a text searcher/file indexer, a sound and video annotator, and a speech-recognition module.

Those who build in-house corporate systems will follow a similar paradigm, using network- and OLE 2.0–aware tools tied together with a global scripting language. Each of the pieces will work smoothly with the others and will be provided, presumably, by a teeming third-party component market.

The healthy component market for Visual Basic is a case in point. Small developers are busily creating custom controls for adding specific functionality—such as image management or telephony features—to a mainstream programming environment. Visual Basic provides a set of generic capabilities, and third parties are filling the gaps in creative ways.

But, given the marketing muscle of major Windows vendors and the runaway success of single-vendor office bundles, is this vision of component software viable? Customers will probably feel more comfortable turning to an established vendor and buying all the pieces as an integrated whole. Customers don't care about the state of the market; they want software that works. One vendor providing all the components can ensure that the entire process comes together without incompatibilities and unforeseen glitches.

The future of OLE 2.0 is quite interesting to contemplate. We'll soon see whether OLE democratizes the software industry by encouraging the development of specialized software components, or if—in the ongoing battle of feature one-upmanship—powerful vendors provide most of the major tools themselves and tie them all together into application bundles. A new architecture, perhaps, but monolithic software just the same.

Cross-Application Scripting

Microsoft and Lotus will implement an advanced application language in future releases of their office-suite products. Both languages will do the following:

- **Operate across all major office applications in the vendor's suite**
- **Access and control OLE 2.0 object components**
- **Work with standard languages, including Visual Basic**
- **Call DLLs**
- **Support scalable capabilities, from record and playback to custom applications**

cations is not overly difficult. For the most part, the main players in the Borland, Lotus, and Microsoft application bundles are fully OLE aware, with the capability to operate as both OLE clients and servers (see the table "Integration and Workgroup Features" for particulars about each bundled application). Thanks to these capabilities, creating a compound document composed of text from your word processor, an embedded table from your electronic spreadsheet, and a chart created in your graphics package is neither arduous nor uncommon.

With the advent of OLE 2.0, using the Clipboard, DDE, and OLE as we now know it may soon become old-fashioned. OLE 2.0 heralds the next wave in interapplication awareness, and three applications in Microsoft Office—Word 6.0, Excel 5.0, and PowerPoint 4.0—showcase the new capabilities that OLE 2.0 makes possible. Representatives from both Lotus and Borland stated during interviews that future releases of their Windows applications will aggressively support OLE 2.0. Customers can expect many useful implementations of OLE 2.0 features to appear this year.

OLE 2.0 manifests itself in several ways in Microsoft Office. The simplest benefit is the ability to drag and drop information between applications. For example, if you need to use a range of cells in an Excel spreadsheet as the basis for a table in a Word document, you simply display Excel and Word together on the same screen, highlight the appropriate cells in your spreadsheet, and drag their contents into your document. The resulting table in your Word document is an embedded Excel object.

The second up-front manifestation of OLE 2.0 is what Microsoft calls Visual Editing. With traditional OLE, clicking on an embedded object automatically launches the application used to create that object, and you have the opportunity to edit the object in its native environment. With Visual Editing and OLE 2.0, clicking on an Excel object inside Word changes the menus and icon palette to those for Excel, but the nonspreadsheet portions of your Word document are still visible.

This capability is another good reason for having a consistent interface across applications. When you click on the Excel object from within Word, the same menu structure is still available but with Excel-specific options, making the process much less confusing.

WHAT'S IN THE BOX?

All three application suites are anchored by a world-class word processor and spreadsheet. Borland offers the best database manager by including Paradox for Windows. To get Microsoft Access, you need to pay an additional $149 for Microsoft Office Professional Edition.

	BORLAND OFFICE 2.0	LOTUS SMARTSUITE 2.1	MICROSOFT OFFICE 4.0
Word processor	WordPerfect for Windows 6.0	Ami Pro 3.01	Word 6.0
Spreadsheet	Quattro Pro for Windows 5.0	1-2-3 for Windows 4.01	Excel 5.0
Database manager	Paradox for Windows 4.5	Approach 2.1	Access 1.1 (Professional Edition only)
Presentation manager	None	Freelance 2.01	PowerPoint 4.0
E-mail	None	None	Microsoft Mail 3.2
PIM	None	Organizer 1.1	None

Workgroup Awareness

Microsoft Office enjoys a good head start with regard to its implementation of OLE 2.0–derived features, but the company has no corner on innovation. Lotus and Borland leave Microsoft in the dust on another front: workgroup features.

Most applications in the Borland, Lotus, and Microsoft bundles are mail enabled, allowing you to send a document, spreadsheet, or presentation as a mail attachment without leaving your application. Borland dramatically expands this concept with a tool called Object Exchange, or OBEX. OBEX lets you distribute, or "publish," information (e.g., a spreadsheet or a spreadsheet notebook) to users who "subscribe" to the information. As you prepare to publish information via OBEX, you specify the *version depth*, or how many revision levels of the information are retained for subscribers' use.

OBEX can distribute information via MAPI- or VIM-compatible (Vendor-Independent Messaging) mail systems, using LAN disk space, via MCI Mail, or with any combination of these methods. When you use OBEX inside a Borland Office application, you activate a special icon palette with buttons that enable you to publish new information or poll for subscribed information.

Lotus gives information-sharing an interesting twist of its own. Using technology called Notes FX (short for Notes field exchange), Ami Pro, 1-2-3, and Freelance can intelligently store information on a Lotus Notes server. (Notes is Lotus's popular groupware product—a Notes server is an "object warehouse" that has the ability to intelligently store, index, and retrieve information in virtually any combination of formats.)

Notes FX lets you use a Notes server as an intelligent document management and revision-control back end for Ami Pro, 1-2-3, and Freelance. Notes can store data files from these applications, and the Notes database can attach fields to the data files, so you can catalog and index documents. For example, with Notes and Ami Pro, you can create a document library and management system to track the revision history of documents and index them by last revision date, description, size, style-sheet type, and other categories that you specify.

Notes FX supports bidirectional data exchange. For instance, data contained in a 1-2-3 field can act as a field in a Notes form or view. The Notes view is updated each time you enter data into the spreadsheet, or you can update the spreadsheet from a Notes form. Notes agents and macros can use the spreadsheet data in a Notes field to build a dynamic chart or to control a workflow application.

Obviously, to use Notes FX you must have a Notes server installed on your network. Unfortunately, neither the Notes server nor the client software is included in the SmartSuite bundle. But clearly, Lotus includes Notes in its vision of the future of automated office software.

INTEGRATION AND WORKGROUP FEATURES

Microsoft has a head start on OLE 2.0 integration, but all three vendors have pledged strong support of the open standard in 1994. (● = yes; ○ = no.)

	OLE CLIENT	OLE SERVER	OLE 2.0	MAIL-ENABLED	WORKGROUP FEATURES
Borland Office					
WordPerfect 6.0	●	●	○	●	OBEX
Quattro Pro 5.0	●	●	○	●	OBEX
Paradox 4.5	●	○	○	●	OBEX
Lotus SmartSuite					
Ami Pro	●	●	○	●	Notes FX
1-2-3	●	●	○	●	Notes FX
Approach	●	○	○	○	
Freelance	●	●	○	●	Notes FX
Organizer	○	○	○	●	
Microsoft Office					
Word	●	●	●	●	
Excel	●	●	●	●	
Access	●	○	○	○	
PowerPoint	●	●	●	●	
Microsoft Mail	●	○	○	●	

Coming Soon: Global Scripting Languages

The average full-featured word processor or spreadsheet includes a macro language that lets you automate repetitive tasks and build custom applications. Because macro languages tend to parrot the menu and command structure of the programs they come with, the macro syntax of one application is likely to vary dramatically from that of another.

If a macro language that can automate tasks within a single program is good, then a language that can do the same thing across program boundaries should be even better. Microsoft and Lotus both seem to think this is the case. Lotus has announced LotusScript, a BASIC-like scripting language that is rudimentarily implemented in Improv for Windows, Lotus's alternative spreadsheet. And Microsoft has weighed in with VBA, which premieres as the new macro language for Excel 5.0.

While neither language can yet be considered global (since each one works in a single application for now), both companies have committed to scripting languages that will work across all their major Windows applications. Both companies suggest that these languages will be phased in with major new releases of their Windows applications. Since recent major new releases of Word and PowerPoint have just occurred without internal support for VBA, it is probably best not to hold your breath. Microsoft has promised that Visual Basic will be integrated across the Office product line by 1995.

Microsoft's implementation of VBA in Excel is particularly appealing. When you use Excel's keystroke recorder to build a macro, the keystrokes are captured as Visual Basic code. You can edit the macro with a built-in code editor and use the capable debugger to detect and correct errors. If you're a Visual Basic programmer, your learning curve will be very slight.

Combined with OLE 2.0, VBA will ultimately enable you to write applications built from the prefabricated parts of your favorite Windows programs. For now, you will have to settle with Word 6.0's WordBasic and Microsoft Access Basic. With these tools, you can make calls to the macro languages and return results, instead of controlling the applications directly from Visual Basic.

Lotus plans the same type of strategy for LotusScript as Microsoft has announced with VBA. The language will be scalable, supporting a wide range of functionality, from simple record-and-playback techniques for easy macro creation to the ability to call DLLs created as external C routines.

OLE 2.0 compliance will give LotusScript the same type of access to application objects as VBA has, allowing you to create custom applications from components of the Lotus suite (or from any other OLE 2.0 server that exposes software objects). LotusScript will also be compatible with other BASIC languages; this will allow a LotusScript application to be incorporated into other BASIC programs,

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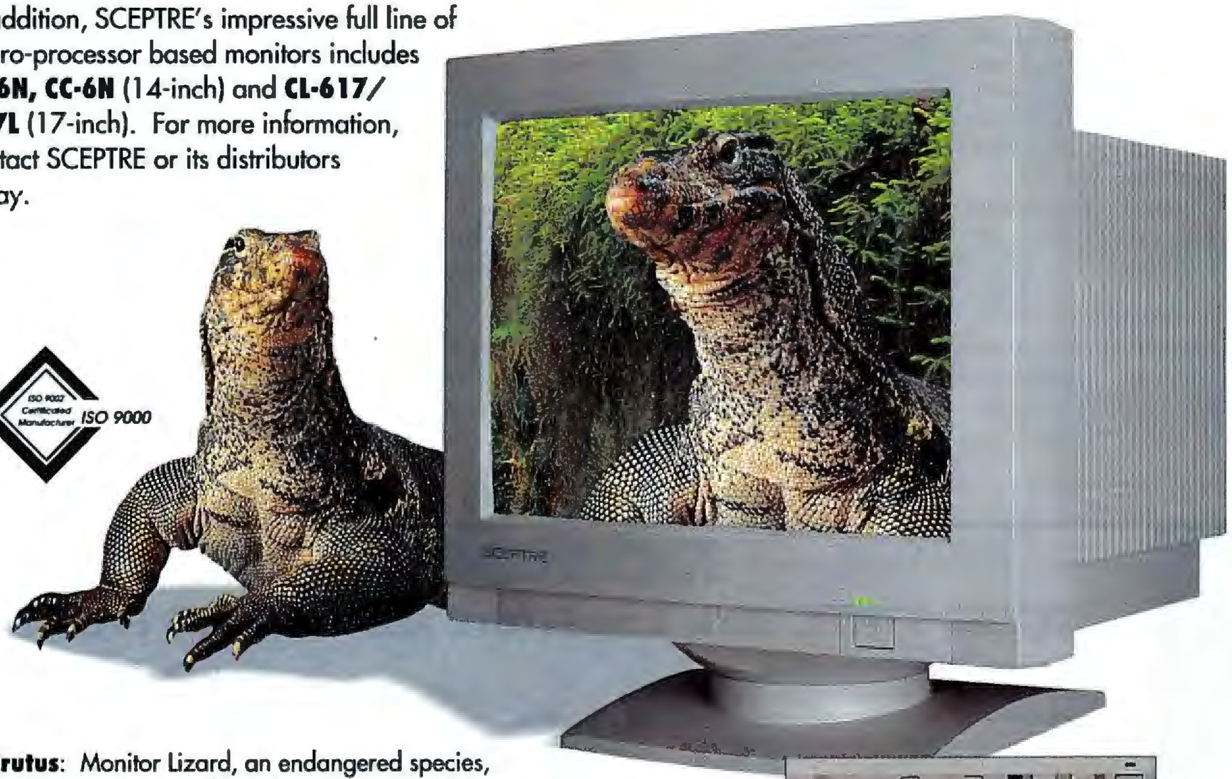

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including Visual Basic.

With these cross-application languages, you could build a front end to an application and then use components of the office suites to perform specific tasks. For instance, you could populate a spreadsheet with customer account information held in an external database, create a data file of overdue accounts, and print personalized letters requesting prompt payment. The applications would perform specific functions in the background. The spreadsheet would pull in data and perform calculations; it would then pass the table on to a word processor, which would use the table as data for a mail-merge operation.

The user would see only the front end; the application components would be totally invisible. The end user would deal only with the significant data and the controls needed to accomplish a particular task.

As a result, each corporate desktop would be customized, iconized not with a set of software applications but with a set of specific tasks that a particular worker performs. The applications become, as they should be, a means to the end of getting work done, not the central focus of the desktop.

Taking the Plunge

Is the purchase of an office application suite a good move for your organization? Taking only the up-front costs into account, the answer is an easy yes; such a collection is the best way to legally get your hands on a lot of good software at a very reasonable price.

In the corporate realm, however, true costs are seldom so easy to tally. For example, if your organization has invested considerable effort into building value around a particular group of programs (e.g., you've got thousands of pages of extensively formatted documents in WordPerfect format, or you have a body of critical engineering calculations built into macro-laden 1-2-3 worksheets), rocking the boat to achieve lower initial software costs and a consistent user interface may simply not be worth it. In the short term, buying a suite will deliver improved cross-application integration, but over time, tools such as OLE 2.0 will enable all applications to integrate easily.

If you've concluded that buying an office application suite is a good idea, which one should you choose? Lotus's SmartSuite clearly delivers the most programs for the money and is the best among these near-equals in terms of value. If you use Notes or plan to implement it, SmartSuite is an even sweeter deal.

But if you've already got strong ties to a particular word processor or spreadsheet that is contained in one of these bundles and want to extend your software arsenal inexpensively with a minimum of relearning, pick the bundle that includes the highest percentage of your favorite programs.

No matter which bundle you choose, you can rest assured that with future releases, the individual programs in your collection will become more feature-rich and better equipped to collaborate with each other. And if past trends are a true indicator, they'll also continue to go down in price. ■

About the Products

Borland Office 2.0 ....$595
Upgrade and competitive upgrade $299
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Scotts Valley, CA 95066
(800) 331-0877
(408) 461-9000
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SmartSuite 2.1 for Windows.....$795
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(800) 343-5414
(617) 577-8500
fax: (617) 693-0968
Circle 1341 on Inquiry Card.

Microsoft Office Standard Edition 4.0 ....$750
Microsoft Office Professional Edition $899
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Redmond, WA 98052
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Multiprocessor Horsepower

Systems from ALR, Compaq, and VTech show that for a SQL server, two CPUs are better than one

RAYMOND GA CÔTÉ

Admiral Grace Murray Hopper liked to say that when farmers wanted to pull a heavier load, they didn't breed a bigger horse, they simply used more than one. Aside from providing extra pulling power, a team of horses provided flexibility, because the farmer could harness them in whatever arrangement suited the task at hand. Although Admiral Hopper was brought up in the great farm country of northern New Hampshire, her story was aimed not at horse breeders, but at computer designers: Multiprocessor computers are the way of the future.

Windows NT's support for multiple processors has encouraged the development of a crop of relatively inexpensive Intel-based multiprocessor, or MP, PCs. These are systems that can run standard DOS and Windows software, as well as 32-bit NT programs. Any multithreaded application ought to get a significant boost from running on more than one processor at once. In addition, NT is able to distribute concurrently running programs among processors, whether those programs are multithreaded or not.

To find out just how much performance an MP PC can deliver, I tested dual-processor systems from Advanced Logic Research, Compaq, and VTech. Prices for the three systems range from $3999 for a base-model VTech Platinum SMP 486-DX2/66 desktop system running two 486 CPUs to over $20,000 for a fully configured Compaq ProLiant 2000 server with dual Pentiums. The ALR ProVEISA DMP 4/66d, a floor-standing server, fell in the middle of the price range.

To compare performance, I used Microsoft's SQL Server, a true NT application. Using different processor modules in the Compaq system, I also tested one processor against two, the 486 against the Pentium, and perhaps most interesting, two 486s against a single Pentium.

Judging from the SQL Server test results, two processors are definitely better than one for an applications server, where processing power shares importance with file I/O. I also found a wide latitude in the performance of different systems and discovered that simply adding a second processor doesn't necessarily increase performance when running a single application.

MP Design

Adding extra microprocessors to a system is an attractive idea that has cropped up more than once in the last 10 years. Because they leverage off standard PC designs, shared-memory MP designs in particular promise an economical means to increase computing power—either beyond levels available with the current hot processor, or to levels competitive with that chip but using several less expensive CPUs.

Three dual-processor systems *from Compaq, ALR, and VTech (left to right). The ALR ProVEISA DMP and the VTech Platinum SMP systems each have two 486DX2/66 CPUs. The Compaq ProLiant 2000 can take two 50-MHz 486DX or two 66-MHz Pentium processors.*

In a shared-memory design, several processors sit on the same bus and share memory space and other resources. Contention for the shared resources, however, limits the number of processors you can add and still gain performance. The more capable the bus between processors and main memory, the more processors a shared-memory design can support. Adding a second processor provides the biggest performance gain of all. (For more on MP computers, see "All Systems Go," August 1992 BYTE.)

Despite their promise, MP PCs have not yet received general acceptance, for two reasons. First, most MP implementations have used proprietary designs that require a specially modified operating system and are therefore incompatible with the rest of the industry. Second, aside from a brief flurry of Unix support for multiple processors, there hasn't been a widely popular operating system to run on the hardware.

Windows NT changes this situation by defining built-in support for SMP (symmetric multiprocessor) PCs, with a standardized low-level interface to identify and control multiple processors. With an SMP hardware design, any processor can handle any job as well as another, and that makes easier the operating system's job of distributing the processing workload, even when the number of processors can vary. (Asymmetrical designs dedicate different processors to different tasks and need proprietary operating-system support.) Standard NT can support two processors, while NT Advanced Server can support up to four. Proprietary OEM versions of Windows NT will support up to 16 processors.

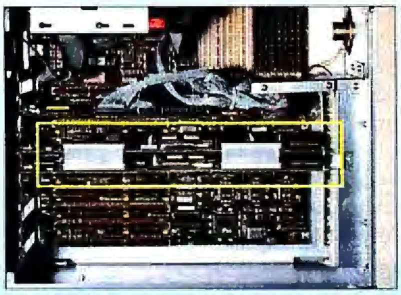
Testing

Initially, the most likely job for an MP machine is as an applications server, processing transactions or perhaps providing decision support from a database. MP's extra horsepower is overkill for a straight file server. It's appropriate, then, that I used Microsoft's SQL Server for Windows NT to test MP performance. SQL Server is also one of the few available 32-bit applications designed for NT, and it can take good advantage of multiple processors.

For my evaluation I ran a modification of NSTL's SQL Server benchmark, a test that models a transaction-based book-ordering application. The test ran a series of order transactions and returned the

A Trio of Dual-Processor Systems

ALR ProVEISA DMP 4/66d



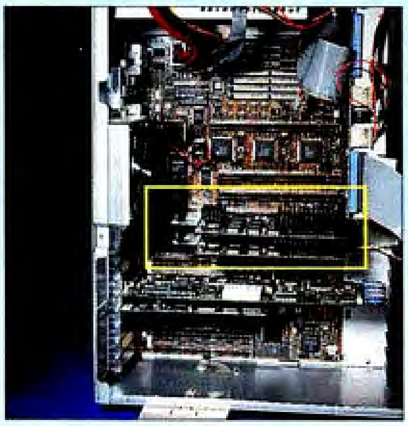
Each 486DX2 chip sits on a circuit card (outlined) in an extended EISA slot with a 512-KB RAM cache. The two CPUs communicate via two ribbon cables.

ALR's ProVEISA is a server with a floor-standing case, 10 EISA slots, and 12 half-height drive bays (half 5¼-inch, half 3½-inch). A 300-W power supply is also appropriate for server duty. The ProVEISA provides built-in SVGA graphics with 1 MB of RAM, upgradable to 2 MB.

The dual-processor ProVEISA comes with a single floppy drive and a Texel double-speed CD-ROM drive to load Windows NT. The tested configuration included NT, 32 MB of RAM, and two Maxtor 540-MB SCSI hard drives. ALR supplied the system with a caching SCSI-2 card with 4 MB of RAM. A plastic door covers access to drive bays and user controls such as the reset button. The case locks onto its chassis, but I easily broke the lock (accidentally, through misunderstanding the key position).

The ProVEISA places each 486DX2/66 processor on a separate plug-in card, each of which takes an EISA slot. The two processor cards sit side by side with direct processor control and communication going through two sets of directly wired connectors. Each processor gets its own 512-KB RAM cache in an effort to minimize competition between the two processors for access to main memory.

Compaq ProLiant 2000



Each of two special processor cards (outlined) holds a 66-MHz Pentium with a 256-KB external cache.

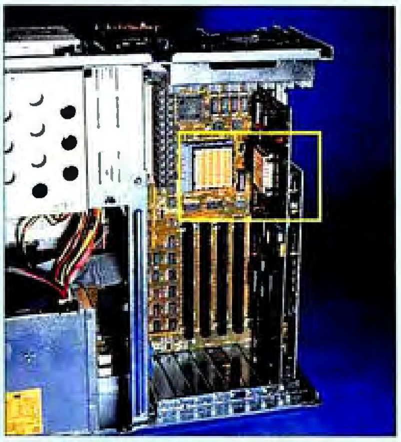
Compaq's ProLiant 2000 is a full-fledged server with lots of reliability and usability features, accounting for the $15,000 and $20,000 prices of the two test configurations (dual 50-MHz 486DX and dual 66-MHz Pentium processors, respectively). Reliability features include error-correcting memory, Compaq's Smart SCSI drive array controller, hot-swapping hard drives, and built-in SNMP-compatible system diagnostics. The SCSI controller can be configured for RAID, although I didn't take advantage of it in testing.

Compaq's Insight system management software works with the hardware to catch problems before they become disasters. The Windows-based software is easy to use and flexible in setting up server management functions. CD-ROM-based start-up software guides you through installation and configuration. Other features include Compaq's 32-bit EISA combination Ethernet/Token Ring network card and a double-speed CD-ROM drive.

Inside the big tower case are six available EISA expansion slots out of a total of eight. There are four processor slots, although the ProLiant 2000 has the power and cooling abilities to support only two. It uses the same motherboard as the ProLiant 4000, which can take four processors.

The ProLiant TriFlex architecture provides separate 64-bit processor, 128-bit memory, and 32-bit I/O buses, with a buffering bus controller between them that allows concurrent memory access by both system and I/O processors most of the time (70 percent, according to Compaq).

VTech Platinum SMP 486DX2/66 dual



The motherboard holds a 486DX2; an optional card holds a second matching CPU (two chips outlined).

VTech's dual-processor Platinum is a desktop system, aimed initially at software developers working on MP applications and running NT-based workstation applications once they become available. Besides good performance, the VTech also has an exceptionally low price: $3999 with 16 MB of RAM, a 527-MB IDE hard drive, a double-speed CD-ROM drive, VL-Bus (VESA local bus) graphics, a 15-inch color display, and Windows NT.

The system combines two VL-Bus expansion slots with standard ISA slots. The MP daughtercard, however, takes one VL-Bus slot. The Platinum also provides built-in IDE and SCSI-2 connections, as well as high-speed serial (16550) and parallel (ECP [extended capabilities port]) ports.

The Platinum has a standard motherboard configuration with an optional plug-in card to support the second processor. The motherboard processor is installed in a ZIF (zero insertion force) socket and can be upgraded to a Pentium OverDrive chip. Both SCSI and IDE interfaces are provided standard. The dual processors communicate through the VL-Bus and the proprietary processor socket.

As with the ALR and Compaq systems, the Platinum SMP design is 100 percent symmetrical; either processor can handle any task, including hardware interrupts, thanks to two Intel APICs (advanced programmable interrupt controllers). The Platinum takes a minimalist approach to multiprocessing by providing no separate secondary cache on the MP plug-in card. Both CPUs share the same 256-KB writeback cache. Even so, the Platinum provided excellent throughput results in my tests.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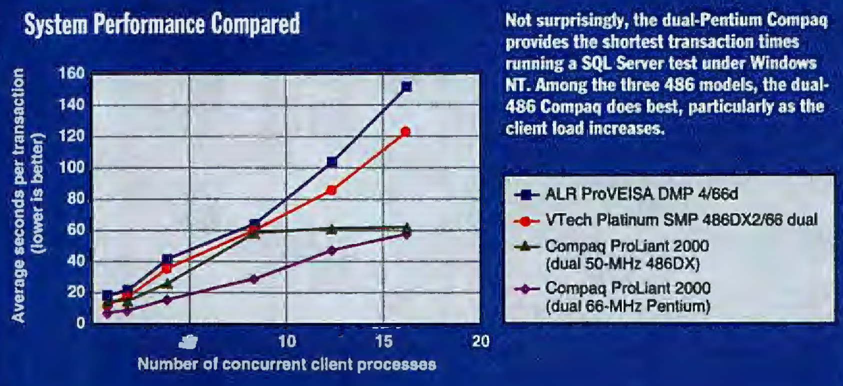
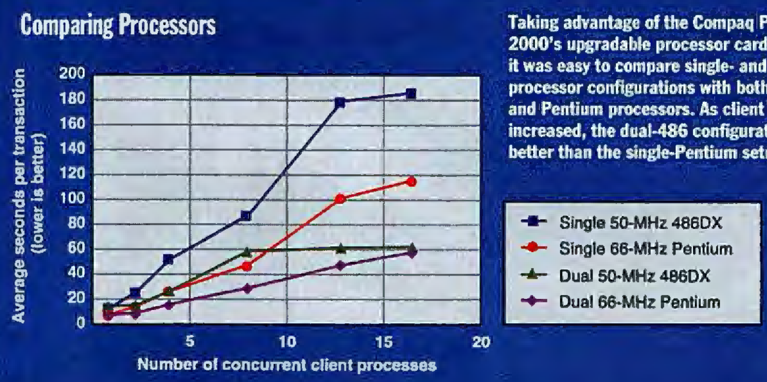
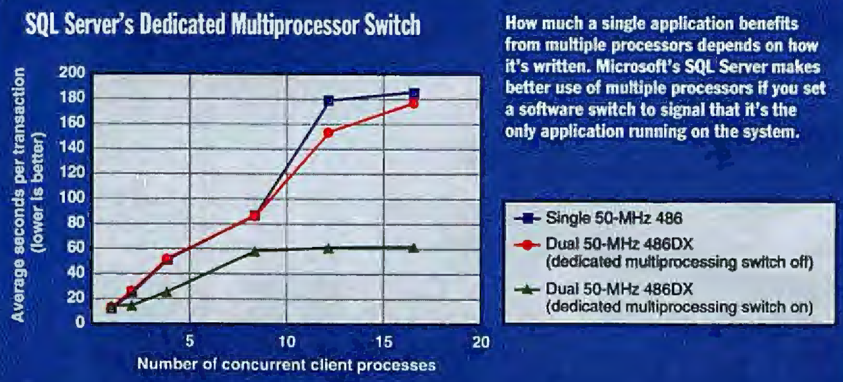


Not surprisingly, the dual-Pentium Compaq provides the shortest transaction times running a SQL Server test under Windows NT. Among the three 486 models, the dual-486 Compaq does best, particularly as the client load increases.



Taking advantage of the Compaq ProLiant 2000's upgradable processor card design, it was easy to compare single- and dual-processor configurations with both 486 and Pentium processors. As client load increased, the dual-486 configuration did better than the single-Pentium setup.



How much a single application benefits from multiple processors depends on how it's written. Microsoft's SQL Server makes better use of multiple processors if you set a software switch to signal that it's the only application running on the system.

average time per transaction. The test database on the server consisted of five tables. A Gateway 486DX2/66 running OS/2 generated the client requests, issuing SQL Server queries and commands to the NT server over an Ethernet connection. I generated up to 16 simultaneous test sessions from the client system.

For the purposes of the NSTL test, each system came with 32 MB of memory, two 500-MB SCSI hard drives configured as two volumes, and a CD-ROM drive to load Windows NT. The test configuration provided for 16 MB of SQL Server cache—enough to minimize disk activity. There was also very little network activity. The resulting tests provide a good indication of processor throughput.

Both ALR's ProVEISA DMP and VTech's Platinum SMP systems come with two 486DX2/66 CPUs. Compaq's ProLiant 2000 can take either 50-MHz 486DX or 66-MHz Pentium modules—up to two of one design or the other. I ordered two of each so that the ProLiant could serve as a consistent platform to test

486/Pentium Cross Platform Tools

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different processor configurations.

All three machines provide a standard hardware interface to Windows NT, which allows them to run the off-the-shelf version of NT. The ProLiant comes with Compaq's Smart Start configuration software, which installs a special configuration and error-recovery partition on the hard drive. However, I ran the tests using the same copy of NT that was installed on the other two systems.

MP Approach Delivers

As expected for all systems, the average time per test transaction climbed as more clients were active (see the figure "System Performance Compared"). However, some systems were less affected by client load than others. Among the three dual-486 systems, the Compaq ProLiant 2000 did the best, taking significantly less time per transaction than the ALR and the VTech with 12 or more clients. The ProLiant has the advantage of a faster memory-bus clock speed—50 MHz versus 33 MHz for the two DX2 systems—and Compaq's high-throughput TriFlex bus architecture. The VTech consistently outperformed the ALR, which has the oldest MP design of the three.

The dual-Pentium ProLiant generally got the job done in half the time it took the 486 systems. However, with 12 and 16 clients, it wasn't twice as fast as the dual-486 configuration of the ProLiant. Testing with more than 16 clients should widen the gap between 486 and Pentium configurations.

It isn't surprising that two processors are faster than one when comparing one versus two 486 modules, or one versus two Pentium modules on the ProLiant (see the figure "Comparing Processors"). That the dual-processor configurations took roughly half the time to complete the tests as comparable single-processor setups indicates that the two modules are working mostly in their separate memory caches and that accesses to main memory are relatively unimpeded by competition. Score one for the TriFlex bus.

In all cases but one, the dual-486 configuration of the ProLiant provided similar or better performance than the single-Pentium configuration. Under higher loads, the dual-486 system provided much better performance, and the prices of the two systems are almost the same. Of course, with the dual-486 configuration, you've reached a performance limit, while you can still add another Pentium module to the single-Pentium model (for $5059).

continued

The VTech Platinum SMP dual-486 system provided performance that kept pace with or did slightly better than the single-Pentium ProLiant, falling slightly behind only with 16 clients. Costing $10,000 less than the ProLiant, the VTech system is tempting unless you need server security or high storage capacity.

No Guarantee

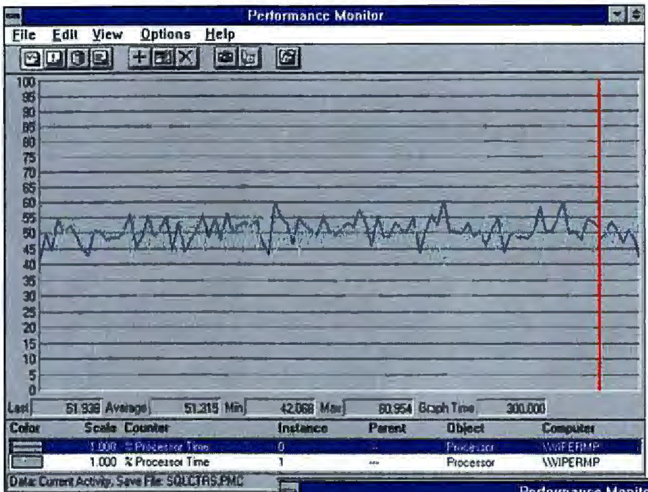
One of the promises of NT is the ability to toss another processor into your machine and enjoy nearly double the performance. Is that really likely? The answer is a resounding maybe.

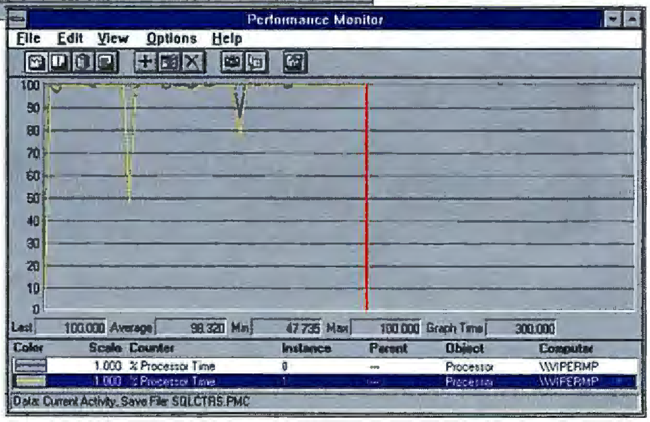
After my first installation of SQL Server, I ran a set of tests on the Compaq using first one and then two 486 processors. The dual-processor results were simply not impressive. In most tests, the dual-486 configuration actually ran slightly slower than the single-processor setup. Only the tests with 12 or more clients showed any speed increase, and that was marginal.

In trying to solve the problem, Compaq's technical folks happened to ask if I had set the *dedicated multiprocessor* switch. I hadn't even seen the option because it's hidden away in a nonobvious configuration screen. When I set this switch, performance nearly doubled (see the figure "SQL Server's Dedicated Multiprocessor Switch").

Running the Windows NT processor performance monitor shed some light on the situation. While running the SQL Server test on the Compaq system with two clients and the switch off, the two processors worked just slightly harder than 50 percent each. In other words, I was getting basically the same performance as with a single-processor machine. Turning the switch on let the two processors zoom to nearly 100 percent load.

According to Gary Schroeder, a SQL engineer at Microsoft, setting the dedicated multiprocessor switch provides the best performance in most situations, but not when SQL Server has heavy multitasking competition from other applications. With the switch on, SQL Server operates with a greater degree of parallel processing, making it more efficient. It also sets for itself a higher multitasking priority. With the switch off, the program uses a coarser-grained multithreading that is less susceptible to interruption than when the switch is on. The conclusion is that even a traditionally multithreaded application such as SQL Server may not see significant performance increases from multiple processors without specific algorithm changes to take advantage of the environment.





The Windows NT processor performance monitor showed dramatic improvements in processor utilization once SQL Server's dedicated multiprocessor switch was turned on. With the switch off (left), processor utilization for the Compaq's dual-486 system averages around 50 percent with two clients; with the switch on (below), it climbs to 98 percent.

What You Pay For

Comparing the test results, features, and prices of the ALR, Compaq, and VTech systems, it seems you get what you pay for. The Compaq ProLiants have the features and performance you'd generally want for a superserver, but also the price tag. However, they are much less expensive than older MP superservers.

The ALR system has basic server features—storage capacity, EISA slots, and a strong power supply—but it lacks standard ProLiant features like error-correcting memory and a RAID-capable SCSI controller, and its performance is on a par with a fast single-Pentium system. It also costs over $5000 less than a ProLiant for similar memory and hard drive capacities.

The VTech beats all when factoring both price and performance, but for most uses, it isn't a server in form factor or features. With the desktop case, VTech is banking that eventual NT CAD/CAM, engineering simulation, and DTP applications can also use the extra horsepower provided by symmetrical multiprocessing. In the meantime, it's a great system on which to develop those applications. ■

About the Products

ProVEISA DMP 4/66d...$9638
(tested configuration, no monitor)

Advanced Logic Research, Inc.
9401 Jeronimo
Irvine, CA 92718
(800) 444-4257
(714) 581-6770
fax: (714) 581-9240
Circle 1078 on Inquiry Card.

ProLiant 2000
$15,824 for 50-MHz 486 dual-486 model; $15,296 for single 66-MHz Pentium model; $20,355 for dual 66-MHz Pentium model (all tested configurations)

Compaq Computer Corp.
P.O. Box 692000, M120208
Houston, TX 77269
(800) 345-1518
(713) 378-8820
fax: (713) 378-1442
Circle 1079 on Inquiry Card.

Platinum SMP 486DX2/66 dual...........$4549
(approximate price for tested configuration, no monitor)

VTech Computers, Inc.
800 North Church St.
Lake Zurich, IL 60047
(800) 284-3976
(708) 540-8086
fax: (800) 947-3976
fax: (708) 438-1671
Circle 1080 on Inquiry Card.

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Q+E: The Key to ODBC

Build database-independent applications with ODBC and Q+E's 2.0 release of Database Library

STEVE APIKI

What Microsoft's ODBC (Open Database Connectivity) is only beginning to provide today—database-independent applications for users and a single database target for developers—Q+E Software has been delivering for over two years with Q+E Database Library. Although it fit the bill, however, the initial release of Database Library wasn't quite flexible enough. As it freed applications from supporting multiple databases, it bound them to drivers sourced solely from Q+E, making Database Library 1.0 a less-than-open solution.

Database Library 2.0, built on ODBC itself, sets this tested database technology squarely on top of a well-supported multivendor standard. ODBC is still maturing, and addressing the ODBC API directly is coding a little too close to the metal; all the low-level details are up to the developer. Q+E Database Library 2.0 abstracts ODBC a few steps further, letting you build your application assuming you'll run on a database system that supports the most sophisticated database management functions available. If, instead, your application finds itself running against dBase files, Database Library will (for the most part) fill in the resulting gaps.

One Library, Many Databases

Q+E Database Library is actually not a single library but a family of DLLs. Using any development tool that can call a DLL (and that can range from Microsoft Excel to Borland C++), you build an application that conducts all its database access through calls to Database Library. The DLL, in turn, calls ODBC-compliant drivers that provide client-server access to the database. The data can ultimately reside in any database for which someone has built an ODBC driver, including SQL Server, dBase, or DB2.

Most of this interoperability comes courtesy of ODBC, so you could write directly to the ODBC API. But not all ODBC drivers support all the features you may need, and you have to handle the differences on your own. Database Library masks these differences. For example, level-1 drivers and some level-2 drivers don't support backward-scrolling cursors, but Database Library provides this capability for you.

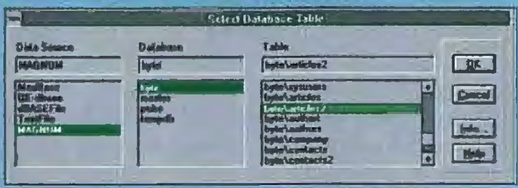
Also, Database Library is just easier to use. As a high-level interface, it can automate functions and tune for performance above the driver level, saving you considerable effort. This includes automatic establishment and tracking of additional database connections when you execute multiple SQL statements against databases (e.g., SQL Server) that allow only one statement per connection.

Equal Footing

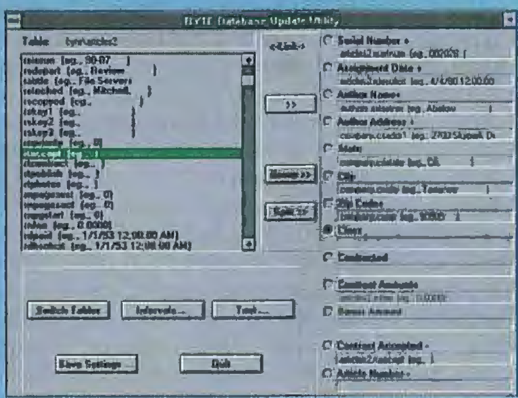
The best part of Q+E Database Library, and the single item that most sets it apart from other ODBC toolkits, is its provision of an unvarying set of powerful database management functions on every database platform. Using Database Library, you can safely write an application that assumes forward, backward, and random record selection, and even transaction support, regardless of the underlying database.

However, that functionality is not delivered solely by the DLLs; some of it relies on the support that is provided by Q+E's ODBC drivers. Q+E supplies 20 database drivers with Database Library.

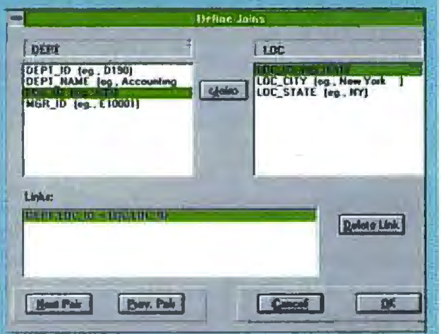
An Application Built with Q+E Database Library 2.0



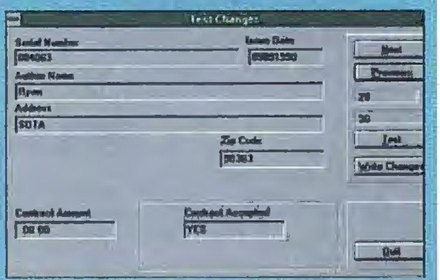
❶ Q+E's data-dictionary functions qeSources(), qeDatabases(), and qeTables() provide a catalog of data sources visible to the client workstation. You can use these functions to let users switch between data sources at run time. Once the choice is made, your application makes the connection to the database through the library and the database driver, which together can handle all log-on details.



