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Volume 21, Number 8

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Any PC maker can claim to offer a solution that covers your needs. But at Micron Electronics, we prefer to let our history and our products speak for themselves. We think you'll agree, it's an impressive story.

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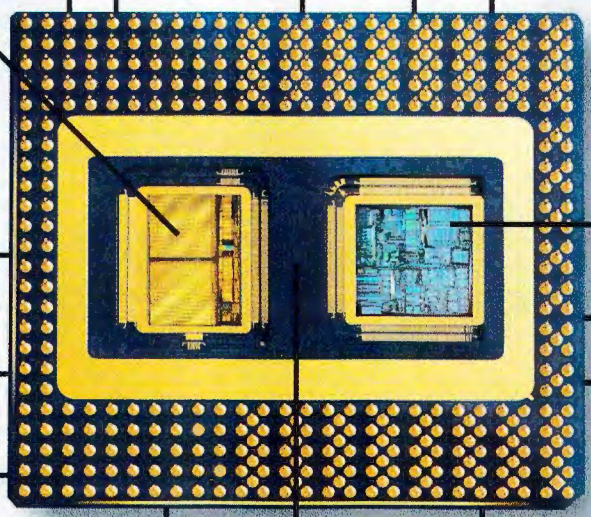

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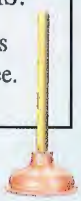

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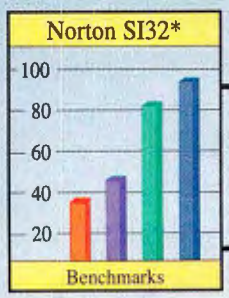

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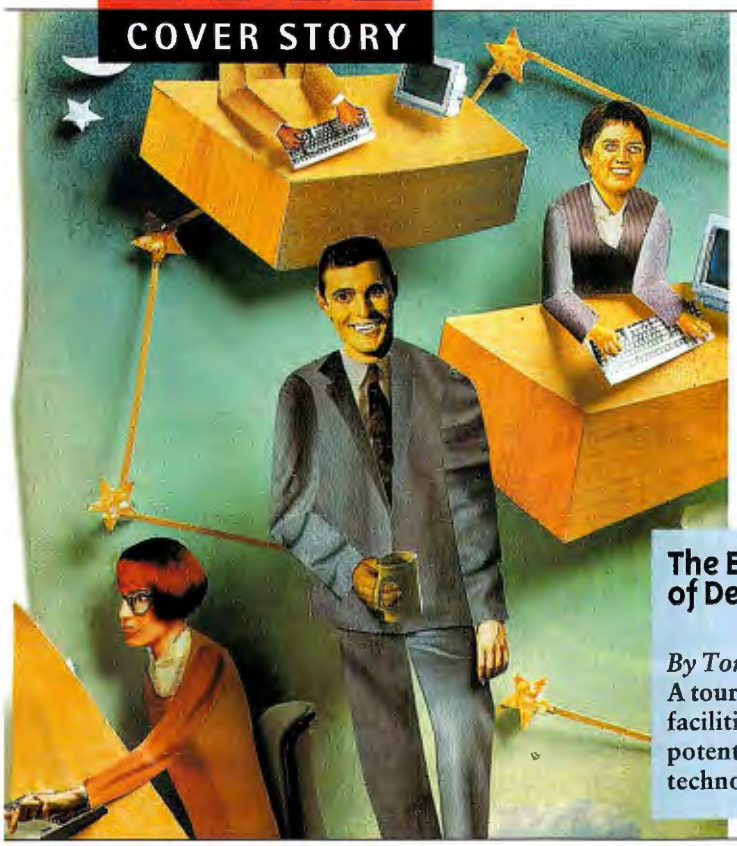

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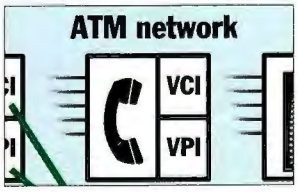

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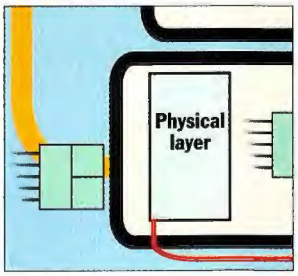

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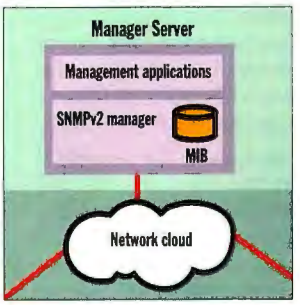

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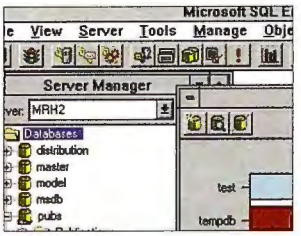

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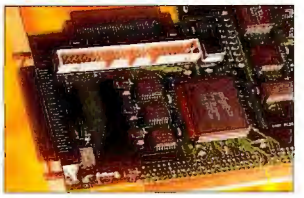

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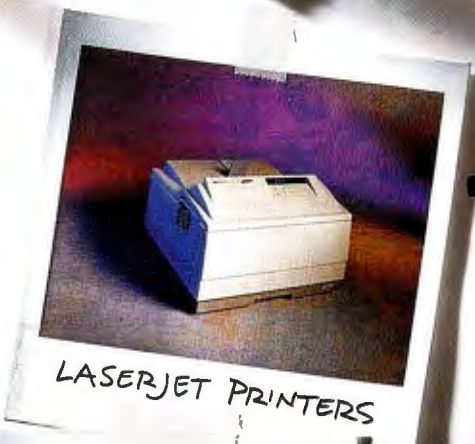

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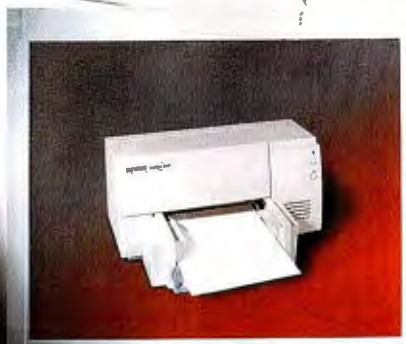

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BYTE

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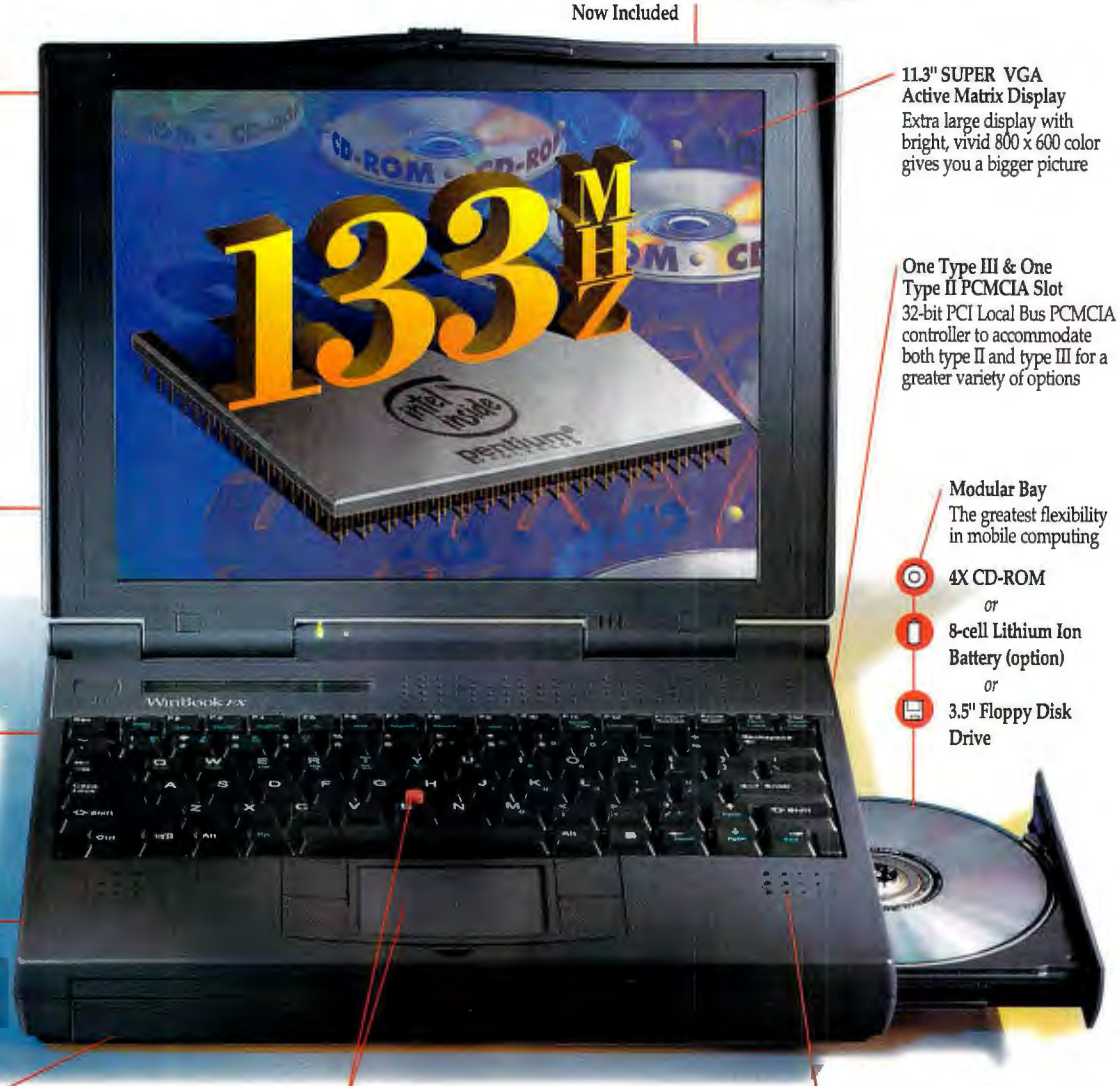

