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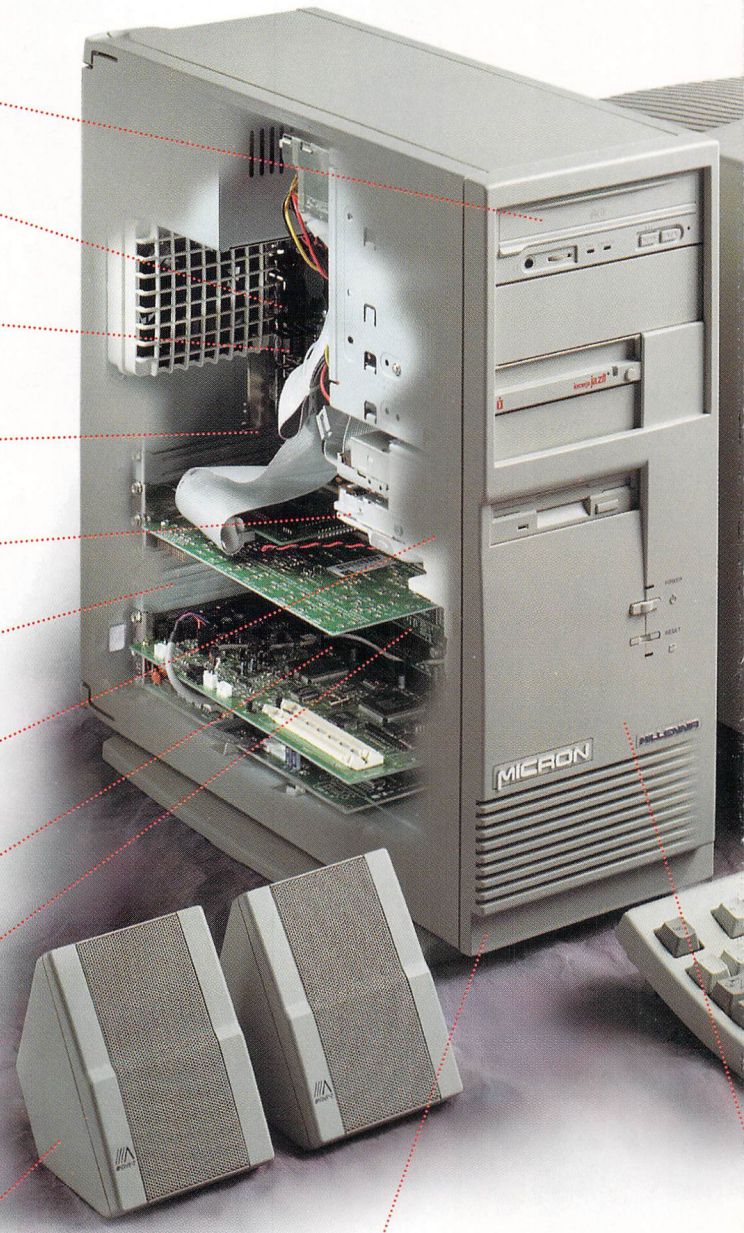

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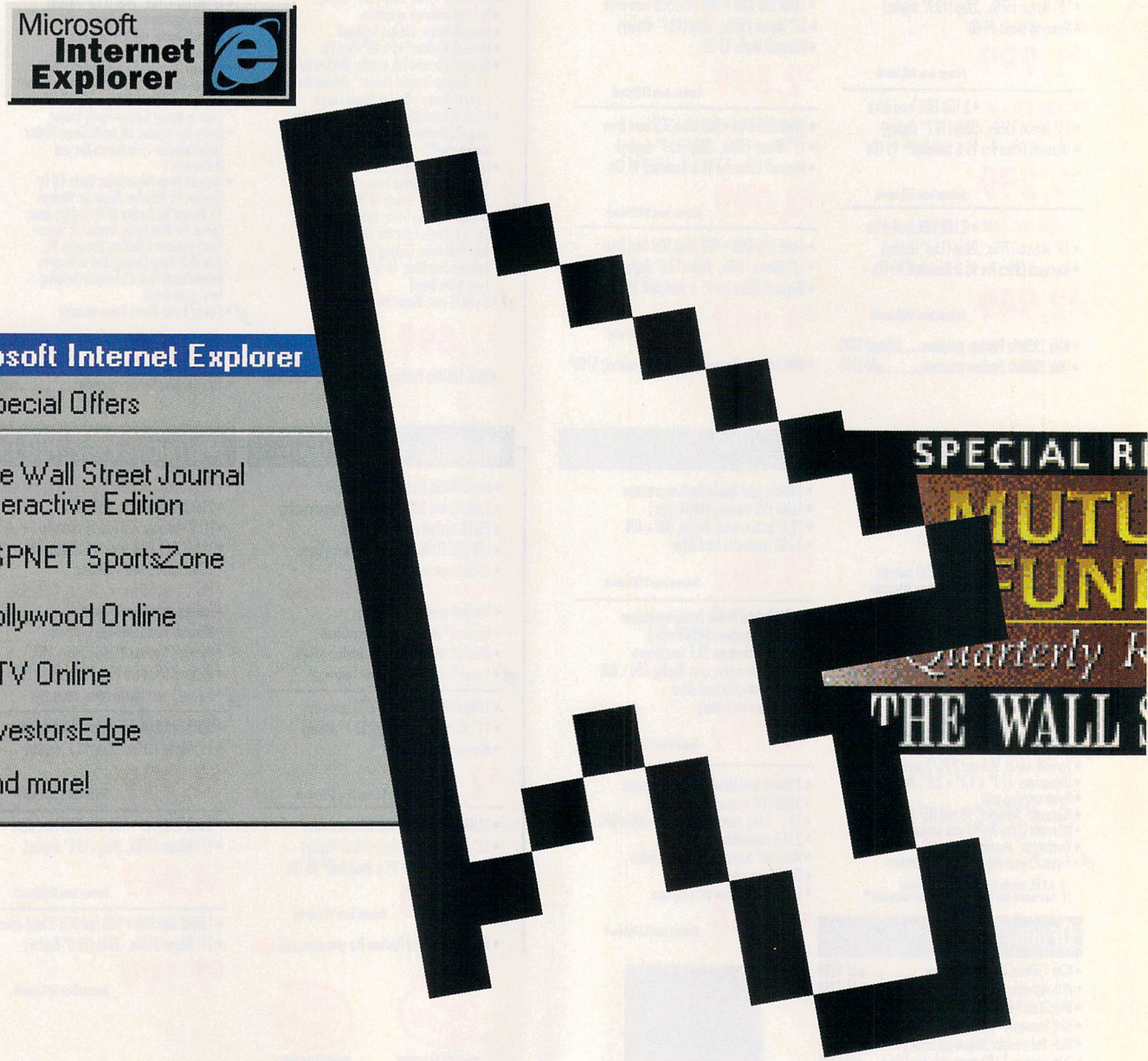

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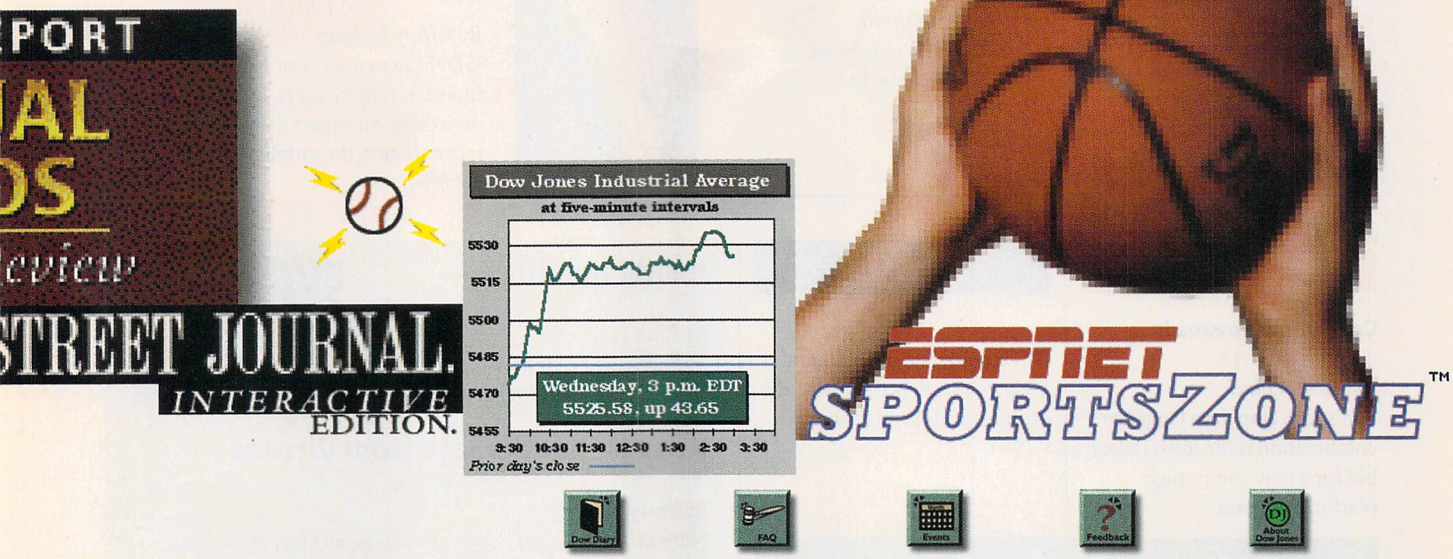

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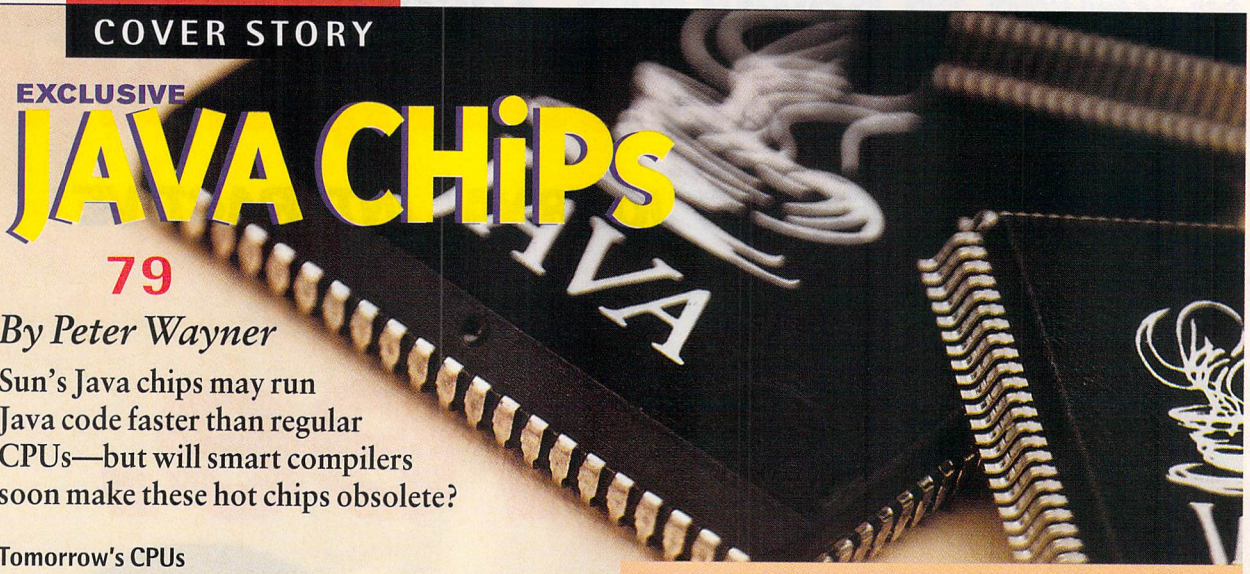

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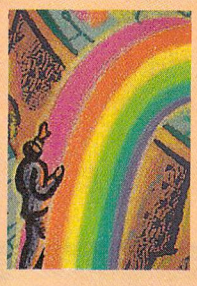

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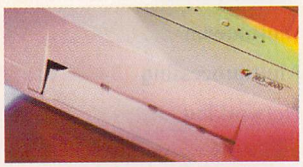

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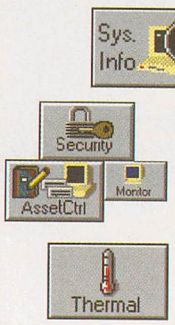

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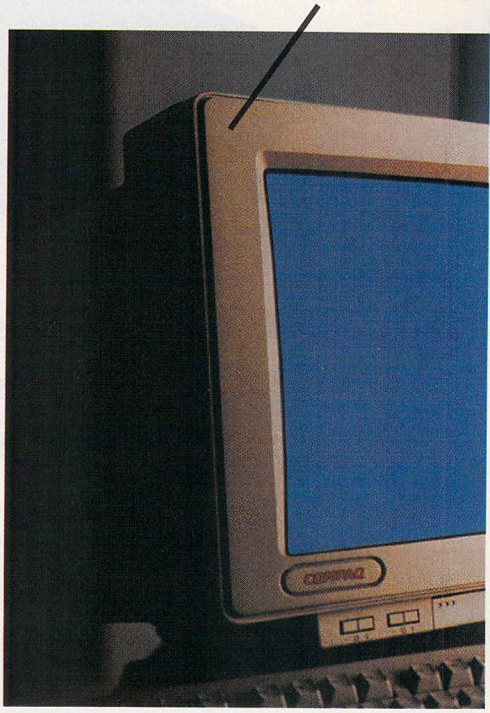

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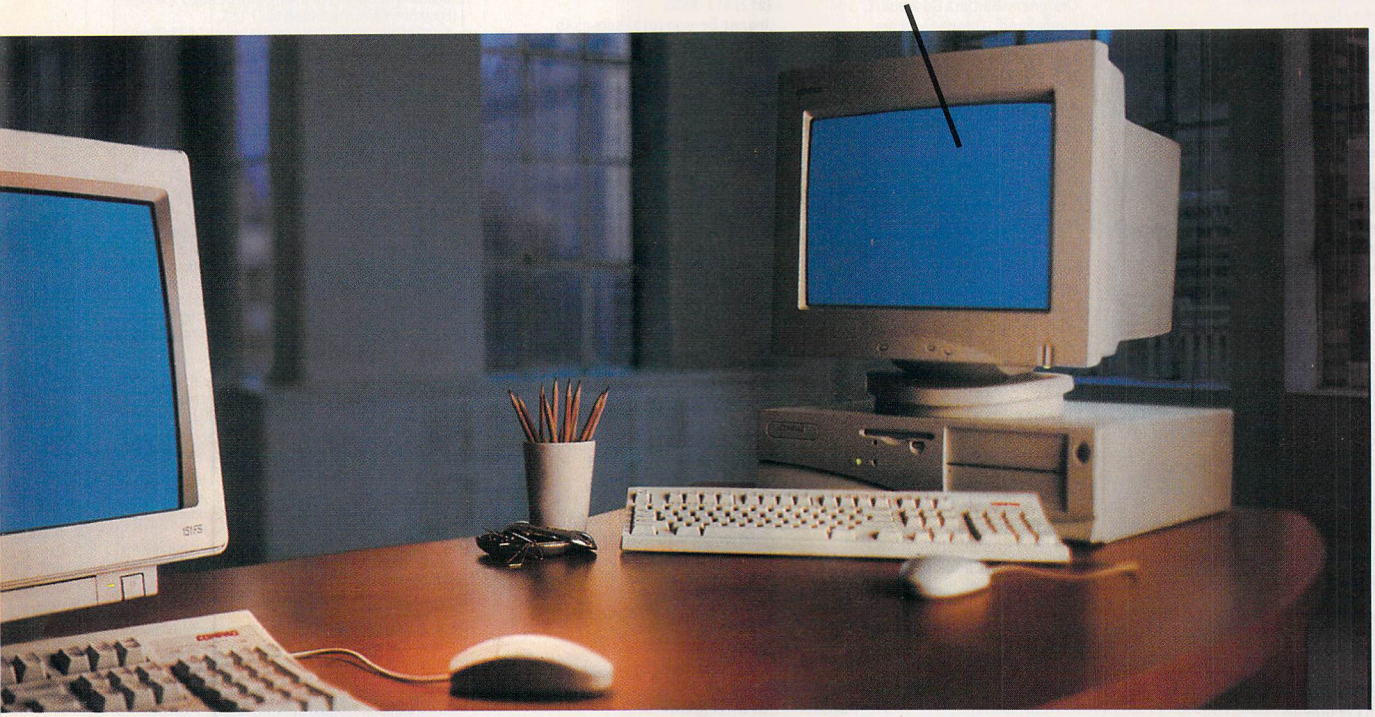

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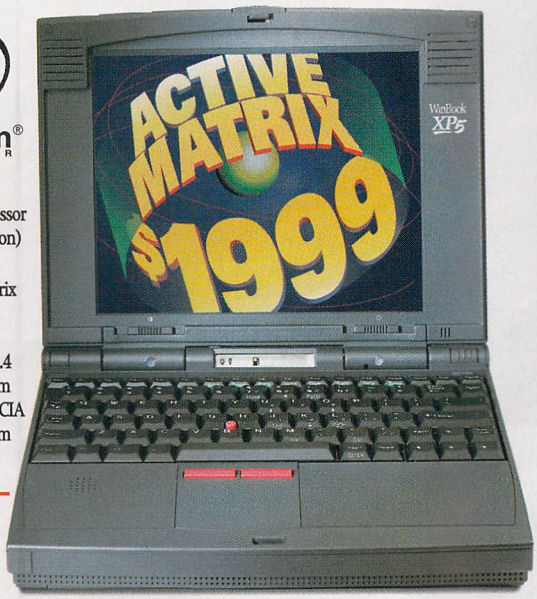

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editorial

Computing Crossroads

Will it be Intel inside or Java everywhere?

This month, our Cover Story (which is the State of the Art section) highlights the most radical bid in years for a new computing platform: Sun Microsystems' Java chip/Java language combination. This is not just an alternative to Intel/Microsoft computing, à la the PowerPC/Mac OS package. It's a reinvention of the computer into a more universal, versatile, and interoperable device. The Java model could obliterate many of the distinctions between standard computers, embedded systems, and products still to come, such as intelligent cable boxes and cellular phones.

For years, we've lived with chips that will run almost anything and languages that will run on almost anything. Java chips will give us performance where we need it—running Java applications—while the Java environment will give us interoperability with every other hardware platform.

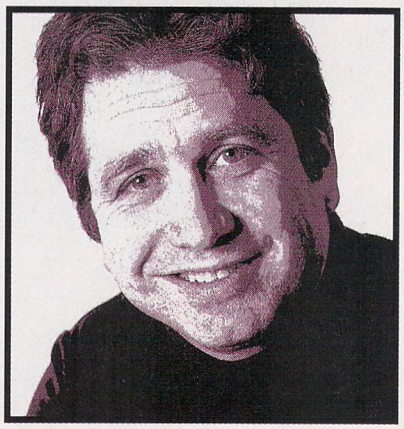
Sun hopes that electronic designers, corporate information technology (IT) departments, and, ultimately, end users will find this so compelling that they will leave behind the Intel architecture. However, it's a tall order. Look at how hard it's been for the mighty PowerPC troika of Apple, IBM, and Motorola to make headway against the x86 line.

Still, I think Sun will win a significant place with its Java chips. In the last year, we've started to hear some awful gnashing sounds coming from Redmond, as Microsoft grinds off a few gear teeth trying to keep up with the paradigm shift toward the Web. On the hardware side, Intel hasn't made any major adjustments to the infobahn. Check out our story on Intel's road map ("The x86 Gets Faster with Age") on page 89, and the only new signs that you'll see are those for multimedia. Keep those MIPS coming!

There's no question that simpler, cheaper, faster PCs will spread computers to people who have never used them before. As business communications and public commerce march relentlessly toward computerization, the network computer (NC), or Web PC, or whatever you call it, will proliferate (see "Inside the NC" on page 105). Ditto for new devices we haven't named: the wireless gameboyphonebrowseremotecontrol and such.

But Sun may be ahead of its time. When will the network infrastructure arrive to make fully networked computing possible? It will definitely be a year that begins with 20 before we have the kind of end-to-end digital broadband network we'll need.

So don't put all your money on one horse just yet—you'll need both Java and Wintel for the foreseeable future. Java chips and the Java language will solve some of client/server's thorniest problems. (Do you really want to individually maintain hundreds of PCs that are nothing more than cash registers or data-entry terminals?) The Java duo will also make lots of cool but dumb stuff like cellular phones much smarter.



It will be a year that begins with 20 before we have the kind of broadband network we'll need.

Yet our familiar OSes and applications make the classic PC—Intel, PowerPC, or whatever—much more flexible than those devices will ever be. Throughout the next decade, I may want a Java unit for the office and a self-sufficient but connectable machine for computing on airplanes or when I'm otherwise outside the wired urban hubs of the world.

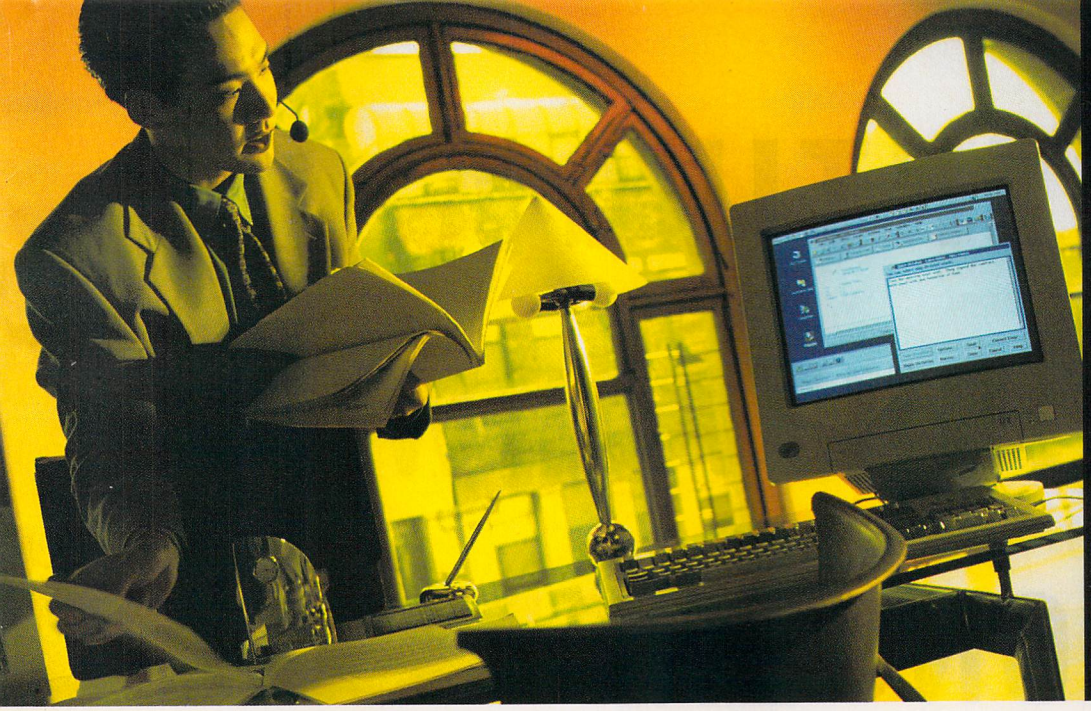
Win, lose, or draw in the commercial war, Java has already changed the way we think about computing. Can it be a coincidence that Microsoft has revived its hand-held computer OS project, now called Pegasus? Or that Oracle hopes Intel will buy into its Network Computer concept? That's not the end of it: Look for traditional OS vendors to let you turn the desktop GUI into a screen onto which you project server-based applications, NC-style.

Users' interests lie in being able to flexibly combine the best elements of the Java concept with the best of what we have now. For example, products such as Notes and higher-end database managers can choreograph local and centralized data management. Make that skill widely available to all sorts of applications, and we'll have the best of both worlds.

Mark Schlack

Mark Schlack, Editor in Chief
mschlack@bix.com

PHOTOGRAPH: KELLIE WALSH © 1996



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inbox

The Future On-line

I found the vision of the on-line future that Mark Schlack described in "Smart, Fast, and Well Connected" (September Editorial) stimulating and bracing. However, I don't believe that vision will be fully realized until the companies concerned with building the global infrastructure forget the idea, at least for a quarter of a century, of making substantial money out of it. The Internet arose out of a sense of collective experimentation that had little to do with the profit motive. Tim Berners-Lee is not as wealthy as Bill Gates by a long way!

Paul Richards
East Finchley, London

I agree it will take visionaries to make the intelligent network happen, but they won't have to ignore the profit motive. For some time, the telecom industry has been making the transition from hardwired, inflexible switches to a software-defined network, and for their own reasons: efficiency, manageability, expandability, and the ability to sell value-added services. Once the network is programmable, nearly anything is possible. The biggest obstacle will be for carriers to act more from their customers' perspective. —Mark Schlack, editor in chief

Wizard Review

Kudos to BYTE for the crisp and substantive review of the OS/2 Warp 4.0 beta ("You Talk, Warp Listens," September). I have my sights set on installing Merlin as soon as it arrives, and the article gave me sufficient edge to coordinate my programming strategy starting today. Now I will pass around that issue of the magazine to my 30 OS/2 coworkers, and I will buy future issues.

Mark A. Ehlen
Germantown, MD
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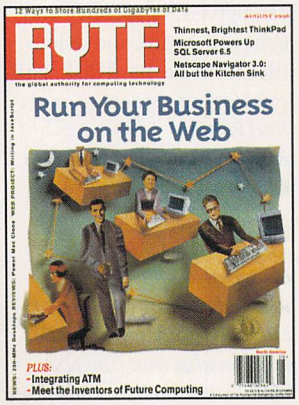
Cover Story Uncovered

BYTE is usually pretty good, but the August cover is misleading. There is no article called "Run Your Business on the Web" but rather something called "Your Business Needs the Web." These are not even remotely the same thing. To run a business you need marketing, production, financial, and personnel strategies. Your article doesn't touch on these. And yes, I really did expect it to, or at least to show examples of businesses that are unique in how they exploit new opportunities enabled by the Web. I don't care what not-for-profit organizations like NASA and Harvard are doing with mammoth budgets and half the brainpower in the free world; show me what economies my business can achieve or how it could be transformed in the short as well as the long term.

Greg Graham
gregg@idacom.hp.com



Refreshing!

I get sick of all the hype and misrepresentation about the huge shift that has happened with the Internet. So many articles, so little substance. "Your Business Needs the Web" was different. It was well written, well researched, and informative—a breath of fresh air. I think you actually touched on the real issues, challenges, and exciting prospects facing all us poor slobs who have to implement this stuff.

Ryan Sutter
Ryan.Sutter@mortenson.com

Thanks! Used to be, I wrote about a lot of things that were far removed from what I did on the development side of BYTE's business. Now I build things and write about what I learned. What cuts through all the Internet hype for me is simply the fact that this has become possible. It's just plain exciting. —Jon Udell, executive editor

Inspiration and Perspiration

Let me be the one-millionth customer to point out that Thomas A. Edison did not exactly work "on his own" in his lab ("The Elements of Design," August). He may have in the early days, before he set up his lab, but not later. He had lots of assistants with whom he interacted and to whom he assigned "polishing up" tasks. Many historians feel that those people received nowhere near the recognition they deserved.

K. Steven Knudsen, Ph.D.
Resolute Research Ltd.
Calgary, Alberta, Canada

You're not quite the millionth customer to point this out. However, you're the first to realize that I was talking

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about his early days. I certainly did not intend to rewrite history. It might have made good closure to the article to point out that Edison adopted this administrative model for his research work. The same model is used today, but on a larger scale. —Tom Thompson, senior technical editor

Token Token Ring

In this age of political sensitivity, I was disappointed to see you slip into a minority-unfriendly attitude in "Mainstreaming Pentium Pro" (August). No, you didn't bash a political minority—just a technical one. A significant portion of the networked world uses Token Ring, and we know that "built-in networking" is media slang for "built-in Ethernet," which for us translates into "a tax on minorities." May the Deity, if H/She exists, bless AST for not wasting the electricity and materials for such a device on those of us who live happily without. Otherwise, nice job!

Tim Schultheis
Victoria, MN

OS Insecurity

In "Air-Tight Windows NT" (August), author Jim Reynolds states that the U.S. National Security Agency granted Windows NT 3.5 C2-level approval. What few people know is that this evaluation was limited to a stand-alone computer and did not include network interfaces. If a user hooks up an NT server to a network, the computer can no longer be considered C2-secure until almost all network functionality is disabled. Failure to mention this is misleading and lures users into a false sense of security. The article also doesn't mention the so-called "boot floppy" vulnerability of Windows NT. By booting from a floppy and using assembly language utilities, a person can bypass NT security and can read, write, and delete files from the hard disk without leaving a trace.

Karl Pottie
Rumbeke-Roeselare, Belgium
karl@vl-brabant.be

The security features I discussed also apply to networked computers. NT is currently undergoing network evaluation (the NSA usually conducts stand-alone and network evaluations separately). But remember, the evaluated configuration, which includes hardware and software, might not match what you have or need. The NSA team was aware of the boot-with-floppy issue; the evaluated configuration prohibited physical access to the floppy. A less stringent need for security might take advantage of the common PC feature that prevents booting from a floppy. Of course, without physical security this solution can be circumvented. The bottom line is that if you can boot a different OS, then none of the security mechanisms of NT work. This is to be expected with any OS. What makes the NT case appear different is the ubiquitous character of the hardware platform and the fact it is generally designed to boot from floppy, unlike older, time-sharing systems such as Unix. —Jim Reynolds

Xyratex Omitted

While your news story on Serial Storage Architecture ("SSA Products Deliver Better Storage," September Bits) was informative, it neglected to mention that Xyratex supplied the pair of eight-SSA-disk deskside tower units (S9000) for BYTE's testing of this hot technology. We also manufacture single-SSA-disk desktop models and 16-SSA-disk rack-mount units, as well as SCSI RAID devices and a complete line of test equipment for SCSI, SSA, and Fibre Channel interfaces.

Roger Nixon
Xyratex International Ltd.
71740.3316@compuserve.com

Mr. Nixon is correct. We apologize for the oversight. —Editors

Apache

I've been reading your Web Project column on Web site management with growing amazement. How can you continue to write about the Web without ever mentioning the world's most popular Web server, Apache? Apart from this glaring deficiency, it's an interesting column.

Ben Laurie
Freelance consultant and technical director
A.L. Digital Ltd.
London
ben@algroup.co.uk

I use Apache on my main conferencing server, a Linux machine, and, in fact, I mention that in this month's Web Project. Currently, I'm experimenting with dual-mode NNTP/Web conferences, where the primary message base is handled by INND, but a Web view—which now includes posting as well as reading capability—echoes the message base using Apache. The conference, which will now become an ongoing accompaniment to the column, is at http://dev4.byte.com/joncon/threads.html or news://dev4.byte.com/joncon. —Jon Udell, executive editor

Java and Forth

After reading your August issue with all those Java articles and code examples, it became very clear that we old-timers can pull our Forth manuals out of storage and put them to use again. If Java basically is Forth, is this a copyright infringement?

Thomas A. Naegele, DO
Albuquerque, NM
tanman@swcp.com

The Java and Forth virtual machines do share many common elements, but the syntax of the Java language is quite different from Forth's. —Rick Grehan, senior technical editor

Why Not Tao?

In "Weird, Wacky, and Wonderful" (August Editorial), you question whether distributed computing can be made to work. The technology to do this already exists in the form of the Tao operating system, which has been reported on by your own U.K. correspondent, Dick Pountain, in "Parallel Course" (July 1994). The big advantage of the Tao OS's translated system is that the speed penalty is only about 1 percent; this leads inevitably to the fact that it reduces the processor to a commodity item, something that can only benefit the consumer. For more information about Tao's technology, go to http://www.tao.co.uk/.

Russel Hughes
rhugesc@cix.compulink.co.uk

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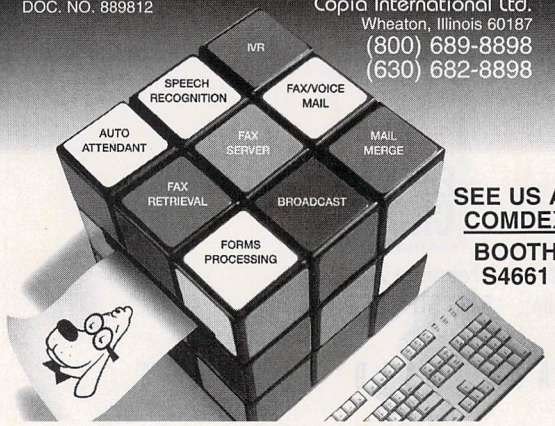

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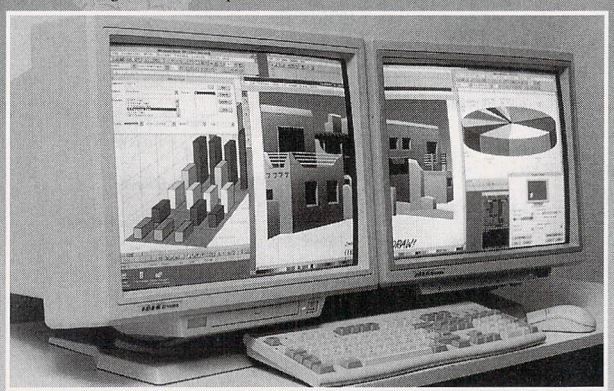

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tronics companies but has yet to name any licensees. That's why we haven't covered the Tao operating system recently. If any deal is announced or new development occurs, we'll be sure to mention it.—Dick Pountain, contributing editor

FIXES

Due to editing errors, we omitted some text in "Cyrix 6x86 Matches Pentium," (September Bits). The $1500 price we cited in the article was meant to refer to the approximate cost of the SCSI controller with 64 MB of memory, not the entire system. The price at the end of the story is the correct approximate system price. We also said the Cyrix system had 64 MB of RAM. The SCSI controller had 64 MB of memory; the Cyrix system itself had 32 MB of RAM.

The rightmost graph in the figure "SQL Server Performance" on page 162 of the Quad Pentium Pro Server comparison (September) was mislabeled. The scale at the bottom should have read 1 to 4, reflecting the number of processors.

In "Microsoft Catches Up with Netscape" (September), we referred to "Sun's JavaScript." JavaScript is a Netscape product.

COMING UP IN DECEMBER

COVER STORY
The Microprocessor at 25
BYTE examines how, in 25 years, the microprocessor has changed the world. We'll also explore the evolution of microprocessor design and where it's going, and we'll bring you the views of industry luminaries on the impact of future advances in computing technology.

EXCLUSIVE!
Hot New Processor
We take a detailed look at Exponential's PowerPC-compatible bipolar chip, which delivers clock speeds in the range of 500 MHz.

STATE OF THE ART
Next-Generation Internet Applications
As a platform for distributed applications development, the Internet is dynamic but immature. BYTE takes a close look at evolving standards for directory services, e-mail, and security and explains what they'll mean for developers deploying enterprise-wide applications on the Net of 1997 and '98.

HARDWARE LAB REPORT
Network Laser Printers
NSTL tests monochrome laser printers with output speeds of 17 to 32 pages per minute. Here's where to find the one that can meet the needs of large corporate departments and small businesses.

SOFTWARE LAB REPORT
Lotus Notes and Microsoft Exchange
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Windows for Tiny PCs

Seamless information synchronization with desktop PCs will highlight Windows CE.

If at first you don't succeed, try again. Following an earlier effort to develop an OS for hand-held devices, Microsoft will release an OS called Windows CE this fall. The first products based on the new OS, which is code-named Pegasus, will be hand-held PCs that are about the same size as today's Psion 3A and Hewlett-Packard's 200LX.

Unlike these other devices, however, the new Windows CE hand-held PCs will feature an OS that provides a Windows 95 look and feel. Windows CE will also offer programmers a subset of the Win32 APIs, making it easier for developers familiar with those interfaces to write applications for these new hand-held PCs. Microsoft says that Windows CE will also be appropriate for such items as cellular smart phones, digital information pagers, and entertainment and multimedia consoles.

The first Windows CE hand-held PCs will likely be released late this year. They will ship with slimmed-down versions of popular applications such as Microsoft Excel and Word, although the CE versions will probably offer only some of the features available in desktop applications. The devices will reportedly let you synchronize information with Schedule Plus and possibly other calendar programs from your desktop.

Microsoft declined to comment in depth on the devices or the OS, but company officials say the hand-held PCs will offer strong connectivity to Windows PCs. Initially, companies such as Casio, Compaq, HP, LG Electronics, NEC, and Philips Electronics will offer them. Compaq, perhaps PDA-shy from its initial work with the abortive WinPad OS, will reportedly resell a hand-held PC made by another company.

Windows CE is a 32-bit, multitasking, multithreaded OS. It is also portable to a variety of microprocessors, such as Hitachi's 32-bit SH3. Processors from NEC Electronics and Philips Semiconductor can also be used in Windows CE hand-held PCs. The OS will be stored in 5.5 MB of ROM, according to reports.

These hand-held PCs will probably sell for about $500. Whether they will be breakthrough products that breathe new life into the market or just another bust in a field littered with failures remains to be seen. However, even if Windows CE isn't perfect in its first release, it's possible that Microsoft will continue to improve the product until it is as popular in the hand-held PC arena as Windows 95 is on the desktop. **–Dave Andrews**

Windows CE Highlights

- Good PC connectivity
- Programming interface based on Win32
- Windows 95 look and feel
- Backed by several hardware manufacturers
- Device price near $500
- First release slated for this month

geek mystique

Surf Now, Fly Later

From 3Com (aka Candlestick) Park to rock concerts, Internet-access terminals are showing up in various mainstream venues. Now they are also arriving in airports and hotels. Atcom/Info, which is a San Diego–based provider of public communication and information resources, will have 10 of its Internet-access kiosks (see the picture) installed at Dallas–Forth Worth International Airport. From there, business travelers will have access to e-mail, the Web, Internet newsgroups, ticketing services, information about local attractions, and other information. Each kiosk will have one sit-down and one stand-up access terminal, plus two stations for phone service. An electronic card-reader slot will accept credit-card payments. GTE, which is installing the terminals, will also provide the ISDN connections.



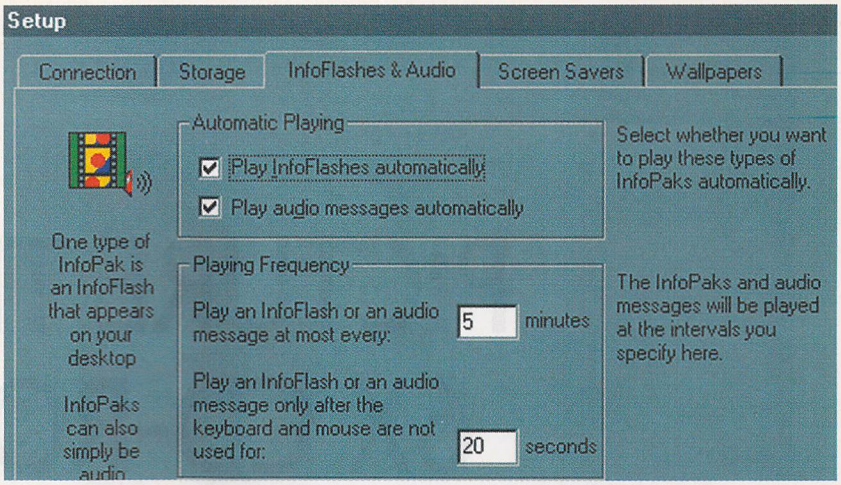
Web Surfing at DFW

If you're too busy to stop at the airport to do some Web surfing, or to dash off a last-second e-mail message, perhaps you can do so when you get to your hotel. Atcom/Info is developing Internet-access systems for hotels that will allow busy business travelers to log in on the road even if they have forgotten their notebook. **–D.A.**

Web Info the Way You Want It

The strength of the Internet, its vast collection of information, is a double-edged sword. You can spend hours looking for something without finding it. To address this problem, several new products and services let publishers deliver information over the Internet in a focused way to the people who most need it.

Search tools such as Yahoo and Alta Vista can help you find something more quickly on the Web, but sometimes you still have to browse through many bad hits before you find what you want. Off-line browsers can download information from Web sites while you sleep, but they don't help if your job requires instant access to the latest information. If you've configured your off-line browser to download information at midnight, you may not get an important piece of news that breaks early the next morning for another 24 hours.



BackWeb can deliver news as an audio message, a news flash, or in an information package.

yeah, but...

The Internet is growing so fast that we can't keep up with it. It's where everything cool in the computing world is happening, and nothing can stop it from growing.

Yeah, but a recent report by Yankelovich Partners (Norwalk, CT), a market research firm, indicates that the Internet is at a crossroads, and that unless the cost of access devices such as PCs and modems improves, the rate of Internet growth will decline. The firm says the annual average growth rate in the number of cybercitizens will decline to 20 percent by the end of the year unless the price to play on the Internet comes down. Another caution flag: Between May 1995 and May 1996, average on-line time fell by 25 percent, from just over 16 hours to 12 hours.

New services that address the above problems let information-oriented businesses deliver just the news you care about directly to your PC. Subscribers to these services specify topics they are interested in, such as business competitors or stock prices. When news about those topics breaks, it is sent to your PC.

Pointcast's (http://www.pointcast.com) advertising-supported service allows you to customize which kinds of topics you want to know about from a variety of news sources, such as Reuters, newspapers, and others. A new product from Pointcast called Iserver ($995 per server CPU) lets corporations distribute information more efficiently over an intranet.

BackWeb's (http://www.backweb.com) namesake product suite lets content providers create information-delivery broadcasts and send information to a wide audience or just a single end user. The BackWeb server console lets you track detailed statistics of how users interacted with information, and a scripting language allows you to control how information appears at the end user's desk. WavePhore (http://www.wavo.com) is also getting into the Internet and intranet real-time news-delivery business to complement its current broadcast services. And NetGuide (http://www.netguide.com), an on-line guide to the Web, will deliver content based on your information preferences.

One problem for would-be content providers is that some of these server platforms can cost thousands of dollars. That price is prohibitive for many small-size and midsize businesses, says Ross Rubin, senior analyst with New York City–based Jupiter Communications (http://www.jup.com), an Internet consultancy. He also says that a subset of what vendors such as Pointcast are offering may be available in a few years from standards-based Internet e-mail and even sooner from Web-server and database vendors.

John MacFarlane, CEO of software.com (http://www.software.com), a provider of standards-based Internet mail servers, agrees. Already, says MacFarlane, the new IMAP 4 standard lets mail users store Internet mail on servers instead of having to pull them onto a client machine. This lets active agents automatically file mail to the correct folder on the e-mail server. Although this filtering doesn't currently approach the level of functionality offered by services such as Pointcast and BackWeb, MacFarlane points out that the standards will continue to evolve. Also, discussions are under way among vendors to improve the integration among e-mail server and client programs. Improved integration would let someone using a program such as Qualcomm's Eudora create sophisticated filters that work well with any standard Internet mail server. Until then, products such as Pointcast provide a valuable filter for people who want targeted, fresh information updates. **–D.A.**

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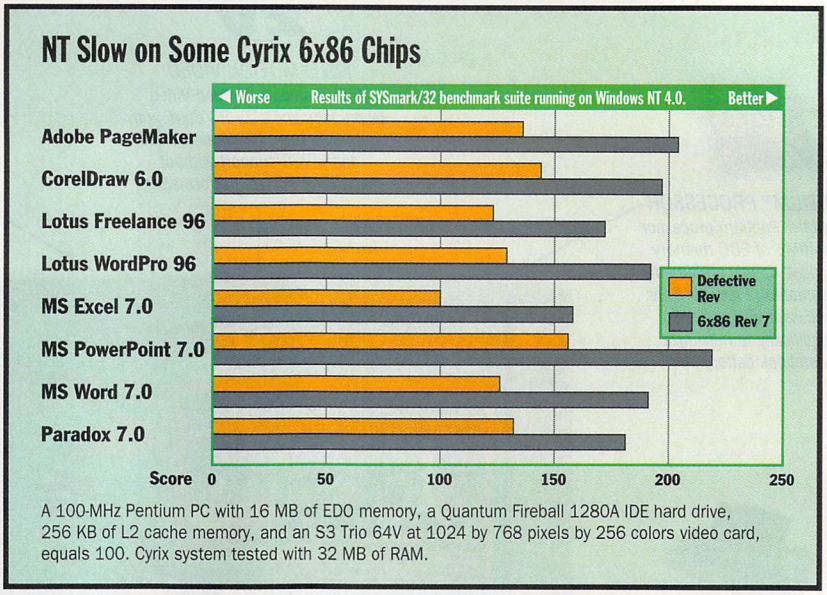
Circle 166 on Inquiry Card.

Cyrix 6x86 Bug Puts Brakes on NT 4.0



Real-world applications show the 6x86 slowdown.

Cyrix has apparently fixed a bug in its flagship 6x86 processor that results in sluggish performance of Windows NT 4.0, but not before chips affected by the bug reached the market. This bug, uncovered by Microsoft during its prerelease tests of NT 4.0, caused the new OS to crash. To guarantee NT 4.0's stability, Microsoft added code that disables write-back caching in the 6x86's on-board cache. Tests BYTE performed on a Cyrix PC with the 150-MHz 6x86-P200+ processor revealed that applications running under NT 4.0 on a Cyrix chip containing the bug suffered a performance degradation of about 30 percent, compared to later revisions of the 6x86.

Cyrix says it hasn't identified the specific problem in the 6x86 that caused the instability during Microsoft's testing. "We're trying to figure out what exactly is going on," said a Cyrix spokesman.

BYTE has confirmed that a new version of the 6x86 (designated as revision 2.7 by Cyrix) doesn't exhibit the slowdown, indicating that NT 4.0 can distinguish between defective and fixed versions of the chip. If NT 4.0 detects one of the fixed chips, it runs at standard speed with the chip's internal cache fully enabled.

Cyrix would not specify what changes it made in the chip or the manufacturing process between revisions 2.6 and 2.7 that may have fixed the problem. Company officials said it is Cyrix's policy not to discuss the specifics of chip revisions.

When asked about the 6x86/NT problem, Microsoft stressed that NT 4.0 is stable on all certified platforms, including all versions of the 6x86. Once Microsoft discovered that a 6x86 couldn't complete the company's so-called stress tests, it alerted Cyrix, and both companies developed a workaround for the problem.

In the workaround, the companies added a series of instructions to NT 4.0 to identify problematic 6x86es. When a chip with the bug is found, NT 4.0 changes the chip's internal cache operating mode from write-back to write-through. As a result, all memory writes, even those cached inside the chip, force an access to system memory. This change let the 6x86 complete Microsoft's testing, but at the cost of reduced system performance. Cyrix says it is investigating whether a software patch to NT 4.0 will correct the problem. The company also says that other members of its 6x86 family that run at slower clock speeds may be affected by the NT slowdown.

Measured by the SYSmark/32 benchmark suite of eight real-world Windows applications, a 6x86 with its write-back caching disabled turns in poorer NT 4.0 performance than a 133-MHz Pentium. One vendor who sells Cyrix-based systems didn't seem worried by the performance problem. Art Afshar, who is president of Micro Express (Irvine, CA), said that most of his customers buy a 6x86-based PC to run Windows 95 and choose the Pentium Pro to run NT. However, about 25 percent of the people who responded to an article about the Cyrix/NT performance slowdown that BYTE posted to its Web site said they had either bought or were strongly considering a 6x86-based PC as a platform for running NT. Afshar said that the company will replace the chip for customers with slow NT 4.0 performance on a 6x86.

Cyrix recently began direct-marketing

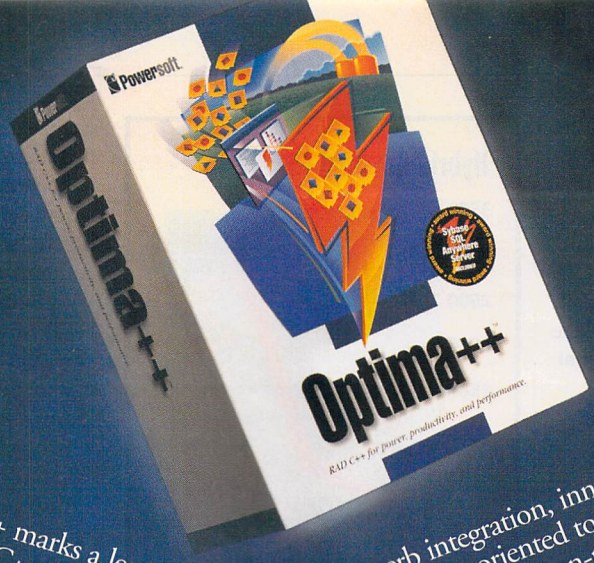
future watch

Cruising Twenty-First Century Style



Smart cruise controls for cars could prevent drowsy drivers in the future from drifting out of their lane or driving too fast around a curve. Today's cruise-control systems let you set a preferred speed at which your car will travel, freeing you from the tedium of stepping on and off the accelerator on long drives. Researchers at the Robotics Institute at Carnegie Mellon University (Pittsburgh, PA) are working on next-generation systems that combine visual sensors and microprocessors. These intelligent systems will change speeds relative to the curvature of the road. They will also be able to warn you if you are not traveling in the correct lane and alert you to potential obstacles, even ones you can't see. Another possibility is maintaining a certain distance between your car and the one in front of you.

This is one of several new uses of robotics (for others, see this month's interview on page 48). Takeo Kanade, director of the Robotics Institute, says smart cruise-control systems should be ready in about two years. However, before they start showing up in cars of the twenty-first century, car manufacturers and the public will need to accept the concept. –D.A.



"Optima++ marks a leap forward over traditional C++ tools." *Rich Dragan, Windows Sources - June 1996*

"Powersoft's new development tool makes creating corporate applications with C++ an optimal experience." *Dan Rogers, Software Development, September 1996*

"Optima++ is a powerful product that combines the ease of use of VB's component metaphor with the speed and power of C++." *Steve Jackson, Visual Programmer++, September 3, 1996*

"Powersoft has scored a home run." *Dan Rogers, Software Development, September 1996*

"Optima++ represents a breakthrough in visual programming not only for C++ developers, but for all users of fourth-generation language (4GL) client-server tools." *Rich Levin,*

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"Look, it's VB - No, Wait - C++" *Rick Grehan, BYTE, August, 1996*

"Optima++ provides direct ODBC support, meaning classes and bound controls call the ODBC API directly, without an intermediate layer such as VB's Jet engine or Delphi's IDAPI." *Steve Jackson, Visual Programmer++, September 3, 1996*

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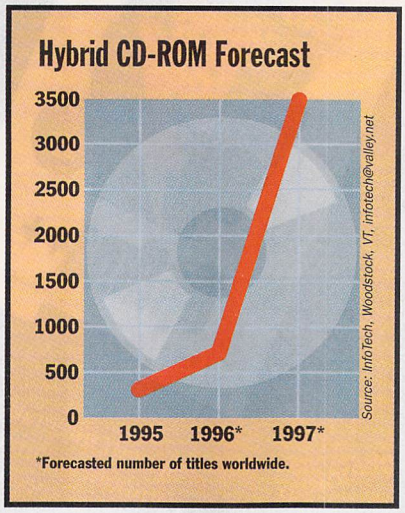
its own brand of PCs built around the 6x86p. When asked if Cyrix would provide a chip that runs at full speed under NT 4.0 to customers who request one, Steve Tobak, vice president of marketing at Cyrix, said that it would offer a software fix if one is available. Or, he added, at the user's option, Cyrix will replace the chip. **–Robert L. Hummel**

CD-ROM Weds the Web

Although digital videodisc (DVD), the impending new CD-ROM standard, is currently attracting much attention, another important trend in optical storage is the marriage of the CD-ROM and the Internet's World Wide Web. Hybrid CD-ROMs are titles that include on-line communications, such as links to Internet sites where users can access expanded content. According to InfoTech (Woodstock, VT), a CD-ROM research and consulting firm, hybrid CD-ROMs are expected to account for nearly 10 percent of all CD-ROM titles in print worldwide by 1997.

Hybrid CD-ROMs have numerous advantages. A publisher can put high-quality video clips on the CD-ROM, instead of making you squint at postage-stamp-size, slow video as it transmits over the Internet. Game developers can establish links to Web sites that let you download gaming scenarios or participate in networked multiplayer sessions. Edutainment developers can create titles that have a link to an on-line interview. For example, a new title from the Graphix Zone (Irvine, CA, (800) 828-3838 or http://www.gzone.com/) called Herbie Hancock Presents Living Jazz includes links to an FTP site where you can download interviews with jazz greats to your hard drive.

Besides providing advantages to content developers, the emergence of the hybrids is also an opportunity for publishers of toolkits that make it easy to create such CD-ROMs. One such product is the WebCD development program, which is available from MarketScape (Colorado Springs, CO, (719) 593-9890 or http://www.marketscape.com). It does much of the work for you by helping you organize your Web content (for more information, see "Hybrid Web/CD-ROM: Do It Yourself" on page 54). Companies such as Folio (Provo, UT, (801) 229-6700 or http://www.folio.com), whose customers access data stored in proprietary infobases, have introduced Internet-enabled programs that leverage their core products.



The next big thing: CD-ROMs with on-line access.

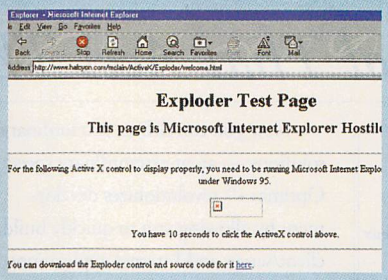
For example, Folio says it will release a new version of its Web publisher that lets Internet users access information contained in Folio infobases. Folio's first Web publisher worked with only one HTTP server. Version 2, which should ship this fall, will run on HTTP servers from Netscape, Microsoft, and others.

Another version of Web publisher, which will follow version 2 and should ship late this year or in early 1997, will add some new features. They include support for document metering, rights management, and other functions currently supported in Folio, company officials say. Folio also provides tools for integrating disparate data stored in Folio infobases and Hypertext Markup Language (HTML) into a hybrid CD-ROM package. Says Ted Pine, chairman of InfoTech, "The Web will become the universal way to look at things, but the data you're browsing may originate from legacy databases." **–D.A.**

Bug of the Month

Be Careful Out There!

This month's choice isn't a bug per se, but rather a dramatic example of what can happen when good people download bad ActiveX controls. Fred McLain, CEO of Apropos, a software engineering company, wrote an ActiveX control to illustrate the potential dangers in downloading ActiveX programs. If you're using the final version of Microsoft's Internet Explorer 3 and download his Exploder control, it performs a clean shutdown of your Windows 95 system.



"I'm warning visitors to my Web page [http://www.halcyon.com/mclain/ActiveX] that you have to be careful," McLain says. He points out that someone else could just as easily write an ActiveX control that formats your hard drive or does other equally bad things.

Exploder went through the Authenticode process, in which controls are submitted to VeriSign, the digital-authentication company that is working with Microsoft. With Authenticode, a software publisher signs its code with a unique digital signature, which confirms to users who published the control and that it hasn't been hacked.

Microsoft says Authenticode wasn't designed to guarantee that users won't download malicious code, but that the technology does provide a measure of accountability on the Internet. McLain is not convinced that's enough.

"If I were to put a loaded pistol on the table with a note indicating who owns the gun, that won't prevent a 3-year-old from walking in, picking up the gun, and accidentally shooting himself," says McLain. "The note wasn't enough to prevent the accident." At press time, McLain was putting the final touches on a version of Exploder that does another clean shutdown, this time of Windows NT. **–D. A.**

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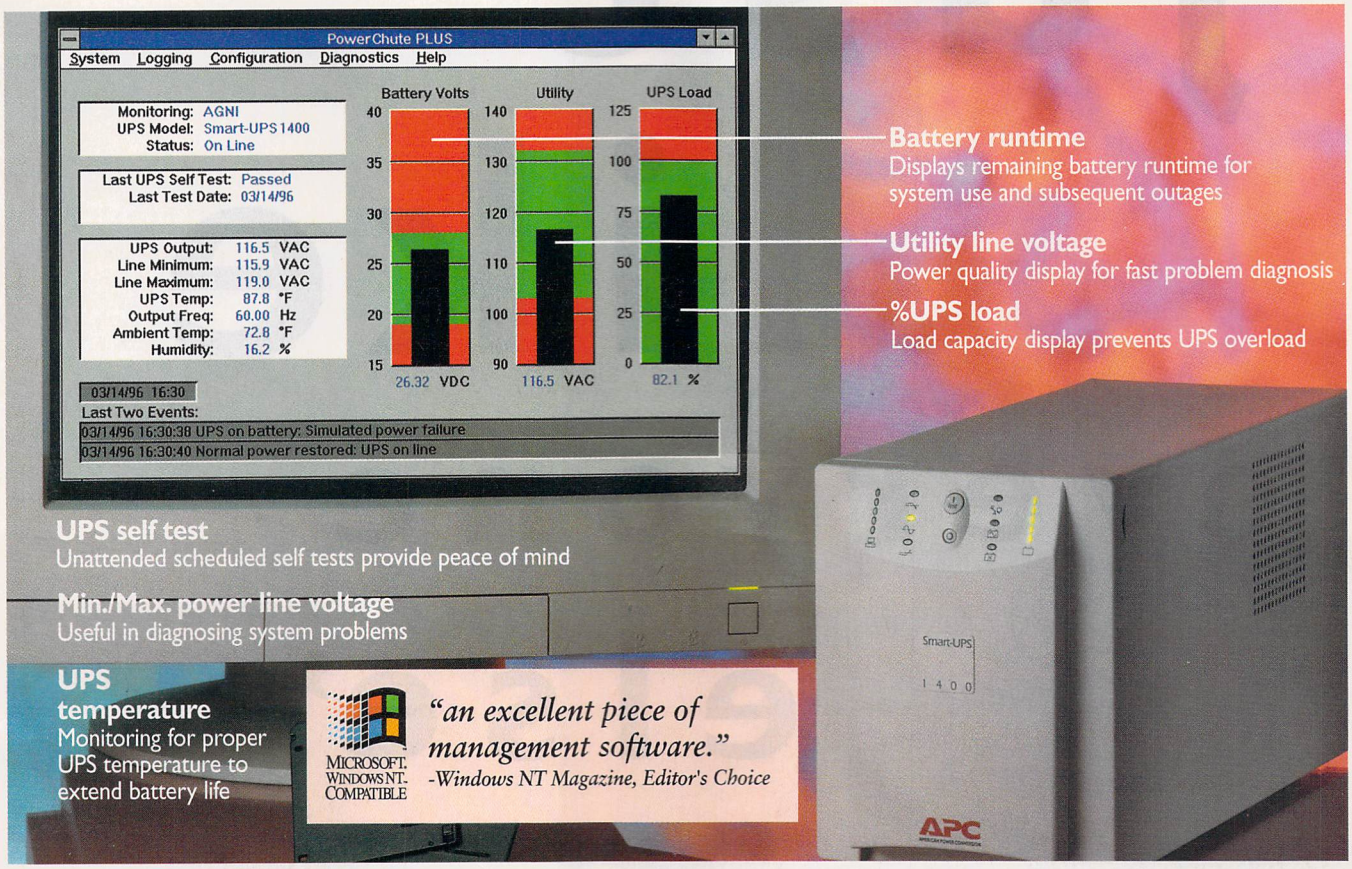

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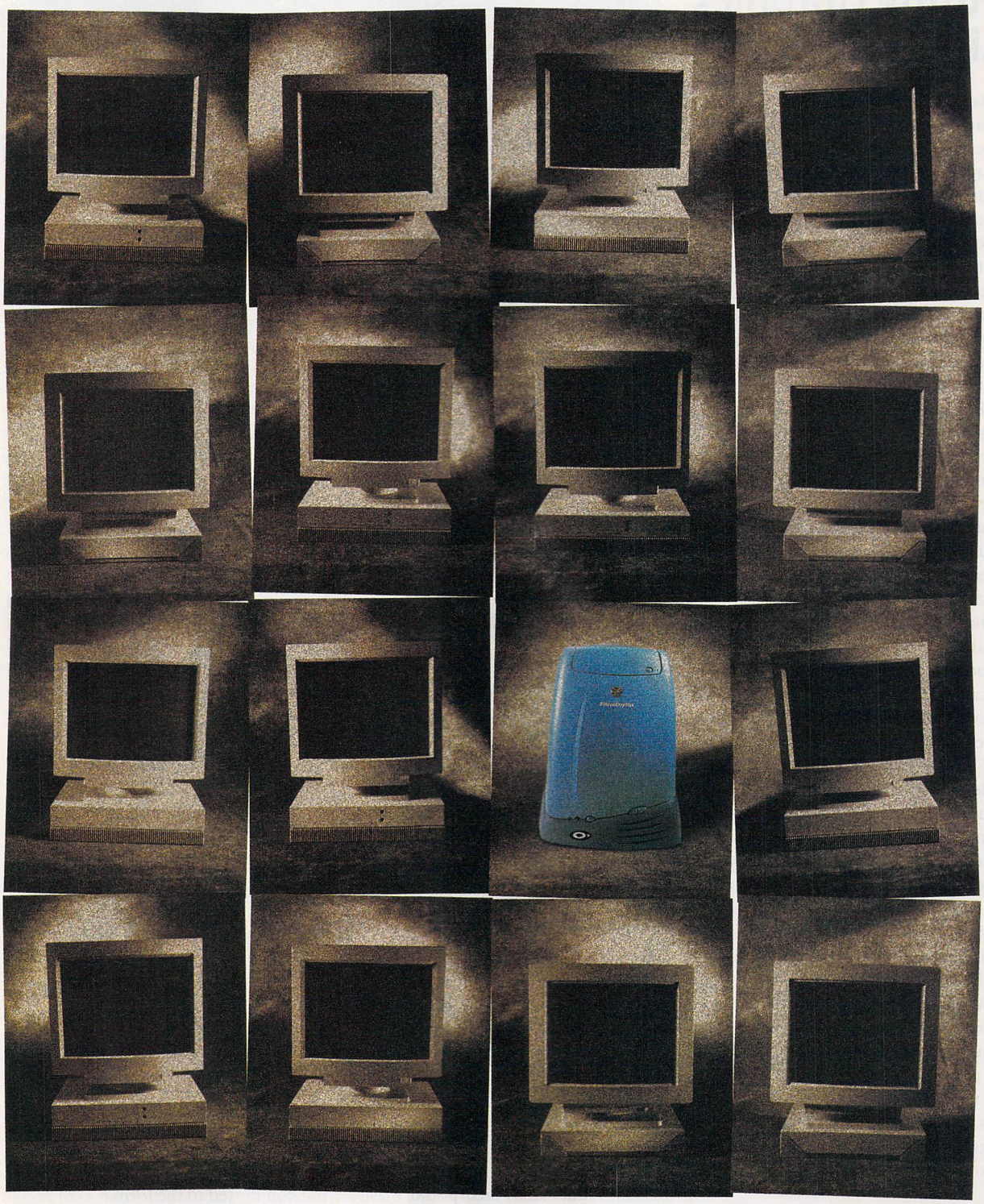

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FlashPix: Future Graphics Lingua Franca?

It isn't often that a file format generates much excitement or offers much to end users, but the new FlashPix architecture may be the exception. Kodak created FlashPix, in collaboration with Hewlett-Packard, Live Picture, and Microsoft, to provide a better way for people to work with digital images. One important design goal of the FlashPix file format, which should now be available, is to let you work with large photographic images without requiring high-end computing power or bandwidth.

FlashPix meets this challenge in an ingenious way, based on the premise that most people don't need to work with all parts of an image at once. Images saved in the FlashPix format are automatically stored in a tiled format of 64 pixels per square. In this way, you can save images of any size, and when a FlashPix-optimized software program asks for data, only the specific tile or tiles requested are loaded into memory. The benefits of this approach: Photo editing is much faster because only the affected area is loaded into memory, and the changes are available almost instantly for the same reason.

FlashPix stores single images at multiple resolutions and enables applications to automatically choose the best resolution for a particular activity. You can thus access a smaller low-resolution image for an on-line preview and then download a bigger high-resolution copy of the image. This should eliminate the long waits currently associated with viewing high-quality graphics on the Web.

Another big plus is FlashPix's ability to save edits as a linked file, which can reduce storage requirements, especially for graphic artists who often save multiple versions of the same image. You can link edits to an original file but store the edits separately, thus eliminating the need to store multiple versions of the entire file.

At press time, there was only one program, Microsoft's Picture It, an image-editing application, that supported FlashPix. Software Development Kits (SDKs) for writing Windows and Mac FlashPix applications should now be available. Several vendors may incorporate FlashPix into scanners, printers, and digital cameras. Microsoft says that it will incorporate FlashPix into its Internet Explorer Web browser.

However, not everyone has endorsed FlashPix. One notable company that had not committed to the format as of press time was Adobe. Kodak officials say they will continue to discuss FlashPix with Adobe and others. If the standard is successful, FlashPix could make digital imaging easier, faster, and more fun.

–Jon Pepper

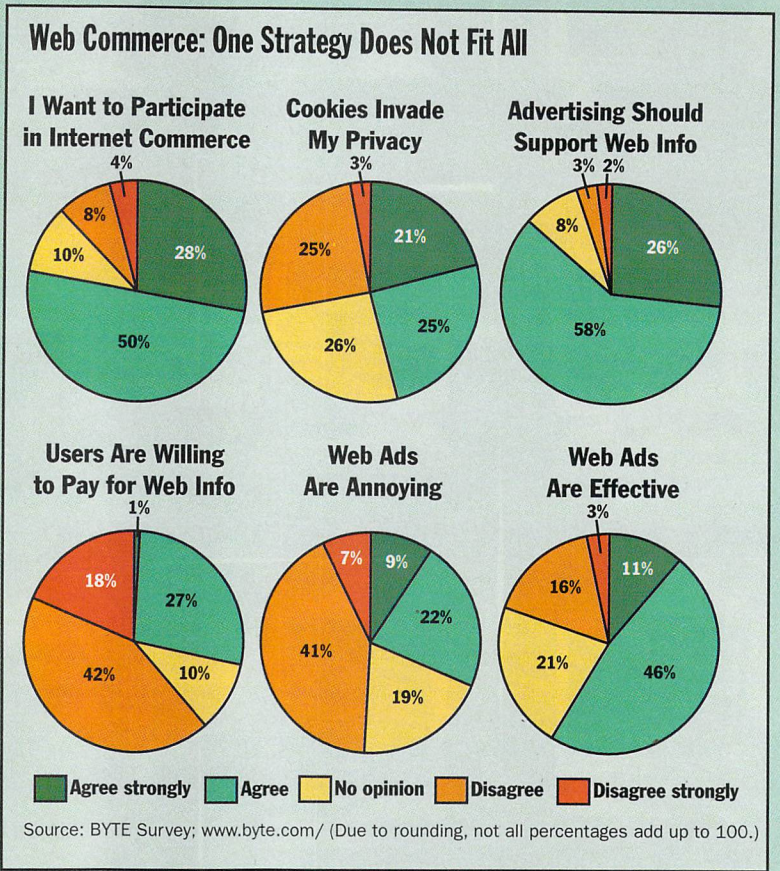
Survey

Web-Commerce Polarization

This month's BYTE survey on Internet commerce and privacy reveals a sharp difference of opinion regarding how much privacy users are willing to give up in exchange for access to free information. The topic of cookies is an especially tricky one. Cookies, small pieces of code that are stored on an end user's computer, let a Web server automatically grant visitors access to areas to which they are specifically entitled. Paid subscribers can automatically access value-added information, for example, but Web masters can use cookies to track your activity on their sites in a detailed way.

This tracking capability makes users nervous. "Commercial sites have every right to monitor your actions within the spectrum of their site," says one respondent. "But they should not have the right to distribute that information to others." Another says, "Use of tracking data aggregated to eliminate individual identity is OK, but using individuals' data is too great an invasion."

Other respondents favored the use of advertiser-supported free information. Also, if faster links to the Internet become prevalent, letting ads come up more quickly in a Web browser, that may reduce complaints against on-line ads. What's the answer? Probably a mixture of strategies. As one respondent says, "I guess we live in interesting times when it comes to formulation of Net commerce."



Source: BYTE Survey; www.byte.com/ (Due to rounding, not all percentages add up to 100.)

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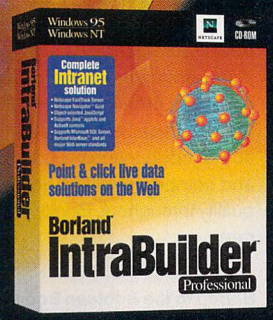

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Java Forms: Better than HTML

Now that forms vendors have tackled the Common Gateway Interface (CGI) problem, they are addressing the next step in Internet forms software, the incorporation of Java. Vendors such as JetForm (http://www.jetform.com) and Caere (http://www.caere.com) have introduced products that let developers create—without having to learn CGI programming—forms solutions that can integrate with databases for electronic-commerce and work-flow applications.

However, the current solutions have trade-offs. You can let an end user fill out a Hypertext Markup Language (HTML) form using any Web browser, but HTML doesn't let you preserve the exact look of a paper-based form. Or, users can fill in a non-HTML form that has added intelligence (e.g., field validation and error checking at the client) and a more robust look, but that requires them to download a proprietary filler product such as JetForm Filler for the Web. This is where Java can save the day.

JetForm, which acquired Delrina's forms and work-flow technology from Symantec, is about to enter beta testing on an upgrade to its forms designer, which will soon emit a Java applet. According to Michael Cohen of Paperless Performance (http://www.paperless.com), a developer of electronic-forms solutions, Java support lets you have the best of both worlds. You can view forms in any Java-compliant Web browser, and, unlike HTML forms, the Java applet can have field-level intelligence and help, and also be an exact replica of a paper-based form. Field-level intelligence lets a form catch user-input errors before erroneous data is sent to a server. "And providing an exact replication of the paper form that may be used today makes people, especially computer novices, more comfortable when filling in the electronic form," says Cohen.

JetForm admits that the initial version of its Java solution will not have the full functionality of its JetForm Filler. For example, the initial Java implementation probably will not support database lookups. But JetForm officials say they will continue to improve their Java story. **–D.A.**

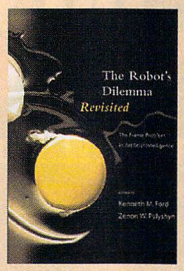
Book Reviews

What Was the Question?

The most obvious problem with this collection of nine essays on the frame problem in AI is that it does not tell you exactly what the frame problem is. Your best bet is to read the epilogue first. This pseudo-Mother Goose–style section is probably intended as an inside joke by the cognoscenti, but it's actually more helpful than the rest of the book.

As I understand it (and if I'm wrong, write to Ford and Pylyshyn, not me), the frame problem involves how much information you need to give a robot (or a computer) for it to perform a task as well as a human would. For example, when frying an egg, do robots need to know what to do when the egg carton is empty? What about when the frying pan used yesterday still sits in the sink, unwashed?

Other descriptions of the frame problem include "describing and updating a set of beliefs efficiently" and (my favorite) "Now what do I do?," which almost any reader of this book can say at anytime. Clearly, the folks who work on the frame problem have a hard time agreeing on exactly what it is. Furthermore, it overlaps many subject areas, including psychology, ethics, philosophy, and religion.



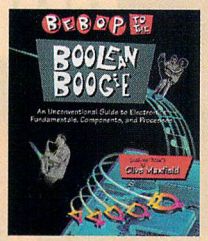
Reading this book is tough work. The authors do not adequately define words such as *metaphrands*, *metaphiers*, and *Quineian*, as well as references to concepts such as *Yale shooting*. The book lacks a glossary and provides a mere one-page index of topics. One particular essay, a poorly written science fiction story containing profanity and spelling and grammatical errors, illustrates the book's low level of editing.

I would recommend this book highly for anyone whose essay is published in it. For the rest of us, any robot story by Isaac Asimov or Stanislaw Lem will tell us more—in a more lucid and entertaining manner—about the difficulties of designing thinking machines. Now what do I do?

–Edmund X. DeJesus

Deluxe Digital-Electronics Primer

Having picked up digital electronics on my own, I've always looked for a book that could fill in the holes in my piecemeal self-education. This is it. With clear explanations, many effective figures, and typical British humor, Clive Maxfield surveys not only the basics of computer electronics, but also state-of-the-art semiconductor fabrication and packaging techniques. I am happily amazed that Maxfield covers so much, so well. Four hundred plus pages on electronics have never gone so fast.



The humor that peppers the introduction, footnotes, and appendixes (especially the last one, a seafood gumbo recipe) makes for easy reading, but the content is serious, well researched, and up-to-date. It starts with just enough basics from chemistry, physics, and number systems to get you to the workings of semiconductors and simple logic circuits. From there, the book covers tools such as Boolean algebra, Karnaugh maps, and state diagrams that circuit designers use to build more complex logic from basic gates.

The book then switches gears to discuss semiconductor fabrication processes, the design of memory and programmable logic devices (PLDs), a bestiary of ASICs, packaging strategies (including multichip modules), and promising fabrication technologies such as 3-D interconnect. That the author obviously hand-edited the glossary and comprehensive index is a sign of the quality throughout. Books of this caliber are rare. **–Dave Rowell**

The Robot's Dilemma Revisited: The Frame Problem in Artificial Intelligence
Edited by Kenneth M. Ford and Zenon W. Pylyshyn, Ablex Publishing Corp., 141 pages, ISBN 1-56750-143-5, $22.95

Bebop to the Boolean Boogie (An Unconventional Guide to Electronic Fundamentals, Components, and Processes)
by Clive Maxfield, High Text Publishers, 471 pages, ISBN 1-878707-22-1, $35

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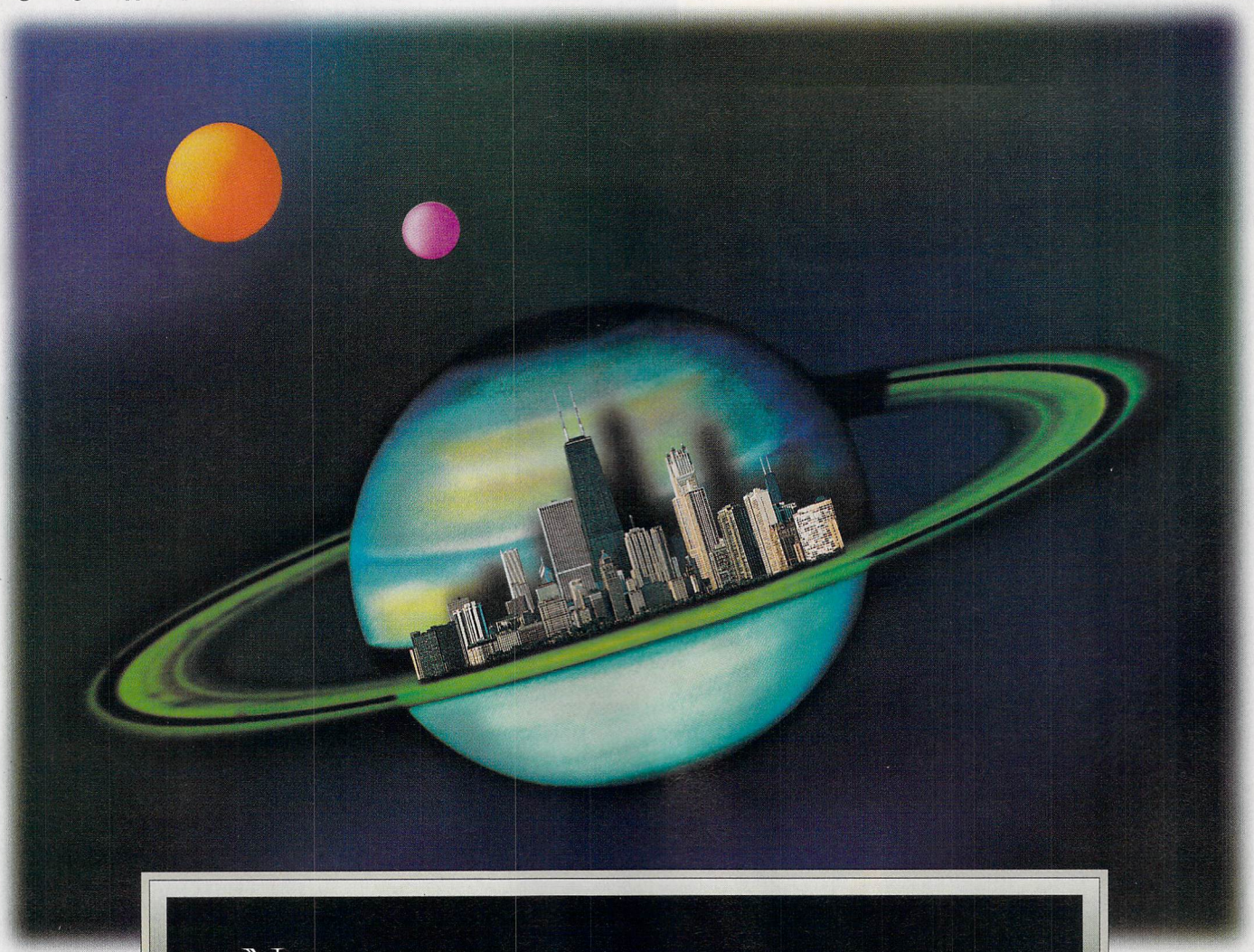

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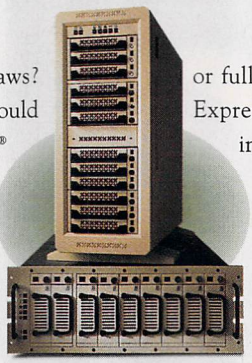

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Datapro Report

Wanted: Client/Server Expertise

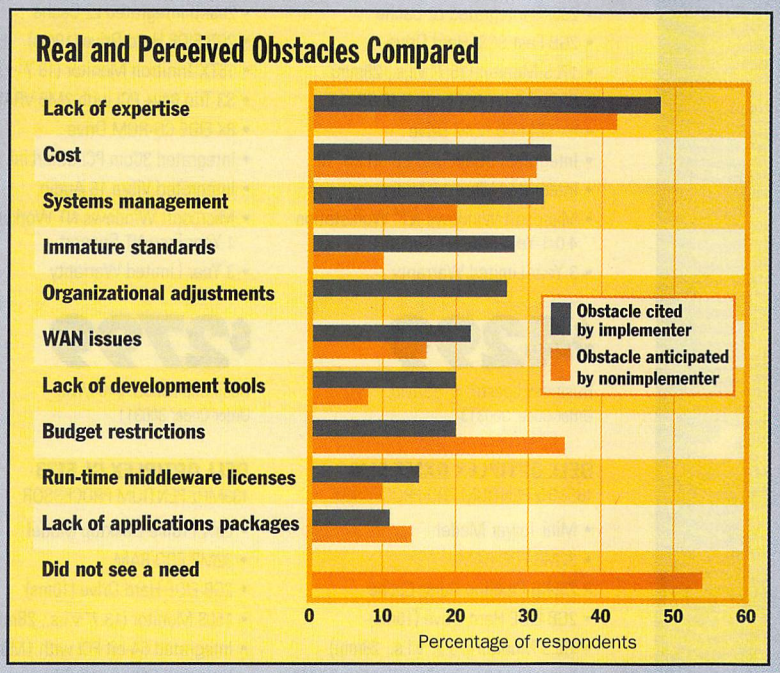
High costs and lack of expertise and systems management are the major obstacles on the way to realizing the benefits of client/server computing, according to Datapro's 1996 International Client/Server Issues Survey. Information systems executives understand the cost implications of client/server computing, realizing that, despite the conventional wisdom of the early 1990s, expenditures may be even higher than those of a monolithic system. However, they also believe that the benefits outweigh the cost and other disadvantages.

Implementers said the top benefits are improved end-user access to information, the ability to flexibly react to business needs, and scalability (i.e., the ability to add additional capacity).

As expected, the trend line for full implementation of a client/server system continues strongly upward. In 1994, 18 percent of the respondents to Datapro's survey had fully implemented a client/server system. By 1995, that number increased to 25 percent, and this year, it was up to 46 percent. Of the implementers, half use a two-tier scheme, but a third use multiple-tier schemes. Additionally, about 75 percent of them incorporated legacy systems, and about one-third of those incorporated legacy systems through real-time connections, as opposed to gateways or batch data transfer.

As you can see in the chart, the perceived disadvantages of client/server computing among those who haven't implemented a system differ—in some cases by a large margin—from the disadvantages as stated by those who have completed their systems. Nonimplementers seem to have less awareness of the pitfalls of immature standards, system management, and the lack of development tools compared to those who have already implemented a client/server system. Of this year's respondents, 29 percent are still making client/server plans. Those who are still in the planning process might want to reevaluate how many resources they plan to devote to trouble areas such as systems management and immature standards.

Dennis Byron *is a senior analyst for Datapro Information Services. For more information on Datapro Information Services: (800) 328-2776, (609) 764-0100, or http://www.datapro.com.*



Those not implementing a client/server system underestimate the obstacles of management and immature standards.

Notebook Screen Future: Bigger and Wider

Major suppliers of LCD panels—including Sharp, NEC, and Mitsubishi—are developing displays that are larger and more advanced than today's 12.1-inch thin-film-transistor (TFT) standard. Sharp's new Super-V LCD, currently available only as a 13.8-inch prototype TFT model, has 1024- by 768-pixel resolution, a 140-degree viewing angle, an ultrahigh brightness-to-darkness contrast ratio (300-to-1), and a viewable image area roughly equivalent to that of a 16-inch CRT.

Although Sharp is not shipping this model yet, its PC-9090 notebook, due for delivery by the end of the year, will include some of its aspects. The PC-9090 uses a Super High Aperture 12.1-inch TFT with 1024- by 768-pixel resolution and brightness Sharp claims is 50 percent higher than previous models.

Sharp ((800) 237-4277 or http://www.sharp-usa.com) also just released the first wide-screen notebook, the 4.6-pound WideNote portable. Its 9.6- by 5.6-inch display (see the photo) can show two side-by-side Web pages or a standard-width letter with extra space left over on the side. The 16-to-9 aspect ratio is the same as a movie screen. The wide-screen LCD has a resolution of 1024 by 600 pixels and a diagonal measurement of 11.28 inches.



Sharp's WideNote display reduces the need to scroll through spreadsheets.

NEC and Mitsubishi (among others) are currently working on LCD screens bigger than 13 inches, and NEC has

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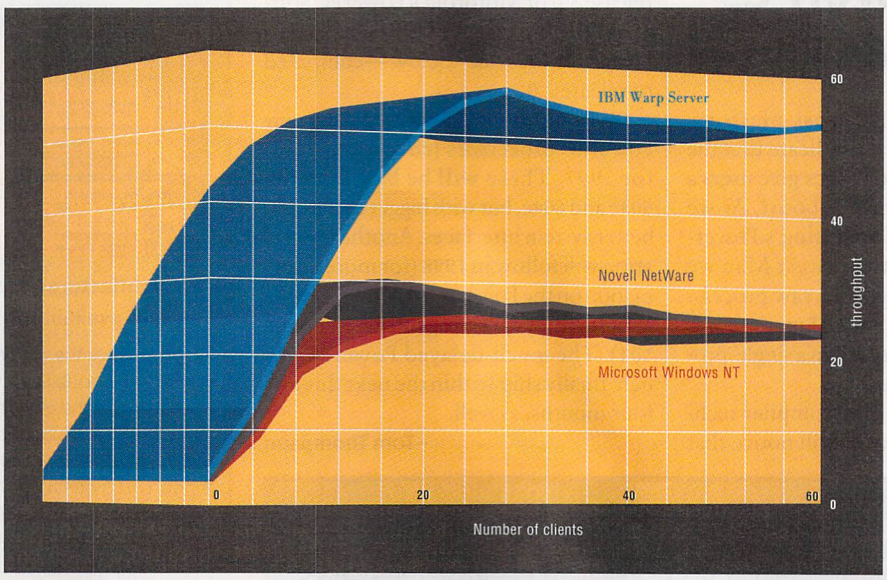

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demonstrated 20- and 26-inch panels in Japan. While those are not intended for use in a notebook (such screens are wider than today's standard laptop size), analysts expect the 13.8-inch size to appear in notebooks toward the end of 1997. Today's 12.1-inch display that seems large will soon look as outmoded as 10.4-inch displays do now. **–J.P.**

New PowerPCs Boost Macs

Results from BYTE's cross-platform BYTEmark benchmark indicate that the latest PowerPC-based Macs give users a significant performance boost. As we expected, Power Computing's PowerTower Pro 225 is the fastest Mac we have tested, in terms of its raw processing power. Indeed, its BYTEmark scores are the highest we've seen in a single-processor desktop system.

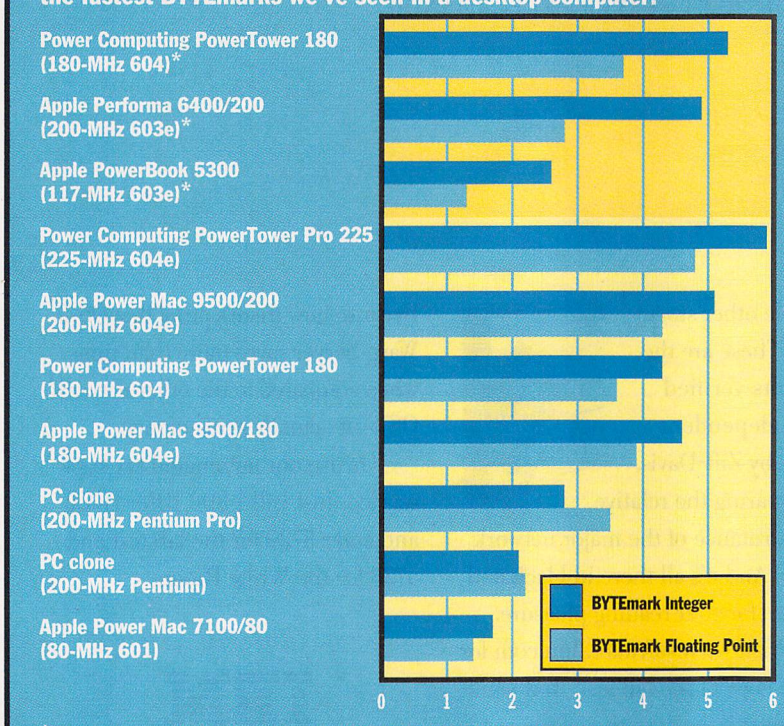
Due to differences in compiler technology, a careful reader will notice that the results shown here for certain processors (e.g., the 200-MHz 603e) differ from the results we posted in our August issue. This is because we used different compilers to compile the BYTEmark suite for Windows NT and the Mac OS. Improvements in compiler technology can also improve performance on the same chip. For example, the 180-MHz 604 gets a big boost in integer performance when executing BYTEmarks that were compiled by release 3.0 of Motorola's PowerPC Software Development Kit (SDK)—see "New Power for the Mac" below—compared to release 2.0.

IBM and Motorola are preparing new PowerPC processors (code-named G3) for 1997. These will be based on the 603e and 604e, but with bigger caches and better system interfaces. Another generation will follow in 1998 (for more information on the PowerPC road map, see the article "PowerPC Regroups" on page 101). The much-delayed PowerPC 620 may finally ship within the next three or four months, as well.

–Tom Thompson

New Power for the Mac

New Mac OS systems based on the 225-MHz PowerPC 604e turn in the fastest BYTEmarks we've seen in a desktop computer.

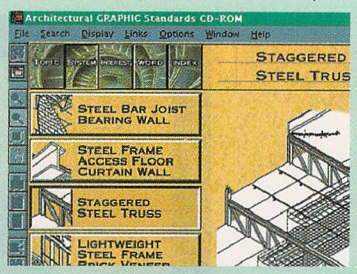


*BYTEmarks compiled using Motorola's PowerPC C/C++ SDK for the Mac OS, DR 3.0. All other Mac OS BYTEmarks compiled using Motorola's PowerPC C/C++ SDK for the Mac OS, DR 2.0. A 90-MHz Pentium equals 1. PC BYTEmarks compiled using Watcom release 10.

cd-rom review

Architecture Bible on CD-ROM

Moving a venerable reference book onto a CD-ROM can be either a waste of plastic or a huge step forward in terms of usefulness. You hope that such a transposition increases the convenience, searchability, and portability of the material.



An architectural reference bible is now available on CD-ROM.

John Wiley and Sons has put the entire contents of *Architectural Graphic Standards*, a reference bible for architects since 1932, on CD-ROM. The disc defines and explains structural, mechanical, and electrical systems with text and technical diagrams. You can search it by several methods, including standard text searching and an index.

A potentially great feature of a CD-ROM like this is the ability to use its included diagrams in your drawings. However, only 10 percent of the diagrams on this version are in accurate vector format.

The interface is intuitive, although navigation is difficult because it is hard to retrace your steps. You can export whole illustrations or parts of them into your word processing or graphics programs, but you cannot cut and paste from this program. Currently, tables and equations found in the CD-ROM are not interactive, but they will be in a future version (slated to ship in about a year and a half).

John Wiley and Sons has not created a perfect transition of *Architectural Graphic Standards* from one medium to another. However, it is an important beginning that hints at exciting possibilities.