❷ qeColumns() provides the application with a list of columns in the database. You build SQL SELECT statements and pass these to Q+E to gather field information from the database (in this case, Microsoft's SQL Server).



❸ If the underlying database driver supports SQL joins, your application can build a SELECT statement that joins independent tables. However, you can't join tables that come from separate sources (a limitation of ODBC). Both of these tables are dBase files.



❹ Using SQL statements and Q+E record-based functions, you can retrieve all the data required for a simple browser window in a single loop. Q+E Database Library, subject to the sophistication of the driver, handles transactions, record locking, and forward, backward, and random record selection.

Q+E: The Key to ODBC

Q+E also sells these off-the-shelf ODBC drivers to end users as part of its ODBC Driver Pack. Although you can use them for development, you can't resell them with your final product; you need a distribution license from Q+E for that. However, you can opt not to provide a database driver at all, letting your users install Q+E or third-party drivers instead.

KEY NEW FEATURES IN VERSION 2.0

- ODBC compliance
- Data-dictionary functions for finding data sources
- Built-in query builder

Forward- and backward-scrolling cursors are built into both the Q+E drivers and the library itself, so you're safe whether your customers have Q+E drivers or not. But although transaction support is also provided by the library, it relies on the transaction capability of the database system itself. In the case of dBase (since the dBase-file driver must implement all the SQL management functions itself), this requires transaction capability in the driver. For the moment, that limits you to Q+E's driver.

ODBC is simply not as uniform a layer as it ought to be, and supporting some functions is out of the realm of a database access tool. Database Library works best when running on top of Q+E database drivers, and that's probably the way you should plan on distributing your application.

Building an Application

Q+E Database Library makes support for multiple data sources easy, but it doesn't do much to simplify the process of actually building a database-enabled application. It certainly doesn't compare on that score to VBX-based development kits like Coromandel's Integra VDB or Q+E's own MultiLink/VB.

Nevertheless, it is a fairly high-level library, and the API is not hard to work with. The test application shown on page 139, which can switch between several data sources, browse a database, join tables, and automatically update fields based on the contents of other fields, took about three days to produce from a blank Windows application skeleton.

In general, working with the Database Library means working with SQL. Once you've made a connection, you spend most of the rest of your code building SQL statements and processing those statements and their results using Database Library functions. I built the browser, for example, by building a SQL SELECT statement, executing it through the library, and scrolling back and forth through the results, which were bound to variables displayed in the edit controls.

Database Library also includes an assortment of current-record access functions. You can use these functions to (among other things) update the database without having to write SQL UPDATE statements.

The data-dictionary functions, new in 2.0, provide the information you need to let users choose data sources and tables. You can query the database system for available database names and table names, and the results are returned as if you had executed a SQL SELECT statement. The library and driver handle all log-on details. These functions let you build your application without anticipating a certain database structure—a critical point for developers of shrink-wrapped applications.

Database Library 2.0 includes an entire Query Builder interface. You can use the Query Builder to let users build SELECT statements interactively through a dialog box. Version 2.0 also introduces parameterized SQL statements that let you bind variables to expressions in a SQL statement and thus programmatically modify queries with little effort.

The sample application uses *commit* and *rollback* functions to update all related records in a single transaction. Transaction support, explicit record locking, and determination and setting of database isolation levels are all handled by the library. Again, although the data reliability you'll get is a function of the driver and the database system itself, you can use these calls transparently on any database system.

About the Product

Q+E Database Library 2.0 ....$699
(Driver distribution requires additional license.)

Q+E Software, Inc.
5540 Centerview Dr., Suite 324
Raleigh, NC 27606
(800) 876-3101
(919) 859-2220
fax: (919) 859-9337
Circle 1076 on Inquiry Card.

During the development process, I ran the sample application exclusively on a test Q+E dBase ODBC driver. When it was completely done, I ran it against Microsoft SQL Server, through the Microsoft ODBC driver. Except for exposing an error in my application (I was pulling in system tables when I didn't need to and was getting back EOFs [end-of-file] when trying to read them), the program ran flawlessly. Overall, portability from database system to database system was outstanding; the only real lesson here is that no matter how good the underlying library is, you should plan to test your application on every system you intend to support.

The finished application was fast, even without any tuning on my part. The Database Library provides functions to set virtually every parameter that can affect performance (or reliability), so you can optimize database access by hand if performance is critical.

Toward Greater Independence

Q+E Database Library 2.0 and ODBC are intricately intertwined for the moment, but that's at the middle of the driver stack; your application (at the top) need only concern itself with the Database Library API. This insulation affords your application another level of database independence and allows Q+E to support other database access standards as they mature. Q+E has announced plans to support Borland's IDAPI and could support other database access methods in the future. Since version 2.0 of the library is also backward-compatible with version 1.0, users of version 1.0 can now support ODBC by simply sliding version 2.0 under their existing applications.

Besides database independence, Q+E Database Library provides a measure of operating-system-platform independence as well. As of this writing, Database Library 2.0 runs on Windows only. Q+E says that it will ship OS/2, Macintosh, and Unix versions of the Database Library by the end of the first quarter. All these non-Windows versions will remain ODBC-compliant, and Q+E will provide ODBC drivers on those platforms.

If you're developing Windows database applications today and you can't use a VBX, Database Library 2.0 is a no-brainer—it's the only sensible choice. If you can use a VBX in your development environment and are after simplicity, a toolkit like Integra VDB or MultiLink/VB might be better; however, Database Library 2.0 is still the more powerful and flexible option. ■

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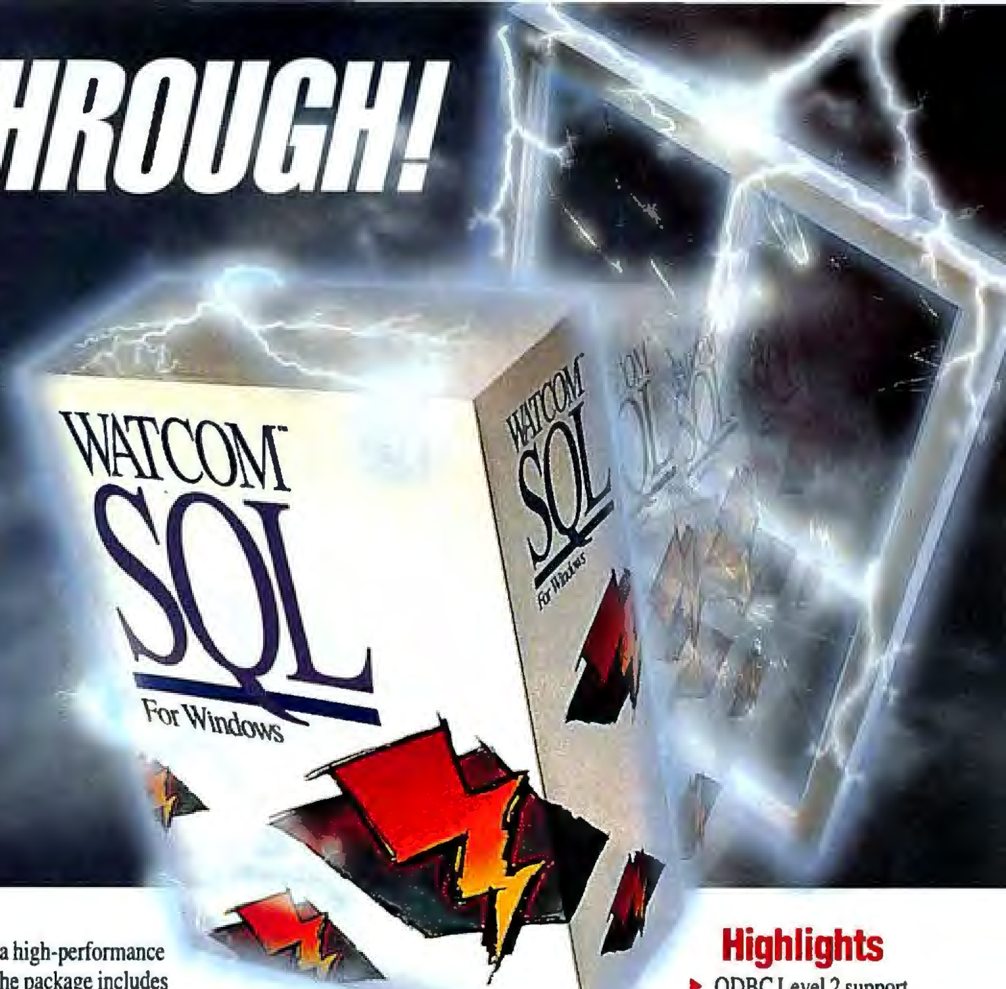
BREAKTHROUGH!

Client/Server SQL Database for Windows Applications



WATCOM™ SQL for Windows is a high-performance SQL database engine for Windows applications. The package includes everything required to begin using WATCOM SQL immediately from many popular Windows applications, supporting interfaces ranging from ODBC and DDE to the Windows clipboard. Everything necessary for application development in C/C++ (using compilers from WATCOM, Microsoft or Borland) is also included.

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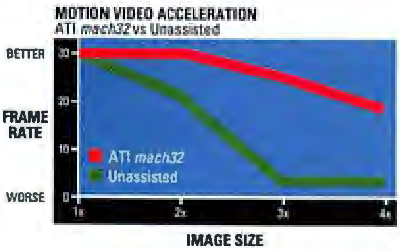

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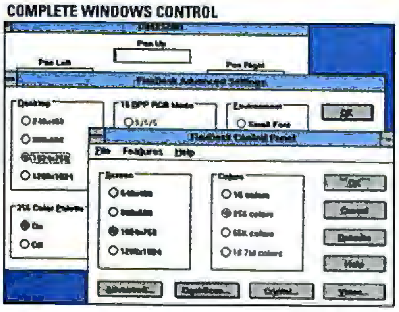

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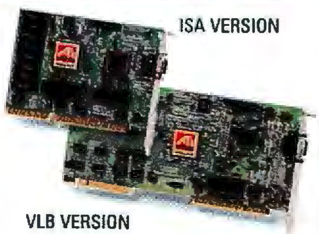

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Client/Server Made Easy

NobleNet's EZ-RPC makes it much easier to build distributed client/ server applications—from scratch or from existing stand-alone programs

BEN SMITH

C language application programmers are seldom network communications programmers. They may understand the concept of client/server applications, but they typically lack the know-how to implement them over heterogeneous networks. NobleNet's new RPC toolkit EZ-RPC gives programmers the ability to write transport-independent client/server applications without network programming skills. EZ-RPC shields you from the network connection, making calls to routines on other systems seem no different than calls to local C functions.

Just a few years ago, typical client/server applications resided wholly within a single multitasking computer. The server and clients ran as separate processes and communicated using operating-system services such as semaphores, shared memory, messages, or named pipes. Today, there's usually a network between client and server processes, and the two can be running on different computers, processors, and even operating systems. While the application may remain the same, implementation has become much more complex, because the old IPC (interprocess communications) methods have no meaning when there is no shared memory or file space.

Enter RPC

IPC over networks is typically handled with sockets, but socket programming isn't trivial. It follows a file I/O model and becomes tedious with anything more complex than a simple data stream. To hide the complexity of socket programming, communications programmers developed an interface for building IPC that mimics the structure of a simple C function call—a function's name, its arguments when called, and its returned value or structure. This method of communication is known as a *remote procedure call*, or RPC. Apollo's NCA (Network Computing Architecture), Xerox's Courier, and Sun Microsystems' ONC (Open Network Computing) have each provided RPC programming tools and libraries.

ONC includes Sun's XDR (cross-platform data representation), which allows little-endian computers, such as Intel-based systems and DEC VAXes, to transparently exchange data with big-endian computers like IBM mainframes and Apple Macs. Now, nearly every Unix applications developer's license includes ONC RPC, NFS/RPC, or the newer operating-system-independent TI/RPC. Open Software Foundation's DCE/RPC, a descendent of Apollo's NCA, hasn't been as widely accepted.

The EZ Advantage

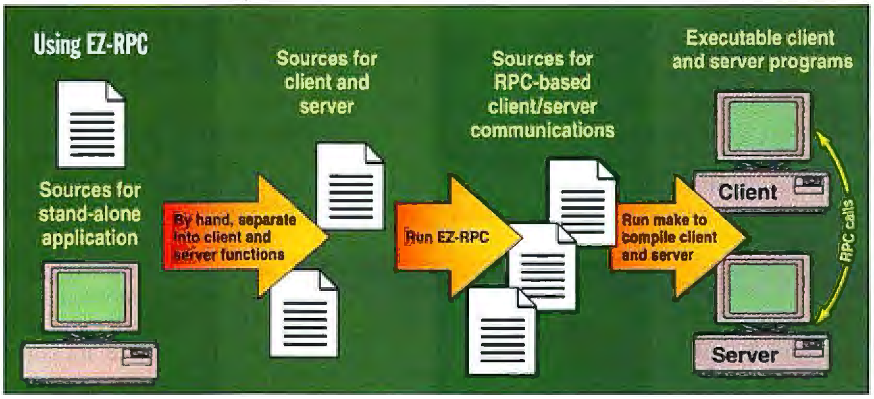
Although RPC simplifies IPC, most RPC toolkits have limits to their abilities to disguise client/server interactions as simple C functions. EZ-RPC overcomes almost all of them (see the table "Advantages of EZ-RPC"). EZ-RPC's most significant feature is that, with few exceptions, it lets you use all standard C argument constructs, variable dereferencing (i.e., use of addresses and pointers), and data structures.

Other toolkits limit you to a single argument and to simple data types that can cross easily between client and server. In other words, you still have to write specially constructed functions for any services that span the connection between client and server. With EZ-RPC, you don't need to rewrite existing functions when creating a client/server application from an existing stand-alone program. Nor do you need to constrain function design if you are developing a new application with distributed computing in mind.

To use NobleNet's RPC development tools, you break the client and server parts of an application into separate compilation file lists. You then define the functions that bridge the client and server in an RPC specification file, run the `rpcgen` utility that generates the supporting source files, and compile the resulting client and server parts of the code, linking them with the RPC library calls that are made in the generated code.

With EZ-RPC, the only necessary addition to your source code is a single function call that your client program must make to establish communications with the server; `myprogram_open_transport(argv[1],0,0);` is an example. But there are a few C language ambiguities that you should resolve. The most common is the use of the construct `char *` as the generic notation for a pointer to any data type. EZ-RPC provides predefined data types that you should use instead to resolve data-structure ambiguities.

The RPC specification file that you must build has a syntax similar to C's. It contains a program specification that holds the information about each server function made available to the clients, plus the data types of these functions and their arguments. The EZ-RPC specification file uses the same format as the TI/RPC or NFS/RPC specifications, with a few enhancements. Each function argument



Building a client/server application with EZ-RPC requires little more than dividing your C code into client and server portions and specifying which functions bridge the client/server gap. You don't need to rewrite existing functions or constrain design of new functions.

Advantages of EZ-RPC

EZ-RPC	OTHER RPC TOOLKITS
PARAMETER PASSING	
Places no arbitrary limit on the argument list.	Allows only a single argument and a single result. Multiple arguments or return values must be packaged as a structure.
DATA TYPES SUPPORTED	
Supports all data types (including pointers) and structures, except those that cannot be fully resolved to having a beginning and an end (e.g., doubly linked lists and rings).	Supports only integer, floating-point, enumeration, structure, fixed-length and variable-length single-dimension arrays, and discriminated union. (DCE/RPC supports a few more.)
TRANSPORT PROTOCOL	
Is built on top of TI/RPC, and so is transport independent. A command-line option produces NFS/RPC calls.	Uses NFS/RPC, which is limited to either UDP or TCP and is not transport independent.
RPC SPECIFICATION FILE	
Provides extensive predefined data types and other enhancements for resolving ambiguities. Can read external header files to understand structures and data type definitions.	Can't resolve data type ambiguities. Cannot read external header files to find data structures.
MEMORY MANAGEMENT	
Has client and server memory allocation and memory management that are controlled by the state of the RPC call using it.	Has no memory management functions triggered by the state of RPCs, so memory "leaks" are hard to avoid.
DOCUMENTATION	
A 290-page manual documents application-building with many examples, a thorough reference section on the RPC specification files, a description of generated files, and debugging methods.	Information is fragmented among several books, technical papers, and Unix manual entries.

specification contains a modifier (in square brackets) that describes in which direction the data is to flow with the argument.

Besides enhancements for resolving ambiguities, EZ-RPC has advanced features for creating complex client/server applications. These include client-broadcast RPCs and, for applications that use multiple servers, `find_server` and `collect_servers` functions. You can also create callback programs in which the client and the server switch roles.

Testing Its Mettle

To evaluate EZ-RPC, I started with source code from a configurable command interpreter I'm building, a stand-alone application that creates a binary tree. I divided the code in an unlikely way (from a client/server standpoint) that forced the client and server to pass the tree back and forth between them. With a single-process, stand-alone application, it makes sense to use pointers. But a pointer to an address in a process on one system has no meaning to another process on another system.

In spite of the inherent difficulties, EZ-RPC easily built the communications stubs that allowed my client and server to continue using these complex structures. This was a particularly challenging task because the size of the shared data structure wasn't available until the functions that generated the tree were complete. (It would have been a nightmare to try to build the data communications with sockets, or, for that matter, with shared memory, semaphores, and named pipes.)

The problems I ran into using EZ-RPC were not in its design and function, which are very robust, but in understanding the syntax of RPC specification files. Even though NobleNet's manuals explain basic concepts well and go into considerable detail with extensive examples, there are some picky syntactical requirements that need greater emphasis. Misunderstanding them delayed me in getting my application to compile and run properly. Fortunately, NobleNet's technical-support team set me straight, without confusion or delay.

About the Product

EZ-RPC $4995 for first platform, first seat; $1495 for additional platforms; $495 for additional seats. No fee on use of the libraries.	NobleNet, Inc. 337 Turnpike Rd. Southboro, MA 01772 (508) 460-8222 fax: (508) 460-3456 **Circle 1075 on Inquiry Card.**

Beyond Unix

I evaluated NobleNet's Unix product, EZ-RPC, but network IPC is not limited to the Unix environment, and neither are NobleNet's products. You can provide DOS/Windows applications with client/server capabilities using WinRPC ($995), which generates WinSock-compliant RPC DLLs. RPCWare ($4995) does the same for NetWare clients and servers, generating C source stubs for EXEs and NLMs (NetWare loadable modules). And programs developed in the Windows environment, for example, can communicate transparently with client or server code that you build in the Unix or Novell environment.

EZ-RPC supports Unix implementations from Sun, Hewlett-Packard, DEC, Silicon Graphics, IBM, The Santa Cruz Operation, Data General, and Next. Licensing of the first seat for either EZ-RPC or RPCWare is $4995 on the server side; the price decreases for additional seats. This may seem steep to a PC developer, but there is no licensing for code generated by these products, nor for including NobleNet's libraries in the executables you link and distribute.

I found EZ-RPC to be an easy-to-use tool valuable for converting any appropriate application program to a network-based client/server design, and it doesn't require an understanding of network programming. What EZ-RPC will not do is claw apart your application into client and server components; you have to perform this onerous task by hand. However, because EZ-RPC makes it so easy to move functions between the client and server sides, design iterations are painless.

Whether you're converting an existing program or building a new distributed application, EZ-RPC is a valuable tool for creating robust, well-behaved communications links. NobleNet's RPC tools let you build client/server applications that run on almost all Unix platforms, and, with NetWare and Windows, all from source code with no built-in communications. These distributed-application tools are far more economical and expedient than hiring or training communications experts to build distributed applications. ■

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Budget CD Recording

The cost of cutting your own CD-ROMs has never been this low, but you'll need a big, fast hard drive

TOM THOMPSON

CD-R drives *from (left to right) Microboards, JVC, and Pinnacle Micro come with recording software and cables and cost around $4000. All three support Mac and PC platforms. The JVC and Microboards systems also work with some types of Unix.*

Much has changed since BYTE looked at low-cost CD-R (CD Recordable) drives just over a year ago (see "Affordable CD-R Drives," February 1993 BYTE, page 118). Then, a CD-R system cost from $9000 to $18,000. One reason earlier setups were so pricey is that, in addition to the CD-R unit and recording software, they included an expensive hard drive—one large enough to hold the 650 MB of data you planned to record, and fast enough to pump that data into the CD-R drive at the sustained rate required by the recording process.

Today, several vendors offer SCSI CD-R packages that cost right around $4000. The prices vary slightly, depending on the platform (Macs have built-in SCSI, but most PCs require a SCSI adapter card) and whether you order an internal or external CD-R unit. At these prices, however, you get only a CD-R drive and recording software; you have to supply your own large, fast hard drive to feed the data to the CD-R unit. While that makes the drop in price smaller than it first seems, the price of cutting your own CD-ROM disks has dropped thousands of dollars.

I evaluated JVC's Personal Archiver, Microboards' PlayWrite 1000, and Pinnacle Micro's RCD-202. I ordered external units to make it easier to check out the recording software on both Macs and PCs. JVC and Pinnacle Micro offer internal versions of their CD-R units that cost slightly less because the drives run off the computer's power supply; Microboards doesn't offer an internal CD-ROM drive at this time.

All three reviewed units can record onto 63-minute and 74-minute CD blanks. In computer terms, the 63-minute CD holds 580 MB of data, and the 74-minute CD stores 680 MB. (The time values are standards for audio CD recording.)

As test systems, I used a 33-MHz Mac Quadra 800 with 8 MB of RAM and running System 7.1, and a 50-MHz 486-based Texas Microsystems computer with 8 MB of RAM and running DOS 6.2. The PC's SCSI connector was an Adaptec 1542C card. Since the ISO 9660 CD-ROM standard serves as a nearly universal interchange format among various platforms, I used it to make the test CDs.

JVC Personal Archiver

JVC's Personal Archiver works with PCs, Macs, and the Sun SparcStation Solaris 1.0 Unix system. The software supports three recording modes: track-at-once (the regular single-session CD-ROM format), incremental (a special mode of JVC's that lets DOS users record and read portions of the data before finalizing it as a single session), and multiple sessions. The DOS software writes ISO 9660 or High Sierra formats, and the Unix software writes ISO 9660 and native UFS (Unix File System) formats. On the Mac, you can record ISO 9660, Mac HFS, or Red Book Audio (CD-DA) formats; the audio material must be 44.1-kHz, 16-bit stereo data captured on the Mac. Once you record this data in the audio format, you can play the resulting CD on a standard audio CD player.

The CD-R unit, the JVC XR-W1001, is a single-speed drive with a built-in 64-KB cache. A thumb wheel lets you quickly set the drive's SCSI ID. On the Mac, I simply selected an unused ID and added the drive to the Quadra 800's SCSI chain. This chain consisted of an internal hard drive and CD-ROM drive, an external 1-GB Envisio SmartStack hard drive, an Epson 800C flatbed scanner, and a Kodak slide scanner. I used the last two devices to generate 400 MB of test image data in 50 files that I stored on the Envisio hard drive.

The Mac Archiver application lets you select files scattered among various servers on a network and consolidate them into a single image file that represents the CD image byte by byte. Using an image file reduces system overhead during recording. This was important because of the JVC drive's small 64-KB cache buffer, although the drive's single-speed (150 KBps) transfer rate isn't all that demanding. By pre-assembling the data into an image file, I thought I would easily write my first disk.

Wrong. I ruined two blanks before discovering that the Quantum hard drive inside the SmartStack was undergoing TCAL (thermal recalibration) every 20 minutes and the process was interrupting the data flow long enough to wreck the blank. (See the text box "Recording Perils" for more on this and other CD recording pitfalls.) I obtained a Maxtor 1-GB drive that uses a less disruptive TCAL mechanism and copied my source files to it. The

JVC software then produced a perfect ISO 9660 CD-ROM.

Adding more sessions is a snap: Set up the data, insert the CD into the CD-R unit, and let the Archiver software add the new session. To play back one or more sessions, you use the Mount command within the Mac Archiver application to display the list of sessions on a CD and pick the ones you want. These sessions then appear as volumes on the Mac Desktop.

On the PC side, the Personal Archiver setup can be restrictive. The SCSI ID of the CD-R unit *must* be one less than the SCSI ID of the hard drive. This means you can't make the data storage drive a boot drive, because that requires a SCSI ID of 0 with most SCSI adapters.

The PC Archiver program uses a character-mode user interface with a minimalist set of menus. Several keystrokes got the recording run set up. Then the CD-R drive ground away for the 50 minutes required to write the test data, burning a perfect ISO 9660 CD the first time. Making a multiple-session CD is just a matter of selecting the Add Session command from a menu and inserting the CD. A SESSION .EXE program lets you list and then mount one session at a time.

Microboards PlayWrite 1000

The PlayWrite 1000 comes with recording software for three platforms: DOS, Mac, and Unix (flavors supported are SunOS 4.1.x, HP-UX 8.07, and NEC EWS V/4). The recording software is from Dataware Technologies and supports Mac HFS, ISO 9660, RockRidge, CD-ROM XA (Extended Architecture), and UFS formats as well as multiple sessions.

The CD-R drive is an external Ricoh RS9200CD. One minor annoyance is that you have to remove a small plate on the drive's housing to get at DIP switches that set the SCSI ID and SCSI termination. Note that Microboards doesn't supply a SCSI card for the PC; the company assumes that you already own an ASPI-compatible (advanced SCSI programming interface) board. (If you don't, Microboards recommends an Adaptec card.)

The Dataware software sets up a virtual ISO 9660 partition on the source hard drive. It does this by using a driver that maps and converts the hard drive's native file structure into ISO 9660 format on the fly as the drive is accessed through the MSCDEX CD-ROM driver. This way, you can examine the results of your planned CD-ROM image before committing it to a blank.

The mapping software accomplishes this sleight of hand by consulting a map file that you write to describe the CD-ROM's layout and the corresponding links to files on the hard drive. The map file is an ASCII text file, and the commands you write in it provide an exact description of the CD-ROM. You can create simple one-to-one links between files and directories on the hard drive and the planned CD-ROM, or you can arrange more exotic fare with mixed data files and audio tracks.

Once you've written the map file, you run the mapping application. On the Mac, VMapBuild creates a map file that's used with another application, VMapMount, to "mount" the virtual CD-ROM image. The virtual image appears on the Mac Desktop, and you can explore the arrangement of the CD-ROM by pointing and clicking.

Under DOS, the VMAP_ISO.EXE program places the map in memory, and you mount the virtual image using MSCDEX .EXE. You then examine it using DOS commands. If you reboot the system, you'll have to rerun VMAP_ISO.EXE to re-create the virtual CD-ROM. When the virtual image meets with your approval, you run CD-Record (both platforms) to either make a real image file or record on a blank.

The ISO 9660 CD-ROMs I made were readable on both the Mac and the PC. However, the Mac-made CD-ROM had some nested subdirectories (well under ISO 9660's limit of eight) that the PC

RECORDING PERILS

If you thought dye-sublimation printing goofs at $3 a page were expensive, brace yourself for the cost of CD recording mishaps. At $20 to $40 a blank, the cost of mistakes mounts rapidly. Obviously, you want all your data together and organized before writing a blank. But an important fact often overlooked is that once recording begins, data must flow to the CD-R drive at a constant rate without interruption—otherwise, the blank is ruined. Here are some hints to minimize expensive recording goofs.

- Check out your SCSI setup. Loose cables, improper termination, and conflicting SCSI IDs can introduce all sorts of hard-to-trace intermittent problems and data dropouts.
- Use a hard drive with unobtrusive TCAL (thermal recalibration). TCAL is the periodic process most hard drives use to check head tracking and adjust it to temperature-related dimension changes. Depending on how it's done, TCAL can (and often does) disrupt the data flow to the CD-R drive, with catastrophic results. Newer drives stagger this operation among read/write heads so the data flow remains essentially continuous. Ask your CD-R drive vendor for a list of recommended hard drives. Also, a CD-R drive with a large cache, like the Microboards unit, can help smooth out dips in the data flow.
- Reduce system overhead. First, switch off network services or disconnect the network line; unexpected network traffic can interrupt the CPU and create a glitch in the recording data stream. Also turn off screen savers, sound utilities, and any other TSR programs or Extensions that might unexpectedly take control of the CPU.
- If your CD-R recording software has a test option, use it. This software can evaluate your system's throughput and, with some packages, identify potential ISO 9660 name problems or missing files. Generating an image file of the CD-ROM you're about to create can also spot missing files; this has the added advantage of turning the recording session into a simple data-copy operation, which reduces system overhead.
- For the most predictable results when making ISO 9660 discs, Mac users should restrict filenames to ISO name format (an eight-character maximum plus a three-character extension, like MS-DOS filenames). Some recording applications offer automatic name conversion when making a disc. But you'll avoid surprises if you do it yourself.
- Although the reviewed systems can record multiple sessions per the Orange Book specification, this standard for magneto-optical, CD-R, and WORM recording isn't final yet. (For more information on the Orange Book standard, see "Start the Presses," February 1993 BYTE). Minor last-minute adjustments could create compatibility problems for any CDs you record before finalization. For the same reason, not all drive vendors have written multisession Orange Book drivers. If possible, restrict yourself to single-session recordings for the sake of compatibility.

claimed were "invalid directories," even though the directory and its files were visible on the Mac. The PC-made CD-ROM, using the identical file data and directory structure, had no problems at all. Dataware is aware of the problem and should have it fixed by the time you read this.

Depending on the CD-R drive, CD-Record writes the data at single speed or double speed (300 KBps). For the Ricoh drive, it uses single speed, so the 400-MB data transfer took about 50 minutes. This drive has a 1.2-MB cache, which makes the recording session less susceptible to data dropouts; I confirmed this by successfully writing a CD-ROM using the Envisio drive with its clumsy TCAL process. As with the JVC software, adding another session is just a matter of putting the CD back into the drive and writing more data to it.

Pinnacle Micro RCD-202

Pinnacle Micro's recording software supports ISO 9660, CD-ROM XA, CD-I (CD Interactive), Photo CD, multisession, and audio CDs. As with the JVC software, you use 44.1-kHz, 16-bit stereo (AIFF or Sound Designer files) on the Mac for the audio data. A utility program on the PC lets you convert WAV files to the appropriate format. The Mac software can also make Mac HFS-format CDs. There's no support for Unix systems at this time.

The Pinnacle RCD-202 CD-R drive lets you set the SCSI ID by a thumb wheel, which simplifies installation. It's a single-speed drive with a 64-KB cache, and, as with the JVC drive, this small buffer means that you need a peppy system and a fast source drive to maintain the data flow.

The RCD recording program provides a neat drag-and-drop interface on both the Mac and the PC running Windows. You click and drag the source drive's icon and the destination drive's icon from a listbox to the appropriate windows to arrange the data transfer. With the listboxes beneath the source/destination windows, you drag and drop to assign the desired source files and folders for transfer to the destination drive. Once you've finished arranging the data, you can create an image file.

On the PC, you can "mount" this image and test it. As with the Dataware software, a special driver maps the ISO 9660 data so that the MSCDEX.EXE considers it a CD-ROM. However, the mapping information is obtained not from a text file, but from a database created by RCD as you arranged the files. On the Mac, you can select a target SCSI drive and RCD will format the drive into an ISO 9660 CD image. A provided Extension allows the Mac to access this non-HFS volume. You can also mount multisession CD-ROMs, where each session appears as a separate volume on the Mac Desktop.

Now you're ready to burn a blank. RCD lets you do a test run to verify that the system can sustain the transfer rate for the duration of the recording; or, if you prefer, you can skip the test and go ahead with the recording session. Using the Maxtor drive, in about 50 minutes I made ISO 9660 CD-ROMs that were readable by both Macs and PCs. As with the other programs, adding sessions was simply a matter of writing more data to the CD.

One annoying quirk I discovered with the Mac version is that once you drag and drop a source drive, you can't also use it as the destination. This is a problem if you were planning to use the same large drive as both the container of your source files and a destination for the image file. The workaround is to partition the drive and set one partition as the source and the other as the destination.

Recording Results

JVC's setup gave me the least trouble in making CD-ROMs on both platforms. Aside from the initial problem with my choice of source hard drive, the JVC hardware and software provided trouble-free recording. The programs were simple to use, and they supplied good status information as they operated. This was especially valuable when the error messages pointed out that the drive might be at fault during my first two recording attempts.

If you already have a SCSI card in your PC, Microboards' solution might be the better choice. (Microboards doesn't supply an adapter.) With its large cache, the Microboards drive is also more tolerant of data dropouts, which might be an issue if you already own a hard drive and a desktop computer. The Dataware software manual gives you comprehensive information on CD formats, which is a plus for both the novice and the expert planning a sophisticated product. The virtual CD image is a nice concept, although I wish making the map file was easier.

Pinnacle Micro's click-and-drag assignment style will appeal to those who'd rather not tinker with map files. This product has no Unix support, however. Interestingly, the PC manual gave copious details as to CD formats and storage requirement calculations, while the Mac manual did not.

With their low prices, these three CD-R setups offer new opportunities for small companies to manage and distribute large amounts of information. They're also a convenient way to archive data, especially scanned images or reams of printed text. Given a choice, I'd pick JVC's Personal Archiver, although the Microboards PlayWrite 1000 and the Pinnacle Micro RCD-202 placed a close second. ■

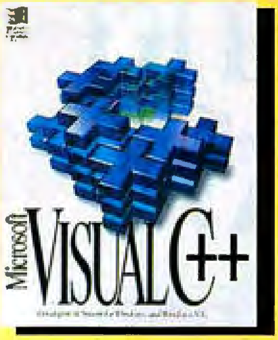
Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. from Memphis State University. He is an Associate Apple Developer. You can contact him on AppleLink as T.THOMPSON, or on the Internet or BIX at tom_thompson@bix.com.

About the Products

Personal Archiver
Internal Mac....$3995
Internal PC....$4100
External Mac....$4495
External PC....$4595
Price includes CD-R drive, Adaptec SCSI adapter card for PCs, Archiver software, SCSI cable, one recordable media blank, and caddy. Media: $26 per 63-minute blank; $29 per 74-minute blank.
JVC Information Products
17811 Mitchell Ave.
Irvine, CA 92714
(714) 261-1292
fax: (714) 261-9690
Circle 1081 on Inquiry Card.

PlayWrite 1000....$3899
Price includes external CD-R unit; Dataware Technologies CD-Record software for Mac, PC, and Unix systems; 3-foot SCSI cable; two recordable media blanks; and caddy. Media (box of 10 discs): $190 for 74-minute blanks; $170 for 63-minute blanks.
Microboards, Inc.
308 Broadway
Carver, MN 55315
(800) 225-4414
(612) 448-9800
fax: (612) 448-9806
Circle 1082 on Inquiry Card.

RCD-202
Internal Mac or PC....$3995
External Mac....$3995
External PC....$4195
Price includes CD-R drive, Adaptec SCSI controller board for PCs, RCD software, SCSI cabling, and caddy. Media: $39 per 63-minute or 74-minute blank; $35 each in quantities.
Pinnacle Micro
19 Technology
Irvine, CA 92718
(800) 553-7070
(714) 727-3300
fax: (714) 727-1913
Circle 1083 on Inquiry Card.

Microsoft 

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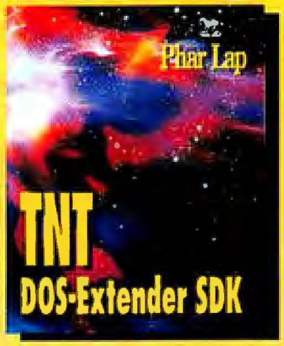
Phar Lap 

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Desktop Telephony

Develop your own automated phone applications with PhonePro

RAYMOND GA CÔTÉ

Most businesses have invested in computers hoping to leverage available time and manpower. While the productivity gains that PCs provide are currently under debate, such technological wizardry as E-mail, online databases, and computer-based faxing systems have become indispensable business tools. To these basic office necessities you can now add PhonePro from Cypress Research.

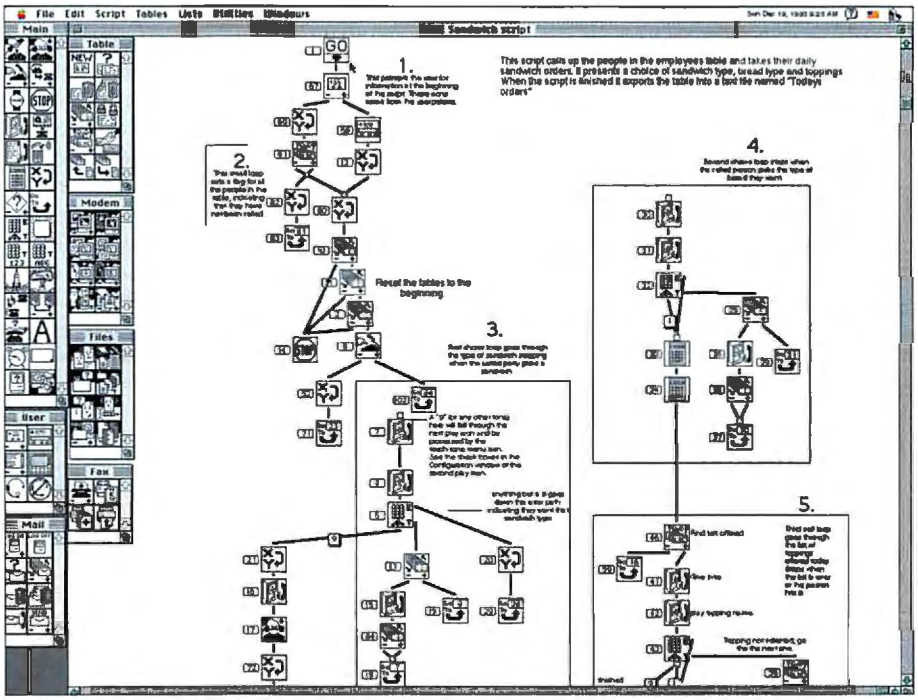
PhonePro, a Mac program for creating automated, programmable voice-mail systems, can help you to work smarter, particularly when you're not around. In fact, you can build an entire business around a PhonePro-based service. With its graphical scripting language you build scripts that answer the phone, present spoken menus, and respond to callers' Touch-Tone entries. Callers can leave private voice messages or transfer to another extension.

PhonePro works with any analog telephone system and can communicate with an ISDN phone line using third-party hardware. Cypress Research provides sample PhonePro scripts that can have you operating a simple voice-mail system within minutes of installing the software.

However, PhonePro goes far beyond voice messaging. Cypress Research calls it a *telephony applications builder*. With PhonePro, you can construct just about any imaginable application involving telephones. I spent a day sketching out programs for answering services, information retrieval, automated wake-up services, and fax-back applications—enough to determine that almost everything I wanted to do was within the realm of PhonePro.

In addition to recording voice messages, PhonePro can identify the source of the phone call using Caller ID and can store call-related information in its integrated database. The database can handle variable-length text strings, numbers, dates, times, and sounds. You could, for example, associate menu choices with caller ID for an order-taking application, or track which information callers are requesting most as a form of market research.

Customers can call in on Touch-Tone telephones or use the optional computer-direct access. With the latter, callers can peruse menus from a terminal program and receive information directly via modem. In addition, PhonePro communicates with FaxPro software, also from Cypress Research, so that callers can request information to be faxed back to them.



A moderately complex PhonePro script overflows a 21-inch monitor's display. All the available program icons fit into seven tool palettes. This sample reads a series of names and phone numbers from a database, calls each person in turn, presents a series of luncheon options, and then places each order in a text file along with the name of the person who ordered it.

PhonePro currently does not allow the fax-back to occur on the same phone line as the originating call. The caller must specify a fax number, and FaxPro makes a separate return call—an added expense for the service provider. It's also awkward for the caller, who must enter additional information. Cypress Research is working on providing same-line fax-back in an upcoming release.

Recorded Sound

You can quickly construct a voice-mail system using built-in capabilities. PhonePro can record messages and store them in a common directory for later retrieval. All voice recordings are stored in Macintosh sfil format, which can be played back directly by double-clicking on the file from the Macintosh System 7.0 Finder. You can also call in through PhonePro and receive your messages over the telephone.

PhonePro maintains multiple dictionaries of prerecorded sounds. You can easily add complete messages to a sound dictionary, or paste sounds together into longer recordings, such as "You have ... 2 ... new messages." All spoken messages must be prerecorded. PhonePro speaks only text stored in its dictionary; it doesn't read text phonetically. Recording sounds requires a sound-capable Mac or a third-party sound board. You can't use the telephone connection to record your dictionary entries.

Since many offices already have an E-mail system installed, an important feature of PhonePro is its ability to work cooperatively with Microsoft Mail 3.0, CE QuickMail 2.5, and Apple Computer's new AOCE (Apple Open Collaborative Environment) PowerTalk messaging systems. You can mail any PhonePro-generated text or data, including voice messages. But note that a voice-mail system will consume large amounts of hard disk storage and possibly load down your network with long messages containing voice data. A single second of typical voice recording will consume over 4 KB of storage.

If you have an all-Mac environment and only want to transmit small messages and sounds between workstations, you can use Cypress Research's Remote_Mac Control Panel device. This device lets you send messages to a remote computer. It uses the ADSP to send messages to remote machines for display by the Notification Manager. This is particularly useful for sending status information quickly to users even if they don't have E-mail capability, or for transmitting important status information.