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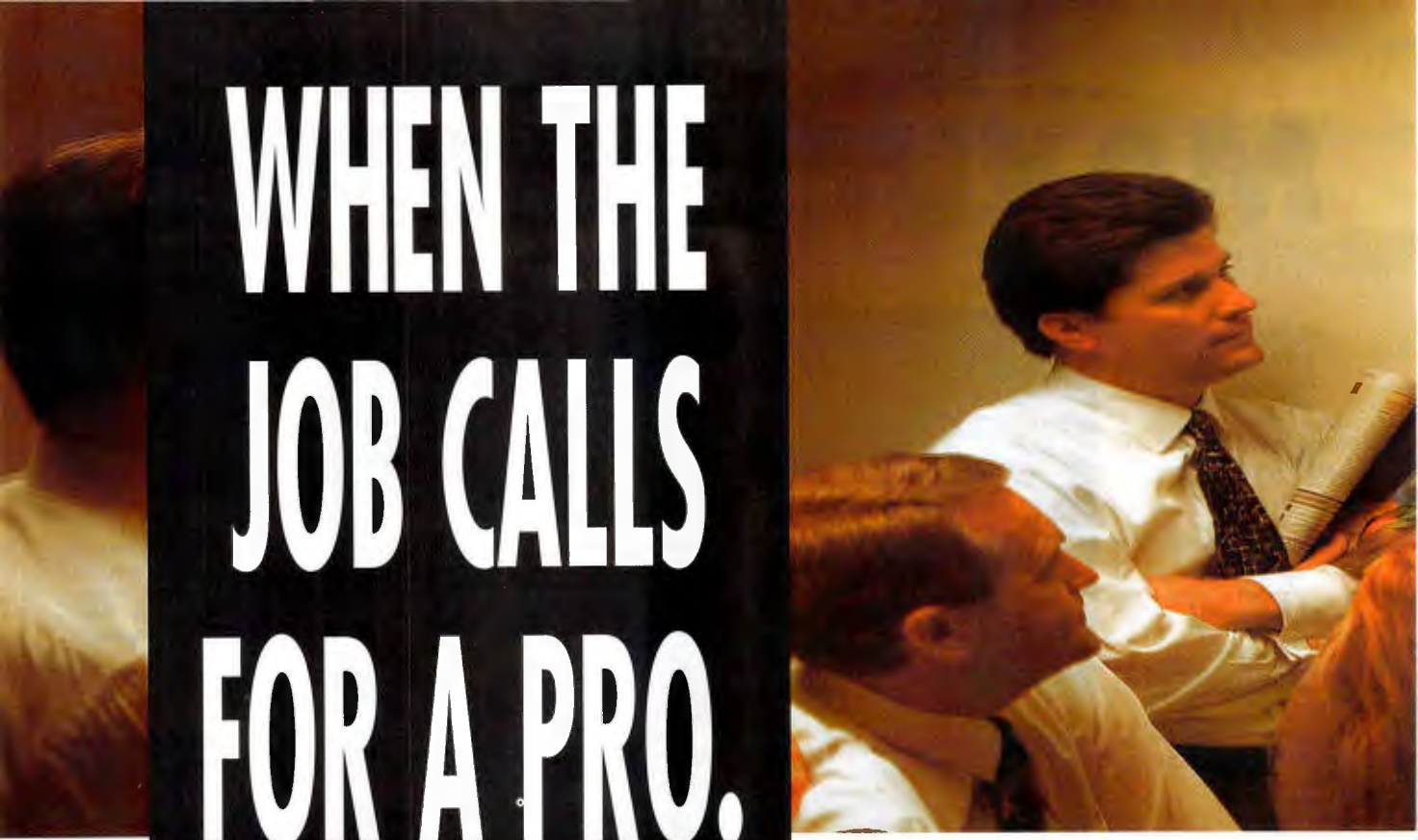

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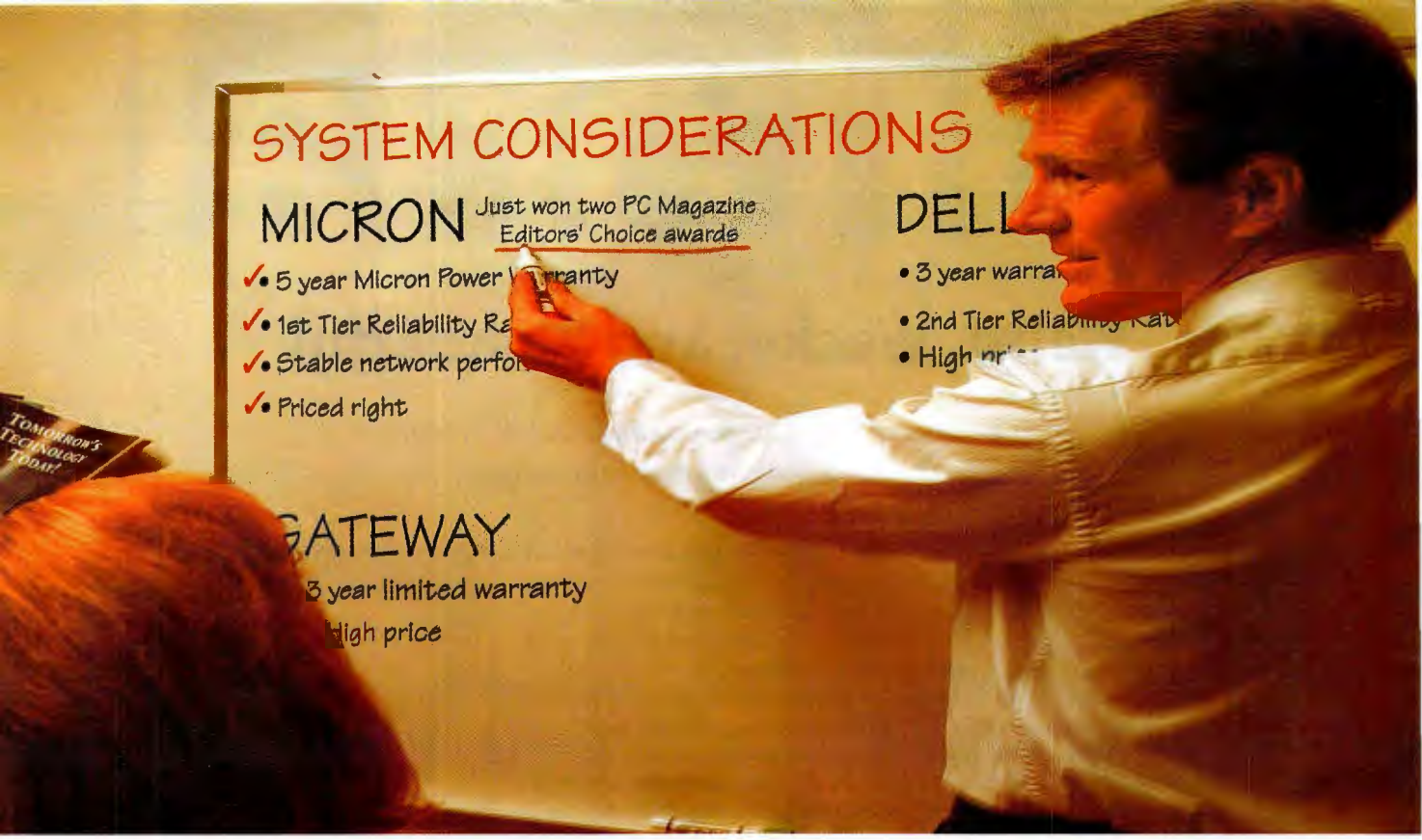

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editorial

Weird, Wacky, and Wonderful

Life's never boring in computing, and it's about to get a whole lot more interesting.

Every few years, the computer industry experiences a collective madness in which Northern California civility gives way to a mentality more typical of Chicago commodities pit bulls. It's shaping up to be one of those years.

Those of us who buy and use computer technology are confronted by a horde of shouting, shoving vendors, all vying for our business. Our whole world is being shaken up. And that's probably a good thing.

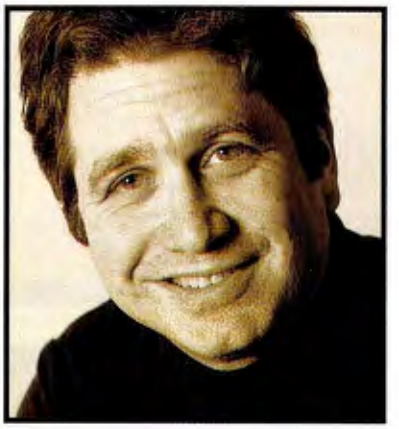
After all, it's been relatively calm for a few years. It used to be you bought a Novell LAN, Windows or the Mac OS, somebody's Unix relational database management system (RDBMS), maybe PowerBuilder if you wanted to be really cool, and voilà!—a mainstream client/server computing architecture.

Then this weird technology called the Web kicked in. Build information systems around plain-ASCII text? Program in scripting languages? Sounded pretty primitive compared to database managers, SQL, and C++. But somewhere along the line, the sharpest information-technology (IT) people got a gleam in their eye. This Web technology seemed to address a whole host of problems that client/server computing just hadn't delivered on: portability, flexibility, and location independence.

Remember how client/server computing was supposed to let you shift work between client and server as needed? No MIPS would go unused. However, nearly a decade after client/server first debuted, few tools exist that allow anything like a dynamic repartitioning of an application; none that I know of does it in real time or automatically. And even the best application splitters work only within their own confines. Try taking a complex application system developed in C++, PowerBuilder, and Visual Basic and start shifting functions around. Can't get there from here, as they say in Maine.

The wacky part is, this new Webbed world can get you at least partway there. Start with a plain-vanilla browser. It'll run on the thinnest client platforms, even the much-heralded Web PC. Need a fatter one? Add plug-ins, Java, or ActiveX applets. Want a totally obese client? Put Windows 95 underneath.

The wonderful part is, you can figure out all this for yourself. The whole fat-server/fat-client debate has gone from a strategic one to a tactical one. There's no one right way to divide the work between server and client, despite the marketectural pretensions of our software pit-bull traders.



computing, replaces monolithic blocks of code with many smaller objects that cooperate to form a working application. The objects can move around and be moved around by an intelligent networked OS.

The whole fat-server/fat-client debate has gone from a strategic one to a tactical one.

Will embracing this flexibility and diversity bring you closer to that holy grail of application systems that automatically reconfigures itself for maximum performance and balanced capacity utilization? No; the best you can do is achieve a static load balance with this new toolkit of architectures.

For now, that's as good as it's going to get. If we can just avoid getting sucked into a whirlpool of false pronouncements that a particular programming paradigm is the right one, we now have the tools to get halfway toward that holy grail.

When do we get to the finish line? Ironically, we'll have to wait until client/server computing withers away. Its emerging successor, distributed object computing, replaces monolithic blocks of code with many smaller objects that cooperate to form a working application. The objects can move around and be moved around by an intelligent networked OS.

If it works (and that's a big *if*), it will be a big step forward. Meanwhile, the newfound flexibility of browser clients, server farms, and components that are their own middleware should keep us busy learning and marveling for the next few years.