–Jason Kraus

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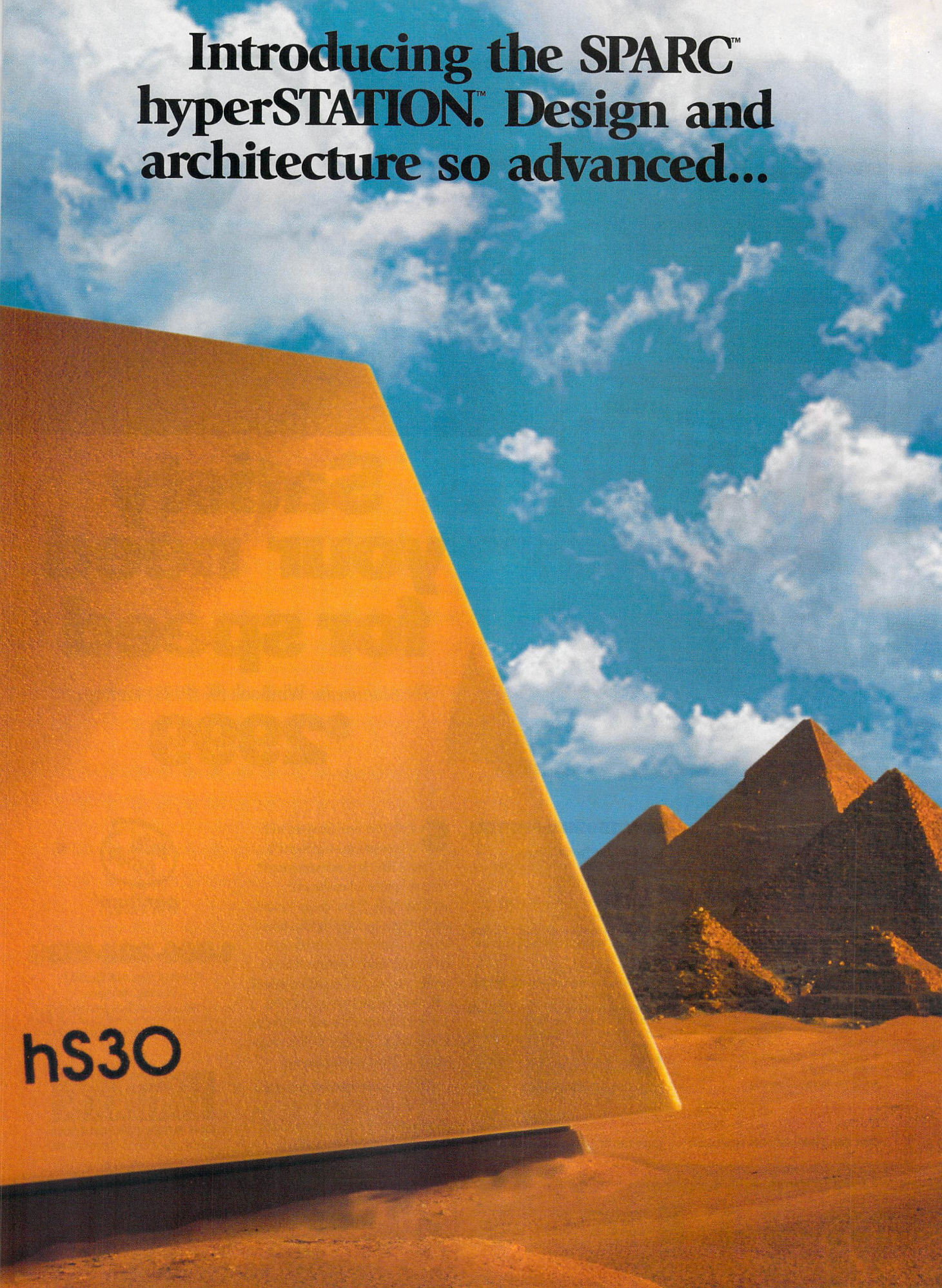

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Circle 161 on Inquiry Card (RESELLERS: 162).

Blasts from the Past

5 Years ago in BYTE

The industry was in transition. Apple and IBM were working together, as were IBM and Microsoft, despite their recent public divorce. More details on a new OS called Windows NT began emerging. Sales of Windows 3.0 were encroaching the Mac, but Novell was still pushing DR DOS. Meanwhile, we put the ill-fated Momenta computer on the cover. Pen-based computing hasn't yet broken into computing's mainstream, and Momenta Corp.'s eventual collapse is a good analogy for the eventual fate of many of the pen-based start-ups. A stronger trend that we devoted coverage to in that issue: network interoperability.

10 Years ago in BYTE

BYTE took an early look at Compaq's Deskpro 386, which started at about $6500. We also reviewed the Mac Plus, which upped the Mac's memory from 128 KB to 1 MB and increased the floppy drive from 400 to 800 KB, among other things. Also in that issue: scads of information on knowledge representation.

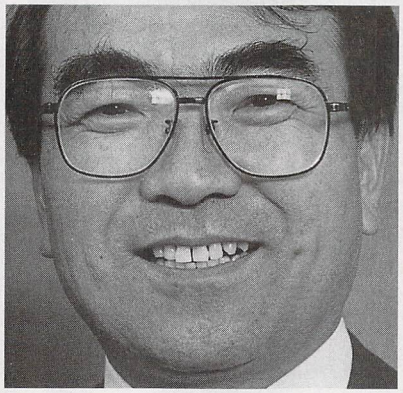
15 Years ago in BYTE

We focused on data management and the problems thereof. Other articles focused on how to use the microcomputer as a laboratory instrument and a hardware product from Microsoft called the Softcard. This was a $399 board that allowed you to run programs and languages written for CP/M on your Apple computer.



Beyond R2D2: Robots Evolve

Takeo Kanade, director of the Robotics Institute at Carnegie Mellon University, reveals how robots will make our world better and more entertaining.



BYTE: *Robots are showing up in new places and in new forms. What interesting new uses are you exploring for robots?*
Kanade: The scope of where robots are used has been and will be expanded from the factory floor to more "natural" environments, including agricultural fields, mines, and construction sites. We are also looking at space and planetary exploration and other hazardous environments, including natural environments such as volcanoes and those of human origin, such as nuclear environments.

BYTE: *Your robots have explored volcanoes to gather data. What other tasks can robots do that humans currently must perform at great risk?*
Kanade: Another one that we are working on is a helicopter project, a flying robot. This has an advantage when rescuing people in bad weather or fire fighting. In bad weather, for example, a ship sinks and survivors are expected. The first thing is to try to find them. But the rescue mission may be put on hold in bad weather because the rescuers would also be in danger. Now if this is an unmanned mission, we can risk a helicopter crash. On all these dangerous missions, the key factor is, the more risk you take, the more effective is the mission. If you can do a task in such a way that even a crash is acceptable, the effectiveness grows rapidly.

BYTE: *A robot helicopter could help fight fires, too?*
Kanade: Yes, and again, the more effective the mission, the more dangerous. If you hit the hottest spot with a fire-fighting agent, it's very effective. But it's also dangerous. So human pilots don't fly that close. But a robot-powered airplane can accomplish dangerous missions without risking human life.

BYTE: *What about robots and entertainment?*
Kanade: That's a new breed of robotics, what is called *virtualized reality*. We have built a 51-camera dome that we call 3-D Dome. It's a 5-meter dome where the cameras are looking inside. In other words, the dome space is covered by a sea of cameras. And whatever happens inside is modeled into a CAD model. It's a natural event. So imagine that you are inside the dome, and you swing a baseball bat. How your shirt, body, and hand move are modeled into the computer. Because it is modeled, we call it virtualized reality. Once we do that, we can place you in that environment anyway you want. Thanks to the 3-D models, you can actually immerse yourself into that environment. One of the best applications that I envision is watching NBA basketball on the court.

BYTE: *So this would let you watch the game from the referee's point of view?*
Kanade: Or from anywhere inside the court. You could see what it's like blocking Michael Jordan. Or you can enjoy the view that the ball would see, if it could see.

BYTE: *What about using robots to manage data?*
Kanade: We have an infomedia project that lets you navigate in a large video database very quickly by using natural language as a query. The important viewpoint I would like to convey is that robotics is not limited to mechanical things.

For more information on the Robotics Institute, see http://www.ri.cmu.edu.

An OpenDoc word processor delivers on component software's promise of small, tightly coupled parts. ***By Tom Thompson***

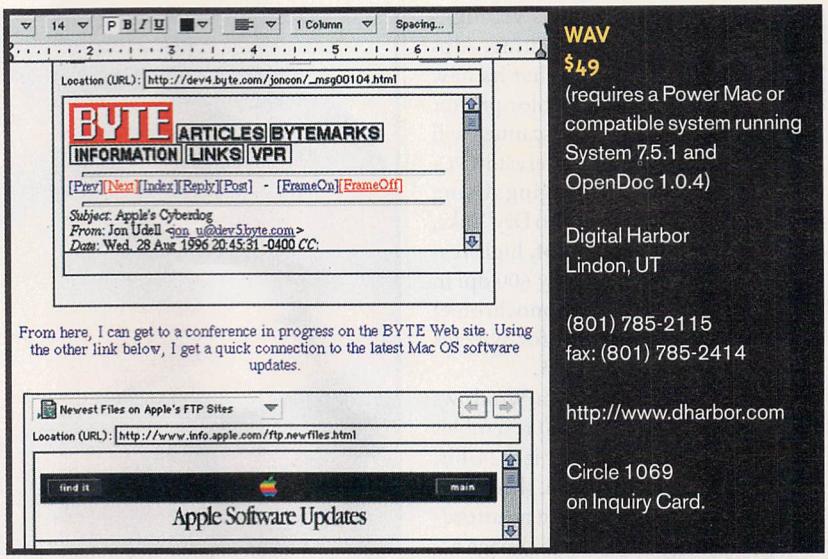
Componentized WAV of the Future

As Apple's cross-platform OpenDoc technology celebrates its first birthday, practical component software is starting to appear. One such component is Digital Harbor's WAV, which implements the bread-and-butter task of word processing. I saw a preliminary beta version. Currently, only a Power Mac version is available. As beta software, WAV has some rough edges and missing features, but it proves that OpenDoc's component-based architecture is sound.

At 1.5 MB, WAV offers a lean-and-mean set of features. That's fine: I don't want unnecessary wizards and other "features" that contribute to code bloat. For text, you get basic formatting, where you pick a typeface, style it (bold, italic, underline, and a color), and align it with a few points and clicks. WAV has a simple word-count command, a handy feature if you write to length. It does have advanced layout facilities, such as arranging the text into columns (a maximum of five) and the ability to tinker with the text spacing. To readily get at existing text, WAV has conversion filters for WordPerfect 3.x, Word 4.x, and Word 5.x files.

A FolderBay function consolidates operations or content into virtual "folders" with clickable tabs at the top of the document window. Default folders are text functions, CyberDog (Apple's Internet tool suite), and a parts folder for additional OpenDoc components (e.g., a draw editor part or a bit-map editor part). You can add your own "project" folder tab to consolidate work documents.

As an OpenDoc component, WAV takes a document-centric approach to creating and handling data. You don't launch WAV itself. Instead, you open a WAV stationary (or template) file to make a new document. A Document Info command lets you set each document's file type (e.g., WAV format or ASCII text) and memory size, so you can conserve memory by adjusting it to suit the document.



WAV
$49
(requires a Power Mac or compatible system running System 7.5.1 and OpenDoc 1.0.4)

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fax: (801) 785-2414

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WAV's tight Internet integration lets you build documents containing live updates.

WAV integrates well with other OpenDoc parts. If you have CyberDog installed, its functions are immediately available from WAV's CyberDog tab. More important, you can drag and drop Internet uniform resource locators (URLs) and graphics from CyberDog into a WAV window, and save the information into a live document. When you next access the file, CyberDog automatically connects to the Internet and fetches the URL's current information.

For example, I have a WAV file that points to a conference on BYTE's Web site pertaining to CyberDog discussions. When I'm notified of new messages in this conference, I just open the WAV document, and I'm automatically positioned at the last-read message. Conventional Web browsers do this with bookmarks, but WAV does them one better: It lets you capture links, text, and graphics into documents, bypassing the usual download, file-conversion, and import stages.

Because OpenDoc components are small and tightly focused, development costs are lower. Thus, WAV costs only $49. While you couldn't publish a book with it, you can crank out sophisticated publications with embedded images, diagrams, tables, and charts—thanks to the OpenDoc components that make WAV greater than the sum of its parts. Also, WAV represents the future of on-line publishing, where you build documents with dynamic links to information on the Web. WAV has no equal in this area. **B**

RATINGS	
TECHNOLOGY	★★★★★
IMPLEMENTATION	★★★

Tom Thompson is a BYTE senior technical editor at large. You can contact him at **tom_thompson@bix.com.**

Alps' MD-4000 prints high-quality, high-resolution color images, indelibly and inexpensively. ***By Robert L. Hummel***

Waterproof Color That Lasts

Boasting inexpensive, high-quality color printing, Alps Electric hopes that its new $499 MD-2010 color printer and $699 MD-4000 printer/scanner will ride the current wave of interest in PC-based photo-realistic imaging. Using Alps' thermal-transfer "Micro Dry" inks, these units print waterproof, high-resolution color images (600 by 600 dpi in color, 1200 by 600 dpi in monochrome) affordably, though slowly, for systems running Windows 3.x and 95.

I tested the MD-4000 in a Windows environment. The MD-4000 resembles the MD-2010, but within it is a 24-bit, 600-dpi, TWAIN-compatible, sheet-feed color scanner, which makes it an affordable one-package solution for image acquisition and printing. Alps also offers a Mac version.

With four snap-in ribbon cartridges, the MD-4000 supports hands-off CMYK printing. The printer determines the position of each cartridge. If a needed color isn't loaded, the printer prompts you for it. A $6.60 ribbon produces about 35 to 40 pages at 100 percent coverage. Alps also offers 20-page metallic ribbons (gold, cyan, magenta, and silver) for $8.99 each.

Alps claims that the MD-4000 doesn't require special paper, and my testing bore this out. I printed full-color images on copy paper, postcards, iron-on T-shirt transfers, transparencies, and photographs, as well as other coated papers, with good to excellent results. The MD-4000's multipass print engine shows minor banding only on large expanses of CMY-composite black. The printer's default color-matching produced acceptable-looking prints, and the Windows driver gives you ample opportunity to fine-tune the output.

The MD-4000's pluses are quality and affordability; speed is the minus. It took 8 minutes to print an A4-size color image at 600 dpi. Reducing image size or density accelerates the printing process proportionally. Text prints at a page per minute. Mechanically, the printer is less than rugged. A bevy of pull-out, flip-down, and sliding trays, drawers, and compartments invite accidents. I also found the feeder tray somewhat finicky.

To scan a document, you must place it in a plastic envelope—a 4- by 6-inch unit for small documents and photos or an 8½- by 14-inch unit for larger media. The Alps Copy Studio software provides bare-bones service. For anything beyond color copying, you'll want to scan from your own TWAIN-compatible image editor. Alps includes Adobe's consumer-oriented PhotoDeluxe with the MD-4000.

The MD-4000 printer isn't likely to find a home in a high-production photo studio. But for the small office or home, the attraction is clear: durable, high-quality color printing and high-resolution scanning at an affordable price. B



MD-4000
$699
(estimated street price)

Alps Electric, Inc.
San Jose, CA

(800) 825-2577
(408) 432-6000
fax: (408) 432-6035

http://www.alpsusa.com/

Circle 1070
on Inquiry Card.

The MD-4000 also has a 600-dpi color scanning head on its printing carriage. Printing and scanning share the same paper path.

RATINGS	
TECHNOLOGY	★★★★
IMPLEMENTATION	★★★
PERFORMANCE	★★

TECH FOCUS

Micro What?

The Alps "Micro Dry" process applies dry resin-based inks to paper with a 240-element thermal-transfer head. Like wax-thermal-transfer printers, the MD-4000 melts small dots from an ink-coated ribbon, one pass per color. Unlike wax transfer, resin-thermal transfer doesn't require special paper, and the output doesn't look waxy.

Robert L. Hummel is an electrical engineer, programmer, and consultant. You can reach him at **rhummel@monad.net.**

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★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

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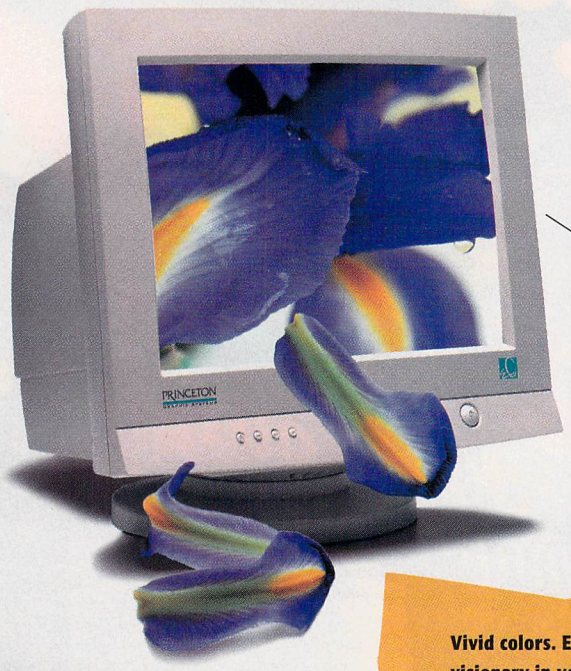

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With its latest GroupWise release, Novell goes head-to-head with groupware giants Lotus and Microsoft. ***By Steve Gillmor***

GroupWise Sends a Message

Choosing the right groupware product is harder now with the release of Novell's GroupWise 5 (hereinafter GW5), which adds significant document management tools to an already feature-laden messaging product. The new version also has state-of-the-art NetWare Directory Service (NDS), TCP/IP client/server technology, OLE automation, shared folders, and an enhanced interface.

We installed the GW5 beta on a NetWare 4.1 server, using NetWare Administrator 4.1.1. An included two-user version of NetWare 4.x gives access to NDS tools. Initially, GW5 runs only on Windows NT Server. Setup went smoothly. The GroupWise Setup Adviser walks you through extending the NDS tree; defining domain, post office, and agent names, locations, and contexts; and adding current users or new ones.

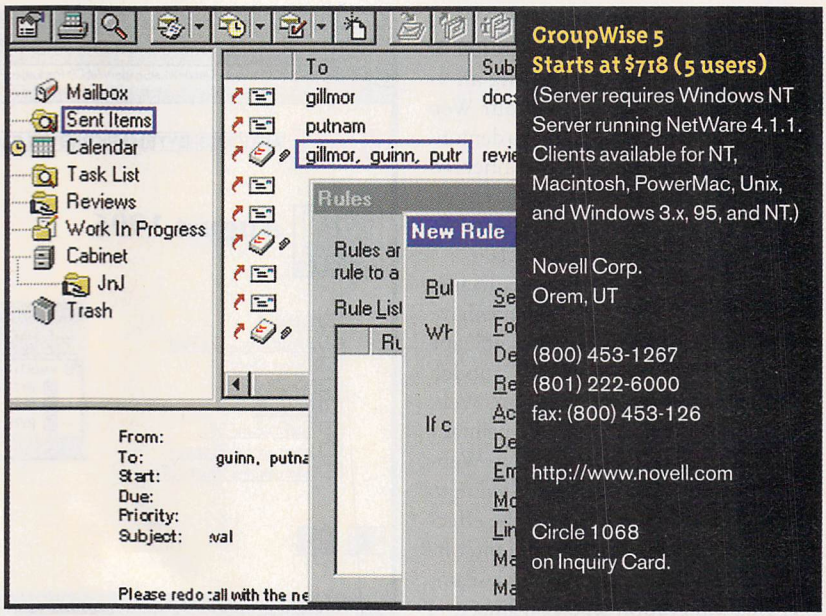
The GW5 client adopts a three-pane interface, like cc:Mail, Lotus Notes, and Microsoft Exchange. The left window displays the folder list. You can organize multiple item types by subject or by project in folders within cabinets, and sharing folders is easy.

GW5 leads the pack in document management. Novell has integrated much of its Soft Solutions product, including document check-in, check-out, versioning, sharing control, version-level security, and an activity log. Documents are stored in libraries, and mailboxes display only references to documents.

GW5 adds client/server connectivity while maintaining its drive-mapped access to the post office to ease migration and use existing hardware. GroupWise's proxy capability lets users access other mailboxes in different post offices.

With GW5 you can convert items from one type to another—for example, mail messages to calendar appointments. You can track message status by right-clicking a mailbox item and viewing its properties. You can also see incoming and outbound messages in a threaded view. You can create a rule to move items into folders, and you can define trigger events that let rules execute on a server—when you're away, for instance.

GroupWise offers a complete toolkit for messaging, calendaring, scheduling, and managing documents. It also gives you tools for single-point NDS-based administration. The package represents a tremendous value for existing NetWare shops. Its ease of use and configurability compete favorably with Exchange, but its Web integration lags behind Notes' Domino technology. And with Windows NT gaining fast on NetWare, the network administrator must think twice before making the leap to GroupWise. B



Novell's GroupWise lets you use drop-down menus to select event types, condition filters, and actions.

RATINGS	
TECHNOLOGY	★ ★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

Still to Come

The initial release of GroupWise 5 does not include everything we'd hoped for. Here are a few important omissions:

- Novell's GroupWise WebAccess supports busy searches and virtually all of GroupWise's client functions via the Internet, but this isn't bundled into GW5.
- You can't create custom icons for specific URLs in the mailbox.
- Unix and OS/2 versions are in the works.
- Promised work-flow tools won't ship until a later, interim release.

Steve Gillmor, of Southern Digital, has extensive experience with groupware applications. You can reach him at **sgillmor@aol.com.**

MarketScape's WebCD packages Web content for off-line use and automates CD-ROM mastering. ***By Jon Udell***

Hybrid Web/CD-ROM: Do It Yourself

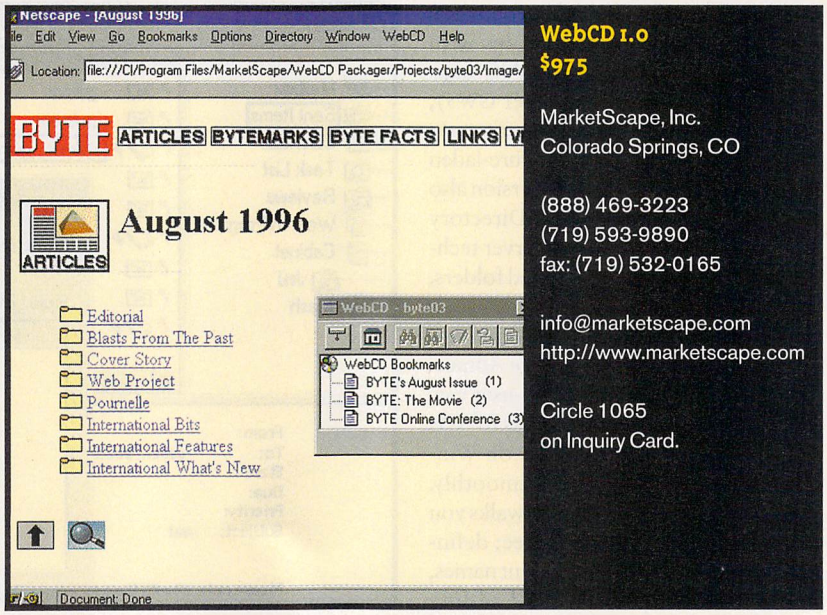
Why bother with CD-ROMs in the Web era? There are lots of reasons. Try hosting an 8-minute video on your Web site. Try asking your sales force to demonstrate your site to non-Web-connected clients. Try using your site's content on an airplane. You can solve all these problems with MarketScape's WebCD.

CD-ROMs that venture on-line to augment static content with live updates have been around for a decade. MarketScape calls it the "big CD, small Web" model. WebCD heralds a new era—big Web, small CD. It acknowledges the primacy of the Web. It delivers a native Web-browsing experience and adds value to that experience by facilitating the effective use of high-bandwidth content, off-line access to all packaged content, seamless Web integration when on-line, and content aggregation across multiple sites.

To build a site image, you run WebCD Packager, a Windows 95 application that integrates a Web crawler, a browser, and a CD-ROM-mastering utility. Point it at your Web server—or even several of your servers, or any servers anywhere (be careful!)—and scoop up the content you need. As you construct a package, you can browse it live—no waiting until the build finishes before you can view it.

To distribute the image, you deliver it—on a CD Recordable (CD-R) disc, tape, or conceivably by way of FTP—to a mastering shop. The image contains all your Hypertext Markup Language (HTML), GIF, Audio Video Interleave (AVI), and other files, mapped to the eight-dot-three filename convention required by ISO-9660 and optimized for the peculiar access behavior of CD-ROM drives.

The image also contains a setup program that installs WebCD Viewer. It's a wrapper that will find and integrate with Netscape Navigator or Microsoft Internet Explorer, adding to either browser a floating window that controls special WebCD search and bookmark functions. Mac and Unix users miss out on WebCD Viewer. However, they can point their browsers directly at the data.



WebCD lets you seamlessly integrate live Web pages with static pages and high-bandwidth data types such as video.

I tested WebCD Packager on The BYTE Site. The image I built (see the photo) combines articles from our document server with messages from our conference server. When you aggregate content across multiple Web servers (or sites), where's the home page? You can choose an existing one or make a new one, but either way, you'll want WebCD Viewer's bookmarks to call out landmark pages.

I discovered a few glitches. Although it supports proxy servers, WebCD could not tunnel through our multiple-proxy setup. Because it interleaves uniform-resource-locator (URL) discovery and retrieval, I found it tricky to map out our whole site before choosing what to package. Also, when I ran my first build, some links resolved on-line rather than locally. I'd have liked a verification tool to ensure that all referenced pages were included in the package. You wouldn't want to find on-line dependencies after you mastered your CD-ROM.

RATINGS	
TECHNOLOGY	★ ★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

Its minor immaturities aside, WebCD is an outstanding tool that I recommend highly. There's no easier or better way for marketers to transform a company's Web site into a distributable, stand-alone, high-impact presentation. B

*Jon Udell (**judell@bix.com**) is BYTE's executive editor for new media.*

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

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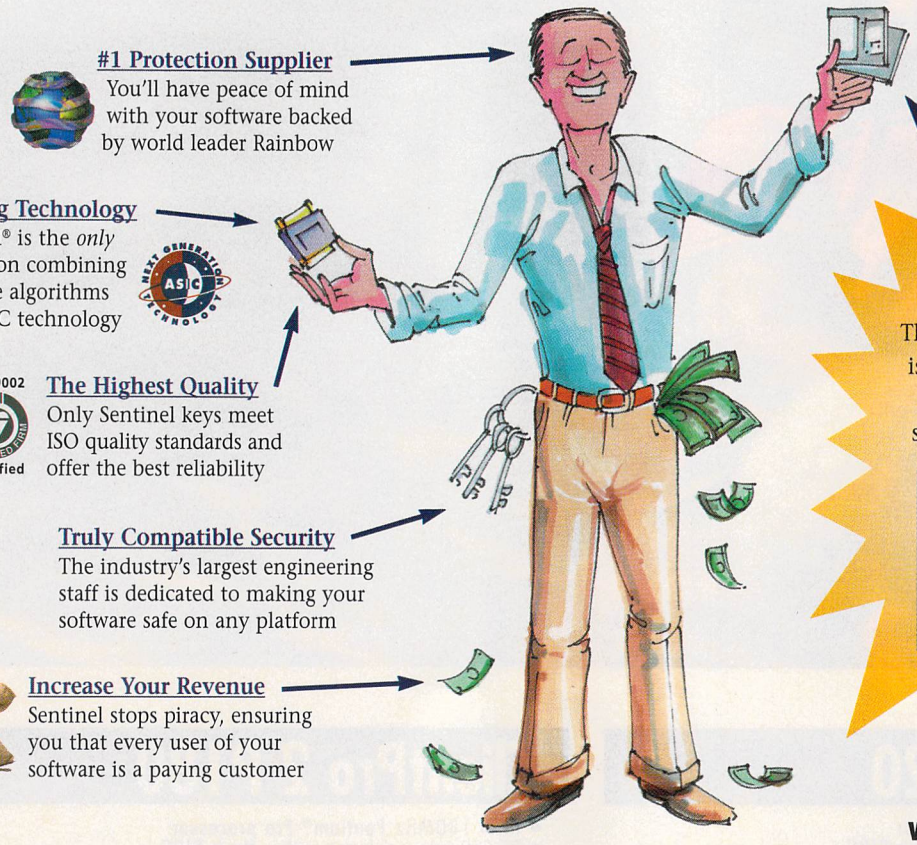

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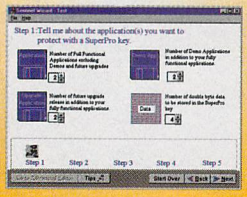

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Better reasons than tradition explain why Digital's VMS operating system continues to survive. ***By Ben Smith***

VMS: Alive and Well

With a face betraying my shame, I mumble, "Hi. My name is Ben, and I am a VMS user." The crowd responds: "Hi, Ben. We're VMS users, too!" But using a 20-year-old OS called VMS—which unofficially stands for Virtual Memory operating System—doesn't mean you have a disease, or even a temporary condition.

Besides its longevity and proliferation, due in great part to its robustness and sophisticated management design, VMS is adept at handling mission-critical jobs, and its clustering capabilities make it well-suited for multiprocessing. The OS isn't without flaws, which become more apparent because of its age. But Unix, which is even older, is growing in popularity, whereas VMS is just holding its own. Is VMS at the end of its life cycle?

Who Uses VMS, Anyway?

The VAX computer and VMS have been inseparable since birth. In fact, the VAX is one of the earliest designs in which the software engineers played a major role in the hardware design: They determined what structures and services should be implemented in microcode. Now, with the VAX being supplanted by Alpha VMS servers, VMS survives beyond its original architecture despite the close hardware ties.

VAXes have been applied to every kind of computing, so VMS has been used by every kind of user, from scientists running supercomputing applications to office workers doing word processing. But the days of broad-spectrum computing are past. Personal computers and much simpler LANs have replaced VAXes and terminal servers for low-end office computing. What work can't be handled by desktop computers can be done inexpensively on Unix machines and, despite their immaturity, Windows NT servers. Still, VMS can be found handling the critical, the fault-tolerant, and the secure computing jobs such as bank and stock market transaction processing, record keeping, and billing systems. A hiccup in any of these applications could cost millions of dollars in a flash, or even put lives in jeopardy.

Another important VMS feature is clusters. The basic concept is: If performance isn't adequate, add another server; they all appear as one.

The engineering and research communities have a huge investment in VMS applications. These are the millions of lines of FORTRAN code that also fall into the category of legacy systems. These hoary applications work perfectly well in the VMS environment, and they continue to gain in performance whenever Digital ships a newer, faster, VMS server.

Another reason for the OS's continuing popularity is a feature that all VMS applications exploit: VMS programs can share the same data types, system resources, and process control. Developers can thus seamlessly build a monolithic application in which each individual part is crafted in the language best-suited for its function. For example, an application's general business logic might be coded in COBOL, its bit-manipulation aspects written in C, and its sophisticated numeric operations and utilities composed in FORTRAN.

VMS vs. Unix

VMS, along with its hardware counterpart, the VAX, was over a year in design, not counting the six months of discussions that took place before Gordon Bell (then head of R&D at Digital) wrote a memo, in April of '75, committing to its development. From the very beginning, VMS was built for demanding commercial applications. The VMS/VAX design team tried to anticipate all the levels and details that any commercial operation might need, and to implement them at as low a level as practical. High on the list of VMS features has been its consistency, its rich set of management features, and its security (C2/B1 rating from the U.S. government). Most important, VMS was the VAX's native operating system. Even today Unix, which is VMS's closest competitor, is considerably weaker in all these areas. Conversely, VMS's file system still lacks the ability to handle more than eight levels of subdirectories.

Unix is the quintessential example of ad hoc OS development. Unix grew out

A VMS Time Line

April 1975: DEC's Gordon Bell writes memo that starts formal work on VAX/VMS.

April 1978: First VAX shipped, with a preliminary version of VMS.

August 1978: VMS 1.0 ships.

April 1980: VMS 2.0, VAX/750 (first new processor) added to DEC product line.

April 1982: VMS 3.0, VAX/730 rolled out. Ethernet connectivity added.

September 1984: VMS 4.0 and VAXcluster introduced. Many new VAX models introduced.

September 1988: VMS 5.0, the VAX 6000, and symmetric multiprocessor VAXes introduced.

November 1992: VMS 1.0 for the Alpha processor released.

July 1993: VMS 6.0 released. The major features are support for very large VAXes and a C2/B1 government security rating.

January 1996: VMS 7.0 released. Kernel-level support for DECthreads and 64-bit memory management supported on Alpha.

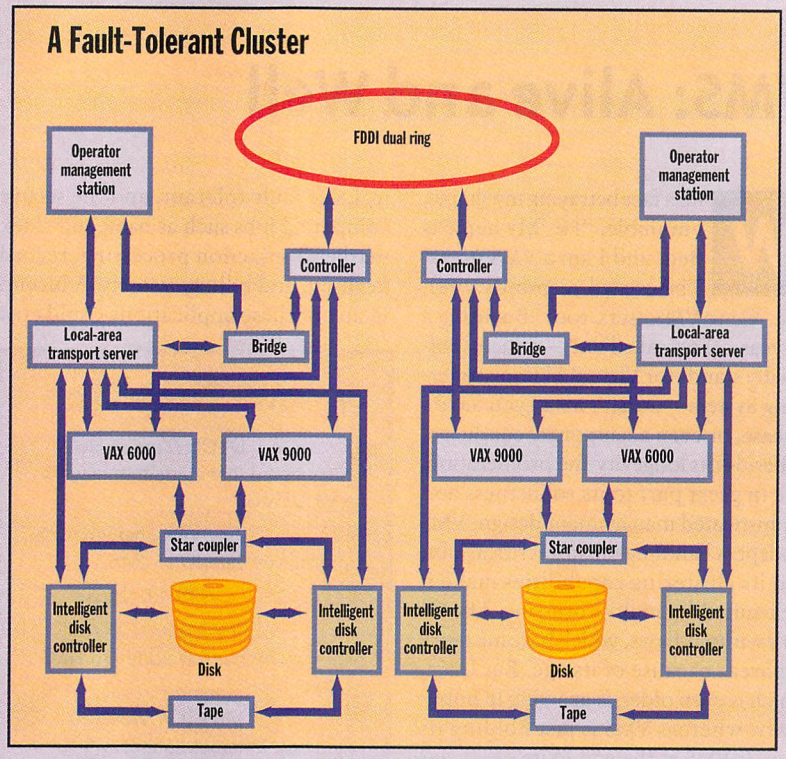
In Case of Emergency, Use Duplicate Clusters

Digital implements multiprocessor computing over the entire spectrum of configurations: from tightly coupled computers that share memory and whose processes must be tightly synchronized, to the very loose asynchronous model of networked heterogeneous computers that share tasks through remote procedure calls (RPCs). The VMScluster lies between these two extremes.

VMScluster implementations share resources between processors in such a way that the processors and the resources appear as a single system to the user. The connections between a cluster's elements can be through just about any method; the loosest is a simple Ethernet connection. These connections are made through redundant one-way cables with duplicate "send" and "receive" ports.

For disaster tolerance, portions of the cluster "mirror" the activity of the other portion, as shown in the figure at right. That is, the system takes all the processing and storage that lives on one part of the cluster and duplicates it in another part of the cluster. One side is designated as the primary segment of the cluster until it fails, at which time the other section becomes the primary.

By placing parts of a cluster several miles from the other and having the processing and storage mirrored between the sites, disasters such as a power failure or fire at one site don't affect the others. When the systems are connected by high-bandwidth fiber-optic lines, processing continues uninterrupted. This kind of fault-tolerant computing is what stock exchanges, electronic funds transfer centers, and military systems require. Additionally, VMS is laudably secure in contrast to the majority of Unix systems.



Smart disk controllers make devices they manage available to all processors on the net, thus resembling a unified system.

of a solution to running a compute-intensive simulation program on a computer that had been all but abandoned (ironically, a DEC PDP-7). Unix has grown as need be. Great leaps in design have been the result of some special application, research project, or academic program. Unix didn't actually become a commercial product (from Interactive Systems Corporation) until 1977, the same year that VAX/VMS was announced at a DEC stockholders' meeting.

While the VMS OS was integral to the VAX and hadn't (until the DEC Alpha) run on anything but VAX computers, Unix has been uniquely portable. Because of its humble roots and minimalist hardware requirements, Unix was quickly ported to all platforms, including the VAX. Despite the system's haphazard beginnings, many Unix features have become models for implementing similar services on other OSes, including Unix's simple file I/O, which was extended to devices and interprocess communications (through sockets); a configurable hierarchical file system; and more than one way for a user to interface with the OS (different command interpreters, or "shells").

Reports of My Death Are Greatly Exaggerated

An OS has reached its terminus when it's no longer breathing with new development. VMS is still alive. And it's drawing new energy from another OS: NT. The connection here is DEC's NT Affinity product and the concept of using VMS servers to do the high-end computing for NT servers and workstations. To support this capability, VMS has incorporated many of NT's data structures and design elements. There is a life-supporting transfusion going on between VMS and NT.

The VMS development group is very much alive and well. Some of the original developers are still there, turning out new releases. The truth is, VMS does just fine for its long-term customers who are running COBOL and FORTRAN applications, as well as for customers writing applications in C/C++, using RDB or Oracle databases and doing distributed transaction processing. Both of these types of users are going to be around for a long, long time.

VMS still serves as a reliable tool for getting the job done, particularly in mission-critical situations. There is no shame in being a VMS user. B

Ben Smith is an independent contract programmer specializing in Unix and Perl. He used to be a BYTE technical editor. You can reach him at **ben@ronin.com**.

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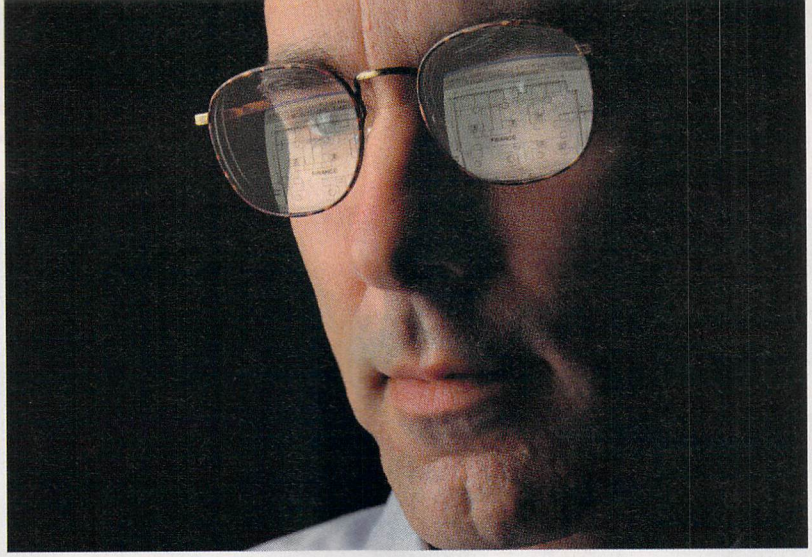

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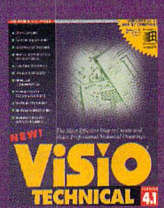

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Sun's revised NFS could overcome HTTP's limitations in handling large amounts of Web data. ***By Bob Friesenhahn***

A File System for the Web

The popularity of the Web has skyrocketed in the past few years. Few technical challenges have impeded its expansion. However, it is beginning to show severe growing pains. Popular Web sites now use networks of multiple high-performance computers to sustain the heavy load when serving data via HTTP.

The intranet is now beginning to rival the Internet's growth. Corporate users expect to manipulate Web data in the same way that they deal with data in their other productivity applications. Unfortunately, poor data-manipulation capabilities are the Achilles' heel of existing Web technologies.

The Web is based on Hypertext Markup Language (HTML) and the simple HTTP. While it's simple to implement and understand, HTTP is an expensive protocol in terms of connection overhead and data transfer. Each object you transfer via HTTP requires a new TCP connection. (See "The Backbone of the Web," October BYTE, for details.) Furthermore, you must transfer the entire object at one time. Each HTML page can contain references to other objects (e.g., graphics images) that you must download to build the entire page. This requires additional TCP connections.

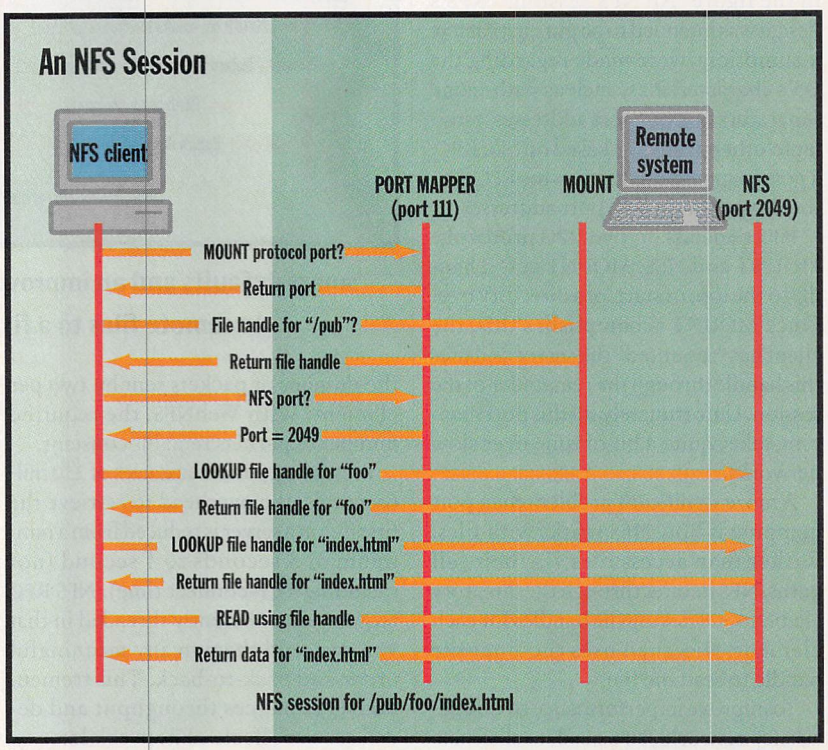
Web browsers such as Netscape's Navigator have adopted a threaded model that allows multiple HTTP accesses to be concurrent per HTML page. While threading helps avoid TCP-connection latencies (causing pages to load faster), it increases the load seen by the server.

What we need are more efficient Web data-access technologies that let users selectively access, manipulate, and update data as they have become accustomed to. Sun Microsystems believes it has a technology in its inventory that can provide the solution with a little brushing up. The basic technology is NFS, and the Web-enhanced version is called WebNFS.

NFS in a Nutshell

NFS implements a virtual network file system that maps remote disks so that they appear local to a client computer on the network. NFS is a mature product that Sun introduced commercially in 1986. It rose to industry-standard status in 1989 with the publication of RFC 1094, covering NFS 2. In 1995, there was the publication of RFC 1813, which covers NFS 3.

NFS is based on Sun remote procedure call (RPC), RFC 1057, which is in turn based on data formats established by External Data Representation (XDR), RFC 1014. Client and server versions of NFS are available for all major OSes. Development of NFS is relatively easy, because the source codes to XDR, RPC, and NFS are available in the public domain. Alternately, you can license NFS technology from Sun as part of its ONC+ platform, which most Unix system vendors license.



NFS requires many data transfers to establish access to a specific remote file.

Sun considers any Web use of NFS—whether it's NFS 2, NFS 3, or NFS with WebNFS enhancements—to be a form of WebNFS. This can be extremely disconcerting to users, given that no specific form of the protocol can be labeled as WebNFS. In this article, I refer only to Web-enhanced versions (described

below) of NFS as WebNFS, rather than using Sun's broader scope.

The Evolution of NFS

If NFS is so great, how come we have not seen it used on the Internet? NFS is an efficient protocol that's optimized for LANs. As such, it originally relied on UDP, which provides no flow-control mechanisms or error recovery, other than for timeouts. Because of this, NFS has proven to be largely unusable over the Internet.

With the advent of NFS 3, TCP became the preferred transport protocol. TCP offers flow control, reliable transfer, and ordering characteristics that UDP lacks. With Sun's recent announcement of WebNFS, many of NFS's drawbacks over high-latency networks have now been eliminated.

Unaltered NFS is a terrible protocol for use over high-latency networks, as shown in the figure "An NFS Session." NFS's design was intended to be pure in that few assumptions were made regarding the OS's characteristics, such as path-name separators or even port addresses. Similar to other protocols based on Sun RPC, a port-mapper process maps the RPC protocol types to specific port addresses.

NFS depends on two RPC protocols: MOUNT and NFS. MOUNT gets a handle to the top, or start, of a directory tree. Once MOUNT accomplishes this, the client has "mounted" the server and uses this handle through the remainder of the session. Unfortunately, all this port mapping takes quite a bit of time over slow networks.

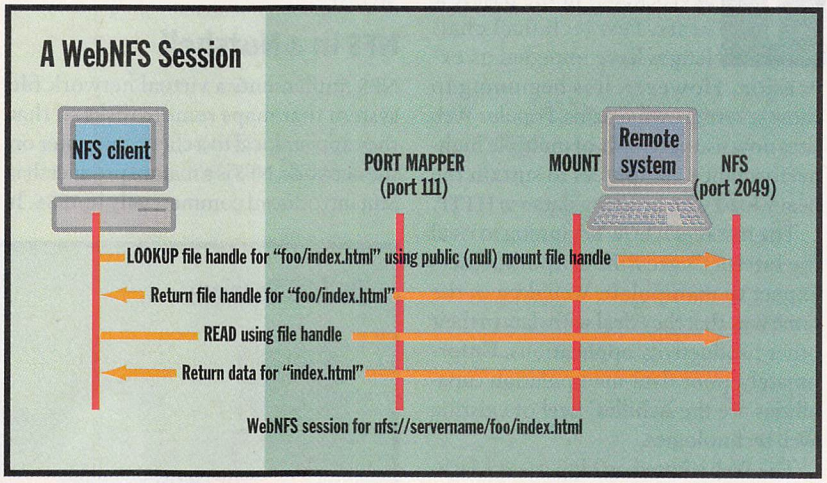
A more significant problem than port mapping is how NFS works with files. Rather than access files via their full paths, NFS iterates through the directory elements, retrieving file handles for each element. NFS then uses the final file handle to read the file.

To improve its performance over high-latency networks, NFS needs to eliminate port mapping, mounting, and path-name recursion overheads. To accomplish this, WebNFS makes three assumptions: The NFS default port is 2049, a directory can be exported as "public" with a known handle (zero or null length), and path-name delimiters are similar to an HTTP uniform resource locator (URL). That is, they use a forward slash to separate path elements, which lets full file paths be specified.

WebNFS thus introduces a new type of URL, the *nfs URL*. Nfs URLs are specified via the format nfs://server:port/path, which is immediately familiar to Web users because the format is similar to that used by HTTP. As just mentioned, WebNFS uses the default NFS port of 2049, unless the URL specifies one.

The steps the modified protocol takes are illustrated in the figure "A WebNFS Session." These steps reduce the number of RPC packet transmissions to retrieve a relatively short path name from 12 to four. Furthermore, with traditional NFS, retrieving extra path elements increases the number of packets sent by two per element. With WebNFS, the required number of packets remains constant.

Presuming packet latencies of 250 milliseconds, the overhead to retrieve the first file on a server is reduced from a minimum of 3 seconds to 1 second (not including TCP-connect time). NFS RPC requests are inherently threaded in that you can send them in any meaningful order and back-to-back. This tremendously enhances throughput and decreases the effects of network latency, because responses stream back to the client as requests are serviced.



Smart defaults and an improved file mechanism reduce access to remote files to a fixed number of transfers.

WebNFS Limits

While use of WebNFS provides significant performance and usability benefits, it has inherent limitations. They are related to the fact that NFS implements a file system. A network file system implements the semantics of a file system on a local disk drive. As a result, many features that HTTP provides today (or may provide in the future) cannot be supported directly by WebNFS.

For example, WebNFS does not support the Multipurpose Internet Mail Extensions (MIME) Content-Type information, a feature that HTTP supports. Thus, data that's obtained via WebNFS must be identified locally by some means (usually a file extension) rather than being identified by the server (which could have more accurate information).

WebNFS has another significant limitation: It is impossible to support server applications without radical modifications to the NFS server. You might overcome this limitation by simply using HTTP where NFS is not appropriate.

Will you ever see WebNFS in a Web browser near you? There are still many unanswered questions regarding how WebNFS would be made available in a browser, and even whether any major browsers will support it. WebNFS has the technical prowess to become a major Web technology. At the same time, we have seen how difficult it is to predict which technology will succeed. We can only wait and see how the story unfolds.

If you would like to learn more about WebNFS, Sun has made the technical details available (including an excellent white paper by Brent Callaghan of SunSoft) at http://www.sun.com/sunsoft/solaris/networking/webnfs/. B

Bob Friesenhahn is a consulting writer for BYTE who specializes in Unix and TCP/IP networking-related topics. You can reach him at **bfriesen@simple.dallas.tx.us**.

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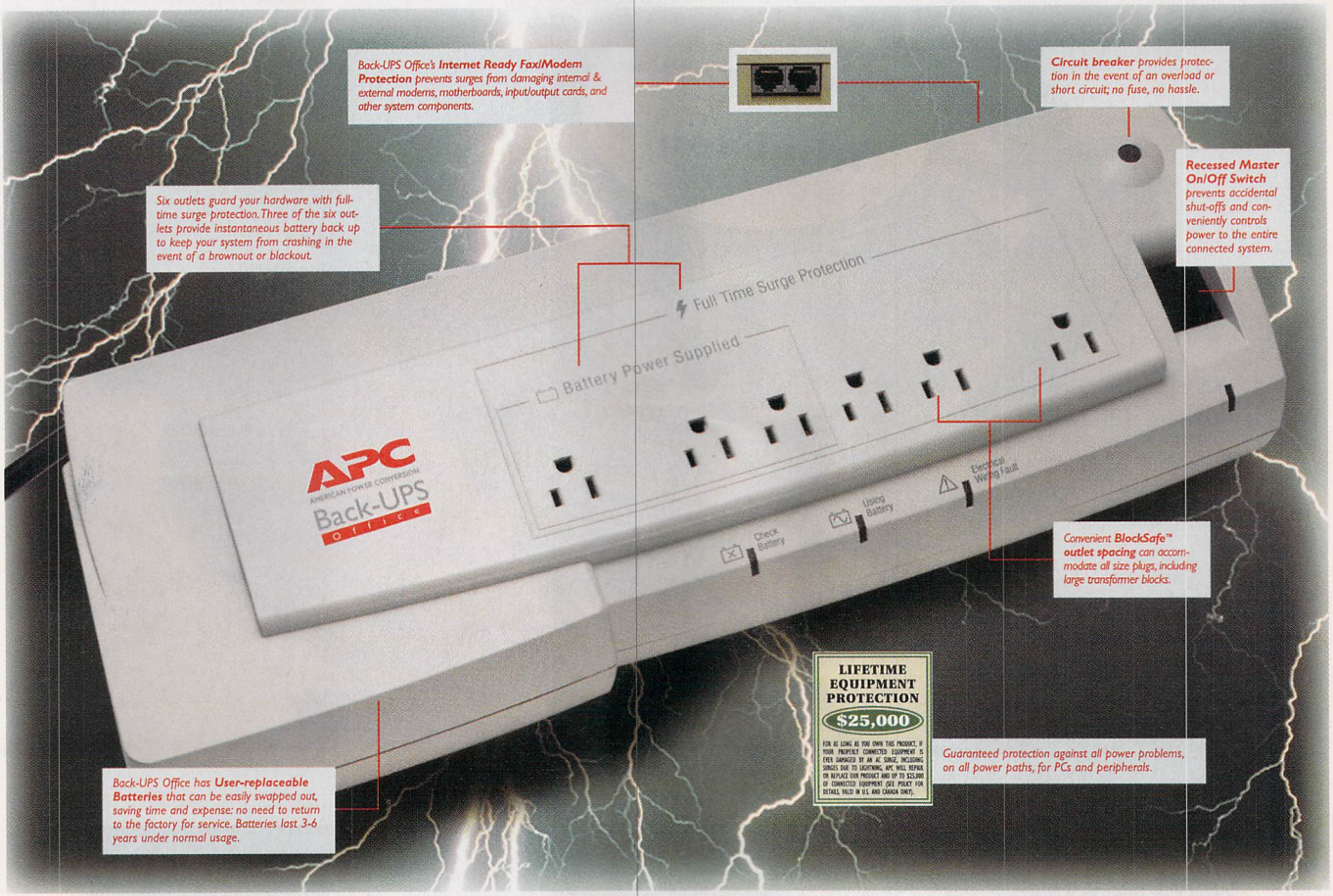

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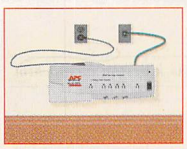

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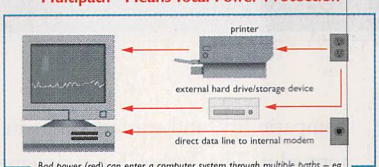

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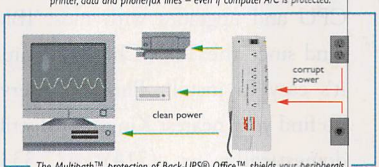

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Motorola's embedded PowerPC processor offers a rich set of communications features. ***By Tom Thompson***

The Consumer PowerPC Revisited

Motorola intends to expand its reach into the world of personal communications with a slimmed-down variant of the PowerPC called the MPC801. The chip began sampling recently and will be available in quantity late this year. The MPC801's feature set makes it attractive not only for use in communications products such as pagers and cellular phones but also for general-purpose embedded applications and consumer electronics.

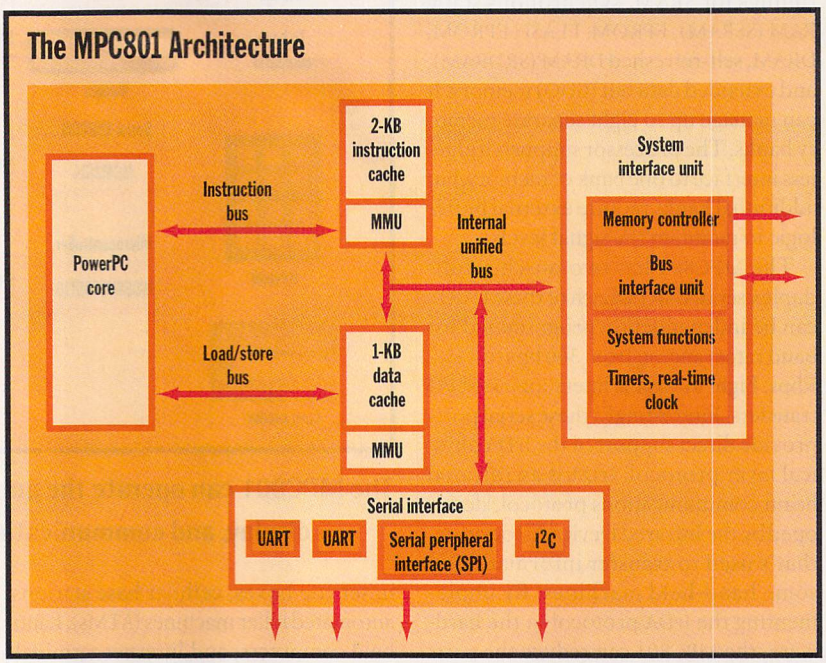
The MPC801 is a three-metal-layer, 0.35-micron CMOS part with 800,000 transistors. The fully static 3.3-V chip consists of an embedded PowerPC core plus caches, timers, memory controller, and peripheral support logic. It has four low-power modes that make it suitable for hand-held products, for which long battery life is paramount. If these specifications sound familiar, it's because they're similar to IBM's embedded PowerPC processor, the 401GF (see "The PowerPC Goes Consumer," August BYTE). Upon closer examination, there are significant differences between the two chips.

IBM's 401GF serves primarily as an embedded controller. The MPC801 also acts as controller but, true to Motorola's heritage as a communications company, it sports a rich set of communications features. This includes two serial UARTs and a serial peripheral interface (SPI). (IBM can provide a custom 401GF part that includes a serial I/O interface.)

The heart of the MPC801 is its PowerPC core. It is a 32-bit implementation of the PowerPC architecture. It has thirty-two 32-bit general-purpose registers. Two function blocks, an integer unit and a load/store unit, execute all integer and load/store operations in the hardware.

To reduce the transistor count—which both reduces the processor's size and power consumption—the designers removed a number of features present in the 60x architecture. The floating-point unit is gone, since embedded applications execute mostly integer instructions. Additionally, the core's architecture was simplified so that the core executes only one instruction per cycle. This compromise eliminates the support logic required to implement multiple execution units. While this approach does exact a performance penalty, the design win is reduced power consumption. To boost performance, the core provides several instruction queues. It also has branch prediction logic that performs branch folding and branch prediction with conditional prefetch. However, in keeping with the goal of a simple, low-power design, the branch logic doesn't do any conditional execution on any prefetched instructions.

The core has two on-chip caches, a 1-KB data cache and a 2-KB instruction cache. The caches are two-way set associative, which helps compensate for any performance hit due to their small size. Portions of each cache can be locked to hold critical sections of code or frequently used data sets. Each cache has its own memory management unit (MMU). The MMUs support a variety of memory page sizes ranging from 4 KB to 8 MB. They can arrange a maximum of 16 virtual address spaces with 16 protection groups. You can program the MMUs to set the data caches to copyback or write-through modes and inhibit the caching of specific pages in memory (typically for memory-mapped I/O). The combination of the PowerPC core and the caches allows the MPC801 to deliver 33 MIPS at



Motorola's MPC801 processor has a built-in memory controller and a number of serial functions.

25 MHz (using Dhrystone 2.1) and 52 MIPS at 40 MHz.

To reduce power consumption, the MPC801 supports four low-power modes: doze, sleep, deep sleep, and low-power stop. A phase-locked loop (PLL) obtains the processor clock signal, which enables a system designer to dynamically reduce the clock rate to conserve power when a hand-held device is idle.

Interfaces Galore

The MPC801 has a system interface unit (SIU) that enables it to work with a variety of peripherals. It handles dynamic bus sizing to 8-, 16-, and 32-bit wide memory and devices. The SIU's built-in memory controller can generate the signals and timings for SRAM, synchronous static RAM (SSRAM), EPROM, FLASH EPROM, DRAM, self-refreshed DRAM (SRDRAM), and extended data out (EDO) memory. It can manage up to eight separate memory banks. The processor supports a glueless interface to one bank of memory, but additional banks require external buffer logic to maintain the signal levels.

The MPC801 has two on-chip full-duplex serial UARTs. Each of these UARTs can be independently programmed for baud rates ranging from 300 bps to 115.2 Kbps. Eight maskable interrupts assist I/O transfers. Interestingly, these serial ports provide direct support of the IrDA physical layer protocol. IrDA is an infrared beam communications protocol, developed by the Infrared Device Association, that's used to transfer information in some hand-held machines. By implementing the IrDA protocol in the hardware, the MPC801 can reduce the parts count in a hand-held's design, thereby lowering its costs.

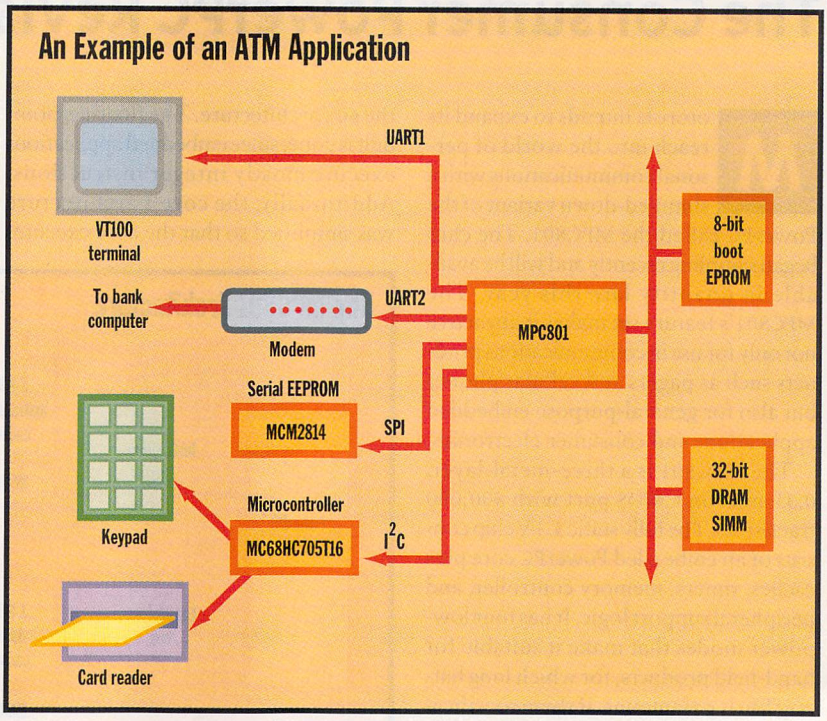
The processor also provides two other communications interfaces: SPI and I^2C. The SPI is a four-wire, full-duplex, character-oriented interface. It supports 8- and 1-bit character operations, and it can operate in master or slave modes. Like the UARTs, the SPI can also interrupt the processor to expedite data transfers. I^2C is a low-speed, full-duplex, two-wire bus that enables the MPC801 to communicate with a variety of controller chips. It, too, supports interrupts.

ATMs and Web TVs

Because of its built-in communications functions, the MPC801 is thus ready-made for embedded applications that require such capabilities. It can be used in set-top boxes, cellular base stations, automated teller machines (ATMs), hand-held computers, and Internet terminals or network computers. Two examples help emphasize how the MPC801 is an ideal fit for applications that demand extensive communications support. In the figure "An Example of an ATM Application," the MPC801 is shown acting as an embedded controller. The processor operates the hardware and handles the user's interactions with the machine. It can also manage the communications the ATM requires to verify transactions with a remote bank computer. One UART operates a smart terminal that serves as the teller machine's display screen; the other operates a modem that relays transaction data to and from the bank computer. The SPI updates nonvolatile data in a serial EPROM. This nonvolatile data might consist of encryption codes and hardware configuration settings, which can change over time. The I^2C interface directs a microcontroller that scans the teller machine's keypad for key presses and reads the data from the magnetic strip on the customer's ATM card.

Here's the most intriguing application of the MPC801. Mitsubishi Consumer Electronics is using it to convert a 40-inch TV into a Web browsing box called the DiamondWeb TV. Because of the MPC801's glueless interface to memory and to Motorola's Scorpion Graphics processor (which is used to mix text, graphics, and live video), the DiamondWeb TV's parts count—and therefore its cost—can be kept low.

The MPC801 implements a Web browser and a Java virtual machine on the device. Its serial connections help implement the TV's audio, modem, video, and TV monitor interface functions. The DiamondWeb represents the convergence of TV, the Web, and computing in one integrated device. The MPC801's capabilities make it all possible. And affordable. B



The MPC801 can operate the automated teller machine's hardware, display, and communications with the bank computer.

WHERE TO FIND

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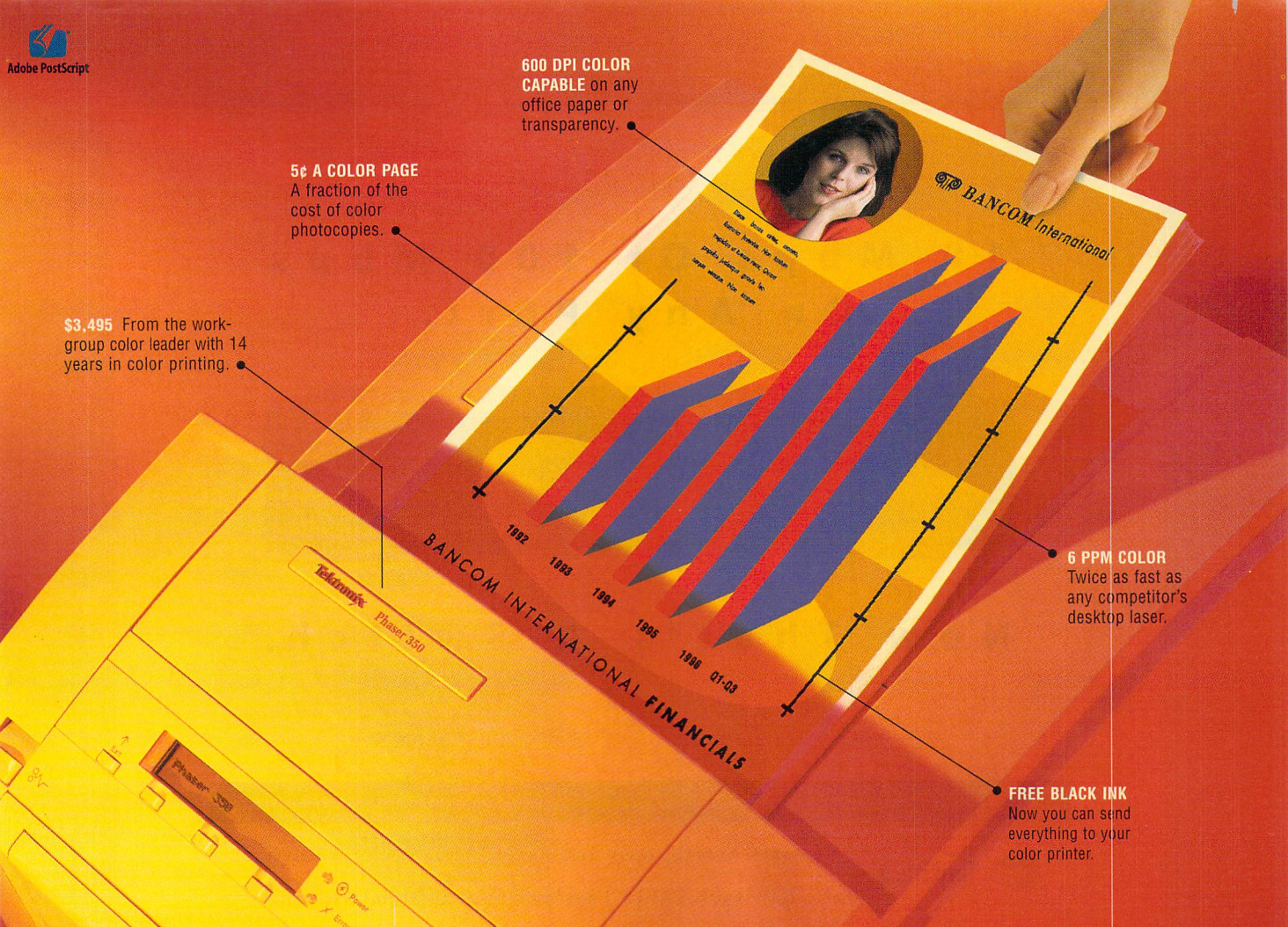
(512) 891-3823
http://www.mot.com/SPS/HPESD/prod/eppc/MPC801.html

Tom Thompson is a BYTE senior technical editor at large. You can reach him at **tom_thompson@bix.com.**



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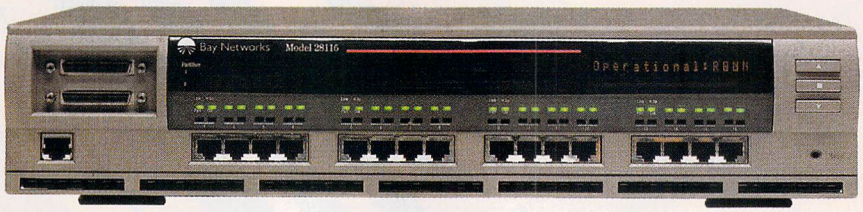

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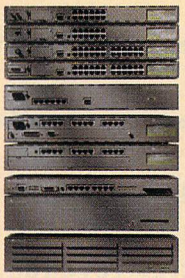

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A new programming model for parallel processing simplifies writing programs and promises code portability. ***By Dick Pountain***

Parallel Processing in Bulk

Parallel processing—using more than one CPU to increase computation speed—is one of those cutting-edge technologies that always seems poised to break through into the mainstream. The problem has been that writing software for parallel computers is just too difficult. It requires complex code to synchronize the data and activity of tens or hundreds of processors. Furthermore, because parallel programs aren't portable between different supercomputer architectures, no volume software market has ever taken off to sustain the effort.

A new parallel-programming model, called Bulk Synchronous Parallelism (BSP), promises to remedy this situation. Developed by teams at Oxford in the U.K. and Harvard in the U.S., BSP offers a simple synchronization mechanism. It also has the potential to make parallel programs portable between different parallel-computer architectures.

Parallel's Pitfalls

Parallel programming's fundamental problem is that there has been no generally accepted model of what a parallel computer should look like. Some designers have favored distributed-memory machines, whose processing nodes communicate by passing messages. Others have preferred symmetric-multiprocessing (SMP) or shared-memory architectures, where all the processors read and write the same memory.

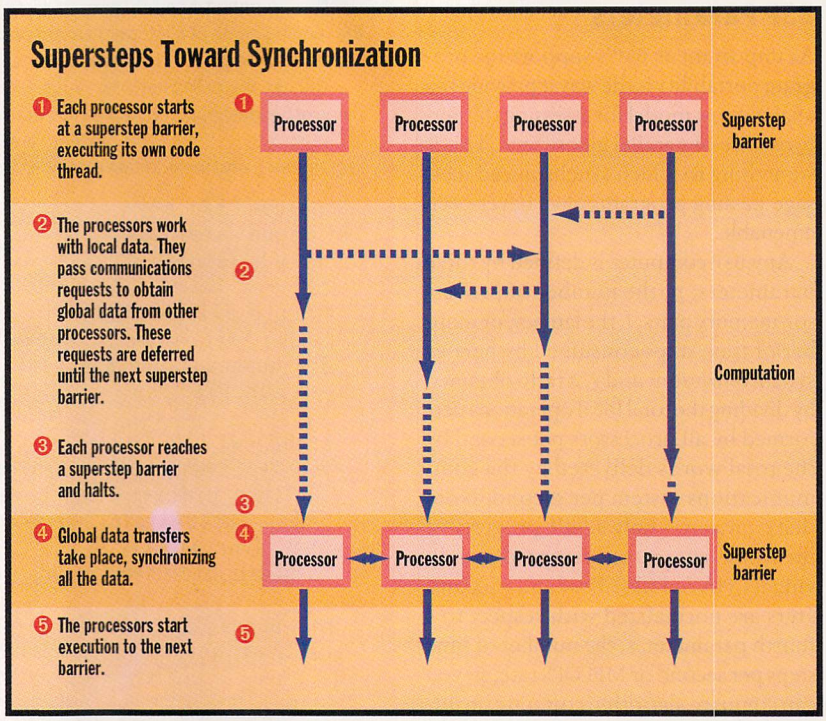
Yet others have used collections of workstations connected by a LAN to simulate a single parallel computer. The clustering of workstations into virtual parallel computers is immeasurably easier since the emergence of standard message-passing environments such as Message Passing Interface (MPI) and Parallel Virtual Machine (PVM). Still, moving a program from one type of parallel machine to another normally involves a complete rewrite of the program.

What's needed is an abstract model of a parallel computer that describes all these schemes, hiding the physical details of particular architectures from programs to make them portable. Another desirable feature of such a model would be predictability (i.e., the ability to accurately analyze how such portable programs will perform on different real architectures). BSP provides just such a model.

BSP's Structure

The BSP model assumes a set of processor/memory pairs. These pairs are connected by a communications network that efficiently supports a global memory space and a mechanism for the *barrier synchronization* of all the processors. Execution of a BSP program proceeds in phases, and all global communication takes place between phases.

Each phase is called a *superstep* . It consists of a number of parallel-running threads that contain any number of operations. The threads perform only local communication until they reach a synchronization point or barrier. At a barrier, all the threads must wait until the last one becomes ready, at which time all global communication (i.e., accesses to the physical memory of remote processors) takes place, as shown in the figure "Supersteps Toward Synchronization."



BSP's step-by-step scheme simplifies the synchronization of both processors and any shared (global) data.

continued

This model completely decouples communication from synchronization, so that the synchronization of individual messages ceases to be of concern to the programmer.

BSP doesn't care whether a parallel computer implements barrier synchronization via hardware or software, because this affects only absolute performance. As an example, Cray's T3D, a massively parallel supercomputer based on Digital Equipment Alpha RISC processors, supports hardware barrier synchronization by providing each processor/memory node with a special barrier register.

BSP is equally unconcerned about the underlying mechanism used for communication. Thus, the same program could run on an Ethernet of PCs using the WinPVM library or on a T3D.

BSP Parameters

As important as BSP's support for program portability is the way it provides an analytic cost model for assessing the performance of parallel algorithms. This is something to which synchronized message-passing programs have never been amenable.

Any BSP computer is defined by three parameters: p, the number of processor/memory pairs; l, the latency, or number of time steps consumed by barrier synchronization; and g, a ratio obtained by dividing the total local operations performed by all processors per second by the total words delivered by the communications system per second. Note that g measures only a *bulk* property of the whole system, not the speed of individual CPUs or links. The l and g parameters are normalized with respect to a fourth parameter, s, the number of time steps per second or MFLOPS rate, so you can compare algorithms running on different hardware.

You can consider any scalable parallel system to be a BSP computer and determine what its p, l, and g parameters are by benchmarking. You can then use these results to analyze the computational complexity of both architectures and algorithms. Designers of parallel architectures strive to reduce l and g to a minimum. Likewise, a programmer's choice of algorithm will try to offset the bad effects of large l and g inherent in a hardware design.

A Parallel Future

The Oxford University Computer Lab (OUCL) has set up a unit called Oxford Parallel to commercialize and spread the word about BSP. The firm offers the Oxford BSP Library for a number of machines, including a free generic version for any homogeneous parallel Unix machine that has access to PARMACS, PVM, TCP/IP, or System V Shared Memory primitives. There are also optimized native libraries for IBM's SP1/SP2, Cray's T3D, Silicon Graphics' Power Challenge, Meiko's CS/2, and other supercomputers.

Oxford Parallel is working on BSP support for SMP machines running Windows NT and for clusters of NT servers. Such a development would be timely indeed, given that the PC industry is entering an era of multimedia and 3-D graphics applications that cry out to be accelerated by parallel processing. Perhaps after all those false dawns, BSP is the technique that will bring parallel processing into the mainstream for the first time. B

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Programming with BSP

BSP doesn't require the invention of any new programming languages. You can write BSP programs in conventional sequential languages such as C or FORTRAN 90. You then link the program to a library that implements a few primitive BSP operations.

The simplest primitives are `bsp_put` and `bsp_get`, which are requests for nonlocal data access, and `bsp_sync`, which marks a barrier for synchronization. `Put` and `get` are both one-sided operations, and you don't need to pair them: You either put a value into a remote process or get a value from it, but not both. They do, however, require variables to have the same names in different physical address spaces, so they are most suited for Single Program Multiple Data (SPMD) algorithms.

Other BSP primitives are better suited for different types of parallelism. `Put` and `get` are nonblocking, so the process that calls them can proceed immediately. Issuing a `put` or `get` guarantees only that the requested data operation will be completed by the end of the superstep or next barrier synchronization.

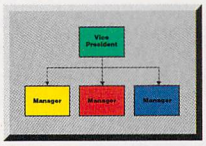
The C function, `bsp_allsums()`, hints at the flavor of BSP programming. It calculates the running sums of p integers stored on p processors. Put another way, if integer `xi` is stored on processor `i`, the result on processor `i` is `x0 + x1 + ... + xi`.

You use the primitives `bsp_pushregister` and `bsp_popregister` to register the name of the destination variable `left` across all the processors. The cost of this algorithm is `log(p)x(g + 1 + 1) + 1`, as there are `log(p) + 1` supersteps (including one for the registration), and the addition operation costs 1 FLOP.

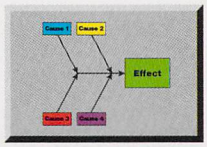
```
#include "bsp.h"
#include <stdio.h>
#include <stdlib.h>

  int bsp_allsums(int x) {
  int i, left, right;
  bsp_pushregister(&left,sizeof(int));
  bsp_sync();

  right = x;
  for(i=1;i<bsp_nprocs();i*=2) {
   if (bsp_pid()+i < bsp_nprocs())
    bsp_put(bsp_pid()+i,&right,&left,0,sizeof(int));
   bsp_sync();
   if (bsp_pid()>=i) right = left + right;
  }
  bsp_popregister(&left);
  return right;
 }
```



Human resource tools like organization charts and relationship diagrams



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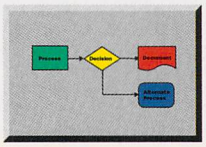
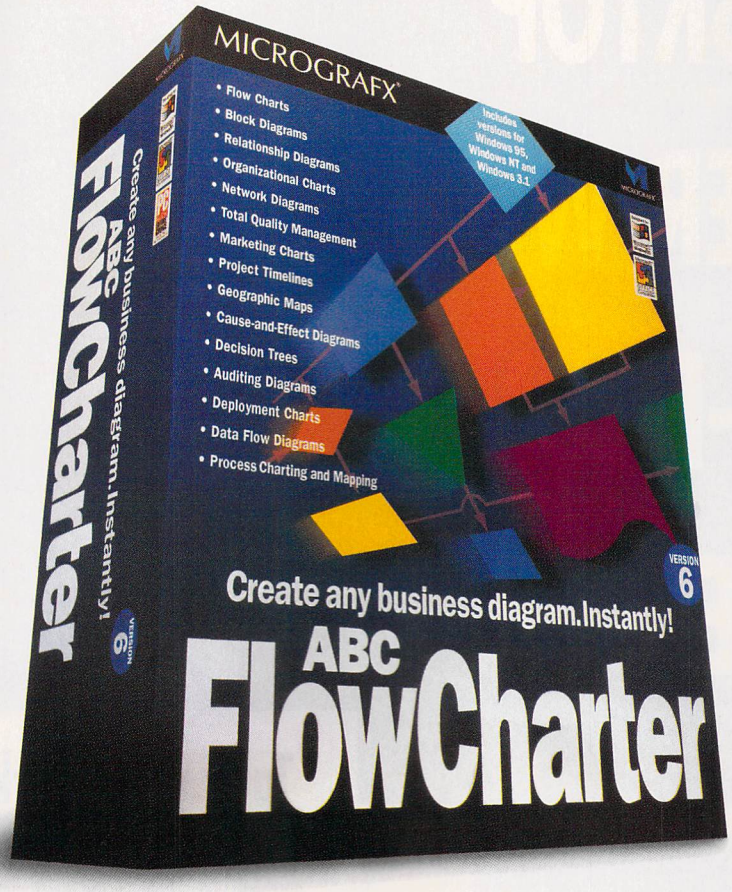
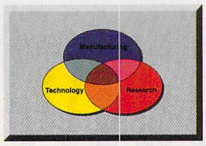
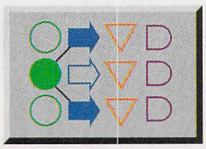


Business process re-engineering diagrams like flow charts and data flow diagrams

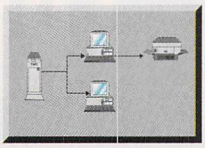




Marketing tools like venn diagrams, targets, pyramids and geographic diagrams



Total quality management diagrams like process charts and maps



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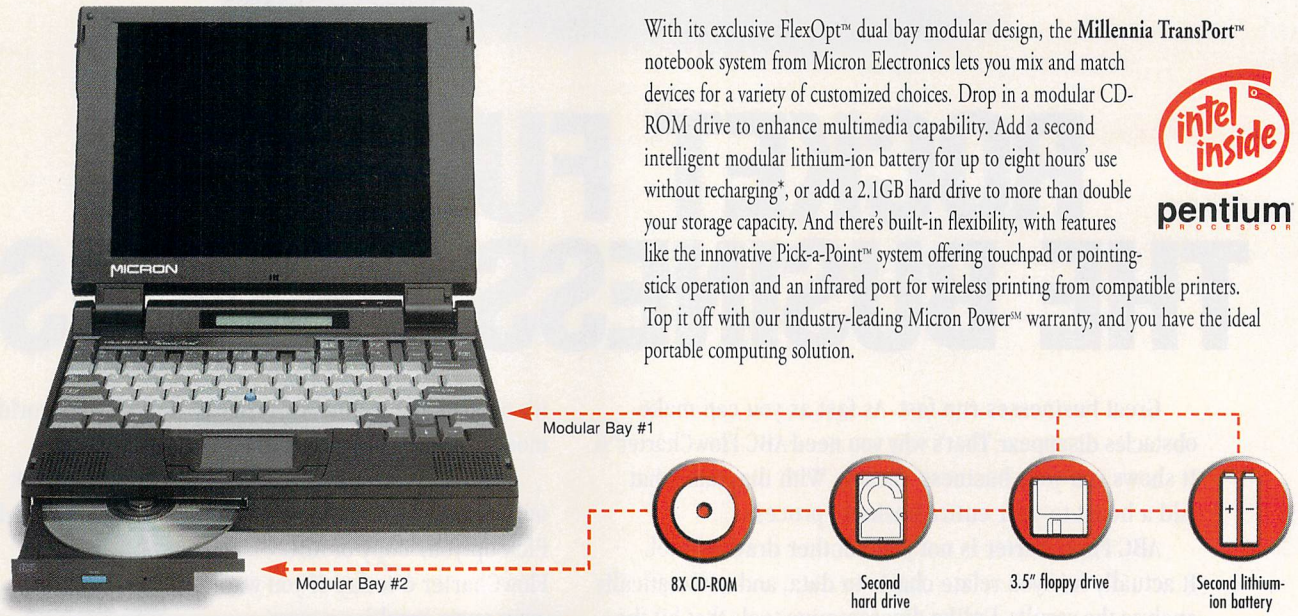

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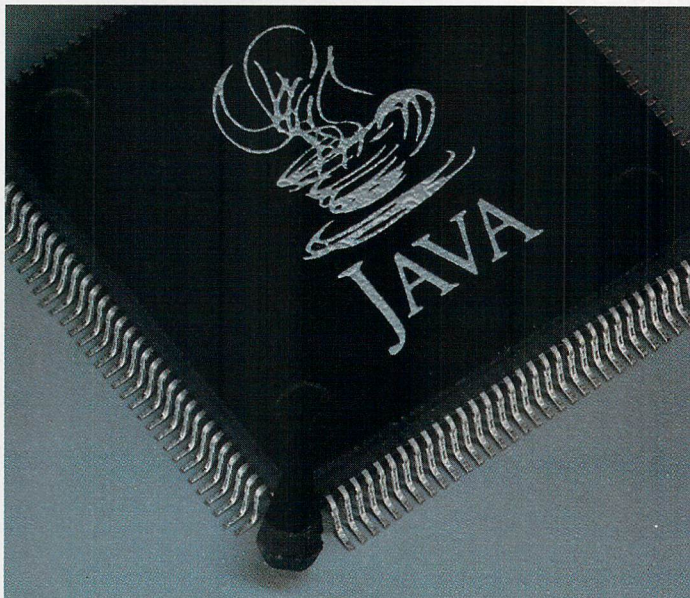
Tomorrow's CPUs

The hard part will be choosing among major new chip platforms and families; easier to take will be the blazing speeds of tomorrow's processors.



Conventional wisdom says that Intel dominates the desktop CPU market. But look at the company's development plans for the next year, and you'll see a corporation that's acting a lot more like a hyperactive start-up than a sleepy giant.

Why? The CPU decisions we make will fuel a fundamentally new battle among processor architects. Some RISC-chip vendors are developing a new family of processors designed from the ground up to run Java applications at optimum speed. BYTE obtained exclusive technical details about Sun's picoJava architecture, which will provide the underpinnings for some Java chips that should ship next year. Early tests using Java-chip simulations point to significant speed advantages over general-purpose CPUs that use interpreters or just-in-time compilers to run Java code.

Intel hasn't announced Java-specific architectural changes for its processors, but it's not standing still, either. Over the next 12 months, the company will introduce three major new chips, including the first Pentium Pro to break the 300-MHz barrier. Stretch your sights into 1998, and you begin to see Intel's seventh-generation processor, the secretive Merced joint project with Hewlett-Packard.

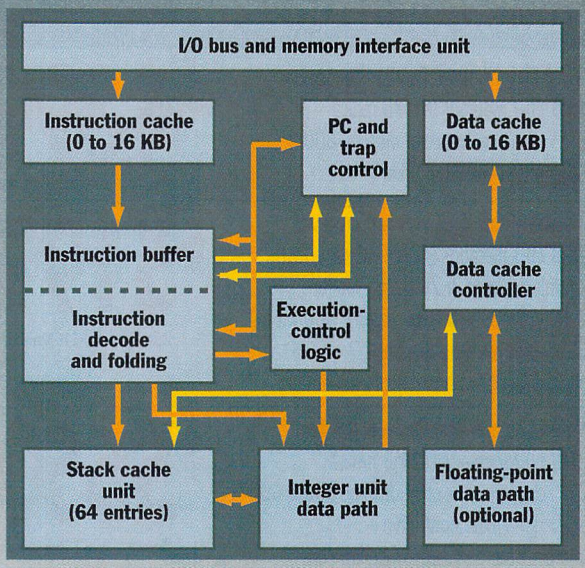
Intel has good reason to continue to innovate. Even if Java chips never take off, we expect to see nine new x86 chips from AMD, Cyrix, and the lesser-known IMS. At the same time, the PowerPC Alliance is redoubling its efforts to develop pace-setting chips and a hardware standard that will spawn PowerPC systems for the Mac OS, Windows NT, and Unix.

Myriad CPU choices may be confusing at first, but if you choose wisely, your next computer might give you the fastest performance ever for the applications that are important to you. In relative terms, your next processor will deliver this performance at a bargain price. If you choose badly, however, you may be shackled with a processor that's blazingly fast for some applications but a slouch for others. If that happens, no price is a bargain.

The following stories can help you find your next CPU and begin to plan for the generation after that. In the end, you may long for the days when you needed only to compare clock speeds to find the right chip.

–Alan Joch

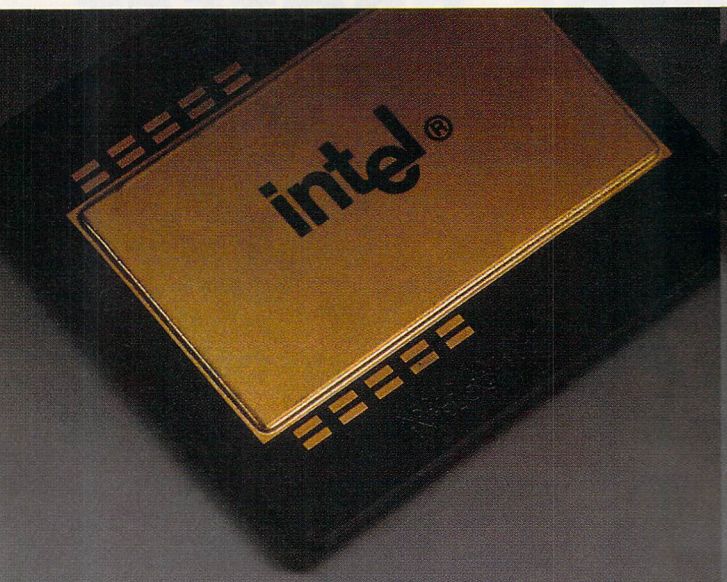
Inside picoJava

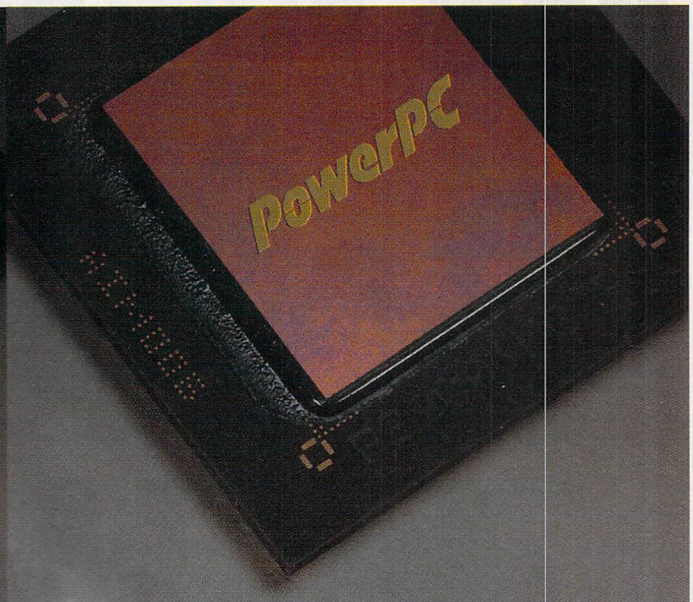


EXCLUSIVE

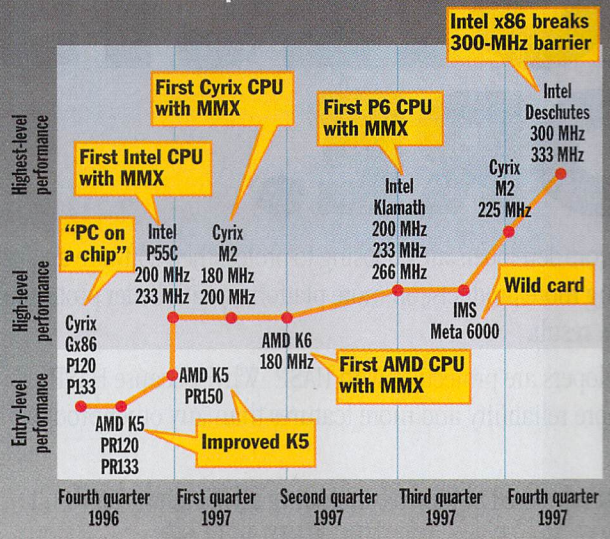
Sun Gambles on Java Chips...79

An innovative interpretation of RISC design could produce Java-specific processors that transform computing...

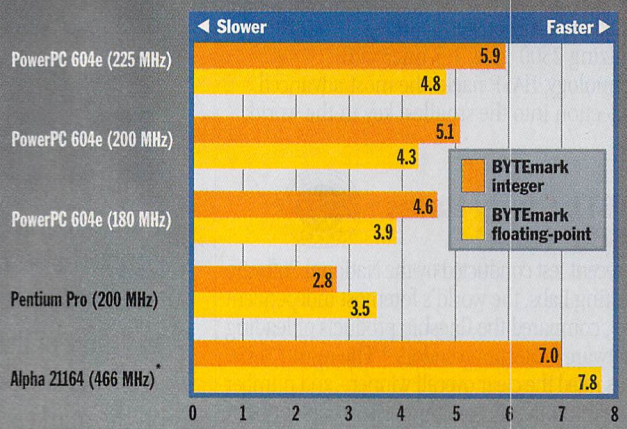




The x86's Growth Spurt



PowerPC Overpowers x86



*For comparison. Alpha scores are fastest BYTEmark scores to date. From BYTEmark run on Windows NT.

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...while Intel and a host of competitors plan a dizzying number of introductions in the next year intended to maintain the x86's dominance...

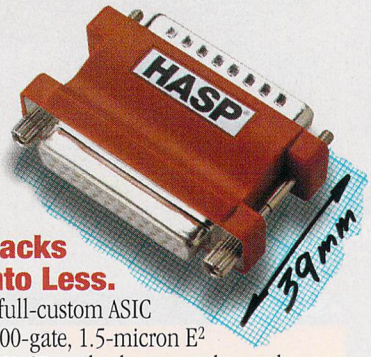
PowerPC Regroups...101

...and the PowerPC Alliance continues to push the performance envelope for general-purpose computers.



MORE DEVELOPERS PROTECT.