Scripting

A typical problem with graphical scripting languages is devising meaningful symbols. Aside from the tactless use of a mushroom cloud as a fatal-error icon, PhonePro has done a reasonable job of defining suitable icons. One pass through the palettes with Balloon Help turned on is sufficient to understand what each icon represents. Also, once an icon is placed in a script, moving the cursor over the icon when Balloon Help is active shows how the icon's internal settings have been configured.

PhonePro's scripting language is a good example of how well graphical programming can work for creating applications within a narrow functional environment like telephony. It's easy to get it running out of the box and create simple applications; more complex programs with full error control will take some effort.

A moderately complex script easily overflows a 21-inch monitor display even without a lot of error-handling routines. It helps that scripts can call other scripts and multiple scripts can be open simultaneously for editing, but having several zoom levels would be useful for seeing an overall program flow.

Once a script is complete and tested, you can create a *captive* version—basically a compiled representation. Compiling provides security by ensuring that changes can't be made to a production system.

PhonePro can also be used to develop applications such as for telemarketing stations that require a user interface. PhonePro provides a front-end designer that creates a consistent user interface.

Limitations

PhonePro does have some annoying limitations. Although it is simple to program using the graphical scripting language, moving beyond the simple demonstration applications and adding the proper error handling is a formidable task. Don't expect to sit down in the morning and have a fully functioning multiuser database response system by afternoon. Plan on devoting a week or two to the project.

The current version of PhonePro (1.2.0) supports only a single-line phone system. This limits the number of calls you can take in a day and means you can't average the cost of a computer system across multiple phone lines. Cypress Research reports that it is working on a multiple-

About the Product

PhonePro $349
Cypress Research Corp.
240 East Caribbean Dr.
Sunnyvale, CA 94089
(408) 752-2700
fax: (408) 752-2735
Circle 1077 on Inquiry Card.

Circle 168 on Inquiry Card (Resellers: 169).

line system for future releases.

Another potential difficulty is that AppleTalk operations can interrupt PhonePro long enough to make it lose pieces of telephone recordings, especially when file sharing is active. I've seen this problem with other communications applications that transfer large amounts of data at high speeds. To fix this, PhonePro has an option to automatically disable AppleTalk during recording and playback. The trouble with this approach is that applications connected to the server may drop their connections when the server does not respond.

Although I saw this problem with the standard AppleTalk network active, I did not experience any difficulty when connected through an Ethernet network. The lesson is that voice capture requires a dedicated machine so as not to lose information transmitted by the modem.

Promised Futures

According to Cypress Research, PhonePro responds to the core Apple Events and also the entire Telephony Suite, although the company provides no documentation on the Telephony Apple Events. Cypress Research says it intends to provide further support for the Database Suite of Apple Events, as well as communications with other applications through Apple Events, in a soon-to-be-released upgrade.

By the time you read this, Cypress Research should also have released Voice Messenger, a stand-alone voice-messaging system, and Fax Messenger, a stand-alone fax callback system that integrates with Cypress Research's multiuser fax send/receive server, FaxPro II. FaxPro II also integrates with PhonePro.

Previous releases of PhonePro have required special Cypress-provided hardware to connect a Mac to the phone line. The latest release can run with an off-the-shelf Supra V.32bis fax modem equipped with the latest voice upgrade ROM. The Supra proved to be a reliable voice-processing modem, even though I've had numerous problems making reliable high-speed data connections on my phone lines. According to Cypress Research, Supra will offer a \$99 stand-alone version of PhonePro with its \$49 ROM upgrade. This is a single-user, run-time-only version of PhonePro that will take voice-mail messages for you.

Cypress Research sells the software-only version of PhonePro for \$349, which includes the latest voice-feature ROM upgrade for Supra V.32bis fax modems. FaxPro II retails for \$550.

If all you need is a simple phone-answering function, it doesn't make sense to replace a \$150 answering machine with a \$2000 Mac running PhonePro. However, there are thousands of legitimate and potentially profitable uses for PhonePro. Logging incoming calls and information requests, providing immediate fax feedback, and constructing a custom telemarketing workstation are just a few.

PhonePro has changed the way I view my telephone lines, and I've happily adopted it as a tool to make my company run smoother and more profitably. ■

Raymond GA Côté, a BYTE consulting editor, is vice president of product development at Appropriate Solutions, Inc. (Peterborough, NH). He can be reached on the Internet at rgacote@world.std.com or on BIX as "rgacote."

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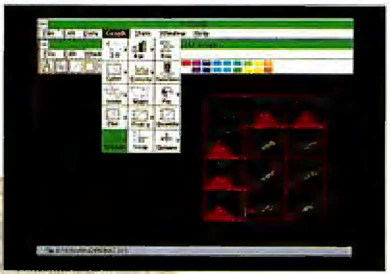

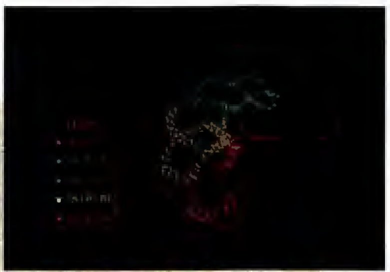

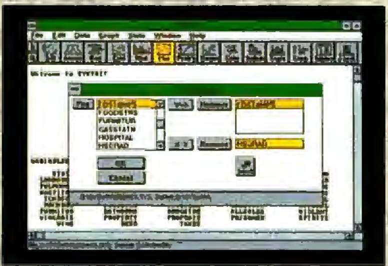

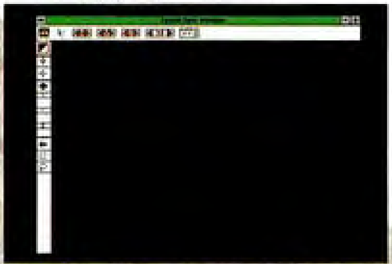

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46 POWERFUL PORTABLES

Our tests show which 486-based notebooks and subnotebooks are best for your applications

ANTHONY LENNON

Today's 486-based notebooks and subnotebooks give you the processing power to handle strenuous computing tasks while on the road. Many notebooks are also well suited for desktop use with their processing power and support of external resolutions of up to 1024 by 768 pixels. In the smaller subnotebook class, you can easily pack a Windows-capable system into an attaché case. To find the best model for a variety of business applications, we tested 38 notebooks and eight subnotebooks with 486 processors. These ranged from Intel's 25-MHz SX and SL CPUs to its clock-doubled 66-MHz DX2. We also tested three Cyrix 486SLC-CPU systems.

Our test sample shows that color notebooks are one of today's hottest products: 30 of these notebooks came with an active-matrix, dual-scan, or passive-matrix color display. These three technologies compete at clear price points, which lets you select the level of color quality and price that matches your needs. The average price of an active-matrix color notebook in our sample was over $4500. Passive-matrix systems sell for an average of only $2700, but their display quality is generally fair or poor. Dual-scan color notebooks average $3400, but we found their quality only slightly better than a passive display's.

Monochrome notebooks offer the lowest price (an average of about $2300). They are an obvious choice if you are on a budget and color isn't a necessity.

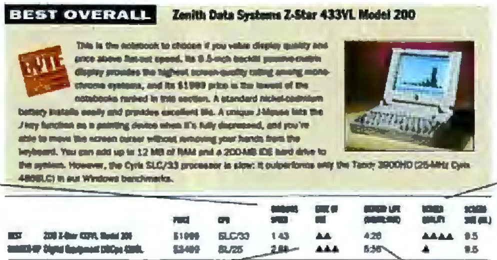
We tested 486-based notebooks with internal floppy drives and weights of less than 10 pounds (including an AC adapter and a battery). Subnotebooks also had to be based on the 486. They weigh under 7 pounds with a battery, an AC adapter, and an external floppy drive.

Subnotebooks, which cost an average of $2200, make some ease-of-use trade-offs for a low weight,

How to use this guide

We selected notebooks by choosing the ones with the best mix of performance, screen quality, battery life, price, features, and ease of use.

Scores are calculated from appropriate Windows and DOS tests. Higher numbers mean better performance.



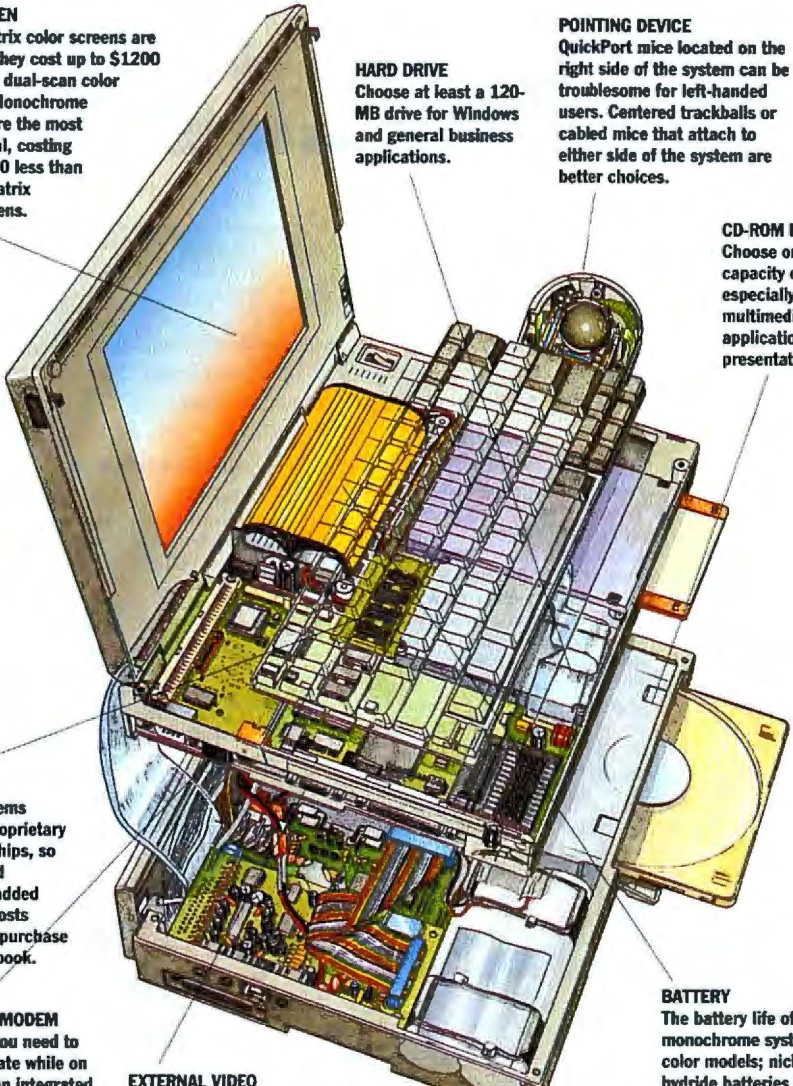
Rating clarity, reproduction of gray scales or color, and range of viewing angles.

Rating based on quality of keyboard design, pointing device, status lights, and other considerations.

Battery discharge under real-world conditions.

PHOTOGRAPHY: STEVE BELKOWITZ © 1994

What to Look For



LCD SCREEN
Active-matrix color screens are best, but they cost up to $1200 more than dual-scan color screens. Monochrome displays are the most economical, costing about $400 less than passive-matrix color screens.

HARD DRIVE
Choose at least a 120-MB drive for Windows and general business applications.

POINTING DEVICE
QuickPort mice located on the right side of the system can be troublesome for left-handed users. Centered trackballs or cabled mice that attach to either side of the system are better choices.

CD-ROM DRIVE
Choose one with high-capacity data storage, especially if you run multimedia applications for presentations.

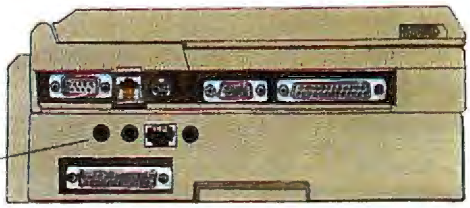
MEMORY
Most systems require proprietary memory chips, so you should consider added memory costs when you purchase your notebook.

DATA/FAX MODEM
A must if you need to communicate while on the road; an integrated modem means you'll have one less box to pack or forget.

EXTERNAL VIDEO
Most notebooks handle a resolution of only 640 by 480 pixels. Make sure your notebook's VGA controller can support a resolution of up to 1024 by 768 pixels on the external port if you want to use a desktop display. If you need an external monitor at higher resolutions, buy a notebook with 1 MB of VRAM (video RAM).

BATTERY
The battery life of monochrome systems outlasts color models; nickel-metal-hydride batteries last longer than standard nickel-cadmium batteries.

Side View



AUDIO JACKS
Used for connecting headphones, small powered speakers, audio playback equipment (i.e., CD or cassette player), and a microphone.

but they compete head-to-head with traditional notebooks in performance.

We also evaluated three notebooks that were designed for presentations. See "Mobile Multimedia" on page 172.

Our report last October separated monochrome notebooks into Windows and DOS categories, but performance scores this time showed little differentiation between Windows and DOS notebooks, leading us to eliminate the DOS category. Hewlett-Packard's 486-based OmniBook wasn't available in time for testing. Also, CompUSA Direct, Epson America, and IBM either declined or were unable to send portables for testing. Apple hasn't introduced new PowerBooks since the October report.

MARCH 1994 BYTE BEST 486-BASED PORTABLES

BEST

WINDOWS

Zenith Data Systems Z-Star 433VL Model 200

This system's 9.5-inch monochrome display received an "excellent" screen-quality rating. The system placed fourth overall for battery life (almost 4¹/₂ hours). The 33-MHz 486SLC CPU didn't match the speed leaders in this category. The notebook features a handy J-Mouse pointing device and is priced under $2000.

PAGE 158

COLOR

Sharp PC-8650

Rated "excellent" for both color screen quality and ease of use, this notebook was also among the fastest 33-MHz machines we tested. It features an 8.4-inch active-matrix display and a nickel-metal-hydride battery that powered the unit for over 3 hours. Its price of $3699 is the lowest among active-matrix color systems.

PAGE 166

DESKTOP REPLACEMENT

NEC UltraliteVersa 33C

This 33-MHz notebook tied for the highest-quality active-matrix color display we tested and provides above-average overall performance. It has a high-quality keyboard, and the cabled mouse is ideal for left- and right-handed users. An optional expansion chassis supports two ISA expansion adapters and provides two drive bays.

PAGE 171

SUBNOTEBOOKS

Packard Bell Diplomat 170M Subnotebook

This subnotebook (and the identical-looking but more expensive ZDS Z-Lite 425SL Model 170W) provides excellent screen quality and an impressive battery life. The systems tied for second for fastest performance in this category.

PAGE 174

THE BEST

WINDOWS NOTEBOOKS

Monochrome notebooks cost less and run an hour or more longer on battery power than the average color notebook. For many users, these advantages make 486-based monochrome notebooks the top choice for Windows on the road.

The Zenith Data Systems Z-Star 433VL Model 200 is our winner for Best Overall (notebooks with processors of 33 MHz or slower). With its $1999 price tag, the system also receives top honors in the Low Cost category (prices less than $2300, the average for monochrome notebooks in this report).

The Digital Equipment DECpc 425SL is the first runner-up in the Best Overall category and provides the best Windows performance among the remaining systems ranked in this category. The notebook's battery life of just under 6 hours was the longest of any notebook in this report, but gray scales produced on its backlit 9.5-inch display are below average and contributed to an overall screen-quality rating of "poor." A detachable trackball can be used with either hand, but it's a little off-center, and its ball is rather small. The keyboard's Backspace key is not the upper-rightmost key (it's located to the left of the PageDown key) and takes time to learn. Retractable legs on the bottom of the unit let you adjust the keyboard angle.

Although its performance wasn't high enough for it to be ranked here, Olivetti's new Philos 44 is notable for some nice usability features. It offers a dedicated numeric keypad (as opposed to the overlaid numeric keypad on most notebooks) and a pop-out mouse that is easy to use with your right hand. A speaker and microphone are installed on the unit above the keyboard, and a status window, which displays the battery-charge level in percentages, is visible when the cover is closed. We found the quality of the 10-inch Hitachi LCD disappointing: It was difficult to distinguish gray bars in the light end of the spectrum.

The Mitsuba Ninja II/DX2-66 and Micro-International HCP Performance Series, Model 6500M, provide the best Windows performance with their 66-MHz 486DX2 processors and finish with similar overall ratings in the High Performance category (systems running at 40 MHz or faster). The Model 6500M contains a VL-Bus video and an IDE interface. The Ninja II contains an efficient Tseng ET4000-based video subsystem, as demonstrated by its performance in

Rankings for This Application Considered

NEW POINTERS

In the never-ending search for a more usable pointing device, vendors continue to present alternative designs. Here is a sample of new pointers that have appeared since our last report on portables:

J-Mouse

Provided on the Zenith Z-Star systems, this pointer is built directly into the J key on the keyboard. The J key acts normally until you hold it down. This activates sensors that let you move the screen cursor in any direction by applying pressure to different areas of the key. Other keys perform the functions of regular mouse buttons. The J-Mouse performs like standard mice, but your fingers never leave the keyboard. The J-Mouse is easy to use once you master the key commands.

Pop-Out Trackball

The Olivetti Philos 44 line offers an innovative pop-out pointing device that's located on the bottom right of the keyboard. The pointer is flexible and includes two command buttons. The trackball offers similar functionality to QuickPort and cabled mice (geared for right-handed users) without being separate from the notebook.

EZ Point

The Gateway 2000 HandBooks feature this small eraser-like device located on the keyboard. The design is similar to IBM's TrackPoint II, but EZ Point falls well short of it in functionality. It's mounted to the right of the keyboard (not in the middle), and the two mouse buttons are awkwardly placed below the keyboard. EZ Point requires extra pressure to point, and it can be used only with your right hand, which must lay across several keys.

Front-Mounted Trackballs

The AST PowerExec 4/33SL-ColorPlus and Digital Equipment DECpc 425SL provide trackballs that attach below the keyboard via mouse ports. You can use the trackballs with either hand, but they are separate from the unit. These notebooks also let you use the function and arrow keys to move the cursor.

our low-level Windows benchmarks and the Microsoft Excel charting test. In the latter benchmark, the Ninja II ran 4.1 times faster than our baseline system; the Model 6500M ran 3.2 times faster than the baseline system.

The Ninja II and Model 6500M provide above-average backlit LCDs and exceptional battery life (about 5 hours) with their standard nickel-cadmium battery packs.

The Commax Smartbook is the only other monochrome unit that competes in the High Performance category. It offers comparable screen quality with its 9.5-inch display. However, its 50-MHz 486DX2 processor cannot match the higher performance of the two ranked notebooks. Also, the Smartbook's nickel-cadmium battery lasted only 2½ hours.

Among Low Cost runners-up, the AST Bravo NB 4/25 S Mono is competitively priced at $2045 and ran for nearly 3 hours on battery power. Indicators are logically grouped (e.g., Caps Lock and Scroll Lock are above the keyboard, while power, standby, and battery status sit on the display hinge, so they remain visible when the unit is closed). You adjust the contrast and brightness of the notebook's above-average-size 9.5-inch display using function-key combinations. A built-in pointing device, which is located between the space bar and the arrow keys, features a tiny trackball (about one-quarter inch in diameter) and favors right-handed users.

The $2069 price of the Tandy 3900HD qualifies it for Low Cost consideration, but we decided not to rank it because of its poor overall performance and last-place finish in each of our application-based benchmarks. This notebook uses a Cyrix 486SLC processor. It was difficult to distinguish gray bars in the dark end of the spectrum on the unit's 10-inch backlit display.

KEY	
Poor ▲	Fair ▲▲
Good ▲▲▲	Excellent ▲▲▲▲

BYTE BEST — WINDOWS

Need the best all-around monochrome portable?

BEST OVERALL — Zenith Data Systems Z-Star 433VL Model 200

MARCH 1994 BYTE BEST WINDOWS NOTEBOOK

This is the notebook to choose if you value display quality and price above flat-out speed. Its 9.5-inch backlit passive-matrix display provides the highest screen-quality rating among monochrome systems, and its $1999 price is the lowest of the notebooks ranked in this section. A standard nickel-cadmium battery installs easily and provides excellent life. A unique J-Mouse lets the J key function as a pointing device when it's fully depressed, and you're able to move the screen cursor without removing your hands from the keyboard. You can add up to 12 MB of RAM and a 200-MB IDE hard drive to the system. However, the Cyrix SLC/33 processor is slow: It outperforms only the Tandy 3900HD (25-MHz Cyrix 486SLC) in our Windows benchmarks. Other drawbacks: The perimeter keys (e.g., PageUp, PageDown, and Home) are small. Undistinguished documentation and the lack of on-line help during setup contribute to the system's "fair" ease-of-use rating.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	ZDS Z-Star 433VL Model 200	$1999	SLC/33	1.43	▲▲	4:26	▲▲▲▲	9.5
RUNNER-UP	Digital Equipment DECpc 425SL	$2499	SL/25	2.88	▲▲▲	5:56	▲	9.5
RUNNER-UP	AST Bravo NB 4/25 S Mono	$2045	SX/25	2.38	▲▲▲	2:55	▲▲▲	9.5

Need high speed?

HIGH PERFORMANCE — Mitsuba Ninja II/DX2-66

The Ninja II is well equipped for processor-intensive tasks with its 66-MHz 486DX2 CPU. This notebook's nickel-cadmium battery pack had the second-longest battery-life time among all the systems and features a 10-inch backlit passive-matrix monochrome display that ranked above average in our overall quality ratings. RAM support goes up to 32 MB, and you can install a 340-MB IDE hard drive. However, system documentation is weak, and it is difficult to see whether the system's six indicators are lit. (Note: One other notebook, the Commax Smartbook, qualified for consideration in this category, but its performance and battery-life scores were too low to be ranked for runner-up status.)

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	Mitsuba Ninja II/DX2-66	$2495	DX2/66	5.63	▲▲	5:05	▲▲▲	10
RUNNER-UP	Micro-International HCP Model 6500M	$2600	DX2/66	5.31	▲▲▲	4:54	▲▲▲	9.5

Cost-conscious?

LOW COST — Zenith Data Systems Z-Star 433VL Model 200

Priced at under $2000, this Best Overall winner is also an economical choice. In addition to the advantages cited above, the Z-Star offers handy usability features. Slide controls for the display's contrast and brightness are located above the keyboard along with the on/off button, which can be configured as a rest/resume switch through Setup. The AST Bravo is a close competitor, with faster Windows speed and an easy-to-read status-light panel. However, the significantly longer battery life and better screen quality tipped the scales in the Z-Star's favor. The Tandy 3900HD, a $2069 notebook, also met the price requirements for this category, but we didn't rank it because of slow performance and "fair" screen quality.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)
BEST	ZDS Z-Star 433VL Model 200	$1999	SLC/33	1.43	▲▲	4:26	▲▲▲▲	9.5
RUNNER-UP	AST Bravo NB 4/25 S Mono	$2045	SX/25	2.38	▲▲▲	2:55	▲▲▲	9.5

How We Tested

PERFORMANCE

We rated the performance of each notebook and subnotebook using BYTE's low-level DOS and Windows benchmarks, along with application tests developed by NSTL. The BYTE low-level DOS benchmarks measure the performance of specific subsystems, such as the CPU, FPU, memory, video, and hard drive. Our Windows-based low-level tests exercise the Windows GDI (Graphical Device Interface). These tests determine how well a system can execute basic graphics calls within Windows, including calls that display pixels, lines, rectangles, polygons, and ellipses. Text and BitBlt operations are also performed. All Windows-based performance tests (low-level and application) were executed in 640- by 480-pixel resolution at 16 colors using vendor-specific video drivers (if supplied).

NSTL's application benchmarks consist of popular business programs to provide accurate real-world representations of notebook performance. For DOS tests, we use WordPerfect 5.1, Lotus 1-2-3 release 2.4, and FoxPro 2.0. Our Windows application tests include the following: Microsoft Excel 4.0a, Microsoft Word 2.0b, and Lotus 1-2-3 for Windows 1.1.

BYTE's Thumper 2 uses optical sensors to monitor power management in portables during battery-life testing.

All applications execute macros that exercise common functions of each application. For instance, the Word for Windows test includes common file I/O, search and replace functions, changing fonts, page and row scrolling, spelling checking, print preview, and print to file subtests.

Prior to testing each system, we installed MS-DOS 6 and Microsoft Windows 3.1 on a freshly formatted hard disk to eliminate any fragmentation. We configured notebooks and subnotebooks with 50- and 40-MB primary partitions, respectively. For comparisons, we scaled all test scores against a 20-MHz 386SX-based Toshiba T2200SX, whose performance equaled 1.0 in our index. Thus, a system with an overall performance index of 3.0 executed our tests three times faster than the baseline T2200SX.

ESSENTIAL FEATURES

We weighted individual features according to importance and used this to determine an overall features rating for each system. We considered the following features most important for 486 portables:

POINTING DEVICES	Notebooks with integrated trackballs scored higher than those with detachable trackballs or no pointing device.
VENDOR SUPPORT	One-year parts and labor warranties are standard, but we gave extra points for longer policies, such as the three-year warranties offered by Compaq, Digital Equipment, NCR, NEC, and Toshiba. We also gave points for on-line support.
PROCESSOR VOLTAGE	Portables built from 3.3-V processors received higher ratings because they require less power and offer improved battery life.
BATTERY CHEMISTRY	We gave extra points for portables with NiMH (nickel-metal-hydride) batteries, which last longer than standard nickel-cadmium batteries for a given weight.
EXTERNAL RESOLUTION	Desktop-replacement systems should support external resolutions of up to 1024 by 768 pixels.
PCMCIA SLOTS	Needed for future generations of modems, network adapters, and mass-storage devices.
REMOVABLE HARD DRIVE	Helps safeguard data and increases the mass-storage potential of the system.

SCREEN QUALITY AND VIEWING RANGE

We evaluated three aspects of display quality: crispness, intensity/color range, and viewing-angle range. Crispness measures line and character quality as displayed on the screen. We used the Sonera Technologies display-test suite to examine text clarity in both color and monochrome environments; horizontal and vertical line placement; color and gray-scale displays; LCD streaking; and solid color and black, gray, and white regions.

We measured the viewing-angle range of each display using a rotating platform that let us move the test unit left and right until we detected visible distortion in the display. Distortion includes loss of text, color changes, and glare caused by the backlighting or edge-lighting. After testing the left/right

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PC MAGAZINE

"Scoring high in overall value and design, the Micro Electronics WinBook gives you a lot for your money, including an outstanding integral trackball."

PC MAGAZINE, Guide to Portable Computing, 8/93

COMPUTER SHOPPER

"If you're a Windows user on a budget, or just have a bad case of Mac envy...you should take a look at the WinBook. It's a machine that can hold its own with more expensive, less thoughtfully designed systems from other direct vendors."

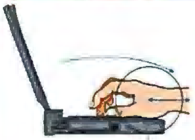
COMPUTER SHOPPER, This Powerbook Twin Acts Like a PC, 9/93

W WINDOWS MAGAZINE

"The WinBook is a great example of what a Windows notebook should be....fast, easy-to-use and a miser on battery life....It's also inexpensive: nearly 50% less than some comparable notebooks."

WINDOWS MAGAZINE, Transcontinental Portable, 9/93

The WinBook Intel486 SX-25, DX-33 & DX2-50 SL Enhanced Features

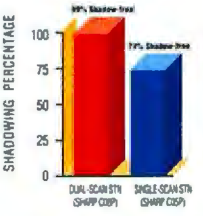


Ergonomically engineered & designed by award-winning Palo Alto Design

The WinBook's unique ergonomic features include a sloping wrist rest and keyboard with full-size keys, plus a centered, dual-button trackball—allowing you to work in total comfort away from your desk.

Clear, sharp color display gives you near-active matrix quality at a passive matrix price!

Images are sharper and clearer with less cursor loss. And the WinBook's advanced dual-scan color display gives you 99% shadow-free performance compared to other single-scan passive matrix displays. You get a brighter, crisper, wider angle of view with an 18:1 contrast ratio—compared to 13:1 with previous passive matrix technology.



Longer battery life

The WinBook features NiMH 2200 MA batteries with gold-plated contacts, allowing it to run much longer than units with traditional NiCAD batteries—and there's no memory effect!

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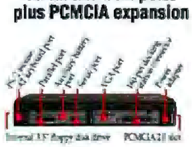

intel inside

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SX & DX Specifications

Size/Weight
- 11" x 8 3/4" x 1 3/4"
- SX monochrome: 5.4 lbs. with battery
- SX and DX dual-scan color: 5.9 lbs. with battery

Pointing Device
- 18mm Alps dual-action, Microsoft-compatible trackball

Battery
- SX-25: up to 3 hours with power management, over 5 hours with auxiliary power system (less 30 minutes for color)
- DX-33: over 2 hours with power management, up to 5 hours with auxiliary power system
- NiMH (no memory effect)
- World-wide auto-sensing AC adapter

Processor and Memory
- SL enhanced Intel486 SX 25MHz, DX 33MHz, or DX2-50MHz CPU
- 4MB RAM upgradable to 32MB
- Pico Power Evergreen Hi chipset
- 8k internal cache

Drives
- 1, built-in 1.44MB 3.5" floppy drive
- Internal 200MB (16ms) hard drive

Software
- Comes loaded with MS-DOS and Microsoft Windows

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- SX monochrome: super-twisted 64 gray-scale 10" LCD and 1024 x 768 for external monitor
- SX and DX color: dual-scan STN color display 9.5" LCD and 1024 x 768 for external monitor
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How We Tested *(continued)*

range, we tilted the screen backward to measure the vertical viewing range of each screen.

After we computed a display's viewing range, we compared it to the range of the best system we tested; in this way, we determined ratings for each screen. Screens tended to cluster at viewing ranges from 40 to 45 degrees left and right and a viewing range of 20 degrees when tilted backward.

To determine color quality, we displayed a color bar on each color system and segregated displays into five categories, ranging from those with bleached and barely distinguishable colors up through the best screens with solid, pure colors. We grouped active-matrix, dual-scan, and passive-matrix color displays together for evaluation. We performed a similar test for passive-matrix monochrome systems using a 16-level gray scale. For monochrome systems, we looked for level gradation, evidence of *banding* (i.e., groupings of gray levels in the middle of the display), and the intensity of the white and black bands.

Testing team (from left): Alan Joch, Michael P. Connors, Siva Kumar, and Anthony Lennon.

BATTERY LIFE

We measured the battery performance of the notebooks using BYTE's own Thumper 2, which is a hardware-and-software test system that determines battery life with power management features enabled. A control program simulates the load of a word processing application.

Time-out periods are set for each notebook's display and hard drive (1 and 2 minutes, respectively), and notebooks are configured to enter standby mode after experiencing 5 minutes of inactivity. Thumper 2 uses robotic arms and an optical sensor to detect and control each system's power management functions.

Prior to testing, we completely drained and recharged each system's battery according to the manufacturer's instructions (and then repeated the procedure). We configured each system's power management features to let the hard drive spin down and the screen's backlighting shut off after a set period of inactivity. The unit is also allowed to enter a standby mode during the test cycle. Each system is put through the test cycle repeatedly until its battery dies.

EASE OF USE

We worked extensively with each notebook over the course of the test cycle and assessed the quality of each keyboard. Although keyboard feel is highly subjective, we based our judgments on specific usability issues. Nonstandard keyboard designs save space but present difficulty for touch-typists. We determined if the system design offered a comfortable typing position and rated the response and feel of the keys.

Pointing devices were evaluated in terms of their placement and ease of use for both right- and left-handed users. The quality of the status indicators was also considered. We determined whether common conditions (e.g., battery low and hard disk access) were represented and if the indicator's meaning was obvious or obscure.

We evaluated the quality of the technical documentation from both a novice and experienced user's point of view. Novices require detailed setup instructions and benefit from troubleshooting information. An experienced user may require detailed system specifications and instructions for advanced setup options. Manuals should be well organized and grammatically accurate; they should also contain a detailed index.

We evaluated the ease of installing new batteries and upgrading the system RAM, and the quality of each unit's Setup utility. We assessed how clearly the I/O ports were labeled. These usability items are less frequently used and therefore carry less weight in determining each system's usability rating.

CONFIGURATION

Our testing was open to all 486-class notebooks and subnotebooks. We specified that notebooks have a minimum of 8 MB of RAM, contain at least a 120-MB hard drive, and weigh less than 10 pounds with their battery, AC adapter, and power cord. Each notebook had to have an internal $3\frac{1}{2}$-inch floppy drive and a VGA display.

We requested vendors to configure subnotebooks with a minimum of 4 MB of RAM and at least a 40-MB hard drive. To classify as a subnotebook, the system had to weigh under 7 pounds with its external floppy drive, battery, AC adapter, and power cord.

Contributors

Michael P. Connors, *Contributing Editor of* PC Digest *(an NSTL publication), writes and researches reviews of systems and other hardware.*

Alan Joch, *Senior Editor/BYTE, coordinates combined testing between the BYTE Lab and NSTL.*

Siva Kumar, *Technical Analyst/NSTL, specializes in hardware and network operating-systems testing.*

Anthony Lennon, *Technical Editor/NSTL, evaluates systems, notebooks, and peripherals.*

The Lab Report is an ongoing collaborative project between BYTE Magazine and National Software Testing Laboratories (NSTL). BYTE Magazine and NSTL are both operating units of McGraw-Hill, Inc.

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Lease $61/month

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- 80MB IDE hard drive
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THE BEST

COLOR NOTEBOOKS

Color notebooks make graphical applications easy to use, but they extract a cost in system price and battery life. Not surprisingly, the active-matrix screens all produced higher display-quality ratings than the dual-scan and passive-matrix models. However, we found quite a variation in display quality between systems using the identical display technology. For example, active-matrix color notebooks ranged from excellent (a perfect 10 for NEC's UltraliteVersa 33C) to average (a 5.3 for the Eurocom 8200T) in overall display quality.

Our results using Thumper 2 showed little correlation between battery life and color display technology. The average active-matrix and passive-matrix models ran for about 3 hours; the average dual-scan battery life was 2.8 hours.

The Sharp PC-8650 received top honors as the Best Overall color notebook (33 MHz or less), and with its price of $3699, this notebook also won in our Low Cost category (notebooks less than $4000). The PC-8650 and NEC UltraliteVersa 33C provide the best display quality among color systems. However, the Toshiba T4600C, AST PowerExec 4/33SL-ColorPlus, and Mitac Micronote Performance Model 4021G/CT posted much better battery-life times (45 minutes or more) than the Sharp PC-8650. All five units contain NiMH battery packs.

The all-out speed leader among the Best Overall color systems was the Mitac Micronote Performance Model 4021G/CT. The unit features a fast memory subsystem and is proficient in video-intensive tests with its Western Digital 90C24 video-processor chip. This notebook is 6.6 times faster than our baseline unit in the Lotus 1-2-3 for Windows screen test, compared to 5.5 times faster for the UltraliteVersa 33C. However, the Model 4021G/CT was also the most expensive notebook we tested in this report, excluding the multimedia systems.

The Sharp PC-8650 and NEC UltraliteVersa 33C gave the best performance among the remaining systems. The PC-8650 contains a more efficient memory subsystem than the UltraliteVersa 33C, as shown in the Microsoft Excel exponentiation benchmarks: The PC-8650 was 25.9 times faster than the baseline notebook (by comparison, the UltraliteVersa 33C was 24.4 times faster). However, the UltraliteVersa 33C provides excellent video performance with its Chips & Technologies 65530 processor, as demonstrated by its showing in our low-level Windows tests, where it was 4.6 times faster than the baseline unit. By comparison, the PC-8650 was 3 times faster than the baseline unit in the same test suite.

The Sharp PC-8650's

Rankings for This Application Considered

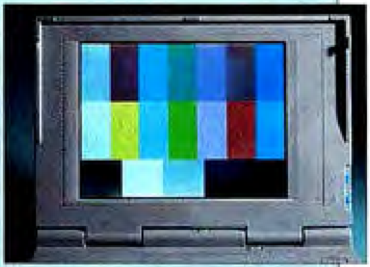
DUAL SCAN: AN ECONOMICAL COMPROMISE?

Each column or row of pixels in passive-matrix displays uses three transistors to control red, green, and blue signals. By contrast, each pixel in an active-matrix screen is controlled by three color-signal transistors, which produces more vibrant colors and higher image quality. Six of the color portables in this report use dual-scan color displays. With average prices of $3400, dual-scan systems offer a value point between passive-matrix and active-matrix color models.

Dual-scan technology, a type of passive-matrix display, divides the screen into top and bottom halves. Each half is scanned simultaneously and in theory produces higher contrast ratios and wider viewing angles than traditional passive-matrix displays. The physical screen size and fundamental technology are the same for both types of screens.

However, we found little difference in color quality between passive-matrix and dual-scan displays. The average dual-scan display received an overall screen-quality rating of 3.1 compared to 2.6 for the average passive-matrix display. (The average active-matrix rating was 7.2.)

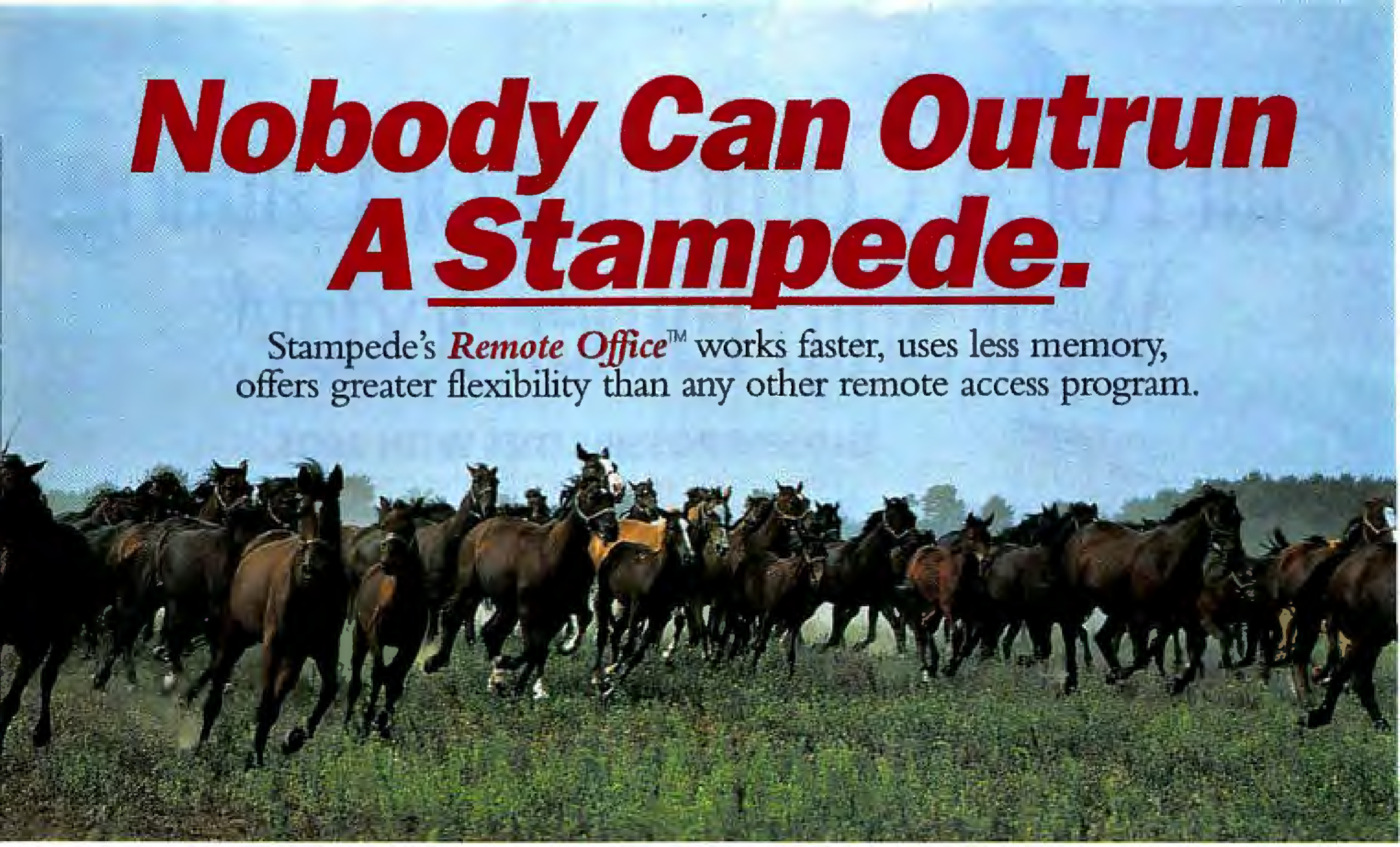
We compared the Texas Instruments TravelMate 4000E WinDX2/50 active-matrix and dual-scan color models ($4678 and $4178, respectively). The active-matrix model (7.3 pounds) is only an ounce heavier than the dual-scan unit, and battery life was identical. The active-matrix model received an "excellent" rating for color purity compared to the below-average rating for the dual-scan model. We also compared the Zenith Data Systems Z-Note 433Lnp+ ($3878) dual-scan notebook with the Z-Star 433Vlp Model 200 ($2699) passive-matrix model. We noticed little difference in color quality, contrast, or viewing angles.