Mark Schlack

Mark Schlack, Editor in Chief
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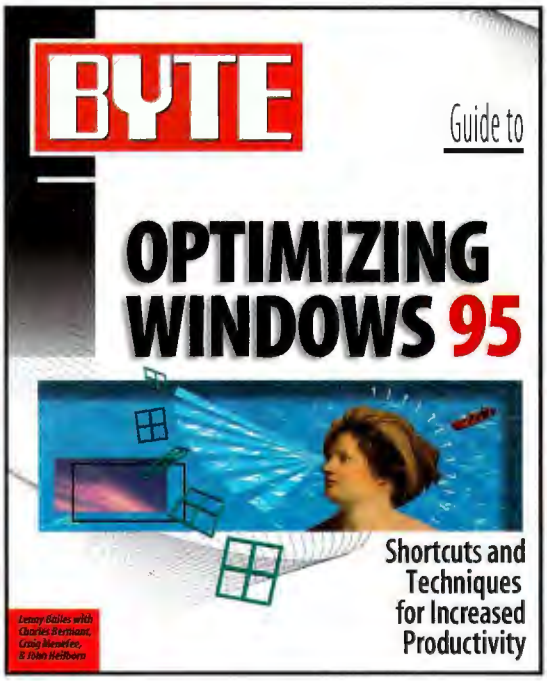

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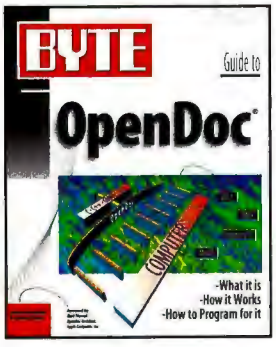

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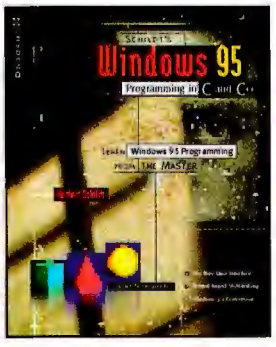

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inbox

The New BYTE

I really like BYTE's new format. Your use of pastel colors makes the magazine seem less stuffy and more approachable, yet you retain the same high quality in your in-depth coverage of state-of-the-art technology. My congratulations to your layout designers.
Frank Palmer
FPalmer@msn.com

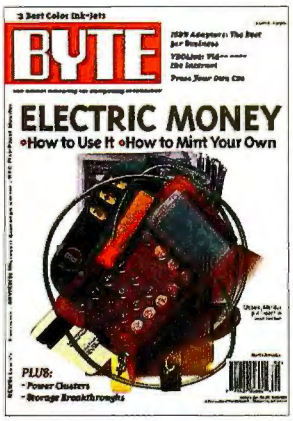
I've just read the June 1996 issue and wish you hadn't made the format switch. The script-like font used on the cover and for article headlines and subheadlines is difficult to read and does not present a high-tech feel. The new graphics are even worse. They make it appear that BYTE is dumbing down to reach a less technically oriented audience. I don't doubt that the same level of material is present, but I think it's being delivered in the spoon-fed manner of magazines for novices. Please reconsider your new look and make sure it's in keeping with your audience.
Alan T. McDonald
atmcdona@lanmail.rmc.com

We've had some feedback from readers about the new typefaces, and it's clear that we've gone too small and too scripty in a few instances. We're fixing those readability problems. To readers who are concerned that we're dumbing-down BYTE, I can only say, watch us. We're absolutely not dumbing anything down. I have received clear and consistent feedback from computer professionals over the last few years that they have too much information to assimilate in too little time. Often, they have to quickly come up to speed on areas outside their specialties. Our goal is to help you access and assimilate complex technical information in the shortest possible amount of time. Our new diagram style is intended to be simple—not simplistic—bold, and dynamic. We think that in time you'll appreciate that approach.—Mark Schlack, editor in chief

Get CORBA

After reading through several issues of BYTE, I have become very interested in the Common Object Request Broker Architecture (CORBA). Your articles mention the 440 companies that subscribe to this standard; however, nowhere is any mention made of how others can obtain a copy of the latest CORBA specifications.
Roy Weston
rweston@galileo.co.uk

You can find information and several links, including one to the CORBA 2.0 specification, at http://www.omg.org/, which is the home page of the Object Management Group (OMG). The Advanced Computing Laboratory at the Los Alamos National Laboratory also maintains a CORBA and



OMG information resources page (see http://www.acl.lanl.gov/CORBA/), which includes many technical papers as well as links to several related consortium, company, and project sites.—Eds.

Unix vs. NT—and OS/2

I was displeased at not seeing OS/2 included in your article "Unix vs. NT" (May). I believe there are more LAN Servers out there than NT servers—your own pie charts show what a small fraction of the market NT currently has, despite all the predictions for its glorious future. However, OS/2 didn't even rate a text box.
Geoffrey Snyder
gsnyder@gsnyder.seanet.com

*This was strictly a story about Unix and Windows NT. In addition to not bringing OS/2 into the discussion, we didn't write about NetWare, the Mac OS, the many different versions of Unix, or any other OSes. We cover all those OSes regularly in BYTE; in fact, we're the only computer magazine to do so. In this case, we decided to focus on Windows NT—because of its status as a newcomer—and compare it to Unix as a representative of the old guard. No slight to other OSes was intended.
—Tom R. Halfhill, senior editor*

Porting Unix

I use Unix extensively in a scientific research environment, but looking at the price of new NT machines—and especially NT software—often makes me think about switching. But I have invested years in developing code in a Unix envi-

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ronment. How difficult will it be to port this code to NT? Will I be able to use Unix's powerful shell and great tools in NT? Alternatively, does NT have comparable text-processing tools? Will I have to learn a new editor, a new way of managing files, and so forth? Are there products that give NT a Unix-like flavor and help with the porting process? I wish answers to these questions had been included in the article.

Mark Gerstein
Structural Biology Dept.
Stanford University
mbg@hyper.stanford.edu

Unfortunately, those questions were outside the intended scope of the article. That said, there are a number of alternatives. The Hamilton C shell port is available from Hamilton Laboratories (Sudbury, MA; hamilton@bix.com). Mortice Kern Systems (http://www.mks.com/) sells a popular Toolkit for NT. Datafocus (http://www.datafocus.com/) offers the Nutcracker family of products. Softway Systems (http://www.softway.com/) recently released OpenNT, and GNU tools are also available from various sources.

A search of the Web will turn up other resources. One place to start is the Windows NT Links page at http://www.unitek.com/pages/ntlinks.htm. If it's primarily a matter of cost, don't forget inexpensive Unix variants, such as Linux and FreeBSD.—Eds.

Use at Your Own Risk

Besides being interesting in itself, Microsoft's Power Toys suite of utilities ("Underground Upgrades for Windows 95," April) shows a design flaw in the localization model of Win 95. Since the suite's installation procedure did not recognize the standard folder names of my Italian version, it created a new, parallel, English folder hierarchy—"StartUp" instead of "Esecuzione automatica" and "Accessories/Multimedia" instead of "Accessori/Multimedia." It may cost companies substantial money, both in support and wasted employee time, to help their Win 95 users remove the clutter from their desktops.

Paolo Amoroso
amoroso@mclink.it

Microsoft is quick to point out that the Power Toys—and the newer Kernel Toys—are not part of Win 95 and are unsupported. At the present time, they exist only in an English-language version; you won't find them in any international area on Microsoft's Web site. While this may not constitute a localization flaw in Win 95 itself, it's definitely something that users of international versions should consider.—Eds.

No Fear with SGML

Many of the work-flow problems you identified in "Work Flow Without Fear" (April) may be symptoms of either using proprietary data formats that tie the user to particular products (and limit the types of processing that can be done) or using APIs rather than data formats, which leads to monolithic systems. Standard Generalized Markup Language (SGML), a highly successful ISO standard (ISO/IEC 8879:1986), allows a work flow of documents to be modularized: SGML can be used to define the interface format of the documents through the work flow. Apart from the extra certainty and rigor this can give to contracts for parts of a work-flow system, it also goes some way toward addressing some of the problems you mention.

Rick Jelliffe
Member, ISO Working Group on SGML
Sydney, Australia
ricko@allette.com.au

CodeWarrior No Be-All

In "The Be-All of Operating Systems" (May) you say, "Because of its Mac heritage, CodeWarrior has not traditionally generated thread-safe exceptions." This is Metrowerks' fault, not that of the Mac OS, which has had a threads library for many years. Apple cannot compel vendors to take advantage of Mac OS features; it's only fair that you castigate those vendors, not Apple, in print.

Maynard Handley
handleym@apple.com

We didn't intend to castigate anyone, but we should have made it clear that Metrowerks' past lack of thread support was a shortcoming of its compiler, not of the Mac OS.—Rex Baldazo, technical editor

It's Worse than You Thought

I find the estimate of $400 billion to be spent on the year-2000 problem ("Year 2000 Promises Strange Days Ahead," February) to be preposterous. If you estimate an average worldwide salary of $30,000—generous outside the U.S.—per programmer, with the four years that remain in which to solve the problem, you get an estimate of over 3.3 million programmers working nonstop until midnight on December 31, 1999. Somebody had better call the folks at Microsoft and tell them to free up their programming talent.

Jim Hyde
jhyde@rwbeck.com

The $400 billion figure that we quoted is actually the low end of the Gartner Group's (Stamford, CT) assessment. Gartner estimates that there are 220 billion lines of extant COBOL code. Locating code that must be modified, modifying it, and testing the modifications will cost 30 to 40 cents per line of code. Beyond the programming phases, additional costs of a year-2000 initiative, such as awareness, design, acceptance testing, implementation, documentation, and project management, increase the estimate to $1.10 per line of mainframe code.

Gartner also factored in the costs associated with languages other than COBOL, as well as the cost of fixing nonmainframe client/server systems, a good deal of which is associated with the labor-intensive process of assessing the problem. The result is a global, macroeconomic-based estimate of $400 billion to $600 billion that covers the years 1995 through 1999.
—Dave Andrews, news editor

FIXES

Due to a typographical error on page 176 of the April issue, we omitted a

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hyphen in the uniform resource locator for V Communications. The company's correct URL is http://www.v-com.com.

In our June comparison of ISDN terminal adapters ("Building Bandwidth"), we attributed the three units' poor transfer performance with V.120 communications set at 115.2 Kbps to some serial-port limitations on one of our Dell test systems. Since then, we've learned that both our test systems support 115.2-Kbps communications. We must therefore attribute all the blame to the terminal adapters.

The numbers in the third pie chart in the text box "Market Forces" on page 52 of the May issue add up to 101 due to a rounding artifact. We should have noted that in the caption.

COMING UP IN SEPTEMBER

COVER STORY:
CAN CABLE SAVE THE INTERNET?
Just as more businesses are building mission-critical applications that rely on the Internet, the network of networks is straining under bandwidth bottlenecks. Are cable modems really up to the task? Is ADSL a better solution? What are the implementation issues?

SPECIAL REPORT:
TELECOM
The telcos and the computer industry dream of a single all-digital network that will carry every type of data over one wire using a small set of protocols—and replace today's physically and logically distinct networks. BYTE examines the technology, protocol, bandwidth, and API issues that must be resolved before video, voice, and data networks can merge.

STATE OF THE ART:
SOFTWARE QUALITY IN A CLIENT/SERVER ENVIRONMENT
Here's what you need to know to create and debug complex applications in a distributed environment, from developing accurate specifications, to maintaining code quality in a teams environment, to real-world testing on a variety of platforms.

CORE:
OPTIMIZING JAVA
Java interpreters pay a speed penalty for their flexibility. Here's how developers can significantly speed up Java code with some help from optimizing compilers and judicious design.

REVIEW:
HEWLETT-PACKARD'S LASERJET 5M
The crown prince of the desktop laser market features PCL6, a radical departure from previous versions of HP's page-description language.

NSTL LAB REPORT
In our hardware Lab Report, NSTL looks at multifunction telephony boards that provide data, fax, and voice communications.

Circle 155 on Inquiry Card (RESELLERS: 156).