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Are Java chips better than general-purpose CPUs? Or will new compilers make them obsolete? **By Peter Wayner**

Sun Gambles on Java Chips

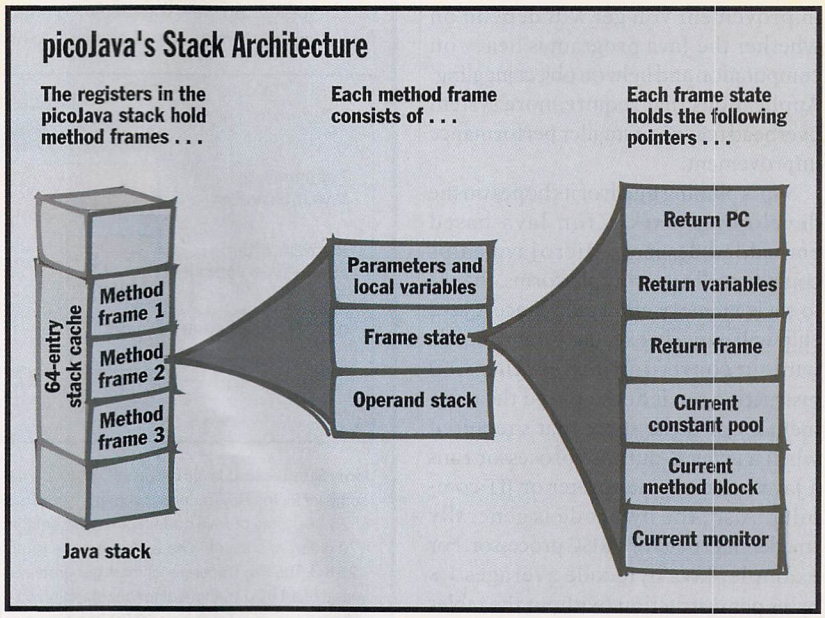
Download a small Java application from the Internet today and your trusty x86 or RISC processor won't blink. These CPUs are designed to optimally run C-based applications, but they also work well at emulating the Java virtual machine (VM) for the simple Web-based applets we're seeing now.

Life is good, as long as Java spawns nothing more complicated than cute dancing applets on Web pages. But Java has the potential to become much more. Its cross-platform compatibility is motivating some software companies, such as Corel, to develop large-scale business applications entirely in Java.

Suddenly, our decisions about which CPU platform to buy may become twice as difficult. Do we stick with a general-purpose processor and hope it will run tomorrow's Java applications efficiently? Or do we bank on a new generation of processors built from the ground up for fast Java performance?

Sun Microsystems, the company that launched Java, is betting on dedicated Java chips to deliver the performance needed for Java-based business and embedded applications. To this end, Sun is developing a core specification—known as picoJava—for Java chips. BYTE has exclusively obtained the spec prior to its public release. The architecture outlines a number of design innovations for optimally running Java code. At prices that fall below $100 for even the most expensive versions of these chips, Sun hopes the price and performance characteristics of Java processors will both ride on and help power the Java wave. Chips based on Sun's picoJava core architecture should appear early in '97 and make their way into commercial products by the end of the year. Sun also wants to license the picoJava core design to other companies that want to produce their own Java chips.

Sun's strategy is compelling but not airtight. Platform-specific processors have been tried before with mixed results. And some competitors believe they can enhance their existing processors to boost Java performance without resorting to Java-specific chips.



The picoJava stack uses 64 32-bit registers. picoJava allocates variables on the stack; method calls pass data through the stack.

Either way, we're watching the opening volley of a technical war that may take months or even years to resolve. While many questions will remain unanswered until we see actual silicon, we can begin to sort out the technical merits of Java chips today.

Two Flavors

Sun's picoJava architecture will be the foundation for the first-generation Java chips, known as microJava, a low-cost (approximately $25–$50) family for resource-stingy embedded applications. Typical applications might include industrial data-acquisition devices, PDAs, cellular phones, set-top boxes, and low-cost network computers.

Sun is also developing a more expensive (approximately $100) chip called ultraJava, which will be for desktop systems. Sun officials won't say whether or not ultraJava chips will use a picoJava core. However, these chips could include multimedia capabilities such as JPEG decompression and the graphics-processing optimizations now found in Sun's UltraSPARC RISC processors.

BYTE couldn't obtain actual silicon samples of Sun's Java chips at press time, so we don't know how well picoJava succeeds at boosting Java performance. According to Sun, these chips will run Java programs about 12 times faster than the same code executed by Sun's current Java interpreter. (See "Preliminary Speed Tests," page 80.) But Java bytecode interpreters are getting better, too. For instance, Intel has written its own Java interpreter for the x86 series and claims it runs Java code three times faster than Sun's interpreter.

Just-in-time (JIT) compilers can run Java code even faster than interpreters, but Sun says the picoJava chips could be

five times faster than a Pentium with a JIT compiler. However, Sun concedes that it still isn't certain how much picoJava's hardware improvements for thread synchronization and garbage collection will contribute to the overall speed of Java chips. Sun officials are optimistic about seeing performance improvements in these areas once they test actual silicon. Nevertheless, the actual performance improvement you get will depend on whether the Java program is heavy on computation and light on object juggling. Applications that require more system overhead may see a smaller performance improvement.

Sun is pinning much of its hopes on the developing market for Java-based embedded devices. MicroJava chips could fit well onto tiny platforms, thanks to their memory efficiency. Since a Java chip will natively execute Java bytecode without converting it to another CPU instruction set, it doesn't need the extra memory or cache space that's required when a general-purpose processor runs a Java bytecode interpreter or JIT compiler. Also, the bytecode is generally smaller than that for a RISC processor. For example, Java bytecode averages 1.8 bytes per instruction (without the tables for dynamically linking the code during method calls), while RISC code generally requires 4 bytes per instruction.

Pushing the Stack

What makes picoJava chips different from other processors? Foremost is how picoJava refines the stack. In the picoJava architecture, Java chips allocate variables locally on the stack, and method calls and bytecode operations also pass data through the stack.

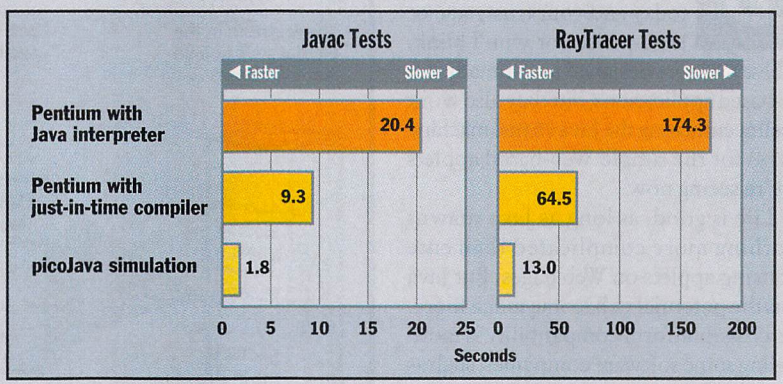
Most C compilers convert C source code into a stack-based language, but the compilers then go through an additional step of converting this intermediate language into native RISC code (see "RISC vs. CISC" on page 82). This allows the compiler to analyze the flow of data and keep the most essential elements in the CPU registers. A standard RISC processor simulates a stack machine by loading or storing data from the stack into registers, then using one of the registers to represent the stack pointer. This operation is simple, but the number of registers limits the opportunities for optimization.

continued

Preliminary Speed Tests

When we went to press, chips based on Sun's picoJava core architecture didn't exist, so we were unable to evaluate performance of these dedicated processors. However, preliminary statistics from internal Sun tests indicate that Java chips could deliver significantly better performance than today's two main alternatives for running Java code: using a Java interpreter or a just-in-time (JIT) compiler with a general-purpose processor.

Note, however, that while Java chip advocates are finishing their core designs, developers of Java interpreters and JIT compilers are creating new and faster versions of these technologies. So view the following numbers as snapshots: The competition to deliver faster Java performance will continue to heat up over the coming months.



How Sun Tested: Javac is Sun's JDK 1.0.2 javac compiler for the RayTracer benchmark. It consists of 25,000 lines of Java code (with comments) in 170 different classes. The Java bytecode totals 422 KB. The RayTracer benchmark generates an image of a 1400-triangle dinosaur standing on a glossy table. RayTracer is a 3500-line Java program in 32 classes. The bytecode totals 36 KB.

The picoJava simulator is 100 MHz, with 4 KB of direct-mapped instruction cache and 8 KB of two-way data cache and no off-chip cache. The FPU is present. DRAM is 120-ns latency.

The test Pentium machine was a Hewlett-Packard Vectra VL 5/166 Series 4, with 32 MB of RAM and 256 KB of off-chip cache. The interpreter is Sun's JDK 1.0.2 for Win 95/NT. The just-in-time (JIT) compiler is Symantec's Cafe 1.5 for Windows 95 and NT.

All the times were scaled to 100 MHz to match the picoJava simulator output. Thus, times for the Pentium system were multiplied by 1.66. The picoJava simulator does not accurately simulate I/O, so 0.8 seconds were added for the Javac benchmark for I/O, and 0.4 seconds for I/O were added to the RayTracer benchmark results. The effects of garbage collection were also minimized by sizing the amount of memory allocated by Java for the program. By allocating a large amount of memory for the benchmarks, garbage collection was never invoked.

Three Alternatives for Running Java Software

Java interpreters

Like a translator at the United Nations, Java interpreters translate Java bytecode into native instructions the CPU understands. Interpreters convert bytecode on-the-fly and must process the same code over and over again when you run the Java program. Java interpreters usually run slowly, sometimes at only 3-10 percent the speed of compiled C code.

Just-in-time (JIT) compilers

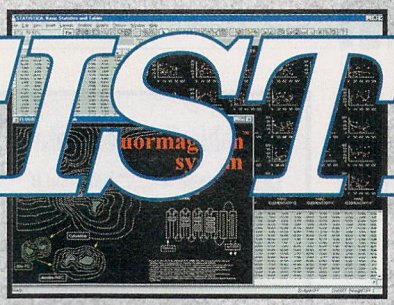
Just-in-time (JIT) compilers translate Java bytecode into native code like interpreters do, but they don't have to translate the same code over and over again because they cache the native code. This can result in significant performance improvements, but sometimes a JIT compiler takes an unacceptable amount of time and memory to do its job.

Java chips

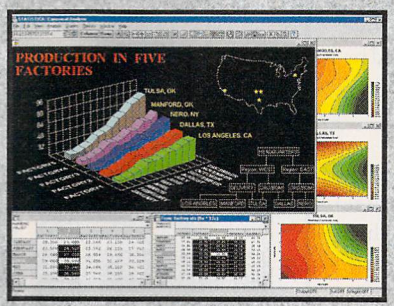
Dedicated Java processors, like those that will be based on Sun's picoJava core architecture, natively understand Java bytecode without the overhead of an interpreter or JIT compiler. Proponents say native-code processing and Java-centric optimizations yield the best possible performance for more complex Java applications that might be on the horizon.

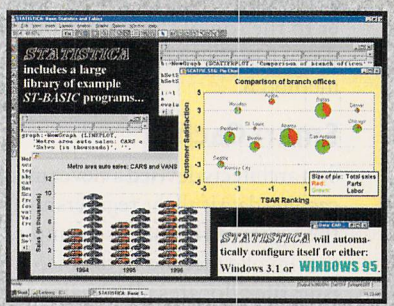
STATISTICA

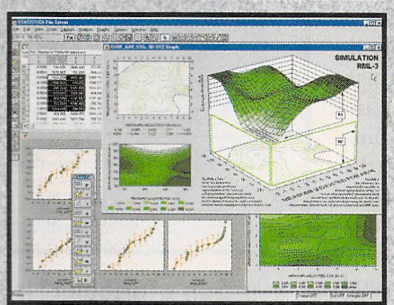
Windows 3.1 and WINDOWS 95

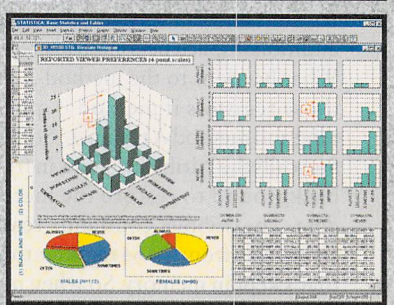


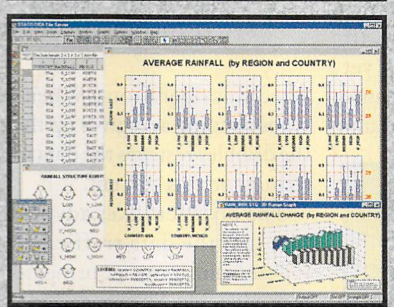


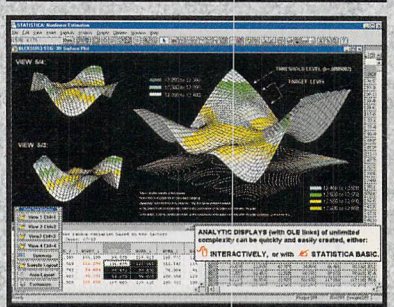


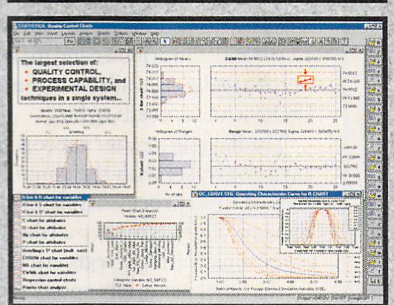


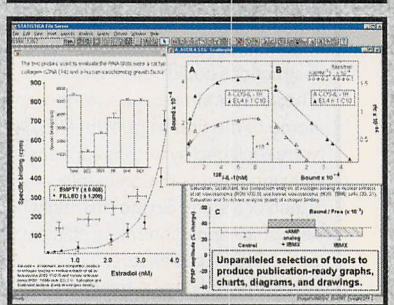


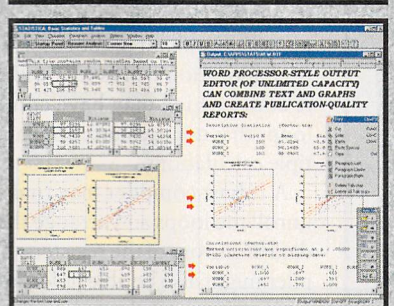


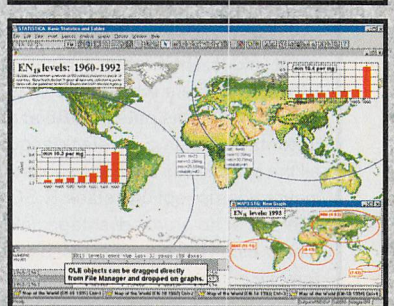












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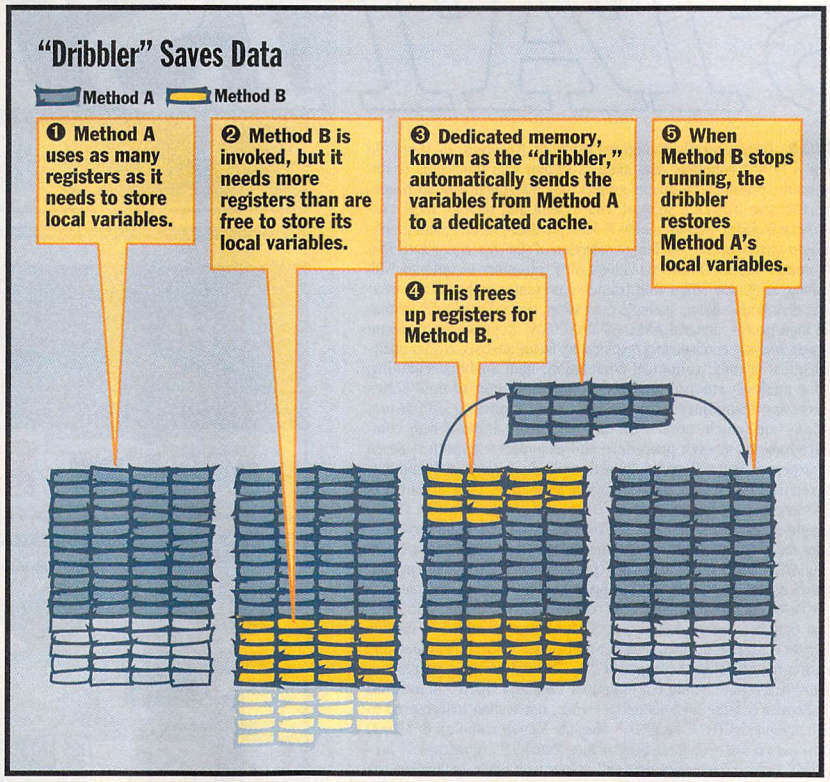
The picoJava architecture uses a stack of sixty-four 32-bit registers with a pointer to the top register on the stack (see "picoJava's Stack Architecture" on page 79). If you have 20 registers allocated for a particular stack frame (call it method A), then a call to another method (B) would begin using register 21. The pointer to the top of the stack would move down from 20 to the last register used by method B.

Smart Cache

Sun architects devised a clever method of caching data if all the registers are full (see the figure at right). For example, when you invoke method B, the picoJava register file allocates all remaining empty registers and carries over to register 1 if additional space beyond 64 is required. What happens to the method-A data in those registers if method B quits running and method A resumes? Something Sun calls the "dribbler" steps in from the background to restore the method-A data. The dribbler constantly reads and writes data from the 64 registers to a copy that's kept in memory. So when method B grabs the additional registers, the dribbler has already copied the data. (If for some reason the dribbler hadn't yet made a copy, the Java chip would pause any processing tasks until the dribbler finished this operation.) When method B stops running and gives up the registers, the dribbler restores the data to the stack, so method A is current.



Sun's "dribbler" is a clever method of caching data and returning it to the stack when registers become full.

The dribbler takes advantage of the fact that the data traffic between the registers and its image in memory is highly predictable. System designers are able to easily tune a cache to anticipate the requests of the dribbler and make sure the necessary data is available in the local data cache when it needs to be.

The flexible register approach of picoJava contrasts with the simple register files of RISC processors. Java's dribbler dynamically tries to keep all the local variables available in fast registers. RISC chips, on the other hand, rely upon the compiler to orchestrate the movement of information in and out of the chip. Static register allocation works well with scientific code, which may have complicated loops that use each piece of data in multiple calculations.

A robust compiler may find a way to unroll the loops and arrange the flow of data in and out of the registers. The compiler might also be able to leave data in a register in cases where the data needs to be reused 50 cycles later.

The picoJava stack is not well suited for leaving data around or for pushing information deeply onto the stack so it can reemerge at the right time. (Smart compilers that do this magnificent optimization for scientific code should be able to do the same for Java code by creating faux local variables that act like registers.)

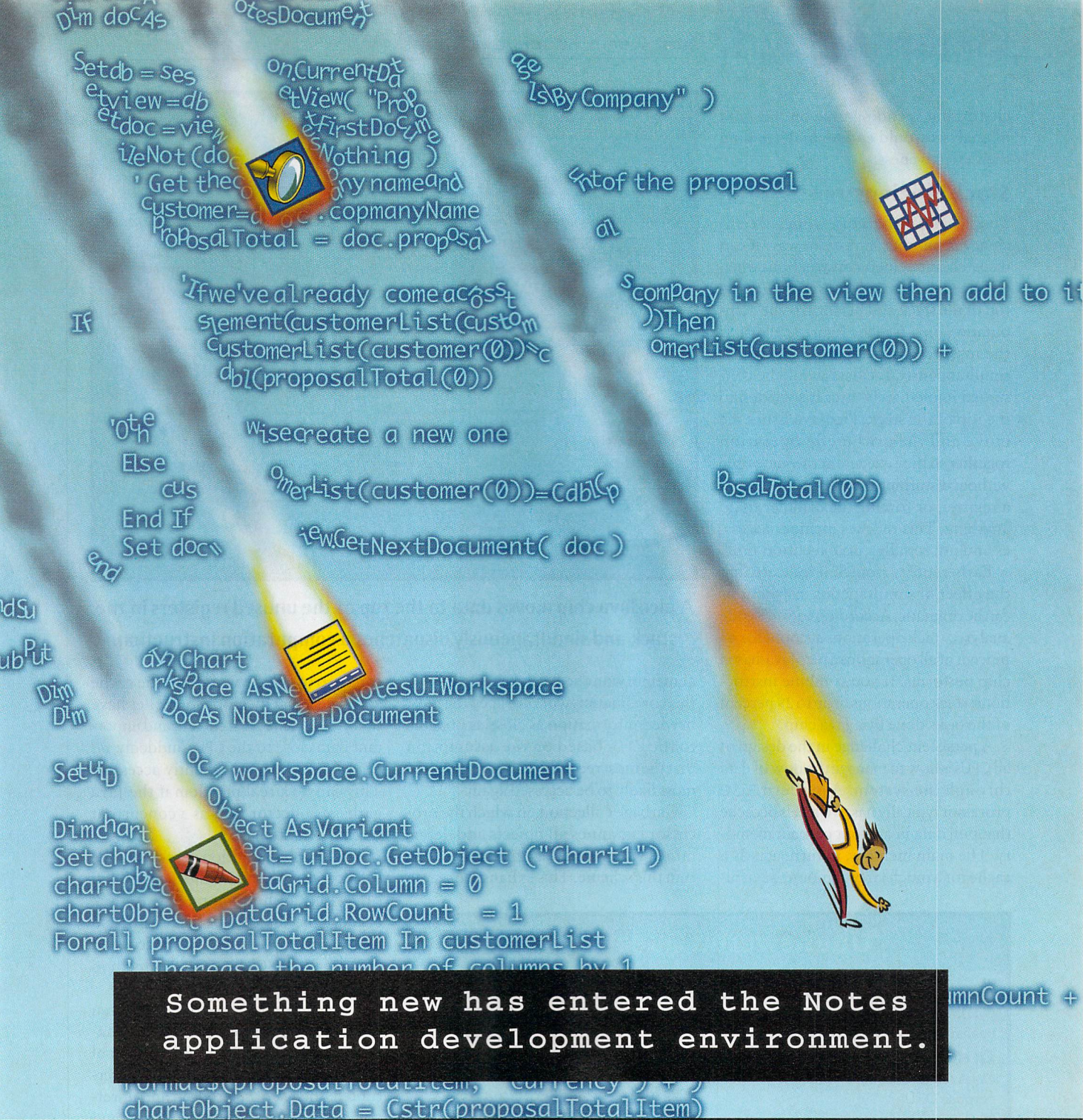
However, the picoJava stack can shine with code that calls many short procedures that are constantly starting and stopping. These function calls are constantly clearing and filling data in registers. The Java stack handles these chores in the background, with the dribbler keeping the register file accurate.

The stack at the center of the Java virtual machine is a simple conceit that makes it easy to pack code. This design challenges RISC machines and their ability to speed the flow of data by using registers in a smart way. A Java interpreter can't anticipate the flow of data through the stack, so it can't use the registers for much more than a temporary image of the very top of the stack. Just-in-time compilers may be able to do the analysis necessary to use the registers more effi-

RISC vs. CISC

How does the x86 stack up against RISC chips when running Java? Interestingly, the ancient x86 has a few advantages. For example, the x86's PUSH and POP instructions could become more valuable. These combination instructions were some of the first to go with RISC. They were replaced by two instructions: a register increment or decrement followed by a load or a store. So the x86 might handle Java stack operations more efficiently than some RISC processors.

One big difference between RISC and CISC is the number of general-purpose registers for storing integer and floating-point values. RISC chips typically have 32 or 64 registers, while the x86 has only 16. Normally, this puts the x86 at a disadvantage. But Java is a stack language; all the information between subsequent instructions is kept on a stack. RISC registers offer no great advantage unless a just-in-time (JIT) compiler can schedule the use of the registers more efficiently.



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ciently, but spending time on this kind of analysis would end up undermining their effectiveness.

Stack Efficiency

The picoJava architecture wrings out efficiency in another important way: It can dispatch simultaneous instructions when you need to move a local variable to the top of the stack and perform some computation on it (see the figure at right). If the instructions were not dispatched simultaneously, the data would be consumed immediately after it's written to the top of the stack. PicoJava issues the move and the arithmetic operation together so they execute at the same time without disturbing the stack, writing over a register, or forcing the dribbler to do anything. This reduces memory accesses and potentially cuts execution time.

Early reports from Sun indicate that the effect of simultaneous instructions can be dramatic. According to Sun's code analysis, stack operations account for 43 percent of all operations a picoJava-based chip performs. If you combine instructions, stack operations drop to 29 percent of the tasks done by a Java chip.

A persistent challenge in the design of all CPUs is how to manage the flow of data through the system. A modern RISC processor typically has two levels of cache that pull data in and out of main memory. The main memory, in turn, acts as a cache for a much larger amount of virtual memory on the hard disk. Ordinarily this combination works to keep the most needed information as close as possible to the CPU, based on the assumption that the most recently accessed data is the most likely to be accessed again.

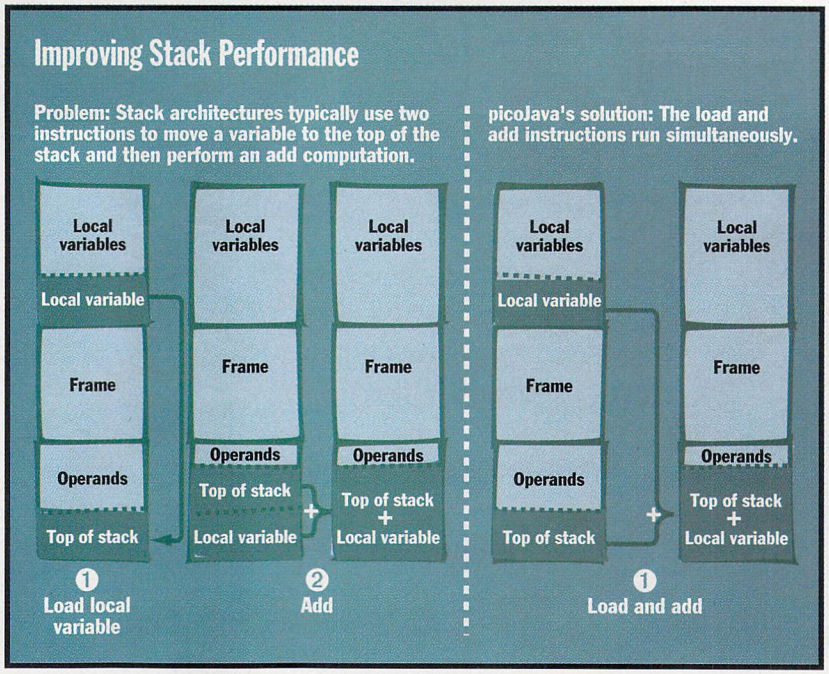
Garbage collection, in which the processor examines all objects and determines which ones are not in use, can ruin this scheme. This exhaustive search can destroy all the work that the cache and the virtual memory controller have done to keep the most current and important data close to the CPU. Suddenly, *all* objects are the most recently accessed. This can be a real problem if the Java garbage collector runs as a concurrent thread, as it often does.

The simplest solution is to allow the software to turn parts of the cache on and off. This can help manage the stack because the top of the stack—more so than the bottom—is likely to be accessed next. Many RISC chips use this method of cache control.

A bigger problem results because even the simplest garbage-collection mechanism cannot be interrupted by normal system tasks. If garbage collection is interrupted, the list of referenced and unreferenced memory might be corrupted and good information thrown away. To guard against this, picoJava maintains a tag bit, known as a *write barrier*, on each object. This barrier allows garbage collection to operate in the background and practically eliminates the effect it can have on running code when the entire machine pauses to identify unreferenced memory.

Streamlined Pipeline

For optimum performance, any CPU design must balance the computational



A picoJava chip moves data to the top of the unused registers in the stack and simultaneously dispatches a computation instruction.

Unanswered Questions

Architectural diagrams reveal a lot about picoJava, but a number of questions remain unanswered until we have live systems.

Q: How fast will systems based on Java chips run compared to PCs with general-purpose CPUs?

A: Sun says Java chips might run Java code 12 times faster than bytecode interpreters. But Java chips currently exist only as simulations, and new generations of general-purpose CPUs, Java interpreters, and just-in-time (JIT) compilers are closing the performance gap.

Q: Can Java chips satisfy multiple demands?

A: With an advanced TV set-top box—a prime potential application for Java chips—you could run Java applets from the World Wide Web or play videogames. But the latest home videogame machines could do this, too. Some of these boxes are surprisingly powerful and are easily capable of running a fast JIT compiler on their general-purpose RISC processors.

Q: How important will Java become?

A: Java has the potential to become a standard for broad-based application development. The more specialized (but still significant) embedded-systems market may become even more important for Java.

Q: How will Java evolve?

A: If Java does become a foundation for a broad range of application software, the size and structure of Java bytecode could change, and hardware architects would need to adjust their designs.

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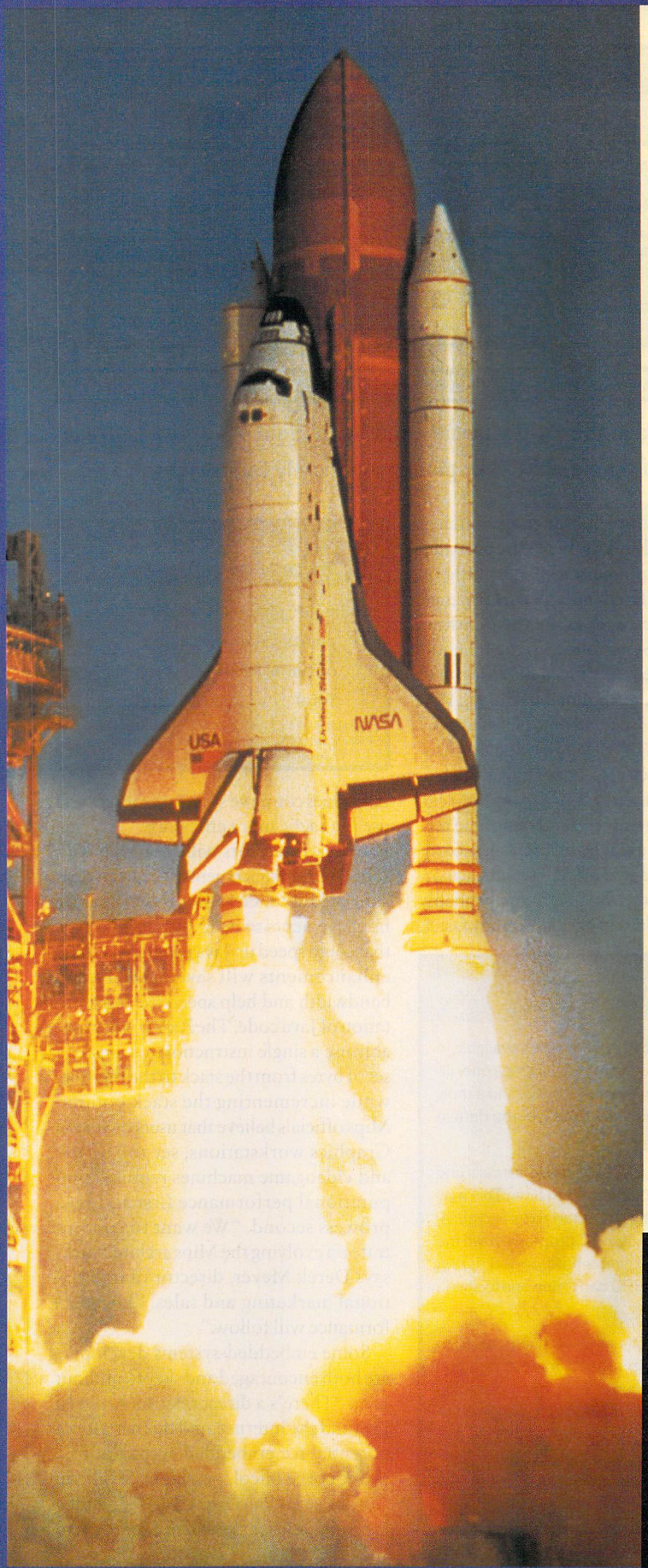

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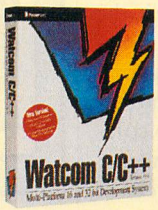

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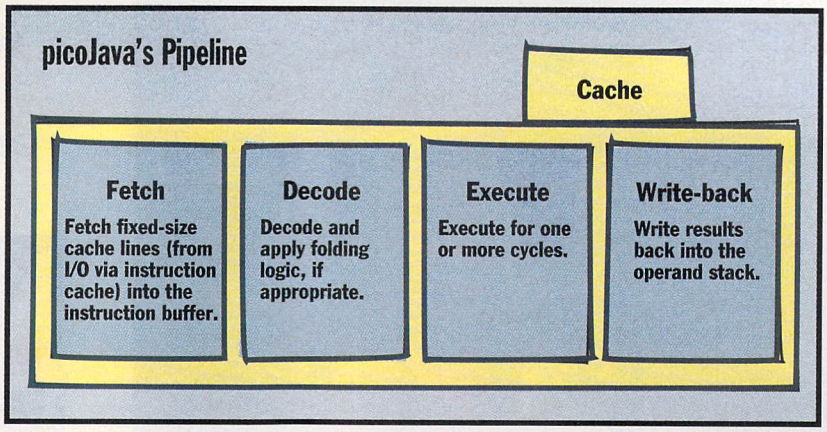
power of each instruction so it can efficiently pipeline the code. Pipelining splits an instruction into several parts, with each part taking the same amount of time to process. This allows a superscalar (multipipelined) CPU to process several instructions simultaneously.

For pipelining to work, all the data needed for a computation must be in the right place at exactly the right time. RISC pipelines driven by optimizing compilers have done this quite well, and Sun uses a very RISC-like pipeline for picoJava. The pipeline has only four stages: fetch, decode, execute, and writeback (see "picoJava's Pipeline" at right).

The chip accesses the cache during the execute phase, which can also perform some addition operations. For example, some Java instructions demand that you access a field of an object by adding *n* bytes to the pointer at the start of the object. These Java instructions execute in the picoJava pipeline as one instruction.

Sun is hoping that an innovative stack architecture, a tweaked garbage-collection mechanism, and a stripped-down pipeline design will add up to fast performance for picoJava chips.



To get data in the right place at exactly the right time, picoJava uses a simple, RISC-like pipeline with only four stages.

Do We Need Java Chips?

The great potential of Java has generated enthusiasm throughout the computer industry. However, not everyone believes dedicated Java chips are necessary. After all, university researchers have built specialized chips for languages such as LISP or Smalltalk only to discover that software implementations running on RISC chips offered superior performance.

Some chip vendors say their existing RISC and CISC architectures can handle Java quite well. Advanced Risc Machines (Cambridge, U.K.) tuned its StrongARM architecture (see "StrongARM Tactics," January BYTE) for embedded applications and stack-based languages, such as Java and PostScript. The StrongARM can move a stack frame in and out of the register set with a single instruction, according to Dave Jaggar, ARM's technical marketing director. By itself, this probably won't make Java programs run any faster, but it does conserve system resources and use the cache more efficiently.

Vital Statistics

Estimated picoJava die: .35 microns	
picoJava core	= 8.0 mm^2
optional FPU	= 5.5 mm^2
Total	13.5 mm^2 *

*Total size without the instruction or data caches, which are both variable from 0 to 16 KB.

Other processors will soon ship with subtle Java enhancements. The Mips division of Silicon Graphics is working on improvements to its Rx000 architecture that could speed up Java programs. These enhancements will save memory and bandwidth and help speed the interpretation of Java code. The Rx000 will probably use a single instruction to transfer a set of bytes from the stack to the registers while incrementing the stack pointer. Mips officials believe that users of Silicon Graphics workstations, set-top boxes, and videogame machines require computational performance first and Java prowess second. "We want to concentrate on evolving the Mips architecture," says Derek Meyer, director of international marketing and sales. "Java performance will follow."

Some embedded-systems developers are both encouraged and skeptical about Java. "There's a direct relation between Java and the Internet, and this has a lot of potential for embedded applications," says George Nicol, president of Silicon Composers (Palo Alto, CA). One idea his company has been investigating is to

Java vs. C

Designing a dedicated chip to run Java software is very different than designing a RISC chip to run C code. Here's why.

- Java is much more regimented than C. The Java virtual machine (VM) stores all its temporary data, including the results of each computation, on a stack. C uses a stack optionally.
- C compilers rarely know much about the pointers they manipulate. Java objects, by contrast, have a type from a strictly defined hierarchy, and this type information is available to the processor. The Java bytecode interpreter uses the structured information for security purposes and to optimize the code.
- Java centrally controls memory by allocating and reclaiming memory for all objects. Central control means engineers can tune the memory/processor interface to keep the most important information available to the CPU. By contrast, RISC chips offer little support for memory control and simply rely upon the cache to deliver the data at the right time.
- Java dynamically links procedure calls and method invocations at run time. This may involve searching several tables and chasing several pointers. C programs have the branches and jumps hard-coded during linking so the CPU can't intervene to speed up the process.
- The Java specification explicitly identifies thread synchronization in the instruction stream. This means that picoJava chips can support synchronization primitives in hardware. In contrast, C programs that are running on a RISC chip carry out thread synchronization only through additional layers of software.

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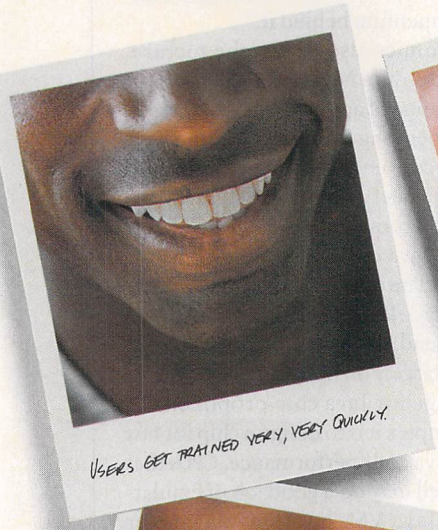



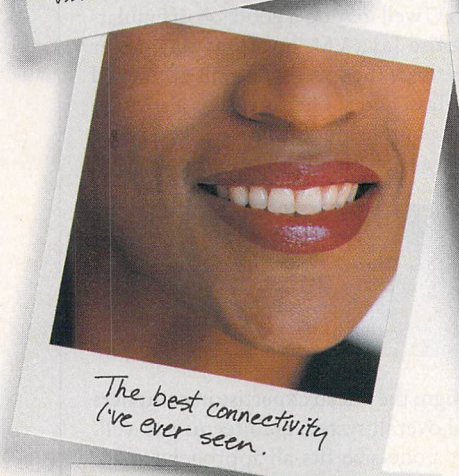

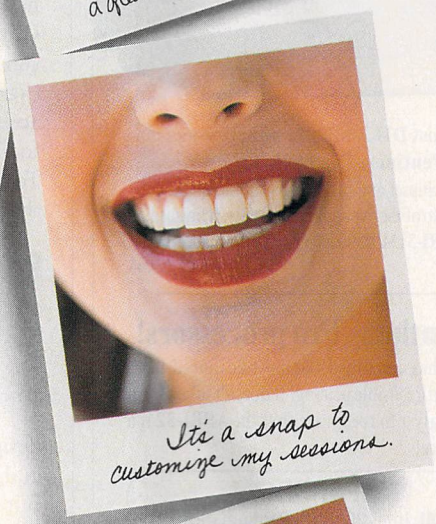

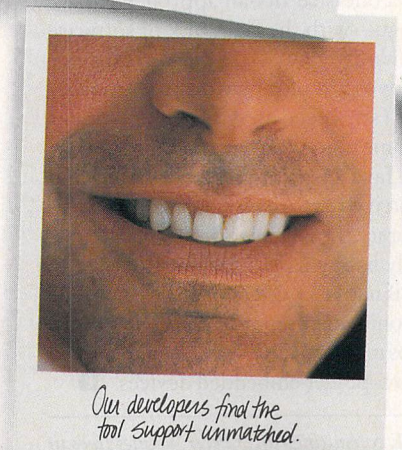

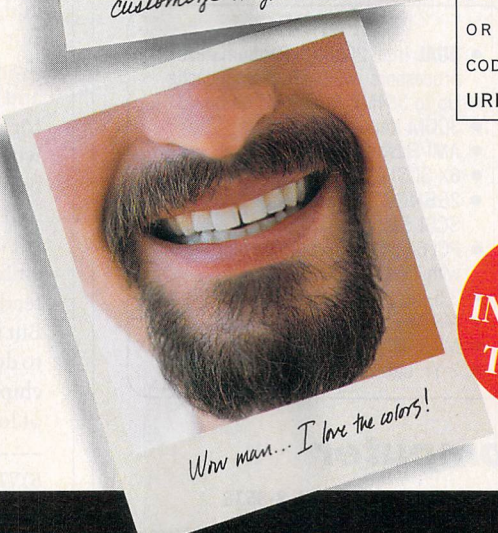

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Running C in a Java World

The picoJava design team knew it had to overcome one major hurdle: the Java language has no instructions for manipulating a computer's main memory. Most computers use memory locations to handle all input and output. For example, getting input from a mouse or a keyboard requires reading directly from memory. For security and safety reasons, Java won't allow this, which is why many system designers believe Java is unusable as a general system language.

But picoJava designers had a trick up their sleeves. They simply added new bytecode instructions for reading and writing memory. These instructions won't work on a Java-ready browser, but they will work for Java chips. Someone could even write an entire OS in Java. You also could compile C for Java-only chips and convert memory references. In fact, C is similar enough to Java that a Java chip running C might be faster than a C chip emulating Java.

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connect real-time data-acquisition instrumentation to the Internet to distribute information quickly to widely dispersed groups of clients.

However, Nicol says the Java language specifications leave him cool in terms of performance for real-time process control and data acquisition. "The design doesn't seem as elegant as it could have been. There's a strong software orientation," he says. "But Java does have business momentum behind it."

Economics also enters the picture. ARM, Intel, and Mips sell their chips for a wide range of applications, so they can justify spending more engineering time on their core engines. This could lead to a tighter performance race between general-purpose CPUs with JIT compilers and picoJava chips. Another hurdle for Sun could be unforeseen problems integrating picoJava chips into systems.

In the end, the success of Java chips will depend largely on the success of Java. An advantage for Java chip proponents is how complex it is to design a chip for fast C and Java code performance. CPUs that run C well may do a good job of emulating the Java VM, but they may never approach the speed of a chip optimized for Java code. The reverse is also true. To compensate, designers need more than a thorough understanding of CPU design; they need expertise in compilers and overall system architecture as well. But a one-size-fits-all approach to CPU design—with the right mix of software and hardware to wring out performance for two different platforms—probably won't satisfy end users if Java applications become ubiquitous.

If Java's platform independence and security features lead developers to embrace the language, users may be perfectly happy with Java-specific systems. But if native-code applications continue to dominate the market, specialized Java chips may be of interest only in the world of low-power embedded devices. B

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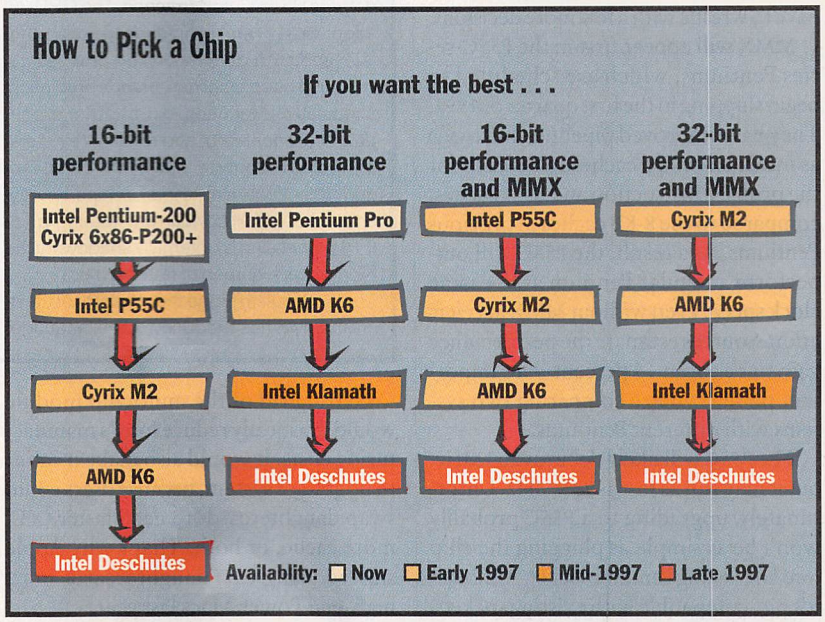
PC buyers face tough choices in 1997 as x86-chip vendors race to maintain their dominance. By Tom R. Halfhill

The x86 Gets Faster with Age

Call it the year of megahurts. Rarely have PC users shopping for a new system faced so many microprocessor-induced headaches. And it won't end in 1997; hotter competition, architectural transitions, and software factors will probably make users' decisions difficult for the next few years. Hibernation is not an option.

While novices continue to blindly compare megahertz and megabytes, knowledgeable users will be juggling many more variables. These are outlined below.

- Intel's fastest Pentium is cruising at 200 MHz this fall, but due to inherent limitations of its aging architecture, it's barely faster than a Pentium-166. Also, the current P54C-series Pentiums don't recognize Intel's new MMX multimedia instructions. Early next year, Intel will address these problems by introducing the new P55C-series Pentiums. But the P55C is still a fifth-generation x86 processor that will appear at a crucial juncture when Intel is attempting to push the mainstream market toward the sixth-generation Pentium Pro.
- Lower prices and new system chip sets are making Pentium Pro–based desktop PCs more affordable. Unfortunately, the Pentium Pro isn't the best choice if you're running 16-bit software, including Windows 95. Also, current Pentium Pros do not support MMX. Intel is readying a new P6-class processor, code-named Klamath, that improves 16-bit performance and supports MMX. But you'll have to wait for it until mid-1997 at the earliest, and the upgrade path for Pentium Pro users is muddy.
- Cyrix's rejuvenated 6x86 handily beats a comparable Pentium, has no trouble with 16-bit code, and boasts the fastest I/O bus in the business. However, Cyrix can't match Intel's fastest core speeds, and the 6x86 doesn't support MMX. In addition, BYTE recently discovered that some revisions of the 6x86 suffer from serious performance problems when running on Windows NT Workstation 4.0.
- Cyrix plans to address all these issues early next year with an improved version of the 6x86, called the M2. But its MMX compatibility will be in question at first because Cyrix doesn't have a licensing agreement for the Intel technology.
- AMD, still struggling with its disappointing K5 series, will finally ship a version that lives up to the company's early promises. But the K5 is hopelessly far behind the leading edge. In 1997, AMD's hopes will ride on the K6, which is supposed to support MMX and match or exceed the performance of the Pentium Pro. After stumbling with the K5, AMD desperately needs to win back the confidence of system vendors and users.
- A new contender, International Meta Systems (IMS), claims that it will introduce a CPU that fits into Pentium sockets and approximates the performance of a Pentium Pro. IMS has made previous attempts to break into the x86 market, but those products never shipped. This time, IMS is taking a different approach (see the text box "IMS Rides Again with the Meta-6000" on page 90).
- Looming on the horizon is Intel's seventh-generation x86, known as the P7 or Merced. It will introduce a 64-bit x86 architecture. However, systems built with this chip probably will not appear until 1998 at the earliest, so the Merced should not affect your near-term plans.



Are you confused by all the different x86 chips that are coming soon? Here's how to find your way through the maze.

Intel's Introductions

To defend its high profit margins and to keep its huge wafer-fabrication plants busy, Intel must periodically abandon an older-generation CPU and steer the market toward the next-generation product. That's what will happen to the Pentium in 1997. Although the Pentium will remain a high-volume product next year, Intel wants users to start thinking of the Pentium Pro as a mainstream CPU. Until now, Intel has mainly positioned the Pentium Pro for servers and workstations.

continued

However, this predictable transition (which happens about every four years) is a little more confusing this time because Intel is simultaneously introducing MMX, an architectural enhancement that spans both generations (see "x86 Enters the Multimedia Era," July BYTE). Because MMX will debut with the Pentium, not the Pentium Pro, users who buy new systems during the transitional phase will have to wrestle with a few more decisions.

MMX will appear first in the P55C-series Pentiums, which are scheduled to begin shipping in the first quarter of 1997. They have improved pipelines and twice as much on-board cache: 16 KB each for the primary instruction and data caches, compared to the 8-KB caches in previous Pentiums. As a result, the P55C will outperform a regular Pentium at the same clock speed, even without MMX acceleration. Sources estimate the performance gain to be about 15 percent—an important point if you're comparing two systems with different Pentiums.

The P55C will likely debut at 200 MHz, but it may run as fast as 233 MHz. Unfortunately, upgrading to a P55C probably won't be as simple as plugging the chip into an existing Pentium socket. Although it's pin-compatible with existing sockets, Intel had to reduce the voltage so that the chip runs cool enough at higher clock speeds. Thus, you'll probably need a new motherboard for the P55C.

Waiting for Klamath

Astute users who want to postpone obsolescence are looking toward the next generation: the Pentium Pro. Unfortunately, this chip has several problems. It bogs down under 16-bit software and won't support MMX until after the P55C. It's also expensive, because it uses a multichip module to incorporate a 256- or 512-KB Level 2 (L2) cache in the same package with the CPU die. And it requires more costly system chip sets and six-layer motherboards.

Intel's solutions are the Klamath and new chip sets. Intel isn't talking about Klamath yet, but this P6-class chip will almost certainly eliminate the expensive multichip module. Intel will reportedly offer the Klamath on a small daughtercard that plugs into a special slot on the motherboard. The daughtercard would include the CPU and the L2 cache, and some daughtercards may have sockets for multiple CPUs.

IMS Rides Again With The Meta6000

Only two companies besides Intel make leading-edge x86 processors: AMD and Cyrix. International Meta Systems (IMS), a small company known for rogue CPU designs, thinks there's room for a third.

IMS claims it will introduce an x86 chip in late 1997 that fits into Pentium sockets and delivers P6-level performance. The CPU will adopt most of the techniques used by other fifth- and sixth-generation x86 processors, including deep pipelines, branch prediction, speculative execution, out-of-order execution, scoreboarding, and rename registers. It will also recognize Intel's MMX multimedia instructions. Unlike Intel's chips, however, it will support concurrent floating-point (FP) processing by internally shadowing the FP registers instead of reusing them.

It's difficult to judge the reliability of these claims. IMS has produced some language-specific processors (for Smalltalk and FORTRAN) and is also working on a Java chip. But until now, the company has never competed against the big boys with an x86. In 1992, IMS announced the 3250, a unique RISC chip with rewritable microcode that could emulate an Intel 486 or a Motorola 68000. That chip never came out, although there were rumors that IMS licensed the technology to other companies.

Is the Meta6000 another vaporchip? Could be, but don't forget the NexGen story. NexGen labored for eight years before shipping the Nx586 in 1994. And although the Nx586 never became popular, it was a respectable design that beat AMD's and Cyrix's fifth-generation CPUs to market. Last year, AMD bought NexGen to obtain the sixth-generation Nx686, now called the K6. So don't diss IMS.

Getting rid of the multichip module would drastically reduce Intel's manufacturing costs. It would also make it easier to upgrade a system, because users could swap daughtercards to get a faster CPU, more cache, or both. That's why Apple started using CPU daughtercards in its high-end Power Macs last year.

But separating Klamath's CPU and L2 cache could have some less desirable side effects as well. First, there's the question of performance. The Pentium Pro's L2 cache is closely coupled to the CPU over a dedicated 64-bit bus that runs at the same clock speed as the core. It's an extraordinarily fast bus that contributes a lot to the Pentium Pro's superior 32-bit benchmark results. Moving the L2 cache out of the package may force Intel to adopt a slower bus. If so, Klamath would need a larger cache, higher clock speeds, and perhaps some additional enhancements to compensate for the loss. If Intel puts Klamath on a daughtercard, the bus that connects this card to the motherboard is another potential bottleneck.

Faster Clocks

In any case, Klamath will support MMX and probably include some modifications to enhance 16-bit performance. Higher clock speeds are a certainty, thanks to Intel's new 0.28- and 0.25-micron CMOS processes. In 1997, these smaller processes will supersede the 0.35-micron BiCMOS process on which today's Pentiums and Pentium Pros are built.

Klamath will debut sometime in 1997 at 0.28 micron, yielding a minimum clock speed of 200 or 233 MHz, going perhaps as high as 266 MHz. Later in the year, Intel will phase in the 0.25-micron CMOS process. This will lead to a P6-class chip (code-named Deschutes) that should hit 300 or 333 MHz.

That'll be great for new buyers, but where does it leave the early adopters of the Pentium Pro? If Intel, as expected, discards the multichip module, Klamath almost certainly won't be compatible with existing 387-pin Pentium Pro sockets. Moving the L2 cache outside the package onto an external 64-bit bus would require 72 more pins. The only alternative would be to interface the L2 cache to the front-side I/O bus, but that would seriously impair performance.

The bottom line: If Intel segregates the L2 cache, existing Pentium Pro systems probably won't be upgradable to Klamath. The new chip wouldn't fit the old sockets, and the old motherboards don't have a daughtercard slot. Intel has long-range plans for Pentium Pro OverDrive chips, but they probably won't appear before 1998. Pentium Pro users will end up swapping motherboards or buying a whole new system.

On the bright side, those new motherboards and systems will cost less. New system chip sets from Intel and Silicon Integrated Systems (SiS) are slashing the cost of building a Pentium Pro system. For example, Intel's new 440FX chip set has

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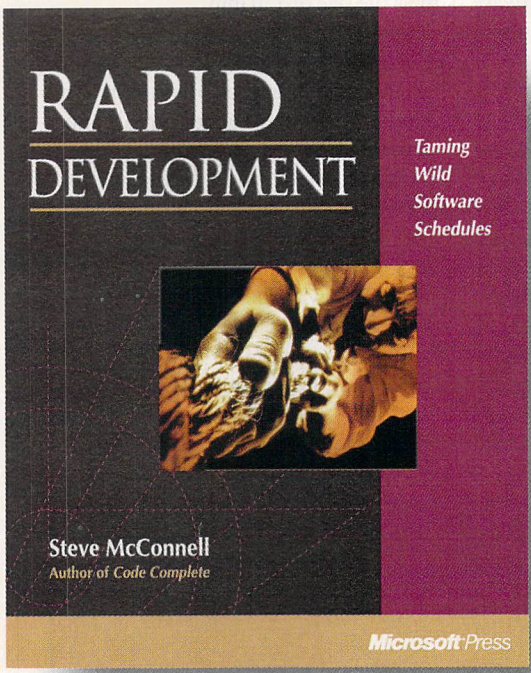

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only three parts and costs less than half as much ($94) as the eight-part 450KX chip set found on many of today's Pentium Pro motherboards. And SiS offers a one-chip solution, called Archer, that costs only about half as much ($39) as the 440FX. Moreover, these solutions work with four-layer motherboards instead of the six-layer boards required by the 450KX. Although they sacrifice a few features—such as memory expandability and multiprocessor support—these compromises are reasonable for desktop systems priced in the $2000-to-$3000 range.

Merced Mania

Further out is Intel's seventh-generation x86, the mysterious P7/Merced. Merced will extend the 32-bit x86 architecture to 64 bits and introduce a new instruction set. This architecture, dubbed IA-64, will be backward compatible with the existing x86 architecture, just as the 32-bit architecture of the 386 was compatible with the 16-bit 286, 8086, and 8088.

Although Merced is the fruit of Intel's partnership with Hewlett-Packard, it's looking less likely that IA-64 will radically depart from today's x86 architecture by adopting very-long-instruction-word (VLIW) technology. Intel will probably take a more conservative approach by extending the microarchitecture of the Pentium Pro. Pure VLIW is the antithesis of Intel's current design track; the Pentium Pro optimizes the instruction stream during execution, while a true VLIW processor would shift that responsibility to the compiler at design time.

There's still plenty of performance to be gained by extending the Pentium Pro's "dynamic execution" core. Intel could expand the reorder buffer, tweak the reordering algorithms, improve the branch prediction, add more execution units, boost the Level 1 (L1) caches (which are relatively small), and make other general improvements that would legitimately represent a seventh-generation design.

If VLIW plays any role at all, perhaps Intel and HP have found a way to adapt some tenets of that philosophy to the x86, just as Intel has integrated some elements of RISC into the Pentium Pro. Or maybe a full-blown VLIW design will appear in a subsequent processor.

Intel's alliance with HP also calls for Merced to run PA-RISC software. Some observers think this trick will require emulation, in either software or hardware. It would be useful to run PC applications on an HP workstation, but it's doubtful that the ability to run PA-RISC software on PCs would win significant additional market share for Intel.

In any event, Intel is committed to a 64-bit CPU that runs 16- and 32-bit x86 software without emulation. Native IA-64 programs will run faster than 16- or 32-bit programs, but nobody—possibly not even Intel—knows exactly how much faster.

Another unknown is how quickly the industry will adopt IA-64. Remember, it's been 11 years since Intel went 32-bit with the 386 in 1985, and most PC users are only now migrating to 32 bits. Microsoft didn't ship a 32-bit OS until 1993, and the vast majority of PC users still use 16-bit Windows 3.1 or 16-/32-bit Win 95. Although Microsoft recently dropped some vague hints about a 64-bit Windows NT, the first 64-bit OS for Merced will probably be Summit 3D, a new flavor of Unix currently under development by HP and The Santa Cruz Operation (SCO). If the 64-bit transition follows the same course as the 32-bit transition, then IA-64 won't be a significant market force until the year 2009.

Cyrix Crystal Ball

After a shaky start with the 6x86, Cyrix is finally gaining on Intel's price/performance lead. The first 0.6-micron version of the 6x86 suffered from a huge die. Cyrix switched to a process with five layers of metal instead of three, shrinking the die from 394 square millimeters to 210 mm^2. During the summer, Cyrix moved to a 0.5-micron process, achieving a die size of 170 mm^2.

Like an overweight athlete shedding excess fat, the 6x86 chip now runs a lot faster: 150 MHz instead of 100 MHz. And thanks to a more efficient microarchitecture, the 6x86 easily outruns a Pentium at the same clock speed. In fact, the 150-MHz 6x86 chip slightly outperforms a 200-MHz Pentium, which is why Cyrix designates this chip the 6x86-P200+ in accordance with the P-rating benchmark (see the text box "The Problem with P-Ratings" on page 94).

Recently, however, BYTE discovered that some 6x86-based systems have a serious problem with the final-release can-

Who's Who in x86

Here's what to expect from x86 vendors over the next year. (Note: Performance estimates and ship dates are BYTE's assumptions based on preliminary information from vendors.)

Company	CPU	x86 generation	MMX	Availability	Comments
AMD	K5	Fifth	No	Now	Latest versions have significantly increased performance.
AMD	K6	Sixth	Yes	March 1997	Redesigned NexGen Nx686.
Cyrix	Gx86	Fifth	No	Now	Highly integrated chip for low-cost PCs.
Cyrix	6x86	Sixth	No	Q1 1997	75-MHz I/O bus is the fastest on any x86 chip.
Cyrix	M2	Sixth	Yes	Q1 1997	Improved version of 6x86; MMX compatibility a challenge.
IMS	Meta6000	Sixth	Yes	Late 1997	Company has uncertain track record.
Intel	P54C Pentium	Fifth	No	Now	Dominates market; fastest speed is 200 MHz.
Intel	P55C Pentium	Fifth	Yes	Q1 1997	Slightly faster than P54C Pentium.
Intel	Pentium Pro	Sixth	No	Now	L2 cache in multichip module; poor 16-bit performance.
Intel	Klamath	Sixth	Yes	Mid-1997 (?)	Improved Pentium Pro; L2 cache probably separate.
Intel	Deschutes	Sixth	Yes	Late 1997	Improved Pentium Pro; should reach 300 MHz.
Intel	P7/Merced	Seventh	Yes	1998-1999 (?)	Highly secretive joint project with Hewlett-Packard.

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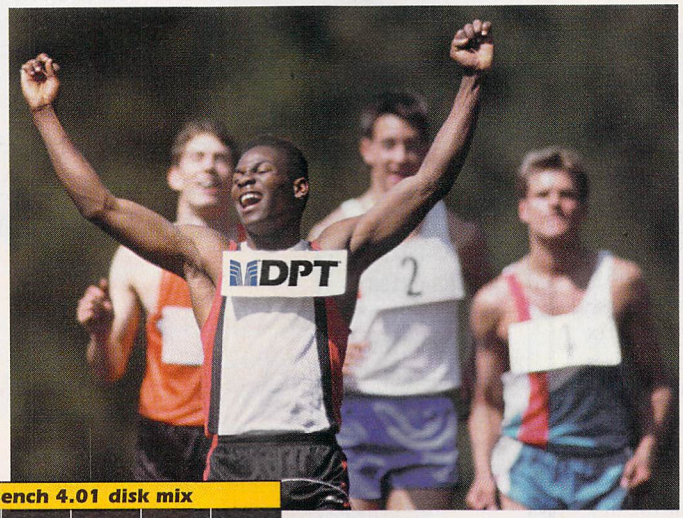

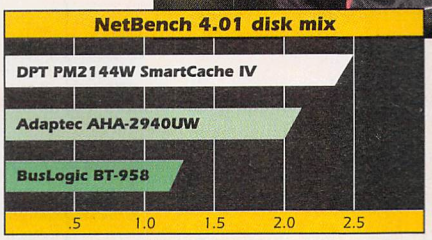

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didate of Windows NT Workstation 4.0. We ran 32-bit Windows applications tests on a 6x86-P200+ system and then compared the results to those obtained on the same system with a beta version of NT 4.0. To our surprise, the tests ran about 25 percent slower on the release candidate of NT 4.0. The 6x86 also ran NT 4.0 about 16 percent slower than NT 3.51 and 24 percent slower than Win 95. In similar tests with Pentium-based PCs, performance improved on the release candidate of NT 4.0.

This problem might be related to some last-minute code that Microsoft added to NT to make it more stable on Cyrix-based PCs. Check The BYTE Site (http://www.byte.com) for the latest updates on this developing story.

Another upcoming challenge for the 6x86 is MMX. Cyrix was working on its own multimedia extensions when Intel unveiled MMX and announced a cross-licensing agreement with AMD. Cyrix doesn't have such a deal, but it promises that the next version of the 6x86—code-named M2—will be MMX compatible.

The M2 is scheduled to start sampling in the fourth quarter of this year and then begin volume production during the first quarter of 1997. That means the M2 will be committed to silicon before Cyrix's engineers can get a close look at the P55C. To support MMX, they will have to rely on publicly available technical data from Intel—and perhaps some Texas windage as well.

Cyrix says that it has indirect access to some Intel technology through its fab partners, IBM Microelectronics and SGS Thomson, which have licensing agreements with Intel. Cyrix also notes that it has a good track record of x86 compatibility. Even so, MMX will be a question mark until independent parties get a chance to thoroughly test the M2.

Klamath Competition

The M2 will also move to a 0.35-micron process and beef up its unified L1 cache to an impressive 64 KB. M2 clock speeds will be 180 MHz and 200 MHz at introduction, with 225 MHz coming later in 1997. In combination with other improvements, those clock rates should allow the M2 to beat a P55C and compete strongly against Klamath.

Cyrix's biggest contribution to the PC industry might be a kick in the pants toward 75-MHz I/O buses. The 6x86-P200+

The Problem with P-Ratings

AMD and Cyrix will soon face a dilemma: How can they compare the performance of their processors to that of Intel's when the baseline keeps changing?

Until recently, users could judge the relative performance of two different x86 chips of the same generation by comparing clock speeds. CPU cores from AMD, Cyrix, and Intel were similar enough that performance didn't vary much—a 33-MHz 486 from one vendor was as fast as a 33-MHz 486 from a competitor.

But as the x86 moves through its fifth and sixth generations, microarchitectures are diverging to the point where clock speeds are no longer valid, even for shorthand comparisons. For instance, Cyrix's 150-MHz 6x86 outruns a 200-MHz Pentium.

Industry-standard benchmarks, such as SPEC95, are one answer, as are magazine benchmarks, such as the BYTEmark and WinBench. But these tests typically yield measurements that don't directly compare different CPUs. (BYTEmarks are normalized to a Pentium-90 baseline, not relative clock speeds, although you could figure it out by doing a little math.)

AMD and Cyrix prefer numbers that users can compare directly to Intel clock speeds. That's why they joined forces last year to standardize on Performance Ratings, abbreviated as *P-ratings* by Cyrix and as *PR-ratings* by AMD.

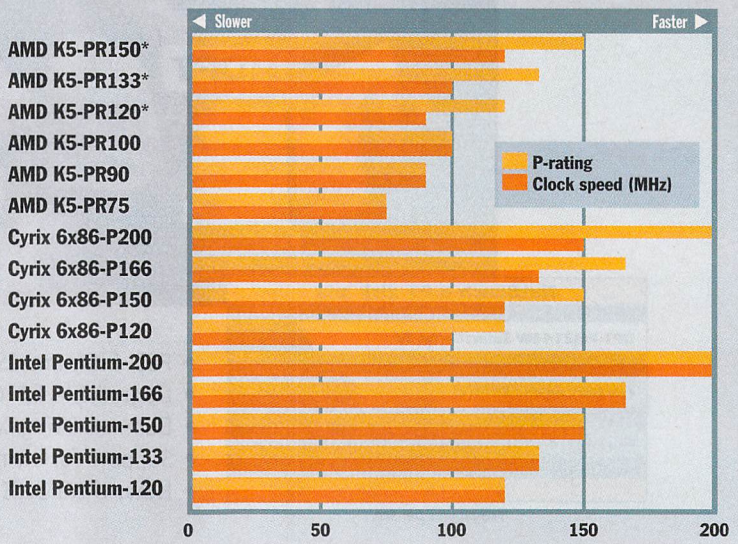
MicroDesign Resources, which publishes the *Microprocessor Report*, acts as the independent testing lab. Cyrix's 150-MHz 6x86 is labeled the 6x86-P200+ because it matches or exceeds the performance of a Pentium-200; AMD's new 100-MHz K5 is called the K5-PR133 because it's comparable to a Pentium-133.

But P-ratings use today's Pentium as the baseline. When Intel introduces the P55C Pentiums in 1997, they're expected to perform about 15 percent better than a regular Pentium at the same clock speed. Users might be confused: Which Pentium does the P-rating refer to?

Then there's the Pentium Pro. Comparisons to Intel's flagship CPU will require yet another variation of the P-rating.

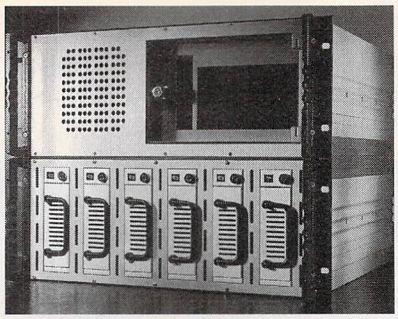
Cyrix and AMD claim they're working on a solution. But knowledgeable buyers don't rely exclusively on vendors' performance claims, anyway. By collecting benchmark data from multiple sources—including the popular magazine benchmarks, which are freely available—expert users can reach their own conclusions, even if it takes a little more effort.

P-Ratings vs. Clock Speeds



*Latest version of AMD K5 is faster than clock speed because of architectural improvements (see text).

An x86-compatible chip rated at P-120 delivers performance comparable to that of a 120-MHz Pentium.



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- fast-SCSI and wide-SCSI cabling according to your requirements
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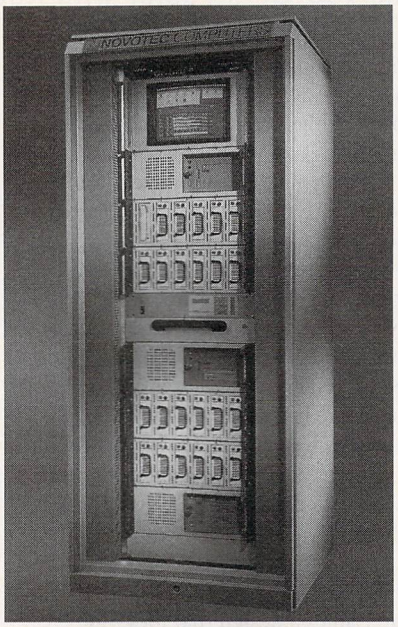

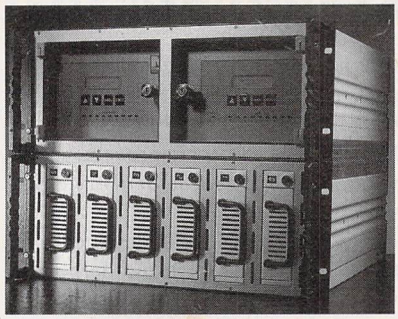

Novotec 19" Cluster
- 8 U-chassis
- modular expandable
- 2 redundant power supplies (600 W)
- maximum ventilation of all built-in components
- drive shuttles with hot-swapping
- flexibility by the use of 1-6 wide-SCSI-channels

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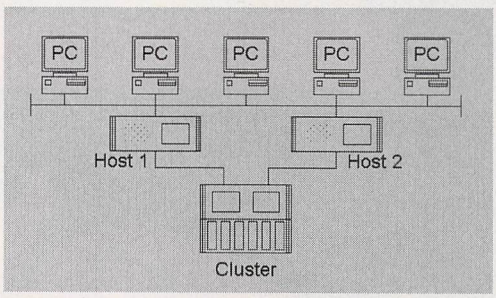

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runs its core at 150 MHz and the I/O bus at an unprecedented 75 MHz. Until now, the fastest x86 buses topped out at 66 MHz. That 14 percent improvement provides a significant boost for I/O-intensive servers.

Unfortunately, systems designers have trouble making 75-MHz motherboards, which is why nobody has done it until now. Only one system chip set (from VLSI Technology) currently supports the 75-MHz bus. Without that chip set, the 6x86-P200+ has to synchronize its bus at 50 MHz, which bleeds so much performance that the chip no longer merits the P200+ designation. Maybe that's why Cyrix entered the systems business last summer; if you want to get a 6x86-P200+ system with a 75-MHz bus, you can buy one directly from Cyrix.

Cyrix is also working on an 83-MHz bus. That's nearly 26 percent faster than 66 MHz and would certainly provoke server envy among rival vendors. Until chip-set makers and motherboard manufacturers catch up, however, these bus speeds are mainly a technical curiosity. It will probably require the weight of Intel to shove the industry forward, and Intel hasn't publicly committed itself to speedier buses.

In another interesting move, Cyrix is introducing a highly integrated chip that would allow consumer PCs to retail for $800. Tentatively called the Gx86, the new processor is based on a low-cost chip that Cyrix announced last year for notebook computers. If the $800 consumer PCs succeed, Cyrix hopes to design a version for corporate intranets. Cyrix would position that chip as a CPU for low-cost, Windows-compatible network computers. (See the text box "Cyrix Gx86 for Dirt-Cheap PCs" at right.)

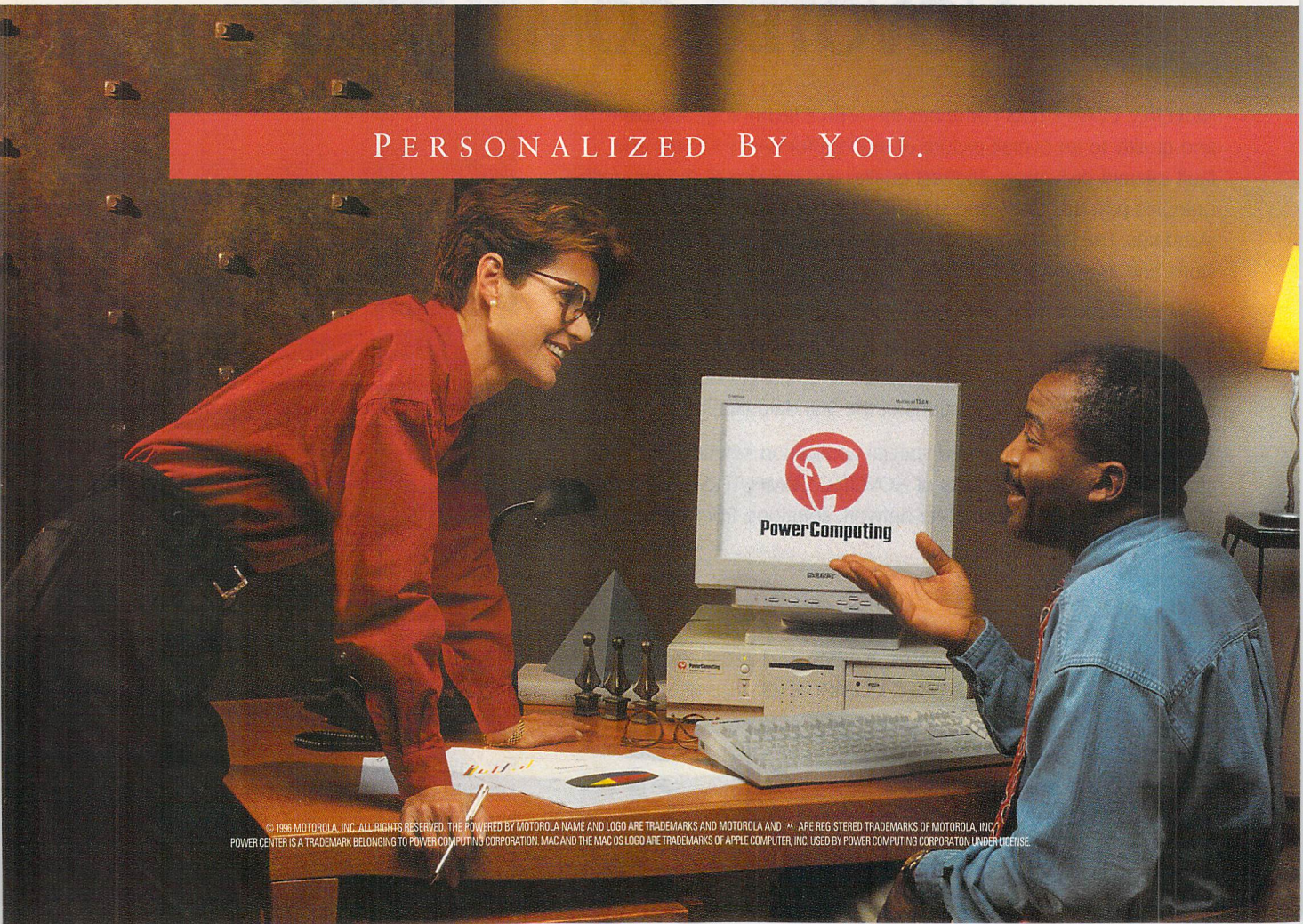
AMD Road Map

Sometimes a design that looks great on paper falls flat in the real world. AMD's ordeal with the K5 wasn't quite as embarrassing as the baggage-handling debacle at Denver's new airport, but it was bad enough. The K5 was supposed to bring AMD's chips within striking distance of Intel's top CPUs; instead, numerous problems have kept the K5 from seriously challenging even the Pentium, much less the Pentium Pro.

Despite the conventional wisdom that PC prices go nowhere but down, entry-level computers have been stuck in the $1200-to-$1500 range for a decade and have actually doubled in price since the early 1980s. Now that IBM, Oracle, Sun Microsystems, and others are promoting economical network computers, some PC vendors are exploring ways to make sub-$1000 systems without sacrificing Windows compatibility.

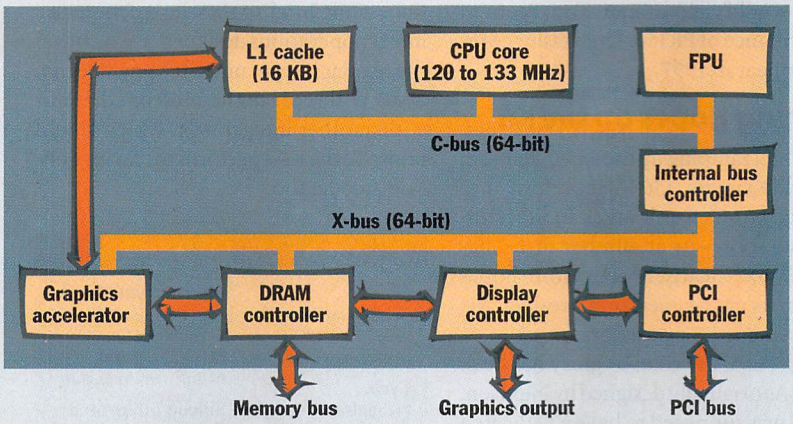
Intel is taking a wait-and-see attitude. Cyrix, however, is jumping in with the Gx86, a highly integrated, low-cost PC-on-a-chip that allows a full-featured system to sell for about $800. Buyers would get a PC with Pentium-120 or Pentium-133 performance, 16 MB of RAM, a hard disk, a six-speed CD-ROM drive, a modem, and input devices.

To make this possible, the Gx86 integrates several functions that normally require extra



Now the K5 is back on track. It's too late for the chip to gain the leading edge, but it can still compete against the Pentium for desktop PCs costing under $2000. Currently, AMD is shipping the K5 at three speeds: 75, 90, and 100 MHz. They closely match Pentium performance at equivalent clock rates, earning them P-ratings of PR75, PR90, and PR100, respectively.

Cyrix Gx86 for Dirt-Cheap PCs



The Gx86 integrates components that normally need separate chips and eliminates the frame buffer and Level 2 cache.

chips. It has built-in SVGA graphics, a PCI interface, and 16-bit Sound Blaster emulation. It also has a unified memory architecture (UMA), which buffers the screen data in main memory instead of in a separate frame buffer. UMA can degrade performance, but Cyrix says the Gx86 avoids this by integrating the video logic with the CPU.

The CPU core is a stripped-down version of the Cyrix 6x86. It sacrifices superscalar pipelines and speculative execution but still predicts branches and retains a 16-KB cache. Although the Gx86 probably would not do as well as a Pentium-120 or Pentium-133 when running a CPU-level benchmark, Cyrix claims the efficiencies of high integration allow the chip to deliver that level of overall system performance. (BYTE has not yet tested these claims.)

Cyrix expects to introduce the chip by the end of this year and says that several "top-tier" system vendors will ship Gx86-based PCs in early 1997.

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The next versions of the K5—which are scheduled to ship in September or October—are supposed to live up to the K5's original specifications, which called for 20 percent to 30 percent greater performance than a Pentium running at the same clock speed. The new chips run at 90 and 100 MHz but carry P-ratings of PR120 and PR133, respectively.

To attain these higher P-ratings, AMD's engineers tweaked the K5 chips's core in several ways. First, they optimized the K5's execution of certain x86 instructions (e.g., repeat MOVs and far CALLs) that occur more often in real-world software than AMD's simulations had predicted. Next, they added a small prefetch cache in front of the L1 instruction cache. This fixed a problem that arose when the K5's prefetch logic aborted a cache fill in order to follow a branch to a new target address; if the program later branched back to the original instruction stream, the K5 had to fill the cache all over again. The new prefetch cache temporarily holds the cache lines to prevent a slow memory transaction. Finally, AMD eliminated some internal bus bottlenecks.

According to AMD, the K5 now runs about 30 percent faster than an equivalently clocked Pentium. (BYTE has not yet confirmed these claims.) In November or December, AMD plans to start shipping a 120-MHz version of this core, which would yield an equivalent Pentium performance of PR150. Even faster cores may appear in 1997.

Pinning Hopes on the K6

With Intel ramping up the P55C, Pentium Pro, and Klamath, 150-MHz performance will keep AMD firmly stuck in the number-two spot—or at number three, behind Cyrix. Clearly, AMD's future hopes ride on its next-generation product, the still-evolving K6 processor.

Here, too, the road to glory has been rocky. As originally designed by NexGen, the K6 was supposed to have a dedicated bus for the L2 cache, an integrated L2 cache controller, and a new execution unit for multimedia instructions. It was also going to be manufactured by IBM Microelectronics, NexGen's fab partner. When AMD acquired NexGen in late 1995, those plans abruptly changed.

For the past year, AMD engineers have been modifying the K6 to make it compatible with MMX. This could require some major changes. The original K6 included a special multimedia execution unit, while Intel's MMX instructions are integer operations designed to execute in the regular integer units. It's possible that AMD will replace the multimedia unit with another integer unit, which would improve the K6's performance with non-MMX code, too.

WHERE TO FIND

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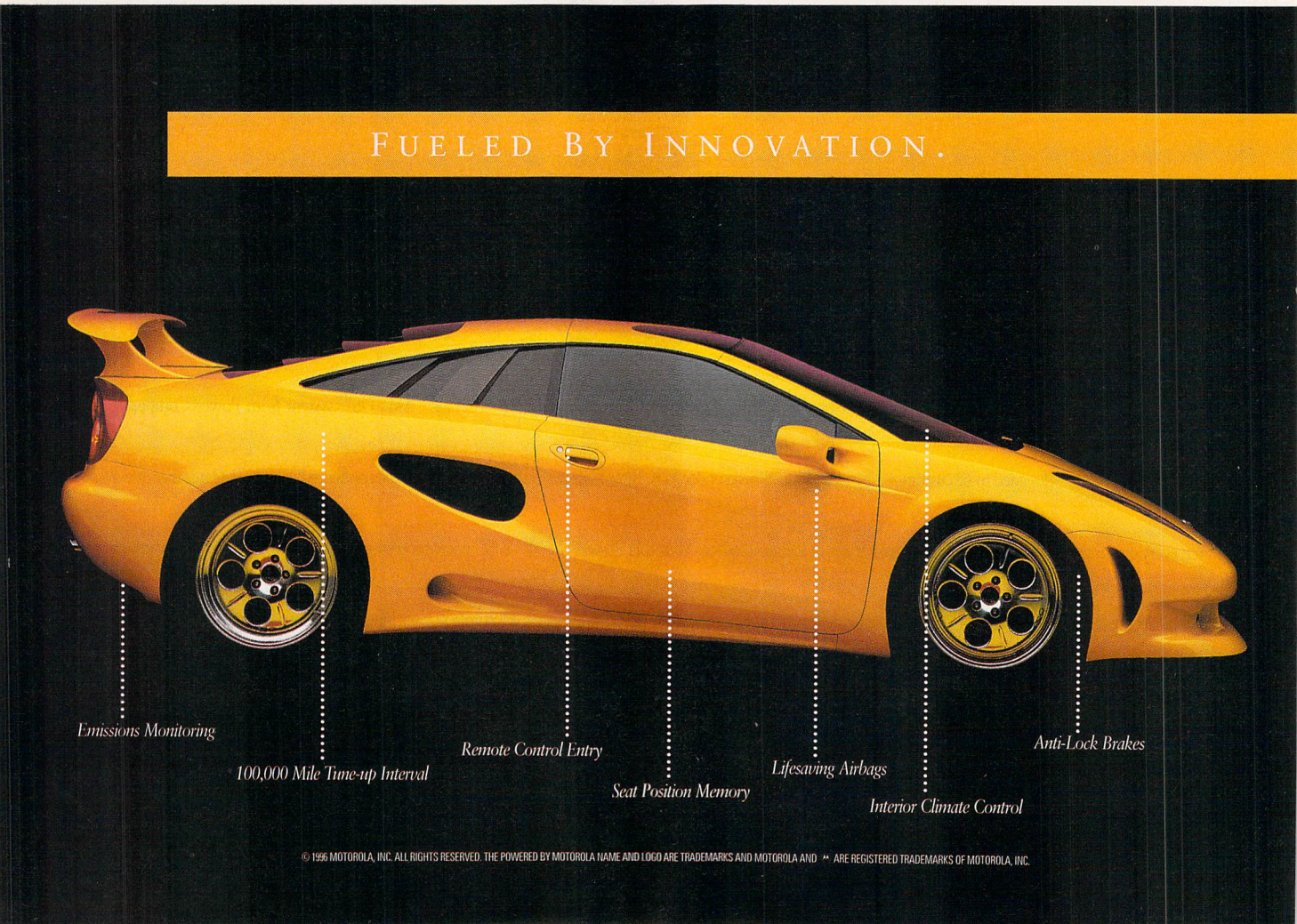

Another significant change is that the K6 will be pin-compatible with P54C-series Pentium sockets. The original Nx686 had a proprietary pin-out that required special system chip sets, a disadvantage that stunted the sales of NexGen's earlier Nx586 processor. Pin compatibility with Pentium sockets opens up a more lucrative market for the K6. Unfortunately, it also forces AMD to abandon the K6's high-speed L2 bus and integrated cache controller, because Pentium sockets don't support those features. To compensate, the K6's L1 caches now total 64 KB, compared to 32 KB for the Nx586.

Finally, engineers are reworking the K6 so that AMD can manufacture the chip at its new Fab 25 in Austin, Texas. The K6 will debut on AMD's 0.35-micron, five-layer-metal CMOS process, migrating later to 0.25 micron.

In an important move, AMD has licensed an advanced pad-bonding technology, called C4, from IBM Microelectronics. On most chips, the wires leading to the pins are soldered onto tiny pads crowded along the edges of the die. C4 technology allows circuit designers to distribute those pads anywhere on the die. This gives the designers more flexibility and also shortens the chip's critical paths, yielding higher performance. In addition, when the chip migrates to smaller processes, C4 prevents it from becoming "pad-limited"—AMD won't have to hold the die at a certain size just to leave room for the pads.

AMD says it will begin sampling the K6 late this year and start production in March. The K6 will debut at 180 MHz and support bus speeds as high as 75 MHz. AMD is sticking to NexGen's original performance estimates for the Nx686, claiming that it will be "competitive" with the Pentium Pro when running 32-bit software and considerably faster with 16-bit code. If AMD can deliver on those promises—admittedly, that's a big if—the K6 will help close the performance gap that widened when the K5 missed the target.

Look Before You Leap

In a transitional year like 1997, purchasing decisions will be more critical than ever. It's not as simple as buying the fastest Pentium.

If multimedia matters, you should wait for MMX. If you want to get the best possible performance with 32-bit software, then wait for Klamath or even Deschutes. If you're running a great deal of 16-bit software (especially on Windows 3.1 or Win 95), wait to see how well Klamath and Deschutes address the Pentium Pro's 16-bit weaknesses—or consider getting a Cyrix or AMD chip. If you crave the fastest possible bus for an I/O-intensive server, the Cyrix 6x86-P200+ is the only game in town.

You can shop for bargains, too. There will be markdowns on regular Pentium systems after MMX appears and while Intel pushes the Pentium Pro as the next mainstream CPU. There's nothing wrong with buying a system that isn't top-of-the-line—as long as you know what you are getting. B

Tom R. Halfhill is a BYTE senior editor based in San Mateo, California. You can reach him at **thalfhill@bix.com**.

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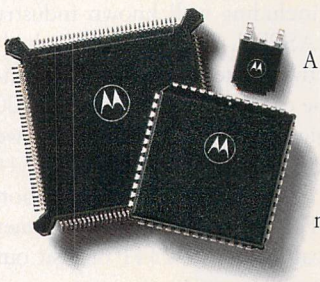

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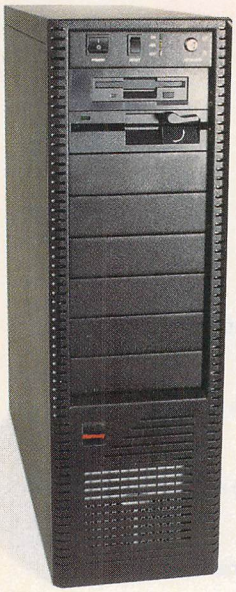

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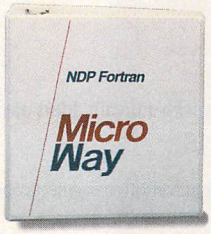

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Stung by Intel's gains in processor performance, the PowerPC alliance will strike back with higher clock speeds and new chip designs. **By Tom R. Halfhill**

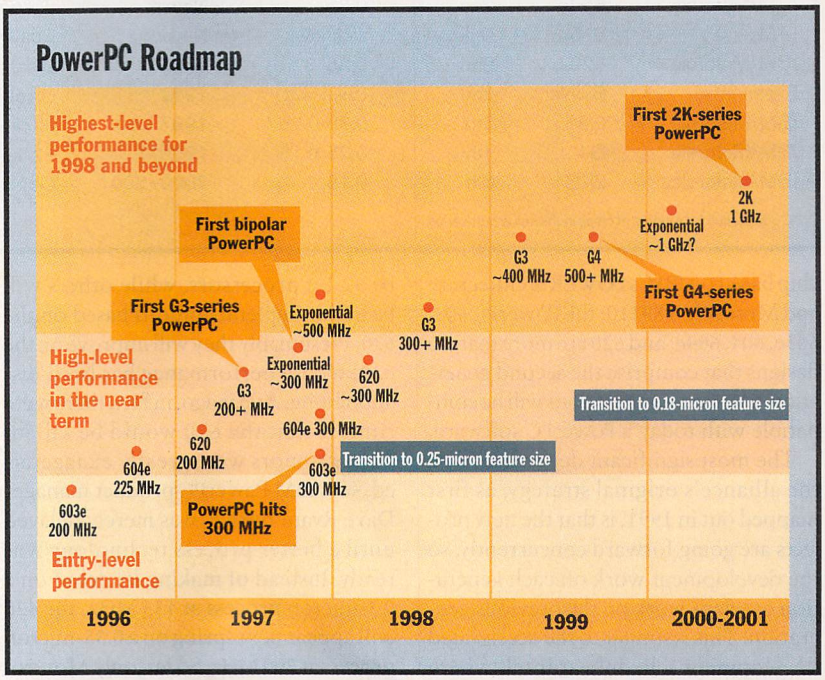
PowerPC Regroups

Don't count your megahertz before they're hatched. That's what the PowerPC alliance has learned after prematurely gloating over the imagined obsolescence of Intel's x86.

One famous advertisement from 1992 showed how CISC performance was falling flat while RISC technology soared toward the SPECint stratosphere. Another ad warned about the coming fate of x86-based PCs by picturing a highway running smack into a brick wall.

Somehow, things didn't work out that way. Intel's Pentium and Pentium Pro have not only managed to keep the 18-year-old x86 architecture competitive; they have at times surpassed the performance of leading RISC chips, including the PowerPC. Apple fulfilled its promise to sell millions of Power Macs, but system-level limitations have foiled Apple's attempts to exploit the full potential of the PowerPC chips. IBM fumbled the introduction of its own PowerPC desktop systems and embarrassingly failed to port OS/2 to PowerPC. And four years after the PowerPC's birth, the alliance is only now finalizing the PowerPC Reference Platform for clone makers.

If the PowerPC is to retain any credibility as an alternative to the x86, the alliance must deliver a steady stream of faster chips and a viable system standard that attracts big-volume vendors. In 1997, Motorola and IBM will roll out faster versions of current PowerPC chips, introduce a new generation of 32- and 64-bit processors, accelerate the development of future CPUs, and oversee the debut of PowerPC Platform systems that can run the Mac OS, Windows NT, and Unix. With Intel running full speed toward 300-MHz Pentium Pros and the 64-bit Merced, 1997 could be the PowerPC's last shot at glory.



PowerPC designers need to achieve 300 MHz next year to stay in the performance race with the x86.