Passive-matrix: Economy, but fair quality.

Dual-scan: Slightly better passive-matrix color.

Active-matrix: The best, for a price.



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detachable trackball is located below the keyboard and can be used with either hand. Even slight pressure will dislodge the Toshiba T4600C's QuickPort mouse from the unit. The T4600C's active-matrix display received only a "fair" overall rating because its colors are relatively dull and its viewing angles are limited compared to the Sharp and NEC displays.

The trackball on the third-runner-up AST PowerExec 4/33SL-ColorPlus sits a little off-center on the front of the system, and you can easily control the screen cursor while keeping your hands on the keyboard.

Four of the five systems in the High Performance category (40 MHz and faster) contain Intel clock-doubled 66-MHz processors; the Texas Instruments TravelMate 4000E WinDX2/50 (it comes with either an active-matrix or dual-scan display) contains a 50-MHz clock-doubled chip.

The Texas Instruments TravelMate 4000E WinDX2/50 contains an efficient memory subsystem and competes with notebooks with faster processors. It outperforms the 66-MHz Model 6500T in the Microsoft Word and Lotus 1-2-3 for Windows benchmarks.

The Olivetti Philos 44c and Gateway 2000 ColorBook 486DX-33 round out the Low Cost category. Both provide over 3 hours of battery life on their standard NiMH battery packs. The Olivetti's active-matrix color display is manufactured by Sharp and offers much better color quality than the Gateway 2000's passive-matrix display. However, the 33-MHz Gateway 2000 outperforms the 25-MHz Olivetti model by almost 20 percent.

The Gateway 2000 ColorBook's retractable mouse, positioned below the keyboard, is serviceable except that the ball and buttons are small. Status indicators are scarce and can be difficult to read.

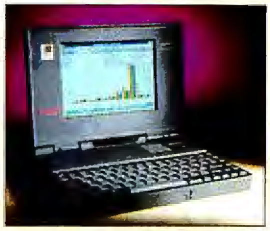
KEY

Poor ▲ | Fair ▲▲
Good ▲▲▲ | Excellent ▲▲▲▲

BYTE BEST — COLOR

Looking for the very best color?

BEST OVERALL — Sharp PC-8650



This notebook sells for more than $1700 less than the runner-up NEC UltraliteVersa 33C and gets an "excellent" screen-quality rating with its 8.4-inch active-matrix display. You can view images from a wide range of angles, and the display's colors are sharp and crisp. The system offers the second-best overall performance among 33-MHz color notebooks and is particularly proficient in doing disk-intensive tasks. The PC-8650 ran for more than 20 minutes longer on battery power than the UltraliteVersa 33C did. You can add up to 20 MB of RAM to the Sharp notebook, and the company offers on-site service.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	SCREEN TECHNOLOGY
BEST	Sharp PC-8650	$3699	DX/33	3.76	▲▲▲▲	3:03	▲▲▲▲	8.4	Active
RUNNER-UP	NEC UltraliteVersa 33C	$5428	SL/33	3.97	▲▲▲▲	2:41	▲▲▲▲	9.4	Active
RUNNER-UP	Toshiba T4600C	$4898	SL/33	3.58	▲▲▲	4:34	▲▲	9.5	Active
RUNNER-UP	AST PowerExec 4/33SL-ColorPlus	$4565	SL/33	3.23	▲▲▲	3:50	▲▲▲	9.5	Active
RUNNER-UP	Mitac Micronote Model 4021G/CT	$6215	DX/33	4.31	▲▲▲	4:09	▲▲▲	9.5	Active

When color quality and speed matter...

HIGH PERFORMANCE — Austin 466T

The Austin 466T features a large 9.5-inch backlit active-matrix display and provides the second-best overall performance among color 66-MHz 486DX2-based systems. The unit is adept at running Windows graphics, thanks to its fast Western Digital 90C24 video-processor chip. A standard NiMH battery provides average life of a little over 3 hours. You can install up to 32 MB of RAM and a 340-MB hard drive. The integrated trackball is centrally located, which makes it easy to use for both right- and left-handed people.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	SCREEN TECHNOLOGY
BEST	Austin 466T	$4499	DX2/66	6.27	▲▲	3:11	▲▲▲	9.5	Active
RUNNER-UP	Micro-International HCP Model 6500T	$4100	DX2/66	5.55	▲▲▲	3:15	▲▲▲	8.5	Active
RUNNER-UP	AMS 5366 ACT	$4875	DX2/66	6.63	▲▲▲	2:18	▲▲▲	9.5	Active
RUNNER-UP	TI TravelMate 4000E WinDX2/50	$4678	DX2/50	5.34	▲▲▲	2:23	▲▲▲▲	8.4	Active
RUNNER-UP	Austin 466D	$2999	DX2/66	6.10	▲▲	3:19	▲▲	9.5	Dual scan

Need top-quality color and economy?

LOW COST — Sharp PC-8650

With a retail price of $3699, this unit is an outstanding value for an active-matrix color notebook (see Best Overall, above). An LCD indicator panel, located on the screen hinge, is visible when the system is open or closed. Easily accessible compartments are provided for expansion, and a sliding eject button is included for the system's Type II PCMCIA slot. System documentation includes all necessary information for novice and experienced users. For those who value flat-out speed over color quality, the first runner-up Austin 466D offers a 66-MHz 486 for less than $3000. However, the quality of its dual-scan screen doesn't match the Sharp's.

		PRICE	CPU	WINDOWS SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	SCREEN TECHNOLOGY
BEST	Sharp PC-8650	$3699	DX/33	3.76	▲▲▲▲	3:03	▲▲▲▲	8.4	Active
RUNNER-UP	Austin 466D	$2999	DX2/66	6.10	▲▲	3:19	▲▲	9.5	Dual scan
RUNNER-UP	Olivetti Philos 44c	$3720	SL/25	2.80	▲▲▲	3:12	▲▲▲	8.5	Active
RUNNER-UP	Gateway 2000 ColorBook 486DX-33	$2964	DX/33	3.42	▲▲▲	3:26	▲	9.4	Passive

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BYTE BEST

DESKTOP REPLACEMENT

Thanks to the processing power of 486-class CPUs, all the notebooks in this review could qualify as desktop replacements. However, we limited the field to systems that provide external resolutions of up to 1024 by 768 pixels, accept 300-MB or larger hard drives, and support a docking station. Fourteen qualified.

The NEC UltraliteVersa 33C and the two other notebooks ranked for Best Overall (33 MHz or slower) contain 33-MHz 486SL processors and feature 9.5-inch active-matrix displays. The UltraliteVersa's display produced the highest overall screen quality for this application and tied for the best within our entire test sample.

The Micro-International HCP Performance Series, Model 6500M, takes top honors in the High Performance category (40 MHz or faster). Three of the four leaders in this category contain active-matrix color displays. The Model 6500M was the monochrome exception.

Micro-International uses a VL-Bus IDE interface in the Model 6500M, which ran the fastest in our disk-intensive FoxPro benchmark.

The Austin 466D stands out in our Low Cost category (systems below $4000) with its $2999 price tag. All three ranked systems in the Low Cost category contain dual-scan displays, which help reduce cost but provide below-average color quality when compared to active-matrix color models.

Rankings for This Application Considered

KEY

Poor ▲ Fair ▲▲
Good ▲▲▲ Excellent ▲▲▲▲

One system for the office and the road...

BEST OVERALL — NEC UltraliteVersa 33C

This notebook is among the top performers in its class, and its active-matrix color display is second to none. The NEC computer outruns the Toshiba T4600C and AST PowerExec 4/33SL-ColorPlus in all our application-based and low-level benchmarks. The efficiency of the NEC's IBM hard drive subsystem is evident in the FoxPro test (2.4 times faster than the baseline notebook). The unit is also proficient in the Windows low-level benchmarks: It achieved a 4.6 score compared to 2.7 and 2.2 for the Toshiba and AST notebooks, respectively. The UltraliteVersa 33C has a well-spaced keyboard, and a standard cabled mouse attaches to either side of the unit to accommodate both right- and left-handed users. An LCD indicator window clearly displays status information (e.g., battery-charge level), and the system's documentation stands out for its clarity and comprehensiveness. The notebook supports only 12 MB of RAM, but it accommodates a 340-MB IDE hard drive, and its optional ($609) expansion chassis provides two ISA expansion slots and two drive bays.

		PRICE	CPU	OVERALL SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN TYPE	MAX. RAM (MB)
BEST	NEC UltraliteVersa 33C	$5428	SL/33	3.52	▲▲▲▲	2:41	▲▲▲▲	Color	12
RUNNER-UP	Toshiba T4600C	$4898	SL/33	3.13	▲▲▲	4:34	▲▲	Color	20
RUNNER-UP	AST PowerExec 4/33SL-ColorPlus	$4565	SL/33	2.99	▲▲▲	3:50	▲▲▲	Color	32

For speed and flexibility...

HIGH PERFORMANCE — Micro-International HCP Model 6500M

VL-Bus video and IDE interfaces contribute to fine overall performance: The notebook is 2.8 times faster than the baseline machine in the disk-intensive FoxPro benchmark. Priced almost $2300 less than the AMS 5366 ACT, the Model 6500M is also among the top three systems in battery life. It ran for close to 5 hours on its nickel-cadmium battery pack. The unit features a large 9.5-inch monochrome display, supports up to 20 MB of RAM, and accommodates a 340-MB hard drive. The optional $520 expansion chassis provides four ISA expansion slots and two drive bays. The system features a comfortable keyboard, and its trackball is solid and easy to control. If speed and color are requirements, the AMS 5366 ACT outran the closest competitor in this group by almost 10 percent.

		PRICE	CPU	OVERALL SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN TYPE	MAX. RAM (MB)
BEST	Micro-International HCP Model 6500M	$2600	DX2/66	4.56	▲▲▲	4:54	▲▲▲	Mono	20
RUNNER-UP	AMS 5366 ACT	$4875	DX2/66	5.42	▲▲▲	2:18	▲▲▲	Color	32
RUNNER-UP	Austin 466T	$4499	DX2/66	4.98	▲▲	3:11	▲▲▲	Color	32
RUNNER-UP	Micro-International HCP Model 6500T	$4100	DX2/66	4.73	▲▲▲	3:15	▲▲▲	Color	20

Need low cost and high speed?

LOW COST — Austin 466D

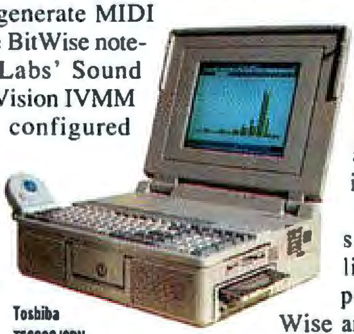
With a list price of $2999, the Austin 466D is the most economical desktop replacement we ranked. It also significantly outperforms the runners-up. It is particularly proficient in video-intensive benchmarks, thanks to its Western Digital 90C24 video-processor chip. The notebook can display up to 256 colors (1024 by 768 pixels) on an external monitor. Colors produced on its dual-scan display were nondistinct, and its range of viewing angles is relatively small. However, display quality was not a strength for any of the notebooks ranked in this category. The Austin 466D can hold 32 MB of RAM and a hard drive of up to 340 MB. Its $299 expansion chassis accepts two ISA expansion cards and two 3½-inch storage devices. An integrated trackball is located in the middle of the unit.

		PRICE	CPU	OVERALL SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN TYPE	MAX. RAM (MB)
BEST	Austin 466D	$2999	DX2/66	4.80	▲▲	3:19	▲▲	Color	32
RUNNER-UP	Eurocom 8200D	$3500	DX2/66	3.17	▲▲	3:29	▲▲	Color	20
RUNNER-UP	Sager NP746D	$3075	DX2/66	3.66	▲▲▲	2:00	▲	Color	16

Mobile Multimedia

Multimedia's ability to combine text, graphics, animation, and sound to produce interactive presentations is no longer tied to the desktop. We tested three portable 486s from BitWise, Scenario, and Toshiba that include sound cards, CD-ROM drives, speakers or headphones, and microphone support. All three comply with the Multimedia PC Marketing Council's recently updated MPC standard.

The BitWise Model 466/ACP, Scenario DynaVision IVMM, and Toshiba T6600C/CDV support maximum 16-bit sound-sample sizes, with sample rates of up to 44 kHz for recording digitized sound, and each can generate MIDI synthesized sound. The BitWise notebook uses Creative Labs' Sound Blaster card, the DynaVision IVMM contains a custom configured Portable Sound Plus card from Digispeech, and the Toshiba notebook's sound is generated by MediaShare's Mambo (i.e., a DVI/Ethernet card).


Toshiba T6600C/CDV

Each system includes a speaker or headphone system. The type of audio system you need depends on the sound quality you desire, as well as considerations like space and whether the sound needs to be heard by others. The Scenario system uses an external speaker (1.8 by 2.8 by 7 inches) that plugs into the side of the unit. It features a volume control and a headphone input jack. BitWise provides small stereo headphones for its multimedia unit, and the Toshiba's sound plays through two speakers located on the front of the system.

CD-ROM DRIVES

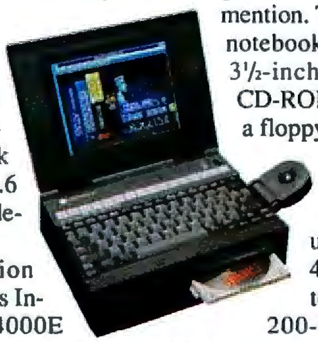
All three systems use CD-ROM drives that support CD Audio, CD Extended Architecture, and Kodak Photo CD multisession standards. (Single-session Kodak Photo CD players can show only pictures recorded in the initial session, while multisession players can show pictures added after the first recording.)

BitWise Model 466/ACP

Each unit uses SCSI CD-ROM interfaces. The CD-ROM data transfer rate for the DynaVision IVMM is rated at up to 330 KBps; the Toshiba and BitWise notebooks are rated at a maximum of 300 KBps. The BitWise's CD-ROM drive provides the fastest rated average access time (280 ms); the average access time on the Scenario and Toshiba notebooks is 200 ms.

Scenario's DynaVision IVMM was the lightest system at 11.6 pounds, while the BitWise and Toshiba units were hulking at 22 and 19.3 pounds, respectively. All three systems are reminiscent of early portable units. The BitWise Model 466/ACP uses a lunch-box-style case with a keyboard that snaps off the front of the box to expose a display that tilts forward. The Toshiba T6600C/CDV requires a great deal of desk space (4.7 by 15.4 by 12.6 inches), but it features a detachable keyboard.

Scenario's DynaVision IVMM consists of a Texas Instruments TravelMate 4000E WinDX2/50 look-alike mounted on top of a lower unit that houses a CD-ROM drive and sound board. This is the only one of the three that runs on battery power.


Scenario DynaVision IVMM

These three multimedia units all use a high-quality active-matrix color display. We rated the color quality of the BitWise and Scenario screens slightly higher than the Toshiba display. However, the Toshiba's screen is the largest of the three—10.4 inches diagonally.

The Scenario's notebook design limits its memory expansion to 20 MB and the number of keys to 83. The BitWise and Toshiba notebooks use full-size 101-key keyboards and support 32 and 40 MB of RAM, respectively.

PERFORMANCE

Each system delivers similar overall performance. The Toshiba and BitWise notebooks contain 66-MHz DX2 processors (the BitWise also features a 128-KB secondary memory cache). The Scenario DynaVision uses a 50-MHz DX2 CPU, but it can compete with systems with higher clock speeds because of its efficient memory architecture.

A final note: The recently introduced Panasonic CF-V21P arrived too late for testing, but its unique features deserve mention. The CF-V21P is the first notebook to support an internal 3½-inch CD-ROM drive. The CD-ROM drive slot also accepts a floppy drive, a second battery pack, or a TV tuner with VCR input. The system features an upgradable 50-MHz 486DX2 CPU, expands to 20 MB, and supports a 200-MB hard drive. The portable accepts three detachable displays (i.e., monochrome, 10.4-inch active-matrix color, and a pen-operated module that fits over the keyboard). It supports external resolutions of up to 1024 by 768 pixels.

HOW THEY COMPARE

MODEL	PRICE	CPU	OVERALL SPEED	EASE OF USE	SCREEN QUALITY	DISPLAY	WEIGHT (LBS.)	DIMENSIONS (HWD)
BitWise Model 466/ACP	$7995	DX2/66	4.35	Fair	Excellent	Active-matrix color	22	9.6x16x8.2
Scenario DynaVision IVMM	$6995	DX2/50	4.47	Good	Excellent	Active-matrix color	11.6	3.4x11x8.5
Toshiba T6600C/CDV	$8999	DX2/66	4.64	Excellent	Good	Active-matrix color	19.3	4.7x15.4x12.6

THE BEST

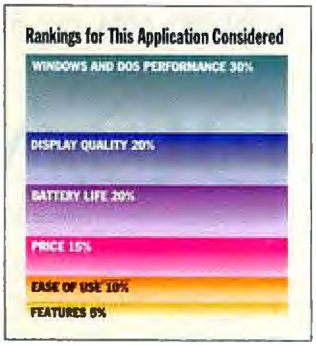
SUBNOTEBOOKS

Subnotebooks are the lightest and smallest DOS and Windows portables. However, there is a trade-off between portability and functionality. By definition, all came with external floppy drives and downsize keyboards (the Gateway models also have nonstandard I/O ports). But subnotebooks are also competitively priced: The average price (not including the $2300 color Sager NP440C) was $2183.

We tested eight subnotebooks with traveling weights (i.e., system, external 3½-inch floppy drive, AC adapter, and power cord) of under 7 pounds. While the system size and weight of a subnotebook are less than a notebook, keep in mind that traveling with all the related subnotebook components can be cumbersome. For example, the average weight of a subnotebook and battery was only 4 pounds, but when you add the external floppy drive and AC adapter, the average weight increases to 6 pounds.

All the subnotebooks we tested support VGA resolution (640 by 480 pixels) and feature passive-matrix monochrome LCDs, except for the Sager NP440C, which uses a passive-matrix color LCD. In this section, we named only a Best Overall winner; we found that overall performance and system prices among these units were too similar to justify High Performance and Low Cost rankings.

Subnotebooks may be small, but they don't necessarily lack expansion capabilities. The eight subnotebooks support up to 20 MB of RAM, and you can configure them with IDE hard drives ranging in capacity from 120 MB (Sager NP440C and Altima Traveler) to 200 MB (Caf 486 Subnote). With their 486 processors, external keyboard ports, and support of external monitors in resolutions of up to 1024 by 768 pixels (the Altima Traveler is limited to 640 by 480 pixels externally), these subnotebooks can function well on the desktop. Each of the subnotebooks we tested provides a Type II PCMCIA slot for network adapters or modems.



The Zenith Data Systems Z-Lite 425SL Model 170W and Packard Bell Diplomat 170M Subnotebook produced the highest overall ratings. However, the runners-up provided some strong overall competition, and unranked subnotebooks made strong showings in individual tests.

The Altima Traveler is a close second to the Zenith unit in battery life, running for close to 4½ hours on its NiMH battery pack. The system's 8-inch monochrome display received the highest screen-quality rating among subnotebooks and stands out for its smooth transitions from light to dark areas. Performance is not this 25-MHz system's strength, because it possesses a relatively slow memory subsystem. The Altima Traveler features a high-quality keyboard, and its LCD indicator panel is visible when the unit is open or closed. An integrated trackball is located above the keyboard on the right-hand side of the system.

We tested two versions of the Gateway 2000 HandBook. They're identical except for their CPUs (486SX/25 and 486DX2/40). Besides being the smallest (1.6 by 9.75 by 5.9 inches) and lightest (5.1 pounds, with accessories) subnotebooks we received, their Sanyo screens offer similar gray-scale quality and an overall "excellent" rating. However, the HandBook display is only 4 inches high and 7.9 inches measured diagonally. Battery life is only around 2½ hours, the shortest among monochrome subnotebooks, using their standard NiMH battery packs.

The 40-MHz 486DX2 HandBook provides better overall performance than its cousin. However, the 40-MHz model's memory subsystem is slow, and the unit performs poorly in BYTE's Windows VGA tests. The 25-MHz HandBook is among the slowest subnotebooks in its class. The parallel port on both Gateway units is nonstandard and requires a special adapter (which could be easily lost) to connect a printer or the external floppy drive. The HandBooks' eraser-shaped

SL-ENHANCED CPUS: POWER MISERS, BUT RARE

The Mitac Micronote Performance Model 4021G/CT is the only notebook in this review that uses an SL-enhanced processor (33-MHz 486DX). It provides the second-longest battery life (4 hours, 9 minutes) among active-matrix color notebooks. The Mitac Micronote Lite Subnotebook Model 4010F and Sager NP440C subnotebooks also make use of SL-enhanced technology (25-MHz 486SX processors). The Model 4010F's battery life (2 hours, 57 minutes) is slightly below average for subnotebooks. The NP440C contains a passive-matrix color display that limits its battery life (1 hour, 55 minutes) in our Thumper 2 battery test.

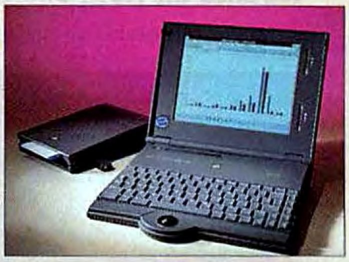
Utilizing Intel's system management mode, the SL-enhanced technology provides the necessary power for applications while the system is conserving energy. Active power management turns hardware components on and off on an as-needed basis. SL-enhanced technology uses clock-throttling, where the CPU can distinguish between the amount of power needed to run at a lower clock frequency (e.g., for a word processing application) or at a higher clock frequency. Stop Clock lets the 486SL CPU operate at any frequency (from 0 MHz to the maximum), and Auto Idle automatically reduces the average power that a 486DX2 CPU consumes by as much as 10 percent.

BYTE BEST SUBNOTEBOOKS

For small size without compromise...

BEST OVERALL **Packard Bell Diplomat 170M Subnotebook**

MARCH 1994 BYTE BEST SUBNOTEBOOK



This slimline, modular unit (and its more expensive look-alike from Zenith Data Systems) competes with similarly equipped monochrome notebooks in performance. The AC adapter on both systems attaches to the back of the external 3½-inch floppy drive. The combined unit then attaches to the left-hand side of the system, giving the appearance of one seamless unit. A detachable trackball screws onto the front of the system and can be used by either hand. However, the keyboards are very small and will take some time for touch-typists to adjust to. Both units ran for over 4 hours on their NiMH battery packs. Both use identical 8.5-inch monochrome displays that produce slightly above average gray scales and an overall "excellent" screen-quality rating.

		PRICE	CPU	SUBNOTEBOOK OVERALL SPEED	EASE OF USE	BATTERY LIFE (HOURS:MIN)	SCREEN QUALITY	SCREEN SIZE (IN.)	MAX HARD DISK (MB)
BEST	PB Diplomat 170M Subnotebook	$2100	SL/25	2.65	▲▲▲	4:04	▲▲▲▲	8.5	170
RUNNER-UP	ZDS Z-Lite 425SL Model 170W	$2499	SL/25	2.65	▲▲▲	4:22	▲▲▲▲	8.5	170
RUNNER-UP	Altima Traveler	$2499	SL/25	2.44	▲▲	4:21	▲▲▲▲	8.0	120
RUNNER-UP	Gateway 2000 HandBook 486SX-25	$1495	SX/25	2.38	▲▲▲	2:37	▲▲▲▲	7.9	130
RUNNER-UP	Gateway 2000 HandBook 486DX2-40	$1995	DX2/40	2.98	▲▲▲	2:37	▲▲▲▲	7.9	130

KEY

Poor ▲ Fair ▲▲

Good ▲▲▲ Excellent ▲▲▲▲

pointing device, EZ Point, mimics IBM's acclaimed TrackPoint II but lacks its ease of use (see the text box "New Pointers" for details).

The unranked (see the "Roll Call" on page 180) Mitac Micronote Lite Subnotebook Model 4010F outperforms the other 25-MHz subnotebooks in each of the application-based benchmarks due primarily to its fast memory subsystem. It ran for about 3 hours on its nickel-cadmium battery pack, and its monochrome display produces average gray scales but an overall rating of "fair." The Mitac Model 4010F's external floppy drive plugs into a PCMCIA slot, leaving one available slot when in use, and its integrated trackball is centered on a hand-rest below the keyboard, which is ideal for right- and left-handed users. The eject switches for the PCMCIA slots are located on the front of the case and are not labeled. Function keys are half-size, and arrow keys are not separated from the cursor direction keys.

The Sager NP440C's 8-inch Sanyo passive-matrix display delivers acceptable color. However, the trade-off for color is battery life—the unit runs for only 2 hours on its nickel-cadmium battery pack, which is over an hour less than the average for subnotebooks. The NP440C performed well in our application benchmarks, with an overall score of 2.43, which makes it the third fastest among subnotebooks tested. Function and special keys (e.g., PageDown, PageUp, Home, and End) are half-size, and LED indicators, the suspend switch, and brightness/contrast controls are bunched together above the keyboard, which saves space. The NP440C's integrated trackball sits to the right of the keyboard, which places your hand in an awkward position.

The Caf 486 Subnote features a high-quality keyboard with average-size keys. Its integrated trackball and buttons are located below the keyboard at opposite ends of the system, and its external 3½-inch floppy drive is bigger and bulkier than those provided with other subnotebooks. The Caf's Toshiba IDE hard drive subsystem performed well in our disk-intensive benchmarks. However, with an overall score of 2.39, it ranks in the second half of the subnotebook field. The standard nickel-cadmium battery provided over 3 hours of life, and the unit's monochrome display stands out for its gray-scale quality.

Lithium Promises Longer Battery Life

Lithium is a volatile and potentially explosive chemical that nevertheless may become the power source of choice for rechargeable batteries. Several American and Japanese companies are currently working to commercialize the chemical.

Nickel-cadmium batteries, currently the most common used in portables (18 in our sample used them), may gradually be phased out because of memory-drain problems. Recharging a nickel-cadmium battery that's not fully discharged can keep the battery from ever being fully charged again. NiMH (nickel-metal-hydride), which doesn't suffer from this problem and can last longer, has become an alternative for some vendors; we tested 17 notebooks that used this battery chemistry.

Recently, Toshiba introduced the Portégé T3400 series of subnotebooks, which are the first portables to use rechargeable lithium-ion batteries. The Portégé was introduced too late to be tested for this report, but Toshiba claims that a lithium-ion battery will provide 75 percent longer life for the same weight as a nickel-cadmium battery and 50 percent more life than a standard NiMH battery of equal weight. Lithium-ion batteries do not suffer from memory drain.

Lithium-polymer batteries, being developed by Valence Technology, may become another lithium-based power source. Still in its early development, the lithium-polymer battery looks like a sheet of plastic about the size of a playing card. Valence Technology claims that it weighs 75 percent less and will run four times longer on a single charge than a nickel-cadmium battery of similar weight. Lithium-polymer batteries can be molded into any shape. The batteries support high-energy densities, do not have memory-drain problems, and use environmentally safe materials. However, lithium-polymer batteries have a limited life cycle of 175 hours and are not expected to be economically viable for several years.

HONORABLE MENTIONS

We liked the AST PowerExec 4/33SL-ColorPlus's integrated tilt stand. Two adjustable pins located under the unit let you adjust the typing position of the keyboard (similar to a typical AT-compatible keyboard), resulting in less strain on your hands and wrists.

Unique features of the Olivetti Philos 44 **(and Philos 44c) separate it from the rest of the notebook systems. Its keyboard flips up on hinges (no tools are needed) to provide easy access to its removable hard drive and battery pack. A mouse pops out from the right-hand side of the unit with the click of a button, and a dedicated numeric keypad is positioned above the keyboard. An integrated microphone is also a distinguishing feature.** ▷

The modular subnotebook design **used by the Zenith Z-Lite 425SL Model 170W and Packard Bell Diplomat 170M Subnotebook results in a very slimline appearance. The AC adapter snaps onto the back of the unit's external floppy drive. The combined unit then attaches to the left-hand side of the system via a small cable that protrudes from the floppy drive. A separate cable for the AC adapter is included that lets you bypass the floppy drive and connect directly to the system.**

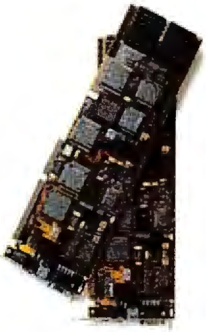
Typical integrated pointing devices can be cumbersome for left-handers. The cabled PS/2-style mice provided with the NEC UltraliteVersa 33C and NCR Safari 3180 alleviate this problem by attaching to either side of the notebook. These mice provide full Windows functionality with better feel and control than most integrated trackballs or other pointing devices.

Dubious Achievements

To receive a generic manual after spending thousands of dollars for a new system is not reassuring to users who want and deserve expert technical support from the vendor. Aspen, Mitsuba, AMS, and Eurocom don't take the time or spend the money to produce their own documentation, which can be invaluable to both novice and experienced users. The manuals they include don't mention specific vendor or product names and lack key items, such as troubleshooting tips, a glossary of terms, and an index.

The Mitac Micronote Lite Subnotebook Model 4010F attaches its external floppy drive through its PCMCIA slot. Although it's an innovative use of the latest technology, there are a few drawbacks. Because the floppy drive takes up a PCMCIA slot, it leaves you with only one remaining slot. Also, you must disconnect the floppy drive to install a Type III PCMCIA card.

High performance 486™DX2. Blazing 66MHz, backed by our exclusive turbo cache, for unparalleled workstation performance.



Two Full-length ISA Slots. Connections are everything. And this machine allows for plenty—Ethernet, video, you name it.

Optional Built-in 5.25" CD ROM. The medium with capacity for video clips, graphics, photo CDs, or an entire set of manuals.

PCMCIA Expandability. The T6600C offers a huge wealth of communication and expansion options, including a 16mm PCMCIA 2.01 compliant slot large enough for a hard drive!

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intel inside

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The New T6600C Series

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- SVGA display with 640x480x256 color resolution
- 510MB HDD
- Two full length 16-bit ISA slots
- One 16mm PCMCIA 2.01 compliant slot
- Built-in SCSI with external SCSI-II port
- Microsoft® Sound System™
- 5.25" half height 200ms double speed CD-ROM (T6600C/CD and T6600C/CDV models only)
- MediaShare®Mambo™ DVI®/Ethernet™ board (T6600C/CDV model only)

Circle 151 on Inquiry Card.

ROLL CALL OF PORTABLES TESTED

NOTEBOOKS

VENDOR	MODEL	CPU	DISPLAY TECHNOLOGY		OVERALL SPEED[1]	BATTERY LIFE (HOURS: MIN)	EASE OF USE	SCREEN QUALITY
AMS, Inc.	5366 ACT	DX2/66	Color	Active	5.42	2:18	▲▲▲	▲▲▲
Aspen Computer	Universa	DX2/66	Color	Active	4.01	3:02	▲▲	▲▲
AST Research, Inc.	Bravo NB 4/25 S Color	SX/25	Color	Dual scan	2.33	1:56	▲▲▲	▲▲
AST Research, Inc.	Bravo NB 4/25 S Mono	SX/25	Mono	Passive	2.32	2:55	▲▲▲	▲▲▲
AST Research, Inc.	PowerExec 4/33SL-ColorPlus	SL/33	Color	Active	2.99	3:50	▲▲▲	▲▲▲
Austin Computer Systems	466D	DX2/66	Color	Dual scan	4.80	3:19	▲▲	▲▲
Austin Computer Systems	466T	DX2/66	Color	Active	4.98	3:11	▲▲	▲▲▲
BitWise Designs, Inc.	Model 466/ACP	DX2/66	Color	Active	4.35	N/A	▲▲	▲▲▲▲
Commax Technologies, Inc.	Smartbook	DX2/50	Mono	Passive	2.87	2:25	▲▲	▲▲▲
Compaq Computer Corp.	LTE Lite 4/33C	SL/33	Color	Active	3.35	2:23	▲▲	▲▲▲▲
Digital Equipment Corp.	DECpc 425SL	SL/25	Mono	Passive	2.59	5:56	▲▲▲	▲
Eurocom	8200D	DX2/66	Color	Dual scan	3.17	3:29	▲▲	▲▲
Eurocom	8200T	DX2/66	Color	Active	4.79	2:53	▲▲	▲▲
Gateway 2000	ColorBook 486DX-33	DX/33	Color	Passive	2.87	3:26	▲▲▲	▲
Gateway 2000	ColorBook 486SX-25	SX/25	Color	Passive	2.22	3:49	▲▲▲	▲
Micro-International, Inc.	HCP Performance Series, Model 6500M	DX2/66	Mono	Passive	4.56	4:54	▲▲▲	▲▲▲
Micro-International, Inc.	HCP Performance Series, Model 6500T	DX2/66	Color	Active	4.73	3:15	▲▲▲	▲▲▲
Mitac U.S.A., Inc.	Micronote Value Model 4020G/C	SX/33	Color	Passive	3.11	1:35	▲▲▲	▲
Mitac U.S.A., Inc.	Micronote Performance Model 4021G/CT	DX/33	Color	Active	3.69	4:09	▲▲▲	▲▲▲
Mitsuba Corp.	Ninja II/DX2-66	DX2/66	Mono	Passive	4.62	5:05	▲▲	▲▲▲
NCR Corp.	3150	SX/25	Color	Active	1.88	3:12	▲▲▲	▲▲▲
NCR Corp.	Safari 3180	SL/33	Color	Active	3.45	2:54	▲▲▲	▲▲▲
BYTE Best **NEC Technologies, Inc.**	**UltraliteVersa 33C**	**SL/33**	**Color**	**Active**	**3.52**	**2:41**	**▲▲▲▲**	**▲▲▲▲**
Olivetti North America	Philos 44	SL/25	Mono	Passive	2.32	3:33	▲▲▲	▲
Olivetti North America	Philos 44c	SL/25	Color	Active	2.52	3:12	▲▲▲	▲▲▲
Sager Midem Computer, Inc.	NP746D	DX2/66	Color	Dual scan	3.66	2:00	▲▲▲	▲
Sager Midem Computer, Inc.	NP846T	DX2/66	Color	Active	4.72	3:07	▲▲▲	▲▲
Scenario, Inc.	DynaVision IVMM	DX2/50	Color	Active	4.47	3:19	▲▲▲	▲▲▲▲
BYTE Best **Sharp Electronics Corp.**	**PC-8650**	**DX/33**	**Color**	**Active**	**3.33**	**3:03**	**▲▲▲▲**	**▲▲▲▲**
Tandy Corp.	3900HD	SLC/25	Mono	Passive	1.36	3:22	▲	▲▲
Texas Instruments, Inc.	TravelMate 4000E WinDX2/50	DX2/50	Color	Active	4.46	2:23	▲▲▲	▲▲▲▲
Texas Instruments, Inc.	TravelMate 4000E WinDX2/50	DX2/50	Color	Dual scan	4.56	2:23	▲▲▲	▲▲
Texas Instruments, Inc.	TravelMate 4000E WinSX/25	SX/25	Color	Passive	2.72	2:20	▲▲▲	▲▲
Toshiba America	T4600C	SL/33	Color	Active	3.13	4:34	▲▲▲	▲▲
Toshiba America	T6600C/CDV	DX2/66	Color	Active	4.64	N/A	▲▲▲▲	▲▲▲
Zenith Data Systems	Z-Note 433Lnp+	SL/33	Color	Dual scan	3.20	3:30	▲▲▲▲	▲
BYTE Best **Zenith Data Systems**	**Z-Star 433VL Model 200**	**SLC/33**	**Mono**	**Passive**	**1.50**	**4:26**	**▲▲**	**▲▲▲▲**
Zenith Data Systems	Z-Star 433VLp Model 200	SLC/33	Color	Passive	1.55	3:39	▲▲	▲▲

SUBNOTEBOOKS

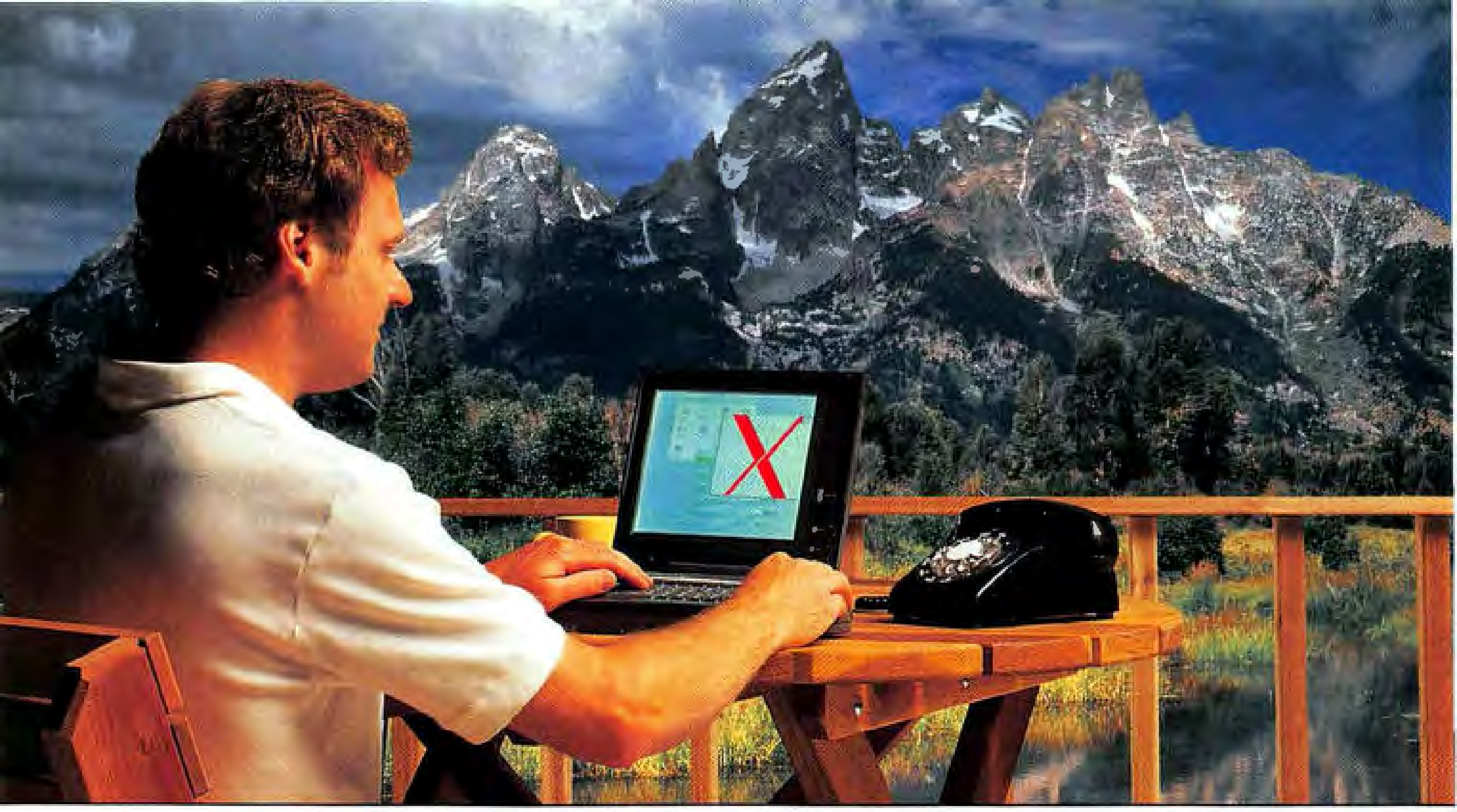
VENDOR	MODEL	CPU	DISPLAY TECHNOLOGY		OVERALL SPEED[1]	BATTERY LIFE (HOURS: MIN)	EASE OF USE	SCREEN QUALITY
Altima Systems, Inc.	Traveler	SL/25	Mono	Passive	2.23	4:21	▲▲	▲▲▲▲
Caf Technology, Inc.	486 Subnote	SL/33	Mono	Passive	2.39	3:19	▲▲▲	▲▲▲
Gateway 2000	HandBook 486DX2-40	DX2/40	Mono	Passive	2.56	2:37	▲▲▲	▲▲▲▲
Gateway 2000	HandBook 486SX-25	SX/25	Mono	Passive	2.18	2:37	▲▲▲	▲▲▲▲
Mitac U.S.A., Inc.	Micronote Lite Subnotebook Model 4010F	SX/25	Mono	Passive	2.56	2:57	▲▲	▲▲
BYTE Best **Packard Bell Electronics, Inc.**	**Diplomat 170M Subnotebook**	**SL/25**	**Mono**	**Passive**	**2.38**	**4:04**	**▲▲▲**	**▲▲▲▲**
Sager Midem Computer, Inc.	NP440C	SX/25	Color	Passive	2.43	1:55	▲▲▲	▲
Zenith Data Systems	Z-Lite 425SL Model 170W	SL/25	Mono	Passive	2.04	4:22	▲▲▲	▲▲▲▲

BYTE Best = BYTE Best. Key: Poor ▲ Fair ▲▲ Good ▲▲▲ Excellent ▲▲▲▲ N/A=Not applicable; notebooks did not include batteries.