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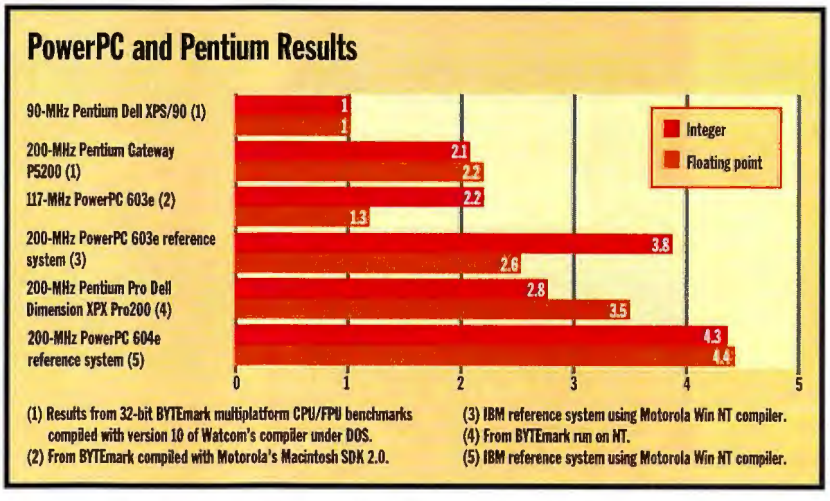
Has It Changed Your Life Yet?

New Desktop Standard: 200 MHz

Power users rejoice! Advances in processor technology bring new levels of affordable performance.

A new round of desktop and notebook systems with affordable but powerful 200-MHz processors will arrive throughout the second half of the year for PC-compatible systems and the Mac. Starting in June, the first systems using Intel's 200-MHz Pentium arrived, beating the 200-MHz 603e and 604e from Motorola/IBM out of the gate. However, companies such as Apple, Power Computing, and Umax Computer, who are basing their new Mac OS–based systems on the latest PowerPCs, should find the extra wait worthwhile. That's because early results from running BYTE's 32-bit multiplatform CPU/FPU BYTEmark tests (see the chart) indicate that the 200-MHz 603e and 604e outperform the 200-MHz Pentium and Pentium Pro, respectively.



Mainstream 200-MHz BYTEmark CPU/FPU results.

Both IBM and Motorola say they will release specific pricing for the 603e, a low-power-consumption processor that targets notebooks and entry-level desktops, and the 604e, which targets desktop and entry-level server systems, later this year. However, Power Computing says it will ship the first of its systems using the new PowerPC processors this summer, and that prices will be competitive with or better than equivalent Wintel PCs. Apple and other manufacturers say new PowerPC-based systems will ship this year.

Besides the price/performance battle between the PowerPC and x86, Intel is finding strong competition in its own backyard in the under-$600 200-MHz category. While Intel pursues numerous strategies in making the Pentium Pro a more affordable desktop PC (see "Pentium Pro Moves to the Desktop," June BYTE), its $599 200-MHz Pentium will soon receive pressure from Cyrix's 6x86-P200+. Cyrix says that when the 6x86-P200+ (which actually runs at 150 MHz with a new 75-MHz system bus) ships in volume this month, it will deliver application performance that slightly exceeds that of Intel's Pentium. And Cyrix is selling the 6x86-P200+ for $499. Whether you use a Mac or a PC, your next top-of-the-line system will probably have a "200" in it.

–Dave Andrews and Tom Thompson

geek mystique

Watch your notebook; it's become a popular target for thieves. According to Safeware Insurance (Columbus, OH), which specializes in computers, approximately 208,000 notebooks sold in the U.S. were reported stolen last year. That's about a 40 percent increase over 1994. One trick that we've heard about: A thief will get between a victim and his or her notebook at an airport security check-in and then stall at the metal-detector gate. Meanwhile, the criminal's partner steals the notebook as it comes off the conveyor belt.

First came product placement shots, in which vendors paid big bucks to Hollywood producers in exchange for prominent visibility in a movie. Then came movie tie-ins, where a feature film release coincided with the release of new CD-ROM titles or high-tech toys. Now it has come to this: Barbie does CAD. This fall, Mattel Media will release an interactive CD-ROM program that lets budding clothes designers create their own ensembles for Barbie, the venerable 12-inch-high fashion doll. The title will include enough fabric that you can feed through a laser or ink-jet printer to create 10 outfits. Cut out the pattern and, voilà, you have a new outfit. The Barbie Fashion Designer ($35) will have built-in bad-fashion prevention. If your design suffers from bad color coordination, the program rejects it.

Vendors Eye Internet Telephony Standard

The best things in life are free, and, for now, so is making phone calls over the Internet. More than a dozen companies, with almost as many proprietary technologies, are producing Internet telephony programs for personal computers. However, analysts believe this free ride may not last.

An immediate threat comes from the America's Carriers Telecommunications Association (ACTA), a trade association of long-distance carriers. ACTA has petitioned the FCC (http://www.fcc.gov) to remove from the market products like VocalTec's (http://www.vocaltec.com/) Internet Phone, Quarterdeck's (http://www.qdeck.com) WebTalk, NetSpeak's WebPhone (http://www.netspeak.com), and Third Planet Publishing's (http://www.planeteers.com/) DigiPhone.

The ACTA petition, which has met with strong resistance from the Voice on the Net (VON) Coalition (http://www.von.org/) of telephony software businesses, is widely expected to be denied by the FCC. After all, the FCC is in the carrier regulation business, not software regulation. Says Nate Zelnick, senior analyst for Mecklermedia (Westport, CT), which is a trade show producer and publisher of Internet-focused titles, "The Telecomm Reform Act of 1995 deregulated the telecommunications industry. It didn't put it in a straitjacket."

That said, Zelnick doesn't expect Internet telephony to play a major role in most people's lives. "The big problem with Net telephony is that a $10 device called a phone already lets you make long-distance calls. You can use a computer, voice card, and software; but then your 'free' phone service must be paid for up front, instead of on a usage basis." But he also says that for businesses that make many long-distance calls, especially to branch offices, "Internet telephony makes a great deal of sense."

Harley Ungar, an analyst and consultant for the New York City–based research and consulting firm Jupiter Communications, believes that interoperability among different vendors' products will be a key requirement for wide acceptance of Internet telephony. "Ultimately, there must be an interoperability standard, but I don't see this happening until the Internet becomes a mass market." Ungar predicts that this won't occur until the "turn of the century, when a third of the population will be using the Net."

Lee McKnight, principal research associate for MIT's Internet Telephony Interoperability Project (http://rpcp.mit.edu/~itel/), is working to ensure that Internet telephony interoperability standards arrive long before the year 2001. He is helping to pull together the proposed Internet Telephony Interoperability Consortium (ITIC). This industry and education group will promote open standards that will be issued via either the Internet Engineering Task Force (IETF) or the WWW Consortium for the benefit of companies and users alike. With telephony and computer powerhouses like AT&T, Microsoft, MCI, and Netscape, plus Internet telephony companies, attending the first organizing meeting of the ITIC, open standards seem possible. Without standards, McKnight says, "None of this will go anywhere."

McKnight is not interested in just the technology. For him, the real questions are: How will the technology be deployed, managed, regulated, and paid for? The last is critical. For now, there's no charge, beyond the initial investment and monthly Internet access fees, for voice over the Internet. However, McKnight says this will change.

"No one has a good idea right now what the financial model will be," McKnight says. "But economic analyses of voice services over the Internet, including cost evaluation, pricing, and yield management models, will produce a viable model."

McKnight also says that while ACTA's petition will fail, "There's a risk or chance that in the future, the FCC may attempt to regulate the Internet. I don't expect it to happen soon, but the risk is there and grows as commercial traffic such as real-time voice services grows." Still, he believes that the future of Internet telephony is bright. According to McKnight, we will see "a whole new range of Net/telephony services. There will be new applications that we can't dream of today. By the twenty-first century, we'll be looking at the first or second generation of standardized products and services that combine the Internet and telephony."

–Steven J. Vaughan-Nichols

yeah, but...

Inconsistent availability of ISDN prevents this useful technology from ever becoming as popular in the U.S. as it is in Europe.

Yeah, but the ISDN situation continues to improve to the point that companies such as JetStream ((408) 777-4300) have released ISDN hubs and communications suites specifically for telecommuters who want the features and power of a company's PBX extended to the home office. Teloquent ((800) 468-6434) also uses ISDN for its Distributed Call Center and Video Call Center. Although Teloquent officials say limited ISDN deployment in the U.S. has resulted in a smaller potential customer base, that situation is improving.

ISDN is just an interim step on the way to asynchronous transfer mode (ATM), ADSL, or cable modems.

Yeah, but those services are still immature in many ways. ATM will likely succeed in the long term. But ISDN will also satisfy an immediate need for midrange data access and a wide variety of services, including videoconferencing, branch-office interconnection, and Internet access, especially as telephone companies improve their ISDN service and support.

Contents

Stratus PC Server Wins Best of Comdex

Stratus Computer and its fault-tolerant Pentium Pro–based Radio PC Cluster server that supports N-way clustering under Windows NT won BYTE's Best of Show and Best System awards at Comdex Spring '96. Finalists for Best System were Ross Technology's SPARCplug, an add-in workstation for tower PCs; Digital Equipment's Prioris ZX 6200MP four-way Pentium Pro PC server; and Hewlett-Packard's quad Pentium Pro–based HP NetServer LX Pro.

Best Technology winner was FlashPix, a technology developed by Eastman Kodak, Hewlett-Packard, Live Picture, and Microsoft. This new imaging architecture should make imaging applications easier, faster, and more consistent.

Best Portable winner was IBM's ThinkPad 560, a 4.1-pound, 1.2-inch-thick notebook with a 12.1-inch active-matrix screen. Best Portable finalists were Texas Instruments' high-end 133-MHz Pentium-based TravelMate 5375ST and Rockwell International's wearable, Pentium-based Trekker 2020.

Quadrant International's VideoWave, a PCI-based video-compression and editing card that uses wavelet compression, won Best Multimedia Hardware. Finalists were Matrox Graphics' MGA Mystique, a 2-D/3-D PC graphics accelerator, and the Color QuickCam, a $229 color digital video camera, from Connectix.

Best Multimedia Software winner, Scala MultiMedia MM100 for Windows ($249), lets you create titles with graphics, animation, symbols, text, and music. Finalists were EMD Enterprises' GLView, an $89 3-D viewer and Virtual Reality Modeling Language (VRML) browser, and Jamba, a $495 visual authoring tool for creating Java applets, from Aimtech.

The award for Best Connectivity Hardware went to NetworkEye/270 Frame Server, a $299 stand-alone network device that provides one image per second from a Connectix digital camera, from Microplex Systems. Finalists were the $225 DWInt jack, from Konexx, and Champion Computer Technologies' FE10/100, a $289 10-/100-Mbps Fast Ethernet Type II PC Card.

Adobe Systems' $49 ATM Deluxe 4.0 Type I and TrueType font management program won as Best Utility. Finalists were DeskMan/2 for OS/2, from DevTech, and Starfish Internet Utilities.

Mannesmann Tally's T7070 Color Ink Jet was the only clear winner in the Best Printer category. Best Peripheral winner was the ViewSonic P815, a 21-inch monitor. Peripheral finalists were the Desktop Projector 4100, from Proxima, and Eastman Kodak's DC-20 digital camera.

The Best Internet Product winner, EchoSearch from Iconovex, is a search tool that analyzes and indexes results from multiple Internet search engines. Level\5's Quest Server tool, which lets you publish relational databases to a Web site, and MCI's networkMCI Backup service, which lets you securely back up data to remote servers, were finalists.

Best Connectivity Software winner was Show N Tel, an applications development kit for creating telephony applications, from Brooktrout Technology. The finalist was MobileWare Personal Edition for Win 95, a peer-to-peer remote-connectivity program.