The Indy 300

One measure of the PowerPC's competitiveness will be its ability to break the 300-MHz barrier. Digital's exotic Alpha did it more than a year ago, but CPUs for mainstream desktop systems are only now creeping beyond 200 MHz. By the end of next year, we should see 300-MHz chips from Intel, IBM, Motorola, and probably Exponential Technology, a Silicon Valley startup that will ship the first PowerPC processor built with bipolar transistors (see "Exponential's Bid to Beat the Pack," page 104).

CPUs capable of attaining 300 MHz include Intel's Deschutes (a Pentium Pro variant), the PowerPC 603e, and the PowerPC 604e. At 300 MHz, the 603e and 604e will offer about five times the performance of the first PowerPC 601, which ran at 60 MHz.

Of course, raw clock speeds are no longer an adequate way to compare processor performance, especially between two architectures as disparate as the x86 and PowerPC. However, clock speeds do indicate which companies have the most advanced wafer-fabrication processes and speed-tuned microarchitectures. Intel designed the superpipelined Pentium Pro for high clock speeds to exploit its lead in building new fabrication plants (fabs). But IBM and Motorola are no slouches in this category, either. The PowerPC 604e hit 225 MHz last summer while Intel's chips were stuck at 200 MHz, and Mac clones running at 225 MHz and 240 MHz have been available for several months now from Power Computing. Even at 200 MHz, the 604e outguns Intel's fastest x86.

As part of their plan to carry the PowerPC architecture into the twenty-first century, IBM, Motorola, and Apple have forecast three generations of chips that will run at even higher clock speeds. They refer to these generations as G3, G4, and 2K. (The 601 is considered the first-generation PowerPC because it was a hybrid

Five Generations of PowerPC

Company	CPU	PPC Generation	Feature Size (micron)	Availability	Analysis
IBM/Motorola	601	1st	0.5	Phasing out	Maximum clock speed limited to 120 MHz
IBM/Motorola	603	2nd	0.5	Now	Smaller caches, slower clock than 603e
IBM/Motorola	603e	2nd	0.35	Now	Exceptionally low power consumption
IBM/Motorola	604	2nd	0.5	Now	Smaller caches, slower clock than 604e
IBM/Motorola	604e	2nd	0.35	Now	Outperforms Pentium Pro at same clock speed
IBM	615	Unknown	Unknown	Never	Dual PowerPC / x86; project probably canceled
IBM/Motorola	620	2nd	0.35	1997	Disappointing performance delayed introduction
Exponential	Bipolar	2nd	Unknown	1997	Unique hybrid of bipolar logic and CMOS cache
IBM/Motorola	G3*	3rd	0.35-0.25	1997	32- and 64-bit chips; up to 30 million transistors
IBM/Motorola	G4*	4th	0.25-0.18	1999	32- and 64-bit chips; up to 50 million transistors
IBM/Motorola	2K*	5th	0.18	2000–2001	Good bet to break 1-GHz barrier

*Code names for a series of chips in the same generation

chip based on IBM's POWER architecture and Motorola's 88110; the PowerPC 603, 603e, 604, 604e, and 620 are more mature designs that comprise the second generation.) All future generations will be compatible with today's PowerPC software.

The most significant departure from the alliance's original strategy, as first mapped out in 1991, is that the new projects are going forward concurrently, so the development work on each generation overlaps work on the previous generation. This is similar to the accelerated development schedule at Intel, where independent teams are working on new x86 generations simultaneously.

To make this possible, the PowerPC alliance has expanded its Somerset lab (a shared design center in Austin, Texas) by 50 percent. In addition, IBM and Motorola are working on PowerPC projects at their own labs in Texas, Vermont, and elsewhere. New designs can emanate from any of these labs, and IBM and Motorola share manufacturing rights to any PowerPC chips they jointly develop.

Future Generations

The G3 series is scheduled to arrive in mid-1997 with a CPU that will run at about 200 MHz on 0.35-micron CMOS. This chip has already taped out and is available in samples. Later G3-series chips will migrate to a 0.25-micron CMOS process, and clock speeds will scale upward to about 400 MHz, according to Will Swearengin, PowerPC product manager at Motorola. The fastest G3 chips will run about 10 times faster than the original PowerPC 601, he estimates.

Some chips in the G3 generation will be 32-bit processors, while others will be 64-bit implementations based on the 620. Presumably they will improve on the 620, whose performance has been disappointing. A year ago, in fact, there were rumors that the 620 would be killed. Those rumors were greatly exaggerated, says IBM PowerPC product manager Dave Ryan; the 620 was merely delayed until a better process technology was ready. Instead of making its debut on a 0.5-micron process at 133 MHz, the 620 will appear next spring on a 0.35-micron process at 200 MHz. So far, only Motorola and Groupe Bull are committed to making 620-based systems.

Some G3-series chips will inherit the 128-bit backside bus that the 620 uses to address its secondary (level 2) cache. Others may have integrated L2 cache controllers, multichip module L2 packaging (like the Pentium Pro), or integrated L2 caches (like the Alpha). A strong clue that IBM and Motorola are thinking about integrated or closely coupled caches is that transistor counts in the G3 series will soar as high as 30 million, nearly an order of magnitude greater than the number of transistors in today's PowerPC chips. It's unlikely that the chip architects will design logic circuits requiring so many transistors in this generation; bigger caches are a virtual certainty.

In 1999, IBM and Motorola plan to introduce the G4 generation, which will first appear at about 500 MHz on 0.25-micron CMOS. Later, the G4-series chips will graduate to 0.18-micron CMOS, which should enable clock speeds approaching 1 GHz (1000 MHz). Transistor counts will range as high as 50 million—again, mostly cache, not logic.

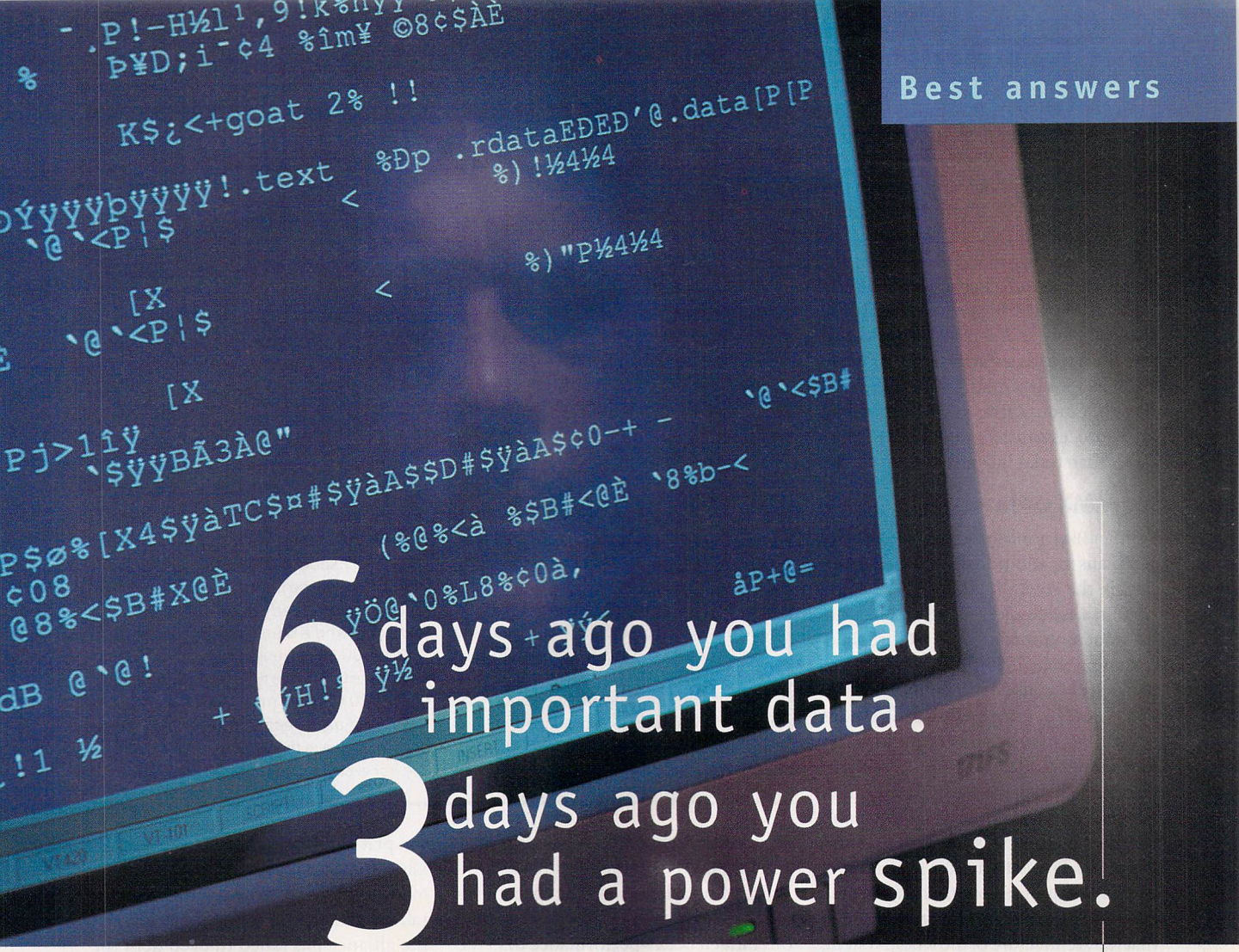
Some G4 chips will be 32-bit, but most will probably be 64-bit. Users probably won't realize the full benefit of 64-bit architectures until OS vendors and applications developers rewrite their software to take advantage of the wider architectures. Even then, I/O-intensive applications such as databases probably stand to gain more performance than mainstream desktop applications.

Even the 32-bit versions of the G4-series processors will match or exceed the performance of Intel's 64-bit Merced, Motorola's Swearengin claims. G4 chips will be available in mainstream desktop systems immediately after introduction, he says. (Intel's pattern is to introduce a new x86 generation in servers and high-end workstation PCs, then phase in the lower-priced desktops later.)

Both IBM and Motorola maintain that the PowerPC will weather the 32- to 64-bit transition better than the x86. Intel's Merced will introduce a new architecture, known as IA-64, that almost certainly will require developers to recompile their software to get maximum performance (see "The x86 Gets Faster with Age," page 89). Although PowerPC developers face a similar transition, it may be a little smoother simply because the PowerPC carries less architectural baggage. For example, x86 users will expect a 64-bit x86 to be backward compatible with 16- and 32-bit software dating as far back as 1981, while the PowerPC started life as a modern 32-bit architecture in the 1990s. Of course, there's no way to verify any of these claims until the end of the decade.

continued

Best answers



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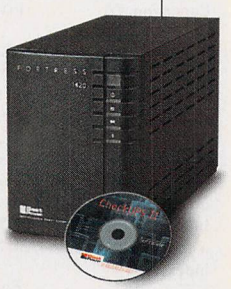

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In 2000 or 2001, IBM and Motorola plan to introduce their fifth-generation PowerPC series, code-named 2K. The alliance is saying very little about this long-range project. If process technology stays on track, the 2K series will premiere at 0.18 micron and the best fabs will be moving toward feature sizes of 0.15 micron or smaller. That should yield CPUs with as many as 100 million transistors and clock speeds exceeding 1 GHz. When combined with further architectural improvements, the result should be microprocessors that run at least 10 times faster than today's CPUs.

No MMX or Java

Neither IBM nor Motorola acknowledge any plans for additional multimedia support in the PowerPC architecture. Intel, of course, is adding 57 new MMX instructions for multimedia to the x86 architecture next year. Multimedia enhancements are less imperative for the PowerPC architecture, which already includes some RISC instructions that duplicate MMX instructions. BYTE's tests show that PowerPC chips have overall better integer performance than x86 chips, and there's no context-switching penalty when the PowerPC mixes multimedia with floating-point operations, as there is with MMX. IBM and Motorola argue that the architecture of the whole system, not just the CPU, is the most important factor in multimedia performance.

Up to now, the vast majority of PowerPC-based systems have been Power Macs. Next year, however, PowerPC systems will undergo a major transition to the new PowerPC Platform. This is the system architecture for all future PowerPC systems, including Macs, Mac clones, and machines that run Windows NT and Unix. Although you might expect that a brand new system architecture would offer much better performance than the older x86-based PC architecture, it's not guaranteed. The PowerPC platform carries some baggage from both the existing PC architecture and the Mac because it's designed to work with industry standard PC components and Mac peripherals. It remains to be seen whether this baggage will compromise performance.

Likewise, it's too early to tell whether Java will become important enough to justify modifications to the PowerPC architecture. Sun is betting heavily on Java with a line of dedicated Java chips—but then, Sun invented Java. Another major chip vendor (which gave BYTE this information on a confidential basis) is planning to enhance its CPU architecture with new instructions that improve Java performance. Other chip makers are waiting to see if Java becomes a significant market force or fizzles out like a fad.

Turnaround: 1997?

Since the PowerPC alliance came together in 1991, it has largely kept its promise to offer microprocessors at roughly twice the price/performance ratio of Intel's x86—in other words, twice the performance at a comparable price, or comparable performance at half the price. But the alliance has failed to even dent the x86's overwhelming market share.

Indeed, it's possible that the most significant impact of the PowerPC has been to prod Intel into accelerating its research and development. Ironically, Intel seemed to take the PowerPC more seriously than almost anyone else. As a result, the x86 is still highly competitive and far from obsolete. The PowerPC is the best-selling RISC architecture on the desktop, but almost all PowerPC systems are Power Macs, and Apple has less than 9 percent of the market.

The long-awaited PowerPC Platform is the best bet for a turnaround. After inexcusable delays, it's finally ready to open up the Mac clone market and provide a common hardware platform for multiple OSes. Although the PowerPC stands little chance of dethroning the x86, the alliance can at least do a better job of running in second place. B

Tom R. Halfhill is a BYTE senior editor based in San Mateo, California. You can reach him at **thalfhill@bix.com.**

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Exponential's Bid to Beat the Pack

Exponential Technology, a start-up company based in Silicon Valley, stands a good chance of breaking the 300-MHz barrier before the big names in the PowerPC alliance. Exponential is pinning its hopes on bipolar transistors, which can switch states much faster than conventional CMOS transistors; faster switching means higher clock speeds. Exponential's PowerPC 604-compatible chip (blessed with licenses from IBM and Motorola) uses bipolar transistors for almost all the logic, or about 40 percent of the chip's circuitry. The remaining 60 percent of the transistors are CMOS, mostly in the SRAM caches.

This radical new processor is on schedule to ship in the first half of 1997, the company says. Exponential estimates peg initial clock speeds at 300 to 400 MHz, with 500 MHz a possibility by the end of next year (see "Watch Out: 500-MHz PowerPCs Planned for 1997," May BYTE, page 40).

Even more intriguing is a little-known U.S. patent Exponential won last January. Exponential won't talk about the patent, but it covers a technique for sharing a CPU's registers between two different instruction sets. This seems to indicate that Exponential is working on some kind of emulation technology. Could this be the spiritual descendant of IBM's PowerPC 615, which was supposed to run x86 software at native speeds? Sources say the 615 project is dead, but maybe Exponential is taking a different approach.

Another possibility is that Exponential is trying to integrate hardware support for 680x0 emulation in a PowerPC chip. Presumably the goal would be to run older Macintosh programs much faster than the software-based 680x0 emulator that Apple built into the Mac OS. (Apple is a major investor in Exponential.) This theory seems less likely because the most important Mac software has already been ported to the PowerPC, and a bipolar CPU that runs at 300 to 500 MHz wouldn't need hardware assistance to emulate 680x0 software faster than a 68040 could run it natively.

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From LAN to WAN with ISDN

ISDN/LAN integration is sometimes complex, but the rewards are worth it.

By Jeffrey N. Fritz

Evangelists often tout the glamorous applications such as videoconferencing, real-time audio, and collaborative computing when they're preaching about the virtues of ISDN. But for many corporations, ISDN can be a cost-effective solution for linking LANs to remote sites and telecommuters, to enterprise networks, to business partners and clients, and to the Internet.

ISDN promises WAN connections that are up to 10 times faster than a 28.8-Kbps modem, call-setup times measured in milliseconds, costs that accrue only when using the digital pipe, flexible configurations, and near error-free transmissions. All this bodes well for integrating ISDN into LAN and WAN connections.

If you can get it at your location (and you probably can), ISDN can provide significantly enhanced remote LAN access. ISDN network equipment, once too pricey for the average user, has fallen into the affordable range. And while there has been some ambivalence from the telephone companies in setting ISDN rates, the general cost trend has been downward. ISDN/LAN integration benefits corporations, telecommuters, small office/home office workers, and Internet service providers. But all is not rosy when it comes to integrating ISDN into the LAN infrastructure.



ILLUSTRATION: TIM GRAJEK © 1996

Optimizing for ISDN

ISDN lines come in two flavors. The Basic Rate Interface (BRI) supports two 64-Kbps digital channels (called B channels) and one 16-bit D channel for carrying signaling and control information. The primary rate interface (PRI) uses a single D channel and 23 B channels (or 30 B channels in Europe). ISDN has some notable advantages, especially when compared to analog phone lines, that make it ideal for the networked computing environment: It's digital, it supports both voice and data on a single line, and call-setup times are fast enough to make connections almost seamless.

Although ISDN can optimize WAN connections, its transmission speed of 64-Kbps is still meager when compared to the native bandwidth of most corporate LANs. Therefore, it's vital to maximize the efficiency of the slower WAN connections. Most network devices come equipped with a variety of tools to overcome the lower bandwidth capacity of ISDN WAN links. Optimization strategies include combining ISDN B channels for additional bandwidth, filtering out unnecessary traffic from the WAN connection, and compressing data to achieve effective throughputs much greater than 128 Kbps. All these measures make the ISDN WAN perform more efficiently.

ISDN connections can be more economical than leased lines when WAN connectivity is intermittent, thanks to features such as networking on demand and bandwidth on demand (BOD). (For a comparison of current and future WAN technologies, see the chart "Linking LANs: ISDN and Alternatives" on page 104NA 6.)

Unlike the case with a leased line, ISDN connection charges are based on usage, much like a standard phone call. When the ISDN line is not in use, you don't pay for it. To save money, many ISDN network devices are programmed to drop the WAN connection after a period of inactivity. Networking on demand keeps the call disconnected when there is no traffic for the network.

Much as networking on demand lets you pay for the con-

nection only when you need it, BOD lets you pay for bandwidth only as you need it. Not all network applications need the same bandwidth, and not all applications need the same bandwidth all the time. BOD can accommodate changes in WAN bandwidth requirements by aggregating multiple B channels into one faster virtual B channel. Depending on the device, bandwidth is usually scaled in 64-Kbps increments, called *N by 64*, all the way from 64 Kbps to T1 rates (1.544 Mbps). When traffic demands fall off, the additional channels can be dropped. If traffic picks up again, more channels can be allocated according to need. This channel flexibility makes WAN connections more cost-efficient than a dedicated line that incurs the cost for bandwidth whether it is used or not.

ISDN network devices that offer BOD generally do so by using the Multilink Point-to-Point Protocol (MP). MP can allocate and deallocate up to six B channels at once on-the-fly. MP negotiates channels rapidly, making it ideal for the bursty nature of network applications.

Compression Varies

Compression increases the apparent bandwidth of a WAN connection by reducing the size of the data files traversing the pipe. However, unless network devices support the same compression suites, the connection will come up without compression. That can slow down the WAN link considerably.

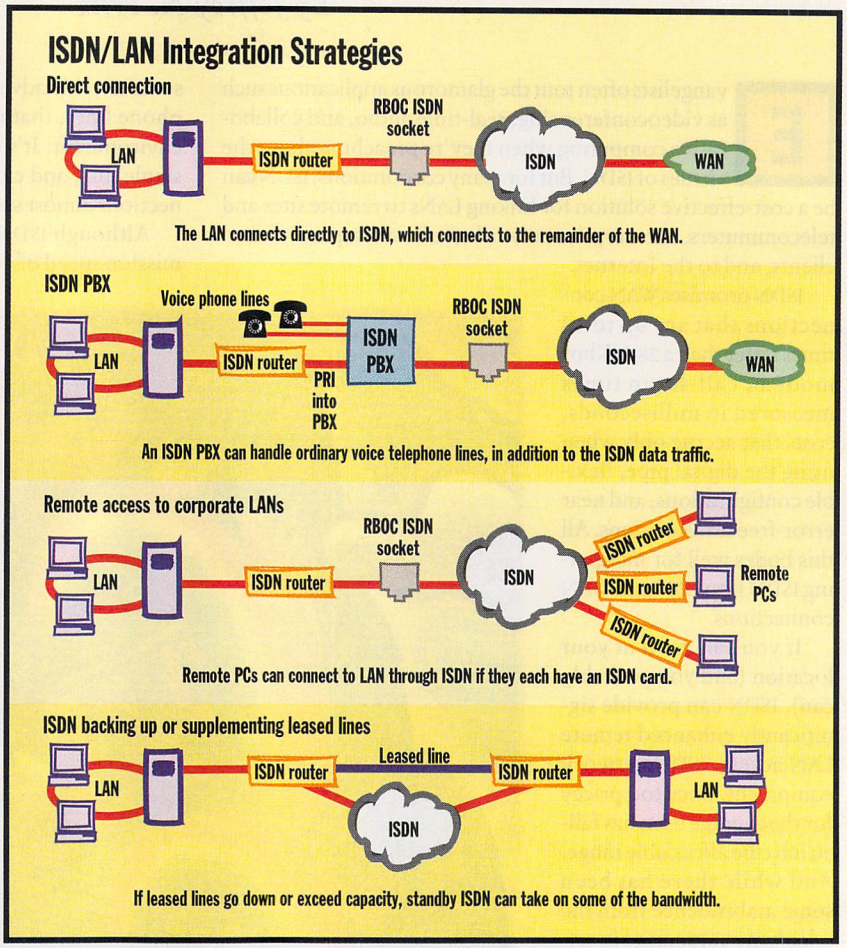
Compression figures are partially determined by file type. Ordinary text (ASCII) files compress well, binary files not so well, and precompressed files poorly. If a vendor measures compression strictly with text files, it will get a very high compression ratio. Another vendor, using the same compression algorithm with a mix of text, precompressed, and binary files, will report a much lower and probably more realistic number. Networks generally have a combination of all three file types traveling across the wires. So when you hear throughput numbers based on compression schemes, be wary. Try to find out the data mix used to devise the throughput numbers.

Most ISDN network devices, working in the real world with a decent mix of file types, can deliver 3:1 compression. Typically, the measured bandwidth for a connection with two B channels is 95 to 105 Kbps. Therefore, with 3:1 compression, the real WAN throughput would generally be about 315 Kbps. While not 10 Mbps, this is respectable throughput—more than 10 times greater than that offered by a 28.8-Kbps modem.

Hardware and Software

If you have ever configured a bridge or router, you should have no difficulty handling most ISDN network devices. However, there are issues to keep in mind when integrating ISDN with LANs (see the figure "ISDN/LAN Integration Strategies" above). Configuring an ISDN bridge, for example, includes setting parameters for switch type, ISDN type, callback (on or off), compression, protocol filters, and security for remote access.

Hardware components in the ISDN/LAN equation include terminal adapters (TAs), ISDN bridges and routers, remote-access servers, and ISDN PC Cards. The TA connects your PC into the ISDN line. These devices are offered in both internal and external configurations, but keep in mind that the serial port's 115.2-Kbps data rate will become a bottleneck on an aggregated ISDN connection (128-Kbps or better). If you have remote PCs that need to hook into your LAN via ISDN, they will each need a terminal adapter installed. Major manufacturers such as Motorola, 3Com, and US Robotics now offer terminal adapters for an average cost of about $500.



You can implement ISDN in a variety of ways to accommodate your communications equipment and applications.

Most ISDN/LAN solutions use routers to direct traffic across the LAN/WAN link. Simple bridges do not always support the type of filtering required for network-on-demand configurations. ISDN routers usually support Ethernet connections to the LAN and a BRI or PRI port for the ISDN link. BRI routers cost $1000 to $1500.

If you're using ISDN to support telecommuters or other mobile workers, you'll need to consider remote-access

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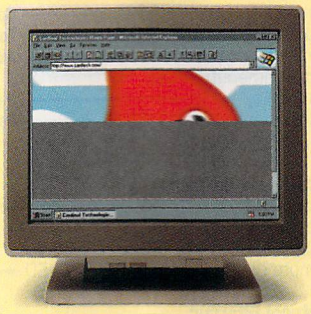

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solutions. Remote-access products from vendors such as Shiva, Microcom, and Gandalf now support ISDN. Remote-access servers with up to eight BRI ports range from $7000 to $10,000. Many models also support standard analog connections, so users well-served by your current analog solution won't have to upgrade right away. Of course, most telecommuters and mobile users carry portable computers, so they'll need an external TA or, better yet, an ISDN PC Card. Current PC Cards such as the IBM WaveRunner are somewhat bulky solutions because the required network terminator is not built in, but that should change soon as vendors ship cards with integrated network terminators.

Client Concerns

Whenever you add clients to a network, you've got to handle the assignment of network addresses, particularly for TCP/IP. With some protocols, such as IPX/SPX or AppleTalk, assigning addresses is semiautomatic. But for TCP/IP, you've got to do it manually with static addresses or dynamically through protocols such as Dynamic Host Configuration Protocol (DHCP) or Bootstrap Protocol (BootP). The point is that remote IP clients must be given an appropriate network address and subnet mask whenever they are connected to the enterprise IP network or the Internet.

Typical Configuration of an ISDN Bridge

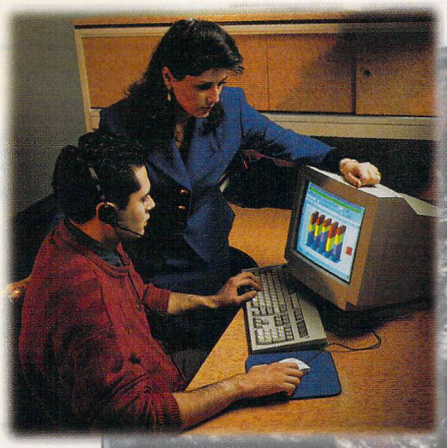
```
Configuration parameters:
Switch type        5ESS        <- Set-up for an AT&T 5ESS custom switch
ISDN type          Custom

Callback           OFF         <- Callback of remote user is turned off.
Line speed         64K/line
Protocol           COMPRESSED  <- Compression is turned on.
Address age time   1000        <- Toss out addresses older than 1000 seconds.
Connection type    Auto On     <- Automatically call the remote device.
Packet timeout     OFF
Retry delay        30          <- If call is unsuccessful, try calling the remote every 30 seconds.
Called number      2935555     <- Remote bridge phone number
Ringback number

Security parameters:
Access status      ON          <- Remote access of device for configuration is turned on.
Client password    Exists
Callback security  None
Remote configuration PROTECTED <- Device configuration is password protected.

Protocol filtering:
0806 ACCEPT                    <- Pass these Ethernet protocol types to the WAN, filter all other protocols.
809b ACCEPT
80f3 ACCEPT
Type forwarding mode is ONLY
Type demand mode is ANY
Number of Ethernet addresses: 20 <- Bridge has learned 20 Ethernet addresses.
```

Network administrators need to use parameters specific to ISDN services in order to configure bridges properly.

Additionally, whenever a client, remote or not, comes on the network, the network topology changes. This can be particularly tricky with network-on-demand connections that are dropped during inactivity. This capability can cause problems for hosts and network protocols that may be looking for the disconnected remote client. On a client/server network, acknowledgment packets are often sent between nodes, even when the nodes are not sending live data. The

Linking LANs: ISDN and Alternatives

	Billing Structure	Strengths	Weaknesses
Current Technologies			
Leased Lines	Fixed rental by speed and distance	Cheap for constant, high-volume access	Too costly for occasional use
X.25	By speed, call duration, data volume	Good for interactive applications	Data volume charge costly for file transfer
Analog Dial-up Services	Same as telephone calls	Okay for short, nonrecurring communications	Low speed, iffy quality, long call setup; poor security
ISDN	By call duration, time of day, distance, per call	Cheap file transfer, cheaper than leased line for occasional use, easy to add more sites and bandwidth	Can be hard to order and set up, not available in some areas
Future Technologies			
Broadcast Satellite	Monthly charge for unlimited usage	Very low cost after initial investment (excellent for Web)	Inbound data only
Cable Modems	Purchase cable modem, setup and monthly rates	High bandwidth, low investment, cable probably already installed	Regulatory red tape, devices not yet widespread
Asymmetrical Digital Subscriber Line	Still in trial mode (no pricing yet)	High downstream bandwidth, works over regular phone lines	Modest to low upstream bandwidth, not ready for prime time



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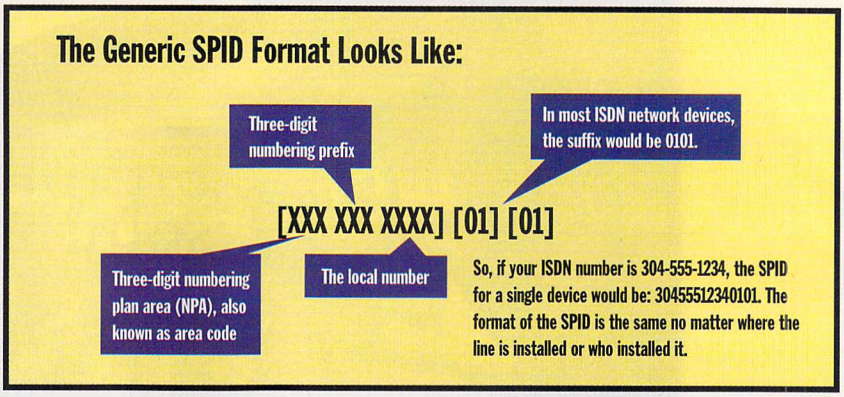
packets can trigger a connection when one is not needed, which incurs additional costs. Different methods of spoofing fool the network by acknowledging the LAN packets locally, as if the WAN connection were still active. Spoofing can save significant costs by preventing unnecessary connections.

It's important to minimize superfluous traffic on the WAN. Typically this is done with address and protocol filtering. You can block unwanted protocols from the WAN link with intelligent filtering. You can also block WAN traffic to selected addresses. This is a key requirement, particularly when chatty protocols that may be on the enterprise network do not need to cross the ISDN WAN.



The service profile identifier, or SPID, looks like a phone number, but its job is to identify the ISDN device for the ISDN network.

Hard to Order

An unfortunate problem that has plagued ISDN implementation since its inception is its burdensome ordering process. Although strides have been made in simplifying ordering and configuration of ISDN lines and equipment, the technology itself is complex, and some of the configuration details reflect this complexity.

One of the most confusing parts in integrating ISDN with LANs is in configuring the ISDN network device. Of all the parameters that must be entered, by far the most mystifying is the service profile identifier, or SPID. The SPID is used to identify the ISDN device to the ISDN network, much like an Ethernet address identifies a computer's network interface card. Without the SPID, which looks like a telephone number with a bunch of extra digits thrown in, the ISDN device simply will not work on most lines.

SPIDs are tricky because they vary from ISDN switch to ISDN switch. For example, some switches require a single SPID for both B channels in a BRI configuration. Other switches may want different SPID numbers assigned to each channel. The SPID itself can vary in format depending on what the switch expects. To make matters even more confusing, some switches do not require a SPID at all.

There is hope that SPIDs will soon be made a little easier. The North American ISDN Users' Forum, along with a number of switch vendors including Lucent Technologies, Nortel, Siemens, and Ericsson, has proposed the Generic SPID Specification. Basically, the Generic SPID replaces the horrendously wide variations in format with one common SPID format for all new ISDN installations. This format is similar to an ordinary phone number, with a three-digit area code (the numbering plan area, or NPA) followed by a three-digit prefix and four-digit local number, but with a four-digit suffix (usually 0101) tacked on.

Getting Up to ISDN Speed

Inside your local telephone building sit the multimillion-dollar digital switches that are owned by the phone company. Until now, you probably could not care less about them. But with ISDN you are expected to know what switch is in your serving office, which software version it is running, and what form of ISDN (Custom or National) it is offering. You need this information to properly configure your ISDN network devices.

To configure a typical ISDN router, for example, you need to know how standard items like filtering, compression, callback, and security are handled. On top of that, the device configuration might also call for switch parameters such as line speed, switch type, and ISDN type. Without this information, which you must glean from your local phone company, the device probably won't work.

And don't assume that your network equipment is compatible with the local ISDN switch unless your vendor specifically says it is. While much of today's ISDN network equipment is designed to work with a variety of ISDN switches, there are still a few devices that are designed to operate only with a specific switch. These devices, when operated on an incompatible switch, either work poorly or not at all.

The good news for users is that National ISDN, a highly interoperable form of ISDN, is now becoming widely available. Currently, there are three National ISDN versions: NI-1, NI-2, and NI-95. Most NI-1 devices will work with virtually any NI-equipped switch, usually without a lot of difficulty.

No matter what version you choose, ordering and configuring ISDN is still complex. Fortunately, once you get beyond the up-front hassles, you'll appreciate the payoff. ISDN brings powerful features to the LAN/WAN environment:

- High-quality digital lines reduce errors during data transmission.
- Bandwidth on demand and network on demand save significant costs over a leased line for intermittent LAN-to-LAN or LAN-to-WAN connectivity.
- ISDN is very flexible, especially when compared to a leased line, allowing you to establish alternate connections quickly and transparently with other ISDN-enabled sites.
- Dial-up and call connection are fast and transparent.

The bottom line is that ISDN/LAN integration extends your LAN out to the world in an efficient, cost-effective way. Plus, remote users will love their enhanced connections. B

Jeffrey Fritz is responsible for the operations of West Virginia University's data networks. He is chair emeritus of the North American ISDN Users' Forum Enterprise Network Data Interconnectivity Family. Fritz is author of Remote LAN Access: A Guide for Networkers and the Rest of Us *and* Sensible ISDN Data Applications. *You can reach him at* **jfritz@wvu.edu.**

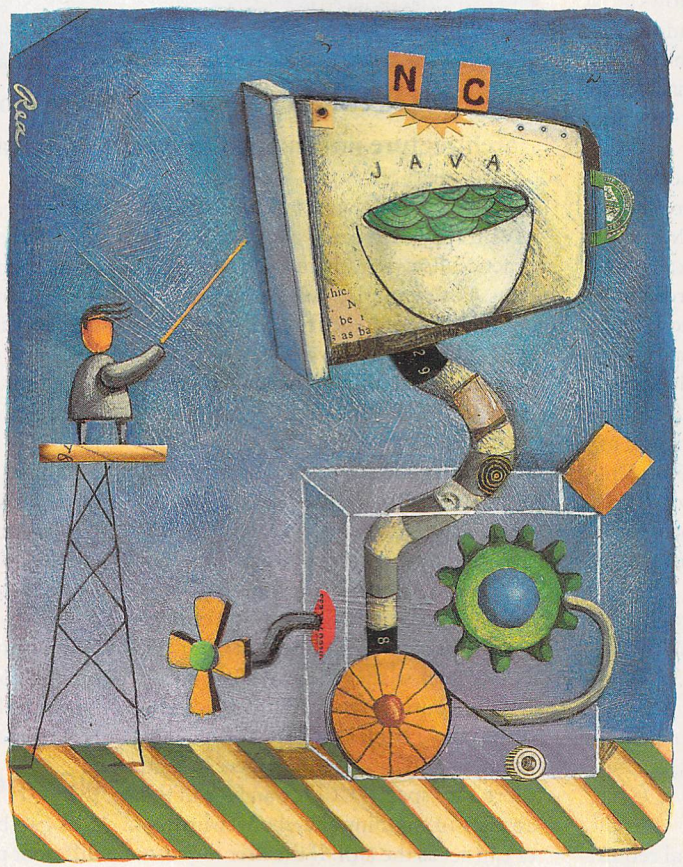
Inside the NC

Are network computers just stripped-down terminals? No way. The official NC platform definition covers everything from a set-top box to a Cray.

By Peter Wayner

Be suspicious when someone denounces network computers as being just dumb terminals: Either they don't know what they're talking about, or they're hoping *you* don't.

A network computer may indeed be a dumb terminal. It may even be a dumb terminal that runs Windows and applications faster than your PC does. Or it could be a conventional PC or Macintosh. It could be an under-$500 TV set-top box or a million-dollar Cray supercomputer. It could be a desktop system tethered to a LAN or even a mobile notebook computer with a modem. A network computer can be any of these things because it's a unique platform that doesn't specify the type of hardware, CPU, or OS it sits on. Instead, it defines an open client model centered around familiar Internet standards and Java.



If this description of a network computer conflicts with what you've heard elsewhere, keep in mind that some people (and companies) who apparently feel threatened by this computing model appear to be spreading disinformation. Other sources are merely uninformed. Most of all, many companies today toss around the term "network computer" rather loosely, along with other terms such as Internet appliance, Web PC, browser box, and net-top box (see "Inside the Web PC," March BYTE cover story).

"Network computer" can be used as a generic term like "personal computer" or "PC." It can also refer to a specific platform standard, just as "PC" often refers to the standard originated by IBM with its Personal Computer in 1981. This article examines the specific network computer platform defined by a loose alliance of companies led by Oracle, Sun Microsystems, IBM, Apple, and Netscape. In fact, Oracle has trademarked the names "Network Computer" and "NC" and has spun off a new company called Network Computer Inc. This group's official NC standard encompasses a wide variety of computing devices for business, education, and home markets.

Defining the Standard

Oracle's vision has two parts. First is the NC Reference Profile. Only computers that offer all the features in the profile can wear the designation "NC." A test suite of Java applets and documents will allow any manufacturer to verify compliance and earn the designation. Numerous hardware and software companies are supporting this profile. (See "What It Takes to Make a Network Computer," page 108.)

In addition, Oracle's Network Computer subsidiary is developing and marketing a software package called the Oracle NC System Software Suite. It includes a microkernel OS known as NCOS, Sun's Java application environment, a Java-enabled Web browser, Macromedia's Director player, Oracle's Media Objects player, and additional software. A company that wants to sell an NC with a minimum of fuss could simply license this suite from Oracle and ship it along with the NC-compliant hardware (see "Oracle NC System Software Suite," page 108).

The NC Reference Profile is not a radical document. It's just a list of what a system has to offer to make the cut. The Mac I'm using to write this article satisfies all the requirements because I've installed Eudora, Netscape Navigator, and Sun's Java Developer's Kit.

The NC basic hardware requirements are simple: a 640- by 480-pixel screen, a pointing device, some provision for text input, and audio output. A hard disk, floppy drive, or other form of persistent local storage is optional. There must be a network connection that can carry IP packets, but the channel is flexible: You can use an ordinary analog modem, a cable modem, a wireless modem, ISDN, or a LAN. *continued*

ILLUSTRATION: BRIAN REA © 1996

The software requirements are equally conservative. NCs must communicate over a network using standard IP protocols: TCP, User Datagram Protocol (UDP), Dynamic Host Configuration Protocol (DHCP), Bootstrap Protocol (Bootp), and Simple Network Management Protocol (SNMP). If users store their data remotely, Sun's Network File System (NFS) will be the standard method for mounting remote drives. Optionally, NCs can support remote connections to other systems via FTP or Telnet, and they can establish secure connections via Secure Sockets Layer (SSL).

Some of these protocols are probably less familiar than others. UDP allows NFS to set up end-to-end application-specific communications. Bootp enables an NC to boot over a network. DHCP allows an NC to automatically acquire an IP address and send configuration data over the network when it boots. SNMP ensures that NCs will act like well-behaved clients on managed networks.

The key requirement in the profile is the ability to read and interpret Hypertext Markup Language (HTML) documents through the Hypertext Transfer Protocol (HTTP). In other words, the NC must run a Web browser. For now, the NC Reference Profile doesn't specify which version of HTML or which tags are required. To exchange e-mail, NCs will use a collection of well-understood mail protocols that dominate the Internet: Simple Mail Transfer Protocol (SMTP), Internet Message Access Protocol version 4 (IMAP4), and Post Office Protocol version 3 (POP3).

In addition, NCs must recognize the most common multimedia formats encountered on the Internet: JPEG and GIF graphics and WAV and AU audio files. Still to come are recommendations for sending output to printers.

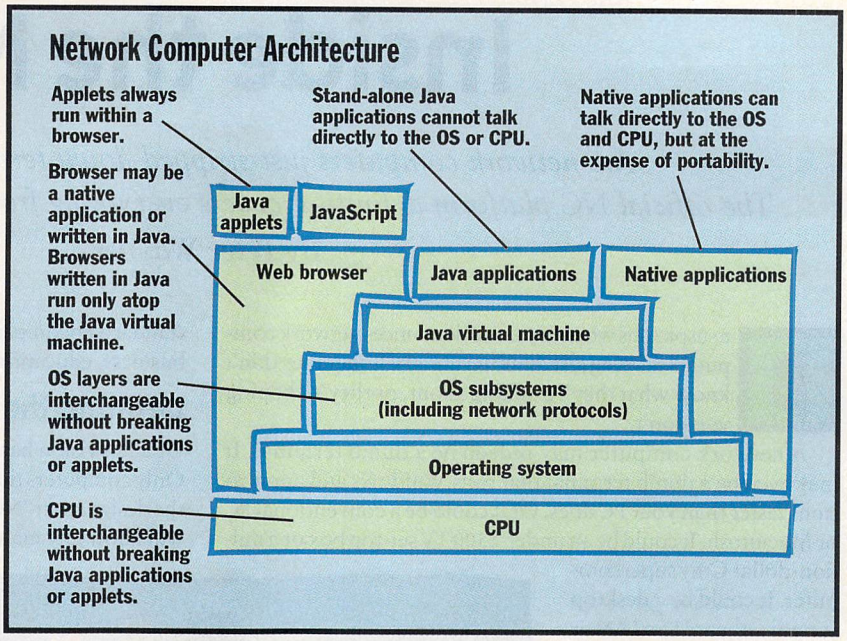
Must Have Java

Perhaps the most fundamental requirement is that NCs must support the Java application environment, which includes the Java virtual machine (VM), the Java run-time interpreter, and the standard Java class libraries. There's nothing to prevent an NC from also running software written for Windows, MS-DOS, the Mac OS, Unix, OS/2, or any other OS. But at minimum, it must run Java.

In fact, there is no description of the OS layer at all in the NC Reference Profile. Theoretically, you could use CP/M or MVS if they supported the Java VM. In practice, however, there are some problems. For example, Java programs can be multithreaded, even though some OSes that support the Java VM are single-threaded. Currently, the behavior of multithreaded code varies from system to system because some OSes, like Windows 3.1, don't do a good job of supporting multiple threads. Others, like the Mac OS, do a reasonable job but don't offer preemptive switching with various priority levels. The best OS for an NC is one that offers full-fledged preemptive multithreading.

Above all, the OS must maintain a TCP/IP stack so the NC can communicate with the outside world. Other OS functions take a back seat—even file management and the user interface. In fact, there's no special GUI for an NC; in the absence of anything else, the Web browser can act as the GUI. If the user requests a file directory of a local or remote drive, the OS can format the directory listing into HTML and display it in the browser. (This isn't unique to NCs; some browsers on PCs already do this for FTP sessions, and Microsoft is adding optional browser views to Windows.)

Because the NC platform is neutral below the Java VM, an NC vendor can change the OS, the CPU, or just about anything else without affecting the user—if the applications are written in Java. (See the figure "Network Computer Architecture" above.) Since Java is the only software guaranteed to run on all NCs, the success of the NC platform depends in large part on the success of Java.



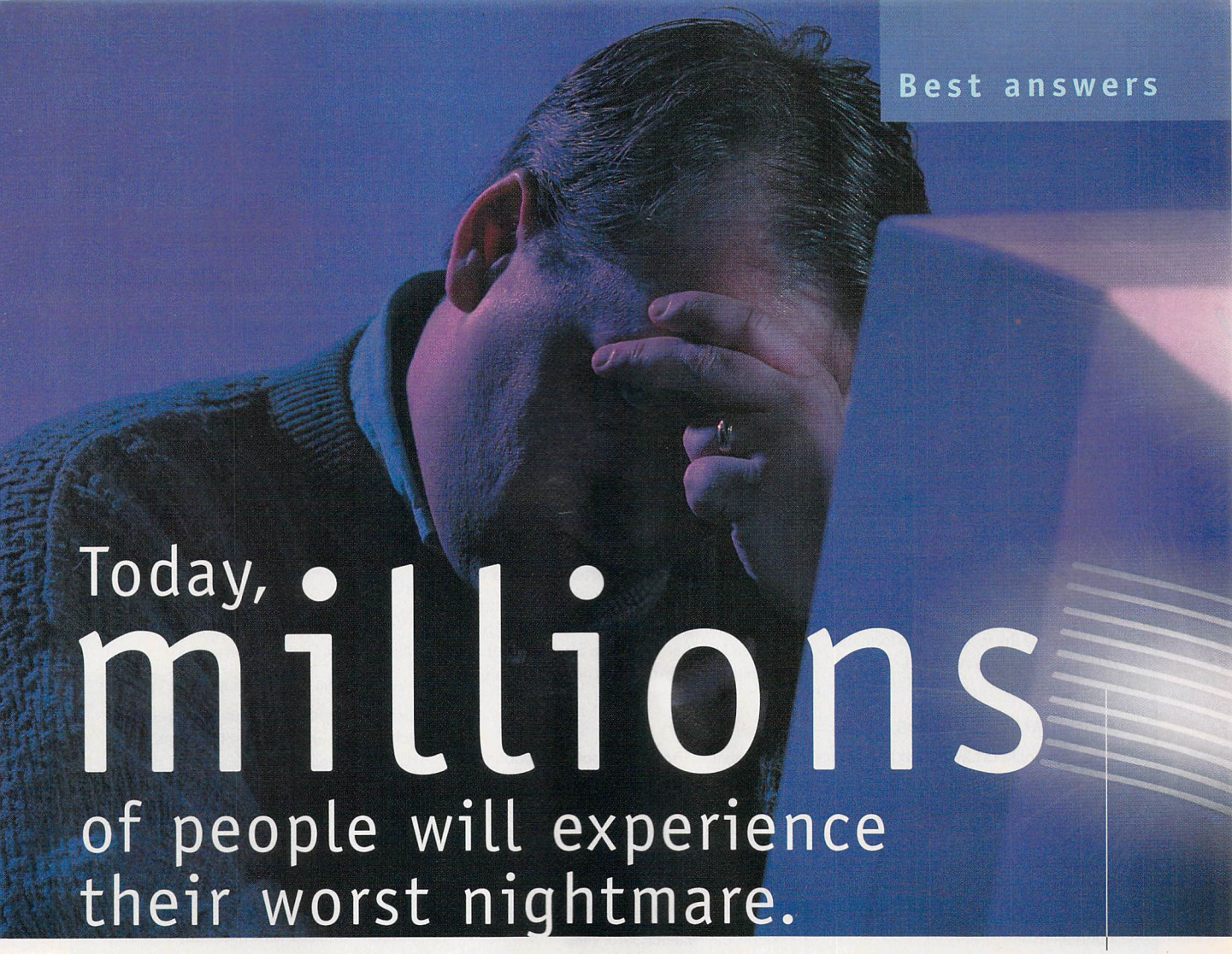
The Network Computer Reference Profile is based on an architecture not chained to specific hardware or operating system.

Most Macs and PCs can hit the NC reference target with software you can get for free or little cost. Eudora Lite can handle the e-mail chores, and a free Web browser such as Microsoft's Internet Explorer can display HTML. Sun distributes free versions of its Java Development Kit that can execute Java applets. Some of these packages aren't full-featured, but you can purchase commercial versions at modest cost. In fact, the latest version of Netscape Navigator will handle both the HTML and e-mail requirements.

NC-Specific Hardware

NCs can be based on a wide variety of different processors and OSes, including some configurations optimized for low retail price and easy administration. For example, Oracle has an NC reference design whose parts cost less than $300. (Oracle says it has no intention of manufacturing NCs; the reference design is for other vendors to use.) In corporate environments, the lower administration costs will be more important in the long run than the initial purchase price.

Most NCs will probably be desktop



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What It Takes to Make a Network Computer

NC Reference Profile Requirements

- Java application environment (which includes the Java virtual machine, Java run-time interpreter, and standard Java class libraries)
- Text input capability
- Audio output
- Pointing device
- Minimum screen resolution: 640 by 480 pixels
- TCP/IP networking
- Simple Mail Transfer Protocol (SMTP), Internet Message Access Protocol v.4 (IMAP4), and Post Office Protocol v. 3 (POP3) e-mail protocols
- SNMP for network manageability
- Ability to use the following file formats: HTML, JPEG, GIF, WAV, AU



NC specs are flexible enough to accommodate devices for office and home.

Oracle NC System Software Suite

All network computers built to Oracle's NC reference specifications will run NCOS and the NC System Software Suite without porting. The next version of the software suite will include a portable OS capable of running on multiple hardware platforms, Oracle says.

NCOS is based largely on a multitasking OS from Acorn. Key features include antialiasing and dithering algorithms that make it possible to display high-quality text and graphics on lower-grade monitors and TVs. NCs can work with regular computer monitors, of course, but low-end devices for consumers may rely on a TV as the display device. The software must be compatible with GIF, GIF89a, JPEG, QuickTime, Indeo, AVI, WAV, AU, and Shockwave files.

The NC System Software Suite includes the following components:

- NCOS
- Web browser
- Macromedia Director player
- Oracle Media Objects player
- Oracle Interoffice suite, including e-mail, scheduling, and calendar functions, plus directory services
- Java virtual machine, with support for both streamlined Java applets and full-function, stand-alone Java applications
- NFS file services
- Network boot services (Bootp/DHCP)
- Support for Secure Sockets Layer (SSL)
- Smartcard authentication mechanism
- Support for streamed video

Optional Capabilities

- Secure Sockets Layer (SSL) for secure TCP/IP connections
- FTP if the NC has local storage
- Sun's Network File System (NFS) if the NC supports a distributed file system
- User Datagram Protocol (UDP) for application-specific, end-to-end connections under NFS
- Telnet (if the NC supports character-based console access to remote hosts)
- Bootstrap Protocol (Bootp) for booting the NC over a network
- Dynamic Host Configuration Protocol (DHCP) for network booting with automatic IP addressing and network configuration
- ISO 7816-standard smartcards
- Europay/MasterCard/Visa specifications

machines, but there's no reason why a mobile computer can't support the NC standard if it has occasional access to some sort of network. The NC standard does not require constant network connections. Mobile NCs will probably have some form of local storage to hold information between network sessions.

Some NCs will be set-top boxes that use a TV as the display device and connect to the Internet via a phone or cable modem. Just about all they need is a relatively fast CPU, a video controller, a network interface chip, and 4 to 8 MB of RAM. The latest home videogame machines from Nintendo, Sega, and Sony are more than powerful enough and cost less than $300. The Nintendo 64 and Sony PlayStation have speedy CPUs based on the Mips R4000 and video capabilities that would put a $2000 PC to shame.

Acorn, a major Oracle partner in the development of NCOS and the NC reference design, plans to introduce a low-cost NC this fall through a U.K. subsidiary, NChannel International. The NC will make its debut in the U.K. at an anticipated price of about £400 (approximately $620). Acorn hopes to introduce a U.S. version a few months later that will sell for about $400. Another company, NetChannel International, is planning to launch a consumer-oriented Internet service for NC users that would put a friendlier face on the Internet and the Web.

One of the most controversial features of the NC is the lack of local storage. This is completely optional, but there are good reasons to leave out the hard drive. The first is cost. Although prices have plunged, it's still difficult to buy drive mechanisms for less than $75, and this can add at least $150 to the retail price. More important, local hard drives invite unskilled users to install untested software. This leads to the administration problems that plague PCs.

Some NCs will have local storage for caching purposes only. The OS and frequently used applications may reside on a local hard disk that's as transparent to users as a CPU cache. For longer-term storage of user files, these devices will rely on network servers.

For instance, Corel could sell its drawing software as Java applets that store their data on the same HTTP servers that offer the applets on the Web. If you create a drawing, you don't need to store it locally; you could store it on the Corel server. This frees users from the responsibility of creating backups. Of course, the downside is that moving large documents

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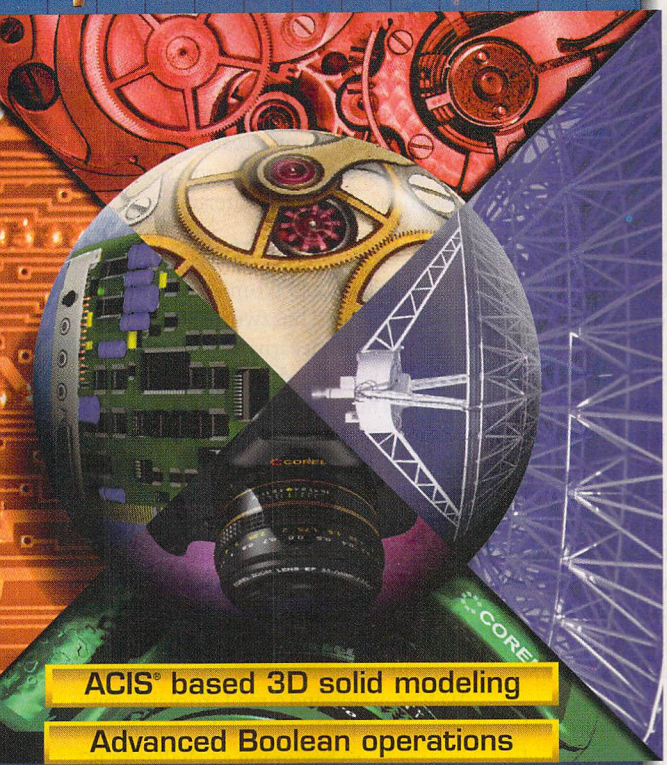

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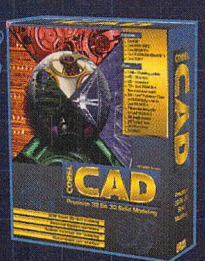

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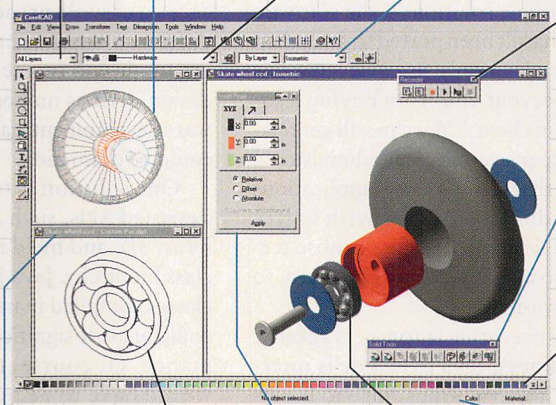

Customizable toolbars give you quick access to different tools.

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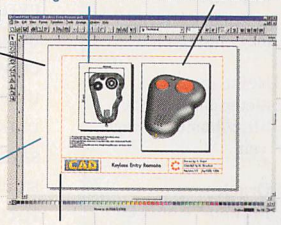

Create and format text for your printed drawing. Use tabs, bullets, automatic hyphenation, spell checker, Thesaurus and Type Assist.

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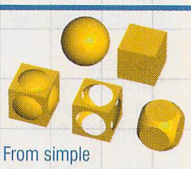
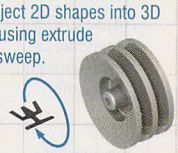


From simple shapes, create intricate objects by using Boolean operations to add, subtract or intersect multiple objects. Project 2D shapes into 3D by using extrude or sweep.



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across the network consumes bandwidth. It's not the ideal client/server model if the files are large and the network connection is slow.

If the files are relatively small or if the connection is fast (for example, an Ethernet LAN or a broadband modem), a stripped-down NC coupled with a smart server could provide many of the functions of a traditional PC at a fraction of the cost. It's not really a new client/server model, but it does expand the definition of a client.

What's Missing?

The biggest problems in the NC concept are lack of compatibility with existing software and the slow speed at which the machines will run certain kinds of software. Backward compatibility isn't required by the reference specification, which leaves a Java-only NC at the mercy of Java. Simple solution: If the software you need hasn't been ported to Java, then don't buy a Java-only NC. Note that this doesn't prevent you from buying a so-called "thin client." You can still get relatively inexpensive and easily administered terminals that run Windows applications on a Windows NT server with Citrix multiuser software. Some of those terminals also meet the NC specification, so they're Java-ready.

Slowly executing software is another Java weakness. Java bytecode is interpreted, so it typically runs only 3 to 10 percent as fast as native code compiled in C. Just-in-time (JIT) compilers may soon boost the performance of Java programs to about 50 percent the speed of native code. Still, there's a performance gap that may never be closed.



One of Oracle's four reference designs integrates a phone with an NC.

For some kinds of applications (word processing, Web browsing, database access, casual spreadsheet work), the difference may not be noticeable. For others (high-end image editing, graphics design, serious number-crunching, software development, games) the difference could be dramatic.

One solution is to take some well-designed APIs, such as Apple's QuickDraw 3D, and meld them into the Java class hierarchy. Java has a provision for classes compiled in native code, and this could provide significantly better performance. Of course, the native classes would have to be ported to different machines, but the cost might be worth the benefits.

Another solution is to optimize CPUs for Java. Sun is already working on Java-specific chips, and another chip vendor is planning to include Java optimizations in the next revision of its RISC instruction set. These chips are still in the testing stages, however (see "Sun Gambles on Java Chips," page 79).

In the meantime, the NC standard will evolve. The NC Reference Profile will undergo revisions as the partners become convinced that new technologies are popular enough and good enough to warrant making them part of the NC foundation, says Lu Kabir, vice president of worldwide sales for Network Computer Inc. In the future, video streaming and MPEG-2 decoding could allow an NC set-top box to replace a cable TV box. The NC standard will embrace Internet telephony in coming months, Kabir promises.

One of the most interesting (but currently optional) features of the NC specification is the ability to read ISO 7816-standard smartcards. These credit card-size devices contain a chip that can store personal information, such as bank balances or health records. They can also act as identification tokens because they can hold a public-key certificate. You could use an NC with a smartcard to download electronic cash or other types of secure information over the Internet.

Earning Respect

Moving forward from a collection of trademarks and buzzwords to a computing platform that earns respect in the marketplace is a hazardous endeavor that has defeated many seemingly good ideas. The NC spec makes a good start by building upon standards that already are commonplace. The ability to retrofit a PC as a makeshift NC provides an easy migration path for those who don't want to gamble on a very different kind of device.

But the NC concept also builds upon trends that are emerging with the development of the Internet. For some users, Web browsing and e-mail are major applications in their own right. Corporate intranets are beginning to challenge PC-centric networks and applications. Many databases are now accessible to Web browsers. Platform-independent productivity programs, such as word processors, are already under development.

The NC Reference Profile wisely avoids specifying an OS, CPU, and GUI. With technology in flux, setting a rigid standard is like trying to hit a moving target. The NC profile recognizes this and leaves them out of the picture.

Perhaps the biggest question is whether any force smaller than Microsoft can establish a new industry standard. Publicly, Microsoft still ridicules the concept of network computers. At the same time, Microsoft says it is committed to making all the software in the Windows realm capable of interacting with the Internet. Wintel PCs will soon meet the NC standard even though, for political reasons, they may never bear the trademarked name. B

BYTE consulting editor Peter Wayner frequently writes about the Web and other Internet-related topics. You can reach him at **pcw@access.digex.net** *or view his home page at* **http://www.access.digex.net/~pcw/pcwpage.html.**

WHERE TO FIND

NC Reference Profile
http://192.86.154.91/nc_ref_profile.html

NC System Software Suite
http://www.oracle.com/products/nc

Acorn
Cambridge, England
http://www.acorn.co.uk/anc

Apple Computer
Cupertino, CA
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IBM
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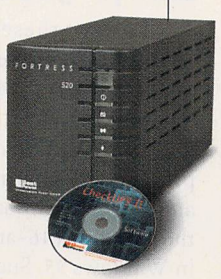

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Eight Twin-Engine Pentium Pro Workstations

For compute-intensive applications, a second Pentium Pro chip can make the job go faster.

By Maggi Bender, Dorothy Hudson, Jim Kane, and John McDonough

For 32-bit number-crunching and running technical applications under a 32-bit OS like Windows NT, the Pentium Pro is the Intel processor of choice. For some people, two Pentium Pros is an even better choice, either to run a multiprocessing NT application or to multitask—downloading from an FTP site or handling e-mail with one processor while you tie up the other with your heavy-hitter 32-bit application.

In this month's Hardware Lab Report, we take a look at eight 200-MHz dual-processor Pentium Pro workstations that will keep you from sitting on your thumbs. Our test subjects come from Dell Computer, Digital Equipment, IBM, Hewlett-Packard, Polywell Computers, SAG Electronics, and Xi Computer (which supplied two systems). These vendors are betting that NT will emerge soon as a prominent general business platform. The recent release of Windows NT 4.0, in particular, has increased interest in high-end Pentium Pro systems.

Built for 32 Bits

With one of these symmetric multiprocessor (SMP) speed demons on your desk, you can take full advantage of both 16- and 32-bit applications simultaneously. Admittedly, the Pentium Pro processor isn't optimized for 16-bit DOS and Windows 3.x software, or even for the mixture of 16- and 32-bit code found in Windows 95. Such software is full of segment writes, partial register operations, unaligned data accesses, and instruction-prefix bytes that have stymied the Pentium Pro in previous BYTE tests.

However, you won't care if a Pentium Pro doesn't run 16-bit code much faster than a less expensive Pentium system for two reasons. First, the clock speed is high enough that you won't notice a slowdown with an older legacy application, particularly if it's running on its own private processor. Your performance-critical software will be 32-bit. Second, business software is starting to go 32-bit; many office suites are already there. The proliferation of Windows NT-optimized applications isn't an adequate reason in itself to buy a dual-Pentium Pro workstation, but it helps.

BYTE BEST
PENTIUM PRO

Dell's OptiPlex GXpro 200
Digital's Personal Workstation 200i
Polywell's Poly P6-200ND2
These three systems offer the best combination of performance, features, usability, and good price.

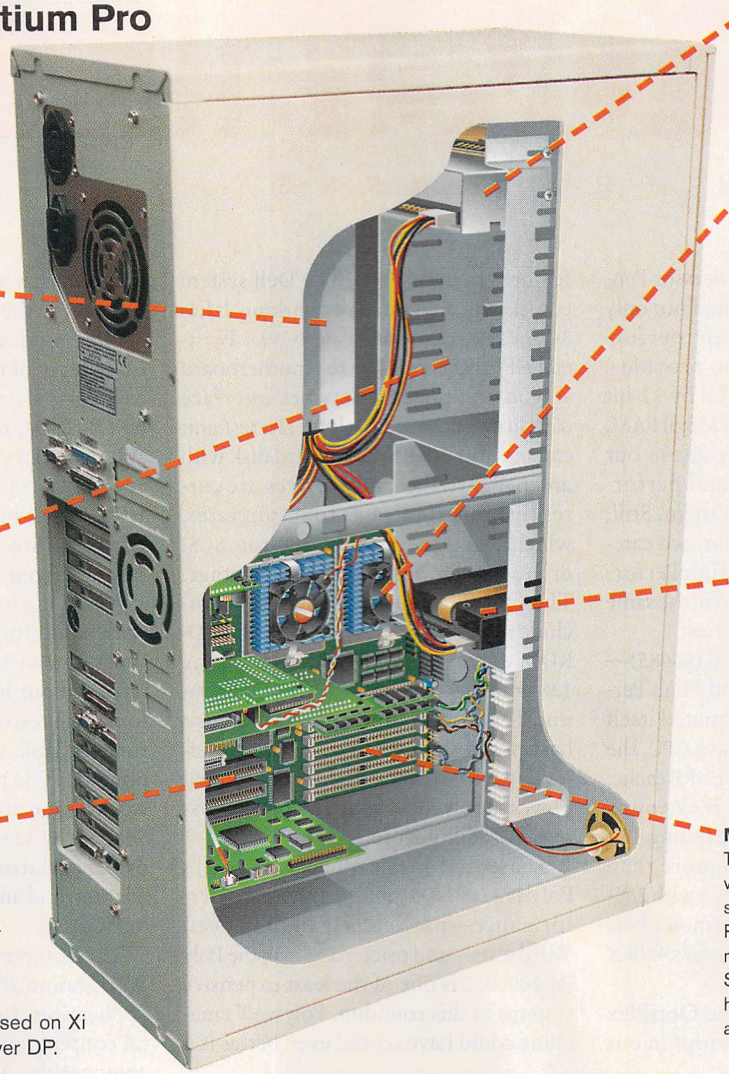
The desktop, mini-tower, and tower systems we review range in price from $4700 to $9200 as configured for testing: with 64 MB of system RAM, 2- to 9-GB hard drives, and 17-inch displays. The Dell, Digital, and SAG models came with integrated Ethernet, while HP provided an Ethernet card. In general, the vendors chose similar high-performance components in designing their dual-processor Pentium Pro systems. Only Dell went with the costly 512-KB-cache version of the Pentium Pro chip.

Six of the eight systems have SCSI hard drives of various flavors, while the Dell and Xi systems have slower-spinning, but less expensive, Enhanced IDE (EIDE) drives. Five systems use a Matrox Millennium graphics adapter, two have a Number 9 Imagine 128 Series 2 adapter, and one has a Diamond Stealth 64 card—all PCI. Most systems include six- or eight-speed CD-ROM drives; the Hewlett-Packard Vectra XU 6/200 has a four-speed drive. (See the features table on pages 120 and 121 for details.)

Most of the systems use Intel's latest 82440FX Pentium Pro chip set, which supports fast extended data out (EDO) memory, Universal Serial Bus (USB), and dual concurrent PCI buses. HP and Polywell stayed with the older 82450KX Orion chip set. Six systems actually implement USB by providing ports. The Dell and HP workstations have none. The Digital, Polywell, and Xi systems have two ports.

The USB defines a standardized connector and socket for many types of peripherals (see the Tech Focus on page 116). Because you can daisy chain many peripherals to a single port, USB has the potential to eventually eliminate the number and kinds of connectors on the back of a typical PC. With USB-enabled PCs, users will also be able to hot-plug USB peripherals without rebooting their systems or having to deal with IRQ settings, DMA channels, and I/O addresses. With USB, you could connect up to 127 devices to a single PC. USB's 12-Mbps serial data rate provides ample throughput for low- and mid-bandwidth peripheral devices. With strong support from Microsoft,

Typical Pentium Pro



POWER SUPPLY
Dual-processor Pentium Pro workhorses use lots of juice. A power supply in the 200-W to 300-W range is appropriate in most cases. A well-engineered system can get by with less.

DRIVE BAYS
The systems in a tower chassis—the SAG STF 3000, the Polywell Poly P6-200ND2, and the Xi Pro400 Ntower DP—provide more drive bays than the mini-tower and desktop systems.

EXPANSION SLOTS
A combination of PCI and ISA expansion slots matches the mix of 32- and 16-bit expansion cards you are likely to install in a system.

CD-ROM DRIVE
Most of the systems we tested have six-speed or eight-speed CD-ROM drives. Faster is better for installing development packages and reading on-line documentation.

DUAL CPU CHIPS
Most vendors place two Pentium Pro chips side-by-side in ZIF sockets on the motherboard, although the Dell OptiPlex GXpro 200 has one CPU on a riser card. To keep the CPUs from overheating, many vendors place a big heat sink and a cooling fan directly on top of the processors. HP takes the more sophisticated approach of directing airflow onto the CPUs from a larger, and perhaps more reliable, stand-alone fan blowing through plastic air conduits (not shown here).

HARD DISK
A SCSI hard drive provides the best performance for an NT workstation, even in single-drive configurations. Compared to EIDE, the disadvantage of SCSI command overhead is more than compensated for by the higher spin rates available with SCSI models.

MEMORY UPGRADE SLOTS
The Pentium Pro chip sets in these workstations support up to 1 GB of system memory, though only the Polywell and Xi systems can take that much. Half the test systems have SIMMs (shown here), and the others have newer DIMMs, which require half as many modules for a given capacity.

Illustration based on Xi Pro400 Ntower DP.

Intel, and big system vendors, USB is as inevitable as was PCI.

Tight Bunch

Although Windows NT 4.0 is the hot news, it was just out of beta when we were testing these systems, so we stuck with tried-and-true NT 3.51. Our suite of NT benchmarks shows that these systems provide unprecedented performance on the Intel x86 platform.

While the three fastest systems—Dell's OptiPlex GXpro 200, Digital's Personal Workstation 200i, and Polywell's Poly P6-200ND2—are benchmark burners, the remaining five models were right behind them. You won't notice speed differences among them when navigating through typical desktop applications. Though it wasn't the fastest overall, IBM's PC 365 performed best in the two benchmarks that test dual-processor efficiency (see Test Specs, page 119). The Dell took second.

Only one system lagged noticeably behind the others—Xi Computer's Pro400 Mtower DP—and that can be blamed on its EIDE hard drive. Xi's Pro400 Ntower DP, which had a high-rpm IBM Fast/Wide SCSI drive, ran right with the pack.

Who needs so much horsepower at their desk? Vendors' marketing plans give some idea. Hewlett-Packard aims its Vectra XU 6/200 at users who need enough computing force to create two-dimensional animation or to design electronic components with a package like AutoCAD. Polywell provides options for its Poly P6-200ND2 that let it serve as a CAD/CAM workstation, a SQL-based Internet server, or a video editing workstation. Dell sees its OptiPlex GXpro 200 as a number-crunching financial workstation. SAG Electronics offers the STF 3000 both as a workstation and, when configured with RAID 5 storage options using the Ultra-SCSI architecture, as a low-end network server; indeed, the SAG system has many built-in server features such as temperature, fan speed, and voltage sensors, as well as the necessary software to report on problems these sensors find.

The systems we tested for this Lab Report were similar in their overall performance, mainly due to the commonality of architecture dictated by Intel's PCI chip sets. The small differences in speed are due mainly to the vendors' selections of hard drives and graphics cards. Given the narrow performance spread between these machines, we recommend that you pay more attention than usual to features, usability, and, of course, price.

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ILLUSTRATION: SANDERS/TIKKANEN DESIGN & ILLUSTRATION © 1996

Best Overall

PENTIUM PRO WORKSTATIONS

The eight dual-processor Pentium Pros we tested not only boast top-notch performance, they also provide a bridge to a future dominated by 32-bit applications. Loaded with 64 MB of RAM, they were all exceptionally fast in our benchmarks, with only small performance differences between them. Still, we had to pick winners in our two categories: Best Overall and High Performance. Tight scoring resulted in the same three-way tie in both categories.

Dell's OptiPlex GXpro 200 ($6685)—a combined Best Overall and High Performance winner—differentiated itself by using Intel's most expensive CPU, the 200-MHz Pentium Pro with 512-KB cache. The big-cache chip helped it eke out a small lead in the performance testing, but at a cost of roughly $1500 more than you'd pay for two Pentium Pros with 256-KB cache (also available). Like most of the other systems, the Dell uses Intel's 440FX Pentium Pro chip set.

Fast performance isn't the OptiPlex GXpro 200's only forte. It's tops in our features category, too. The Dell system comes with integrated networking. It has 3Com's PCI Bus Mastering 3C59X Twisted Pair EtherLink III on the motherboard so you don't need a network interface card in one of your PCI slots. The test unit came with a 2-GB Seagate hard disk with an EIDE interface. EIDE drives are currently limited to 5400-rpm spin rates, which gives systems with 7200-rpm SCSI drives a slight performance advantage. The OptiPlex's other components include five drive bays, an eight-speed CD-ROM drive, a Number Nine Imagine 128 graphics card, and a Dell 17LS monitor. The small-footprint desktop chassis has a push-button removable cover, lever-locked expansion cards, and a hinged power supply, all of which helped the system's Usability score.

The second double winner is Polywell's Poly P6-200ND2. Its strengths are performance—particularly in the Excel/Word tests—and price. At $5270, the Poly P6-200ND2 is one of the least expensive systems in this roundup. Polywell's machine could have scored even better if it wasn't such a hassle to remove the chassis to get to the internal components.

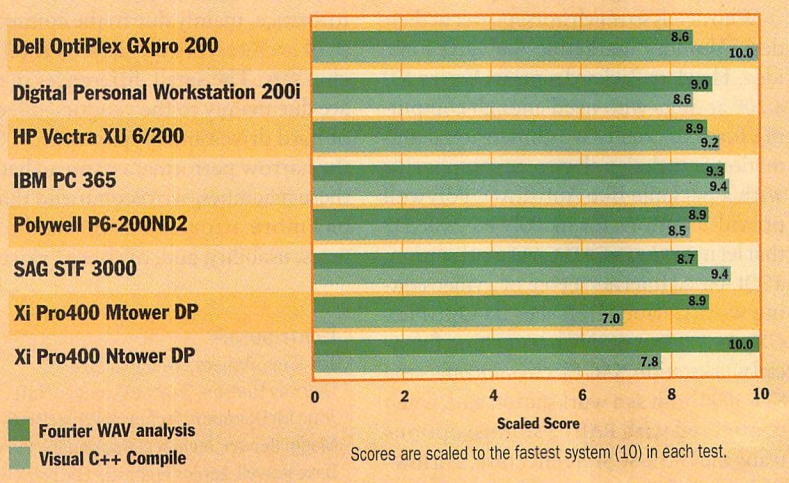
Once inside the Poly P6-200ND2 you'll find plenty of room for expansion. The tower has six available expansion slots (two PCI and four ISA) and seven available drive bays for upgrades. The 4.3-GB Seagate ST15150W hard disk has a Fast/Wide SCSI-2 interface, but the S3-based Diamond Stealth 64-bit graphics card came with only 2 MB of DRAM.

Also tying for first place in both categories, Digital Equipment's Personal Workstation 200i ($5834) had the best scores in our low-level InterMark performance tests, which stress the processor, hard disk, video, and CD-ROM components. The powerful mini-tower NT workstation arrived with a speedy 2-GB Seagate ST32550 Fast/Wide SCSI hard drive, a Matrox Millennium graphics adapter, and an eight-speed Toshiba CD-ROM drive.

The company markets the Personal Workstation 200i for graphics-intensive applications for mechanical CAD, digital content composition, and software engineering. Along these lines, Digital offers more capable 3-D graphics card options. The workstation sports innovative features such as two USB ports and integrated Ethernet (10Base-T/10Base-2) on the motherboard.

Dual-Processor Workstation Tests

The IBM PC 365 performed best overall with the two dual-processor tests. The Dell OptiPlex had the best C++ compilation time, while the Xi Pro400 Ntower did best with the Fourier analysis. Performance differences between the Xi Ntower and Mtower models are due to different hard drives (SCSI and EIDE, respectively). Both tests run two simultaneous instances of the test task.



Scores are scaled to the fastest system (10) in each test.

Best of the Rest

The IBM PC 365 ($7081) provided unmatched speed in our CPU-intensive Fourier and Visual C++ benchmarks that challenge symmetrical dual-processing capabilities. We also found that it boots up Windows NT faster than any other system. IBM's desktop workstation features a Matrox Millennium graphics adapter with 4 MB of Window RAM (WRAM) that supports a 1600- by 1280-dpi screen resolution. The PC 365 has a 2.1-GB IBM hard disk with an Adaptec UltraSCSI PCI host adapter, and it has a six-speed CD-ROM drive.

IBM positions this system at the top of its desktop PC product line yet stresses the machine's network management

LAB RESULTS

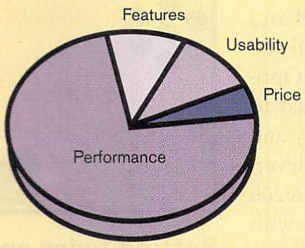
WORKSTATION RATINGS

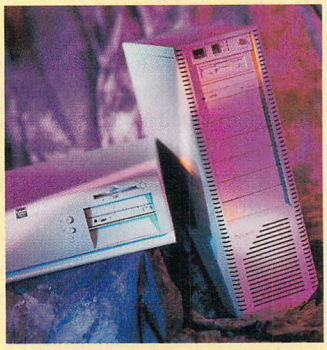
BEST OVERALL

Dell's OptiPlex GXpro 200, Digital's Personal Workstation 200i, and Polywell's Poly P6-200ND2

In a very tight race, the Dell, Digital, and Polywell workstations tied for first in Overall score. They are also the top three in our performance benchmarks. Dell's OptiPlex GXpro received the most impressive Features score thanks to important workstation ingredients like integrated networking and an eight-speed CD-ROM drive. A great performer, the roomy Poly P6-200ND2 also has one of the smallest price tags. Keep in mind that IBM and Xi (the Pro400 Ntower DP) were not far behind.

WEIGHTING





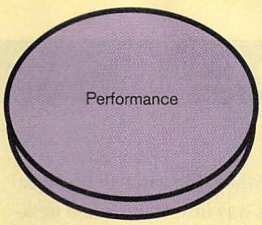
	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	FEATURES	OVERALL RATING
Dell OptiPlex GXpro 200	**$6685**	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
Polywell P6-200ND2	**$5270**	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
Digital Personal Workstation 200i	**$5834**	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
IBM PC 365	$7081	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
Xi Pro400 Ntower DP	$4788	★★★★	★★★★	★★★★	★★★★	★★★	★★★★
SAG STF 3000	$5650	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
HP Vectra XU 6/200	$9206	★★★★	★★★★	★★★★	★★★★★	★★★	★★★★
Xi Pro400 Mtower DP	$4688	★★★★	★★★	★★★	★★	★★★	★★★

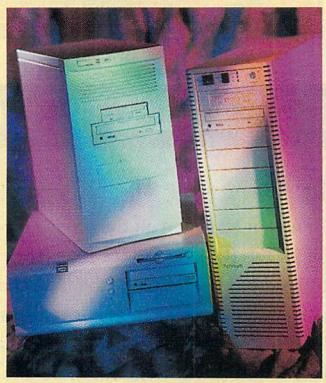
HIGH PERFORMANCE

Dell's OptiPlex GXpro, Digital's Personal Workstation 200i, and Polywell's Poly P6-200ND2

As the top speedsters, these three systems performed within several hundredths of a point of each other. However, each excelled in a different test. The Dell OptiPlex took advantage of its large 512-KB L2 processor caches to get the high score in the dual-processor Visual C++ compiling benchmark. Digital's Personal Workstation 200i got the top score in the InterMark low-level test. Polywell's workstation finished far ahead in the Excel/Word application testing. Again, the other systems were not far behind. The IBM PC 365 had the highest combined score in the two dual-processor workstation tests, but it faired poorly in the less important Excel/Word tests.

WEIGHTING





	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	FEATURES	OVERALL RATING
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Polywell P6-200ND2	**$5270**	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
Digital Personal Workstation 200i	**$5834**	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
IBM PC 365	$7081	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
SAG STF 3000	$5650	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
Xi Pro400 Ntower DP	$4788	★★★★	★★★★	★★★★	★★★★	★★★	★★★★
HP Vectra XU 6/200	$9206	★★★★	★★★★	★★★★	★★★★★	★★★	★★★★
Xi Pro400 Mtower DP	$4688	★★★★	★★★	★★★	★★	★★★	★★★

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

capabilities. The box didn't come with a network card, but it does have Wake-on-LAN, IBM networking tools, and predictive-failure hard drive technology. Wake-on-LAN enables network managers to turn on unattended systems from anywhere on a local network. The system's USB port prepares users for the USB-based hardware peripherals that will be arriving within the next year.

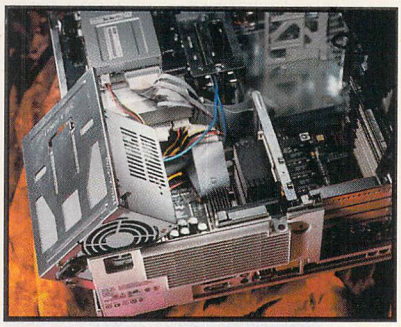
For those who can't afford to spend much more than $4000 but still want power, the Xi Computer Xi Pro400 Ntower DP ($4788), which scored very well in our tests, is a good bet. The tower system has plenty of room for expansion and features top-notch components such as an eight-speed CD-ROM drive and a 2-GB Fast/Wide Seagate SCSI hard drive. At the other end of the price spectrum, Hewlett-Packard's well-engineered Vectra XU 6/200 was a cut above the rest in its Usability score, but it didn't stand out otherwise in this competitive field.

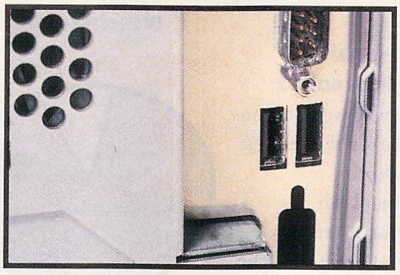
PHOTOGRAPHS: LIGHTWORKS PHOTOGRAPHIC © 1996

Details

Designer's Choice

Kudos to the engineers at Dell and Hewlett-Packard for thoughtful system designs. Dell made its compact OptiPlex GXpro 200 (shown below) easy to service with a hinged power supply and expansion cards that lock in with a lever. Also easy to open, HP's Vectra XU 6/200 achieved our highest Usability score with features like accessible DIMM slots near the top of its mini-tower chassis.



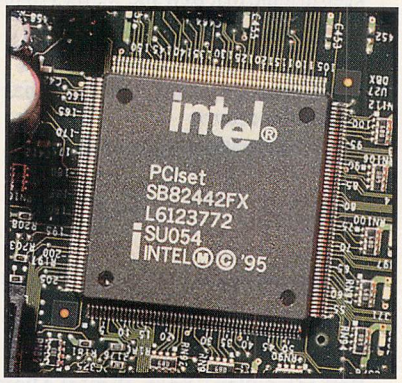


Betting Twice on USB

Digital believes Universal Serial Bus (USB) peripherals will become widely available in the next six to nine months and that you'll want both of the USB ports incorporated in the Personal Workstation 200i. You'll likely use one port to daisy chain the keyboard and mouse in front of the system, the other for peripherals like scanners and printers that cable out from the side or rear. Systems from Polywell and Xi also have dual USB ports.

Down to Three

Most of the systems we tested use Intel's new Pentium Pro chip set, the 440FX PCIset. For workstations, it provides performance efficiencies by reducing the chip count to three (from the seven chips of Intel's Orion sets), supporting EDO memory, and allowing its dual PCI buses to work concurrently.



TECH FOCUS | PERIPHERAL INTERFACE

Let's Make It Universal

Though it has been on the boards for a while, the catchall Universal Serial Bus (USB) interface is working its way into mainstream desktop computers. The USB standard, sanctioned by Intel and Microsoft and strongly backed by major vendors like IBM, Digital, Compaq, and NEC, will arrive more quickly than did PCI. IBM introduced the first two business PCs with a USB port last summer; Compaq, Siemens Nixdorf, and Sony have, too. Six systems in this Lab Report, including the IBM, provide USB ports. The Digital, Polywell, and Xi have two. Microsoft is preparing Windows drivers, and Intel has developed USB device chips as well as USB support in its latest CPU chip sets.

Like the Apple Desktop Bus (ADB), USB lets you daisy chain peripherals like keyboards and pointing devices into a single port. With its 12-Mbps serial transfer rate, however, USB has enough bandwidth to support printers, scanners, ISDN terminal adapters, and telephony devices, including T1 or E1 lines. (The telephony angle explains Nortel's strong backing of USB.)

USB's convenient bus topology is actually more of a staggered star topology than a chain. Hubs that provide seven USB ports can be chained together with 5 meters between hubs to support as many as 127 USB devices from one host system. The four-line USB cable has two lines to carry differential serial signals, one for ground and a +5-V power line, which largely eliminates the need for power bricks for many peripheral devices. The spec defines three classes of device: low power, bus-powered (100-mA maximum current draw); high power, bus-powered (500-mA maximum); and self-powered. USB devices like scanners and printers will obviously have their own power supplies but could use the USB power to exit power-saving states. The cabling is shielded twisted pair to support the 12-Mbps signaling rate. The spec allows a limited number of low-speed, 1.5-Mbps devices.

You will be able to hot-plug and unplug these devices, and they will automatically register with the host operating system in true Plug and Play manner. Not only is the USB topology LAN-like; its signaling protocols are, too. USB has abstraction layers similar to the first three levels of the Open Systems Interconnection (OSI) protocol stack. USB sets up point-to-point connections, termed pipes, between an application or USB driver program and a USB device on the bus. At the physical hardware level, the host controller (always the initiator) and the USB device send and receive serial signals on the bus. At the middle level, USB system software and a particular device send each other framed data. At the top level, an application talks to one of the device interfaces that a USB device can present.

The upshot is that you'll be able to easily attach external peripherals to a PC without rebooting, without confronting a confusing array of ports, and without having to deal with IRQ settings, DMA channels, and I/O addresses. Bring on those USB peripherals.

–Dave Rowell



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Test Specs

A workstation with Intel's fastest Pentium Pro processor provides great performance for running applications. A workstation with two 200-MHz Pentium Pros is even better—but not for everybody. To really get your money's worth, you'll have to be using a technical application that threads well over two processors, or running something computationally intensive as a background task while doing other work. You might, for example, want to write code or answer e-mail while compiling a large application.

The eight systems we tested can all handle this kind of work. For our evaluation, we requested 200-MHz dual-processor Pentium Pros with 64 MB of RAM, at least a 1-GB hard disk, and a 17-inch monitor. All came with at least 2-GB hard drives, mostly SCSI of various flavors; the SAG system came with a 9-GB Wide Ultra-SCSI drive from Seagate. Seven of the systems arrived with 256-KB-cache versions of the Pentium Pro; the Dell OptiPlex came with the newer CPU that has a 512-KB cache (adding around $1500 to its price). Most came with strong 2-D graphics cards from either Matrox or Number Nine. We evaluated the systems for usability, features, and performance with some consideration of price.

SCSI or EIDE?

With higher data densities, quicker head movement, and faster spin rates, hard drives deliver data much faster than they used to, some with sustained rates higher than 8 MB/second. Both the IDE (as EIDE) and SCSI device interfaces have kept pace; either can shoot data to the host PC faster than a single drive can deliver it. So why are high-end Windows NT systems faster with SCSI drives? For single-drive systems that don't fully use SCSI multitasking, an EIDE drive may have a slight performance advantage over a SCSI drive because it has a simpler, more direct interface with little command overhead. The answer is that drive manufacturers put SCSI connectors on their fastest and most expensive drive mechanisms. Currently EIDE (or ATA) drives top off at 5400 rpm, while many high-end SCSI drives do 7200 rpm. Spin rate affects both sustained data rate and access time.

Performance

We tested performance under Windows NT 3.51 with our usual applications-based benchmarks and low-level InterMark tests, but we also hammered the dual-processor machines with two new tests that evaluate their multiprocessor efficiency under NT. Given the nature of the products, our Performance rating is weighted heavily (50 percent) by the dual-processor tests. After putting NT 3.51 on each system, we installed Microsoft Office and Visual C++ (4.2). We used each system's vendor-specified configurations and executed all the tests at 1024- by 768-dpi graphics resolution and 16-bit color depth (65,536 colors).

To evaluate multiprocessor performance, NSTL's R&D department devised two tests that measure system speed when both processors are being pushed to the limit. In the first test, we ran a floating-point-intensive Fourier transform program that analyzes the spectral content of a WAV file. A shell program loaded two simultaneous copies of the test and timed the results. The spectral analysis test has high data locality and little file I/O, so the test data generally resides in cache and the results are primarily dependent on raw floating-point power.

The second multiprocessor test measures how fast a system can build (compile and link) a large chunk of Visual C++ source code. We ran two simultaneous instances of the test. This benchmark produces results that depend on both CPU and hard disk performance; the test hits the hard disk often with both read and write operations.

Although dual-processor workstations are designed for high-end technical applications, many people will want the second processor to run general software. Our applications-based benchmark employs two 32-bit business programs, Microsoft's Word 7.0 and Excel 7.0. The macro-based tests exercise common functions of each application. For example, the Excel test measures the time it takes to delete a variety of cell ranges and calculate various addition, financial, and statistical functions. The application tests account for 20 percent of the overall Performance score.

To get at the performance of important system components, we also ran NSTL's InterMark tests. In addition to CPU performance, these low-level tests measure the efficiency of such components as CD-ROM drive, hard disk, and video/graphics subsystems. InterMark accounts for 30 percent of the Performance rating.

Features and Usability

We also rated system features and checked how easy the PCs were to set up and upgrade. In coming up with our Features ratings, we rewarded system characteristics that differentiate these top-notch Pentium Pro workstations from each other. Length and completeness of the warranty, number of slots and drive bays free for expansion, built-in security, and amount of dedicated graphics memory to support high screen resolutions (1600 by 1200 pixels) all contributed to better ratings.

For usability, a screwless design that makes it easy to remove the case and install an adapter card is a plus, as are clearly labeled I/O ports. On the other hand, an obstructed expansion slot is a minus. We gave extra points to systems that came with clear, well-indexed documentation. We consider adequately detailed jumper and DIP switch settings to be particularly important.

Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of their monthly PC Digest. *To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; on the Internet, editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of the McGraw-Hill Companies.*

PENTIUM PRO WORKSTATIONS FEATURES

	Dell Computer Corp. OptiPlex GXpro 200 BYTE BEST	Digital Equipment Corp. Personal Workstation 200i BYTE BEST	Hewlett-Packard Co. Vectra XU 6/200
Price as tested (MSRP) with monitor	$6685	$5834	$9206
Overall rating	8.2	8.2	7.7
Performance	8.3	8.3	7.8
Features	7.9	7.4	6.4
Usability	8.2	7.9	9.5
MICROPROCESSOR			
Manufacturer and model	Intel Pentium Pro 200	Intel Pentium Pro 200	Intel Pentium Pro 200
Secondary cache RAM per CPU (KB)	512	256	256
Number of processors/maximum number of processors	2/2	2/2	2/2
BIOS vendor and version	Phoenix A01	Phoenix 4.05	Hewlett-Packard
MEMORY			
Standard/**as tested**/maximum (MB)	32/**64**/128	32/**64**/512	32/**64**/256
Package type	DIMM	SIMM	DIMM
Speed (nanoseconds)	60	60	60
ECC	✔	✔	✔
Memory architecture	EDO	EDO	Fast-paged
MASS STORAGE			
Hard drive manufacturer and model number (capacity)	Seagate ST32140A (2-GB)	Seagate ST32550W (2-GB)	Seagate ST32550N (2-GB)
Hard drive interface	Integrated Intel PCI EIDE	Adaptec PCI Fast/Wide SCSI-2 card	Integrated AMD PCI Fast SCSI-2
Standard 3½-inch floppy drive	✔	✔	✔
Standard 5¼-inch floppy drive			
CD-ROM drive speed, manufacturer and model, interface	8x NEC A310-00, EIDE	8x Toshiba XM5602B-FW, EIDE	4x Sony CDU-76S, EIDE
DRIVE BAYS			
Total 3½-inch/5¼-inch	3/2	3/3	4/3
Total 3½-inch/5¼-inch with external access	3/0	1/3	2/3
Available 3½-inch/5¼-inch	2/0	2/2	2/2
GRAPHICS			
Graphics manufacturer and model	Number Nine Imagine 128 Series 2 PCI	Matrox MGA Millennium PCI	Matrox MGA Millennium PCI
Maximum noninterlaced display resolution (refresh rate)	1600×1200 (83 Hz)	1600×1200 (72 Hz)	1600×1200 (72 Hz)
Color depth at maximum noninterlaced display resolution (bits)	16	8	8
Standard graphics memory/**as tested**/maximum (MB)	0.5/**4**/4	2/**2**/8	2/**2**/8
MONITOR			
Manufacturer and model	17-inch Dell 17 LS	17-inch Digital SN-PCXAV-YZ	17-inch Hewlett-Packard Ultra VGA 1280
Dot pitch (mm)	0.28	0.26	0.28
Maximum noninterlaced display resolution (refresh rate)	1280×1024 (60 Hz)	1280×1024 (75 Hz)	1280×1024 (75 Hz)
EXPANSION SLOTS			
Number of PCI/ISA (shared)	5/2 (2 shared)	3/3 (1 shared)	3/2 (1 shared)
Number of slots used	2	2	2
I/O			
Serial/enhanced parallel	2/1	2/1	2/1
Rated throughput of serial port(s)	115.2 Kbps	115.2 Kbps	115.2 Kbps
UART compatibility	16550	16550	16550
Integrated EIDE	✔	✔	✔
Universal Serial Bus (USB) ports	0	2	0
Integrated Fast SCSI-2			✔
10Base-T Ethernet	Integrated	Integrated	Card
POWER SUPPLY			
Output rating (Watts)	230	300	160
AC voltage (V)	110/220	120/240	110/220
Autodetecting/autoswitching	✔		
Energy Star compliant	✔		
DIMENSIONS			
Height×width×depth (inches)	6.5×16.5×17.6	16×8.5×17.5	16.4×8.3×15.9
Weight (pounds)	30	21	33
FCC rating	B pending	B	B
CUSTOMER SUPPORT			
Warranty length (years)/coverage	3/P,L,F,R	3/P,F	3/P,L,R
Phone	Call local Dell dealer	Call local Digital Equipment dealer	Call local Hewlett-Packard dealer
Toll-free phone	(800) 289-3355	(800) 344-4825	(800) 752-0900
On-line address	http://www.dell.com	http://www.workstation.digital.com	http://www.hp.com
Inquiry no.	**1011**	**1012**	**1013**

BYTE BEST = BYTE Best ✔ = yes

Warranty: P = parts; L = labor; F = freight to repair center; R = return to customer.

IBM Personal Computer Co. IBM PC 365	Polywell Computers, Inc. Poly P6-200ND2 BYTE BEST	SAG Electronics STF 3000	Xi Computer Corp. Xi Pro400 Mtower DP	Xi Computer Corp. Xi Pro400 Ntower DP
$7081	$5270	$5650	$4688	$4788
8.0	8.2	7.9	7.3	7.9
8.1	8.3	8.0	7.3	7.9
7.2	7.4	7.3	6.5	6.7
8.7	7.5	7.4	6.8	8.4
Intel Pentium Pro 200	Intel Pentium Pro 200	Intel Pentium Pro 200	Intel Pentium Pro 200	Intel Pentium Pro 200
256	256	256	256	256
2/2	2/2	2/2	2/2	2/2
IBM Flash Level 17A	AMI 3.0.6	AMI 1.01 Beta	Award 4.51 PG	Award 4.51 PG
32/**64**/512	64/**64**/1024	64/**64**/512	32/**64**/1024	32/**64**/1024
DIMM	SIMM	DIMM	SIMM	SIMM
60	60	60	60	60
✔	✔	✔	✔	✔
EDO	EDO	EDO	EDO	EDO
IBM Starfire SX-DFHS (2.1-GB)	Seagate ST15150W (4.3-GB)	Seagate ST19171W (9.1-GB)	Quantum Fireball 3200AT (3.2 GB)	IBM 32160 (2.25 GB)
Adaptec PCI Ultra SCSI card	Adaptec PCI Fast/Wide SCSI-2 card	Integrated Adaptec PCI Ultra Wide SCSI	Integrated Standard Micro Systems PCI EIDE	NCR PCI Fast/Wide SCSI-2 card
✔	✔	✔	✔	✔
		✔		
6x Panasonic LF-1195, EIDE	6x Toshiba 3701B, EIDE	8x Plextor PX-83CS, SCSI	8x Goldstar GCD-R580B, EIDE	8x Goldstar GCD-R580B, EIDE
3/2	0/10	3/3	4/3	2/8
1/2	0/8	2/1	2/3	2/5
2/0	0/7	2/2	2/2	1/6
Matrox MGA Millennium PCI	Diamond Stealth 64 PCI	Number Nine Imagine 128 Series 2 PCI	Matrox MGA Millennium PCI	Matrox MGA Millennium PCI
1600×1280 (85 Hz)	1280×1024 (65 Hz)	1600×1200 (83 Hz)	1600×1280 (80 Hz)	1600×1280 (80 Hz)
16	8	16	16	16
4/**4**/8	2/**2**/4	4/**4**/8	2/**4**/8	2/**4**/8
17-inch IBM P70	17-inch Sampo 17MX	17-inch Princeton Graphics EO75	17-inch ViewSonic Optiquest V775	17-inch ViewSonic Optiquest V775
0.26	0.28	0.26	0.26	0.26
1280×1024 (60 Hz)	1280×1024 (60 Hz)	1600×1280 (75 Hz)	1600×1280 (60 Hz)	1600×1280 (60 Hz)
5/3 (3 shared)	4/4 (none shared)	3/1 (none shared)	5/3 (1 shared)	5/3 (1 shared)
2	2	1	3	3
1/1	2/1	2/1	2/1	2/1
115.2 Kbps	115.2 Kbps	115.2 Kbps	115.2 Kbps	115.2 Kbps
16550	16550	16550	16550	16550
✔	✔	✔	✔	✔
1	2	1	2	2
		✔		
None	None	Integrated	None	None
200	300	230	235	300
115/230	110/240	115/240	110/220	110/220
	✔	✔	✔	
6.3×16.5×17.9	24×7.5×22.5	19.8×7.5×17	20×7.8×17	29×8.8×17.8
28	70	40	20	35
B	B	B	A	A
3/P,L,F,R	3/P,R; 5/L,R	2/P,L,F,R	3/P,L,F,R	3/P,L,F,R
Call local IBM dealer	(415) 583-7222	(508) 683-0339	(714) 498-0858	(714) 498-0858
(800) 426-2968	(800) 300-7659	(800) 989-3475	(800) 432-0486	(800) 432-0486
http://www.pc.ibm	http://www.polywell.com	http://www.sagelec.com	http://www.xicomputer.com	http://www.xicomputer.com
1014	**1015**	**1016**	**1017**	**1018**

NSTL tests four remarkable packages for creating mixed-media hits.
By David Seachrist

How Multimedia Multitools Compare

Putting on a multimedia presentation used to be a real bear. But computer-based multimedia has changed all that. Everything is virtual.

We found the leading edge in four tools on the high end of the scale, all multimedia authoring packages that run under Windows 95 (though some are 16-bit and some are 32-bit): Macromedia's Authorware Interactive Studio 3.5 (hereinafter Authorware), Aimtech's IconAuthor 7.0, Innovus's Multimedia 2.1, and Asymetrix's ToolBook II Instructor 5.0.

As an all-around package for creating our test applications—a computer-based training (CBT) program and a kiosk program—ToolBook II Instructor offers the best balance of usability and flexibility. It comes with the most complete set of tools for developing and managing tests, offers a bevy of learning aids (including wizards and templates), provides the easiest integration of database information, and supports program distribution like no other product. Also, it's the best Web-enabled multimedia authoring tool for distributing CBT material via the Internet.

Macromedia is almost synonymous with multimedia, and its Authorware package is still the one to beat for producing games and other audiovisual-intensive material. However, for the test CBT and kiosk applications we created, the program's flowchart interface was less satisfactory than ToolBook II's screen-based approach. Authorware simply doesn't do as much to automate making tests and accessing databases.

The new kid on the block, Innovus Multimedia, is impressive. Unlike many authoring tools, it isn't designed to create eye-popping audio and video extravaganzas. Innovus says the program is for "business multimedia." It's best used as a kind of programmable, interactive, super PowerPoint. The time-line view is helpful, and its scripting language—compatible with Visual Basic for Applications (VBA)—will be of interest to many people working in corporate environments.

BYTE BEST
AUTHORING TOOLS

Asymetrix's ToolBook II Instructor 5.0 comes with the most complete testing tools and a bevy of learning aids. It integrates database information most easily and supports program distribution features like no other.

But the package's learning aids and test-writing tools aren't as complete as ToolBook II's. The next version's Rich Text Format (RTF) import facility and Internet support will be key enhancements.

Despite its power and many useful mini-applications, IconAuthor's interface, database connectivity, and tools for formulating tests are more difficult to learn and use than ToolBook II's or Innovus Multimedia's. But if you want to develop native OS/2 applications, IconAuthor is the only game in town.

How We Tested

We modeled our tests on typical multimedia projects likely to be encountered in corporate and academic environments. Our target user is someone with basic knowledge of business software but no experience in writing program code. Because these tools can be used to build a vast range of applications, our ratings would likely change if the test application had been, for example, a computer game.

With each product, we created two applications. One was a CBT program designed to teach the user to play a song on the guitar; the program includes text, graphics, sound, digital video, and a test. The second program was an information-kiosk application tied to a real estate database.

We've evaluated these authoring tools primarily on the basis of their ease of learning and ease of use. Performance isn't a big issue with authoring software; speed of operation isn't as important as speed and ease of creation, and the time needed to add or import files into an application is minimal compared to the time needed to construct and check program logic.

Our testers needed approximately two days to learn the programs and create the two test applications with Authorware and IconAuthor. They needed one day with Innovus Multimedia and ToolBook II Instructor.

Structure or Content?

The heart of any authoring process is applying structure to content. You need both subject matter and a logical way to present it. For multimedia authoring, it's especially handy to be able to view both the structure and the content of a project.

Visual programming, shown here as implemented in **Authorware**, is the primary model for constructing multimedia projects with any of these packages.

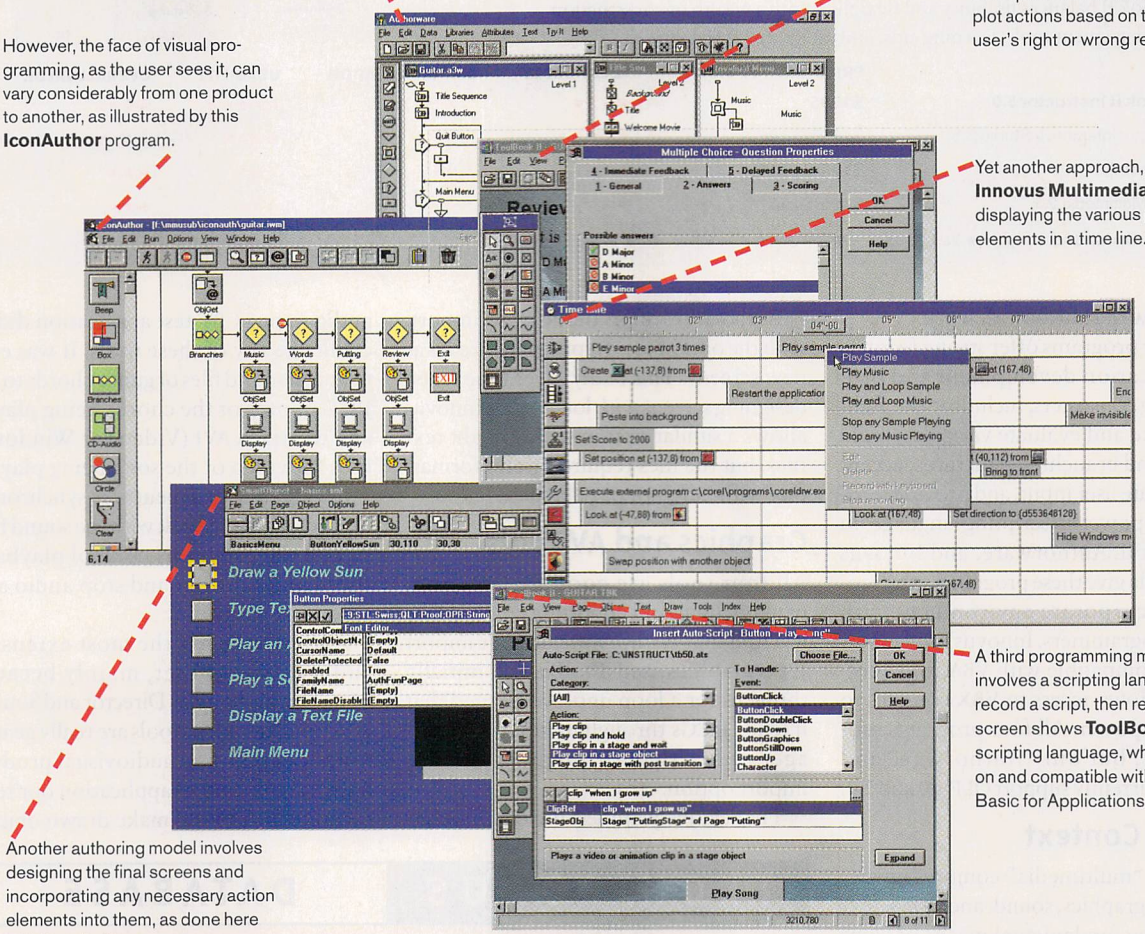
However, the face of visual programming, as the user sees it, can vary considerably from one product to another, as illustrated by this **IconAuthor** program.

ToolBook II proved to be first rate for setting up tests. It has special tools that help the developer present questions and answers and plot actions based on the end-user's right or wrong responses.

Yet another approach, taken by **Innovus Multimedia**, is based on displaying the various project elements in a time line.

A third programming model involves a scripting language. You record a script, then refine it. This screen shows **ToolBook II's** scripting language, which is based on and compatible with Visual Basic for Applications.

Another authoring model involves designing the final screens and incorporating any necessary action elements into them, as done here with **IconAuthor**.



Name your multimedia programming style and it's probably supported by one of these versatile tools.

In fact, each of the four tested programs offers at least two authoring modes. One mode is organizational and provides a top-down view of the components in an application by showing their sequence and relationship to one another. A second mode lets you see how a screen will actually be displayed. Innovus Multimedia also offers a time-line view that shows graphically the timing of all the events and objects tied to a given screen. We found this especially helpful in creating a screen that plays a sound file and a video file.

Authorware, IconAuthor, and Innovus Multimedia all use a visual flowchart for structuring applications. ToolBook II uses an object browser to view component hierarchies; its organizing principle is that of a book with chapters and pages. In constructing the CBT application, we found that Authorware and IconAuthor lend themselves to creating structure first and then adding content. Innovus Multimedia and ToolBook, on the other hand, are better suited to starting with the content and developing screens on-the-fly.

All the packages allow you to create applications using visual programming techniques, though the emphasis varies from program to program. Authorware and IconAuthor, for example, offer on-screen icons that work like elements of an electronic flowchart. To add a bit of programming logic to an application, you drag an icon that represents the desired programming construct into the flowchart area of the screen. Authorware in particular rewards those who plan their text ahead. But as the project grows longer and more complicated, you have to consolidate the individual programming construct icons into compound icons, making it harder to maintain the bird's-eye view of the application.

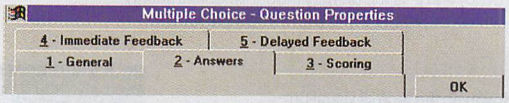
ToolBook II's visual programming emphasis is on screen design. Making a button to play a video involves selecting a button tool, much as you would draw with a rectangle tool in an illustration program. After creating the button, you select menu options in order to assign properties that

MULTIMEDIA AUTHORING TOOLS

BEST OVERALL

Asymetrix ToolBook II Instructor 5.0

ToolBook II balances usability and flexibility with a wealth of construction and management tools, learning aids, and integrated Web features.



	PRICE (NEW/UPGRADE)	TECHNOLOGY	IMPLEMENTATION	USABILITY	OVERALL VALUE
ToolBook II Instructor 5.0	**$1995**	★★★★	★★★★★	★★★★★	★★★★
Authorware Interactive Studio 3.5	$4995/$595	★★★★	★★★★	★★★★	★★★★
IconAuthor 7	$1295/$895	★★★	★★★	★★★	★★★
Innovus Multimedia 2.1	$495/$150	★★★	★★★	★★★	★★★

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

define how the button will work.

All four programs offer strong features for application development and programming constructs, including the ability to create and evaluate variables, build looping and branching structures, accept and evaluate user input, and provide feedback. The powerful scripting languages in ToolBook II, Authorware, and Innovus Multimedia give these programs an advantage in a corporate environment with skilled programmers. Innovus's script language is compatible with VBA, and ToolBook II allows access to VBX controls to extend its power. All four programs support OLE, but only Authorware and Innovus currently support OLE 1.0 and 2.0.

Text in Context

Although "multimedia" conjures images of splashy graphics, sound, and video, text remains the fundamental means of communication. Any authoring tool worth its salt must provide flexible and easy-to-use text tools. The text editing environments in all four programs will seem below par compared to today's word processors. For example, Innovus Multimedia won't let you italicize just one word in a block, and you have to edit a block of text in a dialog rather than directly on-screen. IconAuthor's text editing is also less fluid than other aspects of the program.

Still, these packages are primarily for *combining* content, not creating it. Each one can import text, so you would normally edit and format screen text in with your word processor, then import it into the authoring program. With Innovus Multimedia, you can't currently import RTF files, just straight ASCII text, which doesn't maintain formatting attributes like bold type and character size. The next version, due out in November, will contain an RTF import capability.

Authorware offers the best text import, with the option to interpret page breaks as new screens. This really saves time when designing screens with lots of text. Innovus allows a similar option with straight text files, but the files require careful formatting with tabs, not page breaks.

Graphics and AV Tools

All four tools are good for creating, manipulating, and importing graphics. We did find that Authorware doesn't import JPEG graphics, and ToolBook II initially threw us for a loop until we learned that it loads JPEGs through its resource manager rather than through its graphic import option.

The relatively modest use of video and audio in our CBT test application didn't challenge any of these tools. It was easy to attach sound files of guitar chords to the JPEG photos of the chords being played and to attach AVI (Video for Windows) files for video of the song being played. The only tricky element was synchronizing the video playback with the sound file. But all the programs control playback speed and can start and stop audio and video files easily.

Authorware has the most extensive audiovisual tool set, mainly because Macromedia bundles Director and SoundForge with it. But its tools are really geared toward building an audiovisual production, not the kind of application our tests focused on. You can make drawn objects

TECH FOCUS: DATABASE

Making the Data Connection

Many types of multimedia applications—encyclopedias, kiosks, even some games—depend on sophisticated databases. For these applications, a tool that supports database access is a necessity. All the products we tested offer some form of database support, but they vary drastically in how easy these functions are to use.

ToolBook II Instructor was by far the easiest for adding a database to our kiosk application. ToolBook has a database utility that parses database files and automatically creates a database front end with fields, labels, and browsing buttons. Unfortunately, what ToolBook gains in ease it loses in flexibility because dBase and Paradox are the only two file formats it supports. The other three programs are all compliant with Open Database Connectivity (ODBC) and support many database formats through the Microsoft ODBC driver.

Of these three, Innovus Multimedia was the easiest to use to add the database to the kiosk. It aids in formatting the screen by adding the field placeholders and record navigation buttons. In both Authorware and IconAuthor, the application designer has to add the proper field placeholders, labels, and record navigation buttons manually and individually. The process lacks the automation found in Innovus Multimedia.

Authorware's tutorial material for creating a kiosk application is less than satisfactory. The program comes with a sample application describing how to set up connections to various database formats and a booklet on connecting to databases using Microsoft's ODBC driver. But to succeed in using a database with an Authorware-constructed project, you will need a working knowledge of database structures and SQL statements. There are no automated tools to help here.

move in a designated path (path animation), and you can create simple cel (frame-by-frame) animations. Although ToolBook's animation and video tools aren't as complete as Authorware's, the program offers ancillary video capture and editing software at minimal additional cost.

Testing

ToolBook II is the environment of choice for creating courseware, although a third-party course management package is available at extra charge for Authorware. ToolBook II lets you develop interactive tests that use a wide variety of predefined question types (multiple choice, true/false, etc.). Its course management system allows an administrator to track students' progress and test scores. Design tasks—specifying correct and incorrect answers, answer feedback, and scoring—are all properties of question objects that the application designer can set from a single tabbed dialog box. This was by far the easiest approach to learn and use. Innovus Multimedia has question objects, but with fewer options. Authorware and IconAuthor have programming constructs to facilitate formulating test questions but lack the others' easy, object-oriented interface.

Program Distribution

Once an application is finished, it's time to distribute it. Authoring tools that can save programs as EXE files, easily manage resources (such as digital video, sound files, and drivers), and add an installation program can simplify this job.

All four packages let you freely distribute run-time players. IconAuthor, Innovus Multimedia, and ToolBook II have distribution programs that let you manage program resources and create floppy disk sets complete with an installation program. ToolBook II and Authorware allow you to save your programs as executables, so you don't need a run-time player. All in all, the packaging capabilities of ToolBook II and Innovus Multimedia are more complete than Authorware and easier to learn and use than IconAuthor.

Platform Support

Authorware is the only program we tested that runs as an authoring and playback application under both Windows and the Mac OS. IconAuthor offers OS/2 authoring and playback capabilities in addition to Windows support. Authorware and

FEATURES

	Authorware	IconAuthor	Innovus Multimedia	ToolBook II
GENERAL FEATURES				
Authoring metaphor	Flowchart	Flowchart	Flowchart	Book/Page
Built-in database				✔
ODBC support	✔	✔	✔	
Includes screen/page layout templates			✔	
Training/course management	(A)			✔
CROSS-PLATFORM COMPATIBILITY				
Windows 95: Authoring, playback	✔	16-bit	✔	16-bit
Windows 3.1: Authoring, playback	✔	✔	✔	✔
Macintosh: Authoring	✔			
Macintosh: Playback	✔	Future		Via Web
OS/2: Authoring, playback		✔		Web playback
Windows NT: Authoring, playback	✔	16-bit	✔	16-bit
Unix: Authoring, playback		Future		Web playback
APPLICATION DEVELOPMENT				
OLE 1.0 and 2.0 support	✔	OLE 1.0	✔	OLE 1.0
VBX support				✔
Scripting language	✔		✔-	✔
Script recorder	✔			✔
WYSIWYG structure/screen design	✔	✔	✔	screen only
Hypertext, hypermedia links, event handling	✔	✔	✔	✔
Assign procedures to screen controls	✔	✔	✔	✔
Program flow statements	(B)	(B)	✔	✔
Integrated debugging environment	✔	✔	✔	✔
TEXT TOOLS				
Import RTF and ASCII files	✔	✔	(C)	✔
Search and replace	✔	✔	(D)	✔
Text search and retrieval tools	✔			✔
DRAWING AND IMAGE TOOLS				
Number of graphics formats imported	7	34	14	20
Pen, line, rectangle, oval tools, snap-to grid	✔	✔	✔	✔
Image manipulation	✔	✔		✔
Graphics object manipulation commands	✔	✔	✔	✔
Clipart and tools included	✔	✔	✔	✔
ANIMATION AND VIDEO TOOLS				
Number of animation/movie formats imported	5	7	5	6
Path, frame-by-frame animation	✔	✔	✔	✔
Automatic, polymorphic in-betweening	✔			
Animate text	✔		✔	✔
Video capture and editing tools	✔	✔	✔	extra cost
Video control tools	✔	✔	✔	✔
Transition effects (fades, wipes, etc.)	✔	✔	✔	✔
AUDIO TOOLS				
Number of sound formats imported	3	3	3	3
Sound synchronization	✔	✔	✔	✔
Control sound speed, duration, sequence	✔	✔	✔	✔
INTERNET AND DEPLOYMENT TOOLS				
Package to Web server	✔	✔		✔
Save to HTML and Java				✔
FTP utility to transfer files to Web server	✔	✔		✔
Can be run from Web browser using player software or plug-in	✔	✔		✔
Network deployment	✔	✔	✔	✔
Free run-time player	✔	✔	✔	✔
Create distribution disks with install program		✔	✔	✔
Create stand-alone executables	✔			✔

✔ = Yes
A = Third-party application
B = Branching, conditional branching, and repeat until
C = Import ASCII (*.txt) files; RTF files supported via a separate RTF editor included with the authoring software.
D = Available in script editor environment

New Products, New Properties, New Prices

The range and number of multimedia authoring tools is expanding at an amazing rate. When NSTL started this evaluation a few months ago, none of the programs in this report were available for under $1000, and two were priced at $5000. But since then, several vendors have changed their pricing drastically. Authorware is the only program that remains at $5000; rather than reduce price, Macromedia decided to add value by bundling Macromedia Director, Extreme 3D, SoundForge XP, and xRes with the product.

Several other programs were outside our focus or arrived too late for inclusion in this review. While we didn't put them through the rigors of our testing program, they are packages worth considering.

Corel Click & Create 2.0

This international production (a U.K. product sold by a Canadian company) is aimed at a variety of multimedia developers and uses. The $695 package ($249 update) uses a storyboard paradigm, makes heavy use of drag-and-drop editing, and supports DirectX video, WinG, ODBC databases, QuickTime, and Rich Text Format. As with most Corel applications, it comes with hundreds of fonts, clipart, animation files, and video clips (on two CD-ROMs).

mTropolis 1.1

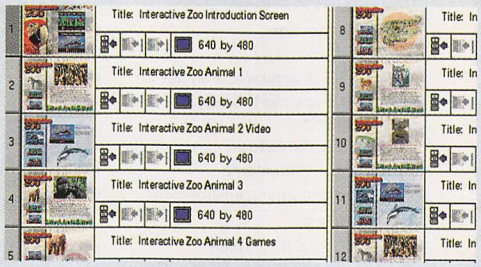
A heavy-duty performer from mFactory, this program lets you build applications out of reusable objects. It's intended primarily for designing commercial CD-ROMs and Internet presentations. It relies heavily on its scripting language, which is extensible. With mTropolis, you create your multimedia program once and can then deploy it on the Macintosh (68K and PowerMac) and on Windows 3.1 and 95 platforms. Cost is $1195.

Oracle Media Objects 1.1

Oracle's entry, as you might expect, readily connects to Oracle databases and is focused heavily on entertainment and interactive broadcast production as well as corporate communications and training. With this product, you can build your program on either a Windows machine or a Macintosh, then play it back on either platform or—tada!—Apple's forthcoming set-top box. With that addition, as well as Oracle's commitment to Web computers, this $495 package may become an important player in the multimedia market.

PowerMedia 2.0

RadMedia's authoring package is a good bet if you don't need database support (though the company promises that for the future). What your $495 buys now is a storyboarding environment that enables easy Web distribution with one-click hyperlinking and generating of Hypertext Markup Language files. You also get hundreds of screen layout templates; good support for a wide variety of graphics, video, and audio imports; an image editor; and illustration tools. This will be of interest to people developing educational courseware, Internet advertising, entertainment titles, and corporate communications.



Corel's Click and Create, with its time line and storyboard, is especially versatile.

Innovus Multimedia run as 32-bit applications under Windows 95.

But platform-specific support becomes less critical as the World Wide Web grows in popularity. Already, ToolBook II is powerfully Web-enabled; it can save applications in Hypertext Markup Language (HTML) and Java formats, has a browser plug-in, and offers templates for building applications distributed via the Web. Authorware also offers a browser plug-in, and end-users can configure Authorware and IconAuthor run-times as helper applications. Innovus Multimedia plans Internet capabilities for the next version, due out in November.

In the final analysis, ToolBook II is our top pick because it does the best job of balancing ease of use with a rich set of features. Innovus Multimedia, which takes a minimalist, PowerPoint-like approach, would be our second choice, especially for developing simple presentations. B

PRODUCT INFORMATION

Authorware 3.5
$4995 ($595 upgrade)
(486, 8 MB;16 MB recommended)
Macromedia
San Francisco, CA
(800) 326-2128
(415) 252-2000
fax: (415) 626-0554
http://www.macromedia.com
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IconAuthor 7.0
$1295 ($895 upgrade)
(486, 8 MB;16 MB recommended)
Aimtech
Nashua, NH
(800) 289-2884
(603) 883-0220
fax: (603) 883-5582
http://www.aimtech.com
Circle 1023 on Inquiry Card.

Innovus Multimedia 2.1
$495 ($150 upgrade)
(486SX, 8 MB; 16 MB recommended)
Innovus
Salt Lake City, UT
(800) 433-1806
(801) 463-8200
fax: (801) 484-9561
http://www.innovusmm.com
Circle 1024 on Inquiry Card.

ToolBook II Instructor 5.0
$1995
(386DX, 8 MB; 12 MB recommended)
Asymetrix
Bellevue, WA
(206) 462-0501
fax: (206) 637-1650
http://www.asymetrix.com
Circle 1025 on Inquiry Card.

Corel Click and Create 2.0
$695 (upgrade $249)
Corel
Ottawa, Ontario, Canada
(613) 728-8200
http://www.corel.com
Circle 1026 on Inquiry Card.

mTropolis 1.0
$1195
mFactory
Burlingame, CA
(415) 548-0600
http://www.mfactory.com
Circle 1027 on Inquiry Card.

Oracle Media Objects 1.1
$495
Oracle
Redwood Shores, CA
(415) 506-7000
http://www.oracle.com
Circle 1028 on Inquiry Card.

PowerMedia 2.0
$495
RadMedia
Palo Alto, CA
(415) 617-9430
fax: (415) 473-6826
http://www.radmedia.com
Circle 1029 on Inquiry Card.

David Seachrist has tested software for NSTL for 10 years, concentrating on desktop publishing and graphics. You can reach him at **dseachrist@prodigy.com.**

Evaluations in this report represent the judgment of BYTE technical editors, based in part on extensive tests conducted by National Software Testing Labs, as documented in a recent issue of NSTL's monthly Software Digest. *To purchase a copy of that report, with NSTL's own evaluations and data, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; (610) 941-9600; fax (610) 941-9950; editors@nstl.com. For a subscription, call (800) 257-9402. BYTE Magazine and NSTL are both operating units of The McGraw-Hill Companies.*



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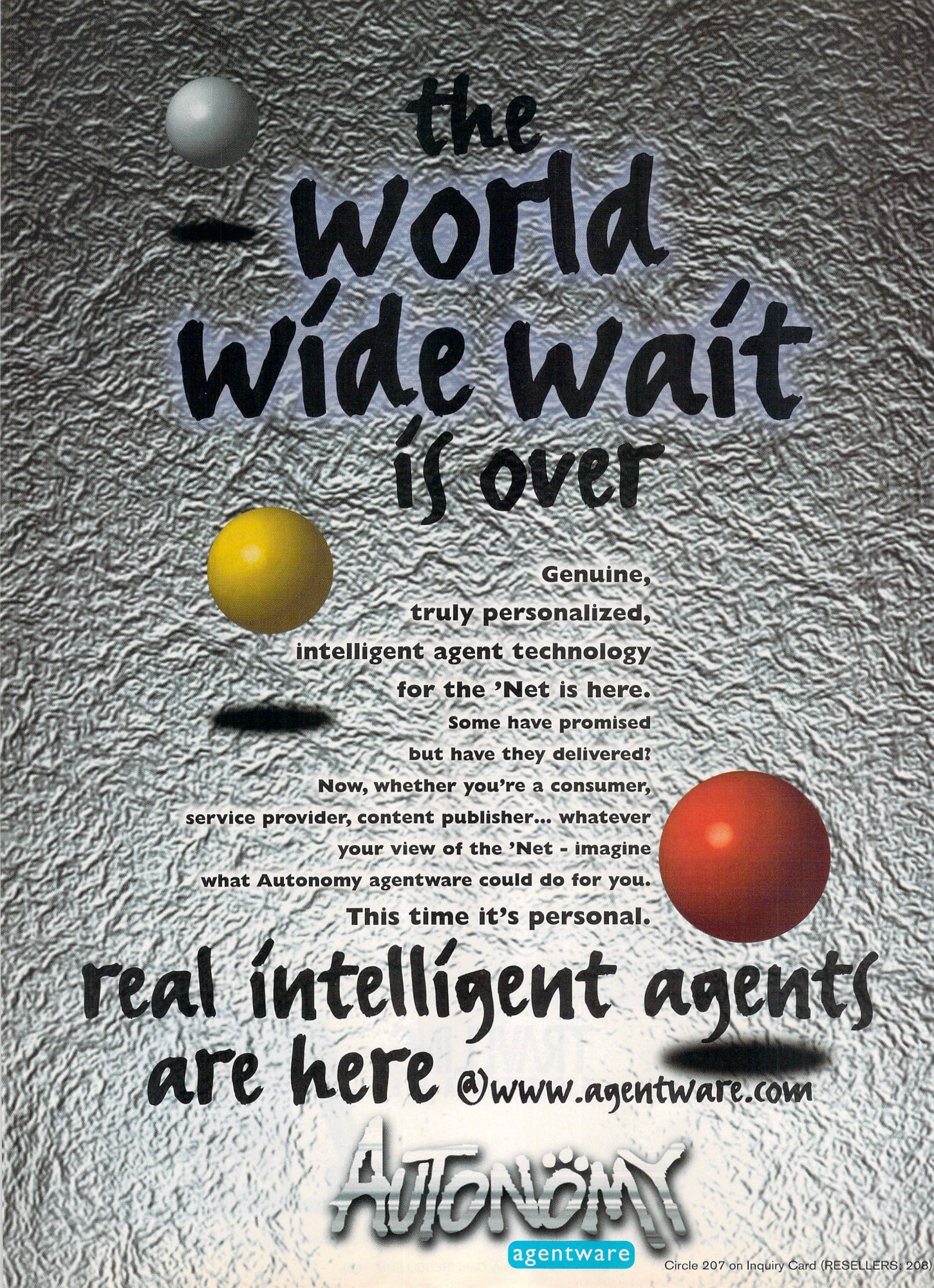


Circle 207 on Inquiry Card (RESELLERS: 208)

Jon Udell

Web Project



On-Line Componentware

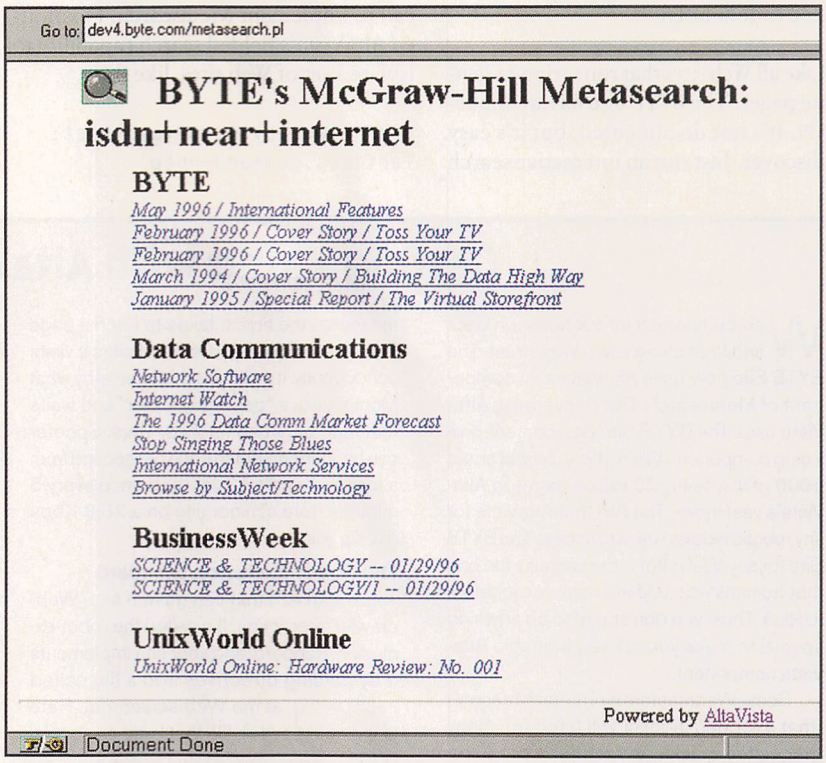
I use AltaVista to build BYTE's Metasearch application and realize that every Web site is a software component.

Software components can turn up in the unlikeliest places. In our May 1994 cover story ("Componentware," http://www.byte.com/art/9405/sec5/sec5.htm), for instance, we pointed out that object-oriented programming (OOP) technology had failed to produce a rich harvest of plug-and-play software objects. However, we showed that Visual Basic custom control (VBX) technology—a hastily conceived mechanism for Visual Basic plug-ins—had, to everyone's surprise, jump-started a thriving component-software industry.

Fast-forward to 1996. I want to prototype a Web-search application that embraces BYTE and five fellow McGraw-Hill publications. I have only a few hours to spend on the task. What component can I pull off the shelf and use? Java or ActiveX components? They're coming, but they're not here yet. Distributable search engines? They exist, but deployment across six Web sites will take more than the allotted few hours.

As I drove home from work, I suddenly knew where to find the right component for the job. It was sitting in plain view at http://www.altavista.digital.com/. That's right—Digital Equipment's AltaVista, a public Web site, is also the software component that let me prototype the McGraw-Hill Metasearch application before I went to bed that night.

A powerful capability for ad hoc distributed computing arises naturally from the architecture of the Web. This month's column demonstrates that fact, in a compelling way, using AltaVista as an example. But the technique that I describe here applies equally to The BYTE Site or any public Web site. My intent is only to demonstrate the technique and consider how it enables large-scale software componentry. For commercial-grade solutions that leverage AltaVista, check out the AltaVista Business Extensions at http://altavista.software.digital.com/sitemap/nfbusexten.htm.



In only a few hours, I created an application that intercepts AltaVista search results and groups them by site of origin.

Web Site as Software Component

Brad Allen, who created Quarterdeck's WebCompass, first showed me how a Web site can work as a software component. At Fall Comdex in 1995, he plugged The BYTE Site into WebCompass and showed how Quarterdeck's product could add value to our site's native search function. How was this possible? If there is a telnet on your system, try doing this experiment:

```
telnet www.byte.com 80
get /
```

The above sequence transmits an HTTP GET request to the BYTE Web server and then asks for the server's root document. What telnet subsequently spews forth will be the Hypertext Markup Language

PHOTOGRAPH: KELLIE WALSH © 1996

(HTML) source text of BYTE's home page.

Internet newcomers are often surprised to learn that the Web is built on such a simple mechanism. Old hands just take it for granted because they're familiar with other Internet applications that work the same way. For example, `telnet` to `dev4.byte.com` on port 119 and enter `help` to reveal the NNTP command set of BYTE's news server. And below is a way that you can query the BYTE archive and our Virtual Press Room for documents that contain references to NNTP:

```
telnet dev5.byte.com 80
get /cgi-bin/sw2.pl?keywords=
nntp&index=both
```

Like all Web sites that run scripts to generate pages, The BYTE Site has an implicit API. It's not documented, but it's easy to discover. Just run an interactive search and then view the source of the results page. There you will see how the form variables `keywords` and `index` control the several search engines that are running on the site.

When you query interactively, those variables are transmitted by way of a temporary file using the HTTP POST method. However, an equivalent command line that uses the HTTP GET method, as shown above, works just as well.

A Naive Implementation of Metasearch

A little interactive experimentation with AltaVista revealed the API that I needed to call to implement Metasearch. I exploited AltaVista's fielded search capability to isolate a set of Web sites, like this:

```
q=host:www.byte.com+and+host:
lantimes.com+and+nntp
```

I couldn't expect users to telnet to AltaVista and type this junk. So my first naive implementation was a Web form that called a BYTE Site script that returned another form that called AltaVista.

Sound squirrelly? It was. I needed the first form to capture the search keywords, the script to interpolate the keywords into a Common Gateway Interface (CGI) request template, and the second form to present the final request to the user as an action that could be invoked via an HTML Submit button.

When Javascript and VBscript stablilize, they'll eliminate the need for many of these CGI gymnastics. Simple active-client technology could have streamlined my naive implementation. But if Metasearch did nothing more than point the user's browser at AltaVista, I'd still call it naive.

The finished application does more. It adds value by intercepting the results that

Getting Along with AltaVista

Web-component interactions run back and forth along a two-way street. The BYTE Site now uses AltaVista as a component of Metasearch. But conversely, AltaVista uses The BYTE Site as a content-providing component. We're the source of about 5000 of the nearly 20 million pages in AltaVista's vast index. The API that AltaVista (or any robotic indexer) uses to access The BYTE Site (or any Web site) is the same as the one that humans use: uniform resource locators (URLs). Thus, you don't need to do anything special to make your site a pluggable AltaVista component.

Some Webmasters worry—with reason—that a robotic indexer will fetch too many pages too quickly and render a site unresponsive to normal users. That isn't a problem with AltaVista, which adapts dynamically to your site's ability to pump out pages. When I first heard about AltaVista last winter, I was amazed to learn it had already indexed our site.

Why the surprise? After a few other robots had applied heavy suction to our server, I added a "pig report" to my daily log processing. It highlights visitors who pull more than 1 percent of any day's pages. These high-volume customers are invariably Web crawlers. I like to keep track of who they are and how they use the data they vacuum out of my server.

But AltaVista never showed up on the pig report. Its inventor, Louis Monier, later explained why. Scooter, the AltaVista spider, measures the time it takes to fetch a page from each of the hundred-odd sites it visits concurrently. It multiplies that interval by what Monier calls a "good-guy factor" and waits that long between fetches. Thus, Scooter can concurrently fetch once per second from a major site on a T3 link, and once every 5 minutes from a minor site on a 28.8-Kbps dial-up link.

The Robot-Exclusion Standard

There's an API that can govern site/Web-crawler interaction. It's called the robot-exclusion standard, and your site implements it by placing directives into a file called `robots.txt` at the Web-server root. Here is the `robots.txt` file that I use on several BYTE Site development servers to lock out robots completely:

```
User-agent: *
Disallow: /
```

Why? A few months back, I did an AltaVista search and turned up URLs pointing not only to http://www.byte.com, but also to a backup archive on one of my development servers. I checked its log and found that about 5 percent of the official site's traffic had diverted to the backup server. Worse, the archive was several months out of date.

How did this happen? I'd let a page on the official site include a pointer to an unrestricted subtree on the backup server. Scooter found the hole and jumped through. Yikes!

To prevent Inktomi and WebCrawler and the rest from following suit, I plugged the hole using access controls and (for good measure) `robots.txt`. But AltaVista to this day remembers these unofficial URLs, and there's no way I can make it forget them.

An ambitious fix would be to regenerate the archive on the backup server, substituting redirection headers for documents. My less ambitious fix was to lock down the backup server and rig it to tell people to look instead on http://www.byte.com. If you're one of those people, I apologize for allowing the sorcerer's apprentice to run amok. Learn from my mistakes and use `robots.txt` (along with regular access controls) to protect what you don't want to publish.

AltaVista's Altruism

Problem: Robotic indexers can clog your Web site by trying to fetch too many pages too quickly.

Solution: AltaVista's indexer, called Scooter, multiplies the time it takes to fetch a page by a "good-guy factor." Thus, Scooter dynamically adapts itself to each site's ability to send out pages.

Result: Scooter may call upon a major site with a T3 link to pump pages at a rate of one per second, while the rate for a site with a 28.8-Kbps link may be one every 5 minutes.

innovus

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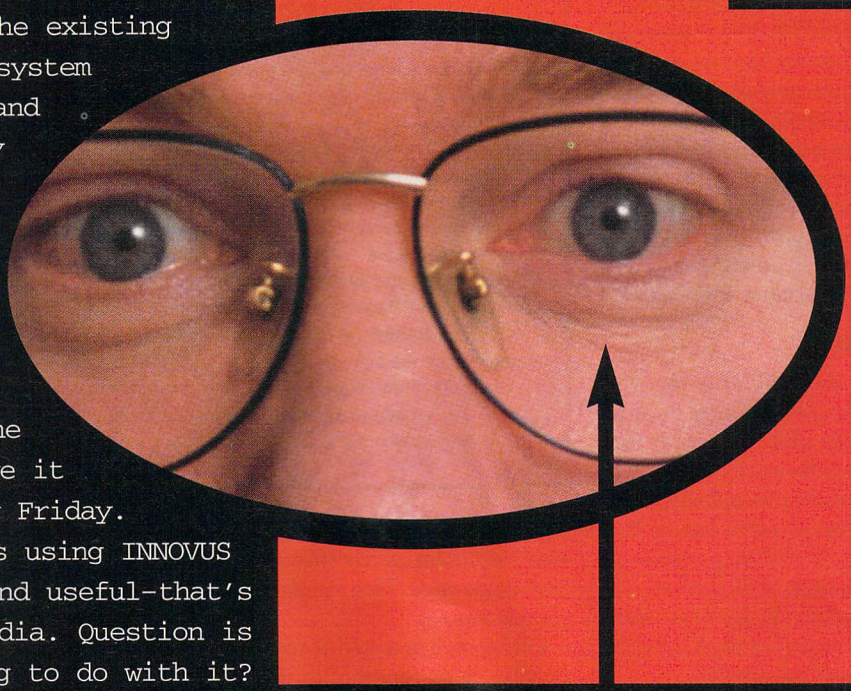

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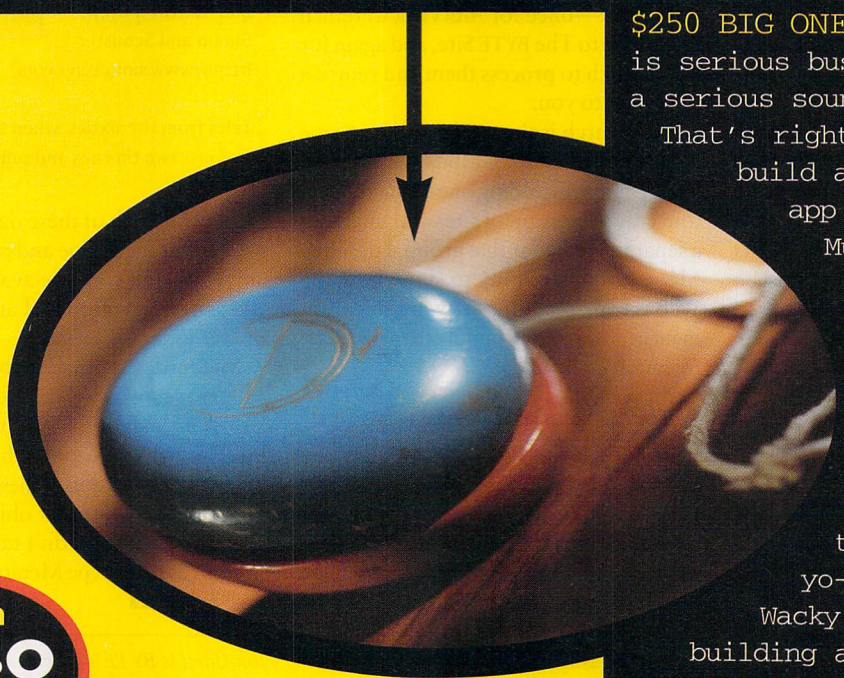

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Circle 202 on Inquiry Card.

AltaVista returns and grouping them by site of origin (see the screen on page 129). You could achieve this effect using advanced active-client technology—a Java program or an appropriately scripted ActiveX control. Or, since these technologies are not yet widespread and stable, you could do it on the server side with conventional CGI techniques. Because I wanted to write the application in a few hours and know it would work on most installed browsers, I chose the latter approach.

Script Control

There are several Perl libraries that you can use to call uniform resource locators (URLs) from your own Perl scripts (see CPAN, the Comprehensive Perl Archive Network, at many URLs, including ftp://ftp.digital.com/pub/plan/perl/CPAN/). Two that I've tried are Roy Fielding's libwww-perl (http://www.ics.uci.edu/pub/arcadia/libwww-perl/) and Jim Richardson's Wire.pm (http://www.maths.usyd.edu.au:8000/jmr/perl/PerlCode.html).

For arbitrary reasons, I used Wire.pm, but libwww-perl (or another equivalent package) would also have worked. With any of these, you can pass a URL to a library function that "calls" it and "returns" the resulting HTML document (or perhaps just an HTTP header), which you assign to a Perl string variable. Then you can use Perl's unparalleled string-handling power to analyze and act on the result page. When that page is program output, it will typically exhibit a regular, repeating structure. Parsing these kinds of pages is like shooting fish in a barrel.

There was one complication. Rather than issuing a single request that combines all the Web sites that are checked on the form, Metaseach instead issues one request per site. Why? AltaVista chunks its results across a series of pages that must be fetched sequentially. A search that produces hits for all the selected sites often won't represent each of those sites on the first results page. That mandated a multi-request strategy.

One approach would be to thread a series of requests using the URL that's behind the Next link on every AltaVista result page. But how to decide when to stop? One query might yield a few result pages; another, dozens. So I opted for one page of results per selected site.

Doesn't that mean each site's results aren't fully enumerated? Yes. There are other problems, too. Metasearch is only as current as the most recent AltaVista visit to the sites I list. And it forces you to wait twice—once for AltaVista to return the results to The BYTE Site, and again for Metasearch to process them and return a final page to you.

Metasearch isn't a real solution. Some commercial-grade solutions are available from Digital, including one that will "custom crawl" a group of sites and maintain a separate index for that group. I describe Metasearch here only to show how the Web is transforming software development even more profoundly than it's transforming publishing.

A Web of Components

It should be clear to you now that you can use tools such as libwww-perl and Wire.pm to quite easily construct your own customized link checkers and Web spiders. Why bother? Well, I've tried a bunch of shareware and commercial link checkers, and none that I've found can integrate easily and well with my site-management procedures.

But spiders and link checkers merely scratch the surface. Imagine a cousin to Metasearch called Metaorder, which would automatically spring into action when you ordered a subscription to BYTE using our site's order form. Metaorder might need to update four or five different databases in different locations around the world. Each of these databases might use a different engine and run on a different OS, but all could be available (behind layers of encryption and authentication) on the Web.

Metaorder could therefore orchestrate a heterogeneous two-phase commit. The "APIs" at each of the sites will have been built anyway to support browser-based interactive execution of these several tasks, per corporate intranet objectives. Once that's done, it shouldn't take 18 worker-months to prototype Metaorder. It should take a day. B

Jon Udell is BYTE's executive editor for new media. You can contact him by sending e-mail to **jon_u@dev5.byte.com**.

Plugging In the Linux Box

A few months back, analysis of the keywords used to search The BYTE Site revealed that *Linux* ranked fifth. Clearly, a lot of visitors knew something I didn't, and I resolved to find out what.

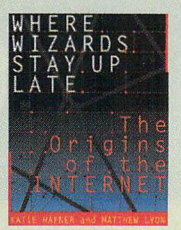
Today, a P150-based Dell running the Caldera distribution of Linux is an increasingly important pillar of The BYTE Site. All our conferences run there; INND supports newsreaders, and Apache provides an alternate Web-based view. I transfer files between Windows NT servers and Unix servers using Samba, a nifty SMB utility that makes the Linux server look like an NT peer file server.

And when I found that the key component of Metasearch (a Perl 5 module called Wire.pm) didn't like my NT Perl setup, I didn't waste time figuring out why. (A lot of Perl tools, though in principle are portable, in practice work better with Unix.) It was easier to build and run Metasearch over on the Linux box, so I did.

What's delightful about Web development is that the components you build can float effortlessly from one platform to another. NT and Unix offer complementary strengths. Exploit them both. And if you want to deploy a Unix system as part of the mix, Linux is a really useful one.

BOOKNOTE

Where Wizards Stay Up Late: The Origins of the Internet



$24
by Katie Hafner and Matthew Lyon
Simon and Schuster
http://www.simonsays.com/

Tales from the sixties, when the Internet was just two tin cans and some string.

TOOLWATCH



QuickDNS Pro

$290
Men and Mice
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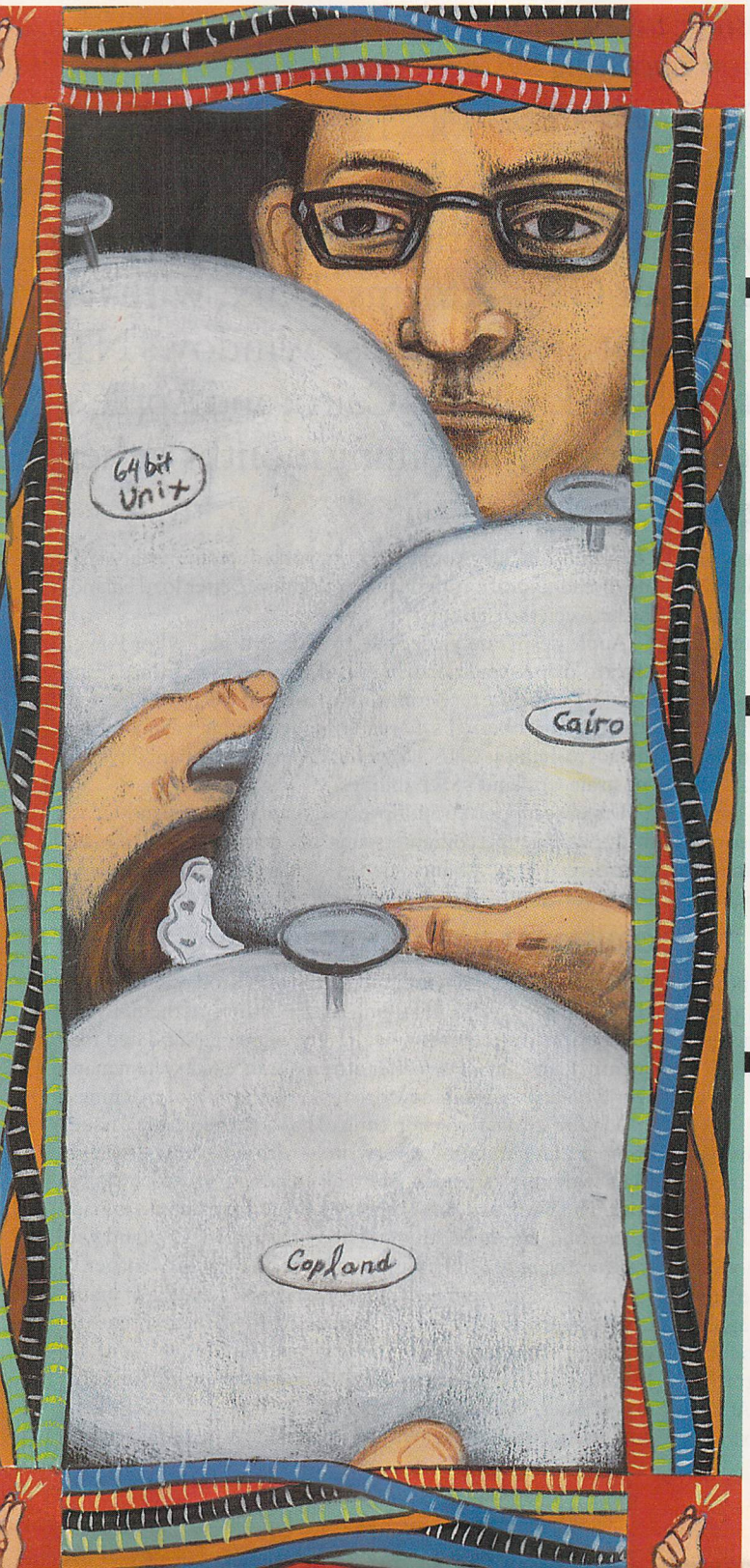
Who says you need a Unix box to provide DNS service for your site? QuickDNS Pro does it very nicely on a Macintosh.

BYTE special report

OS Strategies

How to sort out the technical merits and shortcomings of tomorrow's versions of Unix, Windows NT, and Mac OS.



Your Next OS

Consider these six key issues before committing to a next-generation OS strategy.

Page 134

Unix Leads the 64-bit Charge

64-bit OSes can address massive amounts of memory. But where are the 64-bit applications?

Page 139

Unearthing Cairo

Cairo now may be a set of new features for Windows NT. Can it help Microsoft's enterprise push succeed?

Page 145

Copland, Revisited

Apple's upcoming OS offers new microkernel and hardware-abstraction services to compete with the other OSes. But when?

Page 151

YOUR NEXT OS

What to consider when evaluating next-generation operating systems.

By Dick Pountain

In this Special Report, we'll evaluate the next-generation implementations of three major OS platforms: Unix, with its continued enhancement of 64-bit architectures; Windows NT and the stops and starts of what has been known as Cairo; and Apple's Copland, which will arrive piecemeal over the coming months rather than as one integrated package.

Whether you're committed to one of these platforms or you're considering a switch to a different one, the decisions you make today will affect your OS strategy for years to come. How do you begin to evaluate tomorrow's operating systems? Start by analyzing six key areas.

ROBUSTNESS

An enterprise-level OS ought to run in protected mode and employ preemptive multitasking, so errant programs can be killed off without bringing down the OS itself. Windows NT and Unix both offer such protection now. However, some people are concerned about the robustness of the new kernel-mode graphics driver scheme in NT 4.0 (which will presumably persist in forthcoming versions) compared to the slower but safer scheme in earlier NT versions.

Copland still represents only a partial answer to Macintosh robustness. Copland's new microkernel runs applications, as far as possible, in protected memory, but it must allow kernel access from old applications to maintain System 7.x compatibility.

MULTIPROCESSING

What's driving the move to multiple CPUs? Partly the performance requirements of network servers; partly processing-intensive client-side applications, such as rendering 3-D graphics and calculating large spreadsheets. These applications don't require massively parallel supercomputers, just rather modest symmetrical multiprocessing (SMP) systems that use shared memory and an OS that automatically distributes multithreaded applications over different CPUs. NT already supports one to four processors, and machines like Intergraph's four-Pentium graphics PCs are exploiting NT's multiprocessing capabilities. At the same time, specialist vendors like Sequent run NT with up to 28 CPUs. The Cairo development effort worked at refining the existing thread-allocation algorithms to achieve better load balancing between the CPUs.

Apple desperately needs to provide SMP ability for Power Macs to keep its traditional high-end graphics users from defecting to NT to reduce rendering times. Copland will introduce SMP with the microkernel's Thread Manager, which can allocate threads to multiple CPUs. However, backward compatibility may constrain Copland's SMP abilities.

Unix has supported multiprocessing for years, and most massively parallel supercomputers run Unix-derived OSes. The main commercial Unix variants, such as SCO, Solaris, and UnixWare, all support SMP, and such systems often run with up to 64 CPUs.

CONFIGURATION MANAGEMENT

Perhaps the greatest single disadvantage of PCs today is the nightmarish difficulty of maintaining large numbers of them. Every new peripheral requires new drivers, which get updated frequently. Current PC OSes offer little assistance to a system manager who has to install new drivers on hundreds of machines.

Mature software version control has become a critical issue. OS upgrades commonly overwrite—without asking—system DLLs with new versions that break existing software installations. The Windows 95/NT registry scheme, for example, is inadequate and should be strengthened or replaced. Copland will track software revisions with a service called Patch Manager.

Unix management has traditionally been a matter of maintaining many text-based configuration files, the contents of which are a mystery to all but the gurus. Windows NT and the Mac OS have the advantage of GUIs and interactive configuration utilities. Even so, the sheer number of PC peripherals vendors has made management more and more arduous. Hence

Plug and Play becomes vital, and its absence has stalled wider acceptance of Windows NT.

The Macintosh has long been blessed with true plug and play and easy configuration (possibly due to less nonproprietary hardware). But with the growth of a clone Mac market, this could become an issue. Copland's hardware abstraction scheme, which organizes device drivers into related families, will maintain some discipline while still allowing third-party vendors to differentiate their products.

NETWORK CONFIGURATION

As networks grow, an administrator must get help from the OS to remotely configure systems and share configuration changes. Windows NT centralizes user management onto a single primary domain controller. But if network growth requires multiple domains, it becomes a beast. Microsoft's plan is to organize multiple domains into a tree structure like that of archrival Novell's NetWare Directory Service (NDS). Future versions of NT will also support multiple master domain controllers, giving remote branch offices connected via WANs more independence while still maintaining system coherence. Microsoft also plans retooled directory services to simplify managing mixed networks by unifying log-in and administration procedures. The Open Directory Services Interface (ODSI) is intended to do for directory services what Open Database Connectivity (ODBC) does for database access: make it vendor-independent.

DISTRIBUTED OBJECTS

Unix vendors, under the Object Management Group (OMG), have spent several years on the Common Object Request Broker (CORBA) standard for different systems exchanging objects. OMG recently settled on Sun's Universal Networked Objects as the standard for remote interoperability and on OpenDoc as the compound document model for CORBA 2.0. This conflicts with Microsoft's own proprietary Distributed Common Object Model (DCOM) and ActiveX. To complicate matters, Sun's Java Component Architecture offers a way for Java components to talk across the Net. Sun's approach is backed by Netscape's 38 million copies of Navigator, which is ready to accept Java-based plug-ins. Netscape is cooperating with OMG to make Internet Interoperable ORB Protocol (IIOP) the unifying technology for Internet objects in all its future Web browsers.

This seems to have panicked Microsoft into a compromise: It will hand over its ActiveX object technology to a customer-driven open standards body (a first). So perhaps customer pressure might finally force a convergence of object standards.

64-BITNESS

Unix vendors worry how Microsoft and Apple plan to push Wintel and the Mac further into traditional Unix domains. The Unix solution is to move up to 64-bit OSes (see "Unix Leads the 64-bit Charge" on page 139). Microsoft has only just started offering PC users a fully 32-bit OS: NT, not the 16-/32-bit hybrid that is Windows 95.

The main attraction of these next-generation OSes is that you can access more memory through 64-bit addressing. A 32-bit address space allows up to 4 GB of memory. Until recently, most users have regarded gigabyte memories as quite enough (if not pure fantasy), but the rise of client/server computing has us contemplating servers that cache huge databases entirely in RAM to speed up access rates. Gigabytes of memory suddenly makes sense as a giant disk cache. And a 64-bit address bus and OS can access up to 18 billion gigabytes.

Windows NT already runs on DEC's 64-bit Alpha chips. To push NT as a server OS, Microsoft needs to let Alpha users fully exploit its 64-bitness, or Unix may tempt them away. However, the lack of 64-bit applications, plus Intel holding 64-bit addressing for its next-generation Merced chip, means that this is not a top priority for Microsoft, or most of its users, just yet.

OS Features Checklist

	NT	Copland	64-bit Unix
Symmetric multiprocessing support	✔	✔	✔
Protected-mode kernel	✔	✔	✔
Per-process memory protection	✔		✔
Preemptive task scheduling	✔	Not for legacy code	✔
Multithreaded execution	✔	✔	✔
Automatic hardware detection	✔	✔	
Component architecture	ActiveX	OpenDoc	Various
Extensible OS kernel		✔	Rebuild
64-bit address space			✔
Fault-tolerant file system	✔		Some

✔=yes

WHERE FROM HERE?

If you're a Unix user, you just have to choose when or if you'll move up to a 64-bit version. If you really need the huge address space of 64 bits, you probably already know it. Similarly, the question for a Macintosh user is not whether you need Copland but rather how soon you can get it. If your graphics work involves high-resolution rendering, then you need the assistance of multiprocessing now. Because many Mac tools are being ported to NT, it's becoming a race: The longer Copland takes to deliver SMP, the more alluring are the cheaper hardware and existing SMP of NT.

Windows users face the most uncertainty. For intranets, you could use NT, NetWare, or Unix for the server OS, and any of a dozen choices for your Web servers. Microsoft's new Internet orientation might affect your plans in several ways. The next NT shell—with integrated Internet Explorer—is currently in beta; it presents an "HTML everywhere" desktop that can display live Web pages. Even the Windows Help file format abdicates to Hypertext Markup Language. Visual Basic's current incarnation is temporary, as its forms engine is not based on HTML. Planning to invest in a hypertext or document management system that doesn't involve HTML? Think hard.

Most important, though, you must decide whether Microsoft can make the more ambitious features of the Cairo project work and, if so, when. OS developments are exciting to watch, but excitement may not be what you want when it comes time to making decisions. If you can do it, waiting for the dust to settle may be the best strategy for the next few months. B

Dick Pountain is a long-time BYTE contributing editor who lives in London. You can reach him at **dickp@bix.com**.

Microsoft Windows NT Workstation 4.0

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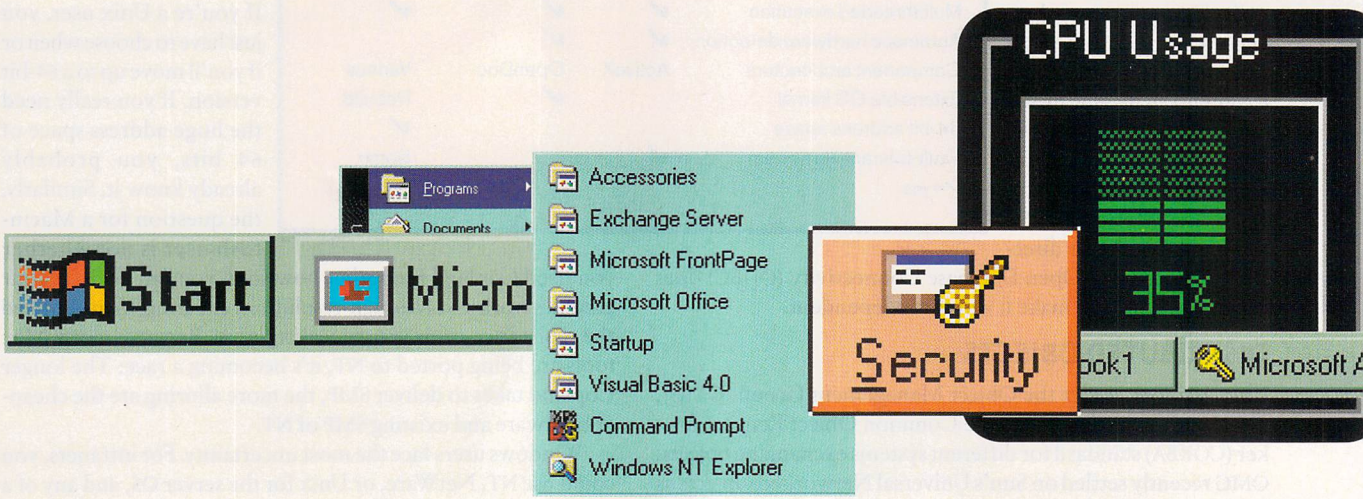

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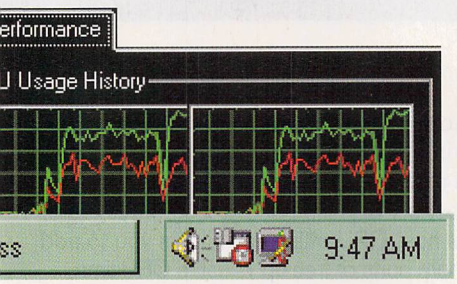
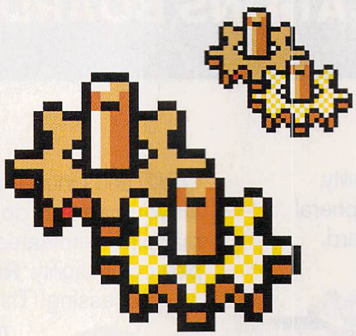
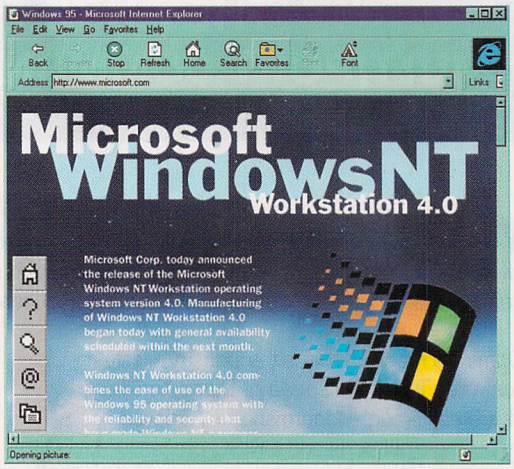
Windows 95. of Windows NT.

computers everywhere drooling.







The new Windows NT® Workstation 4.0 operating system has been designed to be the most powerful desktop operating system. And because all that power is controlled by the Windows® 95 interface, it's much easier to use. The total 32-bit power of Windows NT Workstation means reliability, security, and easy access to the Internet and intranet. It's reliable because all applications run in their own memory space—so that new game beta won't crash last week's work. It's secure because integrated features let you lock your system all the way down to the file level, so you can count on applications and data being safe.

It's Internet-ready because it's loaded with built-in features like TCP/IP, the Microsoft Internet Explorer browser, and integrated Peer Web Services, which lets you create a small intranet for your workgroup. And because it's all controlled by the Windows 95 interface, you can customize your system to work and look however you like. So does all this mean Windows 95 is history? Absolutely not. Windows 95 may still be your best choice, depending on your existing hardware and applications. We suggest you dive headfirst into our Web site to compare and contrast operating systems to see which 32-bit desktop is best for you.

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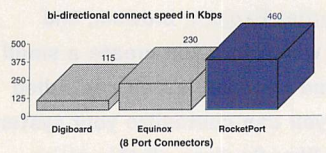

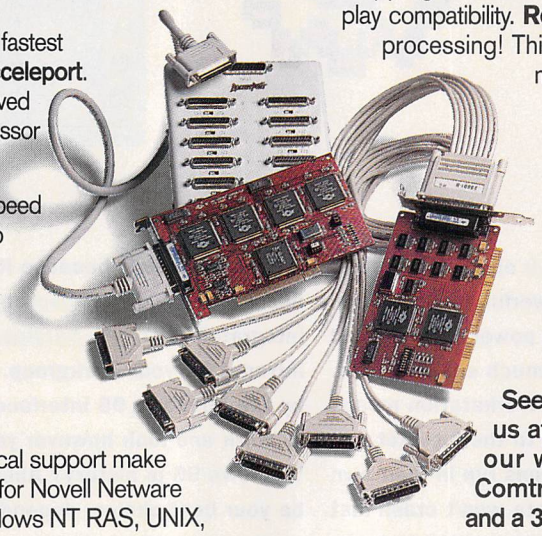

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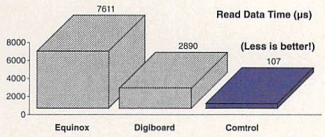

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Unix Leads the 64-bit Charge

64-bit OSes are moving from the horizon to your desktop. And you get the benefits.

By Laurent Lachal

Computer technologies march relentlessly to the rhythm of bigger and faster. CPU clock speeds, which once seemed fast at 33 MHz, now push past the 200-MHz mark. Similarly, OSes that gave us a speed boost with 16-bit architectures now are evolving to 64-bit technology to meet the demands of processor-hungry applications, such as data warehousing and virtual reality (VR).

But if you're not setting up an on-line transaction-processing (OLTP) server, how much can you really benefit from today's 64-bit versions of Unix or tomorrow's 64-bit Windows NT or Mac OS? In reality, the added capabilities of 64 bits are narrow in scope. The most significant changes affect process and file management and memory capacities. The 64-bit transition leaves reasonably untouched such aspects of OSes as *concurrency* (where multiple applications share resources), scheduling, and security.

The answer to how you can benefit from a 64-bit OS ultimately depends on what applications you are running, whether your hardware is tuned for 64 bits, and whether your system has the massive amounts of memory needed to take advantage of the architecture. In the end, the possible advantages of 64-bit technology come in shades of gray, not the relatively black-and-white distinction that defines the performance differences between 16- and 32-bit systems.



ILLUSTRATION: MERYSA NICHOLS © 1996

Faster Number Crunching

Process management benefits from 64-bit OSes because the OS kernel executes larger instructions that can do more processing per cycle. The kernel can also manipulate 64-bit integers to give applications faster, more complex number-crunching abilities.

This increased processing capability goes hand in hand with an exponential growth in the memory (virtual and real) that's addressable by each process. A 64-bit memory space can now address a maximum RAM of 2^{64} bits—or more than 18 billion GB—compared to the mere 2^{32} bits (4 GB) possible for 32-bit OSes.

More and Larger Files

Virtual memory enables an application to use RAM as a disk cache. In turn, a larger disk cache is necessary with 64-bit OSes because not only can they handle a larger number of files, but they can accommodate much larger ones. Vendors are starting to speak in terms of terabytes—not just gigabytes—of data. Data handling among the CPU, memory, and hard disk improves with 64-bit registers because the registers not only enable the system to move data around more quickly but can also reference a larger number of data chunks.

You don't need a 64-bit OS just to handle 64-bit-long integers, manage large files, or get yourself more memory. After all, you can use several 32-bit instructions to come up with a 64-bit operation, split large files into more manageable ones, use a parallel design for multiple storehouses of memory, or opt for a large block of memory residing on a hard disk. However, 64-bit OSes are certainly the most straightforward technology for achieving these capabilities.

Beyond these general benefits, 64-bit OSes have distinct implications for desktop systems and servers. Desktop applications

will be able to exploit 64 bits to provide Nintendo-like graphics—first for 3-D-based programs and then for VR-based ones. Advanced GUIs are already available: Computer Associates' flagship management tool, CA Unicenter TNG, sports a new VR interface.

On the server side, the very-large-memory (VLM) capability of 64-bit OSes will first attract developers in specialty areas, such as video on demand. The technology will then appeal to more mainstream OLTP and data-warehousing applications developers. Microsoft has pointed to credit-card transaction-authorization databases and worldwide reservation-system applications for its long-range move toward 64-bit NT.

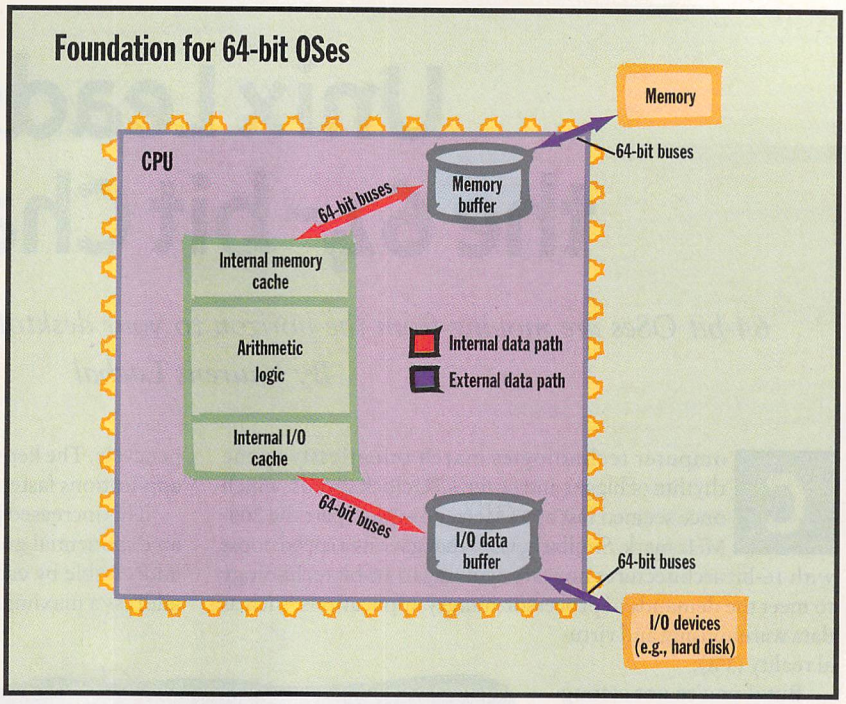
DBMS vendors and, increasingly, business-applications vendors say they will use 64-bit architectures to develop leading-edge technology and support their large corporate customers. Similarly, Unix vendors have jumped on the 64-bit bandwagon, partly because it's a way to keep Microsoft's NT development team on its toes (prompting Microsoft's vague public comments about 64-bit technology being in NT's future). Unix vendors might also find themselves in a battle to keep up technologically with the "Joneses": namely, 64-bit pioneers Digital Equipment and Silicon Graphics.

The Impact on Applications

Overall, 64-bit technology should have little impact on the fundamental architecture of applications, since programs are discrete and rather small data structures. However, applications will benefit from the following.

64-bit high-speed I/O: Commercial applications that shift data rather than just massage it can take advantage of the capability to boss around larger chunks of data more quickly. Devices that require improved I/O, including Nintendo's latest game station, QMS's printers, and Cisco's routers, also have the ability to exploit 64-bit technology.

64-bit logical/arithmetic operations: These operations increase the performance of "rocket science" applications based on complex data calculations, including satellite-imaging, weather-forecasting, technical-modeling, genetic-research, and simulation applications. Graphics also inherently benefit from high-speed calculations and extended memory capacity, as they are essentially continuous large data structures modeled discretely. In addition, 64-bit virtual addressing gives a boost to OLTP and data-warehousing applications, as well as more technical applications, such as computational fluid dynamics. All these types of applications require large amounts of memory.



To deliver performance improvements over 32-bit systems, 64-bit OSes need CPUs with 64-bit data buses for memory and I/O.

Large files: This is a gain for all types of applications, as new features expand software and consume the ever-increasing hard disk space.

OS vendors are promising unified APIs and more advanced compiler technology for software developers who will need to write code for 64-bit OSes. Unix developers in particular will probably be the first to have a unified 64-bit Unix API that will enable 64-bit applications to run on any of the various versions of Unix that support 64-bit architectures.

You shouldn't expect an end to divergent APIs for 64-bit Unix, although we can certainly hope that the number of different APIs will be diminished. An interesting twist to the Unix tale is that the intricacies of 64-bit OSes are likely to lead to fewer versions of Unix as the smaller Unix vendors rally to the bigger ones, such as the Hewlett-Packard/Santa Cruz Operation team, which promises to deliver a super 64-bit OS sometime during 1998.

How will OS vendors migrate from 32- to 64-bit applications support? Each designer team might take a different approach. For instance, Digital chose to skip 32-bit applications support, but it released a 32-bit translator for Ultrix and VMS to 64-bit Alphas. Sun pledges 100 percent binary compatibility between its 32-bit and 64-bit architectures.

Better Compilers

The same Solaris binary source will run on 32- and 64-bit systems, so it won't require the recompiling of 32-bit applications. However, this feature will come in handy only for a while, as recompilation is ultimately the only way to produce executables that use the full capabilities of 64-bit OSes. This process in turn requires sophisticated compilers that will be critical to the competitive edge of 64-bit OS vendors.

Even with a good 32-to-64-bit porting environment, there's still the question of which applications would benefit most from a conversion from 32 to 64 bits. The extra 64-bit coding is difficult to master and can actually decrease performance if the application doesn't have the ability to take advantage of the extra power delivered by the 64-bit OS.

WHAT 64 BITS BUYS YOU

Feature	Benefit vs. 32-bit OSes	Best Applications
Larger files	Can process terabytes of data (vs. megabyte-size files).	OLTP; data warehousing; high-end graphics; processing-intensive applications; general business applications.
Greater RAM	Memory can be a maximum of 18 billion GB (vs. 4 GB).	OLTP; data warehousing; high-end graphics.
Faster processing	Can handle more calculations faster.	High-end graphics; processing-intensive applications.
Faster I/O	Access times between main system and peripheral hardware are shortened dramatically.	High-end graphics; general business applications.

Unix Pushes the 64-bit Envelope

Digital Equipment's Unix, IBM's OS/400, and Silicon Graphics' Irix are the only full 64-bit OS environments available today. Siemens' Reliant Unix (the merger of Siemens' Sinix and Pyramid's DCOSX) should ship by the end of the year.

Other OS vendors have opted for a piecemeal approach. For example, Sun's Solaris already supports 64-bit extended-precision arithmetic and large files, which can both benefit from CPU-specific instructions to speed up networking. You can expect Solaris to handle file sizes up to 1 TB in 1997 and to become a full-featured 64-bit OS in 1998, with a 64-bit kernel and 64-bit virtual addressing.

When will Microsoft deliver a 64-bit OS? Last June, the company promised that Cairo would support 64-bit very large memory (VLM) for applications needing more than the 4 GB of memory addressable with 32-bit systems. But the rollout of Cairo continues to be a fuzzy target (see "Unearthing Cairo" on page 145).

VLM will most likely show up in Digital's Unix for 64-bit Alpha systems, which already can potentially provide 14 GB of addressable storage. This memory space will soon increase to 28 GB—significant, but still a long way from an 18-billion-GB addressable with a true 64-bit OS.

This is why software developers have not started to 64-bit-enable their applications en masse, as few of these packages actually exceed the capacity delivered by 32-bit systems. Indeed, 64-bit technology is likely to come hand in hand with market education; this way, companies will be able to avoid repeating the mistake that Intel made when people realized that the Pentium Pro boosts 32-bit-application performance but delivers poor 16-bit-application speed.

64-bit Technology vs. Parallelism

As important as 64-bit technology is, it's only a small part of some larger changes that are currently taking place in OS development. One trend is the fragmentation and modularization of OSes, which will confine the hardware-specific portion of the OS code to a small microkernel. Another trend is the adaptation of de facto standard OSes to parallel environments—specifically, symmetric multiprocessing (SMP), a shared-disk architecture; massively parallel processing (MPP), a shared-nothing architecture; and clustering.

The advent of 64-bit architectures is interwoven closely with the various approaches to parallelism. Both technologies benefit from the R&D and marketing muscle of vendors of relational database management systems (RDBMSes). These companies are employing 64-bit technology and parallelism to support next-generation RDBMS products, such as content management systems (CMSes), which handle structured and unstructured data alike. (According to one study, reported in the May issue of *European Software Markets Service*, CMSes will represent 28 percent of the total European database market by the year 2000.)

Cost vs. Speed

The best mix of 64-bit technology and parallelism, however, is unclear. "There's no easy answer," says Oracle marketing director John Spiers. "You have to balance cost and need, since infinitely fast is also infinitely expensive."

Indeed, the RAM needed to hold gigabyte-size databases does not come inexpensively. For instance, 4 GB of memory costs hundreds of thousands of dollars, compared to just a few thousand dollars for installing an extra processor in a parallel system. On the other hand, according to Jean Jacque Pairault, senior consultant of R&D strategy at Groupe Bull, you get a decreasing performance boost with each added processor. The alternative—a complete 64-bit system with a lot of memory—yields increased performance over 32-bit systems.

Vendors are unsure about how these technologies will improve your life. "Parallelism boosts performance in all situations, while 64-bit OSes help mostly in read-only situations, such as data warehousing," says Arthur Hochberg, European marketing director for Informix. On the other hand, "the large-memory approach is more relevant to OLTP than to data warehousing, where databases have grown too large for current hardware platforms," explains Spiers.

Alternatively, 64-bit technology may not be the most important issue. "At the high end, where people concentrate more on scalability than on large memory size, [the emphasis is on] solutions that combine parallel systems with advanced disk-storage technology," explains Jon Barnes, RS/6000 hardware product manager at IBM U.K.

The debate goes on. For the moment, the combination of 64-bit and parallel technologies will prove more beneficial to SMP than to MPP and clusters. Why? First, a 64-bit address space dramatically improves the scalability of SMP systems. Second, both technologies address different bottlenecks: SMP addresses a processing-power bottleneck, while 64-bit

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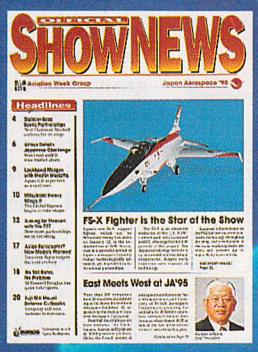

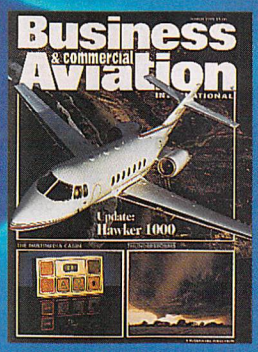

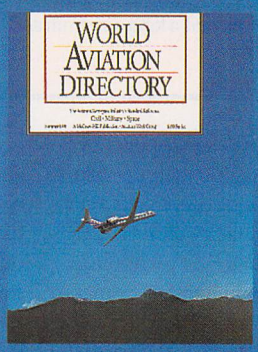

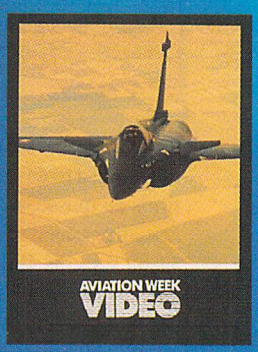

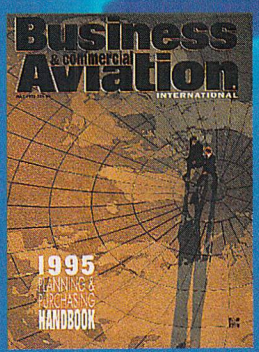

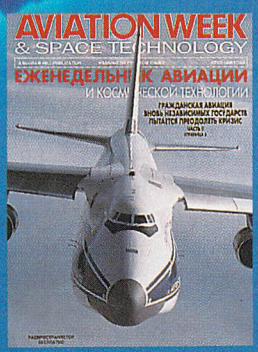

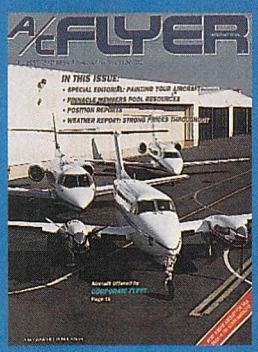



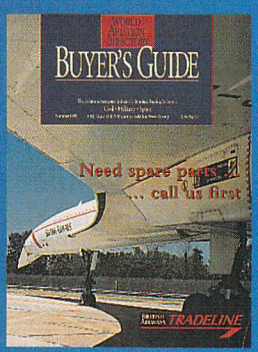

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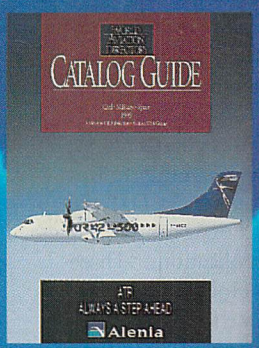



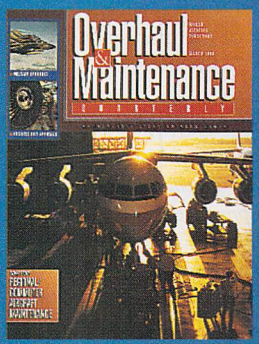

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memory reduces the processor-to-disk bottleneck.

Software developers are likely to postpone implementation of MPP, which requires a real architectural revolution, in favor of SMP, which is much closer to nonparallel systems. "For people who require very high throughput, the real battle will be between 64-bit technology and clusters," says Julian Lomberg, Solaris product manager for Europe. The cost/performance ratio currently favors clusters, due to the huge cost of memory.

In the long run, we will see tighter integration of 64-bit and parallel systems, for two reasons. First, parallel-systems vendors are moving, albeit slowly, toward an architecture that combines SMP and MPP. Second, the data-warehousing and OLTP markets are converging as demand emerges for read/write analytical databases, where decisions from analytical work automatically feed into changes to production data.

Technology Mix

Very few of the 64-bit-enabled hardware platforms that are currently shipping actually sport the huge memory capabilities that make a real performance difference. Digital acknowledges that only about 30 percent of its 2000 64-bit Turbo Laser systems sold during their first 15 months of release have shipped with enough memory to actually benefit from the VLM capability of Digital Unix.

But standard Alpha configurations may soon ship with substantially more memory, according to Pauline Nist, vice president for Alpha Server operations. "DRAM prices collapsed by over 60 percent in mid-1996," she says. "Digital responded with a midrange server, capable of 8 GB of RAM, that started shipping in June." Bill Reed, advanced technology consultant for IBM's AS/400 business, predicts that by the end the century, AS/400s will ship with at least 40 GB of memory and more than 50 TB of disk space.

Performance First

In the meantime, we need to closely watch how software suppliers take advantage of the underlying technology and see whether they implement 64-bit technology or parallelism, says Hochberg. But David Hughes-Solomon, director of technology at the client/server powerhouse SAP, believes end users don't care whether their systems use a 32- or 64-bit OS. "End users are mostly concerned about how well an application performs, especially on a large scale. If it can deliver, then they look at the price and decide," he explains.

In the same way that most PCs consist of a mix of elements running at various speeds and bandwidth capacities (e.g., 128-bit memory buses, 64-bit graphics accelerators, and 32-bit processors), we will probably see a mix of 32- and 64-bit OSes, hardware, and applications. "Three to five years," reasons Hochberg, "seems a reasonable time frame for 64-bit technology to permeate the high end of the market, while 32-bit technology will keep on satisfying the bulk of the market for the foreseeable future." B

Laurent Lachal, a consultant specializing in IT, is editor of European Software Markets Service, *a quarterly publication that analyzes OSes, applications development tools, business applications, and database management systems. You can contact him at* **editors@bix.com**.

Hardware Platforms with 64-bit Muscle

What hardware is available to support 64-bit OSes? All the leading RISC architectures currently use 64-bit designs. Intel's Pentium processors use 64-bit arithmetic operations and internal data paths. We expect that its successor, dubbed Merced, will be a full-blown 64-bit architecture.

Processor designers are further along in embracing 64-bit architectures than are OS developers. Today, there are 64-bit implementations for CPUs and for the data buses that interconnect the main processors with memory and I/O modules. Many data buses are 64 bits (or wider) to keep up with the CPUs that first implemented 64-bit arithmetic operations (i.e., load and store, and then add and multiply). The buses first arrived with a 64-bit internal data path and then moved on with a 64-bit external data path and 64-bit addressing. The latter enhancement enables CPUs to talk directly to 64-bit-wide memory.

All this lane-widening helps the CPU shuffle and process more data per cycle than in 32-bit systems. However, 64-bit architectures aren't the only way to boost CPU performance. Other performance enhancments include larger caches, higher clock speeds, more compact silicon wafers, and technologies such as very long instruction word (VLIW) for fewer but more complex instructions per cycle.

Six for 64

The following companies now offer 64-bit RISC processors.