PRICE AS TESTED	POINTING DEVICE	DIMENSIONS (H×W×D)	WEIGHT (LBS.)[2]	MAXIMUM RAM (MB)	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
$4875	Integrated trackball	2 × 11.1 × 8.58	6.50	32	(818) 814-8851	(800) 886-2671	1146
$4395	Integrated trackball	1.9 × 11 × 8.5	7.20	20	(716) 626-0315	(800) 472-3273	1147
$2850	Integrated trackball	1.7 × 11.7 × 8.8	6.00	20	(714) 727-4141	(800) 876-4278	1148
$2045	Integrated trackball	1.7 × 11.7 × 8.8	6.00	20	(714) 727-4141	(800) 876-4278	1149
$4565	Detachable trackball	1.98 × 11.5 × 8.5	6.90	32	(714) 727-4141	(800) 876-4278	1150
$2999	Integrated trackball	2 × 11.1 × 8.58	7.30	32	(512) 339-3500	(800) 752-1577	1151
$4499	Integrated trackball	2 × 11.1 × 8.58	7.30	32	(512) 339-3500	(800) 752-1577	1152
$7995	Cabled mouse	9.6 × 16 × 8.2	22.00	32	(518) 356-9740	(800) 367-5906	1153
$2432	Integrated trackball	1.5 × 11.5 × 9	8.50	20	(408) 435-5000	(800) 526-6629	1154
$5069	Integrated trackball	2 × 11 × 8.5	7.60	20	(713) 370-0670	(800) 345-1518	1155
$2499	Detachable trackball	1.8 × 11.5 × 8.5	6.20	32	(508) 493-5111	(800) 722-9332	1156
$3500	Integrated trackball	2 × 11.7 × 8.5	6.60	20	(613) 224-6122	N/A	1157
$4450	Integrated trackball	2 × 11.7 × 8.5	6.60	20	(613) 224-6122	N/A	1158
$2964	Integrated trackball	1.77 × 11.7 × 8.5	5.70	20	(605) 232-2000	(800) 846-2000	1159
$2264	Integrated trackball	1.77 × 11.7 × 8.5	5.70	20	(605) 232-2000	(800) 846-2000	1160
$2600	Integrated trackball	1.8 × 11 × 8.6	7.70	20	(713) 495-9096	(800) 967-5667	1161
$4100	Integrated trackball	1.8 × 11 × 8.6	7.70	20	(713) 495-9096	(800) 967-5667	1162
$3158	Integrated trackball	1.9 × 11 × 8.6	6.50	20	(510) 656-2222	N/A	1163
$6215	Integrated trackball	1.5 × 10.5 × 7.8	6.50	20	(510) 656-2222	N/A	1164
$2495	Integrated trackball	1.8 × 11.5 × 8.5	6.10	32	(909) 392-2000	(800) 648-7822	1165
$4160	Detachable trackball	1.9 × 11 × 8.5	6.10	20	(513) 445-5000	(800) 637-2600	1166
$4890	Detachable trackball	2.1 × 11.7 × 9.3	7.00	12	(513) 445-5000	(800) 637-2600	1167
$5428	**Cabled mouse**	**2.09 × 11.69 × 9.33**	**6.80**	**12**	**(508) 264-8000**	**(800) 632-4636**	**1168**
$2394	Pop-out mouse	1.7 × 11 × 8.5	6.10	32	(509) 927-5600	(800) 633-9909	1169
$3720	Pop-out mouse	1.9 × 11 × 8.5	6.10	32	(509) 927-5600	(800) 633-9909	1170
$3075	Integrated trackball	1.92 × 11.4 × 8.6	7.20	16	(818) 964-8682	(800) 669-1624	1171
$4125	Integrated trackball	1.93 × 11 × 8.6	8.10	20	(818) 964-8682	(800) 669-1624	1172
$6995	QuickPort mouse	3.4 × 11 × 8.5	11.60	20	(617) 965-6458	(800) 468-1119	1173
$3699	**Detachable trackball**	**1.81 × 11.42 × 8.86**	**6.40**	**20**	**(201) 529-9593**	**(800) 237-4277**	**1174**
$2069	Integrated trackball	1.65 × 11 × 8.5	5.80	8	(817) 390-3011	N/A	1175
$4678	QuickPort mouse	2.1 × 11 × 8.5	7.30	20	(817) 774-6001	(800) 527-3500	1176
$4178	QuickPort mouse	2.1 × 11 × 8.5	7.20	20	(817) 774-6001	(800) 527-3500	1177
$2499	QuickPort mouse	2.1 × 11 × 8.5	7.00	20	(817) 774-6001	(800) 527-3500	1178
$4898	QuickPort mouse	2 × 11.7 × 8.3	6.90	20	(714) 583-3000	(800) 334-3445	1179
$8999	Cabled mouse	4.7 × 15.4 × 12.6	19.30	40	(714) 583-3000	(800) 334-3445	1180
$3878	Detachable trackball	2.1 × 11 × 8.5	7.50	28	(708) 808-5000	(800) 553-0331	1181
$1999	**J-Mouse**	**1.9 × 11 × 8.5**	**7.80**	**12**	**(708) 808-5000**	**(800) 553-0331**	**1182**
$2699	J-Mouse	2.1 × 11 × 8.5	8.30	12	(708) 808-5000	(800) 553-0331	1183
$2499	Integrated trackball	1.6 × 10 × 7.1	6.00	20	(510) 356-5600	(800) 356-9990	1184
$1708	Integrated trackball	1.5 × 11 × 7.1	6.70	20	(818) 369-3690	N/A	1185
$1995	EZ Point	1.6 × 9.75 × 5.9	5.10	20	(605) 232-2000	(800) 846-2000	1186
$1495	EZ Point	1.6 × 9.75 × 5.9	5.10	20	(605) 232-2000	(800) 846-2000	1187
$2515	Integrated trackball	1.5 × 10.5 × 7.8	6.30	20	(510)656-222	N/A	1188
$2100	**Integrated trackball**	**1.5 × 9.9 × 7.6**	**5.90**	**20**	**(818) 886-9998**	**(800) 733-4411**	**1189**
$2300	Integrated trackball	1.46 × 11 × 7	6.50	20	(818) 964-8682	(800) 669-1624	1190
$2499	Integrated trackball	1.5 × 9.9 × 7.6	5.90	20	(708) 808-5000	(800) 553-0331	1191

[1] Higher numbers mean better performance.

[2] Notebook weight includes battery and AC adapter; subnotebook weight also includes external floppy drive.



Finally, an X rated product you can use anywhere.

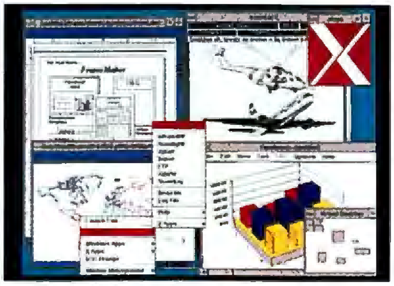
eXceed/Xpress PC X connectivity software from Hummingbird.

Now that home and mobile computing are firmly established, there is a strong demand for access to corporate networks from remote locations.

Until now, remote connection to *graphics* oriented, X Windows based applications posed a serious challenge: The existing on-line protocols (SLIP, CSLIP, PPP) have not provided acceptable performance for effective use of these graphical applications from remote sites.

Hummingbird Communications Ltd., the PC X Windows connectivity specialist, has addressed this issue with eXceed/Xpress, a PC X server for serial connection, based on eXceed/W, the world's best selling X server for PCs running MS-Windows.

Utilizing an innovative combination of compression and decompression techniques inherent in the Xpress protocol, eXceed/Xpress gives you unprecedented performance. While accessing X applications running on UNIX or VMS hosts, you may also run local MS-Windows applications at the same time. And, since you can easily copy and paste text and graphics between remote X environments and local MS-Windows applications, eXceed/Xpress becomes a powerful integration tool.



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A Close-Up of OpenDoc

A new vendor-neutral standard for compound documents offers cross-platform support

KURT PIERSOL

In recent years, there's been an industry shift toward document-based computing and away from application-based computing. Starting in the 1970s at Xerox, and continuing with architectures like OLE from Microsoft, this movement toward more natural ways of assembling documents is now gathering significant industry momentum.

OpenDoc is a new entrant into this field—one intended to be a vendor-neutral, open standard for compound documents. *Compound documents*, the key to this type of computing, are documents composed of many different kinds of content, all of which share a single file. These documents can contain almost any type of data, such as tables, charts, and text, as well as video, sound, note cards, or 3-D graphics.

A Quick Tour of OpenDoc

Typically, you can edit any or all of these types of content in place in a compound document. This means that several editors can work on a document at the same time, unlike in today's computing environment, where one editor owns the entire document.

Given a set of editors working together on the same document, there must be boundaries to sort out where one kind of content ends and another kind begins. Otherwise, it would be impossible to discern which editor should work on particular sections of the document. In OpenDoc parlance, these bounded sets of content are called *parts*.

Of course, the whole point of a compound document is to be able to mix the types of content, so a mechanism is needed that can put one part inside another without the parts' losing either their identity or their boundedness. This process is called *embedding* because it's rather like the typical real-world embedding process. You can embed raisins into bread, for instance, but doing so doesn't change the fact that the bread is still bread and the raisins are still raisins. Still, the resulting raisin bread is tastier than either ingredient alone.

Thus, a compound document has various types of content, as well as parts embedded inside other parts. Each type of part has its own editor. All these parts share the same windows, as well as the same file on the disk or storage server. When you open an OpenDoc document, you're really looking at a collection of parts. When you edit the document, you're using a collection of editors.

These editors must work together smoothly. Editors have only a few basic tasks: storing the contents to disk (if needed), drawing the contents out to the screen or a printer, and letting the user act on the contents by accepting events such as mouse-clicks and keystrokes.

A compound-document system needs to sort out the boundaries between the editors so that efficient editing can occur. OpenDoc does this by using a series of libraries that sort out the boundaries for the part editors. While this is an object-oriented system, it's important to note that OpenDoc isn't an object-oriented framework, because it wasn't designed to be extended through inheritance. Instead, it's an object-oriented interface between part

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editors that can be written in different programming languages and by different organizations. These libraries can be used via procedural code if required.

OpenDoc Components

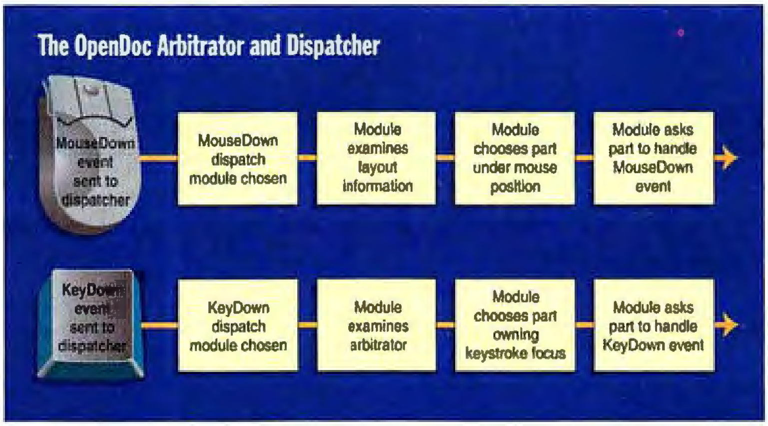
OpenDoc has several important components that are used to organize a document's content and implement the sorting mechanism. The first of these is OpenDoc's layout system. OpenDoc helps the parts negotiate about layout so that they can avoid blasting bits over one another. The same layout system helps determine what editors are invoked and when they get mouse events. The layout system works for on-screen windows, off-screen bit maps, and printer contexts. It handles 2-D and 3-D graphics, overlapping parts, and multiple active parts that are updating asynchronously.

OpenDoc has an event-dispatching system that routes events to the correct part. It uses the layout system to let you activate parts directly, without allowing double-clicking or menus to get in the way.

OpenDoc's storage system helps parts store complex information in a shared file. It even helps with storing multiple document drafts and embedding information. This includes a data transfer system that helps the parts ship information—including embedded information—through the Clipboard, by linking, or by use of the drag-and-drop mechanism.

Lastly, OpenDoc has a scripting system that lets users coordinate the actions of various part editors, either within a document or across a network and across platforms.

Rather than describing all these capabilities, I will instead focus on several of these areas in more detail. Some of the most interesting parts of OpenDoc revolve around how it dispatches events, handles storage, and does scripting.



How the OpenDoc arbitrator *and dispatcher work. A stream of mouse and keyboard events are directed to the dispatcher, which directs them to the appropriate editor handling that portion of the document. Where necessary, as in the case of the keyboard event shown here, an arbitrator module may be required to decide which editor receives the keystroke.*

OpenDoc Event Handling

OpenDoc is a cross-platform architecture, and event handling varies considerably in different GUI environments. For example, in the X Window System, keystrokes go to the window that the cursor is over at that moment. On a Macintosh they go to the frontmost window, at the insertion point. Other systems have yet other ways to determine where keystrokes should go. Similar interface discrepancies arise when you consider how to handle menus, windows, clipboards, and dialog boxes.

We members of the OpenDoc team made an early decision during the design process: Don't demand alterations of the human-interface environment. A good decision, but it left us with a problem. How could we make a mechanism that worked generically if the interface changed among platforms?

There were two options. One was to treat human-interface elements as a collection of special cases on each platform. The other, which we chose to implement, was to come up with an abstraction of the fundamentals of our problem and then fit it to each platform. Our solution was to build two major structures, the dispatcher and the arbitrator. The *dispatcher* is an object that helps the underlying platform's dispatcher to find the correct part editor. The *arbitrator* is a way for parts to tell the dispatcher which editor owns the stream of keystrokes, the menu bar, or any other shared resource. Together, they let OpenDoc work with the different human-interface models of different platforms.

The arbitrator is actually a table that shows the resources that can be owned and what part editor owns them. Each of these resources is called a *focus* of arbitration. To get resources, a part editor asks the arbitrator for a set of foci by name. The arbitrator then uses a two-phase commit mechanism to ask the present owners to give up ownership. The arbitrator asks the various owners to give up the resource in the first phase and then reassigns ownership in the second phase.

Networking and multiprocessing experts will recognize this technique as a standard way of preventing deadlocks involving resources. For example, imagine that one part editor owns the menu bar, and another has ownership of the keystroke stream. If each editor wanted the other's resource but refused to give up the one it owned, there would be a deadlock. By asking for resources as a set and assigning ownership in two phases, OpenDoc prevents this sort of "deadly embrace" between part editors.

OpenDoc's arbitrator is extensible, by both platform implementers and applications developers. At any point, a new arbitrator focus can be added by creating an object called a *focus module* and adding it to the arbitrator. This extensibility means that new hardware resources can be managed through the arbitrator, as well as new software resources, such as server connections.

Most systems deliver events to windows, but because compound documents have parts that divide up those windows, a second stage is needed to get the events from the windows to the parts inside them. The OpenDoc dispatcher does this by taking human-interface events from the operating system and handing them to the correct part editor. This dispatcher is similarly open-ended.

Although some systems have nested windows that could theoretically be used for embedding, they usually don't have enough information about layout to make a very effective embedding tool. So OpenDoc provides a more sophisticated mechanism, called a *frame*. Frames are a part of OpenDoc's layout system, and they help the parts divide up the drawing area of a window into separate regions for each part. The use of frames allows OpenDoc to support overlapping parts that are simultaneously active, a requirement for many multimedia documents. The OpenDoc dispatcher reads the arbitrator and frame information to decide which part editor should get an event (see the figure "The OpenDoc Arbitrator and Dispatcher").

Some systems, such as Windows, have a tremendous array of events that can be passed to applications. Others, like the Macintosh, have a much smaller set of such events. The OpenDoc dispatcher must be able to handle both extremes. It can have a new behavior added at run time to handle new kinds of events. In addition, any part editor can monitor the dispatcher and watch the stream of events that passes through the dispatcher. Both monitoring and extension are accomplished through objects called *dispatch modules*, which are added at run time to the dispatcher.

Storage in OpenDoc

Probably the single most interesting part of OpenDoc is its approach to storage. There are many different data formats on many different systems. Superficially, it appears that programmers have a perverse desire to define new storage formats that are different and incompatible. Even the same applications often have

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different formats on different machines.

But there are some really good reasons for the differences, however annoying they may be. There are some trade-offs that make choosing a file format difficult. The two most common trade-offs come when you must choose between standardization and innovation, and between publication and efficient editing.

The first trade-off problem arises when you want to add new features, but you have an existing file format of your own or there is a market need to support a particular format. Unfortunately, file formats are seldom extensible in a convenient way.

Then there's the second problem, which tends to arise when a standard interchange format has been proposed. The design of such formats is almost always centered around making them easy to read and extend. Unfortunately, this often means that they aren't designed for efficient editing or high performance on a particular machine. The compromise is often to support both formats and allow one to be rewritten as the other.

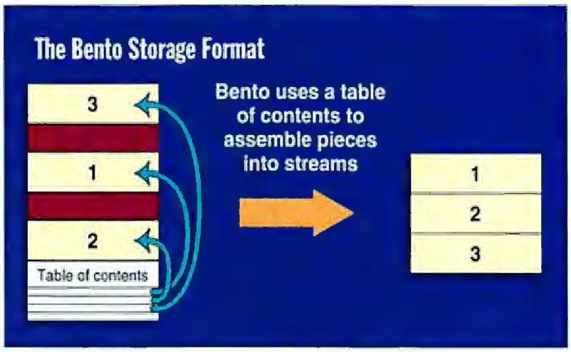
The worst problem from a compound-document point of view is that these formats don't mix very well. Efficient editing formats are often based on replaceable pieces (i.e., strings of bytes) that can be randomly accessed through some sort of table of contents. This makes them very easy to edit efficiently, but they are very specific to a particular editor.

Efficient publication formats are often stream oriented, making them easy to understand for a program, without regard to its internals. Problems arise when you try to mix piece-based formats and sequential formats. If you insert piece-based information into sequential information, there are often unacceptable constraints about when and how new pieces can be added. When you put sequential information into piece-based formats, there are often problems with the size of the sequential information, and there's no way to extend the sequential information without understanding the piece-table structure of the container.

OpenDoc addresses these problems by creating an open metaformat, a way to store both sequential and piece-based information in a file without conflict. Although OpenDoc can support many different storage systems, it specifies one implementation on each platform based on Bento, a compound-document-storage format developed at Apple that was designed to address many of these problems, support multimedia, and work on many platforms (see the figure "The Bento Storage Format"). OpenDoc storage makes no assumptions about whether formats are sequential or piece-based. It allows random or sequential access.

To explain OpenDoc's storage model, I'll work up from the simplest elements of storage to the full document structure. At the base of OpenDoc documents are stream-like entities called *values*. Every one of these values looks to an editor like a complete file. Each value has read, write, and seek operations, just like any typical file.

In addition, OpenDoc supports two extra operations, insert and delete, that insert and delete data into the middle of a stream without copying massive amounts of information. It does this by maintaining a table of contents that assembles random chunks of the file into the appearance of a stream. Inserts and deletes generally alter the table of contents instead of moving the contents around. Sequential formats can use stream operations, and piece-based formats can use insert and delete operations to alter data in place.



Document parts can *be stored anywhere within the file. These parts can then be reconstructed into a single stream of data by referencing the file's table of contents.*

Values are collected inside objects called *storage units*. Every OpenDoc part has its own storage unit, which consists of a list of named properties, each of which has a list of typed values. Thus, a storage unit is a lot like a directory in a typical file system. Properties are a lot like named files, and values form the contents of each file.

Unlike a directory in a typical file system, however, a storage unit has the added advantage of being able to store multiple formats for every property. A file system has only one set of contents per name, whereas a storage unit can have several, each with its own type. This makes OpenDoc uniquely suited to storing multiple representations of a part. An OpenDoc part editor could, for instance, store both a standardized format and an efficiently editable format with a single name.

Storage units are collected into structures called *drafts*. A draft is really a list of storage units—a snapshot of the state of a document. When you make a draft in OpenDoc, you're really saving the state of the document for later retrieval, even if changes are made. OpenDoc is very efficient about how it stores drafts, using the information from read/write/insert/delete operations to store only the changes from the last draft.

One exciting thing about drafts is that values can use them to refer to storage units in a very robust and flexible fashion. Any value can include a reference to another storage unit in a draft. This allows pieces of data in various formats to have a standard way of referring to one another. As a result, a draft can support many different organizational structures, from simple hierarchies such as a file system to full hypertext webs.

Every draft has a pointer to the topmost part, or *root part*, of a document, which is used to open the draft into windows or to print the document. The rest of the document embedding is done using OpenDoc's reference mechanism. Thus, documents can have many different structures. The root part is in charge of it all, and it sets up the document structure based on its own content rules. A spreadsheet, for example, might allow embedding only on the main sheet, while a Rolodex editor might allow it on any card. The same part can be embedded in many locations.

Finally, there are documents that are just lists of drafts. One special draft, the *current draft*, represents the latest state of the document (see the figure "The OpenDoc Storage Model" on page 188). Users see the current draft upon opening a document. This structure is one of the key design points in OpenDoc. It supports more kinds of documents than any previous compound-document system. Even better, for part editors that don't need all its power, they can simply do stream I/O operations and ignore the rest.

OpenDoc Scripting

OpenDoc scripting is designed with two major points in mind. First, scripting is a human interface, intended for users—not C programmers. Second, scripting is most valuable in the context of work-flow applications, where several kinds of data are used in some sequence to accomplish a task.

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Dot Pitch (mm)	0.28	0.28	0.28	0.28	0.28	0.27	0.26
Hor. Freq. (KHz)	30-38	30-50	30-62	30-62	30-65	30-65	30-85
1600 x 1280 NI	—	—	—	—	—	—	Yes(60Hz)
1280 x 1024 NI	—	—	—	—	Yes(60Hz)	Yes(60Hz)	Yes(75Hz)
1024 x 768 NI	87Hz/I	60Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI
Mac Compatibility	—	—	Yes	Yes	Yes	Yes	Yes
Flat Square	—	—	—	Yes	Yes	Yes	Yes
Color Match	—	—	—	—	—	Yes	Yes
Digital Controls	—	—	—	—	Yes	Yes	Yes
MPR-II & ISO9241-3	Yes	Yes	Yes	Yes	Yes	Yes	Yes
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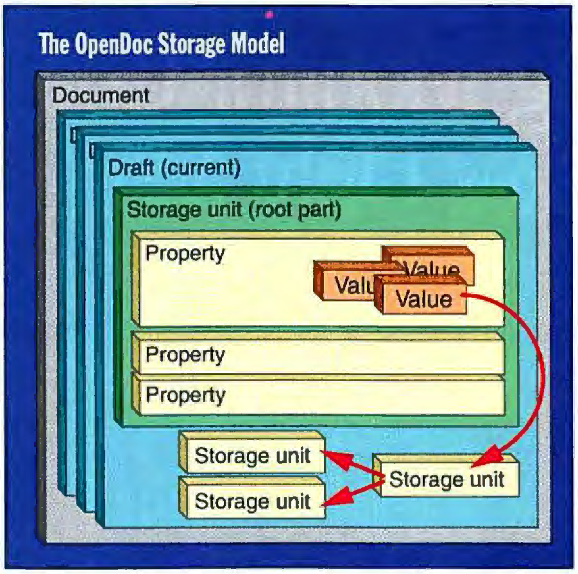
*Based on official 1993 Monitrak U.S. monitor sales research.

programmatic interface: Just expose the innards of your editor and let users program it any way they like.

This doesn't really work, though. Imagine that you're creating a scripting system for a word processor. Internally, run-length encoding is an efficient way to store character-formatting information. However, at the scripting interface, you'd hardly want your users to understand the arcana of run-length arrays so they can set the font of a word. Instead, you'd create an abstraction of the data that lets them select words, lines, or paragraphs, and let them set the font of any of those things.

The second major point of OpenDoc, work flow, is just as important as the first point. A user usually has a task to complete that involves many distinct actions on many distinct kinds of data. To have a useful automation system for OpenDoc, you need to be able to script the actions of many parts in a single script. These parts could be in many documents, on many machines, across a network on many different kinds of hardware and operating systems. Even worse, some of the instructions need to be delivered through store-and-forward systems, such as E-mail. Clearly, this is a tough—but important—problem to solve.



Values contain the basic *atoms of data and look like files to OpenDoc editors. Values are collected inside storage units, which contain a list of typed values. A storage unit functions as a directory in a file system and can refer to multiple copies of the data in different formats. Storage units are collected into drafts. Each draft is a snapshot of the information. A document is composed of different drafts, the latest snapshot of which is contained in the current draft.*

The OpenDoc team chose to extend an existing solution to this problem. Over the past few years, Apple has created a scripting architecture that it calls OSA (Open Scripting Architecture), which solves much of this problem for the Macintosh.

OSA is a series of libraries that each address parts of the problem. There's a standard calling convention, called Apple Events, that allows applications to call one another over a network or on a single machine. OSA scripting systems can coordinate activities among many machines and many applications from a single script. Another library, the Apple Events Manager, simplifies the process of making and receiving Apple Event calls.

Another OSA library allows different scripting languages to call one another and can even be used to plug other scripting architectures into OSA. A good example of such an architecture is the OLE 2.0 automation interface. OSA provides a standard way to adapt other scripting architectures so that they can be called from OSA-compatible languages.

There's also a standard record of calls, called the Registry, that defines a common set of operations that most editors can support. Operations such as copy, paste, create, delete, and move are all defined in a standard way in the Registry.

Central to the design of the Registry commands is a standard way of naming selections in individual applications. This is one of the keys to verbal intuition and consistency in OSA. OSA's naming scheme, called *object specifiers*, lets users name individual objects or groups in a standard way. It lets users treat their documents as if they were a giant object database that they can query in a natural way. For instance, it's quite easy in OSA to set the color of "every cell whose value is less than zero" in a spreadsheet to simply "red" or to set the color of "cell R1C2" to "green."

OSA also includes a standard way for applications to publish the kinds of objects they make available for scripting, as well as what can be done to those objects. This user terminology is described in a resource and allows OSA scripting languages to support many different language syntax forms. Thus, they can be internationalized to resemble natural spoken languages as well as existing computer languages. Since OSA was intended to be a cross-platform architecture, it fits in nicely with OpenDoc's goals.

However, the OpenDoc team needed to extend this naming architecture to handle embedding. OpenDoc includes a service, called the *name resolver*, that allows part editors to easily handle object specifiers. This service parses the object specifier and then calls back into the part editor to resolve object specifiers into pointers to the part editor's data structures. If the specification crosses a part boundary, the name resolver can switch contexts and begin resolving in the new part. It handles query-type specifiers and even does query optimization in some cases.

The OpenDoc team also needed to extend the OpenDoc dispatcher to deliver the Apple Event (which is called a *semantic event* in OpenDoc) to the correct part. This involved using the name resolver to determine which part should handle the semantic event and then dispatching the event to that part.

The result is quite striking. Users can refer to objects using the visible embedding structure of the document, saying things like "delete seconds 1 through 30 of the first movie of paragraph 1 of my document." These instructions can be delivered either in real time or through store-and-forward systems, thanks to OpenDoc's sophisticated naming scheme.

Getting Your Hands on OpenDoc

OpenDoc is being implemented right now. By the time you read this, it will probably be in its alpha-testing phase. Once that is finished, we plan to release the source code generally. A vendor-neutral organization, CIL (Component Integration Labs), will be the owner of OpenDoc (including a cross-platform version of OSA) and will be the point of contact for obtaining the source code. You can contact CIL at 688 Fourth Ave., San Francisco, CA 94118, (408) 974-6549, or on the Internet at cil@cil.org.

There are white papers, specifications, and other documentation available from CIL right now, with more on the way. In the meantime, look for the various CIL companies to begin releasing seedings of the technology on their respective platforms. ■

Kurt Piersol is a software architect at Apple Computer (Cupertino, CA), where he leads design teams and coordinates design elements on a number of projects. Currently working on OpenDoc, he previously led the Apple Events project, coordinated the design of a Mac Interapplication Communication system, and was the early technical leader for AppleScript. You can contact him on BIX c/o "editors."

Life with NewtonScript

Generating cellular automata may not be what the Newton was designed for, but it makes for a good demonstration of the PDA's programming language

DAVID BETZ

Apple's Newton MessagePad comes with applications software built in, and other applications are coming to market for Apple's PDA (personal digital assistant). But you can also program your own Newton applications using Apple's NTK (Newton Tool Kit). The NTK consists of two pieces: an application that runs on the Mac and one that runs on the Newton itself. These applications communicate through the Newton's serial port. The communications link can be either a straight serial connection or an AppleTalk connection.

You develop a Newton application using a Macintosh-based graphically oriented development environment. Newton programs are based on a hierarchical collection of *views*. A view can be a drawing area, an area where pen input is recognized, a button, a pop-up menu, or any of a number of other user-interface features. The NTK allows you to draw these views directly, using a tool palette and a simulation of the Newton screen.

I am going to describe a simple Newton application that I built based on one of the sample programs that comes with the NTK. It is an implementation of John Conway's game of Life. (For a complete discussion of Life, see Martin Gardiner's column "Mathematical Games" in the October 1970 issue of *Scientific American*.)

I chose Life as my first attempt at Newton programming because I thought that the high-speed ARM RISC chip on which the Newton is based would allow me to compute new generations quickly. Unfortunately, this didn't turn out to be the case. Currently, the only language available for programming the Newton is NewtonScript, and even the fast ARM chip gets bogged down interpreting the byte codes that the NewtonScript compiler generates. I'll have to wait for a NewtonScript native code compiler or a Newton C compiler before I can really use the Newton as a platform for experimenting with cellular automata. Still, the Life program serves as an interesting example of NewtonScript programming.

JOHN BREAKEY © 1994

Structure of NewtonScript

NewtonScript is a dynamic language with an interesting object system. It uses an ALGOL-like syntax and untyped variables similar to those in Lisp and Smalltalk. In other words, the data itself is typed, and any data type can be assigned to any variable. The language includes an automatic storage manager that reclaims unused structures behind the scenes so that the programmer doesn't need to keep track of when an object is no longer in use.

NewtonScript has two data classes: scalars (i.e., symbols, integers, floating-point numbers, characters, and Booleans) and composites (i.e., strings, arrays, and frames). It implements an object-oriented programming model by means of its composite data type, the *frame* (a sort of associative array), which is composed of *slots* (the paired elements of the associative array). Each slot has a name and a value, and the value can be of any data type, including another frame or a function. Methods are simply slots that have functions as their values.

Frames can also inherit from other frames. Unlike more traditional object-oriented languages like C++ or Smalltalk, NewtonScript doesn't have the concept of classes. Instead, it supports two types of inheritance, *prototype inheritance* and *parent inheritance*.

Prototype inheritance is used the way classes are in Smalltalk and C++. The prototype on which a frame is based is indicated by the value of its `_proto` slot. Prototypes are considered read-only at run time. Any prototype slot that you change at run time is copied to the inheriting frame and changed there. Therefore, the inheriting frame consists only of the `_proto` slot and those that differentiate it from its prototype—a design that conserves memory by avoiding any unnecessary replication of data.

Parent inheritance differs in that a change to a slot in a child frame affects the parent and other ancestral frames. The parent of an object is indicated by the value of its `_parent` slot. Parent inheritance is generally used to represent the view hierarchy. A frame also inherits slots from its parent and its parent's parents. Unlike prototypes, parents are not read-only.

When a frame inherits from both a prototype and a parent, prototype inheritance takes precedence. The search sequence starts with the frame itself. If the slot is not found in the frame, the search continues through the prototype chain of the frame. If the slot is still not found, the search continues with the parent of the frame and then to its prototype frame, and so on. The search fails only if the frame and all its prototypes and its parents and their prototypes fail to have the slot.

viewSetupFormScript

```
viewSetupFormScript: func()
begin
  local width := viewBounds.right - viewBounds.left;
  local height := viewBounds.bottom - viewBounds.top;
// create the universe
  sizeX := width div cellSize - 2;
  sizeY := height div cellSize - 2;
  universe := :makeUniverse();
end
```

viewDrawScript

```
viewDrawScript: func()
begin
  local dot := MakeOval(0, 0, cellSize, cellSize);
  local rowWidth := sizeX + 2;

// loop through each row
  foreach row in universe do
  begin

// loop through each cell in the row
     foreach cell in row do
     begin
       if cell
         then
           :DrawShape(dot, {transferMode: modeCopy,
                            fillPattern: vfBlack});
       OffsetShape(dot, cellSize, 0);
     end;
     OffsetShape(dot, -cellSize * rowWidth, cellSize);
   end;
end
```

Notation in NewtonScript

You refer to a slot within a frame using dot notation. For instance, the expression `foo.bar` refers to the slot `bar` in the frame `foo`. Within a definition of a method, you can abbreviate the slot name to its first element, since the frame to which it belongs is implicit in the method.

You send messages using the colon syntax. For instance, the expression `foo:countNeighbors(x,y)` calls the `countNeighbors` method of the frame `foo`, passing it the parameters x and y. You can refer to the current frame from within a method by omitting the frame expression. For instance, `:Dirty()` calls the `Dirty` method of the current view when called from within a method of that view.

viewClickScript

```
viewClickScript: func(unit)
begin
  local globalBox := :GlobalBox();
  local clickX, clickY;

// get pen-down location
  clickX := GetPoint(firstX, unit);
  clickY := GetPoint(firstY, unit);

// convert to local coordinates
  clickX := clickX - globalBox.left;
  clickY := clickY - globalBox.top;

// convert to grid coordinates
  clickX := clickX div cellSize;
  clickY := clickY div cellSize;

// toggle the specified cell
  if    clickX >= 1 and clickX <= sizeX
    and clickY >= 1 and clickY <= sizeY
    then
      begin
        local row := universe[clickY];
        row[clickX] := not row[clickX];
      end;

// then force redraw
    :Dirty();
end
```

The Root of Life

The root of the Life application is the `baseView`. As with the base view for any Newton application, it defines the area on the screen used by the application and provides basic functionality to the application, like a title bar and a close box. Nested within the `baseView` are the `nextButton` view and the `clearButton` view (screen buttons with associated actions) and, most important, the `universeView`.

The `universeView` is where the Life universe is displayed. In it, a live cell is represented by a dot, and a dead cell is simply left blank. The most important methods associated with the `universeView` are the `viewSetupFormScript`, the `viewDrawScript`, and the `viewClickScript`. The Newton view system uses these as standard methods to handle events.

In the sample Life program, the `viewSetupFormScript` (see the listing) initializes a view. It computes the size of the `universeView` in cells and creates the initial universe array. Since the `viewSetupFormScript` is a method for the `universeView`, the symbols `cellSize`, `sizeX`, and `sizeY` refer to slots within the `universeView` frame.

The system calls the `viewDrawScript` (see the listing) whenever it needs to draw the contents of a view. Mine simply loops through the universe array and draws dots corresponding to live cells.

The universe array is actually an array of arrays. NewtonScript does not support multidimensional arrays, but it does support arrays of arbitrary objects, including other arrays. I've used an array of arrays to simulate a 2-D array. Also, I've used the `foreach` construct to loop through each row of the universe and each cell in a row. `Foreach` binds each element of an array or frame to a variable and executes the body of the loop for each element; this is supposed to be faster than using an explicit index. (My arrays have a border of empty cells, and the row size is two larger than the width of the universe.)

The predefined `MakeOval` function creates an oval shape. I use this shape to indicate cells that are alive. I use the same shape object for all the live cells by moving it to the appropriate location using the `OffsetShape` function. The predefined `DrawShape` method draws the specified shape in the view.

Another feature of the `viewDrawScript` is the second parameter to the `DrawShape` method. It is a literal frame. You indicate a literal frame by enclosing a list of slot definitions in a pair of braces. Each slot definition consists of a slot name, followed by a colon, followed by the slot's value. The value of this expression is a frame with the specified slots. You can construct

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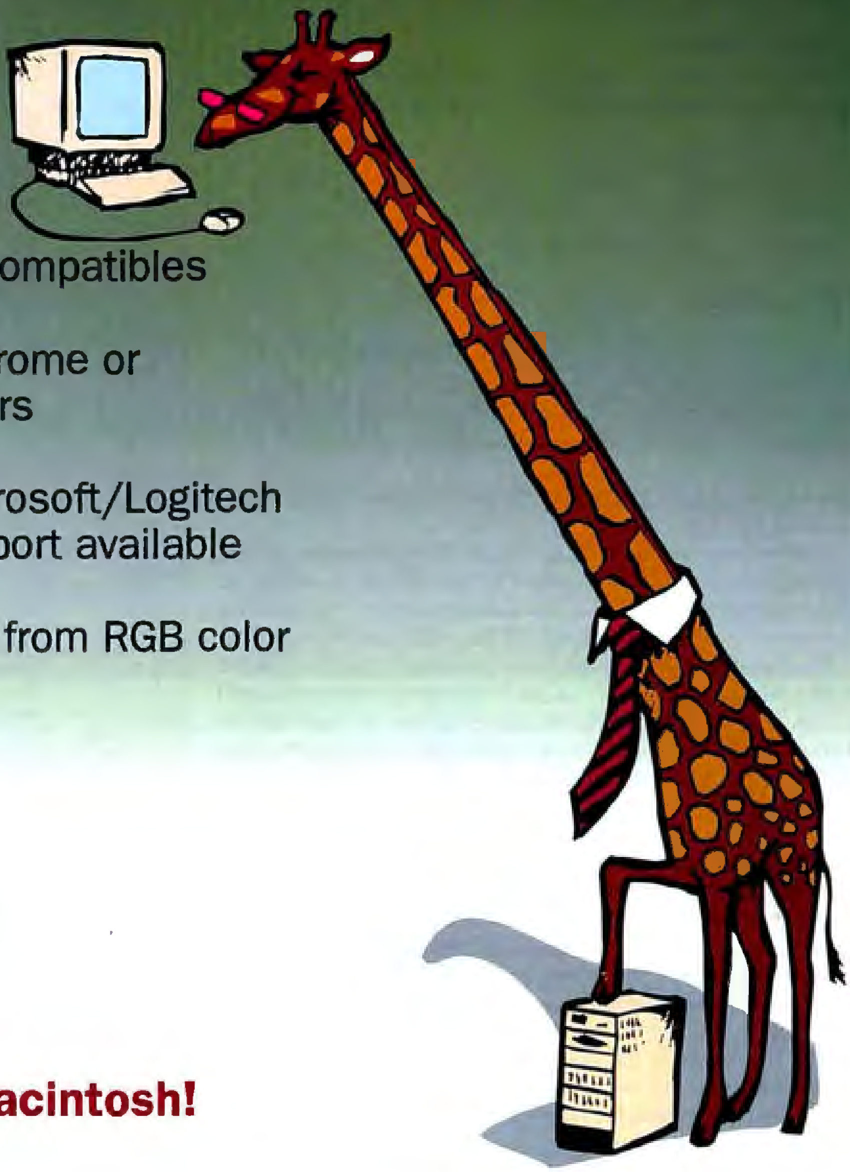

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entire programs using this notation, but the NTK provides a much easier graphical means of defining views and view templates.

The system calls the `viewClickScript` (see the listing) when the user taps the pen within a view. My `viewClickScript` first converts the coordinates where the click occurred to local view coordinates. The system-defined function `GetPoint` returns the `X` and `Y` coordinates of the point where the pen first touched the screen in global coordinates. The system-defined `GlobalBox` method returns the bounding box of the view in global coordinates. My `viewClickScript` then converts the local coordinates to a grid location and toggles the state of the corresponding cell.

A View of the Universe

Within its definition, the frame `universeView` contains some data slots and utility methods. The data slots are as follows:

`sizeX`	width of universe in cells
`sizeY`	height of universe in cells
`cellSize`	diameter of a single cell
`universe`	the 2-D array of cells

The methods are

`makeUniverse()`	create a universe array
`nextGeneration()`	compute the next generation
`countNeighbors(x,y)`	count the live neighbors of a cell
`clear()`	clear the universe of live cells

The `universeView` listing contains the methods that I have defined for this application.

The `makeUniverse` method is fairly straightforward. It creates the 2-D array used to represent the grid of cells by calling the system-defined `Array`. The first parameter of `Array` specifies the Array size; the second specifies the value for each element.

The calculated grid for my Universe covers 1 to `sizeX` in the X direction and 1 to `sizeY` in the Y direction, but the total grid covers 0 to size plus 1 (NewtonScript arrays are zero-based). This creates a no-calculate border around the calculate grid, simplifying the computing of the next generation: I needn't check for the special case of cells on the edge when computing neighbors.

The Universe, Next Generation

The `nextGeneration` method is the core of the application. It creates a new universe array and loops through the cells in the current generation, computing which live and die based on their neighbor counts. It then replaces the current generation with the newly computed generation and forces a redraw of the `universeView` by invoking the `Dirty` method, to mark the view as dirty and refresh the screen on the next pass through the idle loop.

The `nextGeneration` has a supporting function, `countNeighbors`. It simply counts the number of live neighbors a cell has.

Pushing the Buttons of the Universe

The `nextButton` view is a screen-based button that sends off the message to calculate and display the next generation. Likewise, the `clearButton` view is a button that clears the universe. Because these buttons act on the contents of the `universeView`, they must be able to send messages to it. The NTK permits this by having a slot in the `baseView` that points to the `universeView`.