Sybase's Powersoft group won Best Development Software for PowerBuilder 5, which adds support for applications partitioning, compiled code, and Internet access. The other finalists were VisualAgeGenerator 2.2, from IBM's Software Group, and Symantec's Café for the Mac.

Best of Comdex Contact Information

Best System: Stratus Computer ((508) 460-2000). Digital Equipment ((508) 493-5111); Hewlett-Packard ((408) 553-4300); Ross Technology ((800) 774-7677).

Best Portable: IBM ((800) 772-2227). Texas Instruments ((800) 848-3927); Rockwell International ((800) 321-2223).

Best Multimedia Hardware: Quadrant International ((800) 700-0362). Matrox Graphics ((514) 685-2630); Connectix ((800) 950-5880).

Best Multimedia Software: Scala ((703) 713-0900). EMD Enterprises ((800) 898-9363); Aimtech ((603) 883-0220).

Best Connectivity Hardware: Microplex Systems ((800) 665-7798). Konexx ((619) 622-1400); Champion Computer Technologies ((216) 646-2500).

Best Utility: Adobe ((800) 682-3623). DevTech ((803) 790-9230); Starfish Software ((408) 461-5899).

Best Printer: Mannesmann Tally ((800) 843-1347).

Best Peripheral: ViewSonic ((909) 444-8800). Proxima ((619) 457-5500); Eastman Kodak ((716) 724-4000).

Best Internet Product: Iconovex ((800) 943-0292). Level\5 ((800) 444-4303); MCI ((770) 668-6406).

Best Connectivity Software: Brooktrout Technology ((617) 449-4100). MobileWare ((214) 952-1269).

Best Development Software: Powersoft ((508) 287-1500). IBM's Software Group (Somers, NY); Symantec ((800) 441-7234).

future watch

New RAM technologies are almost as plentiful as ticks on a hound in August, but one that's gaining momentum is the new synchronous DRAM (SDRAM) standard. Extended data out (EDO) RAM starts running out of performance at bus speeds above 66 MHz. Because it runs at only 70 nanoseconds, EDO RAM incurs wait states at higher speeds. However, SDRAM can handle bus speeds of up to 100 MHz. SDRAM is also better for multimedia. Due to its multibanked nature (two now, four in future generations), one bank can send data out while the other gets recharged (this increases performance by decreasing latency).

System vendors are already using SDRAM, and officials at DRAM vendor Hitachi America (Brisbane, CA) predict that by the end of 1997, half of all systems will have SDRAM. Sherry Garber, who is vice president of Semico Research (Phoenix, AZ), a semiconductor research company, is only slightly less optimistic. She predicts that 40 percent of systems then sold worldwide will have SDRAM.

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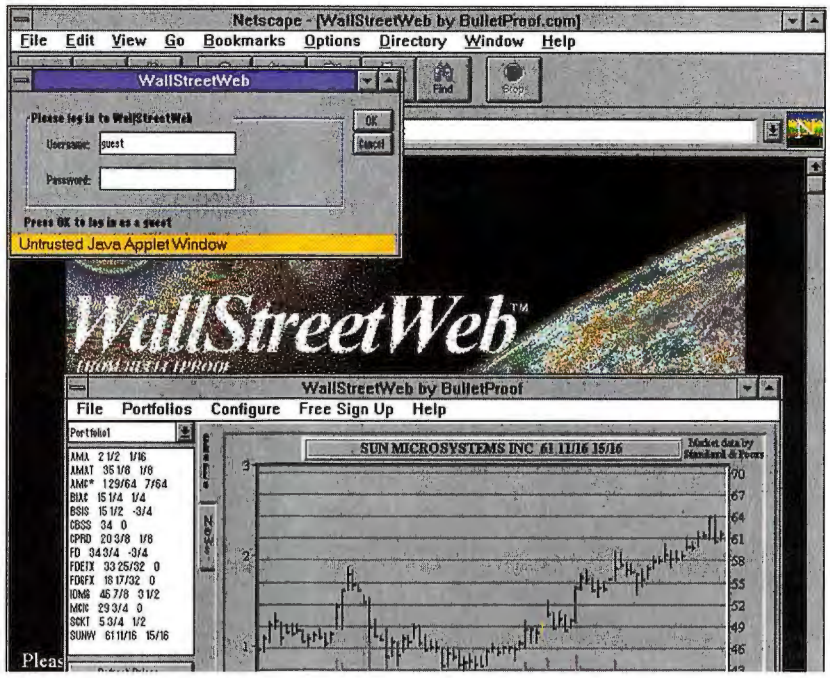
Java Business Applications Arrive



BulletProof's WallStreetWeb real-time portfolio management tool.

When many people think of Java, they think of window dressing for Web pages. However, new client/server Web-based programs written in Java have a strong business focus.

BulletProof's WallStreetWeb (http://www.bulletproof.com/wallstreetweb/), a portfolio management tool, lets subscribers monitor and track their stock holdings in real time from any Java-enabled browser on the Net (see the screen). WallStreetWeb's integrated paging system can inform users of important portfolio changes. On-line help and stock searches are also available.

Java is well suited for distributed database administration and simple query access by outside users. One such Java intranet application is User Administrator from BulletProof (http://www.bulletproof.com/admindemo/useradmin/). Users and administrators access the same Java client but have different levels of access query and update privileges.

Another Java application, Connect's Issues (http://www.connectcorp.com/), provides cross-platform, on-line issue management services. Issues, which is searchable and navigable, is part of an enterprise system that contains help desk and enterprise sales components. Each component has its own user interface and built-in functionality.

Java is also finding early use in the customer service sector. Prominence Dot Com's (http://prominence.com/) Web-based customer service system called Virtual Service Rep (VSR) integrates with databases to augment and partially automate Customer Service Representative (CSR) functions. When accessed, VSR authenticates the customer and attempts to provide automated assistance. You can configure VSR so that a human CSR need never be involved in routine ordering and service issues. If the customer's request requires human interaction, the request is priority-queued for CSR help. During the wait, VSR presents the customer with targeted products and services. Human CSRs can access a customer's help-session history and account information, and VSR suggests a product or service for the CSR to offer the customer.

Many software developers are rushing to provide Java extensions to their applications. Dun & Bradstreet Software's Java client for its SmartStream system is an example. Expect to see more companies port their enterprise software to the corporate intranet.

Whether the network and other advantages will help the "dynamic" Webtop application supplant the "static" desktop application is still undetermined. However, these things are certain: Java is being extended, the language is rapidly maturing, and the potential applications for Java are practically endless.

–Michael Shoffner

Bug of the Month

Look Out for the Guardrails on the Information Highway

There's no lack of characters on the Internet, including programmers who have creative ways of informing users about errors. Although the screen at the left is not necessarily a bug, it sure is an entertaining example of the types of error messages one encounters on the Internet. You know you've taken a wrong turn when you hit this page (http://199.72.95.3/realestate/index.html) on the Web.

–Edmund X. DeJesus

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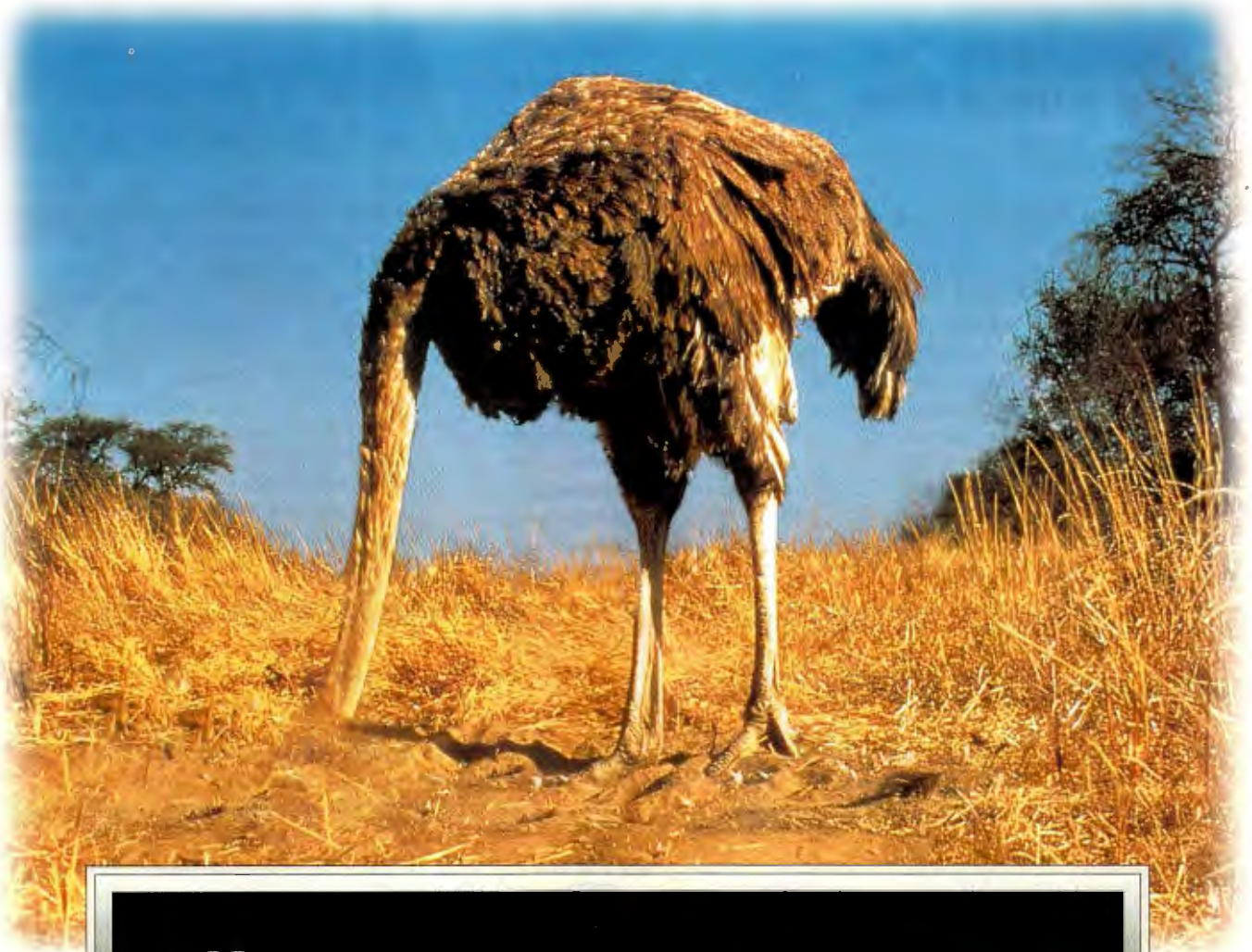

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Forget $500 PCs: How About Free Ones?

Those $500 network PCs may be a bit overpriced. While industry leaders from such companies as Oracle, Sun Microsystems, and Microsoft debate the merits of networking-centric computers (aka Web PCs) that sell for $500 or less, others are creating products and services that assume widespread availability of ubiquitous "free" PCs. Of course, these PCs won't really be free. A new service-based approach to computing, similar to that of cellular telephones, provides a computer for free as part of a service contract. Instead of paying for the cost of the PC up front, you receive your computer when you sign up for a service (e.g., Internet access or cable PC). Proponents say such a solution is cost-effective and easy to evolve.