Company	Processor platform
Apple/IBM/Motorola	PowerPC
Digital Equipment	Alpha
Hewlett-Packard	PA-RISC
IBM	AS/400
Mips	Rx000
Sun	SPARC

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Unearthing Cairo

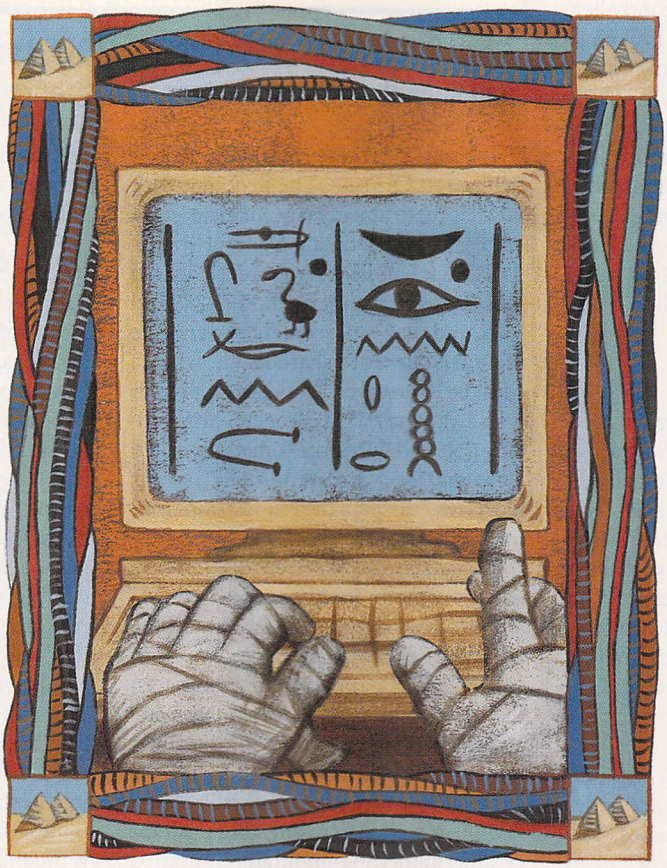
The next version of Windows NT will flex its enterprise muscle by incorporating features from "Cairo."

By Mark Minasi

At the first NT developers conference in 1992, Bill Gates announced that Cairo would arrive in three years and would incorporate object-oriented technologies, especially an object file system. Since then, we've seen Windows NT 3.1, NT 3.5, NT 3.51, and most recently NT 4.0. None is object oriented, none has an object file system, none is Cairo. It seems that Cairo is Microsoft's sly way of promising the world. "Will we see Plug and Play in NT?" "Oh yes, of course, in Cairo." "Will NT ever produce world peace and cheap antigravity?" "You bet—in Cairo."

What is becoming apparent is that we'll never see Cairo as the manifestation of Microsoft's next-generation operating system. But much of the development work that went into the Cairo project will see the light of day. Indeed, some Cairo features have already been bolted onto NT 4.0, and others may be slipstreamed into interim NT releases or will appear in the next major release of NT sometime in 1997 or early '98. Either way, don't expect to see a shrink-wrapped box of Cairo at your corner software store.

For its part, Microsoft is framing its course correction in the best possible light: Cairo isn't an OS, it's a set of technologies. What does this mean for current NT users or for those people who are contemplating a switch? Here's a rundown of the Cairo features you can expect to see in future versions of Windows NT.



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Networking Enhancements

Windows NT will continue to be Microsoft's "enterprise" OS as the company tries to push into large corporations and pry data off mainframes and Unix machines and onto PCs. To that end, the company has partnered with companies such as Digital Equipment to gain access to big-iron IS managers. But NT is developing a reputation more as an excellent OS for workgroup servers than for enterprise-level systems. Thus, one of Microsoft's missions is to instill NT with more enterprise character. To do that, Microsoft must refine how NT handles domains. NT's domain structure looked wonderful when compared to NetWare 3.x's server-based bindery, Novell's term for a server's list of recognized users. Unfortunately, domains pale as an enterprise structure beside NetWare 4.x's NetWare Directory Service (NDS).

That's because NT currently lets you centralize the lists of user accounts for a number of servers on one single server—kind of a security server—called a *primary domain controller*. Taken together, these servers constitute a domain, in Microsoft parlance. (NT allows you to establish "backup" domain controllers as well.) If you've got 50 servers in that domain, then you have to build your company's users only on one server rather than having to rebuild them 50 times, once on each server. But NT-based enterprise networks become clumsy when a second domain appears, which requires administrators to manage interdomain security treaties called *trust relationships*. The number of these relationships can easily grow to become almost unmanageable. For example, six domains require 30 trust relationships, but in organizations with 50 domains, the number of relationships soars to 2450.

One of Microsoft's main development efforts will be to reply to NDS. Instead of having to create dozens of domains, and then having to establish hundreds of trust relationships among them, you'll probably be able to create "trees" of domains. While Microsoft hasn't released much information about this change,

we expect to see a domain tree notion that sounds suspiciously like Novell's directory trees in NDS. In fact, Microsoft has recently taken to calling its current domains-and-trusts model Microsoft Directory Services, or MDS.

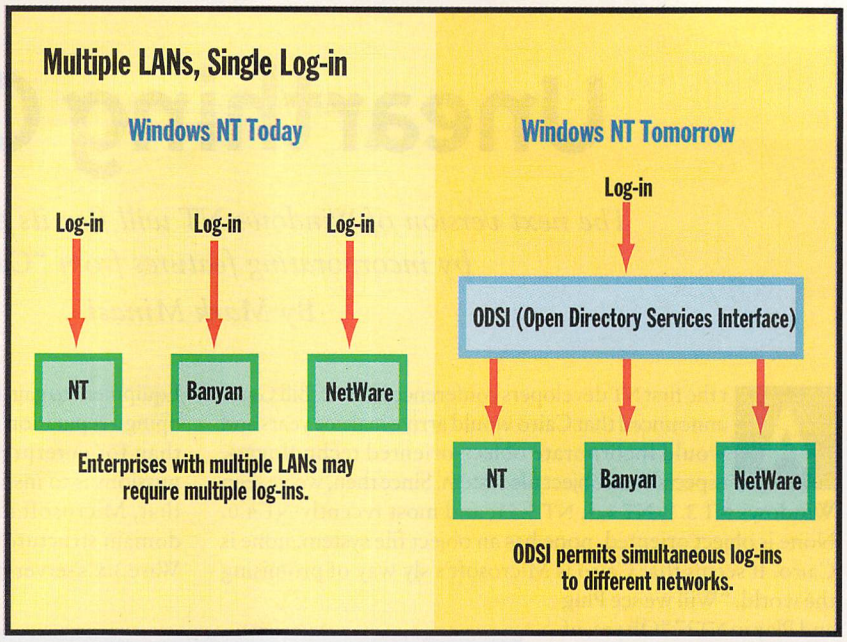
Additionally, NT's current notion of one primary domain controller and a collection of subordinate domain controllers may give way to multiple master domain controllers, a great boon to maintaining geographically widespread domains. Currently, it's possible (and convenient) to put a backup domain controller in a branch office. That backup domain controller can authenticate network log-ins, so users in the branch office needn't wait for their log-ins to occur over the slower WAN links to the primary domain controller. In fact, the WAN link can be down altogether and users can still log on through the backup domain controller.

What users *can't* do now is change anything about their accounts: passwords, groups they're members of, etc. They can do that only if they're connected to the primary domain controller. The multiple master domain controller model would mean the domain controller in the branch office could handle changes locally, reconciling them with the other domain controllers when the WAN link comes back up.

The Cairo Internet

Two pillars of Microsoft's Internet strategy, the Dynamic Host Configuration Protocol (DHCP) and the Windows Internet Naming Service (WINS), will also see changes in future versions of NT. DHCP is a system that greatly simplifies installing IP addresses and TCP/IP configuration information on a new PC. DHCP allows you to create a server that hands out that configuration information. The problem is there's no simple way to provide fault tolerance for the server's function—it's not acceptable to have two DHCP servers on a network handing out IP addresses from the same pool of addresses. The Cairo development effort is working to change that: DHCP servers will be able to replicate among themselves so that if one goes down, the others know what that server was doing.

WINS, Microsoft's server-based "naming" system, supports NetBIOS-based programs (like Microsoft's own network redirector). And it provides translations between human-friendly names like "Bigserver" and the necessary IP addresses like 210.32.11.87. The problem with WINS is there already is an Internet standard called the Domain Naming System (DNS) that handles this chore. NT-based Internet servers must run both WINS and DNS, and they must somehow persuade the WINS server to share its knowledge with the DNS server. The Cairo approach does away with WINS altogether by wedding DNS and WINS into something called Dynamic DNS, which reportedly is working its way through the request-for-comment process now.



Open Directory Services Interface (ODSI) can support unified log-in and administration tools for a variety of network operating systems.

What's more, Services for NetWare (the new name for the combined File and Print Services for NetWare and the Directory Services Manager for NetWare) will include NDS support, something even the NT 4.0 version of Services for NetWare lacks. The Microsoft networking client will include client-side support for the Lightweight Directory Access Protocol (LDAP) as well. Microsoft's big push for creating unified log-in and administration tools sits atop its support of Open Directory Services Interface (ODSI). A user control tool like the User Manager would sit atop an ODSI layer; there would be ODSI drivers for NT, Banyan, NetWare, or other networks. This ODSI-dependent User Manager would handle user accounts for each of those network operating systems. Similarly, an ODSI-based log-on could perform simultaneous log-ins to different networks (see the figure "Multiple LANs, Single Log-in").

Desktop Enhancements

While the enterprise is important, Microsoft also has to battle for corporate desktops. First and foremost is Plug and Play support. This is essential if NT's going to be a simple-to-use OS, given today's PCs and the market's embracing of the PCI bus. PCI's great for its speed and flexibility, but it is nightmarish to try to set IRQs, DMAs, and memory addresses on PCI-based machines, which typically don't give you a way to control what resources your PCI add-in cards claim. Plug and Play gets rid of these problems.

So, why wasn't Plug and Play in Windows NT 4.0? According to NT product manager Andrew McGehee, Microsoft just didn't have time. While Plug and Play may be simpler on Intel platforms, putting it into Mips, PowerPC, or Alpha systems is tough and will require some development support from hardware vendors.

Microsoft is also working to make drivers for hardware easier to come by. The company will merge the driver models of Windows 95 and Windows NT. Because drivers for 95 and NT are now different, board vendors without large programming staffs often end up ignoring NT driver development or staying in "perpetual

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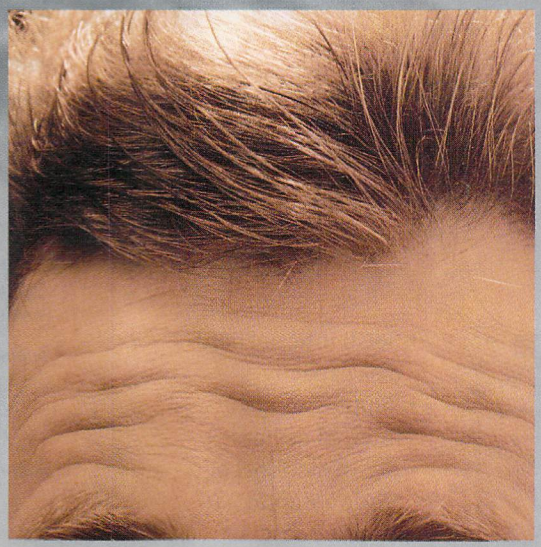

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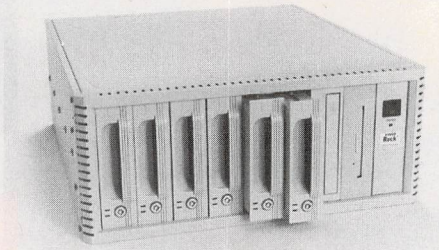

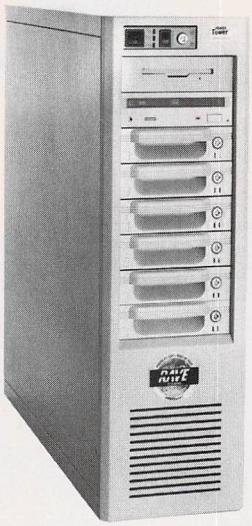

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Cairo Inside

An object-oriented, next-generation operating system called Cairo may never ship. However, future versions of Windows NT will enjoy the fruits of the Cairo development effort.

Cairo Technologies	What They Do
Microsoft Directory Services	Refine how NT handles domains; may use a tree structure à la Novell's NDS for creating one primary domain controller with a collection of subordinate domain controllers.
Dynamic Host Configuration Protocol (DHCP) servers will replicate among each other.	If one DHCP server goes down, another server will be able to take over.
Replace Windows Internet Naming Service (WINS)	Successor will wed WINS with Domain Naming System (DNS), the existing Internet standard for translating human-friendly server names and the necessary IP addresses.
Client-side support for the Lightweight Directory Access Protocol (LDAP)	Provides a low-overhead way for clients to access X.500 directory services.
Support for Open Directory Services Interface (ODSI)	Creates unified log-in and administration tools for enterprises with a variety of network operating systems.
Plug and Play support	Simplifies installation of peripherals that use the PCI bus.
Merge Windows 95/97 and Windows NT driver models	A boon for NT users who often have to struggle to find appropriate drivers for their OS platform.
Bookmark API	Restores the screen and PC state to where they were when you shut down the system.
Object File System	Lets you create a pseudodirectory that unifies local, network, and Internet files.
Power management	Resource efficiency for laptop users.

beta" stage. Microsoft will also try to simultaneously ship Windows 97 and a new version of NT next year. The two OSes will still be quite different, but they'll use identical drivers for sound cards, video boards, network cards, and the like. Hardware vendors will all want to support Win 97, so there'll be tons of drivers for Cairo: a bonanza for NT users.

UI Updates

The NT user interface, which went to the Windows 95 style in version 4.0, will continue to evolve. Expect to see the "Nashville" version of the Explorer, which integrates a Web browser and a disk browser. This may appear before the next major edition of NT, perhaps as part of a service pack.

An interesting rumor, and potentially the most important UI improvement, is the Bookmark API, a set of programming extensions for the UI. Here's how it would work: You shut down NT

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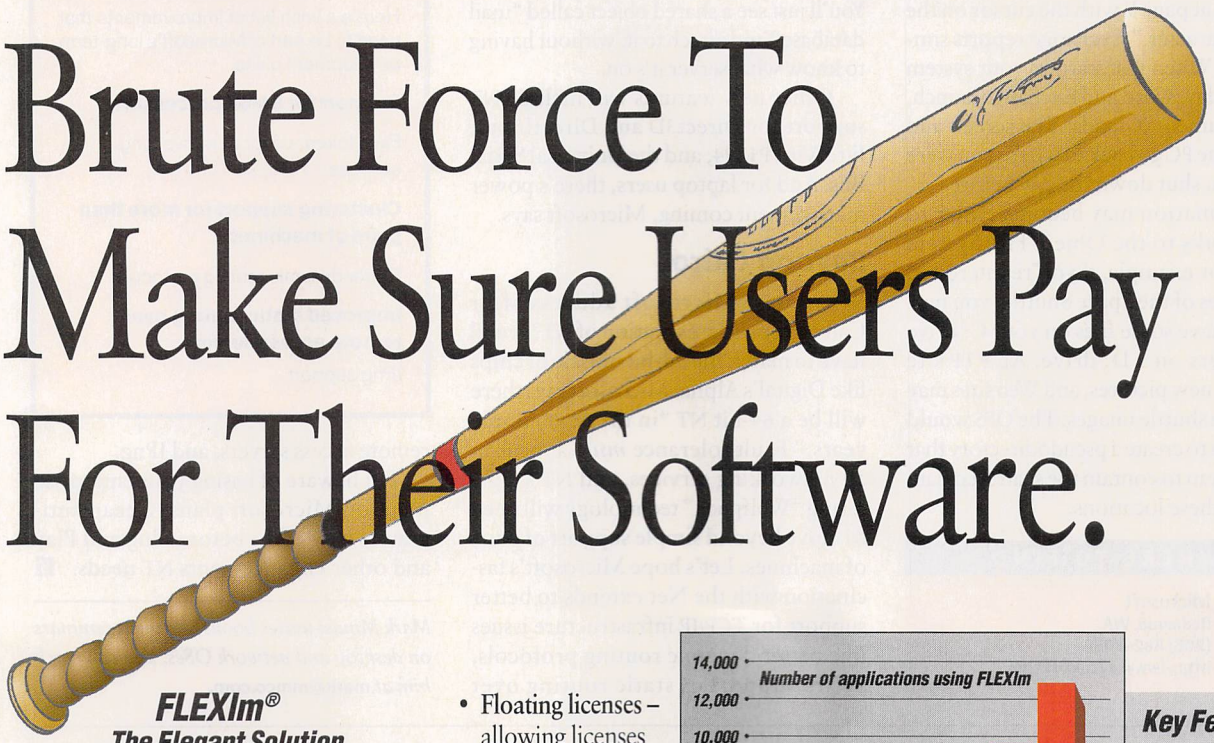

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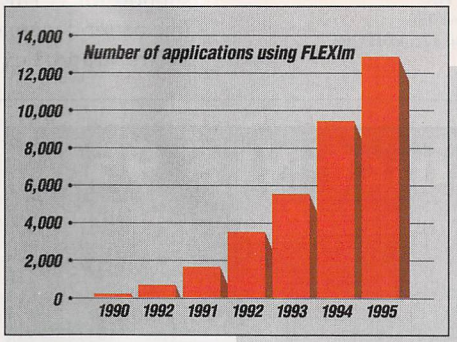

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while Word and Exchange are running. The system says to Word, "Tell me what you're doing." Word replies, "I'm on document X at page Y with the cursor on the 300th character." Exchange reports similar info. When you start up your system the next day, Word and Exchange launch, and document X loads. The screen and state of the PC go back to where you were when you shut down the day before.

Information may become easier to find thanks to the Object File System (OFS). For example, if you're interested in pictures of the Space Shuttle, you may already have some files on your C: drive and others on a D: drive. An FTP site may post new pictures, and Web sites may also store shuttle images. The OFS would allow you to create a pseudodirectory that would seem to contain the scattered data from all these locations.

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Servers will benefit because network objects, such as shared directories, won't be associated with a particular machine. You'll just see a shared object called "mail database" and attach to it, without having to know what server it's on.

Other new features will include NT support for Direct3D and DirectInput, FireWire/P1394, and the Universal Serial Bus. And for laptop users, there's power management coming, Microsoft says.

Beyond Cairo

What must Microsoft address after Cairo pushes the evolution of NT? It will have to match the 64-bit muscle of chips like Digital's Alpha. Microsoft says there will be a 64-bit NT "in the next couple years." Fault tolerance *must* appear in all networking services, and NT's clustering "Wolfpack" technology will need to move beyond simple support of pairs of machines. Let's hope Microsoft's fascination with the Net extends to better support for TCP/IP infrastructure issues like better dynamic routing protocols, better support of static routing over remote access servers, and IPng.

But beware of basing your enterprise plans on Microsoft plans. Cheap antigravity may come before Plug and Play and other enhancements NT needs. B

Beyond Cairo

Here's a wish list of improvements that need to be part of Microsoft's long-term development plans.

Support for 64-bit processors

Fault tolerance for all networking services

Clustering support for more than pairs of machines

Better dynamic routing protocols

Improved static routing over remote access servers

IPng support

Mark Minasi writes books and gives seminars on desktop and network OSes. You can reach him at **mark@mmco.com.**

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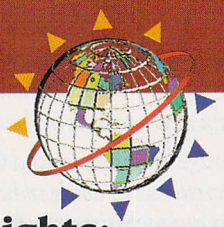

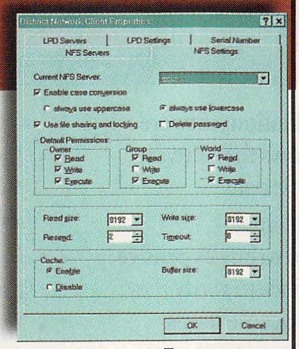

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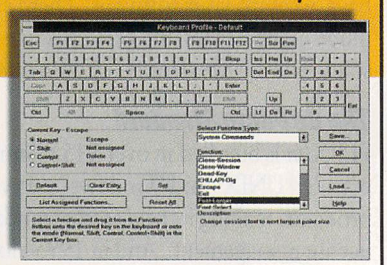

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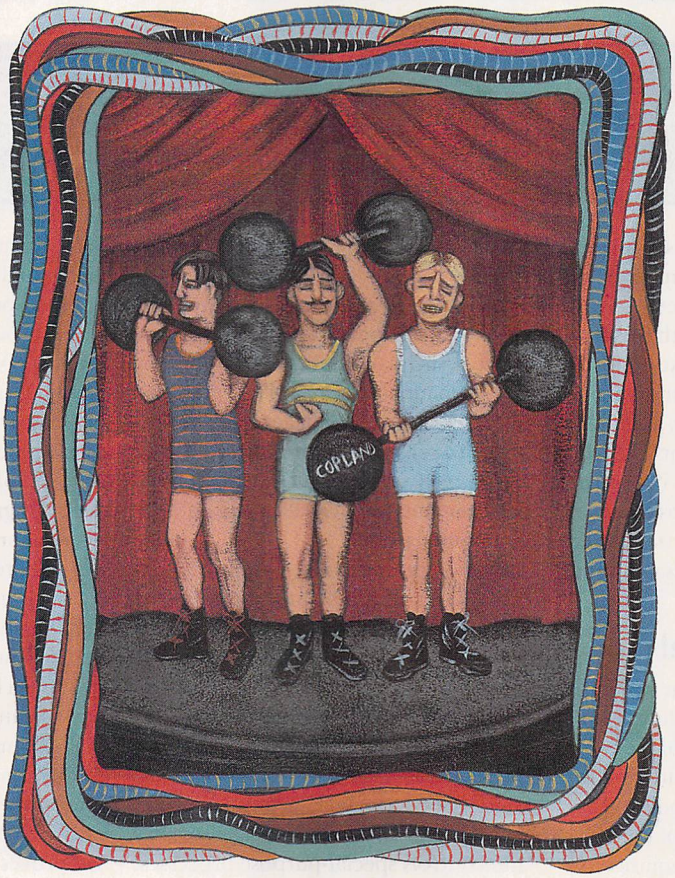
Copland, Revisited

A closer look at how the microkernel and hardware abstraction services will strengthen Apple's upcoming OS.

By Tom Thompson

For more than a year, Apple has provided tantalizing glimpses of Mac OS 8, its future OS, which is more commonly known by its code name of Copland. Unfortunately, much like Microsoft's Windows 95 launch, the release of Copland has been plagued with delays. The expected shipping date has slipped from this year until well into 1997. (For BYTE's previous coverage of Copland, see "Apple's New Operating System," June 1995, and "Copland: The Abstract Mac OS," July 1995.)

At the August MacWorld trade show in Boston, Apple CEO Gilbert Amelio announced a new blueprint for OS releases. Instead of a monolithic release of system software, as happened with System 7, Apple will release portions of Copland piecemeal over the next year.



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Component of the Month

This piecemeal plan has several benefits. First, the development breaks into manageable chunks for the system-software engineers. Any bugs that appear after a release are probably due to the newly introduced OS components, which simplifies code maintenance.

Second, some of the promised Copland technologies will get into the hands of users without their having to wait for Apple to roll out other portions. For example, an OS release slated for the middle of 1997 will provide many Copland user-interface (UI) elements, Java support, and a much-needed multithreaded Finder update, as shown in the figure "Copland Architecture" on page 152. (The improved object-based UI, with sophisticated messaging and scripting functions, was the easiest part of the Mac OS to win early release.)

Finally, the staggered-release schedule means that Apple can craft some of these components as 680x0 code. Thus, some of Copland's features—but not all—will be available to owners of 680x0-based Macs.

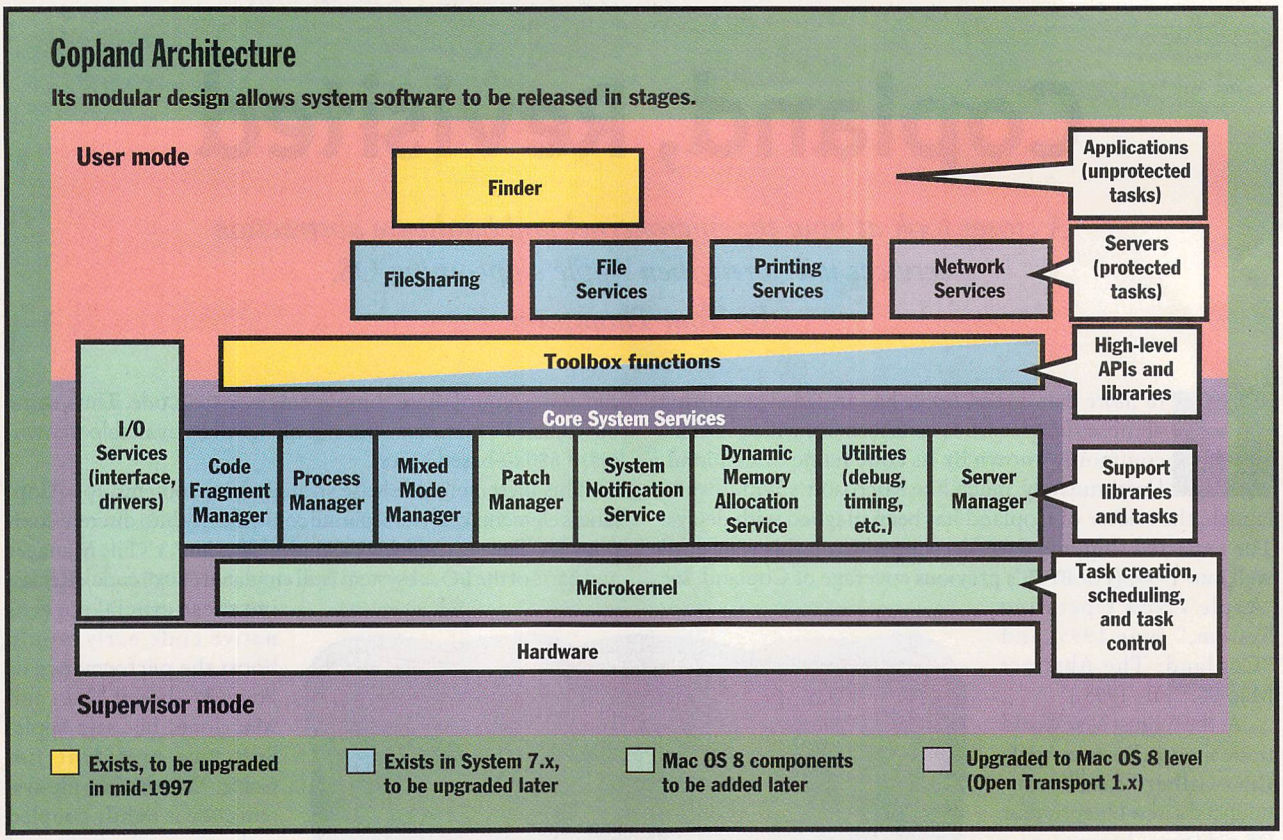
This incremental-release strategy has problems, too. Copland's elements can't all separate conveniently into discrete components. The most glaring examples: System 7.x's File Manager and parts of the I/O subsystem (still emulated 680x0 code). Releasing these crucial parts as native code early would boost the performance of PowerPC-based Macs and Mac clones, but, says AppleSoft vice president Jim Gable, "Much of the file-system code is tightly coupled to the preemptive features of the Copland microkernel: There's no way to separate them."

This plan also affects new PowerPC Platform systems next year: Such systems will need a special System 7.x to manage the hardware abstraction for each hardware design. Finally, Apple must work closely with third-party developers to spot and fix problems that these small releases might cause to applications software.

In Apple's favor, it has experience in extending the OS in stages. Separate releases of QuickDraw GX, QuickTime, QuickDraw 3D, and Open Transport added new capabilities to System 7.5 without revamping the OS code. Furthermore, Apple has been designing parts of the system software as OpenDoc components. This helps the plan because OpenDoc is a modular architecture, the very thing required to ship the OS as parts.

With all these sudden changes in direction, trying to figure out exactly what Copland is requires a scorecard. I'll review the Copland system architecture first, then focus on the latest information available on the microkernel and I/O abstraction.

continued



As of now, Copland consists of several parts: microkernel, core system services, and tasks. The microkernel performs all low-level services directly with the processor or hardware: task creation (programming the processor's memory management units [MMUs] to set up a separate memory space and access rights), scheduling (with the processor's interrupt mechanism and timers), and task control (which uses processor-specific atomic instructions for low-level messaging and semaphores).

Modular Microkernel

The microkernel has a modular structure that lets other software modules (e.g., ones that implement a virtual memory backing store or perform memory allocation) plug into it without modification. This differs from some Unix kernels, where adding a new service requires you to rebuild the kernel. The microkernel's design also supports symmetric multiprocessing (SMP) on systems that have multiple processors. A low-level multiprocessor API has been available for special-purpose applications under System 7.x, and it will work under Copland.

The core system services are clients of the microkernel. They implement a number of services that higher-level portions of the Mac OS rely on. These services consist of either DLLs or OpenDoc components. Some of them are familiar services, such as Code Fragment Manager (which loads and unloads PowerPC code libraries), Process Manager (which manages task creation), and Mixed Mode Manager (which handles transitions between native PowerPC code and the 680x0 emulator).

However, there are also many new services, such as Patch Manager (tracks software patches), System Notification Service (coordinates tasks), and Dynamic Memory Allocation Service (no more fixed memory partitions). Some core software utilities have obvious functions, such as Debug Services, Interrupt Services, Timing Services, and Exception Handler. Another utility, Server Manager, creates and controls special-purpose processes, as described below.

The last part of the OS architecture consists of tasks. A task is a basic unit of program execution in Copland. Processes consist of one or more tasks and use a common set of memory and system resources. Notable examples of processes are the Finder (the shell application that manages the Desktop screen and handles certain file operations), Printing Services, and FileSharing (which implements peer-to-peer network services).

A process's code might be located in RAM or on disk, and it has its own stack and register set. Even better, because of Dynamic Memory Allocation Service, such code need not occupy a contiguous section of memory. Instead, a process's code fragments can be located anywhere in memory, arranged as necessary to best fit a limited amount of RAM.

The familiar Mac application consists of a main task the Process Manager sets up, plus any threads this main task spawns via the Thread Manager. Mac applications can create one or more threads, which implement single paths of execution. For new Copland-aware applications, the microkernel can schedule the tasks to execute simultaneously, which improves load balancing on the system.

It's important to note that certain parts of Copland's services (e.g., the QuickDraw graphics engine) contain nonreentrant code. Therefore, any task using these services must be scheduled to execute cooperatively (i.e., one at a time). Typically, these are applications because they make heavy use of the UI.

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and launches each application's main task, it ensures that only one main task executes at a time. The microkernel, certain core system services, and any task that doesn't rely on graphics can operate under preemptive time scheduling. Processes that provide specific functions but don't need a UI—such as those that handle file-system and network services—are called servers.

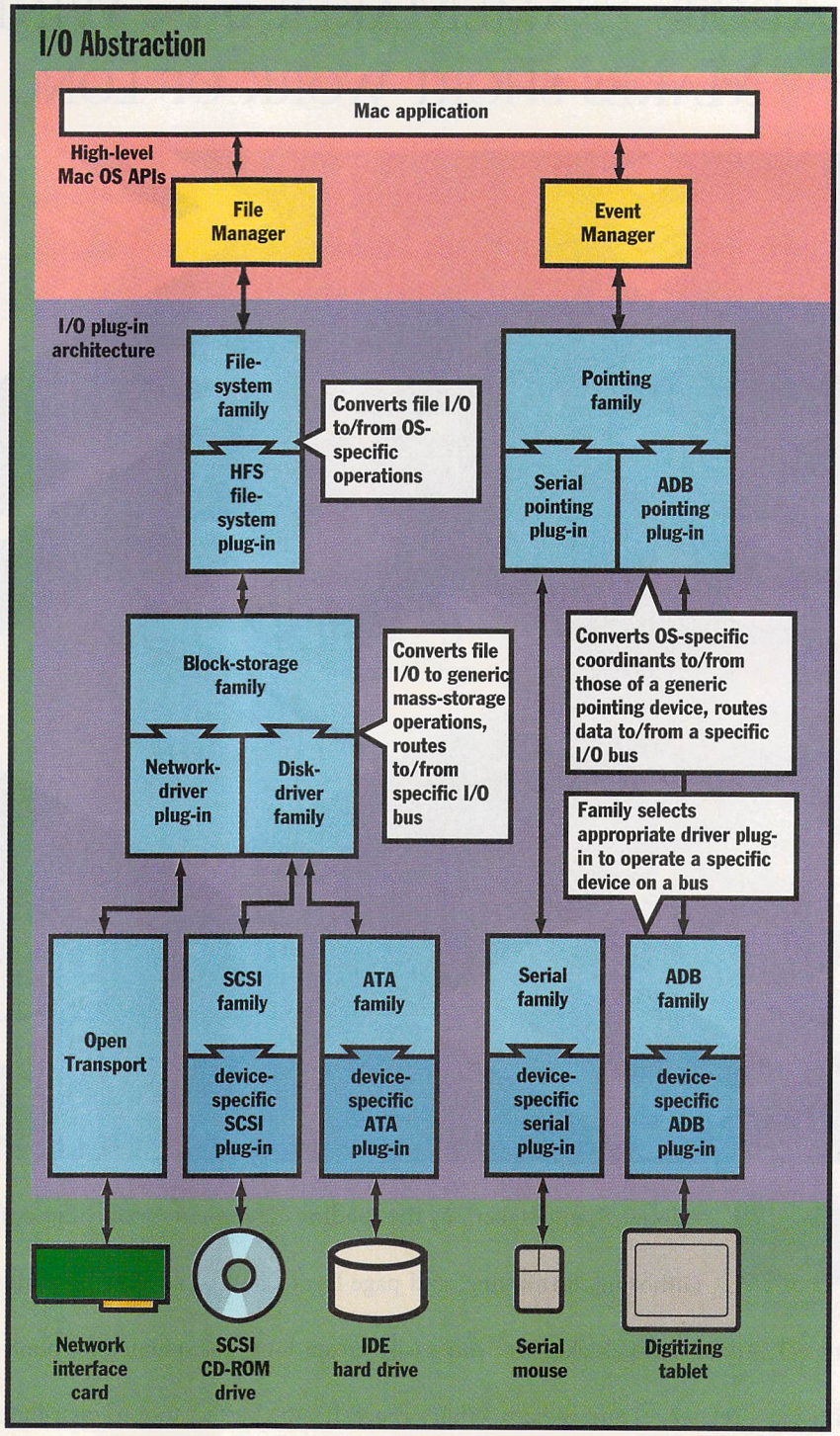
Copland's architecture thus makes Apple's release plan possible. The scheduled mid-1997 release, for instance, consists of a new process (the Finder), which System 7.5 treats as an application. This release will also provide an assortment of DLLs that implement the Copland UI elements and the Java virtual machine, which, again, System 7.x's Code Fragment Manager can handle.

Memory Matters

Copland's microkernel provides memory protection and address-space isolation, except for existing System 7.5 applications. The microkernel, drivers, and certain servers execute in the PowerPC processor's privileged mode. Most servers and Mac applications operate in the processor's user mode, and they can obtain memory or perform I/O only by making requests to the OS. This improves the overall system reliability because it ensures that only the low-level OS code can directly operate the hardware, such as fielding interrupts, modifying the access attributes to sections of memory, and controlling the processor's caches.

The microkernel provides another level of protection by placing servers and OS code in separate address spaces. Accessing a separate space requires building its address using values from page-table entries (PTEs) in the processor's MMU. Because only the microkernel can use and modify the PTEs, this effectively "walls off" these tasks from any errant memory accesses that a malfunctioning program generates. Copland maps the microkernel code into every address space, so that tasks can quickly use system functions without involving cycle-stealing memory-access mechanisms. This scheme still provides ample protection, because the OS code is marked read-only.

For compatibility's sake, existing Mac applications and certain sections of the UI Toolbox code must cohabit a single memory space: The System 7.x application model expects a contiguous address space



Copland achieves hardware independence through a layer of interface libraries and plug-in modules.

and unfettered access to some system globals. Still, Code Fragment Manager flags system code and native System 7.x applications as read-only, which offers some protection.

Process Manager also provides an extra level of safety. When it loads a System 7.x application, it places *guard pages* above and below the application's fixed memory partition. These guard pages are marked with excluded access permission. If an application attempts to overrun its boundaries, it generates an exception. It's possible that a misbehaving application

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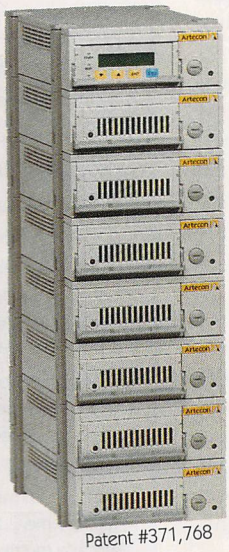

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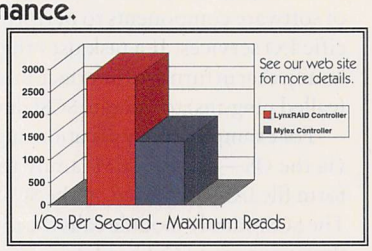

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might corrupt the data of another application, because everyone can modify any of the data inside this address space. However, given the address-space isolation and write-protection safeguards, Copland is significantly more reliable than its predecessor, which has no protection mechanisms.

The payback for this compromise is that users can carry their existing body of Mac software to Copland and expect it to work. AppleSoft's Gable admits: "If we could rewrite the OS without regard for the installed software base, the job would be done by now."

I/O Abstraction

One goal of Copland is greater independence from the hardware. Given the growing Mac-clone market, vendors need to differentiate their systems by distinctive hardware features. Also, the Mac OS needn't rely on erratic supplies of custom ASICs that have, on prior occasions, crimped sales.

All I/O operations—from hard drive to video to pointing devices—are grouped into families (see the figure "I/O Abstraction" on page 154). An I/O family is a set of software components to perform specific I/O services. If a task uses the SCSI family, that in turn uses interface modules (called plug-ins) to operate SCSI devices.

For example, one application might—via the OS—call the SCSI family to perform file I/O to a device on the SCSI bus. The SCSI-family module calls the plug-in that manages a SCSI hard drive. Next, a scanning application uses the SCSI family, but this time the SCSI-family module calls a plug-in to control a color scanner.

The I/O family provides an interface library that implements device functions and exports data structures for use by the applications or the OS. Although an I/O-family module provides one interface, it might have two sets of interface libraries: one for user-mode tasks and another for supervisor-mode tasks. The OS uses the supervisor-mode library, which can be performance-tuned because it doesn't require the user-mode I/O request mechanism, and no address-space conversions are involved.

The I/O-family architecture provides a remarkable degree of hardware abstraction, because an I/O family can call other families to route data to the appropriate device. Suppose an application calls File Manager to perform file I/O. File Manager first calls a file-system family. This family calls a file-system plug-in, which implements a particular OS file format, such as the Mac's HFS or Windows NT's NT File System (NTFS).

The file-system plug-in next calls the block-storage family, which orchestrates operations on large-capacity, random-access storage devices, such as hard drives, CD-ROMs, or digital videodiscs (DVDs). This family in turn calls a disk-driver plug-in or a network plug-in if the target device is on a network. If the disk-driver plug-in is called, it might call the SCSI family or the ATA family, depending on whether the target device is a SCSI or an IDE drive.

Adding a new device usually requires writing a driver that conforms to the Open Firmware specification (IEEE-1275-1994) and a suitable plug-in. Practically, the Mac OS probably won't use an NTFS plug-in, because you normally access such storage indirectly through a networked NT server. However, that you *could* write such a plug-in shows that the microkernel is completely uncoupled from its file system. So, if Apple uses a better file-system format later, it can add a plug-in without revamping the system software.

Furthermore, access to new device interfaces and peripherals is vastly simplified. Normally, you'd have to wait for a new OS release to gain use of a new device interface (e.g., IEEE-1394 Firewire). With Copland, you simply add a Firewire board and the corresponding plug-in modules that handle the Firewire interface. You then connect a peripheral.

Copland Highlights

Apple will release the OS in stages. Open Transport for networking is already out. A mid-1997 release will provide:

- Native PowerPC multithreaded Finder.
- Java virtual machine.
- Advanced user-interface elements.
- OS parts for 680x0-based Macs.
- The Patch Manager's limited support for 680x0-trap patching.
- Complete memory protection for the kernel, drivers, and server tasks. The kernel provides preemptive scheduling with priority levels.
- Limited memory protection and cooperative task scheduling for existing applications that require user interface (necessary for compatibility).
- Support for multiple processors. QuickTime 2.5, QuickDraw 3D, etc., already multiprocessor-ready.

The Once and Future OS

The major problem with Copland: When will it finally ship? While the incremental-release strategy is difficult, Apple has shown it can add new capabilities to System 7.x without overhauling the OS code. Open Transport's release is a prime example. This Copland networking technology was in users' hands last year, letting Apple fix bugs and tune performance before Copland itself ships. Still, releasing the microkernel as soon as is practical helps Apple, because it will significantly enhance the Mac platform.

First, Copland will boost the performance of PowerPC systems by eliminating almost all the emulated 680x0 code. The staged-release schedule also offers the possibility that some Copland services will appear on 680x0-based Macs. The new memory services will also make efficient use of available system RAM.

Another major benefit is that Copland will exploit the computing power of multiprocessor systems. The OS will distribute tasks, which server applications created by calling the microkernel services, among the processors for better load balancing. (For compatibility, applications that spawn threads via Thread Manager must be cooperatively scheduled.)

Technologies such as QuickDraw 3D and QuickTime 2.5 already use reentrant code and can automatically leverage the power of a multiprocessor system under Copland. The multiprocessor systems from Apple and DayStar Digital provide the hardware necessary for work in this area.

Finally, Copland's hardware abstraction will let clone vendors offer a variety of systems. One vendor might opt for low-cost parts, while another might provide advanced high-performance peripherals for vertical markets or custom jobs. This variety lets you pick the system that best fits your needs, and the competition will hold the line on system prices. B

Tom Thompson is a BYTE senior technical editor at large with a B.S.E.E. degree from the University of Memphis. You can contact him on the Internet or BIX at **tom_thompson @bix.com.**

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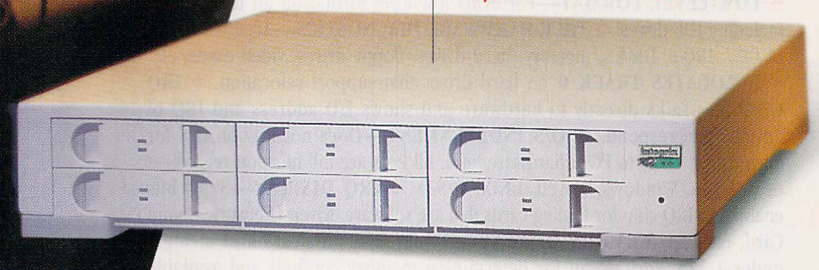

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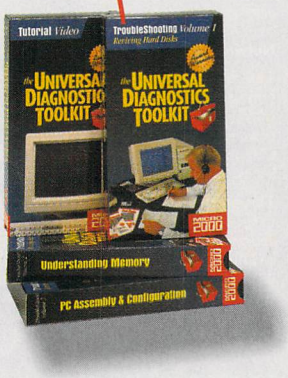



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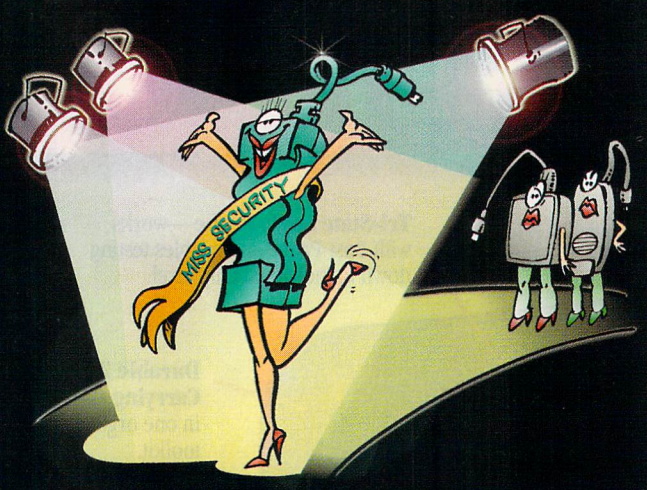

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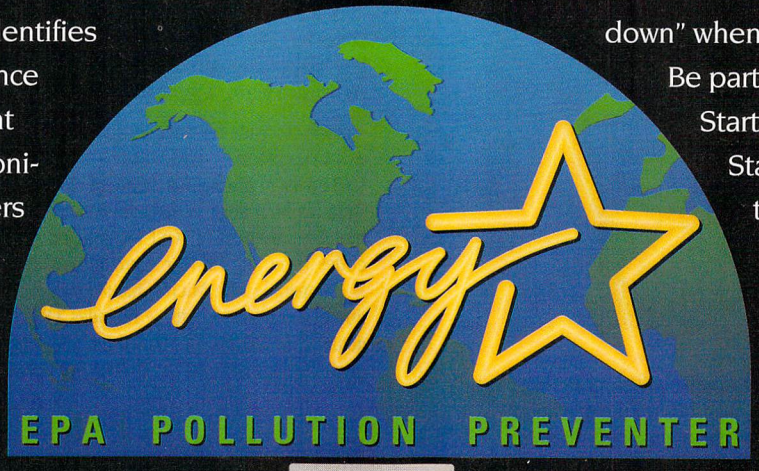

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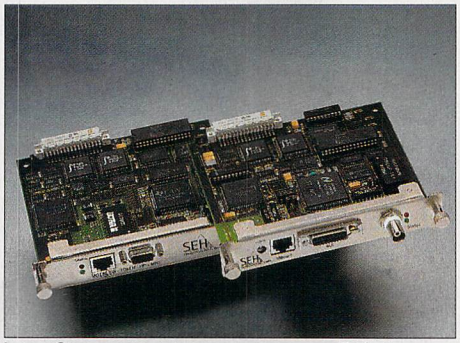

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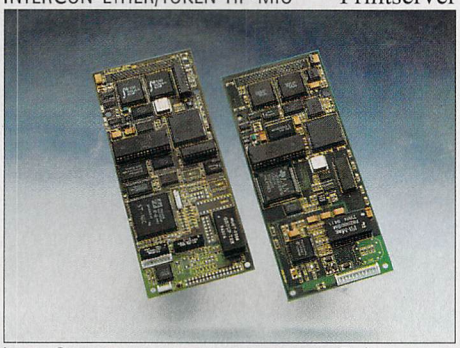

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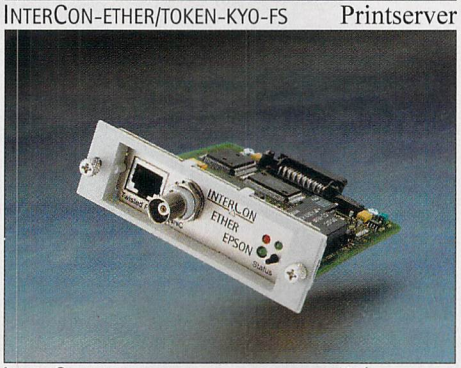

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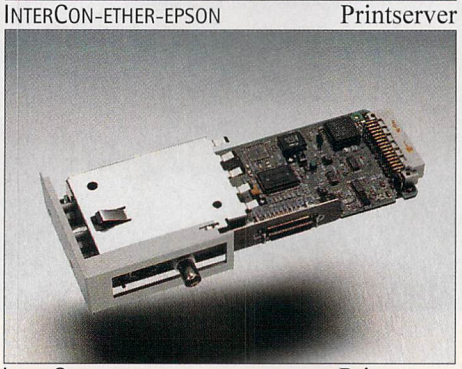

INTERCON-ETHER-MT Printserver

Multiprotocol support of

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- NOVELL (IPX)
- UNIX (TCP/IP)
- Apple Ether/TokenTalk
- Windows NT (TCP/IP)
- Windows '95 (TCP/IP)
- Windows for Workgroups

Hardware Support

- **Ethernet** 10Base2 (BNC), 10Base5 (AUI), 10BaseT (RJ-45)
- **Token Ring** STP (IBM Typ1/2), UTP (IBM Typ3)

Printer / Plotter connections

- Interfaces for MIO V.5.x printers/plotters
- Interfaces for KYOCERA FS printers
- Interface for EPSON printers (Type B port)
- Interface for M-Tally MT350/360/380
- 2x Serial RS232 (Box-Versions)
- 2x Centronics (Box), 1x Centronics (Pocket)

Features

- HTML configurable with Internet browsers like Microsoft Internet Explorer or Netscape Navigator
- Multiprotocol support of all mentioned operating systems
- Automatic recognition of the used network connector
- Software update and upgrade via download in Flash-EPROM
- Printer status request from host computer
- Automatic protocol recognition
- Configuration parameters can be edited by software
- Automatic recognition and reaction to changes in the network environment
- Supports 64 queues on 16 servers (Novell)
- Easy installation via PCONSOLE (Novell)

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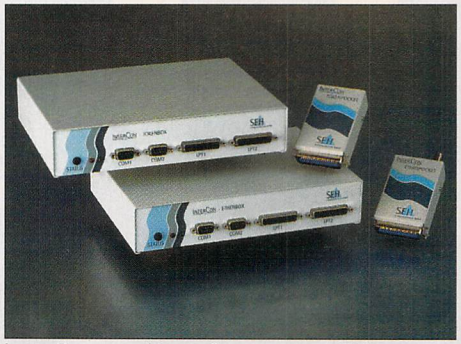

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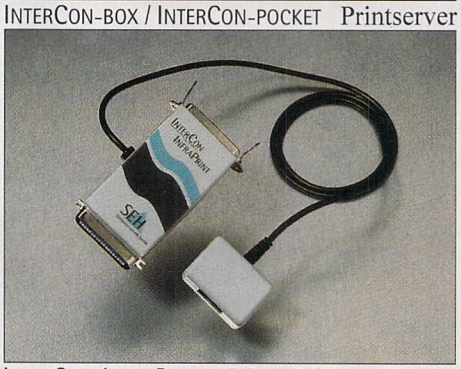
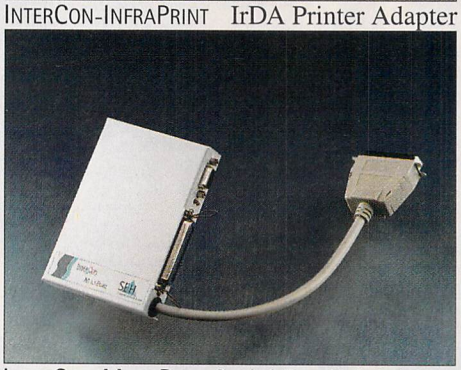


INTERCON-INFRAPRINT IrDA Printer Adapter



INTERCON-MULTIPORT Serial Parallel Adapter

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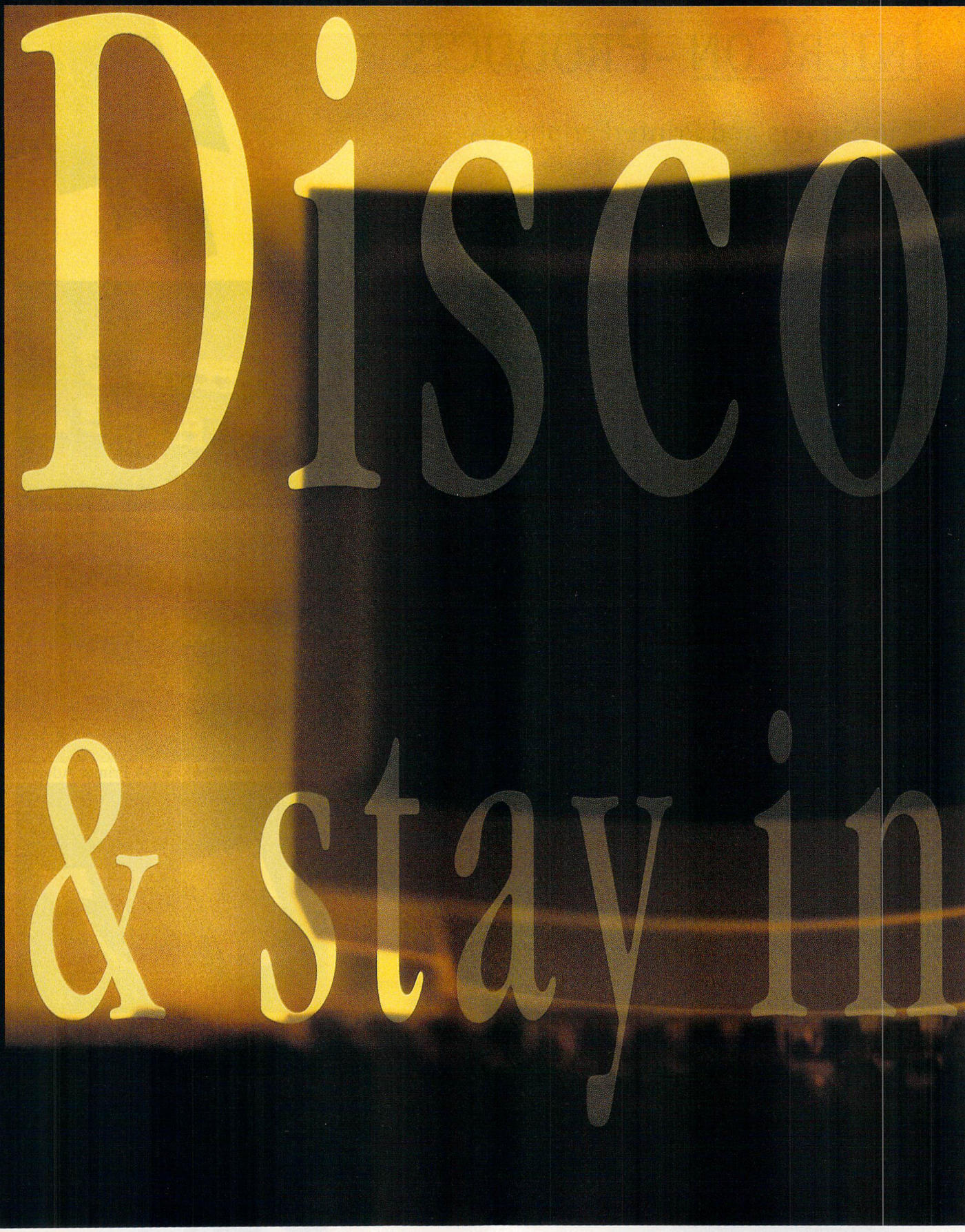

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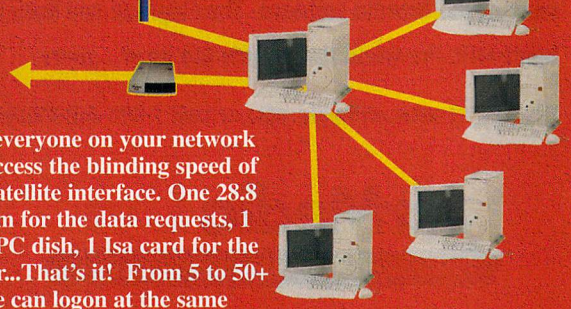

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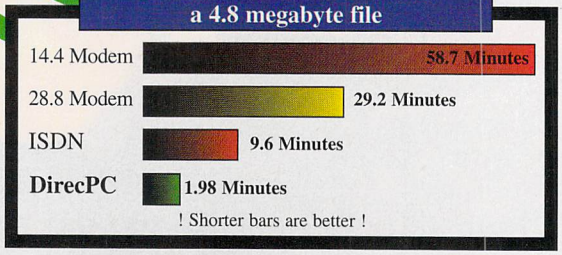

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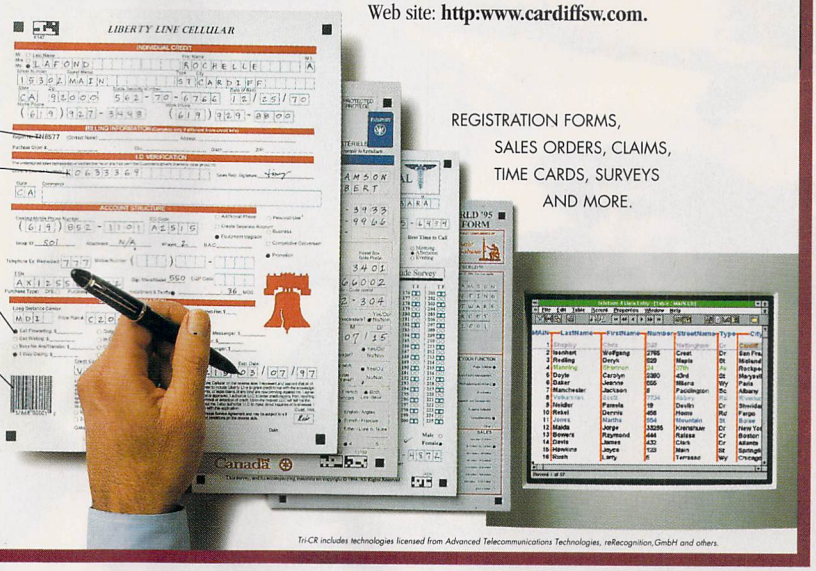

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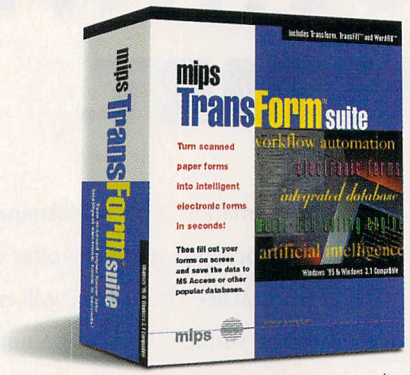

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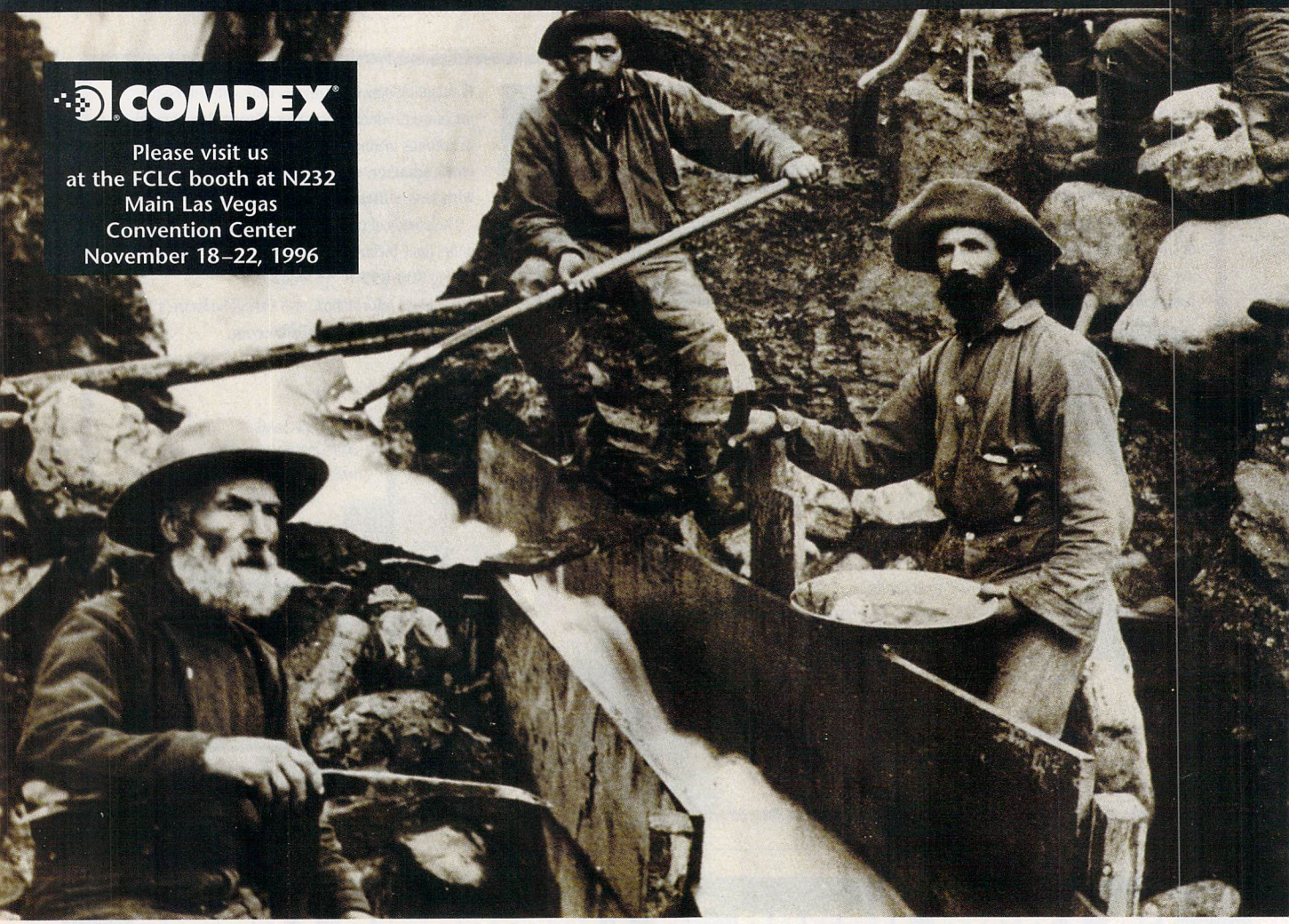

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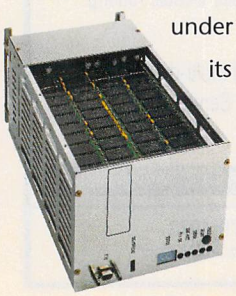

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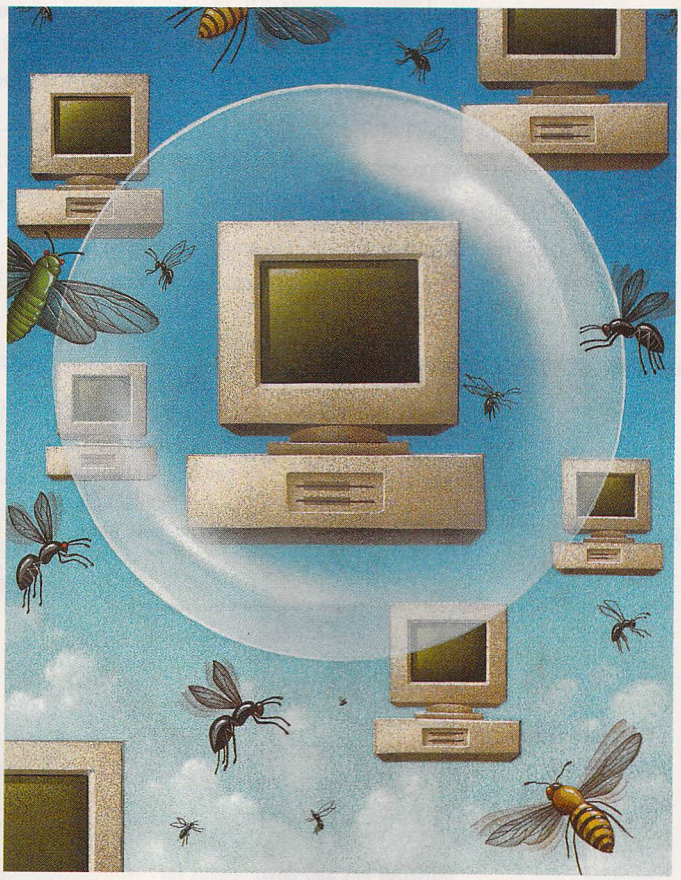
Keep Networks Safe from Viruses

Your network can spread viruses, but it can also help get rid of them. Here's how.

By Barry Nance

The movie *Independence Day* showcased some clever humans defeating aliens by planting a virus in the alien mother ship's computer. The ship—the biggest file server ever—suffered physical damage and crashed. Obviously, the aliens hadn't heard of antivirus software.

Couched in a large dose of poetic license, this entertaining science fiction tale brings computer viruses to our attention yet one more time. Here on earth, computer viruses are a real threat to your data and your networks—but aliens aren't the culprits. Rather, a few individuals feel the need to distribute deliberately buggy software.



Viruses have been a problem for years, of course, but their threat is heightened today because of our growing interconnectedness. We now regularly share files on servers, download files from the Internet, and accept attachments to e-mail messages. Any one of these everyday activities can load buggy software into our computers. And no form of computer file seems to be immune. Java applets, ActiveX components, and word processing and spreadsheet files all can—and do—contain viruses.

Fortunately, there is help. A comprehensive backup plan and centralized antivirus scanning can reduce viruses to minor annoyances.

Network Vulnerabilities

Encountering a virus is riskiest on a network because of the indiscriminate way that people share executable files and data files alike through the file server. Combine inadequate data backups and a virus that's allowed to go unchecked for a period of time, and the cost to your organization in lost data and wasted time can be enormous.

Most organizations encourage the use of antivirus tools, but virus awareness is often left for individual departments or remote offices to administer. This is a mistake. Centralized, enterprise-wide virus detection and reporting are important, and for an important reason: An organization must know quickly whether it's dealing with an isolated virus incident so it can keep the cost of antivirus measures commensurate with the level of threat. The most effective antivirus procedures are those that apply to an entire enterprise, use the organization's network to report any problems, distribute antivirus software updates over the network, and, via the use of log-in scripts, enforce the regular use of antivirus software.

But even before you can deal effectively with the problem by launching an enterprise-wide plan, you've first got to cut through all the vocabulary and euphemisms that have sprung up around viruses. Repeat after me: A computer virus is a buggy program that executes on the computers attached to your network. It's not a germ; viruses don't spread the way germs do. A virus simply copies itself through the file system on your computer or file server.

An antivirus utility does not "inoculate" your system or "disinfect" your PC. It scans for known virus programs, removing buggy programs and their effects using normal file- or disk-management operations. And what seems like an "outbreak" is not a contagious epidemic, but rather the result of a virus reading your computer's clock and taking some sort of action (erasing files, perhaps) on a certain date.

A computer virus is not self-aware. When an unsuspecting victim executes a program containing a virus, the virus program or program segment copies itself to another program file. The

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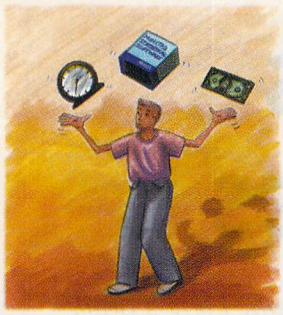

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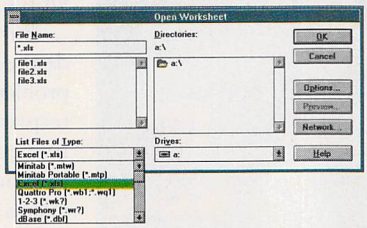

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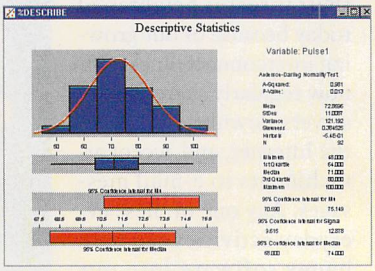

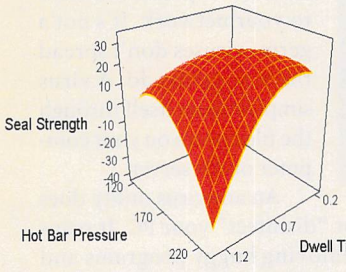

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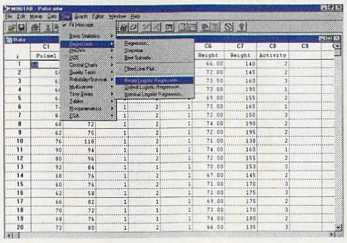

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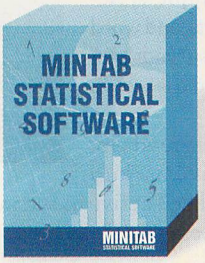

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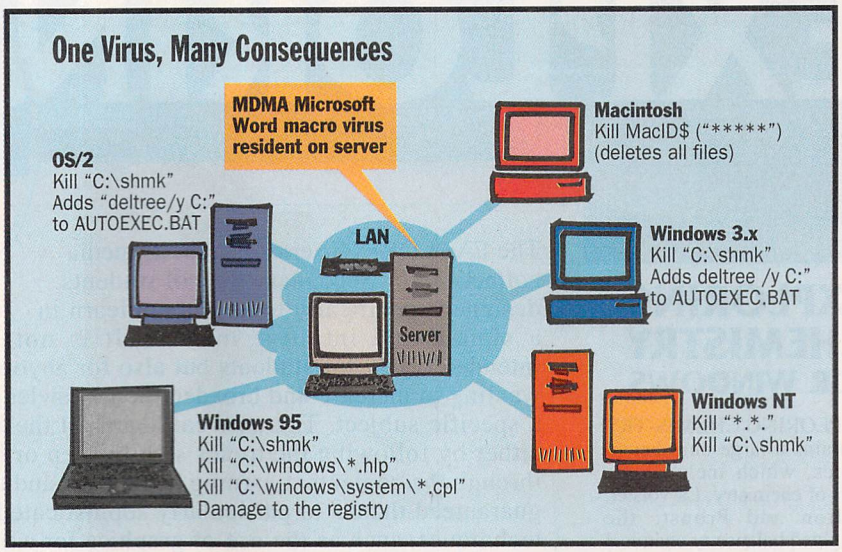
target program is typically an executable file, but it can also be the master boot record of the hard disk. The new copy of the virus in the infected program also inherits the ability to copy itself when run.

Some viruses do nothing else but make copies of themselves. Or they might simply display a message on a certain date. But others are not so benign—they strike by changing or deleting your files.

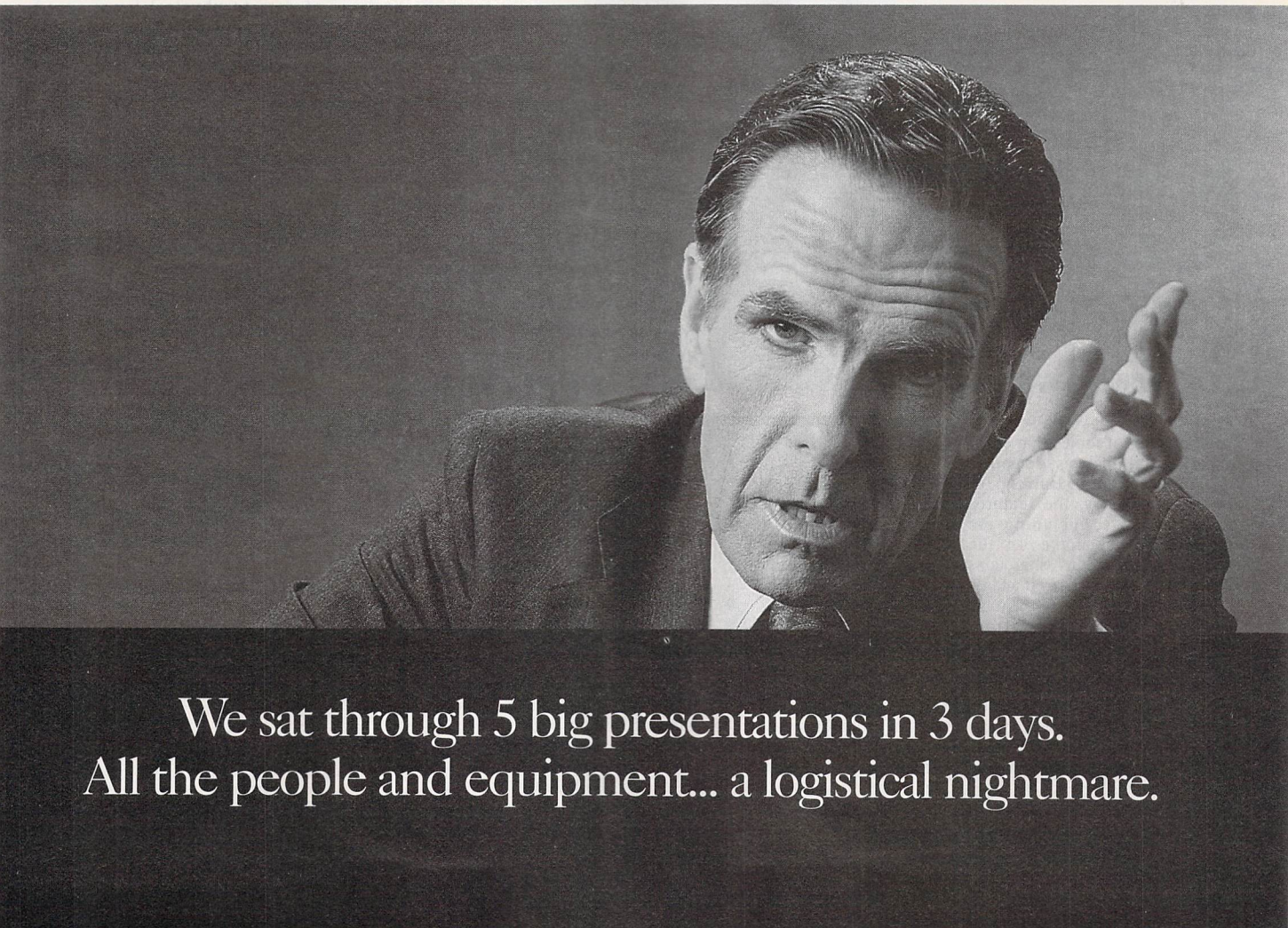
It's a popular misconception that viruses affect only DOS-based computers and that protected-mode systems, such as OS/2, NT, and Unix, are immune. But viruses can attack these OSes. Viruses designed to infect native OS/2 executables are more complicated to write than their DOS counterparts. However, dual-boot OS/2 systems that occasionally run DOS are subject to the thousands of DOS-based viruses. These buggy programs can alter boot records and DOS program files on OS/2-based machines.

In addition, we know of two OS/2 viruses: OS2vir1 and Jiskefet. OS2vir1 replaces all EXE files in the current directory with copies of itself. As a result, this virus is hard to overlook and thus does not spread very far. OS2vir1 displays messages identifying the files that it's replacing as it runs.



Once a macro virus, such as MDMA, infects a server, it can create cross-platform havoc throughout an organization.

Jiskefet replaces EXE files with a new file that contains the original EXE file. When the new, infected file is executed, it re-creates the original EXE file under



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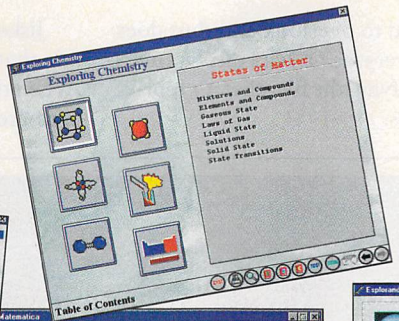

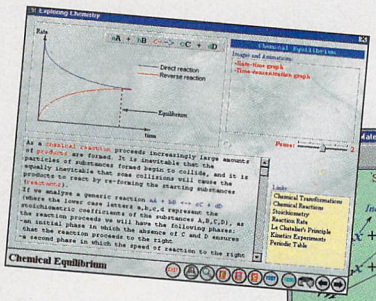

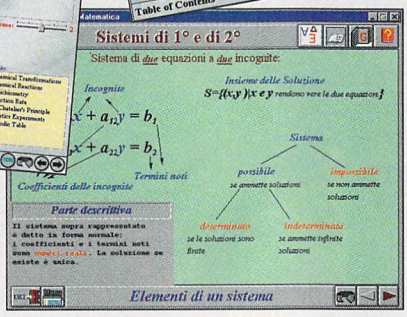

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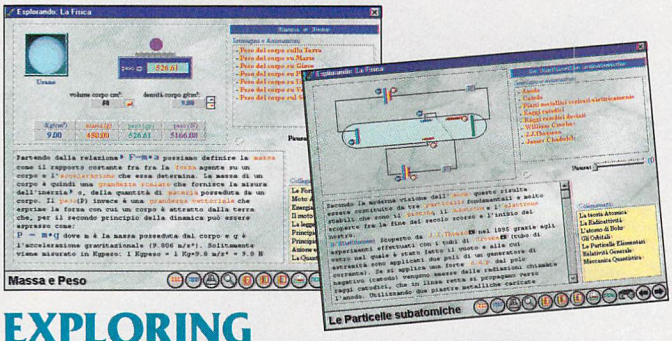

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another name and then executes the original file. Jiskefet is not particularly effective at finding new files to infect. Similar viruses in the DOS world have never spread exceptionally well, which suggests that Jiskefet will not pose any significant threat to OS/2 systems.

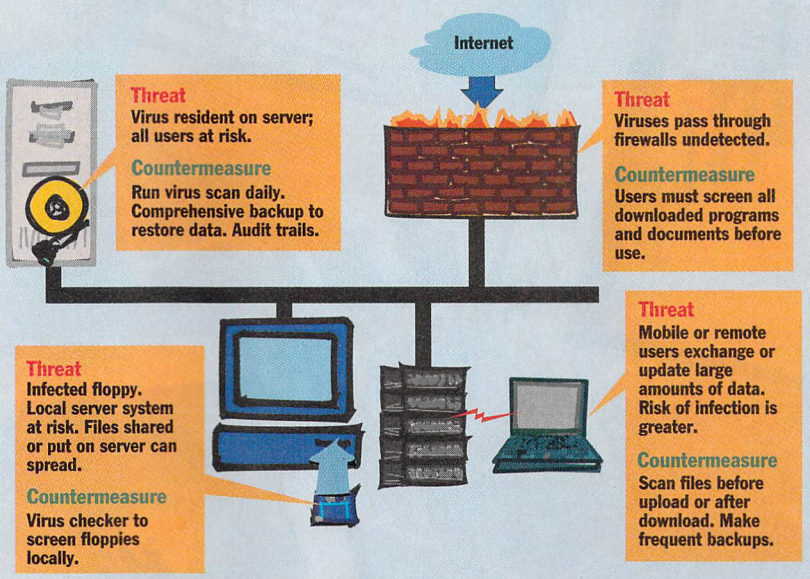
Both Windows 95 and NT are fertile ground for the spread of DOS viruses, as well as viruses specially targeted for Microsoft's two latest OSes. Every unique OS requires individually tailored antivirus-protection software.

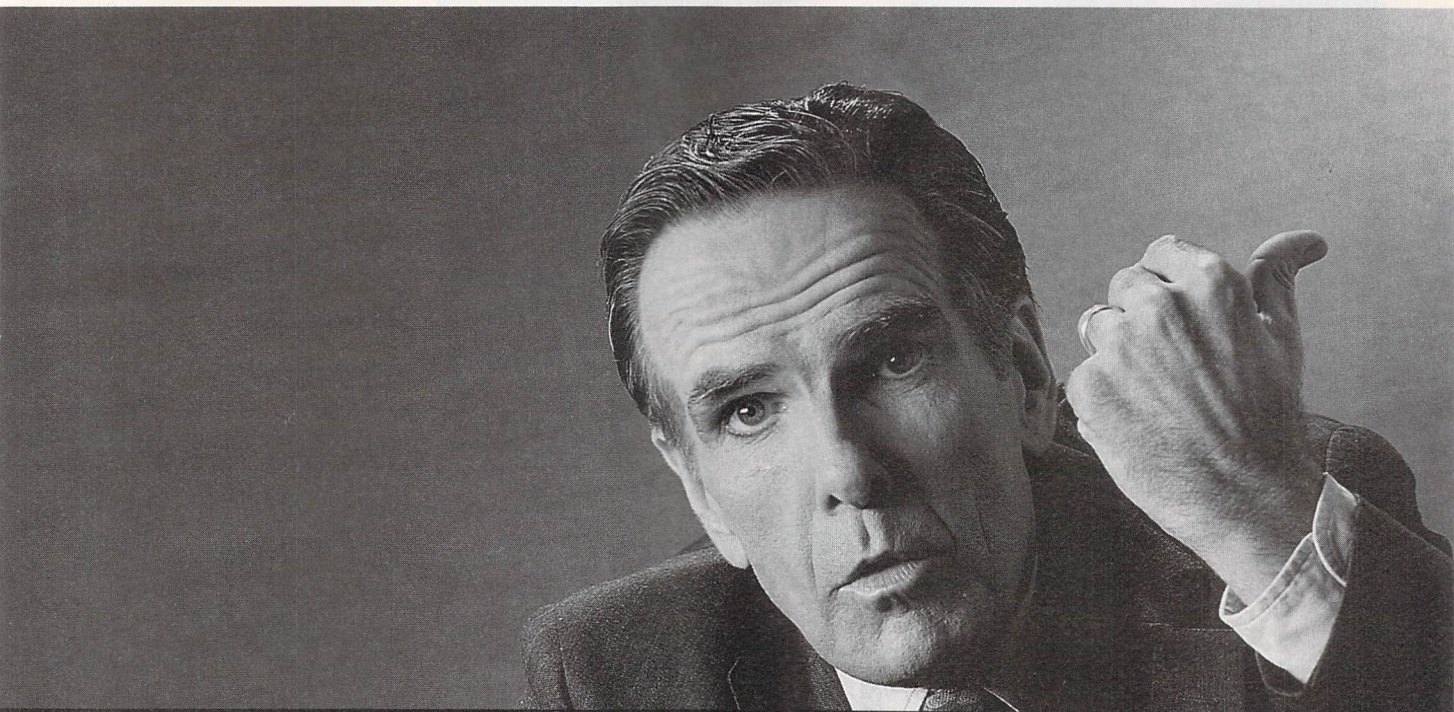
Viruses that infect files typically install themselves as memory-resident TSRs. Win 95 and NT support TSRs running in DOS sessions. These memory-resident viruses can infect new programs or floppies as they are used. Some file-infecting viruses fail in the NT (and OS/2) environment because they attempt to use undocumented and unsupported DOS features. A memory-resident virus can't spread directly between separate DOS sessions, but any program executed in a DOS session that's running a virus will likely become infected.

continued

Threats and Countermeasures

Viruses can infect an enterprise via server files, floppies, the Internet, or remote connections. Each entrance requires a different protection plan.





Then this guy walks in and only has two small bags, a laptop and what looks like *another* laptop.



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OS/2 programs use an executable file format that's different from that of ordinary DOS programs. A file-infecting virus that treats an OS/2 or NT executable file like a DOS file will likely render the target program inoperable. In some cases, starting an OS/2 program from within an infected DOS session will infect the program's *DOS stub* (the part of an OS/2 program that prints "This program cannot be run in DOS mode").

Word processor and spreadsheet macro viruses are nasty cross-platform problems. The destructive MDMA macro virus infects Microsoft Word documents and has the capability to delete files (see the figure "One Virus, Many Consequences" on page 169). Because this virus is application-based, it works across many platforms: OS/2, Windows, Win 95, NT, and the Macintosh. MDMA infects NORMAL.DOT as well as files that use the AutoClose macro.

MDMA activates itself on the first day of the month. The result of an MDMA attack is different on different OSes. A typical effect: After the damage is done, MDMA displays the following text in a message box: "You are infected with MDMA_DMV. Brought to you by MDMA (Many Delinquent Modern Anarchists)."

LAROUX is a another macro virus; it infects Microsoft Excel spreadsheets. LAROUX replicates itself but does not destroy data. It has been reported by only one company, at sites in Alaska and Africa.

The LAROUX virus infects the PERSONAL.XLS file, which is located by default in \MSOFFICE\EXCEL\XLSTART. PERSONAL.XLS is a default filename similar to NORMAL.DOT for Microsoft Word for Windows. If this file does not exist, the virus creates it.

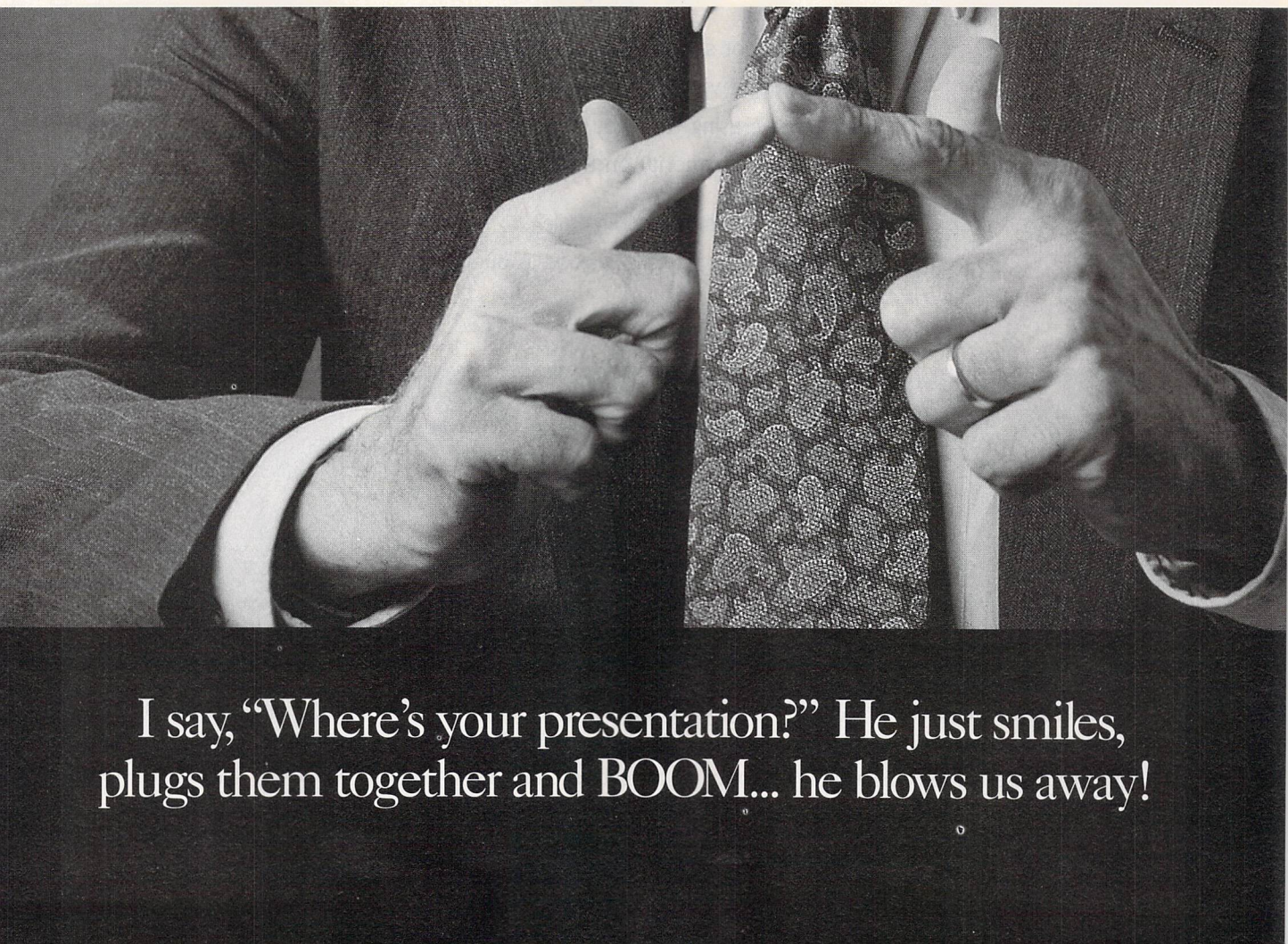
LAROUX uses two macros to replicate: `auto_open` and `check_files`. It infects Excel versions 5 and 7 on Windows 3.1, Win 95, NT, and OS/2. Because of the way it searches for PERSONAL.XLS (which is a DOS filename), the virus does not replicate on the Macintosh.

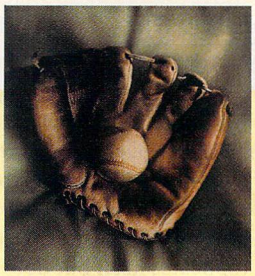
Viruses can spread on any system on which a program can create or modify another program. And they can spread between users anytime a program that one user runs can create or modify a program that another user can run.

Viruses aren't typically network-aware, but there are two notable exceptions. In November 1988, an Internet worm infected thousands of Unix-based machines that were connected to the Internet. And the CHRISTMA EXEC, a Rexx program for IBM's VM OS, produced millions of copies of itself on computers attached to European university networks, as well as IBM's own computers. In both cases, the network structure enabled the programs to spread rapidly in a matter of hours. Within a day or so, network administrators waded in, disabling the programs and cleaning up the mess.

Recommended Dosage

So how do you stop viruses from attacking your enterprise? Stopping your work every 10 minutes to run an antivirus utility is unproductive. But running such a utility just once every few years is a wasted effort. For most organizations, balancing safety and productivity means running antivirus software as frequently





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as once a day or as little as once a week. If your employees frequently use floppies or other uncontrolled media to transport data, running such a utility daily makes sense (see the figure "Threats and Countermeasures" on page 171).

Unfortunately, the majority of antivirus programs are outdated even before you install them; IBM estimates that up to five new viruses are written each day. Updates thus form an important part of any antivirus policy. A typical organization should plan to update its antivirus software at least every quarter.

To remind you of your potential exposure, many antivirus programs will announce their staleness when a certain date is reached. Distribute updates soon after the utility displays its out-of-date message, but let users know that it's OK to run a utility that claims it's a few months out of date. Be sure to distribute updates to all your sites on a timely basis.

You should require 100 percent compliance with your antivirus procedures. If you achieve 90 percent, then you will have a fairly effective antivirus program in place. If your network OS (NOS) is NetWare, consider running the antivirus utility in NetWare's system log-in script. Each computer will then scan for viruses every time a user logs on to the network. DOS, Windows 3.1, Win 95, the latest version of NT, and OS/2 all support NetWare log-in scripts.

No Immunity

Inevitably, every organization will encounter a virus problem. Networked computers, especially those running DOS or Windows, are most at risk. Networks allow viruses, the majority of which are DOS-based, to spread quickly.