That's all there is to the Game of Life application. Not everything is described here; for example, Newton applications usually include a close box that closes down the application. Because

universeView

```
makeUniverse: func()
begin
  local u := Array(sizeY + 2,nil);
  for y := 0 to sizeY + 1 do
    u[y] := Array(sizeX + 2,nil);
  return u;
end

nextGeneration: func()
begin
  local newUniverse := :makeUniverse();

// compute the next generation
  for y := 1 to sizeY do
    begin
      local row := universe[y], newRow :=
                                   newUniverse[y];
      for x := 1 to sizeX do
        begin
          local neighbors := :countNeighbors(x, y);
          if row[x]
            then
              begin
                if neighbors = 2 or neighbors = 3
                  then newRow[x] := true;
              end;
            else
              begin
                if neighbors = 3
                  then newRow[x] := true;
              end;
        end;
    end;
  universe := newUniverse;
  :Dirty();
end

countNeighbors: func(x,y)
begin
  local cnt := if universe[y][x] then -1 else 0;
  for yy := y - 1 to y + 1 do
    begin
      local row := universe[yy];
      for xx := x - 1 to x + 1 do
        if row[xx]
          then cnt := cnt + 1;
    end;
  return cnt;
end

clear: func()
begin
  universe := :makeUniverse();
  :Dirty();
end
```

of inheritance, the Life application gets that, along with other functionality, free through the prototype of the `baseView`.

To create a Newton application, all you do is add your own application-specific functionality (i.e., frames and methods) to the Newton's base functionality and prototypes. This is the advantage of using an object-oriented design that supports inheritance.

The Newton provides tools for handwriting-recognition software, the soup (for permanent storage of objects), and the communications facilities. NewtonScript provides the glue with which these facilities are easily combined to form useful applications. ■

Editor's note: *The complete listings for this article are available electronically. See page 5 for details.*

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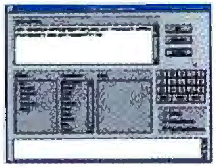

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Visual Basic Custom Controls Meet OLE

1994 may finally be the year that distributed object computing becomes a reality

JON UDELL

"We prototyped our application in Visual Basic, expecting to rewrite it in C," said a friend of mine recently. "But in the end we just shipped the prototype." I have heard this same story from more than a few programmers. How can a mere BASIC interpreter power a commercial Windows application? By exploiting prebuilt components. You use VB to evolve a user interface that VB itself can, in many cases, run acceptably fast. Then you bind that user interface to DLLs or VBXes (Visual Basic custom controls) that do the real computational work in compiled code.

The first wave of VB applications leaned heavily on DLL support. Two years ago I built a VB database application using standard VB controls (i.e., buttons, text fields, and listboxes) and Sequiter Software's CodeBase DLL. The glue holding it together was my own VB code.

Nowadays I use VBXes like Q+E's MultiLink/VB and Coromandel's Integra VDB to write much fancier database applications with much less effort. These new data-smart custom controls understand complex idioms such as navigating related tables. That means less VB code to write (i.e., faster development) and less to interpret (i.e., faster execution). When you do write VB code, it's often just a snippet to handle a navigation or update event generated by the custom control.

VBXes aren't just for database work, although that's the most popular category. There are custom controls for many application domains, including imaging, CAD, telephony, communications, data acquisition, and financial modeling. In fact, the dramatic success of VBXes is quite embarrassing to OOP (object-oriented programming) purists. A VBX is, after all, only an odd sort of DLL that co-opts the VB message pump in a useful way. (VB, in turn, co-opts the Windows message pump in a useful way.) While a VBX encapsulates methods and data, it isn't inheritable or polymorphic.

But despite these theoretical shortcomings, VBXes are just what C++ and other OOP languages have long promised yet conspicuously failed to deliver: reusable software components. The culture clash became brutally obvious when Microsoft and Borland were forced to add VBX support to their C++ compilers. To enable a C++ program to host a VBX, the compiler has to supply emulation code that fools the VBX into thinking it's running in the VB environment.

If native C++ components were abundant and easily reusable, C++ programmers would surely prefer them. Why isn't this the case? There's no good way to package C++ components in binary form for use in Windows. In theory, you ought to be able to bundle a C++ class library into a DLL for use by other C++ programs. But in practice that's hard, because DLLs don't do OOP-style method dispatching and can't smooth over differences in the binary objects produced by different C++ compilers.

IBM's SOM (System Object Model), which can solve these problems and is slated to debut on Windows, currently runs only on OS/2 and AIX. And while Sun Microsystems has now anointed NextStep as its object standard, no one is talking about moving it to Windows. Hence the unholy alliance of C++ and VBX technologies. Windows programmers want to be able to build and use components today, and their binary object standard—for better and for worse—is VBX.

DAVE JONASON © 1994

VBX at the Crossroads

Developers were shaken when Microsoft announced that the 16-bit Windows platform was the end of the line for VBXes. Existing custom controls will operate on Win32 platforms (i.e., NT and Chicago), because these operating systems can run VB and other 16-bit VBX hosts.

But you won't see Win32-based VBXes on Chicago, or portable versions of them on NT. What you will see instead, Microsoft says, are Win32-based OLE 2.0 objects that export methods and properties using the OLE automation interface, IDispatch. Clients that can call those methods and edit those properties will include current and future versions of VB, applications (e.g., Excel) that have VBA (Visual Basic for Applications) embedded in them, and any Win16 or Win32 application that conforms to the IDispatch client protocol.

Were developers reassured by this statement of direction? Quite the contrary. Many were horrified, because OLE 2.0 represents the most stupefyingly complex software technology Microsoft has ever created. IDispatch-style automation is just one of the beast's many heads. Other interfaces govern linking, embedding, in-place activation, data transfer, and structured storage.

Once mastered, however, OLE 2.0 delivers tremendous benefits. Witness Excel 5.0, which, among other things, can function as both an OLE automation client and server. The client capability flows from VBA, which Excel 5.0 offers as an alternative to its existing macro language. An Excel VBA script can control any OLE 2.0 server, including, most notably, Excel itself. OLE 2.0 clients, reciprocally, can tap into the Excel 5.0 object library, which contains dozens of objects and hundreds of methods and properties. You can, for example, quite easily write a VB application that uses Excel 5.0 as though it were a high-powered custom control for charting or data analysis.

Windows component builders know that OLE objects will somehow replace VBXes, but they've found climbing the OLE learning curve to be like an oxygenless assault on Everest. Fortunately, help has arrived.

Make Friends with MFC

The latest release of Visual C++, version 1.5, which includes version 2.5 of the MFC (Microsoft Foundation Classes), delivers a stunningly powerful encapsulation of OLE embedding and automation. "We've written the 20,000 lines of C++ that make OLE useful," says Visual C++ product manager Denis Gilbert. Whether an operating-system extension should require 20,000 lines of code to be usable by mere mortals is an interesting question, but in any case, MFC 2.5 is here, and it works wonders. Experimenting with it has given me a glimpse of how OLE-style custom controls—the VBXes of tomorrow—will work.

I started with a simple MFC database application. Because MFC 2.5 also encapsulates ODBC (Open Database Connectivity) database access, it required essentially no code. I used a checkbox in AppWizard to pull in the database classes, laid out a form in AppStudio, and bound database fields (via member variables) to the form in ClassWizard. When I built the resulting application, it connected to a SQL Server database, and I could use its VCR-style toolbar to advance through a set of records.

There's more. Because I'd used another AppWizard checkbox to indicate that the application should work as an OLE 2.0 in-place server, it was automatically embeddable in OLE 2.0 containers. Using Excel 5.0's Insert Object command, for example, I was able to place an instance of my application on the surface of a spreadsheet; when active, my application's menu and toolbar replaced those of the Excel container.

MFC provided the implementation of multiple OLE interfaces, including IOleObject, IRunnableObject, IViewObject, and IDispatch—things I've read about and understand in a general way but can scarcely conceive of programming with raw OLE API calls. And Visual C++ took care of housekeeping details such as adding the document type to the Windows registry.

Together, MFC and Visual C++ made a mountain of complexity just disappear and handed me a usable OLE toolkit. I'm no hotshot Windows programmer, but I was able to construct what was beginning to feel like a database custom control.

There's more. Because I'd also told AppWizard that my application should include support for OLE automation, ClassWizard invited me to export methods and properties for use by VB

or other OLE automation clients. I decided to export a GetCompany method that returned a value from the current record, and a NextRecord method that would advance the record pointer.

Here, finally, I had to write some code. Implementing these methods took only a few lines of C++, but I spent hours discovering which lines I needed and where to put them. It all hinged on how MFC's generic document and view classes related to each other and to the derived RecordSet and RecordView classes. In MFC, as in Smalltalk, you swim in a sea of objects that you know are all somehow connected. Discovering how they're connected, and learning to manipulate the connections, is the trick.

Eventually—and certainly weeks sooner than had I attempted the feat unaided by MFC—I could launch my application and control it from VB. Now it was *really* starting to feel like a database custom control.

Missing Pieces

There's plenty of work still to be done before OLE custom controls can fully replace VBXes. OLE 2.0 lacks an event model. VB can call my application's NextRecord method, but the application can't report a NextRecord event back to VB. Enabling OLE servers to fire off events, and OLE clients to register handlers for those events, will require extensions to the current OLE 2.0.

Further extensions will be required to extend OLE's interprocess communication across networks. Finally, for visual programming environments like VB, OLE objects will also need a framework for design-time form layout and property editing. So OLE custom controls are still hazily defined.

Component builders shouldn't wait until the picture clarifies, however. The toughest job will be to define which methods and properties your application should export and how to organize them. The hard work of engineering dual-purpose applications that function interactively and as programmable components can and should begin now, because the component software revolution really is—finally—about to happen.

OOP purists bothered by the seeming primacy of BASIC can relax—it's just an accident of history. VB and VBA were the first languages enabled for OLE automation, but I predict that by the end of 1994 you'll see Lisp, Smalltalk, and other interpretive OOP languages acquire OLE bindings as well. Meanwhile, C++ will enable OLE component builders to leverage the power of a compiled OOP language. There's nothing wrong with C++ that a decent binary object standard can't fix. OLE 2.0 will be one of the most important examples of such a standard.

Microsoft detractors bothered by the seeming primacy of OLE can also relax. OLE will likely become network-capable rather sooner than Microsoft's own leisurely schedule for Cairo (ship date: 1995) implies. Distributed object computing can't wait that long. Microsoft and DEC are already working to make DEC's CORBA-compliant ObjectBroker interoperate with OLE. Meanwhile, Symbiotics has announced that its Networks Connect 2.0 will extend OLE linking and automation across networks.

These are just a few of the proposals that will be submitted to the OMG (Object Management Group) this year in response to its request for a next-generation distributed object architecture. As a result, it now seems possible—even likely—that the OMG's influence will prevail and that Microsoft's OLE, IBM's DSOM (Distributed System Object Model), and Sun's DOE (Distributed Objects Everywhere) can meet on common ground. ■

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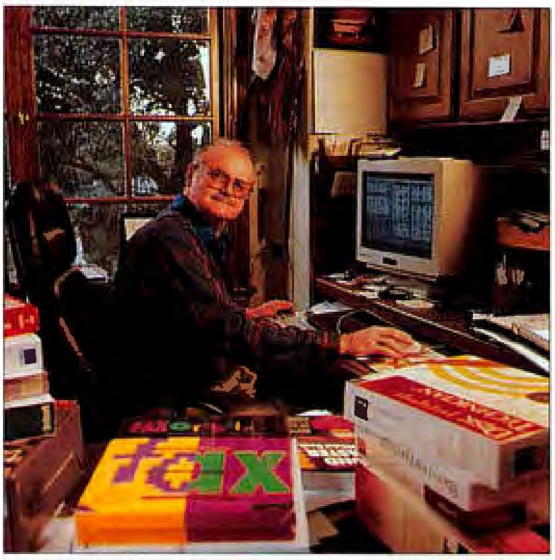
JERRY POURNELLE

Booting, Benchmarking, and Bob's Your Uncle



AMY ETRA © 1994

Jerry's ongoing exploration of Windows takes him to novel boot-up utilities and more benchmarking of video cards

There's so much to talk about this month that it's hard to choose a lead, but let's start with Bootcon 2.0, because it let us do more testing with less trouble. Bootcon offers you up to 26 different combinations of CONFIG.SYS and AUTOEXEC.BAT; choose any one at start-up. It's a godsend for anyone who regularly uses the same system in different ways: for example, running AutoCAD on a bare system to avoid the Windows performance penalties, different networks, or different memory managers.

It's even more important for testing hardware and software, because if you get your system into an unbootable configuration—and that happens to us more often than I like—you don't have to fish out your panic boot-up floppy. Also, if new software crashes, you can easily boot up your system in bare bones with no memory-resident programs at all and see if it works that way. (There's a Clean Boot option for just this.)

You can choose among several incompatible memory management programs such as QEMM and HIMEM, enable CD-ROM or leave it out to have more memory, load different sound drivers, run different setup programs, come up in Windows or in DOS, and even switch over to Dual Boot OS/2, all without having to write (and maintain) a whole bunch of batch files.

I recommended the original Bootcon 1.0 a couple of years ago. The new version not only handles MS-DOS 6 and compressed drives, but it has a completely new interface, making it *much* easier to use. If you know how to edit your CONFIG.SYS and AUTOEXEC.BAT files—and that's easy to learn if you don't—you can use Bootcon, and indeed, if you have Bootcon you can learn how to edit those files without having to worry about getting into an unrecoverable attitude: just leave your original start-up configuration as the Bootcon default.

It's not perfect, however. When we installed Federal Soapbox (which I'll discuss later) it wanted to change CONFIG.SYS by setting BUFFERS=20 rather than the 10 we had. We use Norton Speedcache, and that doesn't need so many buffers, but in the interest of getting on with it we let the Soapbox installation program change CONFIG.SYS.

Alas, it apparently changes *every* buffer statement it can find, which means that when Bootcon came up after reset it wanted a confirmation of that change in every configuration—and we have a *lot* of them on SuperCow, the Gateway 2000 we use as a test-bed system. Bootcon will show you the configuration it believes has changed, but it doesn't show *what* has changed; and it insists that you either accept the changes or put it back the way it was for each configuration it detects changes in.

I didn't quite understand what was going on, and I really dislike programs that do things I don't expect; but there was no harm done, and on reflection I suppose a warning that you have changed your CONFIG.SYS is a good idea. (Gary Palmer insists that the next version will highlight changes for your approval.)

Bootcon does offer a nonmenu mode, which creates a "pure" CONFIG.SYS and AUTOEXEC.BAT, for just such ill-behaved programs as

ILLUSTRATIONS: MIKE McGURL © 1994

SCORES RELATIVE TO 486SX/20 WITH WIN TACHOMETER
Win Tachometer on Jerry's machines. Higher numbers are better.

	WORD PROCESSING	CAD	SPREADSHEET	PAINT	OVERALL
Cheetah 486/33 (Mach 32)	20.37	32.76	38.60	44.37	34.02
Cheetah 486/25 (Mach 32)	14.28	9.16	30.60	16.48	17.65
Cheetah 486DX2/25 (#9GXE)	28.16	52.73	33.28	27.03	35.43
Gateway 2000 486DX2/33 (#9GXE)	31.12	66.76	38.19	34.20	42.57

Federal Soapbox. It's also good for OPTIMIZE, and so forth.

Bootcon works quite well, and if you experiment with your system at all, you need it. Recommended, but do spend a few minutes with the manual.

We may seem obsessed with video speed, but there's a reason: multimedia is growing in importance. You may not care whether it takes an extra 2 seconds to repaint your word processor screen when you change fonts—although remember when that took nearly a minute?—but you will care if your full-motion video gets jerky. Like it or not, video speed and audio fidelity are important, because you will soon see a lot of multimedia educational software and multimedia enhancements to many of our daily tasks.

Last month I reported some times with the Win Tachometer benchmark. We like Win Tachometer (freeware from Texas Instruments, available on BIX in "tojerry/listings") because it's based on a number of things that you actually do with small computers. The winner was the Cheetah 486DX2/33 with the ATI Mach 32 video board, followed by the Gateway 2000 486DX2/33 with the ATI VL-Bus card.

In short order we got two new winners: SuperCow, the Gateway 2000 486DX2/33 with a Number Nine #9GXE Professional Graphics Accelerator, with an overall score of 42.57; and Little Kat, the Cheetah 486DX2/25 with the #9GXE, with an overall score of 35.43. (The #9GXE was not run as a local-bus card, although SuperCow has that capability.) All were run at 1024 by 768 pixels at 65,536 colors (although Win Tachometer reports 32,767 colors); oddly, shifting to 256 colors slows things way down.

Except for the video boards, we made no other changes in these systems.

We had one inexplicable compatibility problem: with the #9GXE in the 25-MHz Cheetah, but *only* in that Cheetah, there are some weird problems with Video for Windows and every sound card we have in the house. That Cheetah was one of the earliest 486 machines, and we think it's a BIOS problem. We had *no* such problems with the #9GXE or any sound card in SuperCow.

There is just a lot to like about that #9GXE board. Installation is exceptionally easy, there are lots of drivers, and it understands a whole slew of monitors, including the big 21-inch Hitachi HM-4319-D that has sat on Little Kat for four years.

continued

It knows about Nanao monitors, including the newest models with Energy Star power-saving features. It has beaucoup monitor-adjustment features, including resizing and moving the display image around on the screen right from within the control panel. Indeed, that "Hawkeye" control panel is about the best we've ever seen. (A minor nit: the control panel is "unkillable"; even pressing Alt-F4 doesn't *really* make it go away.) Images on the Hitachi are steady, Berkeley Systems' Flying Toasters just zoom across the screen, and everything looks crisp and sharp. As a matter of fact, we didn't know how much better a monitor could look until we installed the #9GXE. Video from a CD-ROM looks great, and Classic Clips (Starlite Software, SG 11900 Grant Place, Des Peres, MO 63131, (314) 965-5630) movie previews are now watchable. See Alfred Hitchcock give you a guided tour of the Bates Motel, and Steve McQueen trying to convince people The Blob is coming....

Number Nine advertises their board as the best Windows accelerator you can buy, and we sure can't argue with that on performance grounds, provided you're not talking about the local bus; and you'll note that for CAD it wins even there.

Nits: the #9GXE uses more Windows resources than the ATI Mach 32 card. The #9GXE card that we have does not have a VGA feature connector, meaning that you cannot use it to run Creative Labs' Video Spigot, or the WatchIt TV input board, which in turn means the VideoLabs little Flexcam video camera is right out. (The feature connector is the 26-pin edge connector on the top of your VGA card. Interestingly, the AST Bravo has a feature connector, even though the ATI video system is built onto the motherboard.)

Feature connectors are important: there is still a lot you can do in analog that's too fast for the digital bus. When you read this, most versions of the #9GXE will have a feature connector: look before you buy. Their VL-Bus and PCI cards already come with one. They're also developing control-panel software that will work in DOS.

All told, the #9GXE is very fast and looks great. We like the colors. Recommended. More next month.

While we're on the subject of Win Tachometer benchmark scores, I tried to get one for the PS/2 Model 77, which runs OS/2. Alas, it doesn't work: the usual result of running Win Tachometer is a message proclaiming a protection fault error. The message also says that Win Tachometer will shut down.

Actually, it doesn't quite shut down: it leaves a ghost image on the screen. Invisible under that image is the Windows Program Manager, and if you know where things are in Program Manager you can still click on them to make something happen; and for that matter, if you have Program Manager at less than full-screen size, the OS/2 desktop is under there somewhere as well.

Oddly enough, when I applied the OS/2 `Migrate` utility to Win Tachometer, OS/2 found the program in its database, making me think I might be able to run Win Tachometer directly in Win-OS/2 without Presentation Manager. It started up just fine, but I got the same protection fault error, only this time it really did shut down on acknowledgment.

Win Tachometer *almost* runs, and you can see enough of it to get a notion of how fast Win-OS/2 is; and a couple of times I was actually able to get it to run to completion, although I don't quite know how I did it. The result was about 11 seconds for word processing and similar scores for the other components. This squares with my

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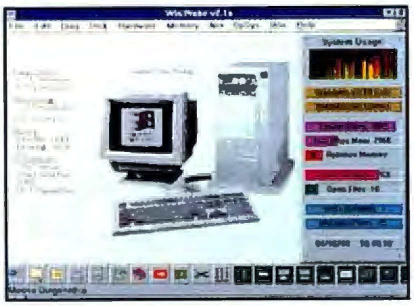

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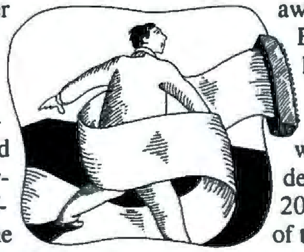
subjective judgment that performance of Win-OS/2 on the PS/2 Model 77 is very similar to what we got on the Cheetah 486/33 with the older ATI board and 8514 video drivers—which, you'll recall, was slower than the 486/25 with ATI accelerator drivers.

While we're on bugs: there is a limit to the number of groups you can have in Windows. That's probably documented somewhere, but I don't know anyone who has read the entire collection of Windows documents. I sure haven't.

I found this fact out while installing several of the Microsoft Multimedia library programs. I did that ostensibly to test the new Creative Labs Multimedia Kit we installed in Big Kat. This comes with a fast two-speed CD-ROM drive, a set of powered speakers, the Sound Blaster Pro sound board, and a whole bunch of CD-ROMs.

Installation was simple, or it would have been except that I had a bad cable: I spent a couple of days finding that out. I have said it many times: if you have mysterious problems, check your cables as the first step. In our case it was the wide ribbon cable from the Sound Blaster Pro board to the CD-ROM drive: as soon as that was replaced, all was well.



The Creative Labs Multimedia Kit works just fine, and I like the speakers. The powered speakers make a *big* difference. Later we installed the Media Vision Pro 16 Multimedia System upgrade kit, with its much better speakers, and even I could hear the difference in sound quality. This was especially true on good music recordings, like the Microsoft Multimedia Stravinsky (one of my favorites); more on that next month, too, when we'll have a sound board shoot-out.

Anyway, we installed Microsoft's Mozart multimedia CD-ROM and discovered that Windows lets you have only a limited number of groups. What actually happened was that once the Mozart program was installed, I got the message "Cannot display Microsoft Multimedia Group," together with the ubiquitous "OK" prompt. I rather resent it when the computer tells me I can't do something, won't tell me why, and then makes me say that that's OK.

I determined that there was no such thing as the "Microsoft Multimedia Group" and attempted to create one in Program Manager: this time I got the message that I had too many groups and would have to delete some. That wasn't a difficult task: about half of the Windows programs create a group that I don't need, since I tend to organize programs by functions; so it was no great trick to delete a dozen groups.

Having got past that annoyance, I installed several other Microsoft Multimedia CD-ROMs, and I have to say I like every darned one of them. Their Encarta is one heck of a history encyclopedia CD-ROM, the kind of thing that I would have sold my soul for when I was in eighth grade (or fifth grade, or high school for that matter). Their music collections, from the Instruments of the World, to Beethoven, to Stravinsky, to Mozart, are wonderful. Multimedia is coming of age, and if your system doesn't do multimedia, you're missing something.

The BYTE editorial staff selects the winners of the Shelly Awards, which are given for the best products being shown for the first time at Comdex. It's a very hectic experience trying to look at all the new stuff and deciding what's best in half a dozen categories, but we get the job done, and our final editorial meeting to decide on the winners is about the best meeting I get to all year. You'll find the awards described elsewhere in BYTE, so I won't list them here.

We really do attempt to look at everything, but there were 2200 exhibits at Comdex this year. We have about 20 editors at the show. Most of them have an assigned floor area, but I'm senior enough that in theory I should look at the whole show. Of course, if I spent 1 minute at each exhibit, and another to get to the next, it would still add up to more 12-hour days than Comdex runs. It's clear I have to be selective.

Before the show I go through press releases to list interesting new stuff. I also read the show daily. All that helps, but when it comes down to it, we still have to rely on what we see: if a new product is hidden away in a booth, we may find it, but it's more likely we won't. However, if we do see something we like, we tell other editors so they can look, too. The process actually works pretty well.

IBM introduced a product at Comdex called OS/2 for Windows. That's a misnomer: it's actually OS/2 for Windows Users. You install this on a system that's already running Windows, and it makes *your* Windows, complete with your desktop and applications, run under OS/2; there is no Win-OS/2 in the package. However, IBM has figured out a way to enable you to launch Windows programs without

Program Manager, exactly as you do with Win-OS/2. Now if they can make this work with Windows for Workgroups 3.11, IBM will have a real winner.

Roberta has been developing the latest Macintosh version of her reading-instruction program on the Quadra 700, and it's coming along nicely. The present version needs an instructor: at one local private school, that's a 10-year-old student who loves using the software to give reading lessons to first-graders. Roberta's goal is to use text-to-speech software to read the instructions so that the program can operate without an instructor.

That was proceeding on schedule when the Quadra's hard disk got flaky. Things quickly went from bad to worse, until the machine was barely running at all. Sometimes it would endlessly reboot itself. Other times it would restart when you attempted to access certain files. It was one sick puppy.

Disk First Aid said there was a problem, but it had no idea what to do about it. Version 2 of Norton Utilities for Macintosh couldn't find any problems to fix. Things got worse, and Alex decided the only remedy would be to save what we could and then reformat the hard disk. My primary backup system (for DOS and Windows) is Palindrome's The Network Archivist; that uses a SCSI DAT (digital audiotape) drive. It's small and portable, so all we needed was a cable to connect the DAT drive to the Quadra, and software to transfer the files to tape.

The cable was standard. One of the major advantages of a Mac is that all you have to do is hang something like the DAT onto the SCSI chain and address it, and the Mac will see it on reboot. The SCSI Probe freeware program immediately saw it and knew that it was an Archive (now Conner) Python 2500 DAT.

We then installed Retrospect 2.0, which will back up Mac data to just about any conceivable SCSI device, including almost all tape drives. It automatically uses the best compression hardware or software available, and Retrospect Remote will back up remote Macintosh systems over a network. It will also back up to floppies, for that matter, but I strongly recommend that anyone serious about computers should get a better backup storage system: floppies are so much trouble that you'll put off doing backups until it's too late.

Alas, the Quadra was so flaky that we couldn't get Retrospect to install on its hard drive. There's a lesson here: don't wait until your drive dies to install your backup software. Fortunately, the internal

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drive is not the only hard disk on that Quadra: we also have an ancient Priam Emm330 MacDisk, which longtime readers will remember was originally installed on a Fat Mac about six years ago. It has been on every Mac we've had since, and like that ubiquitous bunny, it just keeps going and going.

Alex got Retrospect installed on that, after which it was a snap to transfer everything from the Quadra's drive to a new DAT cartridge. Retrospect formats the tape as it copies, and it's pretty fast: with verify, it backed up 5715 files, comprising 266.8 MB, in 39 minutes, for an average of 3.7 MB per minute (6.8 copy, 8.4 compare).

We then reformatted the Quadra's hard disk. The disk's problem appeared to be with the Mac's HFS, and we did lose one unimportant directory, but all's properly restored now.

DAT drives aren't cheap—you'll pay between $1500 and $2000 for a new one; refurbished drives are less—but they're about half the price they were two years ago. A good DAT drive will work equally well with DOS and Mac systems: when we were through backing up the Mac, I put the DAT back on Big Cheetah where it belongs. DAT and 8-mm drives are considerably (like 2 to 4 times) faster than their quarter-inch-cartridge cousins, and they can move between more systems.

DAT tapes are available everywhere. We get ours at Tower Records for maybe $15 a pop retail. Each holds 2 GB, which means that data-storage media costs are lost in the noise. If you're serious about the computer work you do, a DAT with good backup software is one of the better investments you can make.

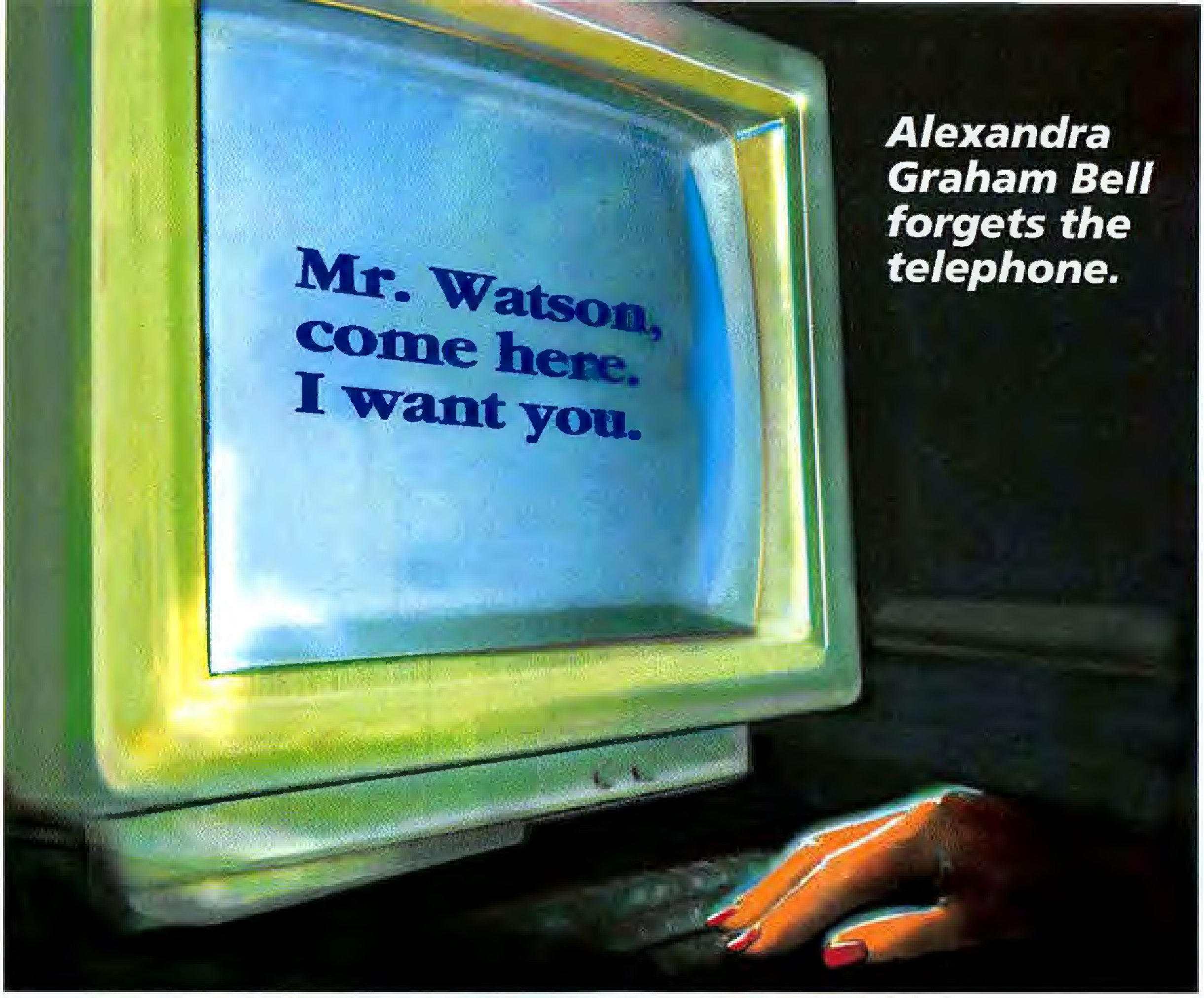
Alex found an interesting problem with memory addressing the other day. He had an old clone with no memory expansion on the motherboard, so he used an old Cheetah memory board with it. Alas, he addressed the board wrong, so it overlapped with already-installed memory. The machine would come up, but whenever he ran a program that accessed that memory area, everything would go weird.

He got out various test programs, with interesting results: Checkit couldn't find a problem. Checkit Pro died. QEMM and its Manifest acted as if there were no problem at all. The new HIMEM.SYS that comes with W4WG 3.11 announced the problem at start-up, and it was the only diagnostic he tried that did find it.

There are other interesting features to W4WG 3.11, including 32-bit file access ("Taken forward from Chicago," according to the beta documentation) and a greatly improved file manager. W4WG 3.11 isn't just an improved W4WG; it's an improved Windows, and we'll see many of those in upgrade releases to Windows itself from time to time.

Meanwhile, Alex has found the secret to getting W4WG 3.11 to work with Novell NetWare. The secret, which cost him many hours of fooling around to discover, is that Novell drivers are not Microsoft installable. You must install W4WG and then use the Novell installer. You also must have a LASTDRIVE=Z statement, or you won't be able to access all the NetWare drives. Get all that done, and Bob's your uncle.

In the course of trying to make NetWare and W4WG work together, Alex found that you can get great help from Microsoft *if* you are a beta tester (he had his own beta copy of W4WG 3.11). However, the


Mr. Watson, come here. I want you.
Alexandra Graham Bell forgets the telephone.

diagnostic tools are pretty awful: MSD (Microsoft System Diagnostic), the program that supposedly takes a complete snapshot of your system to enable the Microsoft help-line people to see what's going on, is quite an old program and doesn't understand a number of new features.

He also found that you really must go to CompuServe if you want Microsoft to hear your bug reports. Sending them in by fax or mail, or leaving a report on voice mail, produced no discernible result, but reports posted in the Microsoft area on CompuServe seem to get quick attention.

If you want or need Windows and you have any networking requirement whatsoever, I strongly recommend you get W4WG 3.11—not just for the networking, but because, as I noted above, it's a better Windows. On the other hand, while MS-DOS 6.x gives you quite a lot for the money, there are superior alternatives to each of its parts.

MS-DOS 5 works fine as DOS; it's very stable and reliable, and if MS-DOS 6.x has any speed improvements, I can't find them. Bootcon takes care of alternate configurations. Stacker is a better compression utility than what you get with MS-DOS 6 and works with PCMCIA cards (Doublespace will not); and while the HIGHMEM.SYS with W4WG 3.11 is much improved over previous models, QEMM from Quarterdeck is still the superior memory manager. Finally, although MS-DOS 6.x gives an improved Smartdrive over the one in MS-DOS 5, Norton Speedcache is better still—and it handles CD-ROMs.

I drove to Comdex this year, so I was able to carry a whole bunch of machines to experiment with. Alas, things conspired to keep me from doing that. The first three days were eaten by running around looking at candidates for the Shelly Awards, Tuesday night was literally eaten by my being the chef for BYTE's entry into the Micrografx Chili Cook-Off—we didn't win the formal vote, but there seemed to be a general agreement that mine was the best there—and then things happened at home to cause me to come back early instead of staying the whole week. Consequently, I wasn't able to do much laptop testing.

I carried, in addition to Old Reliable (the ancient Zenith Mastersport), the new Hewlett-Packard OmniBook 425. This is the smallest and lightest full-size laptop I've ever seen. It has a 486, it runs Windows, there's an ingenious little device that becomes a mouse, and there are four PCMCIA slots. The screen is not backlit but is readable in most normal light. When you turn it off, it remembers where it was, so when you turn it back on it's right there in Microsoft Word for Windows or wherever you left it.

That's the good news. The bad news is that there's no hard drive; that plus the lack of backlighting is how they manage both light weight and long battery life.

Instead of a hard drive, you use the four PCMCIA slots. Two of these contain system software, applications (Word for Windows and Excel are bundled in), and working space. The other two slots will accept standard PCMCIA cards—I plugged in a Seiko Epson IC memory card that I've had here for a couple of years, and while the OmniBook told me the memory card had a low battery that ought to be replaced, it formatted it and wrote a Microsoft Word file onto it.

Incidentally, I couldn't format the card in drive A with File Manager in Windows: I had to open a DOS prompt and do it from the command line. Interestingly, the system prompt told me to insert a blank "card" rather than a disk. On the other hand, the File Manager help file doesn't know what "cards" are, and it tells you that you can format "floppy disks" from the Disk menu in File Manager; only you can't. The Format Disk option in the Disk drop-down menu is grayed out.

Roberta managed to break a leg—that's what got me home early from Comdex—so we've spent a few hours out at Kaiser, giving me some opportunity to experiment with the OmniBook 425. Mostly I used Microsoft Word, but I also played with Excel. There's no floppy disk: the OmniBook comes with a new file transfer program from Traveling Software called LapLink Remote Access.

Once installed, this program automatically moves stuff back and forth between the OmniBook and whatever it's connected to, but fair warning: it does that by continually polling the port you've specified. In my case, I installed the other half of that program on the Zenith, and I about went nuts trying to figure out why I couldn't attach a modem to the Zenith's serial port. The answer was to remark out the stuff in CONFIG.SYS that Traveling Software put there; otherwise you get continuous polling, which makes the modem soggy and hard to light.

continued

I haven't made up my mind about the OmniBook 425. On one hand, it's one heck of a lot of machine in a small and light package. The keyboard is a little bit cramped, but it can be used in awkward positions as well as when it's sitting on a table, and it does the job. Similarly, the little mouse thingy that pops out on a hinged arm seems a little squirrelly, but it does work, and while it takes some getting used to, you can use it. There's no floppy drive (I am told a third-party floppy drive is available, but I have not seen it), but I'm putting a PCMCIA drive into one of my networked desktop machines, and for that matter, the LapLink Remote Access communications package works. The lack of a hard disk is compensated for by the convenience of the PCMCIA slots: just carry a pocket full of PCMCIA cards, and you'll never lose your work to a dying hard disk.

Laptops tend to be personal: you like them or you don't. I am certainly fond enough of the HP OmniBook 425 to recommend that you have a look at it. You may like it a lot.

At the other extreme from the HP OmniBook 425 is the Zenith Z-Note 325Lc active-matrix color laptop. Marilyn Niven, my partner's wife, is very fond of her Z-Note 325Lc. It's not very light, and the battery life is under 4 hours; but it's certainly portable, the screen is bright and clear, and it's a powerful Windows machine.

The hard disk died one day after the warranty expired, but Conner was kind enough to replace it free anyway, although the symptoms are that it looks like someone dropped it. That's about the only problem the Nivens have had with the machine. I've had enough experience with Zenith portables to know they are reliable and rugged; after all, I've been carrying them since they invented the clamshell portable. You might even be tempted to make the Z-Note 325Lc your one and only machine, forgoing a desktop system entirely.

When the Niven laptop's hard disk died just before Marilyn was scheduled to use it to run the art show at a science fiction convention, we loaned them a BSE Flashdrive. For those who don't remember, this is a portable battery-powered hard drive that's smaller than a cigar box. Used with Norton Speedcache, it even made Windows tolerable, which is quite a feat for a parallel-

port hard drive.

You can't boot from a Flashdrive, but you can do everything else. They're also great for storing critical files and are a convenient way to sneakernet files from one place to another. Early versions of MS-DOS 6 had a bug that wouldn't let you have Flashdrive partitions larger than 33 MB, but MS-DOS 6.2 has fixed that (and yet it was a bug in DOS, not in the BSE software).

A BSE Flashdrive is a good combination to use with an HP OmniBook: put the Flashdrive in your checked luggage, and it's available in your hotel room while you use the OmniBook as a notebook. I also use one that way with the Gateway Handbook. If you don't know about Flashdrives, you should.

I know how to solve power and cooling problems with Pentium machines: get PC Power & Cooling power supplies. Longtime readers will recall that I have been recommending PC Power & Cooling power supplies ever since my first Cheetah machines were assembled with them. In the years since, I have had one wear out, and it failed quite gracefully, harming nothing else, and it was easy to replace.

Several industry sources report that Pentium systems have had cooling problems, which isn't surprising: you cannot merely fry, but *boil* an egg on top of a Pentium chip. At Comdex, PC Power & Cooling had exhibits of cooled and uncooled Pentium systems. They also sell a temperature sensor that screams bloody murder if the internal temperature in your computer goes over 110°F. It's worth getting one of those, whatever else you do.

If your systems are getting flaky and you suspect either a power problem or a dying cooling fan, replace your power supply with one from PC Power & Cooling; I think you will be glad you did. Recommended.

It's short-shrift time: there are a bunch of things, each worth a lot more space, but which I simply won't have time to say much about.

I'll start with Federal Soapbox: this is a program that impressed my policy-wonk son Richard. If you have an interest in legislation or regulations, this tells you precisely which officials or congresspersons are relevant. It gives their addresses, and it will make mailing labels, send MCI Mail, or generate faxes as you choose. Specialized, but extremely useful if you need it. Recommended.

I wouldn't have thought that you could make an *indestructible keyboard*, but one appeared in my mail from Everswitch USA. The top is like a solid block of aluminum with a keyboard painted on it. You might hurt it with a sledgehammer, but you'd have to work at it. I would hate to do rapid typing on it—no sense of feel at all—but if you need to expose a keyboard to the public or to guys in work gloves, this is the thing to use.

The Random House Book and CD-ROM *Random House Unabridged Dictionary* is precisely that: the whole thing in both book and CD-ROM form—all the retrieval software you want, plus the hard copy—30 pounds of English. Next to the *Oxford English Dictionary* on CD-ROM, this is as good as you can get. There are a couple of minor glitches: for instance, you can't find the word *mother* except as *mothbr*. That's small beer, though. This is the real thing, and if you like words you'll love this.

continued

Books of the month: John Keegan's *A History of Warfare* (Knopf, 1993) is one of the few books I'll call important: it's an examination of why men—and that's not sexism, but the subject of the book—fight, and whether we still need war. Agree or not, you're in for a heck of a ride. And so you are with John Podhoretz's *A Hell Of A Ride* (Simon & Schuster, 1993), an insider's story of just what happened to send George Bush from an unbeatable 91 percent popularity to defeat by an Arkansas governor. Not *quite* as funny as O'Rourke, and perhaps a bit more serious.