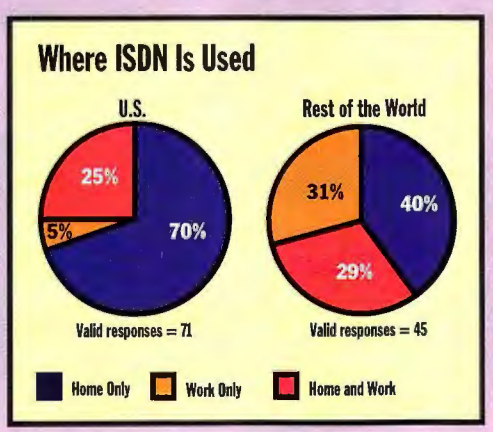
The technology to make this happen already exists. WorldGate Communications (Trevose, PA) has demonstrated a device it calls TV On-Line (TVOL), which displays Web pages that are specially formatted for TV viewing by a cable company's server at the head end. With TVOL, you can launch to uniform resource locators (URLs) displayed on a TV commercial, send and receive Internet e-mail, participate in newsgroups, and join chat rooms. Subscribers don't pay for the devices. They just subscribe to the TVOL service for about $5 a month, and they get the hardware automatically, plus 5 free hours of access. *continued*

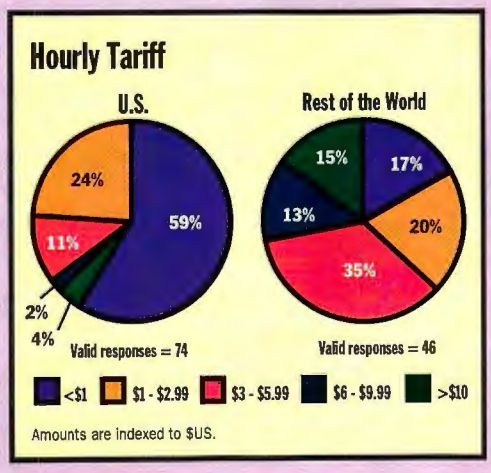
Survey

ISDN at Home in the U.S.

According to the results of a survey taken on BYTE's Web site (http://www.byte.com), U.S. residents are almost twice as likely to use ISDN exclusively at home than in the rest of the world, where use is distributed more evenly across home, work, or both. The reason: When you can get it in the U.S., one-time installation fees and monthly access charges are lower than in the rest of the world, which in this survey consisted primarily of residents in Germany, the Netherlands, Switzerland, Great Britain, and Spain. For example, 48 percent of respondents in the U.S. can get ISDN installation for less than $100, while only 31 percent of the rest of the world can do so. Hourly ISDN rates are also generally lower in the U.S. (see the figure).

So why aren't more U.S. businesses using ISDN? Comments from survey respondents suggest that installation woes or fear thereof may be the cause. In some regions, getting ISDN installed still involve s many phone calls and configuration hassles. U.S. businesses weighing the higher bandwidth and potentially higher support costs of ISDN versus lower bandwidth and support costs of plain old telephone service may opt for the latter solution.





Codetalk

by Rick Grehan

Look, It's VB—No, Wait—C++

It had to happen: a visual development environment undergirded by C++ yet so similar to Visual Basic that you have to stop and look closely to distinguish the two. Powersoft's Optima++ brings VB-style form-based programming to C++.

Is it a Delphi killer? That's part of it. Sybase's SQL Anywhere product is well integrated in Optima++. Add to that bound controls and the bundled ODBC support provided by Intersolv's DataDirect ODBC drivers, and Optima++ becomes a formidable client/server database foundry.

Is it a VB killer? That's part of it, too. When you launch Optima++, you'd swear you've launched VB. Up pops a blank form window, bespeckled with a placement grid. You can drag visual controls from a tear-off toolbar to populate a form. Optima++'s Object Inspector is the spitting image of a VB object's properties window.

Is it RAD? That's another part. You can, at almost anytime in the development process, select Run from the menu and see how your work is progressing. All the compiling and linking are as unobtrusively automated as I've ever seen.

Say you've just deposited a command button on your form window, and you want to specify its behavior. When you right-click on it and select Events from the pop-up list, a mini-menu opens, showing the events that the object responds to. Select an event, and an editor window opens.

Here's the interesting part: Whenever you're in the editor window, you can move the cursor over to the form window, select an object, and drag it back into the editor. This opens a reference card that provides quick access to all the methods that object understands. Furthermore, the reference card can actually "write" code for you.

I did all my explorations with the Developer edition of Optima++. Introductory pricing is $199, which will probably last through September. The Professional and Enterprise editions that will add team development, Internet tools, Java, and more should appear later this year. I'm keeping the sectors warm on my hard disk for their arrival.

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MICROSOFT WINDOWS NT READY-TO-RUN

intel inside PENTIUM®PRO PROCESSOR

Even free notebooks may be possible in the future. Imagine a device, smaller than a laptop, that when unfolded is 8 by 11 inches, half of it a color display, half a keyboard, and that through the miracle of radio frequency cells connects you to the Internet from anywhere. Although such a notebook isn't available today, the wireless aspect is, at least in certain parts of the country. Metricom (Los Gatos, CA) has installed a wireless network that allows connection to the Internet from anywhere in the San Francisco Bay area over a 28.8-Kbps modem. Metricom is also operating in Seattle and Washington, D.C. Don Wood, executive vice president of Metricom, says that it is solving the low-cost wireless access problem (connect rates start at $29.95 a month, $40 with a modem). Says Wood, "If there were a less expensive portable device available, the market for these wireless services would be a much larger segment of the population."

Malcolm Bird, chief executive of Acorn's Network Computing Division (Cambridge, U.K.), questions how many features consumers are willing to sacrifice in exchange for a low-cost mobile device given today's LCD screens and other notebook components. He says such a mobile unit may be viable in the future. "But I think the real solution may be that network computers become so ubiquitous that wherever you turn, there is a network access device." Whether it's a notebook or a PC, your free network computer will not hold personal data; instead, it points you to storage where your personal information is kept secure.

Companies such as SureFind (http://www.surefind.com), XactLabs (http://www.xactlabs.com), and Connected (http://www.connected.com) have provided the technology for private secure data storage on the Internet. Unlike with your hard drive today, you won't worry about losing your data or running out of space with these storage services, because your data is stored in at least two secure mirrored sites that provide unlimited space and tools to help manage your data. When you need printed output, copy shops like Kinkos will offer low-cost local printing services. From any public PC phone, a friend's PC, or a free PC that you just picked up at the store, you will compute without worrying about losing your data or running out of storage space.

–Gary W. Tripp

Book Reviews

Unpredictable Discoveries

Because new technology seems to combine with a blasé attitude to produce forgetfulness, it's probably not a bad idea to look back from time to time, if only to be reminded of how things got started after all. A good place to start along these lines is with the birth, if you will, of the Internet. Katie Hafner and Matthew Lyon describe it in *Where Wizards Stay Up Late: The Origins of the Internet.* This is an account of the engineering and programming required to set up ARPANET, which, of course, is the Homo erectus of modern networking.

The truth is often a surprise. What, after all, could be less cool, more fuddy-duddy, and even vaguely hemorrhoidal than Dwight D. Eisenhower and his pal Neil McElroy, the Sultan of Soap, who ran Procter & Gamble? Well, the next time you send a piece of e-mail, you might take a moment to realize that some of what they did was not so bad after all.

Eisenhower and McElroy, who served as Secretary of Defense, had a belief in science and technology. McElroy, in particular, thought that pure research, if left to its own devices, would be able to justify its existence. But it's not enough to believe. You also have to put beliefs into action, and to this end, Eisenhower and McElroy managed to set up ARPA. The critical thing was the atmosphere that was established in the agency right from the beginning. ARPA saw itself, as the authors point out, as a "group that would take on really advanced 'far-out' research."

So, after setting up a place that had the right attitude, Eisenhower, and then John F. Kennedy, produced the rocket fuel that technological research requires. They turned on the money faucet. The effect of this setup was obvious. For instance, in 1966, Bob Taylor wanted to do something about hooking different computers together. Taylor, a Texan, had made the jump from psychoacoustics to computing and was director of the Pentagon's Information Processing Techniques Office. He went to see the director of ARPA, Charles Herzfeld. In 20 minutes, Taylor walked away with the money, a million dollars to start studying the problem.

In fact, once the right people were involved and the money was there, the Internet seems inevitable. It may be true that all failed research projects are the same, but each successful one is successful in its own way, and this one's success involved a lot of people. The number and variety are staggering—theorists, engineers, administrators, programmers, engineers, graduate students, and the employees of Bolt Beranek and Newman, the Cambridge consulting firm that oversaw the installation of ARPANET's first computers.

J. C. R. Licklider stands out. He was one of those gifted and endlessly curious men who had the knack of attacking what seemed to be widely different problems. If nothing else, he was a visionary when it came to the possibilities of computing. In the Pleistocene Epoch (aka 1960), Licklider, who wrote a paper called the "Man-Computer Symbiosis," foresaw a "massive network" in which "home computer consoles" (not then invented) would be linked.

The truth is, though, there were many others: Vint Cerf, a California computer scientist who came up with such notions as a routing computer to connect networks. Or Larry Roberts, who deserves a lot of the credit for ARPANET, and who, from the beginning, had an instinct for networking computers.

The writing of *Where Wizards Stay Up Late* could be better than it is. At best, it is comfortably readable; at worst, it has the aspect of too much research ground through a word processor. Its biggest flaw is that the authors never allow you any sense of the personalities of the people involved. Sometimes characters are given an identifying tick (one is coldhearted, another is friendly), but even the authors seem to forget such identification after a while.

Nevertheless, the book makes good reading for anyone interested in where the Internet came from, and how policy decisions, particularly where research is concerned, affect the outcome.

–Craig Nova *is the author of eight novels and the recipient of many awards and prizes, including an award in literature from the American Academy and Institute of Arts and Letters. You can reach him on the Internet at nova@sover.net.*

WHERE WIZARDS STAY UP LATE
The Origins of the Internet
by Katie Hafner and Matthew Lyon; Simon & Schuster; ISBN 0-684-81201-0; $24

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Windows 95 Stymies Blind Users

Despite promises to make Windows 95 more accessible to developers who create adaptive technology for the blind, much-awaited technology remains in Microsoft's labs and is still months away. Blind computer users who want to use Win 95 applications or the Internet require a screen reader, which is assistive software that translates standard video monitor output into the spoken word or braille alphabet. Unfortunately, not all software and OSes work well with screen readers and other forms of adaptive technology. Because developers of screen-reader applications can't always determine what's displayed on the screen of a Win 95 application, these programs don't work as well as they could, which costs the disability community jobs and opportunities.

When advocates in the disability community, including the National Council on Disability (Washington, D.C.), complained to Microsoft about the lack of embedded system hooks in Win 3.x, Microsoft said it would make Win 95 more compatible with screen readers and adaptive equipment in general. But features to assist the blind have fallen behind schedule. They include an off-screen model that will keep a record of all information written to the screen, letting a blind user accurately read what is on the screen using special software. According to Microsoft, the off-screen model is still under development and not even ready for alpha release.

Trying to make the best of the situation, adaptive software developers are rolling out new screen readers for Win 95. Without the off-screen model, however, the job is difficult. Nevertheless, Automatic Screen Access for Windows (MicroTalk, (903) 832-3471), the latest entry in this category, supports both Win 95 and Win 3.x. Biolink's ((604) 984-4099) ProTalk 32 screen reader supports Win 95 and NT.