However, no computing environment has a natural immunity to viruses. A good backup of your data, along with an aggressive enterprise-wide antivirus strategy, is inexpensive insurance. B

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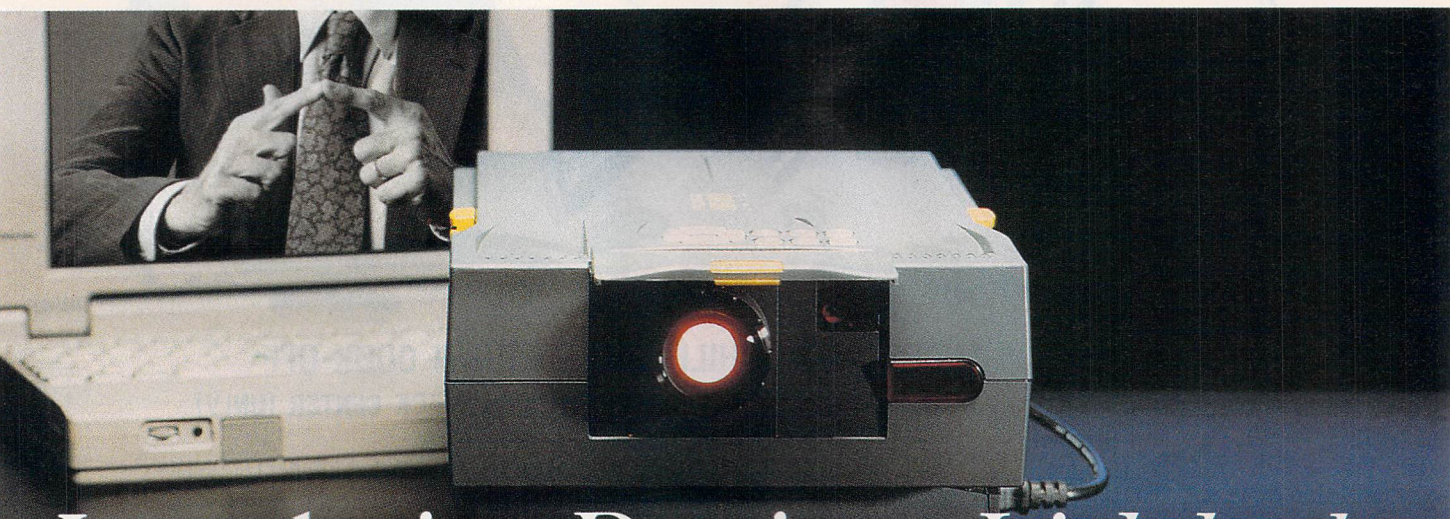
Barry Nance, a BYTE consulting editor, has been a programmer for 25 years. He is the author of Using OS/2 Warp *(Que, 1994),* Introduction to Networking *(Que, 1994), and* Client/Server LAN Programming *(Que, 1994). You can contact him at* **barryn@bix.com**.



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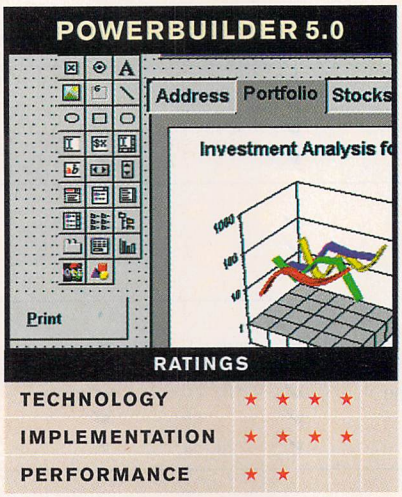
New versions of PowerBuilder and Centura offer improved performance and faster 32-bit applications. By Mark Hettler

Upgraded C/S Tools: How Much Better?

Earlier this year, we compared Borland International's Delphi Client/Server Suite, Microsoft's Visual Basic 4.0 Enterprise Edition, Powersoft's PowerBuilder Enterprise 4.0, and Gupta's SQLWindows 5.0 (see "New Leaders of the Client/Server Migration," June BYTE). Since then, Powersoft has released PowerBuilder 5.0, while Gupta has changed its name to Centura Software and issued Centura Team Developer 1.0. These products are so improved that we considered it important to look them over and update our previous ratings based on the new capabilities.



Both of these packages are development tools for creating custom, standalone client/server applications that let users enter, sort, filter, and report on your organization's data according to your business policies, procedures, and data operations. As in June, we tested these products for performance, usability, and versatility, using each one to develop an order-entry-system database of books, authors, and customer orders. With our test applications, users browse a database of 50,000 existing orders, enter new orders, and run simple and complex reports.

In our tests, PowerBuilder and Centura come out close together. PowerBuilder is a little easier to use and a little more powerful, but Centura builds better-performing applications more quickly. In the June review, Delphi showed itself to be several times faster than Visual Basic, which in turn was several times faster than its other competitors. Centura and PowerBuilder have narrowed the gap, but Visual Basic is still a solid second.

Using NSTL's overall ratings scheme, Centura's greatly improved performance and PowerBuilder's much better versatility move both products within striking distance of Visual Basic. In fact, on the 1-to-10 scale we use, a mere 0.2 delta separates the three runners-up. Though it's a good performer, Visual Basic is clearly on a tier below the other three products in terms of features. Delphi, though it has the steepest learning curve, is still the performance and features champ.

PowerBuilder Enterprise 5.0

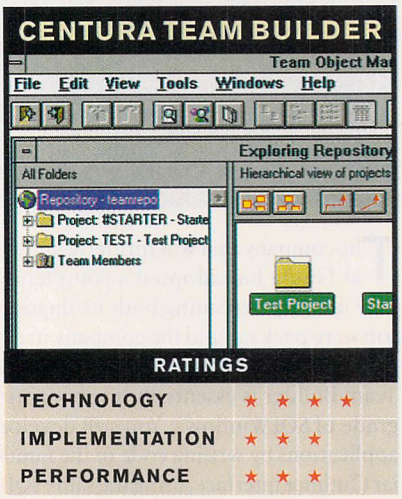
ADVANTAGES

+ Integrated version-control system that's remarkably easy to set up
+ Excellent support for three-tiered client/server applications that communicate with one another

DISADVANTAGES

– Repository platform requires Sybase's SQL Anywhere
– Improved performance still lags behind the competition

Most of the features and architecture that have made PowerBuilder popular are still in place in version 5.0. You still use interfaces called *painters* to create the various parts of applications, and DataWindows allow easy implementation of database access. InfoMaker, the report generator, looks and feels much the same as in PowerBuilder 4.0, but it's now available as a 32-bit application. Developers can create reusable components called *user objects*, which can be based on built-in components or other user objects and inherit their properties.



Beyond the familiar features, however, version 5.0 moves the product into the next generation of client/server development by introducing support for a three-tiered architecture. This capability is already available in Visual Basic and Delphi, but PowerBuilder is the best of the three products at providing step-by-step instructions for developing client and server applications that communicate with each other. Powersoft introduced nonvisual user objects in version 4.0. It extended the capability in version 5.0 to allow the nonvisual objects of one program to be executed by another.

Users familiar with PowerBuilder's Library Painter will go through virtually no additional learning curve with the new version-control system, ObjectCycle. Once you set up an ObjectCycle Server, you simply register the contents of a

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

library with ObjectCycle. From that point, you check components in and out as in earlier versions. Setting up the ObjectCycle Server is effortless. This is amazing given that the system must create a client/server database to store project data.

Centura Team Builder 1.0

ADVANTAGES

+ Much improved performance
+ Allows building of 32-bit applications
+ Data repository uses Oracle, Microsoft, Sybase, or Centura databases

DISADVANTAGES

– Features and versatility are little changed
– Application Server for three-tiered applications is not yet available
– Need to manually edit configuration files

The company that was formerly known as Gupta has adopted a completely new identity, renaming both its flagship software package and the company itself. Inside the new package, however, Centura Team Builder is essentially a version upgrade of SQLWindows. You still develop applications by writing code in the familiar Outliner interface, using the same SQLWindows Application Language (SAL) commands and functions that earlier versions used.

Developers can avoid the Outliner to a large degree by using QuickObjects, which generate forms and other objects automatically based on input supplied by the developer. This isn't a new feature, however, having been introduced in SQLWindows 5.0. The Team Object Manager is essentially Team Windows with a new user interface. Centura's much-touted Application Server, the tool for developing three-tiered applications, won't be available until later in the year.

The earlier version's annoying details are also still in place. To enable access to remote databases, you must still edit configuration files manually. Team Object Manager, like the earlier Team Windows, still leads the field in maximizing the power of the client/server environment for repository-based applications management, but it's still poorly integrated with the main development interface. Also, while QuickObjects produce applications and components more quickly than writing code in the Outliner, it is difficult and confusing to change properties after you generate them.

continued

PowerBuilder vs. Centura

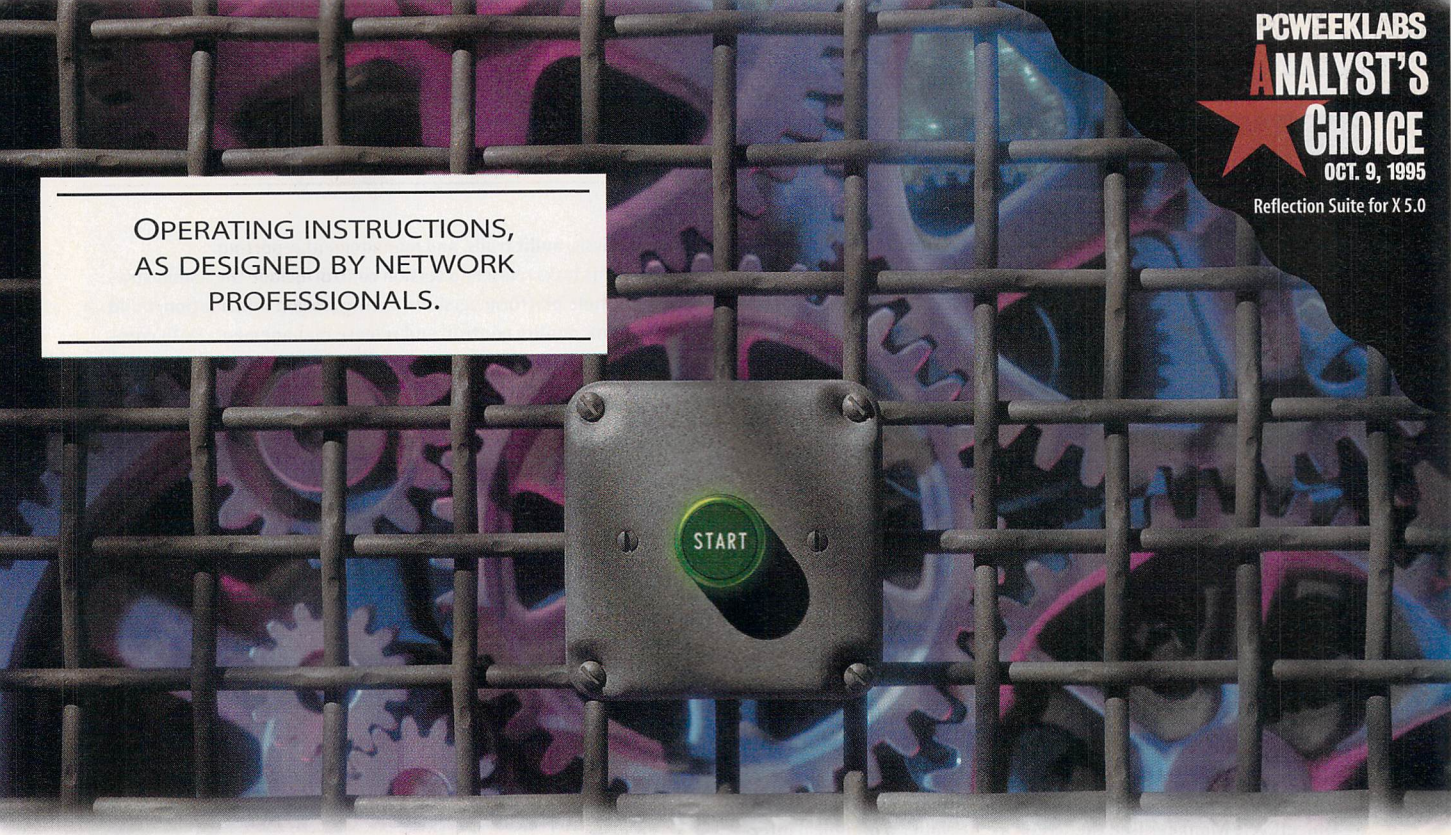
You can access the full data, including Delphi and Visual Basic 4.0, complete with individual weightings and scores in each category and line item, on The BYTE Site (http://www.byte.com/).

	PowerBuilder	Centura
FORM DESIGN		
Visual query builder	✔	✔
Query by form	✔	
Quick form from database table	✔	✔
Move fields after generating	✔	✔
Quick master-detail form	✔	✔
Multiple record display	✔	✔
APPLICATION-CONTROL FEATURES		
Dynamic menu building		✔
Multitab dialog boxes	✔	✔
Form can call another form	✔	✔
EVENT HANDLING		
Procedures triggered by events	✔	✔
Detect keystroke/mouse-click/time event	✔	✔
Process based on old or new value	✔	✔*
Cancel any event	✔	✔
ADVANCED FUNCTIONS		
Incorporate VBX and ActiveX controls	✔	✔
OLE 2.0 edit-in-place	✔	✔
Store OLE objects in database	✔	✔
SQL SUPPORT		
Generic SQL	✔	✔
Engine-specific native SQL	✔	✔
Transparent joins across engines		
REPORT GENERATOR		
Incorporate report into application	✔	✔
Quick report within application	✔	✔
Specify selection criteria, sort order at run time	✔	✔
Event procedures	✔	✔
Multiple records across page	✔	✔
APPLICATION REPOSITORY		
Store application components and reusable objects	✔	✔
Store multiple versions	✔	✔
Store form/report templates	✔	✔
WORKGROUP FEATURES		
Check out/check in	✔	✔
Built-in version control	✔	✔
Version control of external files	✔	✔
REMOTE AUTOMATION		
Produce remote programs	✔	
Call and exchange data with remote programs	✔	✔
Remote procedures can access database	✔	
Call in-process OLE server	✔	✔
Call out-of-process OLE server	✔	✔
Produce in-process OLE servers	✔	
OBJECT MANAGEMENT		
Copy objects between applications	✔	✔
Copy code snippets between applications	✔	✔
Reusable object classes	✔	✔
Subclasses with inheritance	✔	✔
Multiple inheritance		✔

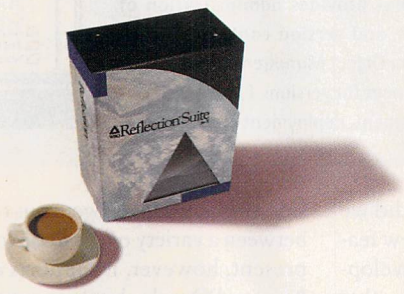
* By retrieving status codes from database. ✔ = yes

PCWEEKLABS
ANALYST'S CHOICE
OCT. 9, 1995
Reflection Suite for X 5.0

OPERATING INSTRUCTIONS, AS DESIGNED BY NETWORK PROFESSIONALS.



PC-TO-UNIX CONNECTIVITY, AS DESIGNED BY NETWORK PROFESSIONALS.



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TECH FOCUS | VERSION CONTROL

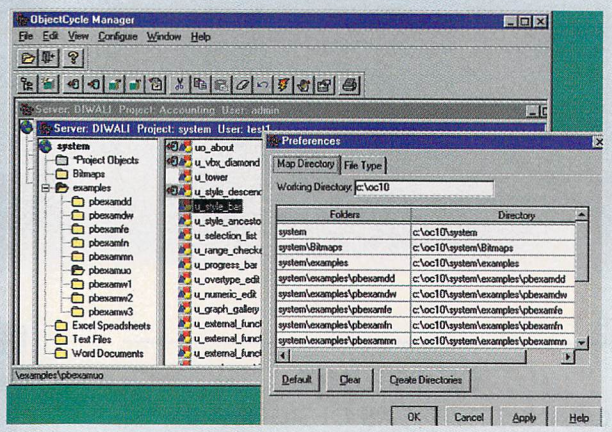
New Versions, New Controls

In any development environment that involves more than one person, the issue of version control (sometimes called change control) becomes critically important. As a software project evolves and grows, you add and change routines and modules, requiring recompilation, relinking, and resynching of some or all of the executable files.

Both PowerBuilder Enterprise and Centura Team Developer include facilities for version control, and both use client/server database technology to create and manage a shared, central object repository. Centura's Team Object Manager lets developers choose from Oracle, Microsoft, Sybase, or Centura databases for a repository platform, while PowerBuilder's ObjectCycle requires Sybase's SQL Anywhere.

Object-based systems must store many types of objects together with their properties and histories, including windows stored in libraries, menus, ActiveXes, bit maps, icons, DLLs, and even Word documents. Centura Team Developer features a graphical class browser that visually describes inheritance relationships among objects and classes, management reports that detail where an object is used in an application, ownership information on objects, the assignment of separate roles to team members who function as class engineers or object assemblers, version control of objects, and much more. PowerBuilder has ObjectCycle Manager (see the screen at the right), a graphical interface to the ObjectCycle Server that provides administration of PowerBuilder objects and projects, and version control for non-PowerBuilder objects. Centura's Team Object Manager supports project branching (e.g., running development for versions 1.1 and 2.0 concurrently), coding standards management, deployment management, impact analysis, audit trails, and management reporting.

Important tasks related to version control include the administration of multiple platform versions, configuration information, build management, quality control, and release management. Both companies claim that their version-control facilities are up to the complete task. For example, PowerBuilder has a build process that's quite different from that used in a C or C++ environment. Third-party tools have only a limited ability to handle such product-specific, cross-tool builds, and that can limit their usefulness and versatility. Centura has a build management feature with which you can specify how different files come together to constitute a deployable application.



With all these holdovers, why did we bother with Centura? Its major new feature is that it now supports the development of 32-bit applications, a change that significantly improves performance (see the section below). In addition, the package incorporates Centura Ranger for database replication. Many leading database vendors (e.g., Oracle, Sybase, and Microsoft) support replication. Centura's strategy is to approach the issue from the client side, providing heterogeneous replication between a variety of database formats. At present, however, it supports only SQLBase and Oracle databases; replicating Oracle databases requires buying an additional product from Centura.

PRODUCT INFORMATION

Centura Team Developer 1.0
$4995
(486 or better, 8 MB of RAM, 80 MB of disk space, Windows 95 or Windows NT)
Centura Software Corp.
Menlo Park, CA
(800) 444-8782
fax: (415) 321-5471
http://www.centurasoft.com
Circle 1004 on Inquiry Card.

PowerBuilder Enterprise 5.0
$2995
(486 or better, 12 MB of RAM [16 MB is recommended], 32 MB of disk space, Windows 3.1x, Windows 95, or Windows NT)
Powersoft Corp.
Concord, MA
(800) 395-3525
(508) 287-1500
fax: (508) 369-8639
http://www.powersoft.com
Circle 1005 on Inquiry Card.

Performance

NSTL ran PowerBuilder 5.0 and Centura Team Builder through the same benchmark suite used in the June review, with the identical configuration: We executed applications on a Dell Dimension XPS P90 with 24 MB of RAM running Windows NT 3.51, accessing a Microsoft SQL Server database. This allowed us to compare the results directly to those of the June review, where PowerBuilder and SQLWindows trailed Delphi and Visual Basic by significant margins.

Both products are markedly faster, but Centura is by far the more significantly improved. This is due largely to its 32-bit capability; the previous 16-bit version was at a disadvantage to the other three products in the earlier review. However, data retrieval is dramatically improved as well. The time to retrieve a 50,000-record data set is 80 percent shorter. Report generation takes a third less time for a complex report, more than half for a simple report. These improvements are enough to move Centura ahead of PowerBuilder, though it's still well behind Delphi and Visual Basic.

PowerBuilder has introduced a new machine code compiler. By Powersoft's own admission, however, the benefits for such operations as data retrieval and screen drawing—which are, after all, the central facets of an on-line database application—will be minimal at best.

Nonetheless, PowerBuilder 5.0 shows a consistent 20 percent to 30 percent increase over version 4.0 on most of the tests. Report execution times are reduced by more than a third, largely because the InfoMaker report generator is now a 32-bit application.

In the final analysis, PowerBuilder beats Centura (despite the latter's improvements), and neither beats Delphi for features and performance. B

Mark Hettler is a senior technical editor at NSTL. You can reach him at **markh@nstl.com.**

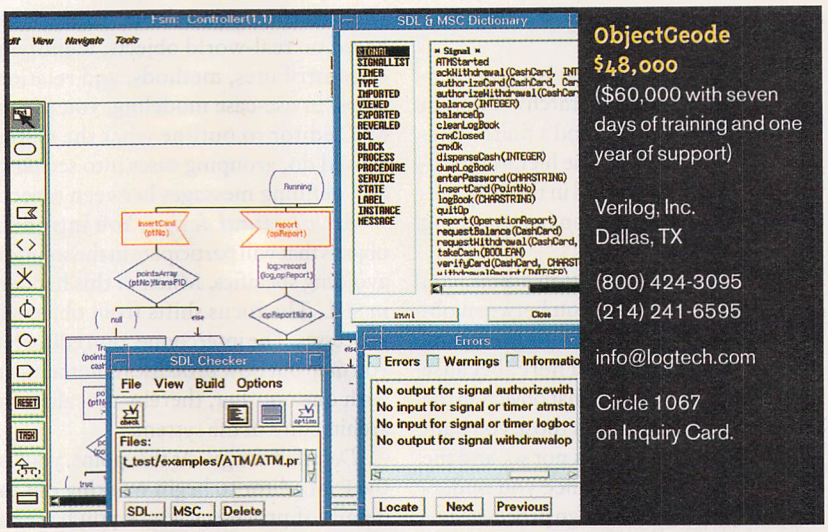
ObjectGeode, an OO CASE tool for real-time development, is a suite of tools based on accepted standards. ***By Rick Grehan***

Real-Time RAD

Object-oriented (OO) CASE tools have been notoriously deficient when applied to real-time applications. Now, Verilog's ObjectGeode, with its triad of interwoven editors, will take on this real-world challenge.

Opponents of generic OO methodologies complain that they are not effective in modeling the asynchronicity, concurrency, and distribution of real-time systems, and that typical OO CASE tools provide no formal connection between abstract models and programs.

Consequently, ObjectGeode has some rapids to cross. It does so by lashing together a collection of tools based on well-accepted standards.



ObjectGeode's SDL editor allows you to design finite state machines and will generate source code.

Editors, Editors

I tested ObjectGeode on a SparcClassic running Solaris 2.5. It is also available for SunSparc, Hewlett-Packard Series 9000/7xx-8xx, IBM RS/6000 and PowerPC, and DEC Alpha/OSF1.

At ObjectGeode's core are three editors: object modeling technique (OMT), specification and description language (SDL), and message sequence chart (MSC). The OMT editor is sometimes referred to as the class diagram editor. Each editor's notations are based on widely accepted standards: SDL and MSC are standard notations in the telecommunications industry. OMT is the well-known technique developed by James Rumbaugh and others.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★
PERFORMANCE	★ ★ ★ ★

The OMT Editor

This editor allows you to build class and instance diagrams using OMT notation. From within the OMT editor, you make sets of modules, each module being a particular view of the system. Typically, you create an overall view of the system to identify the principal actors (i.e., objects) and then construct other modules that describe those actors in increasing detail.

Diagrams you construct with the OMT editor are necessarily visual and fall into two categories: class diagrams and instance diagrams. Class diagrams show the internal structure (i.e., data items and methods) of—and relationships between—the system's objects. For example, if you are designing a system to control a bank's ATMs, you would use a class diagram to define what's inside the system's notion of a bank object and how that object relates to a customer object. Instance diagrams illustrate how a particular set of instances derived from the system's classes might be logically connected to one another.

ObjectGeode can generate C++ code from the modules you create in the OMT editor. This code is really C++-style-header files containing class declarations filled with variable definitions and method prototypes. You can't use the OMT editor to specify the details of a given class's methods.

The MSC Editor

You turn to the MSC editor to diagram each use case, which is like the script of a play. You can read use-case diagrams to determine the actions that unfold as the system operates.

Other methodologies call use cases *usage scenarios* or *event traces*. But ObjectGeode scenarios refer to high-level event descriptions that are separate from the low-level details of the event. Thus, a scenario might be shown as a block labeled *SCSI read* in an MSC diagram, while the MSC would be the chart detailing the steps of the read operation.

It's important to note that the charts you build with the MSC editor show discrete activities, so you cannot use it to

model the entire behavior of the system. Additionally, MSCs show the *expected* behavior of the system—what the system is supposed to do, not how it does it.

Use cases are helpful in determining *derived requirements* of objects. In other words, working out the use case for a particular event may reveal an attribute that was omitted from an object participating in that event. It's a two-step process. First, you identify the functions the system must perform; next, you work through the details of the lowest-level activities.

The SDL Editor

ObjectGeode's SDL editor is a combination of three editors: a hierarchy editor, an interconnection editor, and a finite-state-machine (FSM) editor. The hierarchy editor is similar to one found in the MSC editor and is likewise a means of grouping similar activities.

With the interconnection editor, you can model communication between objects in the system like in a wiring diagram. It's easy to get confused here, because you're likely to conclude that objects in the SDL editor are the same as those you built in the OMT editor. This is not so, and the distinction is revealed once you understand ObjectGeode's design process. Simply put, you use the OMT editor in the problem domain and the SDL editor in the solution domain. Thus, SDL editor objects are often *artifacts*—objects that are constructed to solve the problem outlined in the OMT editor.

You program the machinations of the processes themselves visually, using the FSM editor. From a distance, you could mistake the FSM diagrams for flowcharts, which in a sense they are. FSM diagrams reveal how SDL processes work.

The Process Process

Working through a project with ObjectGeode does not mean moving among editors sequentially. Rather, you visit the same editor multiple times. The overall process goes something like this:

Requirement-analysis phase. Using the OMT editor, you work out major classes based on real-world objects, identifying class attributes, methods, and relationships. In use-case modeling, you use the MSC editor to outline what the system should do, grouping cases into scenarios and defining messages between objects.

Architectural design. You introduce objects that will participate in the solution, avoiding specifics. Much of this happens in SDL. The focus shifts from objects to processes. The interconnection editor lets you map out how processes communicate with one another, thereby revealing the architecture of the system.

Detailed design. At this point, you use the FSM editor to begin working out the details of processes. Once you have the state machine of a process specified, you generate SDL code and run it in simulation on an SDL engine. This lets you catch such problems as deadlocks and unexpected signals. You can also backfill missing details in the OMT class diagrams that preceding phases have revealed.

Test design. You refine the MSCs produced in the requirement-analysis phase to construct detailed message sequences that exercise all possible scenarios. When running an SDL simulation, ObjectGeode will generate MSCs and match them with those specified. You can also create failure MSCs—message sequences that, if executed, indicate a failure of the system.

Targeting and testing. These phases convert the working SDL models to executable code. The conversion is straightforward, but it requires an SDL virtual machine on the target system. Virtual machines exist for a number of popular real-time OSes (RTOSes), including pSOS, VxWorks, and Vertex.

Good, Bad, and Ugly

ObjectGeode has competitors, most notably the real-time object-oriented modeling (ROOM) tool suite called ObjecTime (see "Systems Design in ObjecTime," December 1995 BYTE). Additionally, real-time projects have used the Shlaer-Mellor object-oriented-analysis (OOA) method, which is supported by development tools from Project Technology.

ObjectGeode's indisputable advantage is its use of standard notational languages and methodologies. This saves you from having to learn concepts that aren't applicable elsewhere.

Its use of SDL as the procedural notation provides a measure of portability. Not only can you target a variety of RTOSes, you can also deploy a single SDL model on different topologies (e.g., the same model can produce code for both single-processor and multiprocessor systems).

On the downside, ObjectGeode suffers from the difficulties in applying general-purpose OO-modeling methodologies to real-time systems, such as requiring translation "by hand" of items specified in the OMT and MSC notations into final code. ObjectGeode therefore can't provide a complete model-to-code solution. Contrast this with ObjecTime's ROOM, which uses an executable notation.

The pricing is steep as well. The software suite we tested costs $48,000 ($60,000 adds seven days of training and maintenance support for one year). The different components of ObjectGeode are available separately, and there are discounts for quantity purchases. B

Rick Grehan is a senior technical editor for BYTE reviews. You can reach him at **rick_g@bix.com**.

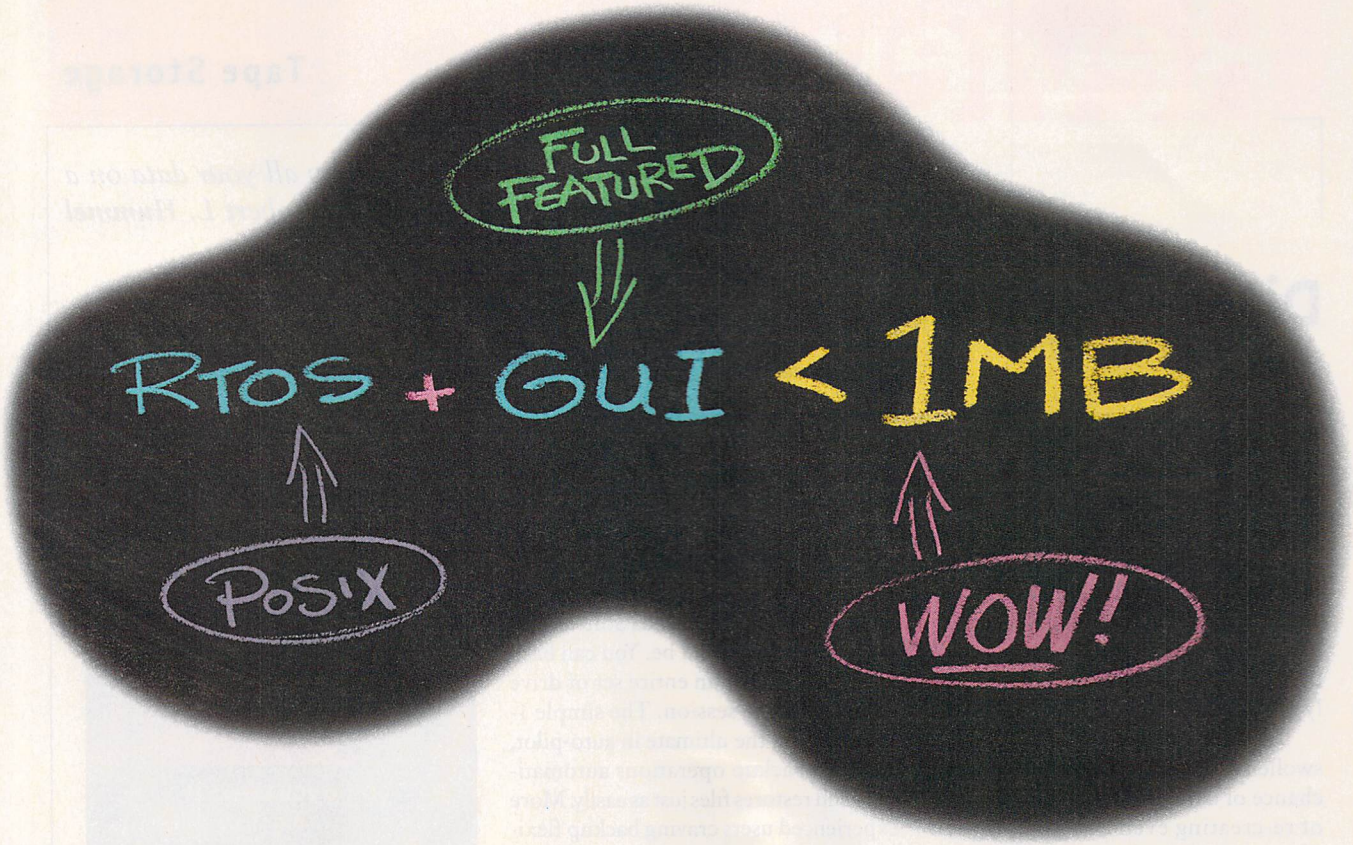
TECH FOCUS: SYSTEM TYPES

What's an Asynchronous System?

ObjectGeode addresses one class of real-time systems: asynchronous systems—those that service nonperiodic events. An example of an asynchronous system is a telecommunications switching system; there's no way for the system to predict when you'll pick up the phone. It's no surprise, then, to find that many of ObjectGeode's customers are in the telecommunications industry.

The other class of real-time systems—synchronous—deals with events or signals that arrive within a known period. (The dichotomy is not rigid. Plenty of real-time systems have both synchronous and asynchronous characteristics.) Synchronous systems also tend to be "hard real time" in nature. That is, not only do the events occur with known regularity, the system must service them in a specified amount of time. An example of a synchronous real-time system is a stepper-motor controller. Signal pulses must be transmitted to the motor at a certain frequency, or the motor simply won't step.

Designing a synchronous real-time system amounts to determining how many events will arrive at the system and at what frequency, and deploying tasks (or threads) to handle each event. The developer then explores worst-case scenarios to determine, for example, whether there would be enough horsepower to service events if they all arrived simultaneously.



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Circle 158 on Inquiry Card.

Iomega's Ditto 2GB tape drive can back up all your data on a single cartridge—albeit slowly. ***By Robert L. Hummel***

Ditto Your Data

Tape backup was once a murky, quirky domain where technicians tended expensive, proprietary black boxes. Today, ease of use and low prices make tape backup a sizzling consumer-oriented aftermarket. Iomega's latest entry into this pageant, the Ditto 2GB External, continues the trend toward higher-capacity media, lower-priced drives, and user-friendly software.

As the size of the average hard disk has swollen to epic proportions, so has the chance of data disaster. Given the cost of re-creating even a single complex file, personal tape-backup devices, such as the Ditto 2GB drive, are increasingly attractive.

Ditto Data

Interface: Parallel port (with printer pass-through)

Read compatibility: QIC-80, QIC-80W, QIC-3010, and QIC-3020; Travan TR-1, TR-2, and TR-3

Writes: Preformatted Iomega 2GB only

Native capacity: 1 GB

Cartridge cost: Less than $20

Measuring 5.4 by 1.6 by 7.6 inches, the Ditto 2GB drive easily finds a home on a crowded desk. It connects to a parallel port (with printer pass-through), and it's eminently portable, weighing in at a svelte 1.4 pounds, although the largish power brick weighs 1.7 pounds.

The drive reads many quarter-inch-cartridge (QIC)–standard tape formats, but it writes only to Iomega's proprietary 1-GB format (2 GB with compression). Fortunately, formatted Ditto 2GB cartridges have a street price below $20—a lower cost per megabyte than comparable formats. If a tape becomes unusable for any reason, however, you'll have to replace it. Iomega decided to prevent the Ditto 2GB from formatting tapes, citing the long format time and higher cartridge price.

Single-Step Backup

The Ditto Tools backup software (developed for Iomega by Arcada Software) is as easy to use as could be. You can back up a single file or an entire set of drive volumes in one session. The simple 1-Step version, the ultimate in auto-pilot, manages backup operations automatically and restores files just as easily. More experienced users craving backup flexibility can choose from various options, including full, incremental, and differential backups. Supported environments include DOS, OS/2, and Windows 3.x and 95. Iomega promises an NT version soon.

You'll appreciate the software's support for unattended backups, given the Ditto's somewhat sluggish performance. For example, on an 8-MB 486DX/66 system running Win 95 with default settings, I measured an average disk-to-tape speed of about 4.5 MB per minute with a typical mixture of applications and data. (Iomega claims speeds up to 9.5 MBps with faster systems.) Adding in the time required to verify the backup reduced the effective backup speed to 1.7 MBpm. At that rate, filling up an entire tape could take 10 hours.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★
PERFORMANCE	★ ★ ★

The Ditto 2GB is not without problems—most of them common to all parallel-port tape drives. To function properly under DOS, for example, the drive needs exclusive use of a hardware interrupt. That means you have to resolve any potential conflicts with sound, network, or other expansion cards manually. Drive performance is also highly dependent on system speed. On slower systems running Windows 95, don't expect to perform other tasks while backing up in the background. It's possible, but not practical.



Ditto 2GB External
$199
(estimated street price; for DOS, OS/2, Windows 3.1, and Win 95)

Iomega Corp., Roy, UT
(800) 697-8833; (801) 778-1000
fax: (801) 778-5763
http://www.iomega.com/

Circle 1066 on Inquiry Card.

A Personal Ditto

The Ditto 2GB drive combines a 1-GB native capacity (or 2 GB, assuming typical file compression) with ultraportability and affordable pricing—both for the drive and the media. And although its parallel-port interface means that it's not the fastest tape drive around, the Ditto is a solid choice for personal system backups. B

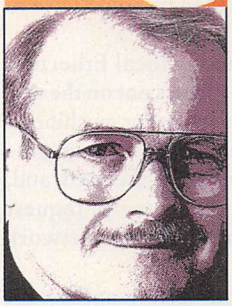
Robert L. Hummel is an electrical engineer, programmer, and consultant. You can reach him on the Internet at **rhummel@monad.net.**

PHOTOGRAPH: LIGHTWORKS PHOTOGRAPHIC © 1996

★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

Jerry Pournelle

Chaos Manor



Don't Swap: Network!

Upgrading the Pournelle way means more than trading in one machine for another.

I've got a new method for writing fiction, and it's been working so far. Every morning, including Saturday, I get up at 8:00, have a leisurely breakfast, and read the papers. By 10:00, I'm upstairs in what used to be Alex's room. There's nothing in it but an elderly (in this business, three years is old) Gateway 2000 486DX2, a steno chair, a portable ice chest I fill with Dr. Pepper and root beer, and Alex's old high school books. There are no distractions. No phone. No modem. No computer games. No interesting books.

I stay there until 12:30. So far, I have averaged more than 1000 words a day plus rewriting the previous day's output. *Starswarm*, my new juvenile about a boy who grows up with a computer in his head, is taking shape wonderfully, with over 50,000 words done. At more than a thousand words a day, it will be finished in two weeks.

The Gateway 2000 486DX2 was Roberta's computer before we upgraded her to a Gateway Pentium 200. It's a perfectly good machine, and we've never had any trouble with it. It's certainly fast enough for what I'm doing. (Heck, for writing fiction, a 286 with Q&A Write is good enough.) The programs I run are Windows 95 (Win 95), Microsoft Office, Norton Commander (for DOS), and Info Select.

Info Select is a general notes program. It started life as Tornado Notes, which was a far better name than Info Select. When Micro Logic changed it from a DOS pop-up to a Windows utility, they changed names. I find the name ugly, but it's a terrific utility.

I use Info Select to accumulate and organize notes, such as character names, locations, and all the other stuff that goes into my novels. It's easy to copy some text, such as the first scene where I name and describe a character, switch to Info Select, create a note or open an existing one, and stuff the new information into it. It's also great for diaries, keeping track of work in progress, and other stuff. You can learn to use it in about 5 minutes, and I don't see how anyone gets along without it. Micro Logic also makes DiskMapper, a program that graphically maps your hard drive and shows you exactly what's eating up all that disk space. I'll try to get to that soon, too.

Heck, for writing fiction, a 286 with Q&A Write is good enough.

I've also installed CyberMedia's First Aid 95 Deluxe on this Gateway machine. I chose it as much for its cleanup capability as anything else. Roberta had a whole bunch of stuff on the computer that I don't need, so after I copied it all to her new machine, I erased almost everything. That freed up a lot of disk space, but it left a whole bunch of Win 95 shortcuts and other junk. First Aid seems to have fixed all that.

I had what I thought were some problems with First Aid on another machine, but I know now that the problems were something else. I've been using First Aid on a number of machines without difficulties. It's good for cleaning up after big deletes, and while I haven't needed the recovery features so far, I might.

On the other hand, the installation program sucks rocks.

Actually, that's not true; the installation program works fine once you get it going. The problem is the serial number. First Aid comes on a CD-ROM. Apparently, CyberMedia caught the serial-number disease from Microsoft, because you can't install First Aid without one. This means keeping paperwork handy, and I don't want to do that, so I use a marking pen to write the serial number on the face (the printed side, not the data side) of the CD-ROM. I do that on all those that need a serial number. Now I can't lose the serial number.

The First Aid CD-ROM is auto-play, so when you put it in the drive, it offers to install the program for you. So far, so good, but now it asks for the serial number. I opened the CD-ROM tray to read the serial number. When I closed it, autoplay brought up another copy of the installation program. Eliminating that blew up the original installation program. There was nothing for it but to close down all attempts to install, copy the serial number on paper, and start over. Once that was done, things went smoothly enough, and First Aid's background programs came up on restart. I fail to understand the point of having serial numbers on CD-ROMs.

I formerly used Norton System Doctor to accomplish the same things that First Aid does, but System Doctor has an ugly feature: when it's running in the background, there's a steady blink-blink-blink of the cursor on the desktop that I find extremely annoying. First Aid does not do that.

What I do on that upstairs machine is important. I back up to floppy disks every day, but I worry about power failures, so I have an American Power Conversion uninterruptible power supply (UPS) on

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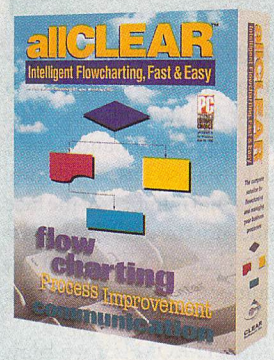

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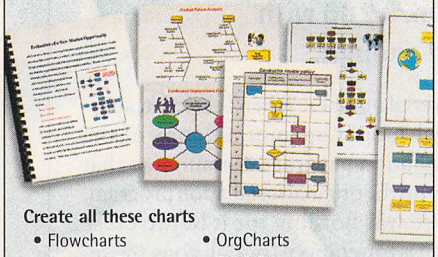

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the machine. If First Aid 95 Deluxe has even a small chance of saving the work in progress, it's worth it, and having it there makes me feel better.

There are still plenty of Windows 3.11 systems out there, so we need one here as a test-bed. The machine that got stuck with the job is SuperCow, a Gateway 2000 486DX2 VL-Bus system. When we got that machine, it was the fastest thing in the house. Over the years, this column has featured upgrades to SuperCow: a Western Digital Caviar AC31000 1-GB hard drive, a new BIOS to support that drive, more memory, and new video cards. One of the first upgrades was a Creative Labs Sound Blaster 16 card and a CD-ROM drive. That was at least three years ago.

Since then, I've used SuperCow for nearly everything, including using it as the world's heaviest portable: I used to lug it down to the beach house when I'd go there to write. Whether it was from doing that or something else, eventually the CD-ROM drive began to fail. It might have been the cable, or perhaps the laser needed cleaning—I'm not sure I ever cleaned it—but whatever happened, it stopped working. I decided this would be a good opportunity to update the double-speed CD-ROM drive, and as it happened, I had a new Creative Labs Sound Blaster Performance 8× Kit.

I've used SuperCow for nearly everything, including using it as the world's heaviest portable.

Physical installation was a bit tight. The CD-ROM cable Creative Labs supplied was shorter than the one that came with the original kit. However, because of the local-bus slots, I didn't have any choice where to put the sound card/CD-ROM controller. Eventually, I had to shuffle the drives so that the CD-ROM drive was on top, with the floppy drives beneath it; hardly a big sacrifice—indeed, it's an improvement—but just a bit annoying because I was working in close quarters.

When I got it installed, I tested it all under DOS. The sound card worked fine. So did the CD-ROM drive. I went into Windows. As Windows came up, Mr. Spock gave me some information about the confines of this solar system, so the sound was working; but when I accessed the CD-ROM drive, the system locked tighter than a drum. The only way out was the power switch.

That happened twice: the CD-ROM drive worked fine in DOS and locked up in Windows 3.1. Time to do some thinking. It took me longer than it should have to figure it out.

SuperCow is on my local Ethernet. When it comes up, it goes out on the network to connect to whatever machines it can find. Until that happens, though, the network card hasn't been accessed, and, more important, the interrupt request (IRQ) hasn't been used by the network card.

The Sound Blaster Performance 8× Kit comes set to use IRQ 5 for the sound card. This is standard: many DOS games expect it to be there, and a few can't be set to look elsewhere. As a general proposition, you are best off leaving your sound card set to IRQ 5. (If you have a second parallel port, you'll have to choose a different IRQ for the sound card.)

The sound card uses a different IRQ for the eight-speed CD-ROM drive, and that is set by default to IRQ 10. Once again, this is no bad thing. Many systems use IRQ 10 for the CD-ROM drive. Unfortunately, that is where I long ago set the Intel EtherExpress card on the grounds that nothing uses IRQ 10 by default—which was true at the time. At least I'd found the cause of the problem.

I now had two choices: reset the EtherExpress card or the Sound Blaster. Resetting the EtherExpress card is simple, so in keeping with the notion that I go to a lot of trouble to try complex things so you don't have to, I decided to reset the Sound Blaster's CD-ROM drive IRQ.

In theory, that should be simple. Like the EtherExpress card, there are no jumpers on the Sound Blaster. Instead, there is software that automatically configures the card, an attempt at Plug and Play. There's also software that is supposed to let you change the card's configuration. It's not well documented, so I called Creative Labs' technical-support department. The first two people I talked to couldn't make it work. The next day, I got calls from increasingly savvy people. It didn't help. We'd manage to get the card to reset to a different IRQ—but as soon as I powered down and brought it back up, it seized IRQ 10 with a death grip.

To make the story short, I finally gave

up. IRQ 10 belongs to the Sound Blaster to control the CD-ROM card. I used SoftSet to change the IRQ for the EtherExpress card. That's a DOS program. One thing: if you change the IRQ for your network card in Windows 3.11, you must then invoke Windows with the command WIN /n, bringing it up without the network; go into the network settings; and manually change the IRQ to your new setting. If you don't, Windows will either lock up or try to change the card setting back to what it expects, and since Windows for Workgroups originally shipped with EtherExpress cards, Windows *knows how to do that*. The result is that you'll be back where you started. This is one case where attempts to Plug and Play actually get in the way.

Now that the IRQ conflict is over, SuperCow's CD-ROM, sound, and networking are fine. The CD-ROM drive is screamingly fast, the new speakers that came with the Creative Labs Sound Blaster Performance 8× Kit are wonderful, and all's right with the system. Of course, the processor is no faster than it was before, but like many of my readers, I get attached to my computers.

Note that if you install the Creative Labs Sound Blaster Performance 8× Kit on a system running Win 95, you shouldn't have any problems. The installation software was designed for Win 95 and understands it just fine. Do make sure you have the latest installation software from Creative Labs; they had some real teething problems with their early Win 95 installation, as did many others, and some of the old software is still in the dealer pipeline. The updates are on Creative Labs' BBS and Web site.

If you need sound—and most of us now do—and you want to add a CD-ROM drive to your system, the Creative Labs Sound Blaster Performance 8× Kit is a good way to go. The sound quality is more than good enough, you get a lot of neat software, and Sound Blaster is the standard that sound-using programs are written to. You won't have any trouble installing it in Win 95, and probably none in Windows 3.11 unless there's a conflict with your network card's IRQ. If there is, change the IRQ on the network card. Recommended.

You will have noted that we have several Gateway 2000 machines. There's RacingCow, a P5-133XL that Eric uses to cruise the Internet; SuperCow, and its non-VL-Bus counterpart I have upstairs; Joizy, my

Circle 144 on Inquiry Card.

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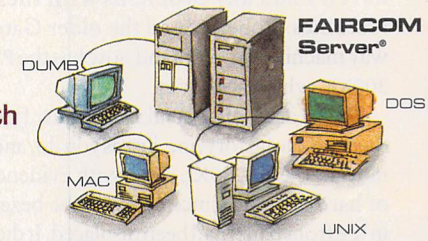

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wife's new P5-200XL; the Liberty laptop; and Alex sometimes uses the old HandBook. We work these machines hard; indeed, SuperCow has undergone some real torture tests, what with frequently being taken apart to accommodate new equipment and every couple of months being carried off to the beach house in the trunk of the car.

Except for an initial problem finding a free IRQ so we could add a SCSI board to RacingCow—that system came fully equipped with an internal modem and sound card, and my first act was to add an Ethernet card, using the last free IRQ—we haven't had any problems with these machines. Roberta used the older Gateway machine for years and now has the P5-200XL, which she loves.

These are not special machines. I get them off the factory line, just as you do, and, indeed, the P5-200XL came with evidence of hard shipping since a few of the bezels in the front panel had been displaced. It didn't seem to matter; the machine worked just fine right out of the box.

I say all this because I get a lot of mail asking if it's really safe to buy computers by mail order, and I can only reply that it depends on the mail-order outfit. I know of several good ones, and I can't possibly tell you which is best. I can only say that I can get just about any machine I want, and I've had quite satisfactory experiences with Gateway 2000 systems. I use them, and I rely on them.

Note also that I write only about what I'm familiar with. There was a time when I might try to keep up with the field and know what's best, but that was long ago. Now, all I can guarantee is that I don't write about what I won't use, and I sure won't use anything that's not more than good enough.

If my mail is any indication, a lot of you are concerned about upgrade paths. I've given this a bit of thought.

First, there are now full-featured laptops that are good enough to be your only computer, and people looking to upgrade might keep that in mind. Example: we just acquired a Nimantics Orion 6×. It comes with a Pentium 150 processor, a built-in 6× CD-ROM drive, Sound Blaster, SVGA video in a 12.1-inch active-matrix display, a 2.1-GB removable hard drive, and many other features. With 32 MB of RAM and the Pentium 150, Blue Streak—I've named it for the blue stripe on the packaging—is a real screamer.

This is one case where attempts to Plug and Play actually get in the way.

The keyboard isn't bad, either: it's full-size, with plenty of keys—it's not one of those "space-saving" designs that assigns two or even three functions to every other key—and it includes so-called Windows 95 keys. Of course, keyboards are a personal thing, but I like this one, and I can write with it.

I could write books with this machine, and, in fact, if I didn't already have the Gateway machine installed upstairs in Alex's old room, I'd probably be taking Blue Streak up with me. Be warned: by

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today's standards, it's a real heavyweight—about 8 pounds—if you're considering lugging it around airports, but on the other hand, it really is good enough to be your desktop machine. I don't have room here for as full a report as I'd like to give; but check the Pournelle bonus section on BYTE's Web site for much more on the Nimantics Orion 6×.

In my judgment, the best upgrade route is not to fiddle with your old system; get a new machine and network it to your old one. Ethernet boards are cheap and getting cheaper, and so are Ethernet PC Cards. Win 95, and for that matter Windows 3.11, make networking simple and painless, and you'll soon find plenty to do with both systems. For one thing, you can do instant backups of important work by sending a copy to the other machine. That practice has saved me more than once.

If you've decided to upgrade by networking, get the fastest new system you can afford.

Full-featured laptops—like the Nimantics Orion 6×—are one way to upgrade your capabilities. However, if you don't need portability, you have other alternatives. The obvious one is to buy the fastest system you can find, a Pentium Pro, a Pentium 200, or one of the Cyrix wonders. Our Cyrix 6x86-P166 system continues to work extremely well, and it's sure a fast machine.

Whatever you do, get a PCI-bus system and a PCI-bus Ethernet card for your new system; they're much easier to set up, and when Plug and Play works, it works very well.

On that subject, we've found there are two kinds of Ethernet cards to consider: 3Com and no-name generics. The no-names are cheap and often work, but if the drivers that come with them don't work well, you'll probably never get anything better. The 3Com cards come with good drivers, and when there are updates, you can download them. A PCI-bus 3Com Internet card will cost maybe $30 more than a no-name card; in my judgment, the peace of mind and absence of installation problems are worth the money.

Understand, this is in the context of a low-cost upgrade by networking; those of you with more serious networking requirements should look into other alternatives, such as Applied Creative Technologies' Ultimate PCI-3000 network card. Of course, if you already have Ethernet cards that work, it's hardly worth buying new cards until you're ready for an upgrade to Fast Ethernet. We'll be doing that one of these days, but for the moment, I've found vanilla Ethernet plenty good enough.

Once you've decided to upgrade by networking, the obvious choice is to get the fastest new system you can afford. Less obvious—but possibly cheaper and better—is to get a reliable dual-Pentium system. If you go that route, you'll have to use Windows NT; Win 95 can't make use of your second processor, and given IBM's treatment of OS/2, I can't recommend that to anyone not already using it. That's a pity, but there it is. Fair warning: installation of NT isn't all that simple. If you don't know what you're doing, be prepared for headaches or get it preinstalled.

Once it's installed, you probably won't have any problems. We've been using NT 3.51 for a while, and it works well with a dual-processor system. Now there's NT 4.0, which is much like Win 95, so much so that most times you need to look to be sure

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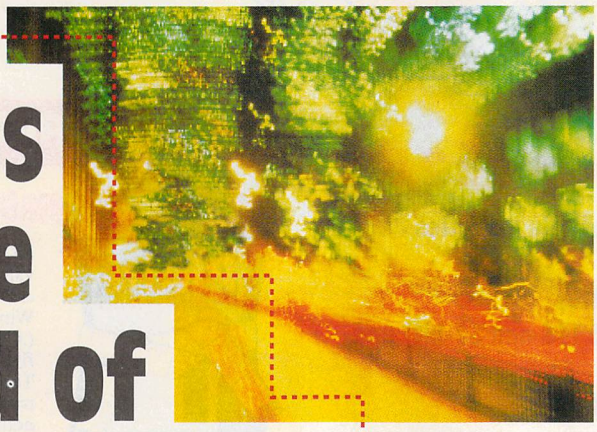

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you're not running Win 95. NT 4.0 is stable and, except for some DOS and Win 95 games, runs all your software.

If you are running multiple programs, especially if at least one is a DOS program, a dual 120 or 133 will likely be faster than one of the screamingly fast single-processor systems. You will almost certainly win with dual processors if you routinely run more than one DOS session simultaneously. DOS programs eat cycles, and handing control to a DOS program and then taking it back involves a deal of overhead. Dual processors let one run the application while the other does the overhead and housekeeping.

Actually, it's not quite that simple. The OS doesn't say "you do housekeeping and I'll do applications"; rather, the OS passes control back and forth as needed. Still, the effect is the same. The applications get the attention they need while the networking and other OS stuff goes on in the background.

A dual-processor system architecture will let you do all your networking and communications without losing speed. We've been experimenting with Diamond Flower's dual-Pentium Doubleshot 133, and for many multiple tasks, it is by far the fastest machine in the house.

The original Pournelle's law was "one user, one CPU," but that was back when CPUs were really expensive. I've since amended it to "one user, at least one CPU." No one deep down inside likes to share CPU cycles with anyone—including oneself. I believe multiprocessor systems are the wave of the future. So, incidentally, does Intel. Of course, it's self-serving for Intel to recommend multiple processors, but that doesn't mean it's not a good way to go.

I'm still tracking down the hesitations I get in Win 95. A dozen readers have made helpful suggestions; and I think I now know what the problem is.

The symptom is that every few minutes there's a series of hesitations, typically manifesting itself when I am typing: I strike the key, and nothing happens for half a second or so. This goes on for a couple of seconds and then the system returns to normal.

The strange part is that Pentafluge, a Pentium 60 that was the fastest thing in the house when we built it, didn't have this problem under Windows 3.11; but as soon as we changed over to Win 95, the hesitations began, and we see them in Win 95, Windows 3.11, and DOS programs.

We don't see these hesitations on all the machines; the common element among those that do have the problem is that they all have Intel EtherExpress-16 ISA Ethernet cards. I am told by a reader that all I need to do is get the updated Win 95 EtherExpress drivers, and my glitches will go away.

I don't know if that's true. I downloaded what I thought were the proper Intel drivers. However, when I went to install them, Win 95 refused to believe there were any proper drivers in the directory I'd put them in. To make matters even worse, when I decided to reinstall the EtherExpress card with its original drivers, it took me five tries to get my network restored. The problem is that when Win 95 installs the EtherExpress hardware and default software, it does *not* automatically install NetBEUI.

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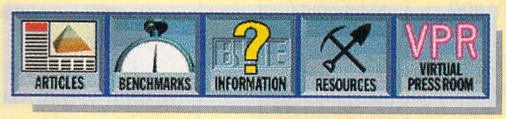

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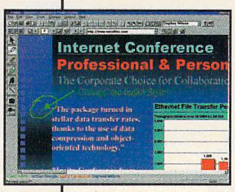

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Circle 211 on Inquiry Card (RESELLERS: 212).

NetBEUI is an elderly protocol whose major—almost only—use is Windows 3.11 and other Microsoft peer-to-peer networks, but you must have it for those.

Worse, the Network Troubleshooter wizard in the Win 95 Help system is almost useless. It does not ask if you have installed NetBEUI, so if you don't know you need that protocol, I don't know how you'd ever find out. I had forgotten I needed it, but since I had other systems networking properly, I could go study one that worked and see what I had left out.

In any event, I'm pretty sure the hesitations are caused by Intel EtherExpress cards running the Win 95 default drivers, and that they can be made to go away by either installing a different Ethernet card or getting the proper drivers for the EtherExpress card. I'll try to test that before we go to press next month.

The first book of the month is also the CD-ROM of the month: Erica Sadun's *Java Script CD-CookBook* (Charles River Media, ISBN 1-886801-35-5). This is a "book" you read with your Web browser. Clearly written, lots of examples, and probably the first of many "books" done this way.

A more traditional computer book of the month is Mark Warhol's *The Art of Programming with Visual Basic* (John Wiley and Sons, ISBN 0-471-12853-8). The subtitle is *Techniques for Writing Solid Code That's Easy to Maintain*, and it is all that and more. The chapter on naming conventions is worth the price of the book. If you do large Visual Basic programs, or you supervise people who do, this is nearly indispensable.

The book of the month is Thomas Cahill's *How the Irish Saved Civilization: The Untold Story of Ireland's Heroic Role from the Fall of Rome to the Rise of Medieval Europe* (Doubleday, ISBN 0-385-41848-5). It's as much a delightful insight into Irish character as a history. Parts of it are serious enough, but even then you'll hear an echo of Irish laughter.

The game of the month is The Pandora Directive from Access Software. This is one of those role-playing movie games, and frankly I wouldn't have fired it up if I hadn't noticed that my old neighbor John Agar is in it.

It's actually a rather interesting plot hinging around what happened in Roswell, New Mexico, on July 6, 1947, involving UFOs. The acting is quite good. I find the pace of this game to be a bit slow, but that's really saying that I am not usually fond of the kind of game where you must poke around, looking in desk drawers and under rugs, and talking to everyone in sight. For those who do like that kind of game, The Pandora Directive is about as good a one as I have seen.

The piles grow higher at Chaos Manor, and even with the longer column—see BYTE's Web site for the parts of the column that didn't get into the printed edition—I can't keep up. We now have CD makers, a lot of great new software, so many CD-ROMs I have lost count, and a whole bunch of stuff I wish I had space to tell you about. The computer revolution isn't slowing down at all. B

Jerry Pournelle is a science fiction writer and BYTE's senior contributing editor. You can write to Jerry c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please include a self-addressed, stamped envelope and 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**.

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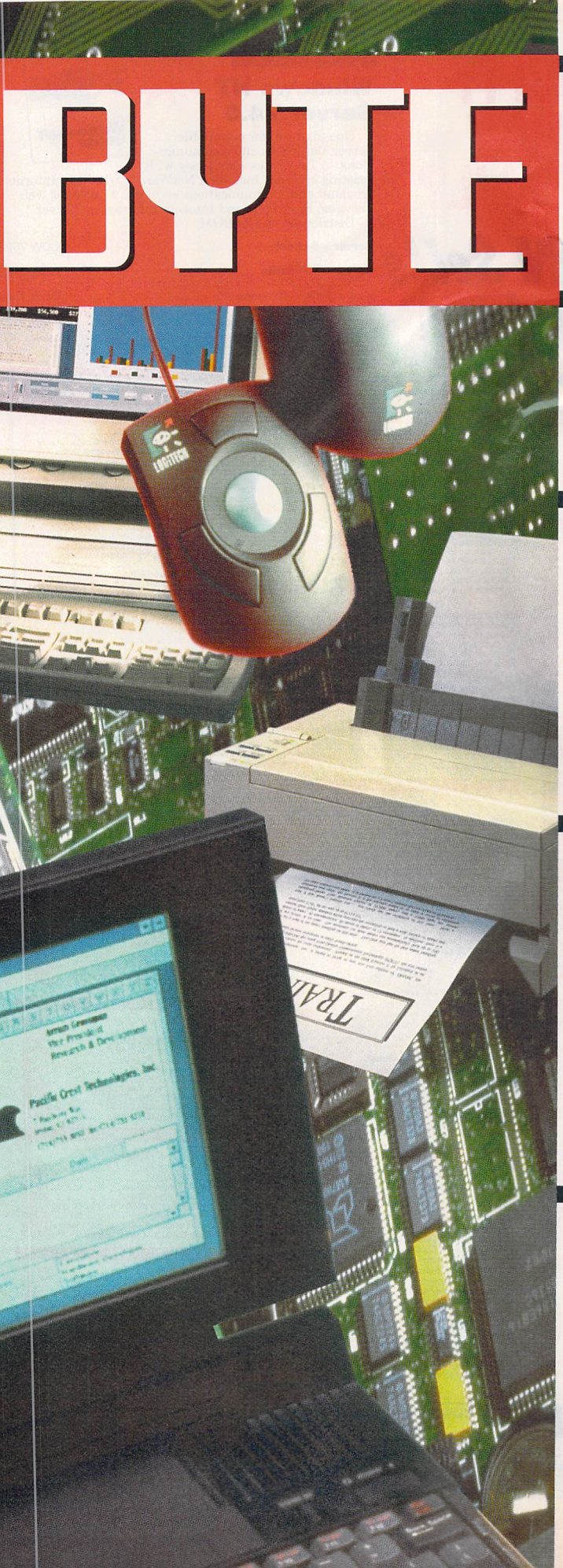

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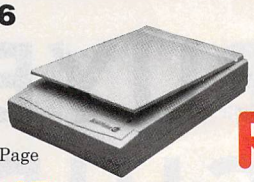

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SO DIMMS (72/144 pin)

72 Pin, 3.3V	4Meg	49.00
72 Pin, 3.3V	8Meg	89.00
72 Pin, 3.3V	16Meg	189.00
72 Pin, 5V	4Meg	49.00
72 Pin, 5V	8Meg	89.00
72 Pin, 5V	16Meg	189.00
144 Pin, 3.3V	8Meg	89.00
144 Pin, 3.3V	16Meg	166.00
144 Pin, 3.3V	32Meg	339.00
144 Pin, 3.3V EDO	8Meg	89.00
144 Pin, 3.3V EDO	16Meg	166.00
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64Meg	2349.00
128Meg	4628.00
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8Meg	106.00
16Meg	209.00
32Meg	329.00
64Meg	709.00

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8 x 64	64Meg	449.00
16x64	128Meg	1995.00
3.3V SDRAM	***8Meg***	***109.00***
3.3V SDRAM	***16Meg***	***209.00***
3.3V SDRAM	***32 Meg***	***449.00***

AST MEMORY

MODEL	AMT. UPGRADED	AST PART #	PRICE
Bravo LC Series, Bravo MT, Bravo MS, MS-L, Advantage Pro DX33, SX25	4Meg	500987-002	34.00
	8Meg	500987-003	68.00
	16Meg	500987-004	119.00
	32Meg	500987-005	278.00
Premmia LX P/60, MX4/66d, 4/100T, P/60	8 Meg	500987-003	78.00
	16 Meg	501340-002	180.00
	32 Meg	500987-005	278.00
	64 Meg	501569-001	649.00
Premmia 4133, 4133S, 4/50d, 4/60d	8 Meg	501159-002	89.00
Premmia SE 4/33, 4/66d, P/60	16 Meg	501159-003	149.00
Premmia MTE 4/33, 4/66d, P/60	32 Meg	501159-004	329.00
Manhattan G, V Series Server	64 Meg	501159-005	859.00
Power Premium 3/33, 4/33, 4/33S, 4/50d, 4/66d	8Meg	500780-001	168.00
Premium 486/25, 486/25E, 486/33, 486/33E Premium 386/33TE, 486/25TE, 486/33TE Prem. II 386/25, 386/33, 486/33, 486 SX/20			
Bravo 486/25, 486/33	2 Meg Kit	500780-005	48.00
Advantage 486/25, 486/33, 486/33P, 486 SX/20 Premium SE4/22	8Meg Kit	500780-001	118.00
Premium SE 4/50, d, 66d, P/60	1 Meg	500780-003	19.00
Prem. 386/33T, 386 SX16, Prem.II 386SX.20, 386/25	4Meg	500780-004	59.00
Premmia GX P/90, P/100	8Meg Kit/16MegKit	501565-001/501566-001	98/178
	32Meg Kit/64Meg Kit	501567-001/501568-001	278/518
AST Cupid Board	0-32 Meg	500818-001	159.00

AMBRA

Ambra NC 425SL	2/4/8 Meg	69/109/189
Ambra N Series	***4/8/12/16 Meg***	***99/169/269/339***
Ambra SN Series	4/16 Meg	79/219
Ambra N-75, N-100	4/8/16	99/129/219

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IBM PS/1, PS/2 MEMORY MODULES

IBM PART NO.	WORKS WITH MODEL NO.	PRICE
30F5360 (2Meg)	30-286, 25-286, 50 MTHR BD.	79.00
6450604/92G7196 (2Meg)	70-061, E61, 121, 502, 55SX, 65SX, P-70, 55LS, 65LS, X-Station 120 & 130, 35SX, 35LS, 40SX	39.00
6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt. 325T	29.00
34F2933 (4Meg)	35SX, 40SX, 55SX, 65SX, 55LS, 65LS	59.00
87F9977/92G7199 (4Meg)	35SX, 55LS, 65SX, 40SX, 35SX, 35LS	59.00
92F9935 (2Meg)	P/S1 & P/S1/386SX-2121	49.00
92F9694 (4Meg)	P/S1 & P/S1/386SX, Model-2121	49.00
92G7200 (4Meg)	PS/1 Expert, Consultant, Wildcat	49.00
4Meg/8Meg/16Meg/32Meg	***PC 300 Series***	***39/69/119/219***
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4Meg/8Meg/16Meg/32Meg	***PC Power Series***	***39/69/119/219***
4Meg/8Meg/16Meg/32Meg	***PC Server 300, 325, 520***	***39/69/119/219***
8Meg/16Meg/32Meg (Ecc)	***PC Server 500***	***119/219/399***
92G7334 (16Meg 168 pin Edo)	***IBM 730/750***	***199.00***
92G7335 (32Meg 168 pin Edo)	***IBM 730/750***	***329.00***
92G7539 (4Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730, Pentium	39.00
92G7541 (8Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730, Pentium	69.00
92G7543 (16Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730, Pentium	1194.00
92G7545 (32Meg)	Aptiva 310, 330, 350, 510, 530, 710, 730, Pentium	219.00
73G3131/92G7201 (4Meg)	Value Point Performance, PC Server 4/66	49.00
73G3132/92G7203 (8Meg)	Value Point Performance, PC Server 4/66	89.00
60G1622/92G7204 (16Meg)	Value Point Performance, PC Server 4/66	139.00
92G7205 (32Meg)	Value Point Performance, PC Server 4/66	239.00
6450902 (2Meg)	56, 57, 57SX,90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	49.00
6450128/92G7200 (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	49.00
6450129/92G7428 (8Meg)	35SX, 40SX	89.00
6450130/92G7202 (8Meg)	56, 57, 57SX, 90, 95, P-75, 57SLC Value Point 77 486DX2, 486SX, SVR 85	89.00
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07G1416/07G1421 (8Meg)	Thinkpad 750, C, 700, C, 720, C, CL57SX	149.00
66G0095 (16Meg, 32Meg)	Thinkpad 750, C	219/359
66G0094 (4Meg)	Thinkpad 755, 365, 360, 355, 340, 450	49.00
66G0094 (8Meg)	Thinkpad 755, 365, 360, 355, 340, 450	139.00
66G0094 (16Meg, 32Meg)	***Thinkpad 755, 360, 355, 340, 450***	***199/479***
8Meg/16Meg/32Meg	***Thinkpad 760EX, Ed, EL, 365X, XD***	***109/199/749***
8189096 (4Meg)	Thinkpad 500, 510CS (3.3 volt)	79.00
8189099 (8Meg, 16Meg)	Thinkpad 500, 510CS (3.3 volt)	119/339
79F0999 (2Meg)	LX40, N33SX, PS Note	69.00
79F1000 (4Meg)	LX40, N33SX, PS Note, Tkpd 350, 350c, PS Note 425	89.00
79F1001 (8Meg)	LX40, N33SX, PS Note	119.00
(4Meg/16Meg) (4Meg/16 Meg w/Adap	Thinkpad 755 Dimm Modules Thinkpad 755	89/199 174/389
60G0378 (8Meg)	Thinkpad 350, 350c, PS Note 425	119.00
60G0379 (16Meg)	Thinkpad 350, 350c, PS Note 425	199.00
4Meg/8Meg/16Meg	***Thinkpad 365***	***119/219/429***
92G7259 (4Meg)	Thinkpad 701C, CS, Butterfly	69.00
92G7261 (8Meg)	Thinkpad 701C, CS, Butterfly	119.00
92G7263 (16Meg, 32Meg)	Thinkpad 701C, CS, Butterfly	169/339
8Meg/16Meg	Thinkpad 820	219/399
4Meg/8Meg/16Meg/32Meg	Thinkpad 850	99/169/299/499
8Meg/16Meg/32Meg	***Thinkpad 760***	***129/199/Call***

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Deskpro 386 25E/20E	1Meg Module/4Meg Module	39/89
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Deskpro 386/25, 20	1Meg Module/4Meg Module	79/129
Deskpro System Pro 386/33, 486/25, 486/50L	2/8/32Meg	29/89/299
Deskpro 4/66l, 4/33l, 4/25lS, 3733l, 3/25l	2/4/8Meg	59/89/169
Deskpro "M" Series	Expansion Board 0K	119
Deskpro 450, 466, 4100, 575, 590, 5120, 5133	4/8/16/32Meg	49/89/149/299
Deskpro XE 433S, 450, 466	2/4/8Meg	49/69/99
Deskpro XE 560 (pairs)	4/8/16/32/64Meg	39/69/139/299/799
Deskpro 4000, 4966, XL560, xl566, XL575, 5100 xl590	4/8/16/32/64Meg	39/69/139/299/799
Presario 433, CDS520, CDJV520, CDL524, CDS526, CDTV528 660, CDS660, CDS720, CDS724, CDS744, CDS860 CDS920, CDTV920, 924, CDS924, CDS954	4/8/16/32Meg	39/69/139/269
Presario 400 Series, 600 Series, 800 Series	4/8/16/32Meg	49/89/139/269
Presario CDS774, CDS972, CDS982, CDTV978, CDS974 (in pairs) CDS992, 7152, 7170, 7180, 9546, 9548, 9564	4/8/16/32Meg	49/89/139/269
Prolinea 4/25S, 4/33, 4/33S, 4/50, 4/66, CDS	1/2/4/8Meg	19/29/49/99
Prolinea MT 433S, 450, 466, Enhanced 433S, 4/50S, 4/50, 4/66	4/8/16/32 Meg	29/49/104/189
Prolinea 450, 466, 4100, 575, 590, 5120, 575, 590, 5120 575 mini, 5100 mini, 5133 mini	4/8/16/32Meg	29/49/104/189
Prolianet 1500 5/75, 5/100, 1500R 5/75, 5100 (install in pairs)	4/8/16/32Meg	29/49/104/189
Prosignia 300, 575, 590, 500 5/90, 500 5/120 (install in pairs)	4/8/16/32Meg	29/49/104/189
Proliant 4000 5/60, Prosignia 5/60 (install in pairs)	4/8/16/32	29/49/104/189
Proliant 2000 486/50, 5/66, 5/90, 2000R 5/66, 5/90 (install in pairs) 4000 486/50, 5/66, 5/90, 5/100, 4000R 5/66, 5/90, 5/100 4500 5/100, 4500R 5/100	4/8/16/32	29/49/104/189

COMPAQ LAPTOPS & NOTEBOOKS

Armada 1100/4100	***8Meg/16Meg***		***149/239***
Elite 5000, 5200	***8Meg/16Meg/32Meg/64Meg***		***99/149/266/513***
LTE/386S/20	4Meg Module	121125-002	79.00
LTE LITE/20, 25, 25C	4Meg Module	129769-002	79.00
LTE LITE/20, 25, 25C	8Meg Module	129769-003	119.00
LTE LITE/20, 25, 25C	16Meg Module	129769-004	219.00
LTE LITE 4/25C/33C/25E/25L	4Meg Module	142337-002	49.00
LTE LITE 4/25C/33C/25E/25L	8Meg Module	142337-003	89.00
LTE LITE 4/25C/33C/25E/25L	16Meg Module	142337-004	219.00
SLT/386	4Meg Module	118305-001	99.00
Concerto, LTE Elite	4Meg	144790-001	59.00
	8Meg	144790-002	99.00
	16Meg	144790-003	189.00
Contura 320, 325	4Meg	139498-001	99.00
	8Meg	139499-001	109.00
Contura 400, 410, 420, 430	4Meg/8Meg/16Meg		49/99/189
Contura 4/25, 4/25C, 4/25CX	4Meg	146520-001	49.00
	8Meg	146521-001	99.00
	16Meg	146531-001	199.00
Aero 4/25, 4/33	4Meg	190532-001	69.00
	8Meg/16Meg	190597-001	99/189

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2.1 GIG	889	1.3 GIG	786	2.1 GIG	849	
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COMPAQ		4700/4800 – 810mg	$499			
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1.3 GIG	Call	Tecra T700 – 810mg	$749			
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TOSHIBA LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
Tecra 500/P650	***8Meg/16Meg/32Meg***		***119/239/459***
Tecra 700, 710, 720 (SDRAM)	***8Meg/16Meg/32Meg***		***149/289/599***
Tecra 700, 710, 720	***8Meg/16Meg/32Meg***		***129/219***
T2000SXE/2200SX/T1800, 1850, C	2Meg/4Meg/8Meg	PC-PA2000U	59/89/119
T2100, 2105, 2150, 2155, 2110, 2115	4Meg/8Meg/16Meg/24 Meg		69/109/189/249
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	69.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	109.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg/32Meg	PC-PA2014U	199/349
T3400CT, T2400, T3600	4Meg/8Meg/16Meg	PC-PA2019U	89/119/179
T600, 610, CT Edo	8Meg/16Meg/32Meg		119/189/319
T400CS, 400CDT, T100, 105 Edo	***8Meg/16Meg/32Meg***		***119/189/319***

NOTEBOOK, LAPTOP MEMORY

MODEL	AMT. UPGRADED	MANU. PART #	PRICE
ACER 730, 735C, 760, 780	2Meg/4Meg/8Meg		49/69/99
ACER 763, 765, 782, 784, 786, 787, ACER 750	4Meg/8Meg/16Meg 4Meg/8Meg/16Meg		69/109/199
ACER Note Pro, ACER Note Lite, 350, 355	***4Meg/8Meg/16Meg***		***59/99/179***
ARM TS38	4Meg/8Meg/16Meg		69/109/219
AST Ascentia P30, P50	***8Meg/16Meg/32Meg***		***Call***
AST Ascentia J10, J30 ,J50	***8Meg/16Meg/32Meg/40Meg Kit***		***99/189/Call/Call***
AST Ascentia 900N, 800N, 810, 910	4Meg/8Meg/16Meg		79/129/219
AST Ascentia 950	8Meg/16Meg		99/189
AST Bravo & Explorer	***4Meg/16Meg***	***5012S5-001, -002***	***79/219***
AST Notebook Prem Exec 386SX/20/25/25L	4Meg	500614-003	69.00
AST Power Exec 3/25C, 425EL, 425SL	4Meg/16Meg	501166-001, -003	79/189
AST Power Exec 4/33SL	4Meg/16Meg	501318-001.002	79/189
AT&T Globalyst 130, 200, 250	4Meg/8Meg/16Meg		79/149/219
Austin DX4, DX2, SX2, SX Series	4Meg/16Meg		79/219
Austin Vista	***4Meg/8Meg/16Meg/20Meg***		***Call***
Canon Innova Book 150, 175	4Meg/16Meg		69/179
Canon Innova Book 200LS	4Meg/8Meg/16Meg/24Meg		69/99/219/349
Canon Innova Book 350CD, 360, 475	***8Meg/16Meg/24Meg***		***109/189***
Canon Innova 486-10	4Meg/16Meg		79/219
Compuadd 450ns, 475ns	4Meg/16Meg		79/219
CTX EZ 4/xxx 5x66 Pent. Series	***4Meg/8Meg/16Meg***		***Call***
DEC HiNote, Ultra HiNote	4Meg/8Meg/16Meg		69/109/189
DEC HiNote VP	***8Meg/16Meg/32Meg/64Meg***		***119/219/395/785***
Dell Latitude LM (pairs)	***4Meg/8Meg/16Meg***		***69/99/189***
Dell Latitude LX 4100C, MX, MC, M	4Meg/8Meg/16Meg		69/99/189
Dell Latitude XPi	4Meg/8Meg/16Meg		69/99/189
Dell Latitude XP, 475, 4100, 4100CX	4Meg/8Meg/16Meg		69/119/199
Dell Latitude 466, 425, 433C, 433CX, 450, 450CX	4 Meg/16 Meg		69/199
Epson ActionNote 650, 650c, 660c, 660cx	4Meg/8Meg/16Meg		69/109/189
Epson ActionNote 700, 700c, 700cx	4Meg/16Meg		79/189
Epson ActionNote 880, 866c, 890	4Meg/8Meg/16Meg/20Meg		69/109/169/299
Epson ActionNote 4LC/25, 4LC/33, 4SLC/2-50, 4000	8Meg		119.00
Everex Tempo LX, LX20, Carrier	2Meg	PCA 00053-0001	89.00
Fujitsu N5100	***8Meg/16Meg/32Meg***		***219/399/599***
Fujitsu Ergolite Series	***4Meg/8Meg/16Meg/32Meg***		***Call***
Fujitsu Monte Carlo	***8Meg/16Meg/32Meg***		***99/189/399***
Gateway 2000 Colorbook 4/33	4Meg/16Meg		69/199
Gateway 2000 Nomad 425 DXL/SXL	4Meg/16Meg		159/759
Gateway 2000 486 Handbook or Liberty	4Meg/16Meg		69/199
Gateway 2000 Solo Series	4Meg/8Meg/16Meg/32Meg		79/109/199
Hitachi C-Series	***8Meg/16Meg/32Meg***		***149/249/399***
Hitachi M-Series	***8Meg/16Meg/32Meg***		***139/279/516***
HP Omnibook 300, 480, 425	2Meg/4Meg		83/129
HP Omnibook 530, 600	4Meg/8Meg/12Meg		89/119/219
HP Omnibook 4000	4Meg/8Meg/16Meg		99/149/299
HP Omnibook 5000	8Meg/16Meg/32Meg		99/199/399
Leading Edge Aviva 2000	4Meg/16Meg		79/219
Lexmark SE10	4Meg/8Meg		79/119
Magnavox Metalis	4Meg	286, 386SX	119.00
Midwest Micro Elite SX-25, SX33, DX2-50, DX2-66	4Meg/8Meg/16Meg		79/109/189
Midwest Micro Elite Sndbk DX2-50, DX4-75, DX4-100	4Meg/8Meg/16Meg		79/109/189
Midwest Micro Elite Sndbk Plus D5-75, D5-90	4Meg/8Meg/16Meg		79/109/189
Mitsuba Ninja II	4Meg/8Meg/16Meg		79/109/189
Mitsubishi Apricot	***4Meg/8Meg/16Meg***		***69/95/169***
NCR Safari 3180, 3181	4Meg/8Meg		79/119
NEC Ultralite Versa, E, V, MP	4 Meg/8Meg/16Meg/20Meg	OP4104	64/99/199/299
NEC Versa S, Versa 2000C & 2000D	4Meg/8Meg/16Meg		69/109/179
NEC Versa 4000, 4050/4080	4/8/16/32Meg		79/119/219/395
NEC Versa 6000	***8/16/32/64Meg***		***169/299/529/1050***
Packard Bell 386SX, 286	4Meg	286, 386SX	119.00
Packard Bell Statesman	2Meg/8Meg		49/99
Panasonic CF380, CF480	2Meg/4Meg/8Meg/16Meg		65/99/135
Panasonic CF-V21P, CF-580	4Meg/16Meg		79/219
Panasonic CF-V41	4Meg/8Meg/16Meg/32Meg		79/119/219/369
Sager Midern, all models	***4Meg/8Meg/16Meg/32Meg***		***Call***
Sanyo 17/18 NB	2Meg	MBC-NBMEM2	89.00
Seaptre Soundx, all models	***4Meg/8Meg/16Meg***		***89/129/239***
Sharp 3030, 3070	***8Meg/16Meg/32Meg***		***119/199/379***
Sharp 6781, 6881, 6785, 6700, 6800, 6741	2Meg/4Meg		79/129
Sharp 8150, 8650, 8670, 7700, 7760	4Meg/16Meg		69/199
Sharp 8700, 8800, 8900	4Meg/8Meg/16Meg		69/109/189
Sharp 3010, 3020, 3050, 3060	4Meg/8Meg/16Meg		69/109/189
Sharp 9000, 9030	16Meg/32Meg		199/349
Sharp 9040, 9070 (pairs)	4Meg/8Meg/16Meg/32Meg		69/129/265/525
TI 4000, TI 4000D, 4000M	4Meg/8Meg		149/219
TI 5000, 5100, 5200, 5300	***8Meg/16Meg***		***109/219***
TI 6000	***8Meg/16Meg***		***219/399***
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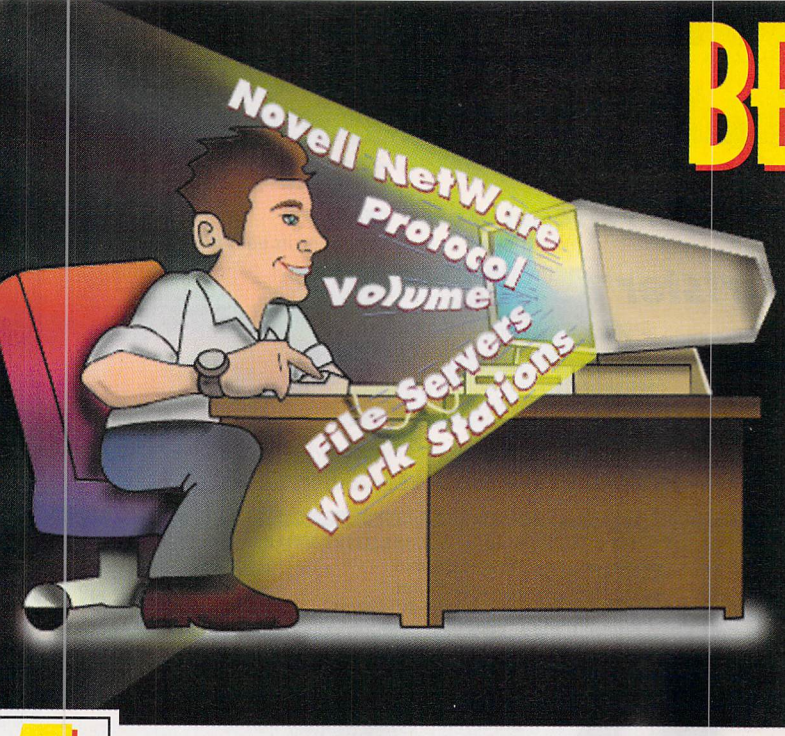

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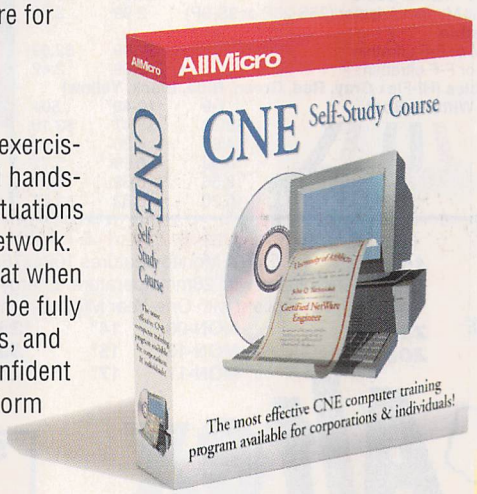

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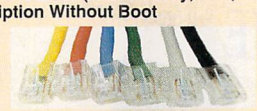

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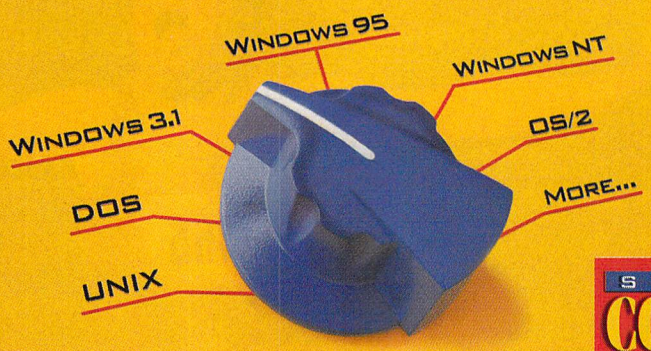

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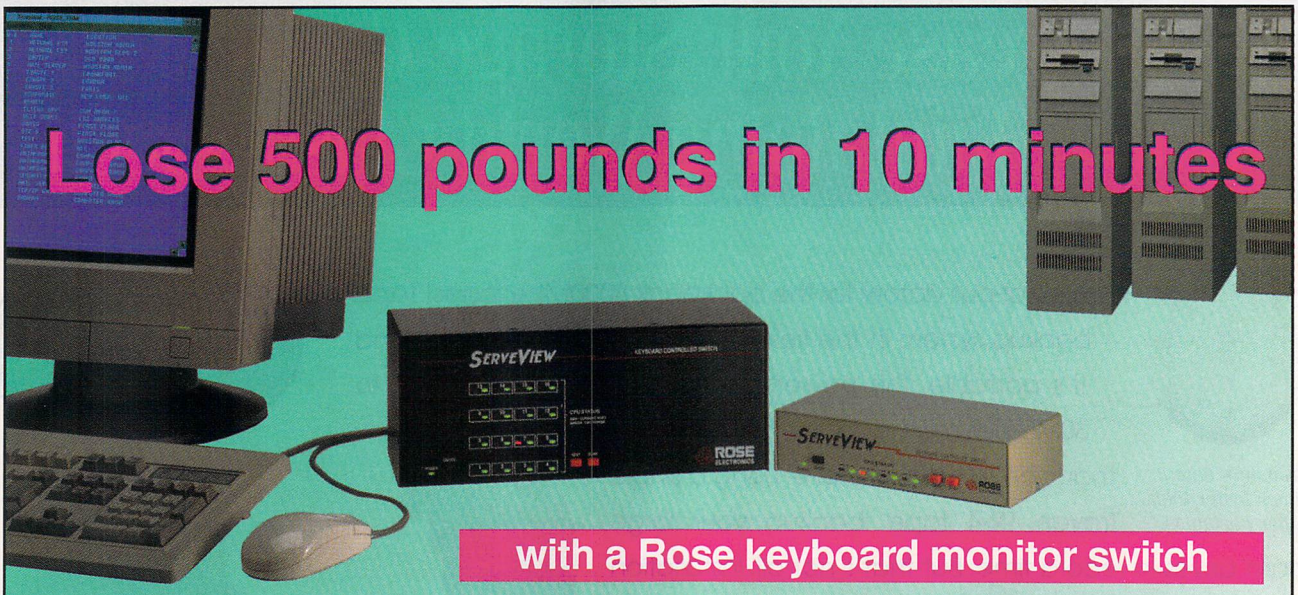

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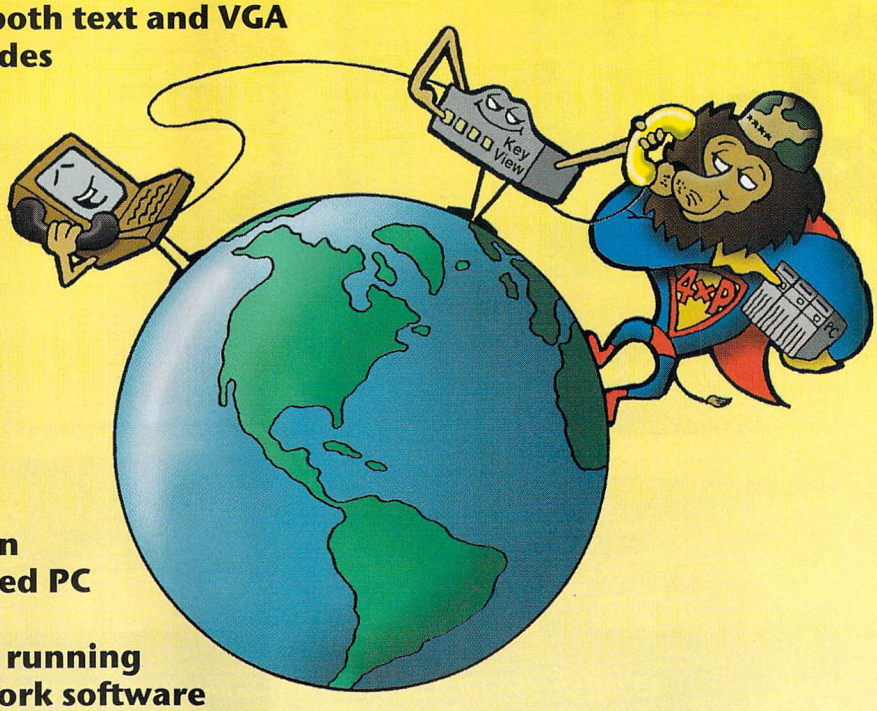



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HP LASERJET 5L/5P	$485/call
HP LASERJET 4+/4M+	$1340/1845
HP LASER 4V/4MV	$1840/call
HP SCANJET 4S/4C	$call/892
HP LASER 5SI/5SIMX	$call
HP LASERJET 4+	$1045
HP LASERJET 5/5M	$1265/1699

COMPUTERS

VECTRA XU SYSTEMS

XU 6/150 16/1GBscsi+CD+Matrox	$stock
XU 6/150 16/2GBscsi+CD+Matrox	$stock
XU 6/200 16/1GBscsi+CD+Matrox	$stock
XU 6/200 32/2GBscsi+CD+Matrox	$stock

built in Network card, Windows NT preloaded

HP NETSERVER

Netserver LC P/100/133/166 32/1gb+CD	$call
Netserver LC P/133/166 32/1gb+CD	$call
Netserver LH P/133/166 32mb, no disk, Array	$call
Netserver LH P/133/166 32mb, no disk	$call
Netserver LH P/133/166 64mb,4.2gb, Array	$call

✻✻ call for all other Netserver configuration ✻✻

HP VECTRA 500 COMPUTERS

515MCX 5/133 16/1.6 GB	+cd+sound+phone answering+headphones	$stock
515MCX 5/166 16/1.6 GB	+cd+sound+phone answering+headphones	$stock

COMPAQ

Notebook Systems

Armada Notebook Systems

Armada 1120CSTN	P100	8/810MB	$1850
Armada 1120CTFT	P100	8/810MB	$2179
Armada 4110CSTN	P100	8/810MB	$2450
Armada 4110CSTN	P100	8/810MB, CD,SOUND	$2850
Armada 4110CSTN	P120	8/810MB	$2999
Armada 4110CTFT	P120	8/810MB	$3685
Armada 4130CTFT	P133	8/1GB	$4350

LTE Notebook Systems

LTE 5150	P/75	8/810MB, Active	$stock
LTE 5250	P/100	8/810MB, Active	$stock
LTE 5250	P/120	16/1.3GB, Active	$stock
LTE 5280	P/133	16/1.3GB, Active	$stock

Deskpro 2000/4000/6000 Systems

Deskpro 2000 p/100, 8/1.2gb	$1275
Deskpro 2000 p/133, 16/1.2gb	$1675
Deskpro 2000 p/166, 16/2.5gb	$2175
Deskpro 2000 6/200, 16/2.5gb	$2690
Deskpro 2000 6/200cd, 32/2.5gb	$3299
Deskpro 4000 6/200, 32/2.5gb, cd	$2799
Deskpro 4000 5/120, 8/1gb	$1599
Deskpro 6000 5/166, 8/1gb, cds	$call
Deskpro 6000 6/200, 32/2.5gb, cd	$1275

Compaq Server

Prosignia 300 Pentium 90,120,150Mhz	$stock
Prosignia 500 Pentium 120,150Mhz	$stock
Prolinat 5000 6/166 Model1	$stock
Prolinat 5000 6/166 Model1A	$stock
Prolinat 5000 6/200 Model2	$stock
Prolinat 5000 6/200 Model2A	$stock
Prolinat 5000 6/166 (rackmount Models)	$stock
Prolinat 5000 6/200 (rackmount Models)	$stock

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TOSHIBA

T2110CS	DX4/75	4/330MB	$stock
T2130CS	DX4/75	8/540MB	$stock
T2150CDS	DX4/75	4/540MB+CD+SOUND	$stock
T2150CDT	DX4/75	8/540MB+CD+SOUND	$stock
T2150CDT	DX4/75	4/540MB+CD+SOUND	$stock
T100CS	P/75	8/810MB	$stock
T400CDT	P/75	8/810MB+CD	$stock
T410CDT	P/90	8/810MB+CD	$stock
T700CT	P/120	8/1.3GB	$stock
T710CDT	P/133	16/1.3GB+CD	$stock
T720CDT	P/133	16/1.3GB+CD	$stock

NEW RELEASE

T110CS	P/100	8/810MB	$stock
T110CT	P/100	8/810MB	$stock
T420CDS	P/100	8/810MB	$stock
T420CDT	P/100	8/810MB	$stock
T500CS	P/100	16/1.3GB	$stock
T500CDT	P/100	16/1.3GB	$stock
T610CT	P/90	8/810MB	$stock
T720CDT	P/133	16/1.3GB	$stock
T730CDT	P/150	16/1.3GB	$call

Also carry Toshiba Refurbished Models
✻ Call for Price ✻

Specials of the Month

Matrox Millenium 2mb WRAM	$189.00	Kodak DC 40 Digital Camera	$523.00	Window NT Workstation 4.0	$278.00
Matrox Millenium 4mb WRAM	$250.00	Kodak DC 50 Digital Camera	$859.00	Mag 15" SVGA Color Monitor	$345.00
Matrox Millenium MPEG Capture card	$call	Microtek Scanmaker E6 scanner	$549.00	NEC XV+ 17" svga monitor	$782.00
Creative Lab Recordable CD-R 4210	$599.00	Seiko Smart Business Card Reader	$call	Adaptec 2940 PCI SCSI	$call
Creative Lab 8X IDE CD	$119.00	Sportster 33.3 Fax/Modem Voice	$169.00	PCMCIA 28.8 Megahertz	$234.00
8X Parallel Port CD	$325.00	Sportster 33.3 win modem	$119.00	PCMCIA Xircom 2.8 fax modem	$219.00
6X Parallel Port CD	$259.00	Zip Drive 100 MB	$195.00	***Black computer case & Monitors***	
Creative Lab SB 32 PnP	$115.00	Jaz 1GB drive	$365.00	14" 1024x768 .28ni	$281.00
Panasonic 6X portable CD-ROM drive	$379.00	Tapestor 8GB internal SCSI Drive	$355.00	15" 1024x768 .28ni	$399.00
Epson Style 500 color printer	$369.00	Pentium Motherboard 512k pipline cache	$139.00	Mini Tower Case 250W 5 bays	$99.00
ZEBRA S-500 Stripe barcode PR SER	$1175.00	Ami Pentium Pro Merlin motherboard	$640.00	Mid Tower Case 250W 6 bays	$149.00
ZEBRA S-300 Stripe barcode PR SER	$899.00	Intel Pentium Pro Venice motherboard	$345.00	Mouse Serial	$25.00
				Keyboard 101 Enhanced	$49.00

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Microsoft Academic Partner

Microsoft Office Professional
for windows 95 (with bookshelf)
$165

MS WINDOWS NT WORKSTATION	$125
MS windows NT Server	$399.00
Ms Backoffice	$1174.00
Ms SQL Server	$799.00

call for other Microsoft Academic Prices

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Embedded 486 CPU Card for Panel PC Based System



For use with the passive back plane (P/N 133250) in industrial panel systems that use heavy duty chassis casing.