The computer book of the month is Francis Hamit's *Virtual Reality and the Exploration of Cyberspace* (Sams, 1993). I wrote the preface for this because I think it's a realistic cut through the hype to look at virtual reality. It's also a key to access David Mitchell's DIASPAR Virtual Reality Network, and anyone who is really interested in virtual reality cannot afford

For More Information

Next to the *Oxford English Dictionary* on CD-ROM, the **Random House Book and CD-ROM Random House Unabridged Dictionary** ($159; book only, $100; CD-ROM only, $79) is as good as you can get. Contact **Random House Reference and Electronic Publishing,** 201 East 50th St., New York, NY 10022, (800) 733-3000 or (212) 751-2600; fax (800) 659-2436. **Circle 1060 on Inquiry Card.**

The smallest and lightest full-size laptop I've ever seen, I'm fond of the **Hewlett-Packard OmniBook 425** (with 40-MB hard drive, $2125; with 10-MB flash disk, $2375). Contact **Hewlett-Packard Co.,** 1000 Northeast Circle Blvd., Corvallis, OR 97330, (800) 433-1254 or (503) 757-2004; fax (800) 333-1917. **Circle 1061.**

The **#9GXE Professional Graphics Accelerator** ($345 to $1095) is very fast and looks great. Contact **Number Nine Computer Corp.,** 18 Hartwell Ave., Lexington, MA 02137, (800) 438-6463 or (617) 674-0009; fax (617) 674-2919. **Circle 1062.**

If you experiment with your system at all, you need **Bootcon 2.0** ($79). Contact **Modular Software Systems,** 25825 104th Ave. SE, Suite 208, Kent, WA 98031, (800) 438-3930 or (206) 631-5781; fax (206) 631-5779. **Circle 1063.**

Retrospect 2.0 ($249) will back up Mac data to just about any conceivable SCSI device. **Retrospect Remote** ($449) will back up remote Macintosh systems over a network. Contact **Dantz Development Corp.,** 4 Orinda Way, Building C, Orinda, CA 94563, (510) 253-3000; fax (510) 253-9099. **Circle 1064.**

not to know about that.

One of the games of the month is MicroProse's Master of Orion, a game of stellar conquest with diplomacy: it keeps growing on you; be sure to get on-line and download the latest upgrades, since the original was a bit buggy. The other is Dynamix's Betrayal at Krondor, about the best fantasy role-playing game I have come across. It's based on Ray Feist's Magician series, and it plays like reading a novel. Warning: both of these are time eaters.

Critical Path from Media Vision is a chase game of a kind that I'm not terribly fond of, but it's a darned good illustration of just what you can do with multimedia now: the action was filmed with Hollywood actors in Chroma-Key with compressed real-time (albeit rather small) video. It also features my friend Min Yee, Media Vision vice president and formerly the publisher of Microsoft Books; it's just about worth the price of the game just to hear his maniacal laugh.

Next month, more multimedia, including ReelMagic from Sigma: full-screen real-time video from a CD-ROM. The first time you see it, you'll be amazed. Also next month: a multimedia shoot-out, and some words about the DTR Dauphin, a small, pen-based 486 Windows machine that's getting closer to the pocket computers I wrote about 20 years ago in *The Mote in God's Eye*. There's just a lot going on out there in Microland.... ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at Jerryp@bix.com.

A portable battery-powered hard drive that's smaller than a cigar box, the **BSE Flashdrive** (210 MB, $749; 340 MB, $849; 500 MB, $1099; smaller sizes are also available) is great for storing critical files. Contact **The BSE Co., Inc.,** 2114 North Fourth St., Flagstaff, AZ 86004, (602) 527-8843; fax (602) 527-1540. **Circle 1065.**

If your systems are getting flaky and you suspect either a power problem or a dying cooling fan, replace your **power supply** with one from **PC Power & Cooling, Inc.** ($89 to $349), 5995 Avenida Encinas, Carlsbad, CA 92008, (800) 722-6555 or (619) 931-5700; fax (619) 931-6988. I think you'll be glad you did. Recommended. **Circle 1066.**

Federal Soapbox ($129) tells you precisely which officials or congresspersons are relevant to certain legislation or regulations, gives their addresses, and will make mailing labels, send MCI Mail, or generate faxes as you choose. Contact **Soapbox Software,** 10 Golden Gate Dr., San Rafael, CA 94901, (800) 989-7627 or (415) 258-0292; fax (415) 258-0294. **Circle 1067.**

The **Creative Labs Multimedia Kit** ($549.95 to $999.95) works just fine, and I like the speakers. Contact **Creative Labs,** 1901 McCarthy Blvd., Milpitas, CA 95035, (800) 998-5227 or (408) 428-6600; fax (408) 428-6611. **Circle 1068.**

I could hear the difference in sound quality from the speakers in the **Media Vision Pro 16 Multimedia System upgrade kit** (System 1, $1049; System 2, $1195). The action in **Critical Path** ($79.95) is a darned good illustration of just what you can do with multimedia now. Contact **Media Vision,** 47300 Bayside Pkwy., Fremont, CA 94538, (800) 348-7116 or (510) 770-8600; fax (510) 770-9146. **Circle 1069.**

Microsoft Encarta ($395) is one heck of a history encyclopedia CD-ROM. I have to say I like every darned one of Microsoft's **Multimedia CD-ROM music collections** ($79.95 each). Contact **Microsoft Corp.,** 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1070.**

You install **OS/2 for Windows** ($49) on a system already running Windows, and it makes *your* Windows, complete with your desktop and applications, run under OS/2. Contact **IBM Corp.,** 1 Old Orchard Dr., Armonk, NY 10504, (800) 342-6672 or (914) 765-1900; fax (313) 225-4020. **Circle 1071.**

The **LapLink Remote Access** file transfer program is available from **Traveling Software,** 18702 North Creek Pkwy., Bothell, WA 98011, (800) 343-8080 or (206) 483-8088; fax (206) 487-1284. **Circle 1072.**

Master of Orion ($59.95), a game of stellar conquest with diplomacy, keeps growing on me. Contact **MicroProse,** 180 Lakefront Dr., Hunt Valley, MD 21030, (410) 771-1151; fax (410) 771-1174. **Circle 1073.**

Betrayal at Krondor ($69.95) is based on Ray Feist's Magician series, and it plays like reading a novel. Contact **Dynamix,** 1600 Millrace Dr., Eugene, OR 97403, (503) 343-0772; fax (503) 344-1754. **Circle 1074.**

You might hurt the **Everswitch** indestructible keyboard ($795) with a sledgehammer, but you'd have to work at it. Contact **Everswitch USA,** 12079 Tech Rd., Silver Spring, MD 20904, (800) 794-8243 or (310) 680-3100; fax (301) 680-9425. **Circle 1339.**

What's New Hardware

WATCH THE SHOP FROM YOUR MONITOR

The Model 722 PC Workmate ($525) lets you watch a live video in a window on your VGA display. From Telebyte Technology (Greenlawn, NY), the device incorporates a full multiband VHF/UHF/CATV tuner that can receive up to 70 channels of TV information. The PC Workmate also has direct video inputs for a VCR, a videodisc, a camcorder, or a surveillance

camera with a built-in speaker. The unit merges the VGA signal with the video signal and sends it to your monitor. You control the display mode, window position, video source, and channel from the front panel.

Phone: (800) 835-3298 or (516) 423-3232.

Circle 1279 on Inquiry Card.

DATA ACQUISITION VIA THE PARALLEL PORT

An analog-input and digital-I/O device, the Datashuttle (from $995) connects to desktop and portable PCs via the parallel port. A high-speed pass-through interface lets you continue to use your printer or modem. From Strawberry Tree (Sunnyvale, CA), the Datashuttle ships with Quicklog applications software for signal conditioning, logging, graphing, set-point and PID control, and alarms. The device has an accuracy of 0.005°C for thermocouple measurement. Since sensor terminals are integrated, you don't need a terminal panel. You can connect up to 15 units to one parallel port with the expandable unit.

Phone: (800) 736-8810 or (408) 736-8800.

Circle 1274 on Inquiry Card.

HIGH-SPEED IMAGING

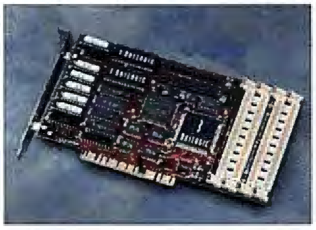
The Chromax 2400S graphics accelerator ($899) uses three S3 accelerator chips, each of which controls an 8-bit-color channel of 24-bit RGB color displays. Resolution goes up to 1280 by 1024 pixels with 16.7 million colors. From Umax Technologies (Fremont, CA), the card is available for ISA, VESA, and PCI systems. The 3-MB-DRAM ISA version is expandable to 6 MB; the standard VESA and PCI versions have 6 MB of DRAM built in. Built with the deluxe version of the AutoCAD driver, the Chromax 2400S provides a display list, a spyglass, real-time panning and zooming, a bird's-eye view, and on-line help. A virtual screen helps with the panning and editing of large pieces of artwork, and a monitor-calibration utility is available for gamma corrections.

Phone: (800) 562-0311 or (510) 651-8883.

Circle 1275 on Inquiry Card.

VESA AND PCI CACHE CONTROLLERS

The KT-410A VL-Bus ($175) and the KT-910A PCI ($255) IDE cache controller kits support four IDE drives, with a capacity of up to 4 GB each, and



two floppy drives. The cache, expandable from 512 KB to 16 MB, is composed of DRAM operating at 80 ns in 256-KB and 1- and 4-MB SIMMs. From BusLogic (Santa Clara, CA), each card has an IDE-disk data rate of 5 MBps, a system-bus data rate of 20 MBps, and an average disk seek time of less than 0.3 ms. In addition to supporting DOS and Windows, the cards provide 32-bit support for NetWare, OS/2, and Unix (SCO, Interactive, and AT&T). The KT-910A PCI controller is software configurable.

Phone: (408) 492-9090.

Circle 1280 on Inquiry Card.

INTEGRATED AUDIO ON A PCMCIA CARD

An audio PCMCIA card with its own high-fidelity speaker and a DSP chip, the Port•able Sound PCMCIA supports most programs written for Sound Blaster. The Type II PCMCIA card lets you record and play back CD-quality, 16-bit digitized voice, music, and sound. You can simultaneously play synthesized and digitized audio files. The card has built-in volume control, a jack for a second speaker, and a stereo headphone jack. The compact speaker is detachable. Cost is $279.95.

Contact: DSP Solutions, Palo Alto, CA, (916) 621-1787.

Circle 1271 on Inquiry Card.

CD MULTIMEDIA

Aztech Labs' (Fremont, CA) CDA 268-01A double-speed CD-ROM drive ($199) is MPC 2–compliant and features MDR (motorized disk return) technology, which eliminates the need for caddies and frees you from manual tray-loading. Compatible with Kodak's Multisession Photo CD software, the drive lets you view multiple photo-realistic images on your PC screen in DOS or Windows. The 630-MB drive has a data transfer rate of 300 KBps, an average access time of less than 380 ms, and a 64-KB internal buffer. Digital-audio output lets you play back 74 minutes of full-motion video from a 12-cm disk using video in CD format. You can also play your favorite audio CD while you're working in an application.

Phone: (510) 623-8988.

Circle 1277 on Inquiry Card.

FASTER PRINTING

An I/O PC card, the PowerPort ($59) from Buffalo Products (Salem, OR) increases the printing speed of your parallel printer, such as the Hewlett-Packard LaserJet 4, to as fast as 150,000 characters per second. Compatible with all ISA-bus PCs running DOS or Windows, the PowerPort plugs into any 8- or 16-bit slot on your computer's motherboard; it can use the LPT1 or LPT2 port address.

Phone: (800) 345-2356 or (503) 585-3306.

Circle 1276 on Inquiry Card.

PLUG-AND-PLAY NETWORK ADAPTER

The EtherGo network adapter ($99) from Alta Research (Deerfield Beach, FL) features a National Semiconductor AT/LANtic Ethernet controller with a custom ASIC that lets ISA cards support the Intel/Microsoft Plug and Play ISA specification. The adapter ships with a utility that provides automatic self-configuration for systems that do not support Plug and Play.
Phone: (800) 423-8535 or (305) 428-8535.
Circle 1278 on Inquiry Card.

A CROSS-PLATFORM, PAPER-DRIVEN SCANNER

With no on/off switch, the paper-driven PaperMax personal scanner is automatically activated and begins scanning when you insert paper into it. A typical typed page scans in less than 6 seconds, and the image immediately appears on your PC (running either DOS or Windows) or Mac screen on top of whatever application you're running. Image enhancement and compression during the scanning process produce a small, file-size image suitable for communication via fax or E-mail.

MaxMate software supports such image formats as PCX, BMP, TIFF, and PICT, in addition to its own file format. You can annotate scanned documents with "sticky notes" and highlight them with an electronic marker; annotations can be viewed across platforms. You can view, save, and print a MaxMate document received through E-mail regardless of the type of sending or receiving platform. The 2½-pound scanner fits between your keyboard and monitor. The unit costs $499.

Contact: Visioneer, Palo Alto, CA, (800) 787-7007 or (415) 812-6400.
Circle 1272 on Inquiry Card.

MULTIMEDIA ON A CARD

HiPerVideo 928Movie, which was developed in conjunction with IBM, combines a Windows graphics accelerator card with software movie acceleration, 16-bit audio, and a VESA Media Channel expansion option. From VideoLogic (Cambridge, MA), the card uses the company's Powerplay Digital Movie Accelerator, a custom ASIC that provides seamless integration of the video and PC graphics subsystems, enabling you to play back full-screen video at 30 frames per second. The VESA Media Channel connector supports a video data connection between peripherals, such as video-capture cards or MPEG playback devices, and the graphics subsystem.
Phone: (617) 494-0530.
Circle 1281 on Inquiry Card.

EASY SCSI CONNECTION

A 16-bit PCMCIA SCSI controller, the SCSI2Go (from $329) lets you easily add SCSI storage devices and I/O peripherals to your notebook or desktop computer with a PCMCIA Type II slot. From Future Domain (Irvine, CA), the card has SCSI-2 data transfer rates of up to 10 MBps and a 2-KB internal FIFO buffer. With the card installed, your system automatically reconfigures itself and installs the SCSI peripheral.
Phone: (714) 253-0400.
Circle 1282 on Inquiry Card.

PORTABLE CONNECTIONS TO TOKEN RING

Olicom's (Plano, TX) PCMCIA Adapter ($495) connects your notebook or laptop PC to token-ring networks via the PCMCIA Type II or Type III port on the PC. The adapter uses Olicom's PowerMac drivers and complies with the PCMCIA revision 2.0 specification. The adapter supports network operating systems such as NetWare and LAN Manager; it is compatible with DOS, Windows, and OS/2.
Phone: (214) 423-7560.
Circle 1283 on Inquiry Card.

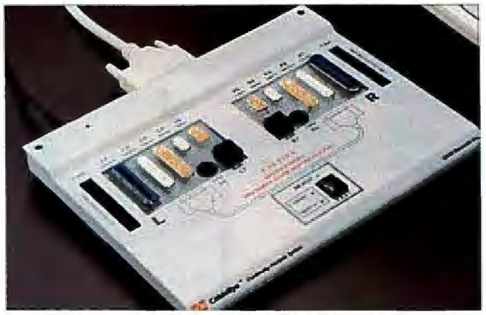
Xircom's (Calabasas, CA) CreditCard Token Ring Adapter and Pocket Token Ring Adapter III ($599 each) feature SmartRing software and a complete LAN-support program that supports most network operating systems. The 16-/4-Mbps CreditCard Token Ring Adapter fits into any PCMCIA Type II or III slot. The Pocket Token Ring Adapter III connects portable and desktop PCs to a 16-/4-Mbps token-ring network through the parallel port and supports enhanced parallel-port data transfers; its Phantom Power Cable powers the adapter directly from a PC's mouse or keyboard port. Both adapters include cable connectors for STP and UTP token-ring cabling.
Phone: (818) 878-7600.
Circle 1284 on Inquiry Card.

COMPUTER TALK ▼

A three-piece computer speaker system, the ACS3 ($200) from Altec Lansing (Milford, PA) consists of two self-powered, shielded satellite speakers and an amplified subwoofer. The subwoofer has a multipath chamber to enhance sound reproduction. Frequency response is 40 Hz to 20 kHz ±3 dB, and the signal-to-noise ratio is 78 dB. The system runs on AC power.
Phone: (717) 296-4434.
Circle 1285 on Inquiry Card.

The magnetically shielded CS-1400 speaker system ($149.99) from Labtec Enterprises (Vancouver, WA) is a 15-W RMS system with a 3-inch rolled-edge woofer and 2-inch alnico tweeters. The system's controls for volume, treble/bass, and balance are on the front of one speaker. Two line inputs are available for secondary source applications.
Phone: (206) 896-2000.
Circle 1286 on Inquiry Card. ▼

What's New Hardware



CABLE TESTER ▲
A PC-based cable tester with a graphical wiring display, the CableEye ($1495) from CAMI Research (Lexington, MA) features an internal cable database with descriptive notes, label-printing capability, hard-copy wiring output on laser or dot-matrix printers, and macro functions for unskilled operators. The system includes an expandable hardware-test fixture that links to your PC via a serial port.
Phone: (617) 860-9137.
Circle 1289 on Inquiry Card.

PERSONAL PRINTER
The OL410e ($899) from Okidata (Mount Laurel, NJ) is a compact, 4-ppm LED/laser printer with 600-dpi output. It includes 12 resident scalable fonts, 2 MB of RAM, and a RISC microprocessor that lets you print the first page of your document just 25 seconds after you turn on the printer. Parallel and serial interfaces with auto-switching let you connect the printer to any type of computer or allow two PCs to share a printer. A power-save mode automatically reduces power use to less than 15 W when the printer is inactive.
Phone: (609) 235-2600.
Circle 1287 on Inquiry Card.

FLEXIBLE SCANNER
ScanMan PowerPage ($799) is a compact, motorized, boardless scanner. You can use it as a sheet-fed, full-page scanner or detach the motorized scanning head from its base and use it as a hand-held scanner. From Logitech (Fremont, CA), the 256-gray-scale scanner is TWAIN- and OLE 1.0–compliant and has a 25- to 400-dpi resolution. Thresholding and dithering features automatically adjust text and image contrast to produce high-quality copies and faxes. Communication between the computer and the scanner is software controlled.
Phone: (510) 795-8500.
Circle 1288 on Inquiry Card.

TV-TO-PC INTERFACE
A video interface card that allows you to watch TV on your VGA monitor, Video Galaxy ($293) is compatible with major video standards and image file formats. From Aztech Labs (Fremont, CA), the 16-bit card provides live TV displays at a resolution of 1024 by 768 pixels in up to 16 million colors. An on/off TV timer lets you preset the TV to turn on at a specified time; a digital clock and preset status can be displayed on the VGA screen. The card, which accepts video from a TV, a videotape, a camcorder, or a laserdisc player, has four audio sources and allocates each video source to a specific audio source.
Phone: (510) 623-8988.
Circle 1291 on Inquiry Card.

LABEL AND BADGE PRINTER
A dedicated label printer, the P-Touch PC ($449) from Brother International (Somerset, NJ) lets you print images from your computer screen onto laminated adhesive labels. Mac- and PC-compatible, P-Touch PC can print most combinations of on-screen fonts, graphics, bar codes, and company logos. P-Touch PC can do thermal-transfer printing and import bit-mapped graphics, as well as print mailing labels with the option of automatically printing the date and time on each label. The unit supports ATM and TrueType fonts and includes more than 250 scalable symbols.
Phone: (908) 356-8880.
Circle 1292 on Inquiry Card.

INTERNAL FAX MODEM
A V.32bis/V.42bis fax modem card, the T/PortModem 1440PT ($299) sends and receives data or faxes in the background while you work on your PC. The Telcor Systems (Natick, MA) card has a coprocessor, 14 KB of transmit buffer, and 16 KB of receive buffer dedicated to the management of the modem/PC-bus serial interface, which permits data transfer rates of up to 115.2 Kbps. The Hayes-compatible modem supports existing DOS communications software and does not use IRQ lines or DMA channels in Windows.
Phone: (508) 653-3995.
Circle 1293 on Inquiry Card.

HEAT ALERT ▲
The 110 Alert alarm ($29) signals when your computer's internal temperature reaches 110°F; when the temperature drops back below 110°F, the alarm shuts off. From PC Power & Cooling (Carlsbad, CA), the device uses a thermistor to monitor the temperature. Compatible with any computer, the device connects to an unused drive plug.
Phone: (619) 931-5700.
Circle 1290 on Inquiry Card.

NETWORK-PERIPHERAL SHARING
The Print Server Plus PS-4 series (from $595) enables you to share modems and printers on your Ethernet or token-ring network. The BayTech (Bay St. Louis, MS) units support up to 32 queues on as many as 32 file servers; they can support four peripherals. The print servers provide continuous parallel printing speeds of 100,000 characters per second and serial printing speeds of 46,000 cps; they support asynchronous speeds of up to 460,000 bps. You can control your printers remotely and are notified of printer errors and form changes.
Phone: (601) 467-8231.
Circle 1294 on Inquiry Card.

TALK AND SEND DATA, TOO

The enhanced MT1932PCS MultiModem ($949), which is based on V.32terbo technology, has a Talk Anytime feature that activates voice-over-data communications whenever the handset is picked up. From Multi-Tech Systems, the voice/data/fax modem operates at 16.8 Kbps and 19.2 Kbps. When you use Talk Anytime, you can switch to simultaneous voice-over-data mode without having to configure the modem.

Contact: Multi-Tech Systems, Mounds View, MN, (800) 328-9717 or (612) 785-3500.
Circle 1273 on Inquiry Card.

Winner 1994 USA

A Winner of the Best Value!

JANUARY 1994 BYTE BEST VALUE GENERAL BUSINESS COLOR MONITOR

"KFC packs quite a lot into this $495 product. The 15-Inch CA 1507 offers resolutions as high as 1280 by 1024 pixels at 60 Hz noninterlaced.... The monitor provides a full set of image-adjustment controls, including pincushion, image rotation, and power management. It uses the VESA DPMS power management control signals to meet Energy Star requirements."

"The CA1507 offers controls that let you adjust image size and position, correct image tilt and pincushioning, recall factory mode settings, and set the power down delay interval.... Its image-quality score was well above average."

- BYTE Magazine, January 1994 -

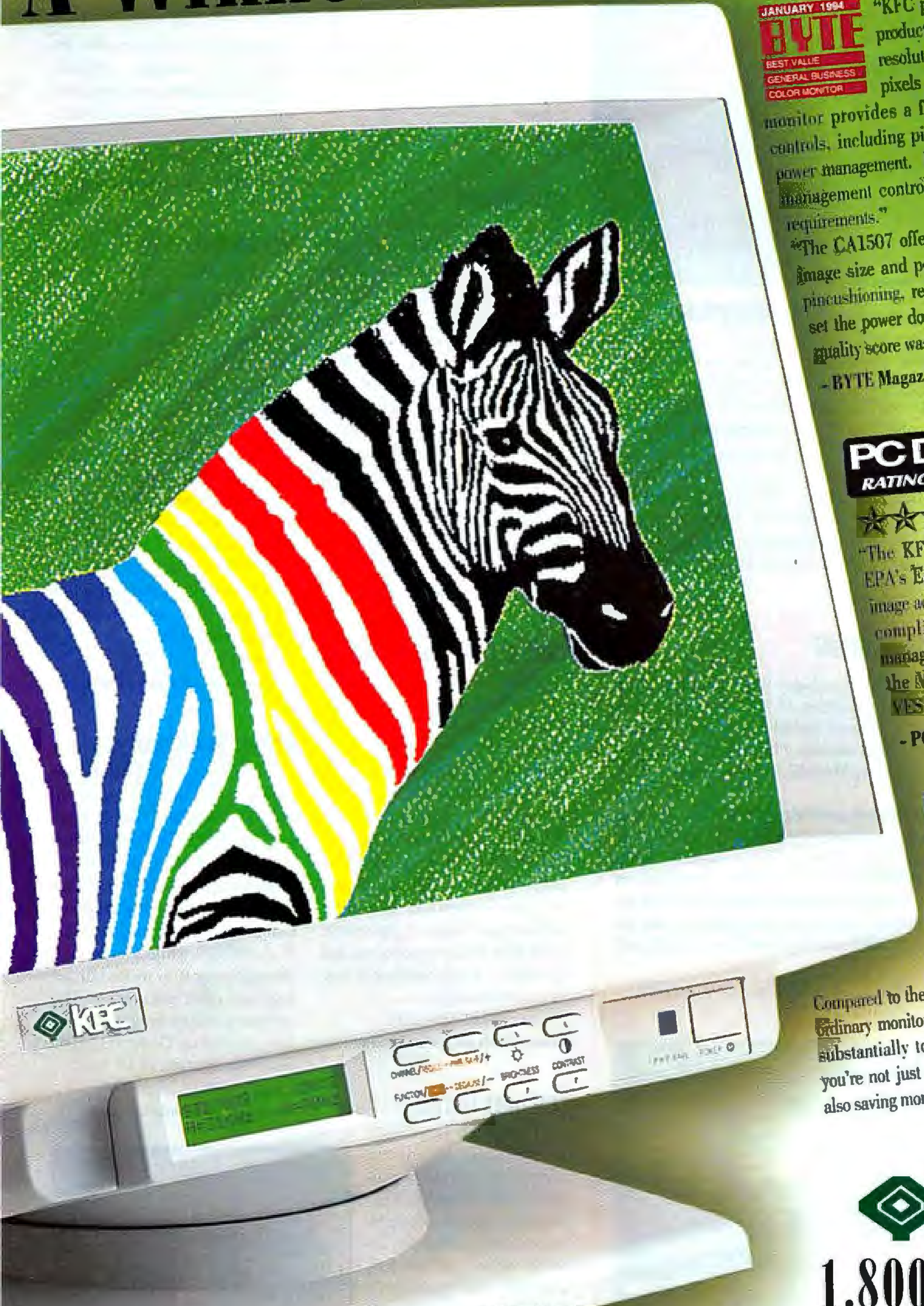
PC Digest RATINGS REPORT

★★★★ Recommendation

"The KFC CA 1507, recipient of the EPA's Energy Star, offers a full range of image adjustment controls. This monitor complies with the DPMS power management standards suggested by the VESA and will work with any VESA-compliant computer."

- PC Digest, November 1993 -

KFC's new green monitors consume less than 1.5 Watts when inactive, and less than 20 Watts when on stand-by. Compared to the average of 85~100 Watts for an ordinary monitor, each KFC monitor contributes substantially to a greener environment. And you're not just sharing the contribution, you're also saving money.



CA1718 was the Best Value Runner-up for Spreadsheet & Graphics Color Monitor in BYTE Magazine's January 1994 BYTE/NSTL Lab Report. CA1507 (picture not shown) was awarded the "Best Value: General Business Color Monitor" by BYTE Magazine in January 1994 BYTE/NSTL Lab Report.

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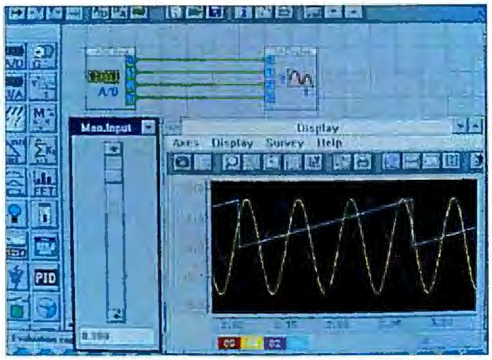
Circle 109 on Inquiry Card.

What's New Software



DATA ACQUISITION ▶

Icon-based applications software for data acquisition, Workbench for Windows ($995) is targeted toward scientists and engineers. From Strawberry Tree (Sunnyvale, CA), the program doesn't require any programming. The Windows environment enables special graphics and live dynamic data export to other DDE-compatible programs. Optional modules, such as FFT/filtering and advanced mathematics, are planned.
Phone: (408) 736-8800.
Circle 1302 on Inquiry Card.

VISUAL DEVELOPMENT

VIA/Visual Information Assistant for Windows (from $295) is an object-oriented application development tool that lets you design an information structure by integrating data from disparate sources. From Applied Logic Programming (Wynnewood, PA), the software accesses data by launching applications or via DDE and DLL mechanisms. It provides hypertext, hyperdata, and hyperquery search and reporting capabilities.
Phone: (215) 649-4740.
Circle 1321 on Inquiry Card.

IMAGING TOOL

An imaging extension to the KIPP Advanced Developers Toolkit, Kofax Mark Sense Detection ($995) permits real-time recognition of check marks, signatures, and other markings on scanned documents. From Kofax Image Products (Irvine, CA), the tool helps businesses route and process forms and other documents by extracting data related to hand-entered markings. You can incorporate the tool into any application that you've developed using the KIPP toolkit.
Phone: (714) 727-1733.
Circle 1307 on Inquiry Card.

CALCULATE TO THE NTH POWER

A programming language with symbolic math-processing capability, Nth ($129) from Nth Power Software (Adair, OK) operates in 32-bit protected mode for full use of available RAM. Among the 11 built-in data types are multiple precision numbers, polynomials, multivariate rational polynomials, and vectors and matrices. Examples of source code include Sturm's algorithm, resolution via list processing, and the Nth root of a number to any degree of accuracy.
Phone: (918) 789-2734.
Circle 1308 on Inquiry Card.

SOFTWARE TESTING

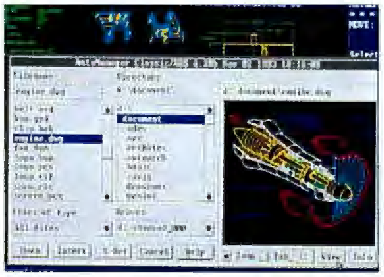
Vermont High Test ($495) automatically records test scripts as you run a program. After recording keystrokes, mouse events, screen images, and the internal details of window controls, the interactive Suite Manager joins the test scripts into test suites. The Suite Manager also creates script hierarchies and sets up loops for multiple script execution. The package is from Vermont Creative Software (Richford, VT).
Phone: (802) 848-7731.
Circle 1303 on Inquiry Card.

MOTION SIMULATION

Working Model ($995), a motion-simulation package from Knowledge Revolution (San Francisco, CA), provides Windows workers with a cross-platform engineering solution for motion analysis. You can create mechanical systems on your PC screen by graphically building objects or importing them from a CAD program. During a simulation, a simulation engine mathematically calculates the objects' motion from their assigned physical properties and displays their movement in smooth animation.
Phone: (415) 553-8153.
Circle 1320 on Inquiry Card.

BROWSE IN AUTOCAD ▼

A file-viewing utility that runs inside AutoCAD by means of the ADS interface, AutoManager Classic/ADS ($95) displays 15 file formats and provides file-importing capabilities into AutoCAD. The Cyco International (Atlanta, GA) utility lets you stay in AutoCAD while you browse through your files to find drawings and other documents. The software views most graphics files, including Generic CADD and MicroStation DGN files.
Phone: (404) 634-3302.
Circle 1305 on Inquiry Card.



POWER TOOLS FOR IMAGING

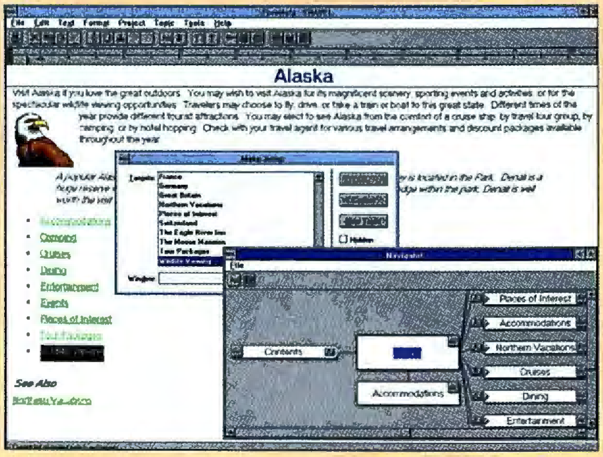
Kai's Power Tools for Windows includes 33 filters and extensions for expanding the capabilities of Windows image-manipulation programs that support the Adobe standard plug-in architecture. Such programs include Photoshop, Fauve Matisse, Fractal Design Painter, PhotoStyler, and Picture Publisher Plus.

The Texture Explorer lets you generate an unlimited selection of textures, backgrounds, and materials that you can apply to images, text, backgrounds, or objects. The Gradient Designer allows the use of up to 500 colors at any time. Gradients on Paths wraps any blend around a free-form user path or text selection; the Julia Sets fractal explorer lets you generate and explore using fractals or zoomed fractal segments for masking and mapping. $199.

Contact: HSC Software, Santa Monica, CA, (310) 392-8441.
Circle 1296 on Inquiry Card.

What's New Software

HELP-AUTHORING FOR WINDOWS



A self-contained development environment, ForeHelp lets you view, create, change, and move through your help projects in the actual visual and functional help setting. ForeHelp supports all Windows 3.1 help features, such as hot spots in text and graphics and macros. An error-detection and resolution facility during the build process lets you jump directly to an error location without having to decipher cryptic help-compiler error messages. Cost is $395.

Contact: ForeFront, Boulder, CO, (303) 499-9181.

Circle 1297 on Inquiry Card.

NETWORK MANAGEMENT

ONdemand Network Control System for Windows (portable version, $895; desktop version, $2995) manages ONline System Concentrators and related network modules. From Chipcom (Southborough, MA), ONdemand NCS for Windows can manage hundreds of users on multiple Ethernet, token-ring, and FDDI networks. The desktop version has graphical point-and-click control, menu forms, and presentation tools for managing all Chipcom devices from a PC.

Phone: (508) 460-8900.

Circle 1304 on Inquiry Card.

MANAGE CD TITLES IN WINDOWS AUTOMATICALLY

Visual CD ($69.95) from Meridian Data (Scotts Valley, CA) automates the installation, management, and operation of multimedia CD-ROM titles in Windows. After you insert a disc, the program scans and identifies it, adding it to a library that lists all your titles. When you open Visual CD, your titles and a toolbar are displayed; you can click on any title to review the contents of the disc and use the toolbar to enlarge photos, listen to audio, or review data.

Phone: (408) 438-3100.

Circle 1306 on Inquiry Card.

PARTICIPATE BEHIND THE SCREEN

Crystal Walls 1.0 ($69.95) from Domain Virtual Worlds (Seattle, WA) uses 3-D animation to create virtual worlds behind your PC screen. You can see and interact with the animated characters in the virtual worlds, and they can continue their interactions while you work in your application.

Phone: (206) 328-7200.

Circle 1311 on Inquiry Card.

OS/2 TOOLS

The GammaTech Power Pack for OS/2 ($69.95) from SofTouch Systems (Oklahoma City, OK) provides tools that help you get more power from your system. The package includes the Extended Attribute Editor, which lets you examine, create, alter, and delete extended attributes on files and directories; the .INI File Editor, which lets you add, delete, and update OS/2 INI files; and a Hot Key feature that lets you define hot-key combinations.

Phone: (405) 947-8080.

Circle 1300 on Inquiry Card.

SHIPPING SOFTWARE

The DOS-based Ship It package ($199.95) from PoinTex (Walnut, CA) comprises a UPS manifest module, a bar-coding module, and a solar calculator. The manifest module produces UPS-approved items such as shipping manifests, COD tags, billing summaries, and shipping labels. The module also provides a detailed daily record of what you ship, where you ship it, and the shipping charges you incur. The bar-coding module lets you enter the numbers, name, and a brief description for any item to which you want to assign a bar code; it then generates the bar code.

Phone: (909) 594-6321.

Circle 1309 on Inquiry Card.

DATA TYPES FOR VISUAL BASIC

Baldar's Data Type Functions for Visual Basic ($49) supports data-type functions for Visual Basic by making available functions such as MKI$, CVI, MKD$, and CVD. From Baldar (Berkeley, CA), the software lets you design data-type records while your program is running and import programs written in other Microsoft Basic languages without reworking any code or logic.

Phone: (800) 367-0930 or (510) 841-2474.

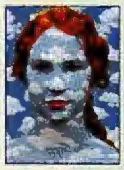
Circle 1301 on Inquiry Card.

Software Update

ImagePals 2, U-Lead Systems (Torrance, CA), provides cataloging for all media types; expanded search capabilities with keywords, subjects, and marks; file conversion for raster and vector formats; additional special-effects filters; interdocument cloning; a global viewer; and multimedia slide-show capabilities. $249.

Phone: (310) 523-9393.

Circle 1323 on Inquiry Card.



HiRes QFX, Ron Scott (Houston, TX), deletes the hardware key; expands Bitmap Object support; and adds image-warping, full-screen editing for video applications, object-file import and export, and function queuing for batch operations. $1000.

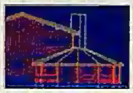
Phone: (713) 529-5868.

Circle 1324 on Inquiry Card.

XPost 3.0 P, LANtec (Provo, UT), features a multitasking, menu-driven, modular Windows GUI; NetPhone; message compression on storage and forwarding; ascending and descending messaging order; application launching under DOS and Windows; message priority rating; and E-mail environment customization. $99.95.

Phone: (801) 375-7050.

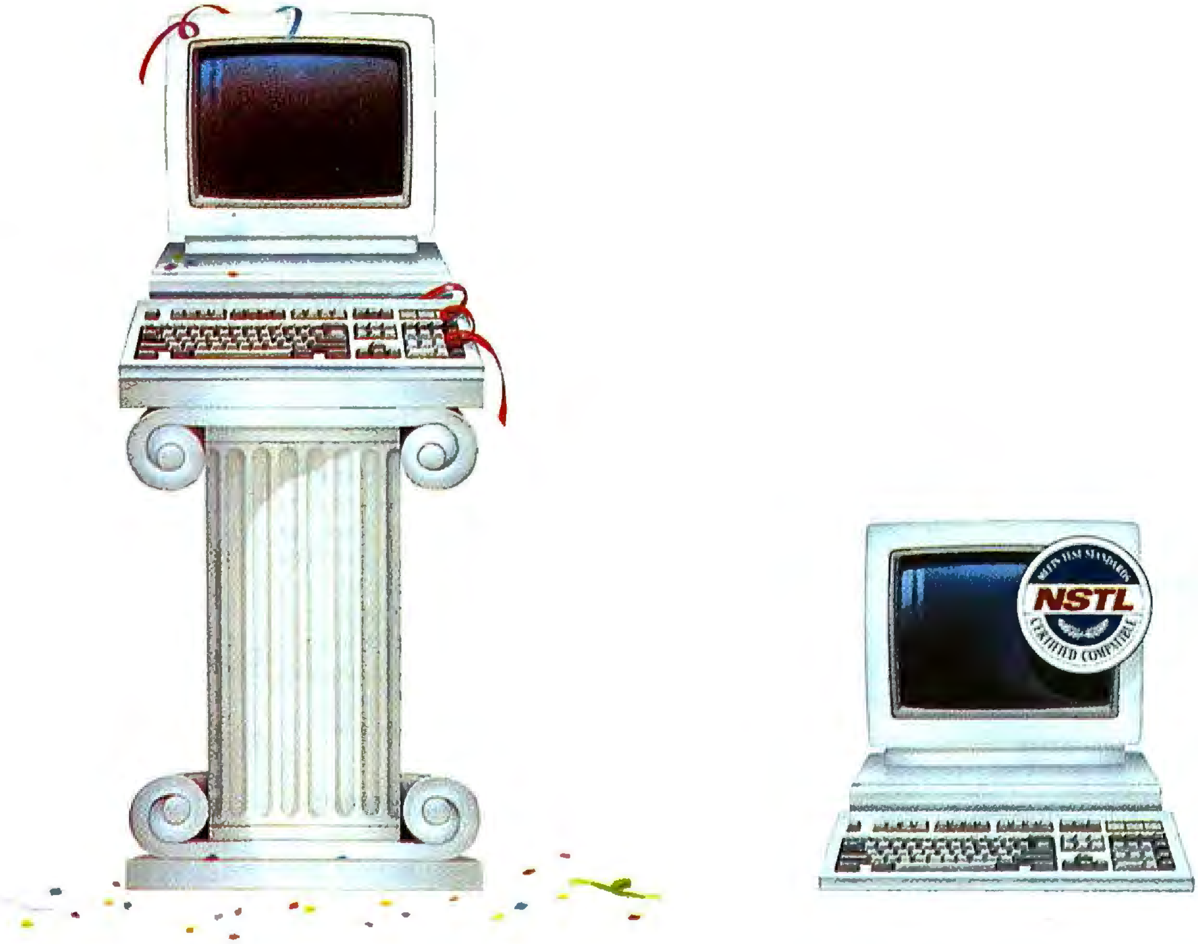
Circle 1325 on Inquiry Card.



AutoSketch release 2 for Windows, Autodesk (Sausalito, CA), enhances the interface, expands CAD functionality, adds drawing tools, increases compatibility with AutoCAD and AutoCAD LT, and enables more accurate importing and exporting. $299.

Phone: (206) 487-2233.