But adaptive technology specialists say computers would be more accessible if software developers worked with the disability community to create products everyone can use. **–Joseph J. Lazzaro**

Datapro Report

How to Create a Network Security Policy

As businesses increasingly rely on computers and networks, the potential for damage from electronic theft or sabotage also increases. A network security policy can make your business less vulnerable to data loss caused by theft, computer viruses, or hard drive failure. Besides establishing policies for personnel in an organization, a network security policy helps a company avoid claims of arbitrary enforcement when disciplinary action becomes necessary.

A network security policy should work with the overall information systems and telecommunications security policy and your disaster recovery plan. A good way to start on the network policy is with a quick look by a small working group. This doesn't require much staff time and resources, and it can save you from implementing preconceived notions as to where security is good or bad. An excellent way to determine where security needs improvement is through surveys of information management and the end users in a business. By surveying both groups, you get diametrically opposed perspectives on the network. Because people who live with the system, day in and day out, get to know it well, a survey of the user community is useful.

However, assembling a questionnaire is an art. To encourage honesty, don't ask for names unless respondents wish to supply them voluntarily. To encourage widespread participation, make it easy for employees to complete the survey. One way to do this is to automate the survey: Put it on a log-in screen and save the results into a file. It will make the survey visible, and the cost for the entire survey will be minimal.

Ask people which systems they use, but do not be so specific that you can identify the individual. Ask users if they have noticed ways to gain system entry through unexpected paths, privileges in excess of those really needed, unusual events that might imply tampering, virus-like symptoms, laxness in controlling physical access, vulnerable systems, and servers or applications that are insecure yet whose absence could damage the organization. It is also important not to convey a sense of the kind of answer you would like. "Is system security satisfactory?" is a poor question because the user reads it in the context of the requester and a yes or no answer is possible. Instead, ask questions that provide even-numbered, not odd, graduated responses. These force the user to take a position.

Checkoff items on the survey are fine, but the survey should ask for measured, thoughtful responses. Indicate that you will use the survey results in a security evaluation, and that users' responses are appreciated and will be used. If it is possible to conduct personal interviews, do so. You must also poll network and computer professionals.

Once you have reduced the collected survey data into tabular form, the working group should arrive at one of three conclusions: Nothing but minor changes are needed. Changes are required, but don't call for an organization-wide effort. A full-scale review plus substantial changes are required. In the last case, you need to make a formal presentation to management. If a task force is approved, it should represent every element of the organization in developing appropriate controlled access to hardware, data, and applications.

The task force or working group should review such areas as physical security, access control, whether media such as wireless communications are properly encrypted, personnel policies, audits, external media such as shareware programs and floppy disks, backups, employee awareness, training, and administrative policies. The hardest part of a network security policy is its execution, and it is much easier to add new encryption to a WAN than it is to change people's behavior. Old habits die hard, and replacing them takes time. Often, a year will pass before the new policies take hold. However, with persistence, managers can reduce or eliminate the threats to important business data.

–Fred Simonds is the author of *Network Security: Data and Voice Communications* (McGraw-Hill, (800) 262-4729 or http://www.books.McGraw-Hill.com; e-mail, customer service@McGraw-Hill.com). For more information on Datapro Information Services reports, call (800) 328-2776 or (609) 764-0100.

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cd-rom review

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An uncluttered interface makes it easy to find what you want.

The CD-ROM is easy to navigate and search, but the $2495 question is, why pay that much money for a compilation of mostly already-published material? A better question to ask is how much time the CD-ROM will save you by providing all the information in one place. According to Deloitte & Touche, "You would have to visit more than 200 [Internet] sites to obtain equivalent content." Obviously, the company is selling convenience and the fact that the CD-ROM yearly charges are fixed as opposed to paying for on-line time with a service such as Nexis. From my quick perusal, there's much good information on the first edition.

–Rich Friedman

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Lower Prices, Modularity, Lead Notebook Trends

What's next for PC notebooks? The answer is either not very much or a lot, depending on how far out you look. In the near term, notebooks will see mostly minor changes: larger hard drives (2 GB and more), faster processors (150 and 166 MHz), and more memory (8 to 16 MB standard). However, you will see a big reduction in the time it takes for features to show up on notebooks after appearing on desktops.

A key trend is the emergence of the true desktop-replacement notebook at far lower price points than before. Complete multimedia notebooks with CD-ROM, sound, and other high-end features are becoming the standard notebook system, with prices around $2500 and up depending on configuration. "It is getting harder and harder to come up with innovative, gee-whiz technology," says Bruce Stephen, who is a market analyst with International Data (Framingham, MA). "The market really revolves now around the continuous loading of the latest leading-edge technology into these products."

Typical of this trend is a new notebook from NEC. NEC's ((800) 388-8888)Versa 2400 line brings high-end features to the value-priced market. Available as either a 100- or 133-MHz Pentium, the system will include a minimum of 1 GB of hard disk storage, an 11.3-inch double supertwisted nematic (DSTN) display, and a snap-in 6× CD-ROM drive with a large software bundle. Prices for the Versa line will start at $2299 for a 100-MHz system without a CD-ROM drive ($400 more buys the CD-ROM drive).

While the Versa 2400 represents the state of the market now, Compaq's new Armada 4100 ((800) 888-5858), slated to ship this month, portends a new trend in modulatrity that will let you tailor your system to your needs. The 1.5-inch-thick Armada 4100, which starts at about 5 pounds and is available with an 11.8-inch active matrix display, converts to a standard notebook with an integrated floppy drive or extra battery pack, and, when you attach the mobile CD unit, to a full multimedia system. The Armada 4100 is the first of several modular systems you can expect to see in the near future. "You will definitely see modularity and interesting design options," says Al Kirts, a spokesman for Gateway 2000. "There will be a whole new generation of notebooks in 1997 in what will be a design-driven market." Look for other major vendors like IBM, Toshiba, and NEC to offer systems like this.

You can also expect that 12.1-inch screens will become the standard, while some vendors will release notebooks with 13.4- and 13.8-inch LCDs. These larger-screen formats won't be mainstream soon, however. New 12.1-inch panels are just coming into full production, and 13-inch panels are too expensive and will require a new wider design.

–Jon Pepper

Notebooks: Weak Link in Ergonomics

Ergonomics is a hot topic among computer vendors and users, but the term *notebook ergonomics* remains an oxymoron. While mouse and keyboard makers continually search for new ways to make their devices more ergonomic, or comfortable to use, the same can't be said for notebook makers. Instead, they say privately, the basic idea is still to "get as much as possible in the smallest package possible."

Consequently, few if any notebooks have ever shown any real ergonomics. One exception is the SENS 810 Multimedia Notebook from Samsung ((800) 933-4110). It features an adjustable split keyboard that you can pull out at angles from the center to allow more natural wrist and elbow positioning. The keys also are full-size. The only other ergonomic approach was probably the much-touted but ill-fated IBM Butterfly, which had a keyboard that expanded to full size from its subnotebook format. Beyond that, don't expect much from notebooks in this area.

True, LCD screens don't have the ergonomic drawbacks of monitors in terms of emissions, but otherwise, the smaller keyboards and pointing devices that are generally inferior to conventional PC mice and keyboards will leave users who are concerned about ergonomics in a dilemma.

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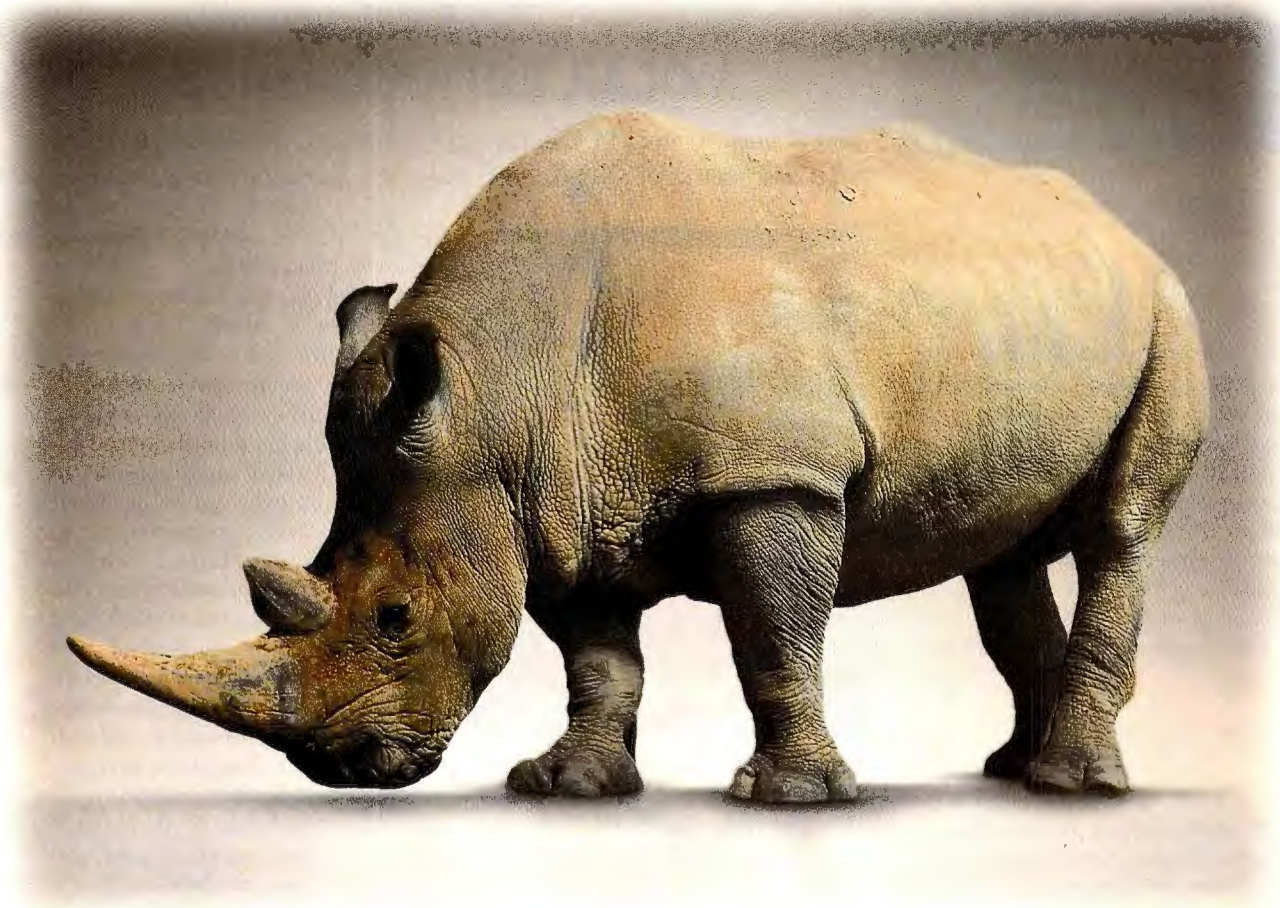

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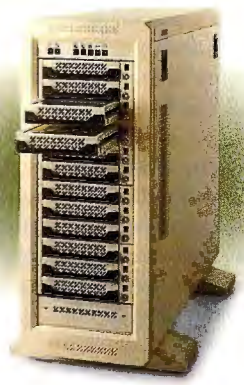

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Blasts from the Past

15 Years ago in BYTE

BYTE devoted almost the entire issue to Smalltalk, Smalltalk-80, and other object-oriented-programming topics. In one article, Apple's Larry Tesler said, "You can write almost any program better in a language you know well than in one you know poorly. But if languages are compared from a viewpoint broader than that of a narrow expert, each language stands out above the others when used for the purpose for which it was designed." Hold that thought.