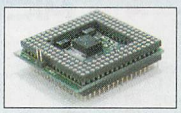
SPECIAL

- Award BIOS
- Compatible with following 168-pin PGA socket CPUs: 486SX/DX/DX2/DX4/5x86 (not included)

133241 Embedded CPU card.....**$299.95**

Power Leap Upgrade Adapter

For 486SX/DX/DX2 to 586-100/120



- Supports 5V 486 motherboards only
- 586-XXX chip not included
- Supports 64-bit X86 compatible processor with 16KB write-back cache
- 100 and 120MHz core speeds with 33, 40 and 50MHz bus options (BIOS written before 1995, will only work with AMD CPUs)
- Includes manual and 3.5" utility/test disk

131941 Upgrade adapter for 586 CPU.....**$49.95**

PCMCIA Type II Combo BNC/UTP Ethernet Card



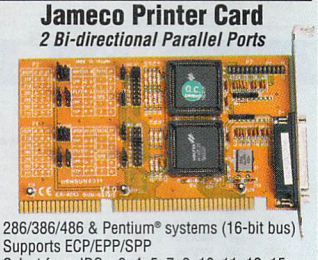
SPECIAL

- Minimum requirements: IBM compatible PC with 386SX, one type II PCMCIA socket, BNC/UTP Ethernet connectivity, PCMCIA release 2.1 compliant card services
- 10Mbps speed in 10BaseT and 10Base2 format

132581 PCMCIA network card.....**$99.95**

Jameco Printer Card

2 Bi-directional Parallel Ports



- 286/386/486 & Pentium® systems (16-bit bus)
- Supports ECP/EPP/SPP
- Select from IRQs: 3, 4, 5, 7, 9, 10, 11, 12, 15
- Address selectable to LPT1-LPT6
- Print mode jumper selectable

132214 2-port printer card.....**$39.95**

Jameco High-Speed Serial Card

4 Serial Ports



- PC/XT/AT and compatibles
- Four serial ports; two each DB9M and DB25M
- High-speed 16C550 UARTs with 16 byte FIFO
- IRQs: 3, 4, 5, 7, 9, 10, 11, 12, 15
- Includes cables and instruction sheet

132572 4-port hi-speed serial card.....**$49.95**

Dynamic RAM

SIMMs

Part No.	Product No.	Description	Price
53701	94000S-70	4MB x 9 70ns	$59.95
53719	94000S-80	4MB x 9 80ns	54.95
75117	P361000-xx-7	1MB x 36 (4MB)	54.95
75096	P362000-xx-6	2MB x 36 (8MB)	99.95
75168	P364000-xx-7	4MB x 36 (16MB)	159.95
41515	41256A9B-70	256KB x 9 70ns	9.95
41769	421000A9B-80	1MB x 9 80ns	20.95

ZYNK 17" SVGA "Green" Color Monitor



SPECIAL

- PC/XT/AT, 386, 486, Pentium® and compatible computers
- 0.28mm dot pitch
- 20 controlled presets for optimal operation
- Push-button degaussing eliminates spurious magnetism
- Green monitor power management

133786 17" SVGA monitor.....**$749.95**

Win '95 104-Key Keyboard w/ Trackball and Palm Rest



- Ergonomic design • Removable palm rest
- Dual connectors: keyboard 5-pin DIN, and trackball 9-pin serial connection on one coiled cable

133760 Win '95 trackball keyboard **$49.95**

IBM 89-Key Adjustable Keyboard



- PS/AT style
- Adjustable keyboard with standard QWERTY layout
- Left and right set of cursor-movement keys
- Erase-ease feature

132978 IBM 89-key adjustable keyboard....**$44.95**

QTRONIX. Sheet Feeding Scanner

256 true gray scale – full width – Windows® '95 compatible!



- 800 dpi x 800 dpi in gray mode
- Minimum system requirements: IBM PC or compatible-386, DOS 3.3, Windows® 3.XX, 4MB RAM, 5MB hard drive space, one 16-bit ISA slot
- Includes software and manuals: Twain, Presto!, wordlinx and Image ProImage Plus

133233 Paper feed gray scanner **$149.95**

Microsoft® 2-Button Mouse



- Serial mouse
- PC/XT/AT/ 386/486/ PS/2 and compatibles
- Includes Microsoft® setup diskette and manual

111860 2-button serial mouse.....**$39.95**

Seagate Performance SCSI Hard Drive Solutions



Hawk

- Average seek, read/write: 9/10.5msec
- 3.5" low profile • One-year warranty

130542 Fast SCSI-II, 1.05GB.....**$409.95**

Barracuda 2LP

- Average seek, read/write: 8/9msec
- 3.5" low profile • One-year warranty

130577 Fast SCSI-II, 2.1GB.....**$849.95**

Barracuda

- Average seek, read/write: 8/9msec
- 1024KB multisegmented cache buffer
- 3.5" low profile • One-year warranty

130593 Fast & fast wide SCSI-II, 4.2GB ...**$1199.95**

Floppy Disk Drives



- PC/XT/AT compatible

118957 Panasonic 1.2 MB 5.25".....**$39.95**
118922 Panasonic 1.44 MB 3.5".....**49.95**
74392 Teac 3.5"/5.25" combo.....**119.95**

NEC 4X IDE CD-ROM Drive with 4-Disc Changer



- Use with enhanced IDE interface (P/N 127386)
- 600KB/sec. data transfer rate, 150KB audio
- Selection button for each drive with indicator
- Cables not included

133508 4X 4-disc DC-ROM drive **$149.95**

6X Enhanced IDE CD-ROM Drive



SPECIAL

- Requires enhanced IDE controller card
- SoundBlaster compatible
- 195ms access; 229ms seek time
- 256KB buffer memory
- 900KB/second transfer rate
- Power tray loading • Windows® '95 compatible
- Also plays video, photo and audio CDs

133031 6X IDE CD-ROM drive.....**$79.95**

Alpec Laser Pointer Pen



Class IIIa Laser Product

- 200 yard range
- 670nm red laser
- Heavy duty silver brass
- Power requirements: 2 AAA batteries (included)

127749 Laser pointer – pen.....**$59.95**

Optical Laser Mouse



Three modes of operation that are selected from a combination of clicking which facilitates mouse mode, sketch mode for 1 to 1 precision, and joystick mode.

- For 486 and Pentium® PCs
- Use with optical mouse pad (included)
- High resolution: 450 dpi
- Auto detection of direction without mechanical ball
- Automatic double click function-side button clicking • Compatible with Microsoft® mouse and Windows® 95

133284 Laser Mouse w/ optical pad.....**$39.95**

Jameco 64-Bit VESA Graphics Accelerator Card



- 1MB expandable to 2MB
- Non-interlaced resolution and Zero-Flicker™ refresh rates provide you with exceptional versatility and display clarity
- VESA-compliant 28-pin feature connector for multimedia applications
- Full VESA and VGA selectable modes

132935 VESA graphics card.....**$99.95**

SPECOM Video-conferencing Card

SPECIAL

With VisionTime Pro Software

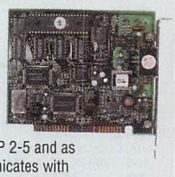
Windows® '95 Ready!



This package offers friendly and affordable, easy to use desktop personal videoconferencing. With a PC and a modem, you can do document conferencing. If you use a DSVD modem, you can do voice conferencing, and adding a camera, actual two-way videoconferencing!

131844 Videoconf. card w/ software.....**$149.95**

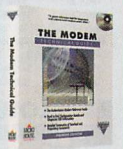
33.6 kbps Data/Fax Internal Modem



- 33,600 bps data modem, 14,400/9600 fax modem
- Fully compatible with ITU-T V.42, V.42bis V.34, V.32bis, V32, V.22bis, V.21-23, MNP 2-5 and as a fax/modem communicates with all ITU-T group 3 fax machines

129672 Internal 33.6 fax/modem **$139.95**

MICRO HOUSE Modem Technical Guide



The Modem Technical Guide is a great tool for beginners and experienced modem users and includes a bonus CD-ROM! The book starts off with a modem primer, then gives you set-up information, hardware configuration settings and diagrams for many of the most popular modem models on the market.

133794 Modem Technical Guide **$49.95**

Switchbox for 4 Monitors



This unit allows you to duplicate a video signal from one source to 4 monitors up to 210 feet.

Perfect for broadcast systems, conventions, schools and multiple display uses!

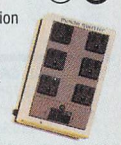
- Suitable for SVGA,VGA and multisync monitors
- Daisy chainable
- Power-save mode when computer is off, indicated by flashing power LED
- DB15 female connectors on box
- Slide switch for video signal gain control
- Includes power adapter 9VDC @ 130mA

133866 Switchbox for 4 monitors.....**$79.95**

SL WABER™ Surge Protectors

- 330V clamping voltage
- EMI/RFI noise reduction
- Audible alarm • 3-line protection

SurgeSentry 6 Outlet



- Ultimate 3-stage protection
- No limit connected equipment manufacturer guarantee
- 62,525 amp spike suppression; 880 joules

133090 6-outlet, suppress 62,525 amp.....**$29.95**

DataGard 7 Outlet



- Standard 1-stage protection
- $1000 connected equipment manufacturer guarantee
- 13,000 amp spike suppression; 520 joules

133081 7-outlet, suppress 13,000 amp.....**$12.95**

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COMPAQ

Presario 425, 433, 633, 650, 660, 800C, 800F, 800S, 833, 850, 866
ProLinea MT 4/33s, MT 4/50, MT 4/66, 4/25s, 4/33, 4/50, 4/66, 4/33s, enhanced 4/100, 4/33s, 4/50, 4/50s, 4/66; Net 1/25s, Net 1/33s

4MB	141684-001	$37	8MB	141685-001	$71
16MB	149320-001	$127	32MB	149147-001	$247

Presario 510, 520, 524, 526, 528, 720, 724, 744, 774, 860, 920, 924, 954

4MB	147522-001	$31	8MB	147523-001	$56
16MB	147524-001	$114	32MB	147525-001	$220
1MB Video	171017-001				$49

Presario 972, 974, 978, 982, 992, 5526, 5528, 5536, 9536, 9546, 9548, 9564, ProLinea 4100, 466, 5120MX, 575MX, 590MX, 5100, 5133, 5120, 5100, 575, 590, ProLinea 450, 5100e, 5120a, 575e, 6130e, 6180e, Deskpro 4100, 450, 466, 575MX, 590MX, 5100, 5120, 5133, 575, 590

4MB	172712-001	$31	8MB	172713-001	$56
16MB	172714-001	$114	32MB	172715-001	$220
1MB Video	171017-001				$49
256K Cache	223557-001				$49

Presario 7212, 7222, 7232, 7234, 7240

8MB	236548-001, 236512-001				$62
16MB	236548-002, 236513-001				$108
32MB	n/a	$228	64MB	n/a	$456
1MB Video	236709-001				$49

Presario 9232, 9234, 9240, 9250, 9642, 9660

8MB	234567-001	$62	16MB	234566-001	$108
32MB	n/a	$228	64MB	n/a	$456
1MB Video	213922-001				$49

ProLinea 5133 2000/ML, 5150 2000/ML, 5166 2000/ML, 5100 840/1200, 5120 1200, 5133 1200/2000, 5150 1200/2000, 5166 1200, Deskpro 5133 2000/ML, 5150 2000/ML, 5166 2000/ML, 5100 840/1200, 5120 1200, 5133 1200/2000, 5166 1200/2000, 575 840

8MB	243011-001	$62	16MB	243012-001	$108
32MB	243013-001	$228	64MB	243014-001	$456
1MB Video	171017-001				$49
2MB Video	223335-001				$139
6MB Video	223336-001				$369

Deskpro XE 560, 5/66M, 5/60M

16MB	149949-001	$148	32MB	149912-001	$284
64MB	149913-001	$508	128MB	149914-001	$988
1MB Video	139167-001				$49

Deskpro XL 450, 466, 560, 566, 5100, 5120, 5133, 575, 590

8MB	148188-001	$74	16MB	148189-001	$142
32MB	148190-001	$254	64MB	148191-001	$494
1MB Video	139167-001				$49

Deskpro XL 6150 1050/CDS, 2100/PD, XL 6200 2100/PD

16MB	210948-001	$481	32MB	228417-001	$375
64MB	228418-001				$851
2MB Video	223335-001				$139
6MB Video	223336-001				$369

Deskpro XE 4100, 433s, 450, 466

4MB	141684-001	$45	8MB	141685-001	$82
1MB Video	139167-001				$49
256K Cache	194358-001, 194358-002				$49

Deskpro 3/25i, 3/33i, 386/25M, 386/33M, 4/25iS, 4/33i, 4/66i, 486/33M, 486/50M, 486/66M, 486s/16M, 486s/25M, 486s/33M

4MB	118690-001	$45	8MB	128877-001	$82
512K Video	141236-001				$39
1MB Video	139167-001				$49

DELL

Power Desktop 486 Models

4MB	310-2507	$37	16MB	310-2625	$127

PowerEdge XE, OptiPlex, Dimension XPS, OmniPlex ME 486 & Performance M/L/T Models

4MB	310-3325	$31	8MB	310-6083	$56
16MB	310-3327	$114	32MB	n/a	$220

Performance ME, OmniPlex Pentium ME, OptiPlex DGX, PowerEdge SP/XE/EL Models

8MB	310-3335	$64	16MB	310-3336	$128
32MB	310-3337	$260	64MB	n/a	$462

PowerLine Workstations SE & DE Models

8MB	310-2468	$74	16MB	310-2469	$142
32MB	310-2630	$254			

Dimension XPS & OptiPlex XL/XM/XMT Pentium Models

8MB	310-2647	$64	16MB	310-3374	$128
32MB	310-3375	$260	64MB	310-3368	$462

NEC

PowerMate & Ready 486 Models

4MB	158-082232-000	$37	16MB	158-082222-000	$127

PowerMate 486 D/M Models

4MB	OP-410-4003	$31	8MB	OP-410-4004	$56
16MB	OP-410-4005	$114	32MB	OP-410-4006	$220

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P5 Series & Family PC P5 Series Models

4MB[BTO]	n/a	$29	8MB[BTO]	n/a	$51
16MB[BTO]	n/a	$104	32MB[BTO]	n/a	$199

Paragon Memory Corporation

AST COMPUTER

Bravo LC & MS Pentium Models

8MB[BTO]	503008-001	$62	16MB[BTO]	503008-002	$108
32MB[BTO]	503008-003	$228	64MB[BTO]	503008-004	$456

Manhattan V & G Models Premmia 4/33, 4/33s, 4/50d, 4/66d, MTE 4/33, 4/66d, P/60, SE 4/33, SE 4/66d, SE P/60

8MB	501159-002	$74	16MB	501159-003	$142
32MB	501159-004	$254	64MB	501159-005	$494

Bravo LP, MT, LC (II) & LC (III), Premmia MX & LX & Advantage! Models

4MB	500987-002	$31	8MB	500987-003	$62
16MB	500987-004	$114	32MB	500987-005	$228

Bravo 4/33 (original), 4/25, Premium, TE, Premium II,

Power Premium Models

4MB	500780-004	$67	8MB	500780-001	$92

NEW LOWER PRICES!!

IBM

Aptiva (all models) & PC 300 Model 330/350

4MB	92G7539	$31	8MB	92G7541	$86
16MB	92G7543	$114	32MB	92G7545	$220
1MB Video	92G7443				$49
256K Cache	92G7251				$79

ValuePoint 6384/6472/6482/6484/6492/6494/6381 SI Models

4MB	92G3131	$37	8MB	92G0130	$71
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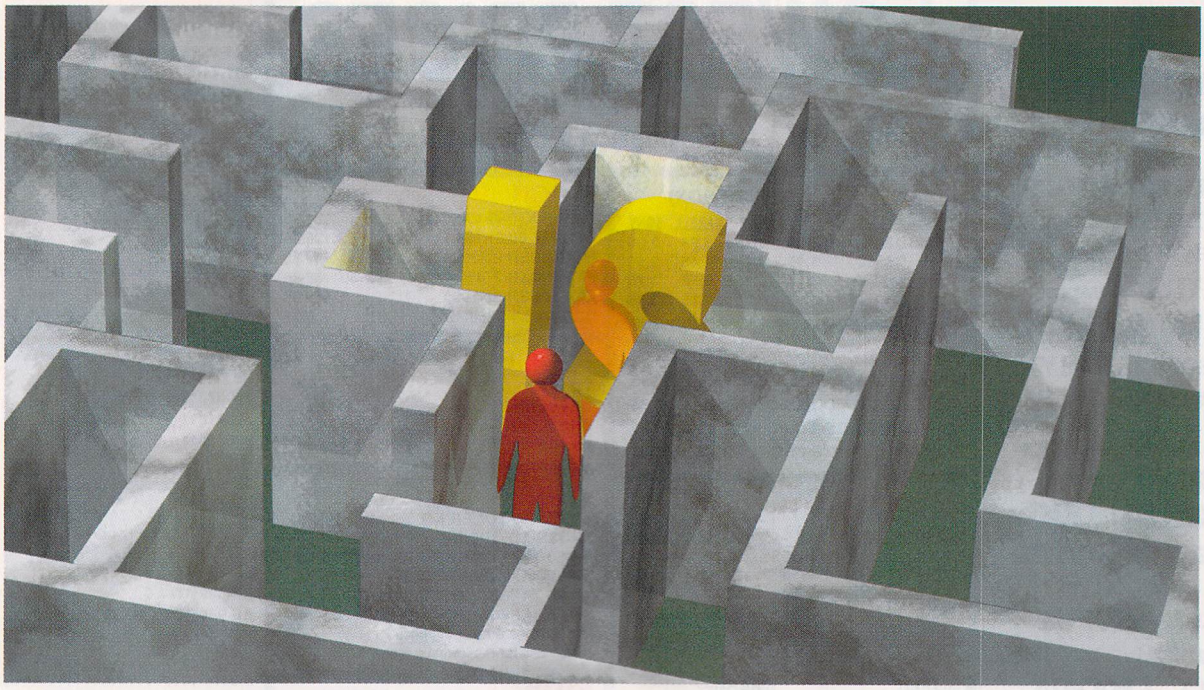

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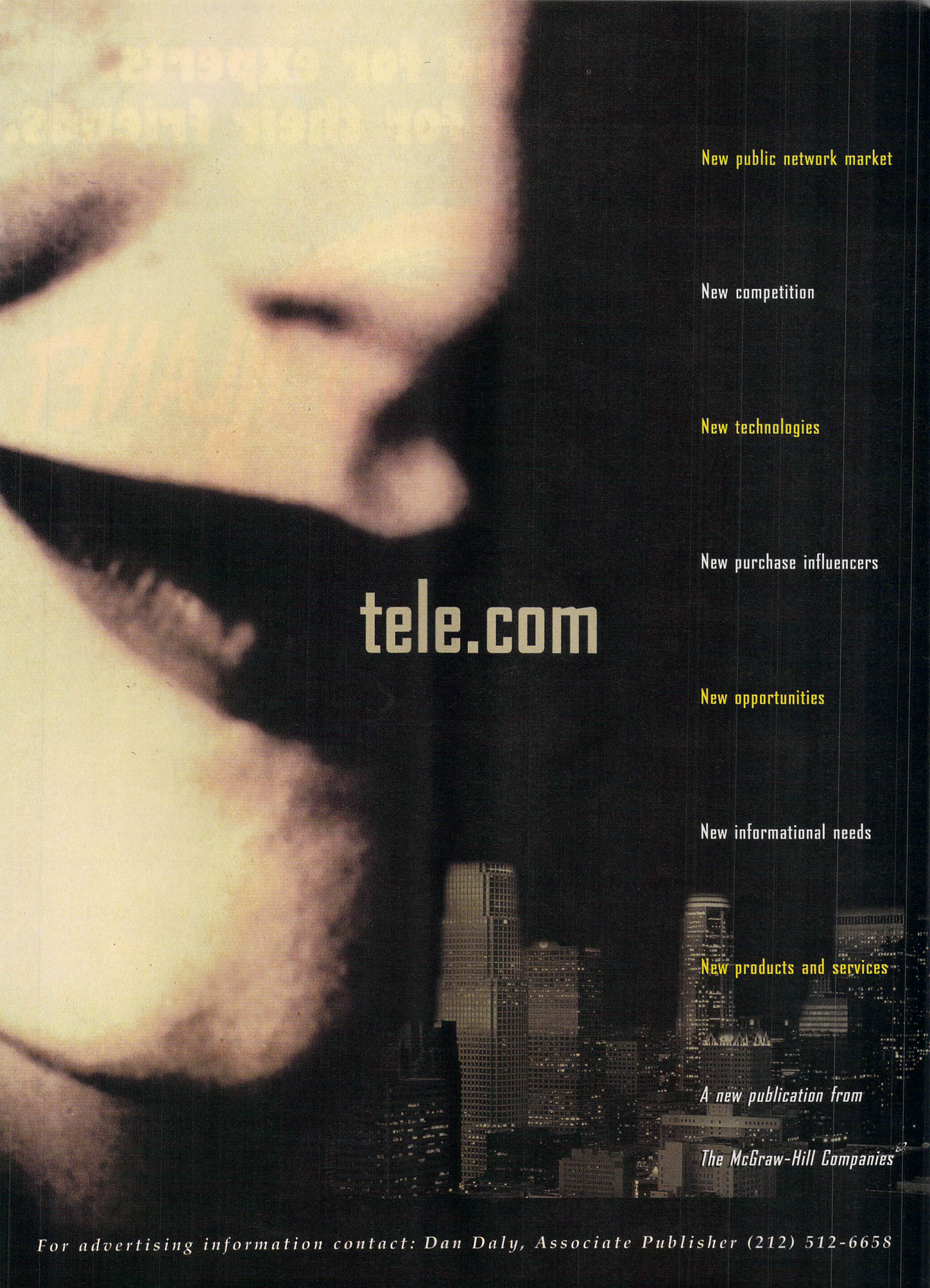

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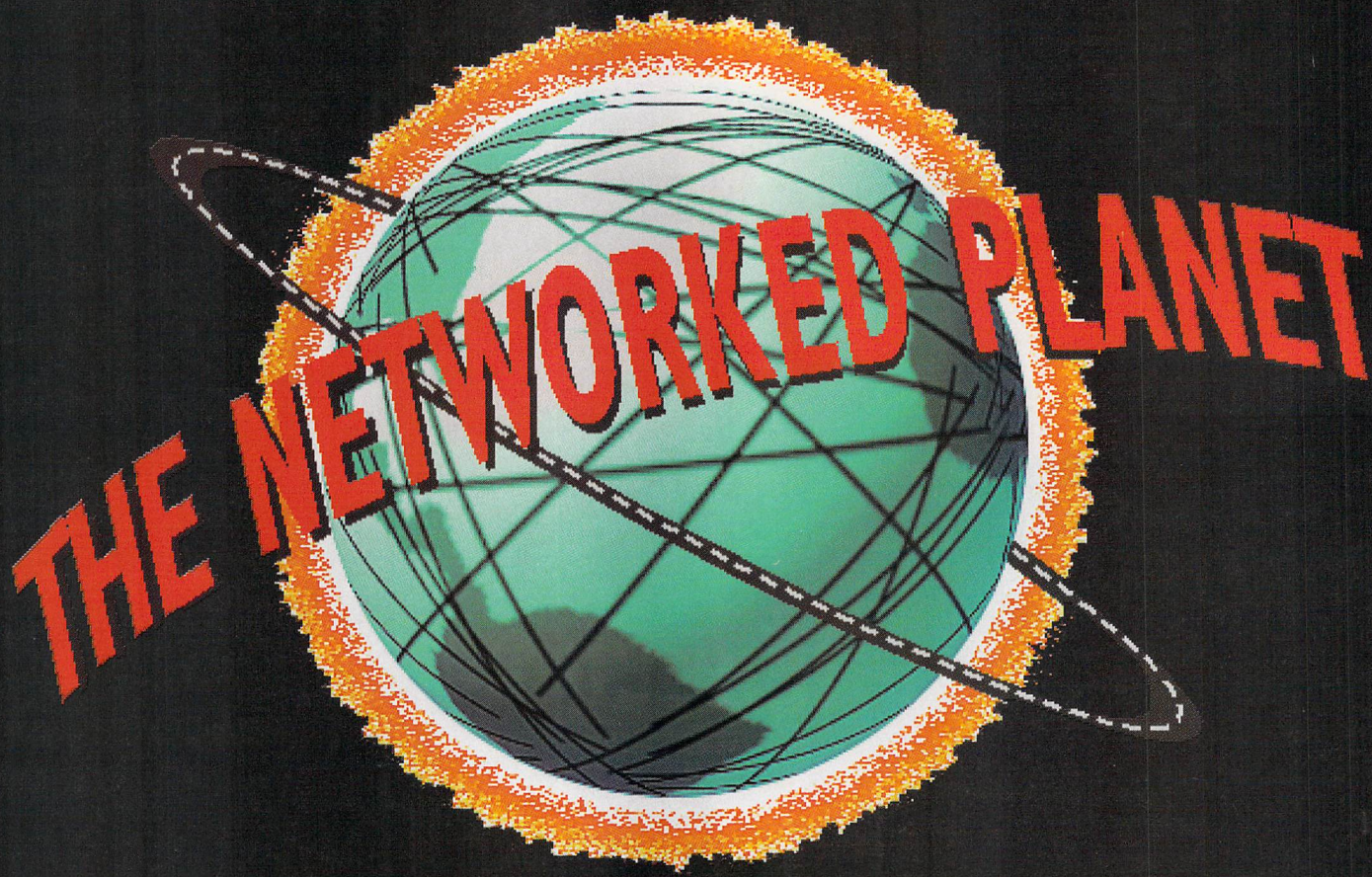

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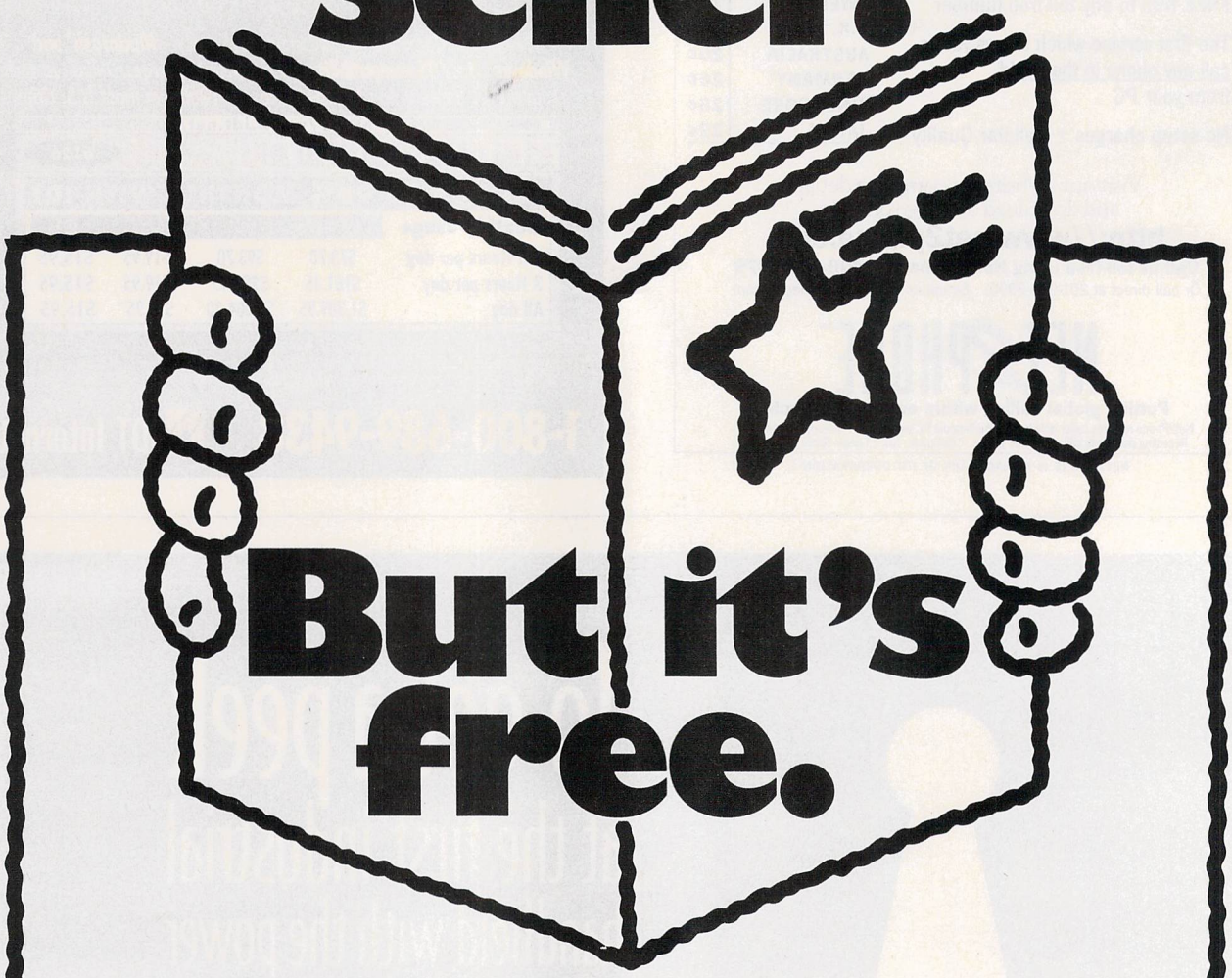

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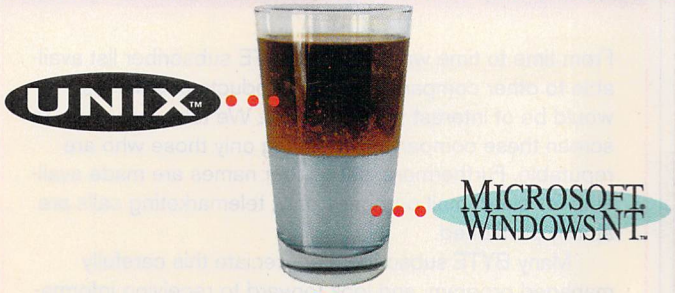

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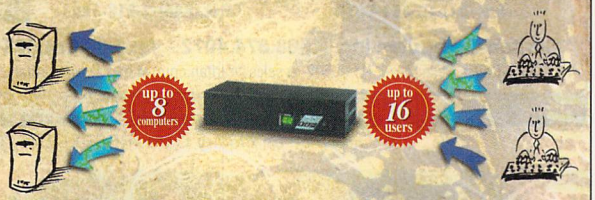

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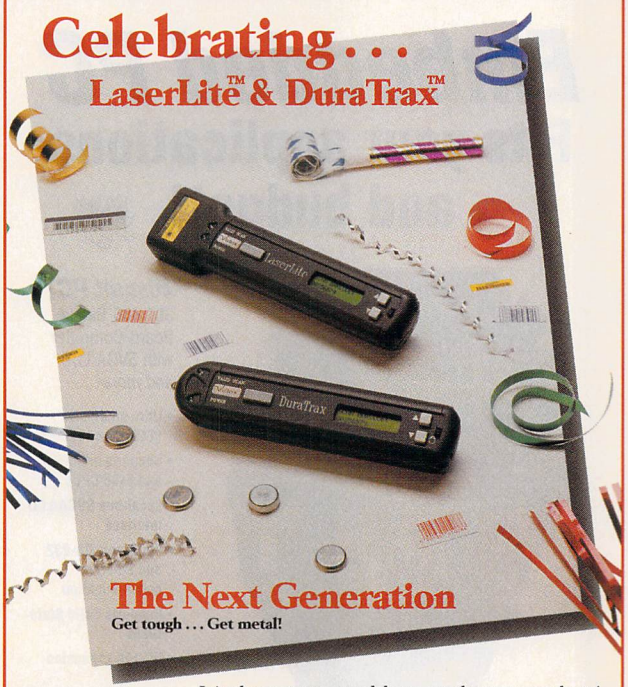

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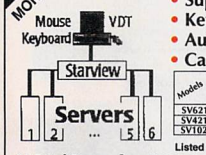

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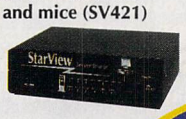

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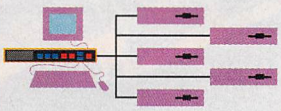

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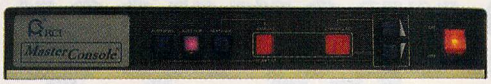

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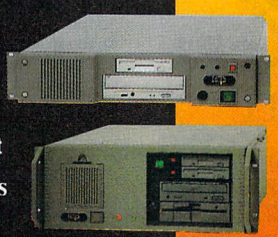

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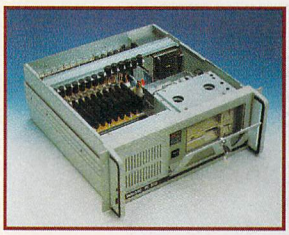



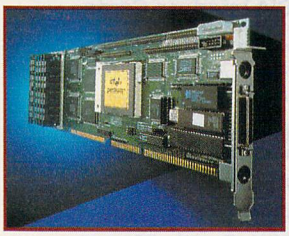

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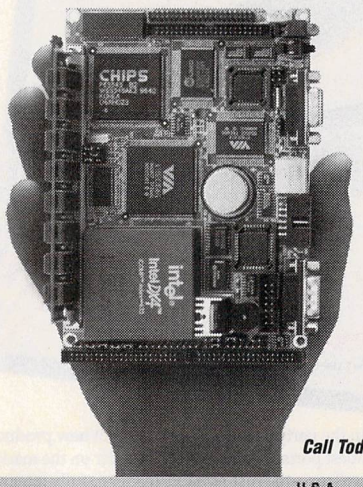

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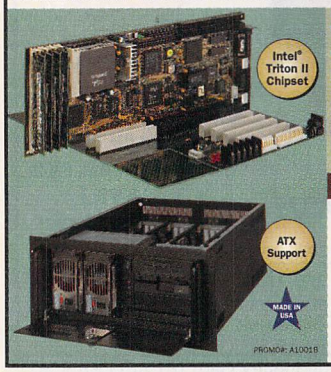

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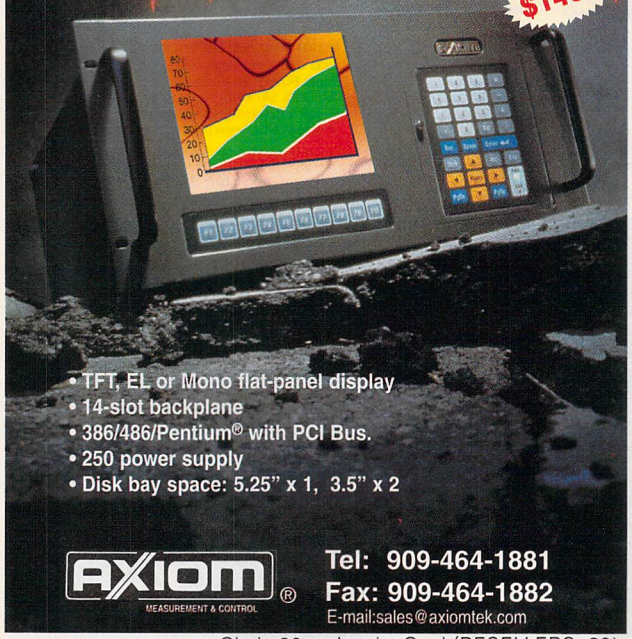

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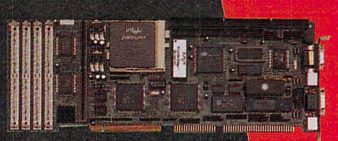

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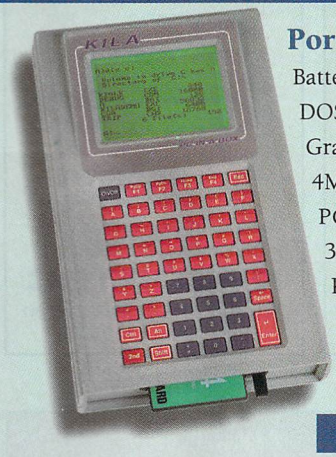

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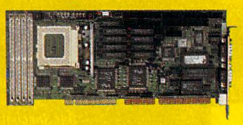

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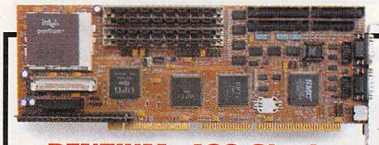

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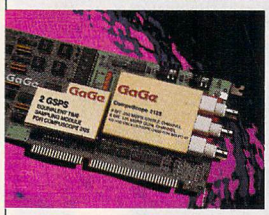

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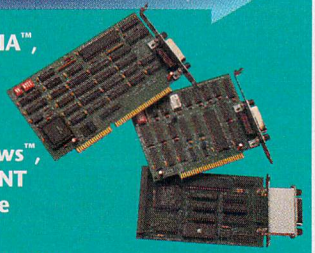

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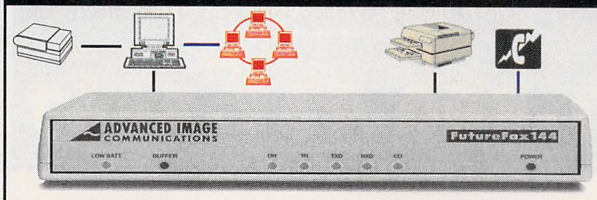

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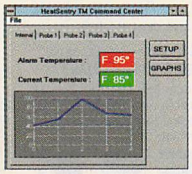

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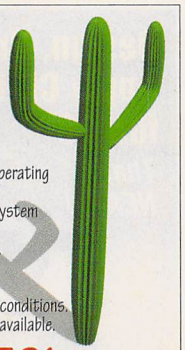

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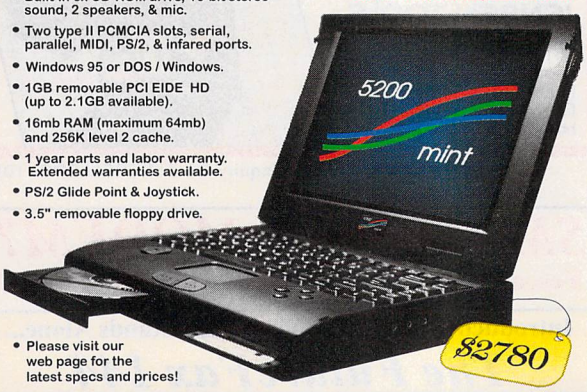

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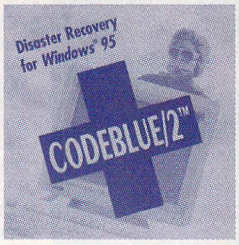

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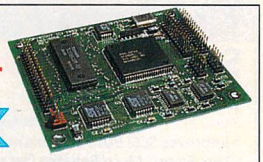

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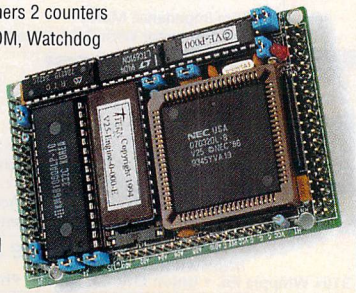

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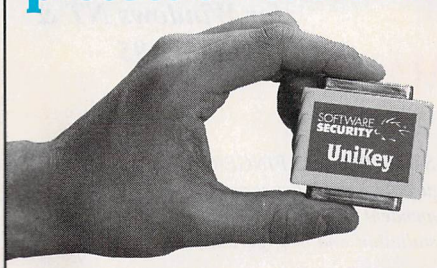

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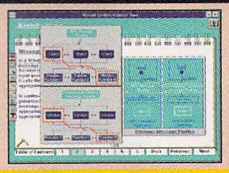

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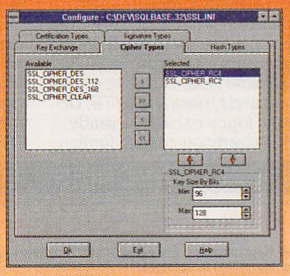

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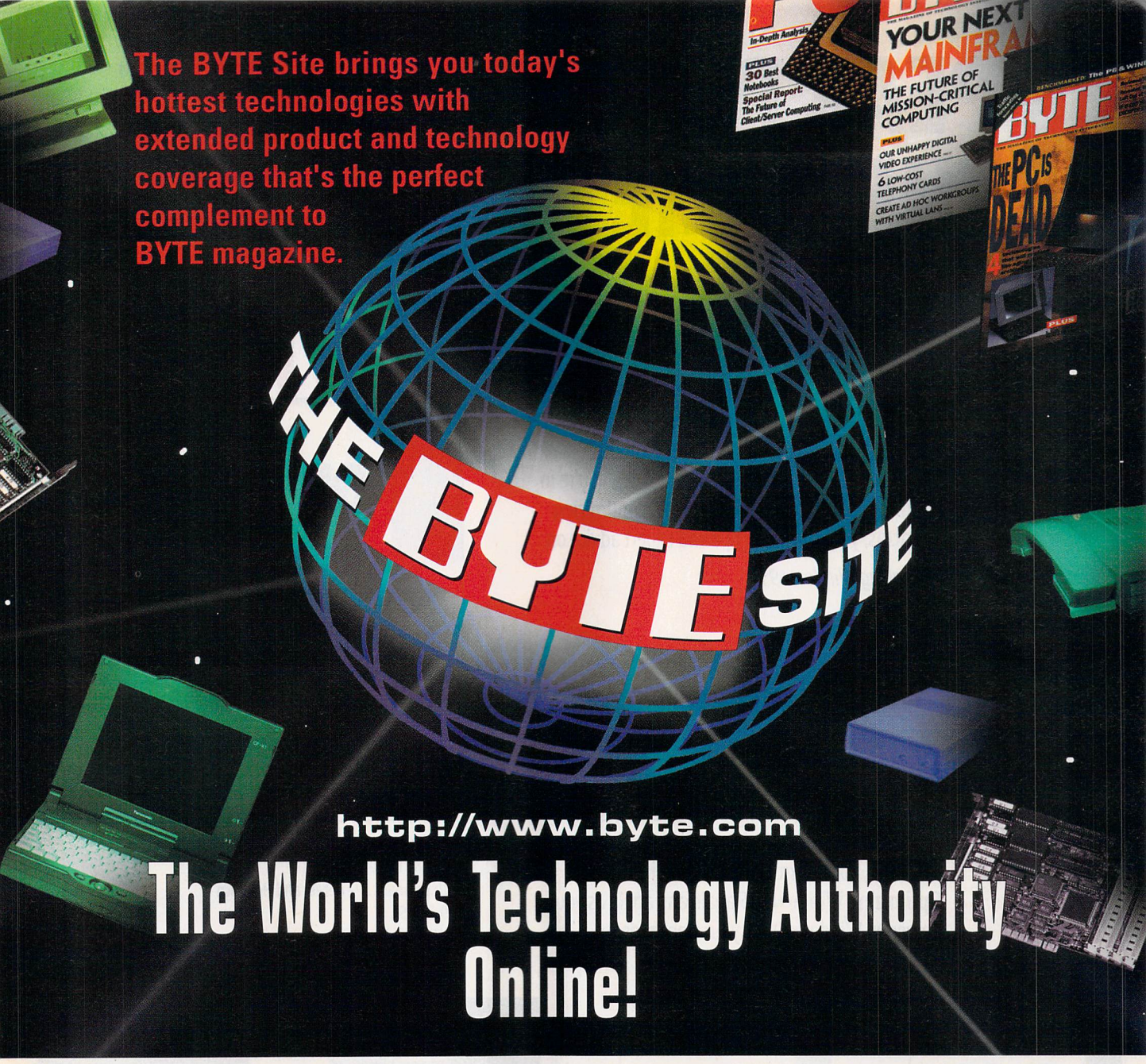

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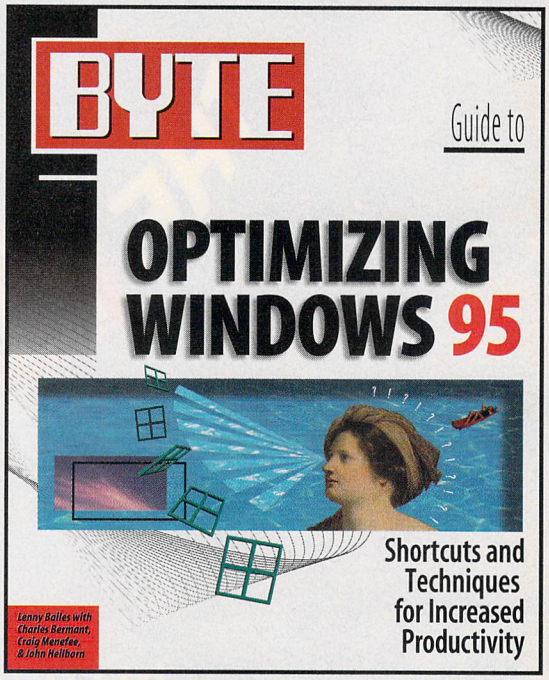

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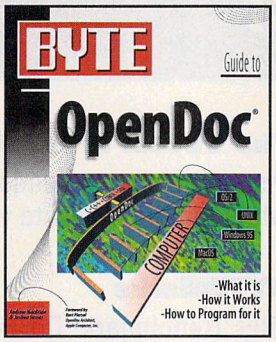

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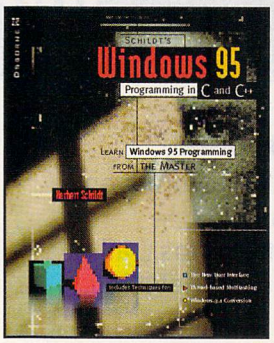

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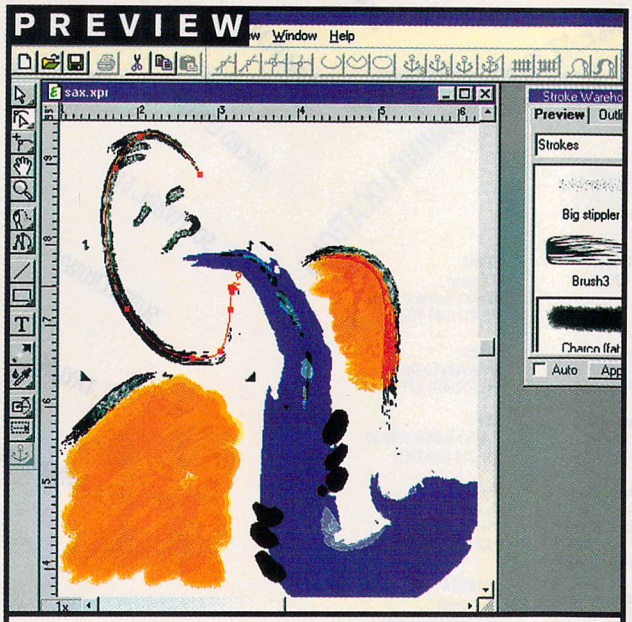

Expression
$449

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Fractal Design Corp.
Aptos, CA
(800) 846-0111
(408) 688-5300
http://www.fractal.com

Mr. Natural Does Vector Graphics

Imagine van Gogh doing technical illustrations: chip schematics done with thick dabs of yellow paint; network diagrams that look like fields of wheat. Not that you'd want impressionistic schematics, but this should give you an idea of the kind of output you can create with Expression, Fractal Design's new drawing program.

If you've worked with other vector packages, you know that to draw, you put down a path. Expression's innovation, called "skeletal strokes," lets you easily change the attributes of a path (which Fractal Design calls a "stroke"), but it also lets you apply any vector picture to a path. The best part is working with vectors in a way that's close to working with traditional art tools.

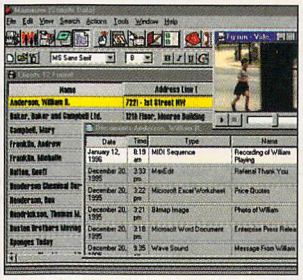
Expression's toolbox includes line- and shape-drawing tools, node tools, a freehand brush, and color gradients and fills. The Windows 95 beta version that I used delivered snappy performance without making me wait several seconds for the lines I drew to appear on-screen. I used Expression with a Wacom pressure-sensitive tablet (the ArtZ II), and the combination worked like a charm.

Expression can handle most vector formats and can save files in these formats, as well as export in bit-map formats. If I had to buy my first illustration program now, I'd buy Expression. It goes beyond the standard packages, and it has that natural feel. **–Dennis Barker**

Business

Download Sales Leads from the Internet

YOU CAN ACCESS, SEARCH, AND DOWNLOAD contact information on 10 million North American businesses directly into Maximizer Enterprise 3.0is (US$660 per seat) via the Internet and MultiActive Data's MultiActive Eagle on-line database. The product combines a contact manager, an application that automatically synchronizes field and home-office databases, and a translator that enables you to read and write Maximizer data from ODBC-compliant applications.



Contact: Maximizer Technologies, Inc., Vancouver, British Columbia, Canada, (800) 804-6299 or (604) 601-8000; http://www.maximizer.com.
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NOW ORGANIZATIONS CAN PROVIDE GUIDED, self-service customer support using the Web or corporate intranets. The Knowledge Builder development environment ($5000 per development-system license) integrates several problem-resolution methodologies, such as natural-language retrieval, case-based reasoning, decision trees, and cause/effect models, into an object-oriented development environment used by the Web Advisor application. Web Advisor ($1500 per concurrent user session) guides users through dialog boxes to solve their problems; it also records customer interaction.
Contact: ServiceSoft Corp., Needham, MA, (800) 737-8738 or (617) 449-0049; http://www.servicesoft.com.
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Communications

Advanced E-Mail Processing

DESIGNED FOR WINDOWS 95 AND NT, Re:Ply ($59.95) checks for and downloads e-mail from multiple accounts; generates responses to e-mail according to your criteria; maintains a library of responses or letters that it can automatically plug in; and maintains mailing lists. You can send and receive encrypted e-mail to and from other Re:Ply users; instruct the program to automatically return unwanted e-mail; forward and redirect messages; and send MIME and UUE attachments.
Contact: Solid Oak Software, Inc., Santa Barbara, CA, (800) 388-2761 or (805) 892-2550; http://www.solidoak.com.
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Data Acquisition

Windows Data-Acquisition Software

WITH WINVIEW ($99), YOU CAN ACQUIRE, display, and store data from data-

For our Previews, we take a look at Fractal Design's drawing package, Expression, and Gateway's big-screen notebook, the Solo 2100 S5-120.

acquisition boards. The program can display collected data in engineering units, including volts, degrees, and microstrain; display inputs in one graph or in separate graphs per channel; provide selectable *x*-axis settings for samples, seconds, minutes, hours, or days; and stream to disk at up to 333 kHz.
Contact: American Data Acquisition Corp., Woburn, MA, (800) 648-6589 or (617) 935-3200; http://www.adac.com.
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Macintosh

Graphics and Word Processing Solution

THE COREL DRAW 6 SUITE FOR POWER Macintosh (US$595) includes CorelDraw 6, WordPerfect 3.5, CorelDream 3D 6, Corel Texture 6, Corel Artisan 6, Corel Multimedia Manager 6, CorelTrace 6, MasterJuggler 2.0 Pro, and CorelChart 6. It offers more than 25,000 clip-art images, 1000 high-resolution photos, 1000 Type 1 fonts, and 700 TrueType fonts.
Contact: Corel Corp., Ottawa, Ontario, Canada, (800) 772-6735 or (613) 728-3733; http://www.corel.com.
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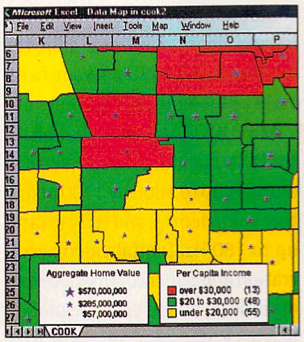
Mapping

Mapping in Excel 95

A MAPPING ADD-IN FOR MICROSOFT Excel 95 and Microsoft Office 95, the FirstMap CD-ROM ($69) includes boundary maps and data for counties, ZIP codes, and census tracts in



the U.S. The package also includes U.S. census information, such as age, gender, race, household, income, employment, and industry. In Excel, you can use FirstMap to create maps of your sales, potential earnings, and competition, from a national level to a neighborhood surrounding a specific store or outlet, and print them out.
Contact: Wessex, Inc., Winnetka, IL, (800) 892-6906 or (708) 501-3662; http://www.wessex.com.
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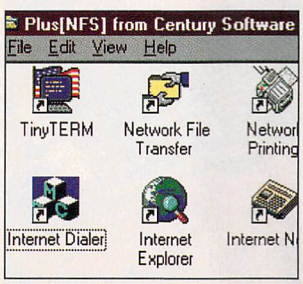
Networking

A Client/Server Intranet Suite

TO GIVE DESKTOP PC USERS SHARED ACCESS to applications, information, and peripherals located on a server or on another workstation, Plus[NFS] (single user, $199; multiple-license packages, from $179 per user) offers the TinyTerm terminal-emulation utility, which allows desktop connections to popular Unix applications; FTP file transfers; an e-mail and newsreader client; a Web browser; TCP/IP file and printer sharing; and client/server and peer-to-peer networking capabilities using TCP/IP.



Contact: Century Software, Inc., Salt Lake City, UT, (800) 877-3088 or (801) 268-3088; http://www.censoft.com.
Circle 1037 on Inquiry Card.

Advanced CD-ROM Networking

WITH SCSI EXPRESS 2.0 FOR WINDOWS NT ($1995 to $3995, depending on device support), you can use NT's performance monitoring to choose optimal configurations for networked CD-ROM drives. The program can map multiple CD-ROMs as a single network share to bypass the 23-drive-letter limitation; it also enables users to share a CD-ROM across multiple groups. The Autoshare feature provides automatic sharing of CDs.
Contact: Micro Design International, Inc., Winter Park, FL, (800) 228-0891 or (407) 677-8333; http://www.mdi.com.
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Unix

Scanning Software for Unix

NOW UNIX USERS HAVE A SET OF TOOLS for scanning and working with scanned images. EasyCopy/Scan (single-user license, $695) lets you prescan a page in low resolution, display the prescan, and modify it before the final scan. You can set the resolution to match a given file's size or an image's dimensions, or you can impose a maximum file size on the available resolution.
Contact: AutoGraph International, Inc., San Jose, CA, (408) 436-7227; http://www.augrin.com.
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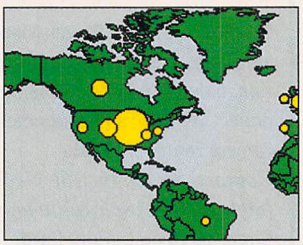
The Web

Web-Server Log-File Analysis

WITH WEB TRACKER 1.0 ($495), YOU CAN analyze access patterns for your Web site. The program, for Windows



3.x, 95, and NT, supports exploratory analysis through fast drill-down and a variety of trending and geographical charting functions.
Contact: Cambridge Quality Management, Inc., San Francisco, CA, (415) 750-1327; http://www.CQMInc.com/.
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Monitor Internet Usage

COMPANIES CAN MANAGE AND REPORT their Internet, intranet, and on-line usage with Sequel Net Access Manager 1.0 (one to 49 users, US$89 per user). You can have the program report at the group level; activate or deactivate logging or monitor-

ing functions; and grant or deny site access. The program enables you to monitor Internet activity based on protocols such as HTTP, NTTP, FTP, and SMTP; internal Web servers; and centrally accessed online services.
Contact: Sequel Technology Corp., Willowdale, Ontario, Canada, (800) 881-2465 or (416) 756-3551; http://www.sequeltech.com.
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Windows NT

Analyze Windows NT Client/Server Systems

DYNAMEASURE (FOUNDATION LICENSE, $29,995) puts controlled stress on Windows NT client/server systems and then measures the effect of the stress. Test specifications include OLTP reads, writes, and mixed read/write tests, including versions that use BLOBs.
Contact: Bluecurve, Inc., Oakland, CA, (510) 267-1500; http://www.bluecurve.com.
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Orderly Shutdown for Windows NT Servers

DESIGNED FOR UNATTENDED REMOTE WINDOWS NT servers, Sentry ShutDown Remote Power Manager provides a multilevel-password interface for power management of mission-critical NT servers and workstations. The product comes in two versions, supporting out-of-band modem and RS-232 communications ($669.95 and $719.95, respectively); an optional model supports an in-band telnet TCP/IP session.
Contact: Server Technology, Inc., Sunnyvale, CA, (800) 835-1515 or (408) 745-0300; http://www.servertech.com.
Circle 1041 on Inquiry Card.

Software Updates

StudioPro 2.0 for Power Macintosh, a modeling, rendering, and animation package, adds in-context modelers; on-the-fly animation; a deformation tool; spline and polygonal-based modeling; a project window; an Environment Palette; a scan-line renderer; and camera controls. $1495.
Contact: Strata, Inc., St. George, UT, (800) 678-7282 or (801) 628-5218; http://www.strata3d.com.
Circle 1044 on Inquiry Card.

A computerized in/out board and messaging package for LANs and WANs, **Who's Where 2.0 for Windows** offers automated status log-in upon start-up, automated status log-out upon shutdown, group messaging, TCP/IP support, reporting capabilities, and integration with e-mail. Stand-alone version, from $50; 10-user license, $395; 25-user license, $835; 50-user license, $1295.
Contact: Core Technology Corp., Lansing, MI, (800) 338-2117 or (517) 627-1521; http://www.ctc-core.com.
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An image editor for Windows 95 and NT, **Paint Shop Pro 4.0** provides an enhanced paintbrush tool; special effects; support for 33 formats; an enhanced retouch tool; a selections feature, which allows you to adjust overall opacity, designate a transparent color, or feather a selected area; an Image Arithmetic feature; and an integrated image browser. $69.
Contact: JASC, Inc., Eden Prairie, MN, (800) 622-2793 or (612) 930-9800; http://www.jasc.com.
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HARDWARE

Add-Ins

2-D and 3-D Graphics and Video Acceleration

BASED ON THE S3 VIRGE 64-BIT GRAPHICS and video accelerator chip, the Fahrenheit Video 3D package (with 2 MB of memory, $239) comes in a 2-MB EDO DRAM configuration for the PCI bus and supports screen resolutions up to 1600 by 1200 pixels, true color depths, and refresh rates up to 160 Hz. Digital video acceleration and SuperZoom video scaling provide full-screen, full-motion playback at resolutions up to 1024 by 768 pixels.
Contact: Micronics Computers, Inc./Orchid Technology, Fremont, CA, (800) 577-0977 or (510) 651-2300; http://www.orchid.com.
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12-bit A/D System

THE COMPUSCOPE 8012 ($7995) IS AN IBM AT-compatible ISA-bus card capable of performing 12-bit A/D conversion at real-time sampling rates up to 100 MSPS in single-channel mode and 50 MSPS in dual-channel mode, with a bandwidth of 40 MHz. The card can store up to 4 million samples in its on-board memory, and you can stack data from successive triggers.
Contact: Gage Applied Sciences, Inc., South Burlington, VT, (800) 567-4243 or (514) 337-6893; http://www.gage-applied.com.
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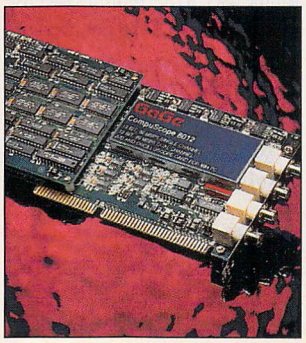

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Communications

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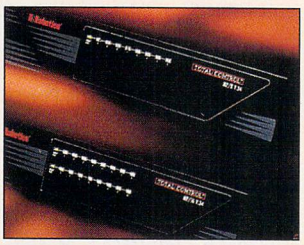

Contact: U.S. Robotics, Skokie, IL, (800) 877-2677 or (847) 982-5010; http://www.usr.com.
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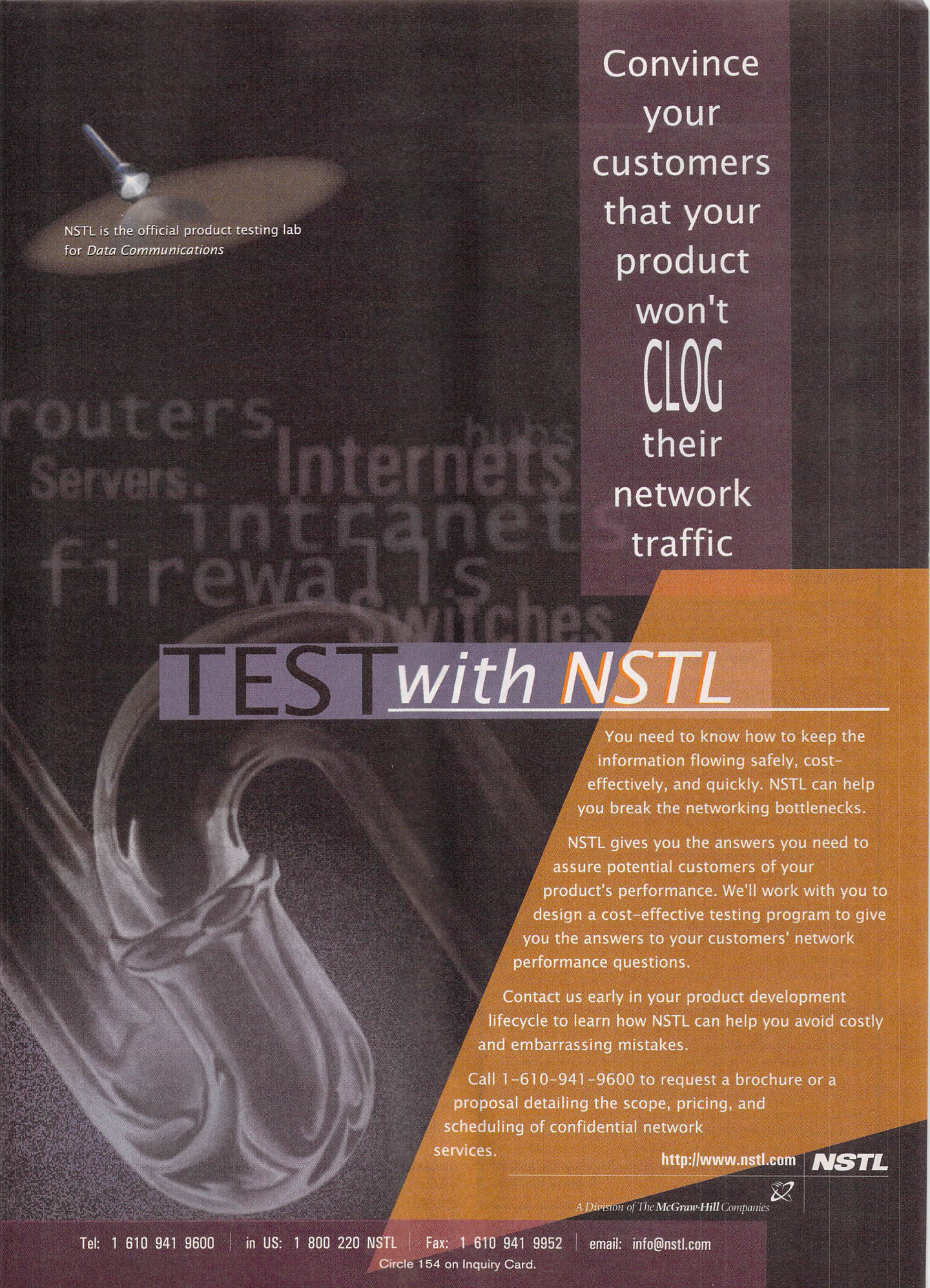
THE VIVITAR MPP-2 ($249.95), A COLOR video phone system, transmits sight and sound over standard telephone lines using a 486-based mul-



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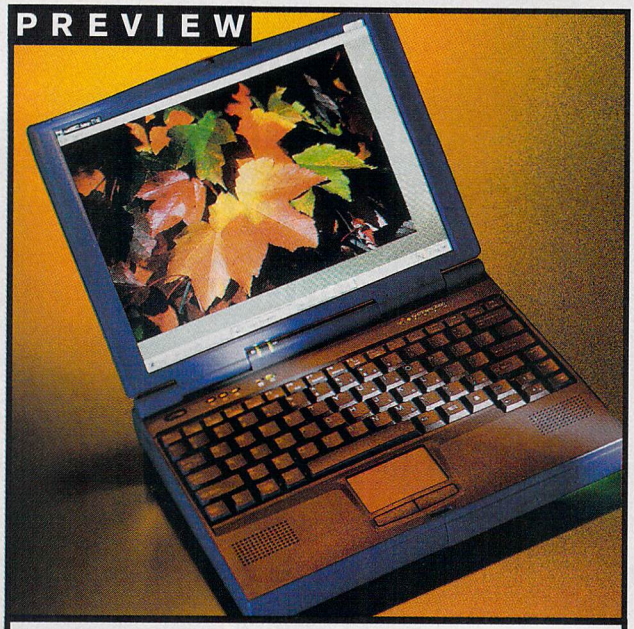
PREVIEW



Gateway 2100 S5-120
$3799 as reviewed

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Gateway 2000
North Sioux City, SD
(800) 846-2000
(605) 232-2000
http://www.gw2k.com

Gateway's Big-Screen Notebook Debut

The Solo 2100 series of multimedia notebooks blends raw power and good looks into a 7-pound package that's a perfect fit for on-the-go computing. Sporting a rich set of standard features and available options, the Solo 2100 affords Gateway the hope of garnering a bigger share of the portables market.

Gateway lets you configure your Solo with a wide array of options: a 100-, 120-, or 133-MHz Pentium; a 256-KB cache; up to 40 MB of EDO RAM; and a 540-MB to 1.3-GB hard drive. Multimedia support includes a six-speed CD-ROM, which you can pop out to insert a floppy drive module as needed; 16-bit sound; and speakers. I found the sound quality from the Solo 2100 S5-120's tiny speakers adequate for Windows' sounds and business audio.

The Solo's 12.1-inch active-matrix color display (see the photo), which is powered by a 32-bit accelerator with 1 MB of EDO video memory, rivals a 14-inch desktop monitor. When configured for a resolution of 800 by 600 pixels and 64,000 colors, images and text were sharp and clear.

Fitting a keyboard and a pointing device onto a notebook can create problems, and the Solo 2100 S5-120 is not exempt. The keys in the top row—including the Ins, Del, Home, End, and function keys—are smaller than normal, making them difficult to find without peeking. And the addition of four new keys to the bottom row shrinks the space bar to a diminutive 3-inch target. The Synaptics touchpad is a joy to operate, but I soon found that its position, directly below the tiny space bar, left me no room to rest my thumbs, which led to a spate of accidental pointing and clicking.

Although it suffers from the same drawback as its peers—cramming a lot of computer into a small package—good looks and versatility make the Solo 2100 S5-120 an attractive choice for mobile computing.

–Robert L. Hummel

PHOTOGRAPH: LIGHTWORKS PHOTOGRAPHIC © 1996



timedia PC and a 14.4-Kbps modem. The plug-and-play system comes with a golf-ball-size, prefocused camera that mounts on top of your monitor and provides refresh rates up to 10 fps. The package includes PictureWorks' PhotoEnhancer software and Smith Micro's VideoLink videoconferencing software.
Contact: Vivitar Corp., Newbury Park, CA, (805) 498-7008.
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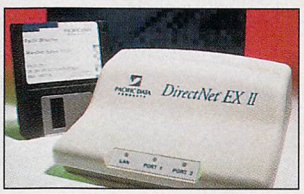
Networking

External and Pocket Print Servers

The DirectNet EX II external print server and the DirectNet PEPS2 Plus pocket print server facilitate access to printer locations on NetWare, TCP/IP, and AppleTalk networks. The EX II ($399) includes two high-speed bidirectional parallel data ports; the PEPS2 Plus has one. Both units support Novell's 4.x Network



Directory Service and have 10Base-2 and 10Base-T connectors.
Contact: Pacific Data Products, San Diego, CA, (800) 737-7117 or (619) 552-0880; http://www.pacdata.com.
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Designed for Internet and intranet applications, the Axis NetEye 200 ($1299) is a self-contained, palm-size camera that attaches directly to a 10-MB Ethernet network. You can use the camera as a replacement for closed-circuit video or a PC with a frame-grabber.
Contact: Axis Communications, Inc., Woburn, MA, (800) 444-2947 or (617) 938-1188; http://www.axisinc.com.
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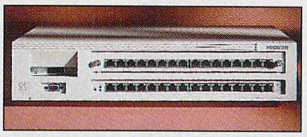
Workgroup Switching

Four Fast Ethernet devices, the Hi-Speed 150 series (from $7595) provides up to 32 Ethernet connec-



tions, as many as 16 Fast Ethernet connections, and the ability to let users interchange FDDI, ATM, and WAN uplinks within the same unit. All Fast Ethernet ports support automatic switchable operation at 10 or 100 Mbps.
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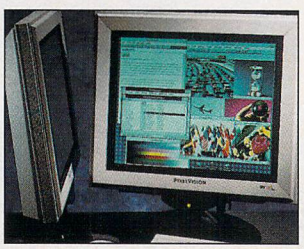
Peripherals

16-inch Flat-Panel Monitor

The PV116SX (under $10,000) is an active-matrix color LCD flat-panel monitor that measures about 3 inches deep and has a resolution of 1280 by 1024 pixels and a diagonal viewing area of 16.1 inches. The monitor provides a 2-million-color palette, on-screen menu controls, and options for finger-touch



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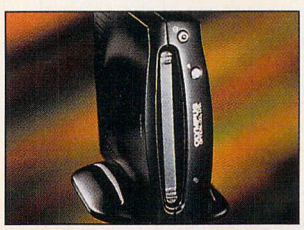

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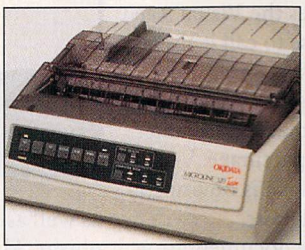

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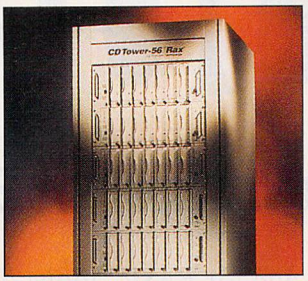

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Contact: Digital Equipment Corp., Maynard, MA, (800) 344-4825 or call local Digital dealer; http://www.workstations.digital.com.
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DESIGNED FOR MULTIMEDIA AND GAMING enthusiasts, the Presario 8000 Series (from $2499, without a monitor) delivers PowerVR Arcade 3-D Graphics technology, featuring 6 MB of graphics memory and supporting up to 1 million large polygons per second; the InterWave sound system; and JBL Pro speakers, with a separate tweeter and full elliptical driver. A 33.6-Kbps Talk and Send DSVD modem provides Internet access over standard telephone lines. Other features include up-to-200-MHz Pentium processors; 24 to 32 MB of RAM; 512 KB of pipeline burst cache; and up-to-3.8-GB hard drives.



Contact: Compaq Computer Corp., Houston, TX, (800) 345-1518 or (713) 514-0484; http://www.compaq.com.
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Visual Age for BASIC...Sort Of

IBM's Visual Age for BASIC looks like VB but adds OOP underneath.

By Rick Grehan

Regular readers of this column may recall that in October 1995, I examined IBM's Visual Age for C++ on OS/2. Since then, IBM has extended the Visual Age product line to new OSes and languages. Visual Age for Smalltalk existed before the C++ variant. Visual Age for C++ is now available on Windows NT. IBM has also released Visual Age for COBOL. The most recent addition to the product line, Visual Age for BASIC (the product had a code name of Bart), however, more closely resembles Microsoft's Visual Basic than it does any of the other Visual Age products.

The Visual Age paradigm encourages construction by *parts* (in IBM lingo, a part is a visual or nonvisual component). The developer specifies the interactions of parts and, therefore, the execution behavior of the application by wiring together parts and defining activities associated with those connections.

For example, suppose you're building a data-input screen that consists of a listbox and a "clear" button. You want the clear button to erase whatever is in the listbox. Using the Visual Age construction methodology, you connect the button to the box—the Visual Age integrated development environment (IDE) will draw a line from button to box—and associate an event with that connection. In this case, you tell the system that a click event on the button triggers the `erase()` method of the listbox. This construction technique applies to nonvisual objects as well as the visual ones I used in the example.

Thus, when Visual Age for BASIC appeared (I examined a late beta version running under NT, but IBM says it will also release versions for OS/2 and AIX), I was eager to explore the Visual Age interface elements of the package and investigate how IBM had whipped BASIC into object-oriented shape. Unfortunately, although I was looking forward more to the former aspect—the program's Visual Ageness—it was the latter aspect—the object-oriented features—that proved to be more interesting.

Bluntly put, it appears that the sole reason the package carries the Visual Age prefix is that IBM chose to call it Visual Age for BASIC. Were Visual Age for BASIC and Visual Age for C++ presented to me as siblings, I'd suggest that the presenter go back and check the parentage. Visual Age for BASIC's interface is obviously descended from Visual Basic.

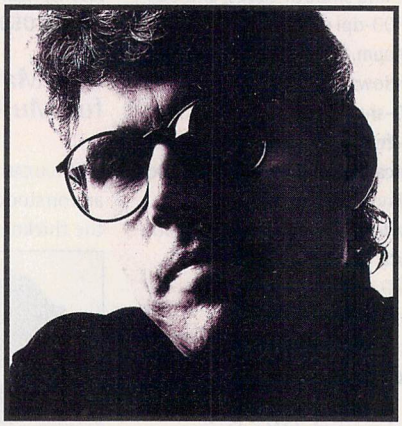
Missing from all the documentation (available in the beta version only in online format) is any mention of the word *part*. Instead, the documentation speaks of *components*. Though some might suggest that I'm nit-picking, I can't shake the feeling that there's some sort of capitulation going on here.

Applications construction under Visual Age for BASIC proceeds along lines similar to those of Visual Basic and draws from a similar cast of characters. Forms are the fundamental window units, and you populate them with controls by selecting from a toolbar. Once a control is situated, you can summon an associated properties window and a code-editing window. However, if you are familiar with Visual Basic, you've seen all this before.

WHERE TO FIND

IBM
http://www.software.ibm.com/ad/vabasic/

On a more positive note, Visual Age for BASIC does a good job of clothing BASIC in object-oriented garb. It supports class hierarchies and multiple inheritance as well as inheritance-based polymorphism. Also, Visual Age for BASIC can digest System Object Model (SOM) objects as well as OLE objects.



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Finally, if your design work tends toward client/server database development using DB2 on NT, Visual Age for BASIC recognizes a separate stored procedure project, which allows you to build and test stored procedures much as you would build BASIC applications. (Admittedly, I did not experiment with that portion of the package.)

Visual Age for BASIC's first release amounts to a somewhat improved Visual Basic. (If you've been wondering, from what I've seen so far, the syntax differences between Visual Age for BASIC and Visual Basic are so minor that porting programs written for the latter to the former should be—and I stress the words *should be*—painless.) IBM representatives have suggested that future versions might incorporate more of the original Visual Age environment. I'd like to see that. B

Rick Grehan is a senior technical editor for BYTE reviews and the coauthor of The Client/Server Toolkit. *You can reach him by sending e-mail to* **rick_g@bix.com.**

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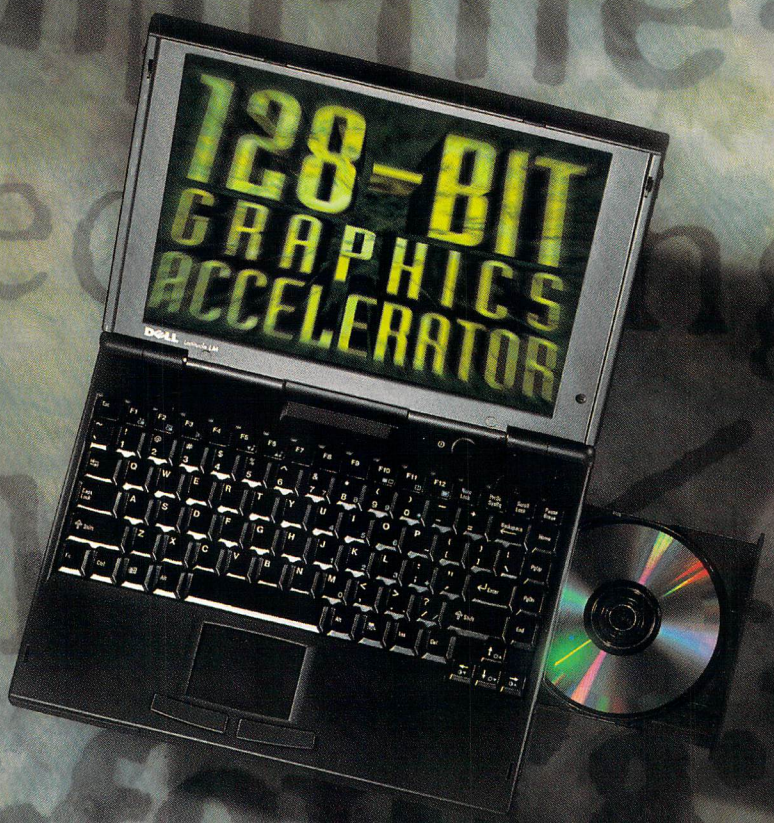

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Windows 95 ◆ MS Plus! CD ◆ MS Intern

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- 3.2GB Hard Drive [9.5ms]
- 17HS Trinitron Monitor (15.9" v.i.s., .26dp, 1600 x 1200 max. res.)
- Matrox Millennium 4MB WRAM Video Card
- *NEW* 12X EIDE CD-ROM Drive
- 33.6 US Robotics Telephony Modem

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DELL DIMENSION P200v
200MHz PENTIUM PROCESSOR

- 16MB SDRAM Memory
- *NEW* 2.1GB Hard Drive [10.5ms]
- 15TX Trinitron Monitor (13.7" v.i.s.)

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★ *Upgrade to a 3.2GB Hard Drive (11ms), add $85.*

★ *Upgrade to a 17LS Monitor (15.7" v.i.s.), add $179.*

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Business Lease: $74/Mo.
Order Code #500348

DELL DIMENSION P133v
133MHz PENTIUM PROCESSOR

- 16MB SDRAM Memory
- *NEW* 2.1GB Hard Drive [10.5ms]
- 15LS Monitor (13.7" v.i.s.)
- 3Com EtherLink Interface Combo PCI Card

★ *Upgrade to 32MB SDRAM, add $199.*

★ *Upgrade to a 3.2GB Hard Drive (11ms), add $85.*

★ *Upgrade to a 15TX Trinitron Monitor (13.7" v.i.s.), add $40.*

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- 32MB Error Correcting Code (ECC) EDO Memory (256MB Max)
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- 6 Expansion Slots: 3 PCI, 3 EISA
- 6 Drive Bays: 3 External 5.25"/ 3 Internal 3.5"

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★ *Upgrade to 3 Years On-Site Service, add $99.*

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- 4GB Fast/Wide SCSI-2 Hard Drive [7200RPM, 8ms] (12GB Max)
- 6 Expansion Slots: 3 PCI, 3 EISA
- 6 Drive Bays: 3 External 5.25"/ 3 Internal 3.5"

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★ *4/8GB DAT SCSI Internal TBU, add $999.*

★ *Upgrade to 3 Years On-site Service, add $99.*

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- *NEW* 2.1GB Hard Drive [10.5ms]
- 15TX Trinitron Monitor (13.7" v.i.s.)
- Matrox Millennium 4MB WRAM Video Card
- *NEW* 12X EIDE CD-ROM Drive

★ *Upgrade to a 3.2GB Hard Drive (9.5ms), add $99.*

★ *Upgrade to a 17LS Monitor (15.7" v.i.s.), add $179.*

$2599

Business Lease: $96/Mo.
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DELL DIMENSION XPS P166s
166MHz PENTIUM PROCESSOR

- 32MB SDRAM Memory
- 3.2GB Hard Drive [9.5ms]
- 17HS Trinitron Monitor (15.9" v.i.s., .26dp, 1600 x 1200 max. res.)
- Matrox Millennium 4MB WRAM Video Card
- 8X EIDE CD-ROM Drive

★ *Upgrade to 64MB SDRAM, add $299.*

★ *Upgrade to a 20TD Trinitron Monitor (19.1" v.i.s., .26dp, 1600 x 1200 max. res.), add $799.*

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- 15TX Trinitron Monitor (13.7" v.i.s.)
- 2MB EDO ViRGE 3D Video Card
- 8X EIDE CD-ROM Drive

★ *Upgrade to 64MB SDRAM, add $299.*

★ *Upgrade to a 17LS Monitor (15.7" v.i.s.), add $179.*

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- MS Office Professional for Windows 95
- 28.8 XJACK®/Cabled Modem
- Leather Carrying Case

★ *3Com 10 BaseT Network Card, add $159.*

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- 16MB/810MB Hard Drive
- Options Bay accepts 6X CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery

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★ *15TX Trinitron Monitor (13.7" v.i.s.), MS Mouse and 104-key Win95 Keyboard, add $479.*

$2999‡

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- 11.3" SVGA Dual Scan Color Display
- 24MB/810MB Hard Drive
- Options Bay accepts 6X CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery
- MS Office Professional for Windows 95
- Nylon Carrying Case

★ *28.8 XJACK/Cabled Modem, add $199.*

★ *2nd Li-Ion Battery, add $249.*

$2799‡

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Order Code #800059

DELL LATITUDE LM P100SD
100MHz PENTIUM PROCESSOR

- 11.3" SVGA Dual Scan Color Display
- 16MB/810MB Hard Drive
- Options Bay accepts 6X CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery

★ *Upgrade to 24MB RAM, add $99.*

★ *Upgrade to a 1.3GB Hard Drive, add $200.*

★ *2nd Lithium Ion Battery, add $249.*

★ *Leather Carrying Case, add $129.*

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- Altec Lansing ACS-31 Speakers
- MS® Office Professional with Bookshelf
- ★ **FREE Norton/Visio Express Software Suite†**
- Microsoft® Windows 95/MS Plus! CD/ 30 Days Free Support/MS Mouse
- 3 Year Limited Warranty† with 1 Year On-site Service^Δ
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- ★ ***Upgrade to a 17LS monitor (15.7" v.i.s.), add $179.***

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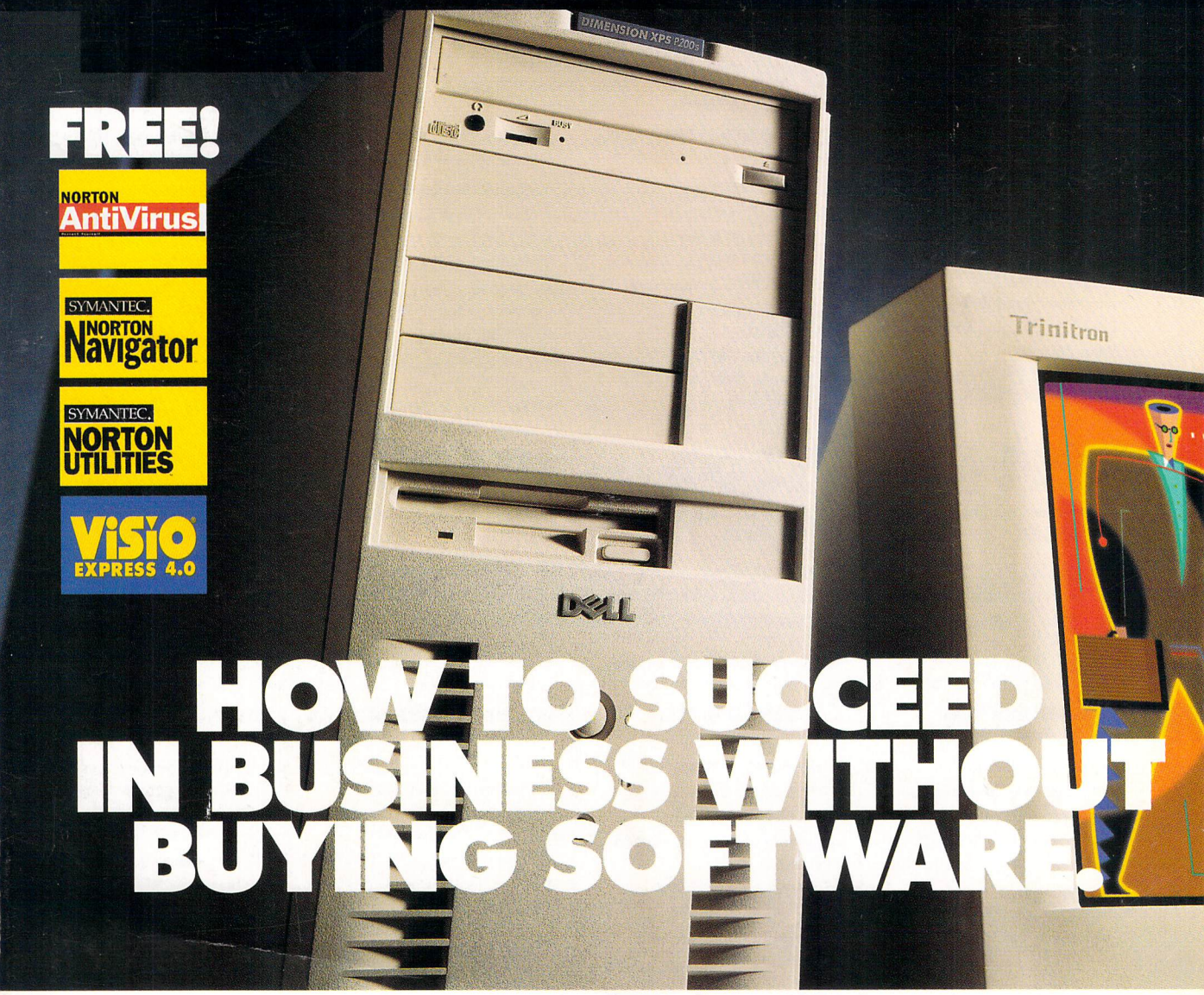

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