Circle 1326 on Inquiry Card.



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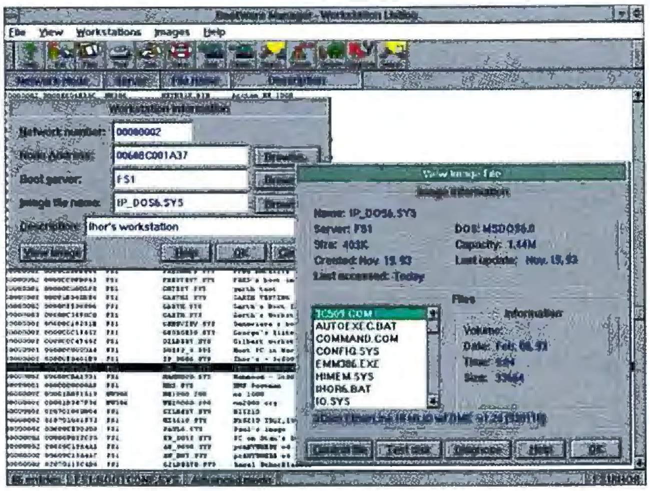
What's New Software



CENTRALIZED LAN BOOT FILES

A Windows-based integrated management tool, BootWare Manager ($259) lets network administrators create, edit, update, and diagnose centralized workstation boot files from a single location. You can create boot files from boot disks by modifying existing boot files or from control files that you define. An NLM directs BootWare ROMs to boot from a specific file server and image file. The package is from Lanworks Technologies (Mississauga, Ontario, Canada).
Phone: (905) 238-5528.
Circle 1310 on Inquiry Card.

TOOLS FOR VISUAL BASIC

XRef for Visual Basic ($99) is a cross-reference developer's tool for fully documenting an application you've written using Visual Basic. From Crescent Software (Ridgefield, CT), the utility lists all forms, controls, properties, events, methods, variables, arrays, constants, and procedures alphabetically by type and scope. The tool reads all source code associated with a program and then parses the individual program symbols into tables.
Phone: (800) 352-2742 or (203) 438-5300.
Circle 1314 on Inquiry Card.

VB ProjectWorks 1.0 (from $295) is a project management and version-control system for developers using Visual Basic. From The Young Software Works (Cooper Station, NY), the package provides a complete set of project-oriented version-control features and lets multiple developers work on a single Visual Basic project. Parallel development and file sharing allow users to work on multiple lines of development simultaneously without one line interfering with another. Projects or files can be merged to combine the changes made in different projects or in separate branches.
Phone: (212) 982-4127.
Circle 1315 on Inquiry Card.

TrueGrid Pro ($129) lets programmers using Visual Basic create in-cell editable and configurable database browse tables without writing code. From Apex Software (Pittsburgh, PA), the data-aware grid supports all database formats that Visual Basic recognizes. Just drop a TrueGrid on a Visual Basic form and set the DataSource property, and your fully functional table is created. A split bar lets you split a TrueGrid into independent grids.
Phone: (412) 681-4343.
Circle 1316 on Inquiry Card.

SELF-BOOTING DIAGNOSTICS

PC Diag ($149.95) from Unicore Software (North Andover, MA) is a self-booting diagnostic software package that runs independently of an operating system. It performs complete system testing, including memory, video, drives, keyboard, math coprocessor, and ports. It has both a CMOS and a boot-disk-partition save-and-restore feature.
Phone: (508) 686-6468.
Circle 1319 on Inquiry Card.

NETWORK WINDOWS MANAGEMENT

An automated file management system, AutoEDMS for Windows lets you jump from AutoCAD to Excel to Word while it keeps track of every drawing, document, and file you use. The software can directly manage, view, and print over 100 types of files. It includes a screen painter and database designer that lets you graphically design database screens and fields. AutoEDMS for Windows supports the leading network operating systems. Cost is $895 for a two-user starter kit.

Contact: ACS-Telecom, Lomita, CA, (310)325-3055.
Circle 1298 on Inquiry Card.

Software Update

Designworks 2 for Windows, GST Software (Falls Church, VA), includes custom shape tools, new text features, an RGB color-mixing dialog box, a redesigned user interface, a snapshot utility, a Clip Art and Photo CD browser, a keypad/font utility, and OLE 2.0 support. $199.95.
Phone: (800) 236-1062 or (703) 560-2354.
Circle 1327 on Inquiry Card.

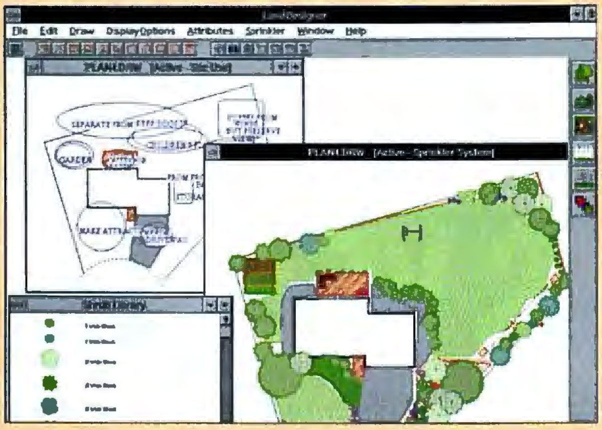
ReportSmith 2.0, ReportSmith (formerly Indigo Software, San Mateo, CA), adds query and interface improvements, more than 100 reporting features, OLE 2.0 support, and improved performance. $299.
Phone: (415) 312-0770.
Circle 1328 on Inquiry Card.

ReachOut Remote Control 4.0, Ocean Isle Software (Vero Beach, FL), adds full support for Windows and DOS, TCP/IP, and high-resolution monitors. $179; network version, $295.
Phone: (800) 677-6232 or (407) 770-4777.
Circle 1329 on Inquiry Card.

DS Lab 2.1, DS Group (Greenwich, CT), supports additional graphical formatting and data-manipulation features; adds functions such as depreciation, VLOOKUP, HLOOKUP, and day of week; and enhances selective password protection for graphical layouts, all elements, and model parameters. $295.
Phone: (203) 861-1833.
Circle 1330 on Inquiry Card.

AM/5, Intelligent Environments (Tewksbury, MA), adds component programming, which lets developers with different programming knowledge work together to build applications. $5000 per server.
Phone: (508) 640-1080.
Circle 1337 on Inquiry Card.

Become a Landscape Designer



LandDesigner for Windows lets you quickly and easily create professional-looking landscaping plans for up to 170 acres. With the CAD software you can create gardens, lawn areas, walkways, and sprinkler systems using the more-than-300 predrawn graphical symbols and the drawing and drafting tools. The program has a fully modifiable plant database that you can search according to any combination of 14 characteristics, such as sun, soil, and water requirements. A grow option lets you view your landscape as it matures; optional regional plant libraries are based on USDA growing zones. Cost is $99.

Contact: Green Thumb Software, Boulder, CO, (800) 336-3127 or (303) 499-1388.

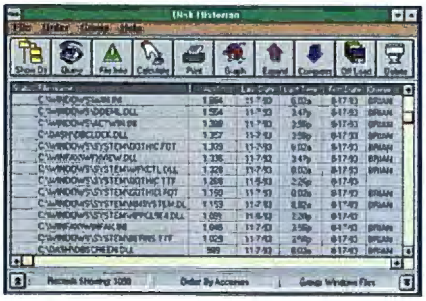
Circle 1299 on Inquiry Card.

CLEAN UP YOUR HARD DISK ▼

Disk Historian ($129.95), from Solid Oak Software (Santa Barbara, CA), is a Windows-based maintenance program that continually monitors the use of all files on your system that run under DOS or Windows. The tool provides up-to-date statistics for each file regarding the number of accesses; date and time of last access; date of first use; age; size; and days since last used. You can build ad hoc database queries; compress, delete, and migrate files; and calculate potential disk-space recovery.

Phone: (800) 388-2761 or (805) 967-9853.

Circle 1322 on Inquiry Card.



PEN-BASED TEXT RETRIEVAL

Isys for Pen ($395) is a pen-based text-retrieval program that enables you to quickly and easily access information on your pen-based computer. With the Odyssey Development (Denver, CO) program, you can specify a given phrase or set of words to search for within a particular database of documents. Search parameters include word, word in paragraph, word association, word exclusion, concept, document, and multiple association. You can port the searched text to your word processing application.

Phone: (800) 992-4797 or (303) 394-0091.

Circle 1312 on Inquiry Card.

LINK NETWARE TO UNIX AND NT

Server software that provides seamless file and print sharing between NetWare workstations and either Solaris or Windows NT, MultiConnect IPX (from $849 for five users) has its own NetWare IPX/SPX protocol stack. The stack is implemented as loadable drivers and provides connectivity at the kernel level. From Beame & Whiteside Software (Raleigh, NC), MultiConnect IPX provides you with full file services. Support for multidirectional printing allows NetWare clients to direct print output to Solaris- or NT-supported print devices or to other NetWare print servers on your network.

Phone: (919) 831-8968.

Circle 1313 on Inquiry Card.

PARADOX FOR WINDOWS UTILITY

The ezDoc for Paradox ($99) documentation utility from Woll-2Woll Software (San Jose, CA) provides visual and text documentation for forms, reports, scripts, libraries, tables, and queries for Paradox for Windows. Reports include the ability to view, print, and scale the object tree and the data model. You can print the form window in data, design, or cross-reference mode; the visual cross-reference of all user-interface objects lets you quickly see where each object is on the form. Text-based reports are dynamically linked to a user-specified editor to enable you to globally search for character strings within forms.

Phone: (408) 293-9369.

Circle 1317 on Inquiry Card.

Software Update

SQA TeamTest 2.5, Software Quality Automation (Woburn, MA), offers specialized support for the PowerBuilder object-oriented development environment, which allows automated test procedures written in SQA TeamTest to directly see into PowerBuilder-unique objects; and extends SQA's Object Oriented Recording technology. $1495 per license.

Phone: (617) 932-0110.

Circle 1331 on Inquiry Card.

Media 100 1.1, Data Translation (Marlborough, MA), features PAL compatibility, Audio Scrubbing, improved disk-space management and error handling, and full program export to QuickTime. $11,995.

Phone: (508) 460-1600.

Circle 1332 on Inquiry Card.

Z-Mail 3.0. Z-Code Software (San Rafael, CA), features MIME support, localizable international support, directory-services access, remote-mail capabilities, configuration capabilities, and hypertext on-line help. $295 for one user; $1395 for 13 users.

Phone: (415) 499-8649.

Circle 1333 on Inquiry Card.

Pacific DirectNet 2.0, Pacific Data Products (San Diego, CA), adds EtherTalk support and an SNMP agent to provide real-time status updates for Unix users. From $399.

Phone: (619) 625-3663.

Circle 1334 on Inquiry Card.

AccuMail 3.0, Group 1 Software (Lanham, MD), includes a new Windows version and an easier-to-use and easier-to-learn DOS GUI version, both on one CD-ROM disc. $295 per quarter; $1095 per year.

Phone: (800) 368-5806 or (301) 731-2300.

Circle 1335 on Inquiry Card.

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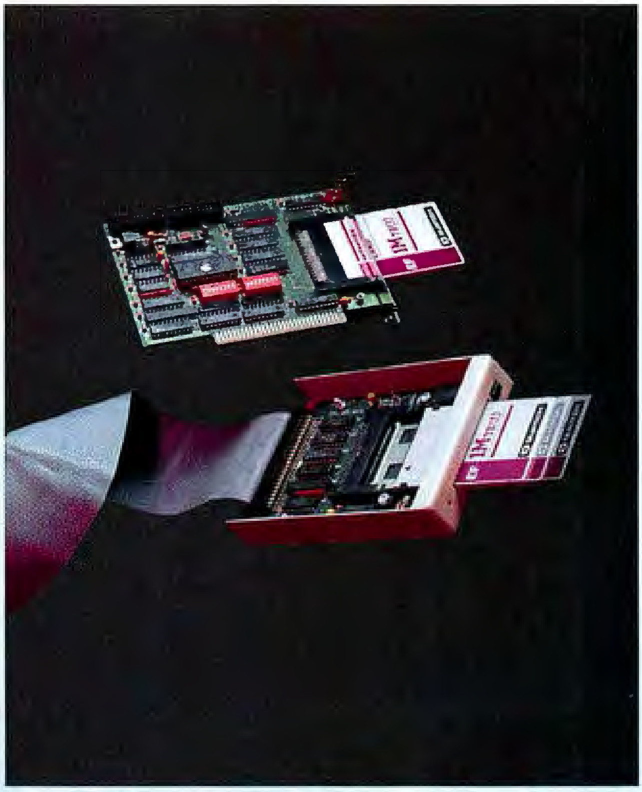

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INTEL OVERDRIVE 16/20MHZ 299.44
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INTEL OVERDRIVE 33MHZ 499.55
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KINGSTON SX/NOW 33MHZ 198.25
KINGSTON 486/NOW 25MHZ 329.76
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ACTIONNOTE 4000 80MB 1699.50

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INTEL 287XL 84.88
INTEL 387SX 16/20/25MHZ 78.84
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CACHE MEMORY

	12NS	15NS	20NS	25NS
8Kx8	–	6.50	6.00	5.50
32Kx8	28.00	9.00	8.00	7.00
64Kx1	–	11.00	9.00	8.00
64Kx4	–	11.00	9.00	8.00
16Kx4	–	8.00	7.00	6.00
128Kx8	–	–	49.00	36.00

Individual D-RAM Chips

MEMORY FOR IBM & APPLE

	60NS	70NS	80NS	100NS
1Megx1	7.35	7.25	6.75	4.95
1Megx4	35.00	29.00	27.00	–
1Megx4 (Zip Pack)	27.00	25.00	23.00	–
256 x 4 (Video Zip)	–	–	11.95	10.98
256x4	7.95	6.95	–	–
256 x1	3.00	2.75	2.50	2.25
256 x16VRAM	–	39.00	39.00	–
64x4	–	–	3.25	–
64x1	–	–	–	2.00

INTEL Math Chips

8087	45.00
8087-2	49.00
8087-1	85.00
80287-XL	55.00
80387-16 DX	45.00
80387-20 DX	55.00
80387-DX (Does All)	79.00
80487-SX (Does All)	309.00
Intel SX (Does All)	79.00
Intel SL Mobil	85.00
Intel 16SX	49.00
Intel 20SX	54.00

AMBRA

Ambra Pentium-60	4/8/16 Meg	CALL
Ambra 54540SL	4/16 Meg Kit	CALL
Ambra Sprinta 386, Hurdla 386SX Enterprise 386 Slim	2/8 Meg Kit	CALL
Ambra Sprinta, Hurdla & Enterprise 486	4/16 Meg Kit	CALL
Ambra NC 425SL	2/4/8 Meg	109.00/209.00/449.00
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Ambra SN Series	4/16 Meg	189.00/829.00

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CX486 DRx²-25/50 ....359.00
CX486 DRx²-33/66..........CALL
CX486 SRX2 16/32........249.00
CX486 SRX2 20/40........249.00
CX486 SRX2 25/50........279.00

SIMM MODULES (Add $5.00 for SIPP)

	40NS	50NS	60NS	70NS	80NS	100NS
1Meg x 9 (3 chip)	55.00	55.00	42.00	41.00	40.00	–
1Meg x 9 (9 chip)	60.00	59.00	49.00	48.00	46.00	38.00
4Meg x 9	–	–	165.00	159.00	149.00	–
16Meg x 9 (9 chip)	–	–	–	799.00	–	–
16Meg x 9 (36 chip)	–	–	–	–	–	–

72 PIN SIMMS (EISA)

256 x 36 1Meg	–	–	–	–	59.00	–
512 x 36 2Meg	–	–	–	89.00	84.00	–
1 x 36 4Meg	–	–	190.00	180.00	175.00	–
2 x 36 8Meg (w/pal)	–	–	359.00	389.00	409.00	–
2 x 36 8Meg (w/o pal)		–	359.00	449.00	449.00	–
4 x 36 16Meg		–	689.00	649.00	649.00	–
8 x 36 32Meg	–	–	1549.00	1499.00	–	–
16 x 36 64Meg	–	–	CALL	3516.00	–	–

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AST MEMORY

MODEL	AMT. UPGRADED	AST PART #	PRICE
Bravo LC 4/25S, 4/33, 433S, 4/50d, 4/66d	2Meg	500987-001	CALL
	4Meg	500987-002	179.00
	8Meg	500987-003	419.00
	16Meg	500987-004	819.00
	32Meg	500987-005	1399.00
Premium 486/25, 25E, 33, 33E			
Premium 386/33TE, 486/25TE, 33TE			
Prem. Serv., Prem II 386SX/20, 25			
Prem. II 386/25, 386/33, 486/33, 486SX/20	8Meg	500780-001	398.00
Premium 386/33T, Prem. 386SX/16			
Prem. II 386SX/20, 25		500780-004	189.00
Premium 386/25, 33, 386/33T, 386SX/16		500780-003	59.00
Prem. II 386SX/20,25		500780-001	59.00
Premia	8Meg	501159-002	379.00
Premia	16Meg	501159-003	789.00
Premia	32Meg	501159-004	1486.00
Premia	64Meg	501159-005	3111.00

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	AST PART #	PRICE
Z386/33, 25, 20, 33E	1Meg	ZA3800ME	59.00
Z386/33, 25, 20, 33E, 486/25E	4Meg	ZA3800MK	180.00
Z386SX	2Meg	Z-605-1 modules	119.00

MAGNAVOX

286/386SX-16, 386SX-20, 486SX-20 & 386-33 all are 72PIN SIMM
1MEG – 59.00 4MEG – 180.00 8MEG – 409.00 16MEG – 659.00

MEMORY BOARDS

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16 BIT MEMORY BD. FOR 286, 386 AT • 0K-8Meg Bd. 4.0 LIM Compat. • New 5 Yr. Warr. Convent., Expnd. & Extnd. Memory • Supports DOS, OS/2, LIM/EMS & EEMS • Versatile Split Memory Addressing • Operates w/CPU Speeds to 33 MHz • Supports Desqview, Multitask operations • ***Bd. made by Boca Research, AT plus***
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0-K – **$99.00** 1Meg **$179.00** 2Meg – **$219.00**

IBM P/S2 32BIT EXPANSION BD.

0-32Meg. Ext.-Expnd. Memory Bd. for P/S2 70, 80, 90, Lim 4.0

0Meg	2Meg	4Meg	8Meg	16Meg	32Meg	64Meg
$139.00	$238.00	$319.00	$499.00	$859.00	$1599.00	CALL

PS/2 MCA 0-8MEG EXPANSION BD.

0-8Meg Extended and/or Expanded Memory for all IBM P/S2 Models 50, 50Z, 60, 55SX, 65SX, 16 Bit, 4.0 LIM Compat.
0K – **119.00** 2Meg – **199.00** 4Meg – **269.00** 8Meg – **439.00**

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IBM PS/1, PS/2 MEMORY MODULES

IBM PART NO.	WORKS WITH MODEL NO.	PRICE
30F5348 (512K)	30-286	37.00
30F5360 (2Meg)	30-286, 25-286 50 MTHR BD	104.00
6450375 (1Meg)	80-041	79.00
6450379 (2Meg)	80-111, 311-121, 321, 081, 161	84.00
6451060 (4Meg)	80-A21, A-61, 80-A31, 80-111, 80-311	189.00
6450604 (2Meg)	70 061, E61, 121, 50Z, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	89.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
78X8955 (128K)	25	35.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 56LS, 65LS	180.00
87F9977 (4Meg)	55SX, 56LS, 65SX, 40SX, 35SX, 35LS	180.00
1057035 (512K)	P/S1-286	49.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	98.00
92F9694 (4Meg)	P/S1 & P/S1/386SX, Model-2121	189.00
6450902 (2Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	90.00
6450128 (4Meg)	57SX, 90, 95, P-75, 57SLC, 56, 56SLC, P/S1, 386SX, Mod-2123, 2133, 2155, Val Pt 77, 486CS2, 486SX, SVR85 Value Point 77 486DX2, 486SX, SVR 85	175.00
6450129 (8Meg)	35SX, 40SX	379.00
6450130 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	379.00
4010 (16 Meg kit)	RISC System/6000	769.00
4033 (32 Meg kit)	RISC System/6000	1699.00
4036 (64 Meg kit)	RISC System/6000	3319.00

IBM NOTEBOOK & LAPTOP MEMORY

79F0999 (2Meg)	LX40, N33SX, PS Note	103.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Thinkpad 350, 350c	199.00
79F1001 (8Meg)	LX40, N33SX, PS Note	349.00
07G1826 (2Meg)	N51 (all)	103.00
07G1827 (4Meg)	N51 (all)	199.00
07G1828 (8Meg)	N51 (all)	419.00
53G6958(2Meg)	Thinkpad 710T	CALL
53G6959(4Meg)	Thinkpad 710T	CALL
53G6960(8Meg)	Thinkpad 710T	CALL
07G1414 (2Meg)	Thinkpad 750, 750c	119.00
07G1415 (4Meg)	Thinkpad 750, 750c	214.00
07G1416 (8Meg)	Thinkpad 750, 750c	419.00
66G0094 (16Meg)	Thinkpad 750, 750c	959.00
07G1420 (4Meg)	CL57LSX LpTp. Thinkpad 700, 700C, 720, 720C	214.00
07G1421 (8Meg)	CL57LSX LpTp. Thinkpad 700, 700C, 720, 720C	419.00
60G0378 (8Meg)	Thinkpad 350, 350c	359.00
60G0379 (16Meg)	Thinkpad 350, 350c	679.00
92F8804 (2Meg)	N45SL	109.00

COMPAQ MEMORY MODULES

MODEL	AMT. UPGRADED	CMPQ PART #	PRICE
DeskPro 386/33, 386/33L, 486/25, 486/33L, 486/50L, System Pro	2Meg Module	115144-001	109.00
	8Meg Module	116561-001	429.00
	32Meg Module	116568-001	1459.00
DeskPro 386/33L, 486/33L	(Exp Bd)	116569-001	279.00
DeskPro 386/25, 386/20	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	219.00
DeskPro 386S-16Mhz	1Meg Exp Bd	113633-001	149.00
	4Meg Exp Bd	113634-001	329.00
	1Meg Module	113646-001	79.00
	4Meg Module	112534-001	219.00
DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	329.00
	1Meg Module	113131-001	79.00
	4Meg Module	113132-001	219.00
DeskPro 286N, 386N, 386SX/20, 386/25M, 486/33M, 486S/25M, 486S/16M	1Meg Module	118688-001	59.00
	2Meg Module	118689-001	89.00
	4Meg Module	118690-001	180.00
Port. I Series 486C	8Meg Module	128877-001	389.00
M Series Exp Bd	0-64Meg	129160-001	279.00
DeskPro 386/16	1Meg Kit	108071-001	99.00
	4Meg Kit	108072-001	299.00
	1-2Meg Exp Bd	108069-001	239.00
	4-8Meg Exp Bd	108070-001	437.00
DeskPro 286	512K Kit	113012-001	49.00
DeskPro 5/60, 5/66M, 5/66M (ALL OF THESE MACHINES USE THESE MODULES)	8Meg Kit	149911-001	389.00
Prosignia 5/60	16Meg Kit	149949-001	739.00
Proliant 100 5/60	32Meg Kit	149912-001	1599.00
Proliant 2000 4/30, 5/66	64Meg Kit	149913-001	2700.00
Proliant 4000 4/50, 5/66	128Meg Kit	149914-001	5900.00
Prolinea 386 3/25S, 3/252S	2Meg	141738-001	109.00
	8Meg	141742-001	320.00
Prolinea 486 4/25S, 4/33, 4/50, 4/66, CDS	2Meg	141683-001	95.00
	4Meg	141684-001	180.00
	8Meg	141685-001	399.00
Prosignia PC Server, 486/33, 486 DSX/66	8Meg	141685-001	399.00
	16Meg	149320-001	719.00
	32Meg	149147-001	1525.00

COMPAQ LAPTOPS & NOTEBOOKS

LTE/286	2Meg Bd	117081-002	99.00
LTE/286	4Meg Bd	117081-003	179.00
LTE/386S/20	4Meg Module	121125-002	229.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	229.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	389.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	809.00
LTE LITE 4/25C, 4/23E, 433C	4Meg Module	142337-002	199.00
LTE LITE 4/25C, 4/23E, 433C	8Meg Module	142337-003	384.00
LTE LITE 4/25C, 4/23E, 433C	16Meg Module	142337-004	789.00
SLT/286	1Meg Module	110235-001	75.00
SLT/286	4Meg Module	110237-001	249.00
SLT/386	1Meg Module	118303-001	79.00
SLT/386	2Meg Module	118304-001	109.00
SLT/386	4Meg Module	118305-001	219.00
Concerto	4Meg	144790-001	CALL
	8Meg	144790-002	CALL
	16Meg	144790-003	CALL
Contura 320, 325	2Meg	139497-001	104.00
	4Meg	139498-001	189.00
	8Meg	139499-001	349.00
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	189.00
	8Meg	146521-001	349.00
	16Meg	146531-001	799.00

PCMCIA VERSION 2.0 (for Palmtop & Subnotebooks)

MODEL	PRICE	MODEL	PRICE
S-RAM Cards 1MEG	159.00	14,400/14,400 Data/Fax Modems	319.00
S-RAM Cards 2MEG	179.00	9600/9600 Data/Fax Modems	259.00
Card Pro (made by Data I/O) Transfers data from PCMCIA card to desktop PC, connects to a parallel port	299.00	2400/9600 Data/Fax Modems	179.00
		Lan Ethernet (10 Base T)	219.00
		Visual Media (CD Rom, Tape Dr)	279.00

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TOSHIBA LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
T1000SE/XE/LE	2Meg	PC14-PA8312U	94.00
T2000/T2000SX	2Meg	PC18-PA8317U	94.00
T2000SX/T1000LE	4Meg	PC-PA8314U	209.00
T2000SX/T1000LE	8Meg	PC14-PA8315U	399.00
T2000SXE/2200SX/T1800, 1850, C	2Meg	PC-PA2000U	94.00
T2000SXE/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	209.00
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	399.00
T4400SX, SXC T6400	4Meg	PC-PA2004U	209.00
T4400SX, SXC T6400	8Meg	PC-PA2005U	399.00
T4400SX, SXC T6400	16Meg	PC-PA2010U	704.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	4Meg	PC-PA2012U	219.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	8Meg	PC-PA2013U	439.00
T4500, T4500C, T4600, T1900, T1900C (3.3 v)	16Meg	PC-PA2014U	959.00
T3300SL	6Meg	PC-PA2008U	329.00
T3300SL	16Meg	PC-PA2009U	699.00
T1200XE	2Meg	PC13-PA8306	99.00
T1600	2Meg	PC8-PA8302U	99.00
T3100	2Meg	PC3-PA7135E	179.00
T3100e	2Meg	PC9-PA8340U	109.00
T3100SX	2Meg	PC15-PA8308U	109.00
T3100SX	4Meg	PC15-PA8310U	209.00
T3200	3Meg	PC6-PA7137U	185.00
T3200SX	2Meg	PC12-PA8307U	119.00
T3200SX	4Meg	PC12-PA8909	209.00
T3200SXC	2Meg	PC19-PA8318U	119.00
T3200SXC	4Meg	PC19-PA8319U	219.00
T5100	2Meg	PC7 PA8301U	95.00
T5200/T8500	2Meg	PC10-PA8304U	114.00
T5200/T8500	8Meg	PC10-PA8313U	419.00

NOTEBOOK, LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ACER 730	2Meg/4Meg/8Meg		109/209/449
ACER 750	4Meg/8Meg/16Meg		199/459/989
ALR Venture	4Meg	12407980	249.00
AST Bravo & Explorer	4Meg, 16Meg	501255-001, -002	199.00/829.00
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500814-003	189.00
AST Power Exec 3/25C, 425EL	4Meg		199.00
AST Power Exec 3/25C, 425EL	16Meg		819.00
AST Power Exec 425SL	4Meg	501166-001	199.00
AST Power Exec 425SL	16Meg	501166-003	819.00
AT&T Safari NSX/20	4Meg	PEC 37651	259.00
Bondwell B310, Plus	1Meg	23050-09100	109.00
Bondwell B310V SX	1Meg		109.00
Bondwell B310V SX	4Meg		229.00
Epson NB3	4Meg	A808511	199.00
Everex Tempo LX, LX20, Carrier	2Meg	PCX 00053-0001	99.00
Gateway 2000 Nomad 425 DXL/SXL	4Meg/16Meg		199.00/1549.00
Goldstar GS520 386SX/16	4Meg	S386-4MC	249.00
Magnavox Metalis	1Meg, 4Meg	286, 386SX	109.00,199.00
NEC Prospeed 286, 386SX-16	1Meg	PC21-21	79.00
NEC Prospeed 286, 386SX-16	4Meg	PC21-22	199.00
NEC Prospeed 386	2Meg	PC31-21	119.00
NEC Prospeed 386	8Meg	PC31-22	399.00
NEC Prospeed 386SX-20	1Meg	PC43-21	79.00
NEC Prospeed 386SX-20	4Meg	PC43-22	199.00
NEC Ultralite III/20, 20P, 25C	2Meg	PC47-21	109.00
NEC Ultralite III/SL/25C	4Meg	PC47-22	189.00
NEC Ultralite SL/20, 20P	6Meg	PC49-21	309.00
NEC Ultralite III/25C	8Meg	PC47-23	389.00
NEC Ultralite Versa	4 Meg/8Meg/16Meg/20Meg	OP4104	209, 429, 849, 104
Packard Bell 386SX, 286	1Meg, 4Meg	286, 386SX	109,199
Panasonic CF170, CF270, CF370	1Meg	CF-BA165	49.00
Panasonic CF38C	2meg/4Meg/6Meg		CALL/CALL/CALL
Panasonic CF48C	2Meg/6Meg		CALL/CALL
Sanyo 17/18 NB	2Meg	MBC-NBMEM2	99.00
Sharp 6781, 6881, 6785	2Meg/4Meg		109.00/199.00
Sharp PC-6220	1Meg	CE 6218	79.00
Tandon, PC Brand, Dataworld	2Meg, 8Meg	NB386SX-20	119.00, 429.00
TI Travelmate 2000	1Meg	2568034-0001	79.00
TI Travelmate 3000	2Meg	2586996-1	84.00
TI 4000	4Meg, 16Meg		199.00, 1549.00
Twinhead, Alltima, Compaddyne Tandy 4860, 486SX, DX	4Meg/16Meg		199.00/859.00
Zeos 386SX Notebook	2Meg		99.00
Zenith Master Sport 386SX	2Meg	ZA-300-1	114.00
Zenith Master Sport SL, SLE	2Meg	ZA-4-4	119.00
Zenith Super Sport 286, 286E	1Meg	ZA-180-66	99.00
286E, SX	2Meg	ZA-180-64	179.00
SX Alpha	2Meg	ZA-180-86	179.00
SX Beta	2Meg	ZA-180-87	179.00
Zenith Z-Note 325L, LC	2Meg/8Meg	ZA3250-4/5	179.00/419.00
Zenith Z-Note 425LN, LNC, LNP	4/8/16Meg		209/519/839

LASER PRINTER MEMORY UPGRADES

AMOUNT UPGRADED OK	64	256k	1	2	3	3.5	4	5	6	8	16	32
Canon LBP4, 4Lite, 4plus	–	–	159	219	–	–	–	–	–	–	–	–
Compaq Pagemarq	–	–	–	99	–	–	180	–	–	369	–	–
Epson 6000, Action Laser	–	–	–	139	–	–	229	–	–	–	–	–
Epson Action Laser II	–	–	89	–	Call	–	–	Call	–	–	–	–
Epson 8000	–	–	89		Call	–	–	Call	–	–	–	–
Epson 1000, 1500	–	–	–	Call	–	–	Call	–	Call	–	–	–
HP 2, 2D–	–	–	–	109	–	–	189	–	–	–	–	–
HP 3, 3D, 3P, 2P 2P+	–	–	–	101	–	–	179	–	–	–	–	–
HP 4, 4M, 4SI, 4SIMX	–	–	–	89	–	–	180	–	–	364	–	–
HP 4L	–	–	59	–	–	–	–	–	–	–	–	–
HP 3SI	–	–	69	–	–	–	180	–	–	359	–	–
HP 4SI	–	–	–	89	–	–	180	–	–	359	–	–
HP Design Jet 600, 650	–	–	–	–	–	–	180	–	–	359	–	–
HP Deskjet 500, 500C, 550	–	59	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200C/P	–	–	–	89	–	–	180	–	–	359	–	–
HP Paintjet XL300	109	–	–	–	–	–	289	–	–	469	837	–
IBM Laser 4019, 4019E	–	–	–	–	–	159	–	–	–	–	–	–
IBM Laser 4029	–	–	–	–	–	–	180	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	99	–	–	180	–	–	350	–	–
NEC 90, 290	–	–	–	139	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	–	99	–	–	–	–	–	–	–	–
Oki 400	–	–	–	89	–	–	–	–	–	–	–	–
Oki 400 E	–	–	135	189	–	–	–	–	–	–	–	–
Oki 830, 840	–	–	–	109	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	130	–	–	227	–	–	–	–	–
Packard Bell 9815	–	–	–	180	–	–	299	–	–	–	–	–
Panasonic 4420/4450i	–	–	–	129	–	–	209	–	–	–	–	–
Panasonic 4410/4430	–	–	–	126	–	–	195	–	–	–	–	–
Panasonic 4450	–	–	99	–	–	–	–	–	–	–	–	–
TI XL/PS17/PS35	–	–	55	–	–	–	–	–	–	–	–	–

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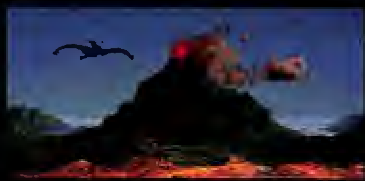

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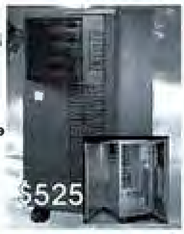

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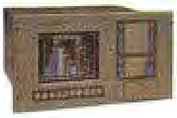

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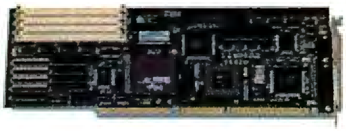

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Model						
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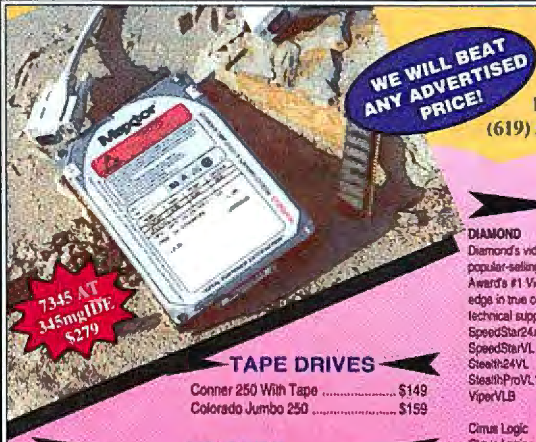

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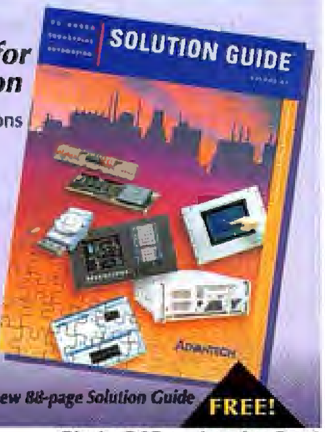

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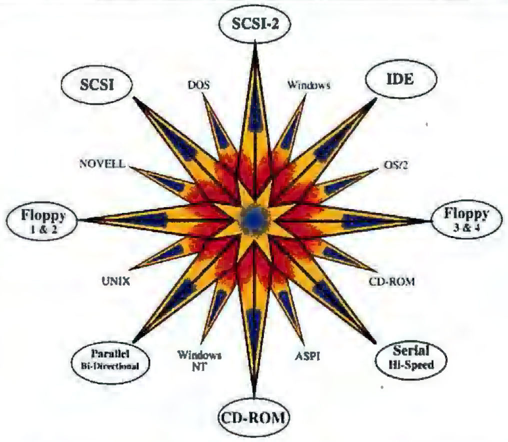

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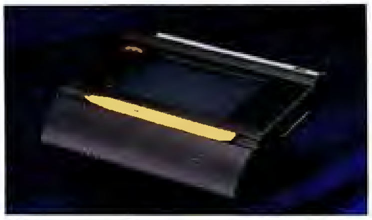

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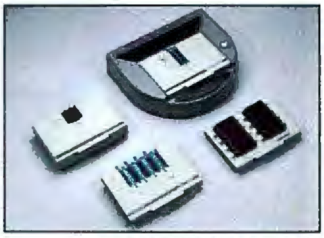

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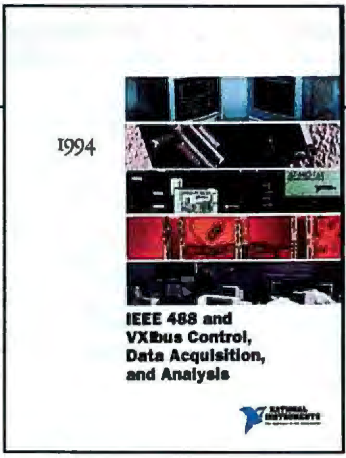

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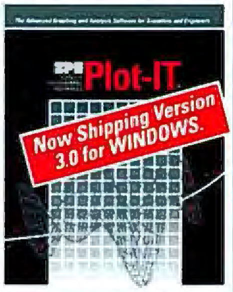

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Virtual Legality

Once on-line, some people totally disregard legally and socially acceptable behavior

WALTER CALAHAN © 1994

Nearly everyone has heard of *virtual reality*, an amalgam of technologies that allows people to act on and react to a perceived world without regard to the real world. Although hyped endlessly, virtual reality isn't commonly available yet. In contrast, another by-product of the technological revolution, *virtual legality*, while almost never discussed, abounds in the on-line world. Virtual legality occurs when people act on and react to the virtual world without regard to the law.

Virtual legality is not software piracy or network hacking or any blatantly illegal act. It arises from more mundane events. When users ignore the legal issues that occur in regular day-to-day human interaction on-line, they've entered the realm of virtual legality.

For example, consider an attempt to create an enforceable contract by exchanging an E-mail offer and acceptance. In the real world, exchanging letters of offer and acceptance does create an enforceable contract (assuming something of value is also eventually exchanged). Unfortunately, without authentication techniques (e.g., digital signatures), E-mail agreements are probably unenforceable in court. Under legal rules governing evidence and contracts, it's hard to prove the existence of a contract based on E-mail; fabricating an E-mail message is just too easy.

Next, consider *flaming* by users of the Internet and on-line services. Flaming is E-mailing or posting a scathingly critical, and often personal, message to or about another user. Sometimes, as when flaming a novice Internet user (for making novice mistakes), it's just the on-line counterpart to real-world hazing—sophomoric but tolerable. Other times, however, it becomes excessive and defamatory; last summer, the flaming of a user on the WELL received national attention because of the extent and acrimony of the accusations. In these circumstances, flaming in private E-mail may be the equivalent of illegal telephone harassment, and flaming in a public news group or discussion board may be defamatory.

Remember, a message posted to a discussion board on a major commercial service or the Internet has a potential readership greater than all but the largest city newspapers. While no newspaper editor would publish a blatantly defamatory article, Internet users may do so with apparent impunity; there are no laws covering such on-line behavior. It's possible, however, that laws pertaining to its off-line equivalent could be stretched to fit.

As these examples show, virtual legality encompasses certain ironies. It seems that users, caught up in the power of self-expression and the accessibility of this new electronic communication medium, assume the old rules apply when convenient—such as in contract law—and don't apply when inconvenient—such as in libel law.

Of course, flaming and E-mail contracts just hint at the breadth of virtual legality: This area extends from privacy and censorship to access to intellectual property rights. And employers may be responsible for their employees' forays into this legal miasma.

Most of us recognize and respect the legal issues in our off-line lives. So what is it about the on-line world that leads to this apparent disregard? In part, the novelty of the virtual world may seduce users into ignoring their usual understanding of legally and socially acceptable behavior. Also, the law tends to lag behind technological and social change, leaving legal rights and obligations unclear.

Most important, virtual legality arises from the nature of the technology. Solely because of the current technological inability to verify that a message is unique and authentic, E-mail should not be used to create a contract. The relative anonymity and socially detached nature of on-line communications allow people to say things on-line that they would never think to say in person. While future technology may eliminate some of these issues, that same technology will, no doubt, raise new ones.

The truth is that, as individuals, we are responsible for what we do. Since there's no reason to believe that the rate of technological change will slow down or the law will catch up, as users we must become attuned to the legal, social, and ethical ramifications of what we do online. We can lose money in an unenforceable contract. We can hurt and defame people and possibly become legally liable. We can have our privacy breached or our words censored, taken out of context, twisted, or falsified. The solution is to treat the virtual world like the real world—because it is. To believe otherwise makes the likelihood of encountering virtual legality a virtual certainty. ■

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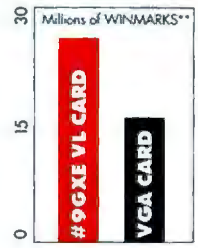

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