10 Years ago in BYTE

We covered object-oriented programming again, only this time we talked about several languages, including object-oriented Pascal, Forth, and C++. Ironically, many programmers' object-oriented language of choice is C++ today, because its object-oriented extensions are built on a language that many already know well. In fact, designers of Java have told BYTE editors that they made the new language similar to C++ because of the latter's extensive use in the programming community.

5 Years ago in BYTE

Smalltalk appears again, but not this time as a cover story. In an article that simultaneously looked back and ahead, authors Adele Goldberg and L. Peter Deutsch wrote that they hope that in 2001 objects will be boring (i.e., no longer radical ideas). However, as Microsoft and Netscape duke it out over who will set the next Internet programming standards, objects will be anything *but* boring.

MOLAP, ROLAP, Overlap

Jeff Stamen, senior vice president of Oracle's OLAP division, discusses the convergence of multidimensional and relational OLAP databases.

BYTE: Where does Oracle stand on the debate between multidimensional OLAP versus relational OLAP?

Stamen: I think the term OLAP [on-line analytical processing] has been overly exploited. People have lost sight of what it really is: data analysis that includes data navigation, query, modeling, what-if, forecasting, and data mining. The way some people have been using the term, if anything has any kind of multidimensional reporting or drill down, they call it OLAP. I don't view these as OLAP products. I view these as products that have extensions to their reporting capabilities. That said, in the OLAP world, there has been a debate as to whether you can do real OLAP as I describe it, directly on relational data, or whether you're required to have a multidimensional database.

A lot of people have said, "Well who cares about that? We care more about the results, and whether it's a multidimensional database or going directly against a relational database is secondary." That's basically true. That should be secondary, but it's not irrelevant. There are a lot of issues in loading, managing, and dealing with data. All things being even close to equal, why not keep the data in the relational database, which everybody knows how to deal with, manage, operate, maintain, and enhance. Our view is you can do much of what you need to do directly against relational databases, generally called ROLAP.

BYTE: When would you want your data in one versus the other?

Stamen: If you're dealing with lots of data, tens or hundreds of gigabytes, it's not realistic to have to take that data and keep updating multidimensional databases with it. That's an expensive and time-consuming proposition. What you'd like to do is go up against that data directly. On the other hand, if I'm [creating] complex multidimensional models or what-if scenarios (what-if meaning simulations, projections, forecasts, and so on), then I'm dealing with very complicated calculations that cannot be expressed in SQL. In that case, it's not realistic to do most of my work against a relational database. You need to do it in a multidimensional cache. It's the old 80/20 rule: For 80 percent of the data, you never have to leave the database. For the 20 percent of data created from higher-level aggregations, stage it in a multidimensional cache.

BYTE: What benefits can users expect from a relational database engine that integrates multidimensional analysis?

Stamen: Long term, and we're talking about a two-year time frame, we're going to be offering one engine that integrates multidimensional data with relational data in the same engine. So you could think of it very much like a data blade for multidimensional data in the Oracle engine itself. With this future program, instead of having just SQL APIs, you'll have both a SQL and a multidimensional API. And the multidimensional API will be the same Express [Oracle's current multidimensional database program] API that we have today. Everything you run today will still run, except that when it actually accesses data, it will get it via the Oracle engine. Performance will be terrific, because we're actually going to have a multidimensional access method right in the Oracle database. But the main benefit is much less support overhead. The benefits are you have one data manager, one set of database administration utilities, and one data dictionary.

With a new Intel chip set, AST's Bravo MS-T 6200 is a high-end PC with a low-end price. By Selinda Chiquoine

Mainstreaming Pentium Pro

You can buy a 200-MHz Pentium Pro NT workstation now for $3000 less than you could six months ago. Take the AST Bravo MS-T 6200 we review here; it starts at $3335 with 32 MB of RAM, a 2.5-GB hard drive, and an 8x CD-ROM drive. Some of that lower cost is due to Intel's new 440FX PCI three-chip set, which effectively replaces Intel's eight-chip 450KX and GX Orion PCIsets in new single- and dual-CPU systems.

The 440FX PCIset, code-named Natoma, represents a savings in silicon and system board space—and as our testing reveals, without sacrificing performance. The Bravo's SYSmark NT score compares favorably to those of earlier systems we've tested. However, the Orion chip sets will continue to be a better fit for quad-processor designs because they support four memory controllers and two PCI bridges.

The 440FX PCIset supports up to 1 GB of extended data out (EDO) DRAM, burst EDO DRAM, or fast page-mode DRAM, and it allows concurrent PCI. It also complements the Pentium Pro's split-transaction bus, enabling more efficient use of bus cycles. The 440FX is PCI 2.1-compliant and also supports the Universal Serial Bus (USB).

Bravo MS-T 6200
$4754
(as tested with 200-MHz Pentium Pro, 64 MB of RAM, 2.5-GB hard drive, 8x CD-ROM drive, 4 MB of WRAM graphics, and 17-inch monitor)

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AST's 200-MHz Bravo, ordered with parity or ECC memory, is well suited for corporate computing.

Although the Bravo MS-T 6200 supports ECC and parity memory, it comes standard with nonparity memory (64 MB of 60-ns EDO RAM in the system that we tested), which could be a reliability concern with some large-memory applications. Maximum capacity is 128 MB divided across four memory banks, in 16-MB SIMMS. A 5200-rpm 2.5-GB EIDE hard drive , 8x IDE CD-ROM drive, 2-MB Matrox MGA Millennium graphics card, and 16-bit audio with microphone are standard. Our test system came with 4 MB of Window RAM (WRAM) on the graphics card and a 17-inch AST monitor. Although there are plenty of available slots, SCSI and networking are not integrated into this system.

Software installed on the Bravo MS-T 6200 includes Windows NT; AST-CommandCenter, a group of utilities; as well as a disk-making utility, NetCom's NetCruiser, Netscape Navigator, Internet Factory's Communications Builder, and SoftQuad's HoTMetaL Light 2.0 (an HTML editor).

RATINGS

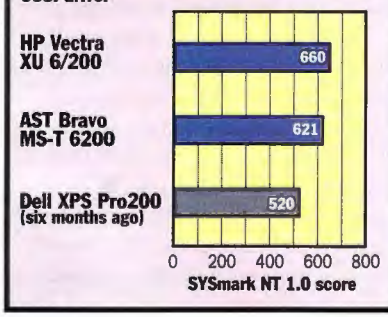
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★
PERFORMANCE	★ ★ ★

AST claims to distinguish itself with high-quality components and construction, aptly chosen software, excellent documentation, and a reasonable price. With some exceptions like nonparity memory and lack of built-in networking, we agree that this system is well suited for corporate computing. B

Selinda Chiquoine is a former BYTE technical editor. You can reach her at **selinda@bix.com.**

NT Performance

AST's Bravo is much faster than the 200-MHz Dell we tested six months ago, thanks to improved NT graphics card drivers. HP's Orion-based Vectra (shown for comparison) is faster due to its 7200-rpm SCSI drive.



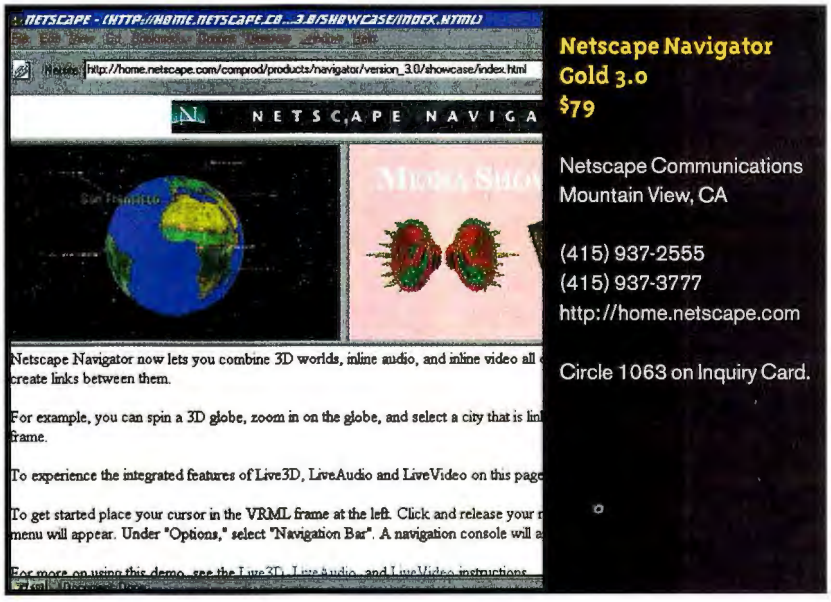
Netscape throws everything but the kitchen sink into the new upgrade of the Web's premier browser. By Rex Baldazo

Navigator Turns 3.0

We've barely had time to digest the new features (and risks) of Navigator 2.0 and—look out—here comes version 3.0. But don't panic: While you'll find new multimedia plug-ins and Java enhancements, as well as some improvements to existing features, there's nothing about Navigator 3.0 that makes it a must buy.

By comparison, the 1.0-to-2.0 upgrade was substantial, bringing innovations such as the now-ubiquitous Java, as well as a very good mail reader and newsreader. Version 2.0 also introduced Netscape Plug-Ins, which let developers offer unique functions that run inside a Navigator window.

Beyond the new Plug-Ins for audio, video, and 3-D Virtual Reality Modeling Language (VRML), Navigator 3.0's biggest changes are the extensions to JavaScript, Netscape's scripting language for browsers and servers. Scripts can now detect installed Plug-Ins, and there's a built-in Array object. A new feature called LiveConnect lets your scripts interact with Java applets loaded in the browser. JavaScripts now have the ability to load images dynamically as needed, depending on specific events or user interaction.



Besides bundling new Plug-Ins for audio, video, and 3-D VRML, Navigator 3.0 retains its predecessor's occasional color glitches.

Hypertext Markup Language (HTML) editing capabilities are also improved. Finally, the company that helped popularize HTML tables offers an editor that can handle them. Unfortunately, the process is still not close to being WYSIWYG. The text in our table was centered and in boldface when we viewed it in the edit window, but it was left-aligned and in normal face when we displayed it in the browser window.

Netscape has finally fixed the Back button so that it now works the way you expect it to in a frame environment. In Navigator 2.0, clicking on the Back button would take you off the current frameset entirely. With 3.0, it navigates you back through the just-viewed frames.

Netscape still knows how to produce interesting bugs. Unlike the infamous invisible/Greek font problems in Navigator 2.0, the bugs introduced in 3.0 seem likely to be fixed in the final version. They'd better be: The one we encountered most often was a crash under Windows NT 4.0. It occurred whenever we tried to view Netscape's Media Showcase, which highlights the multimedia capabilities of 3.0's Plug-Ins.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★

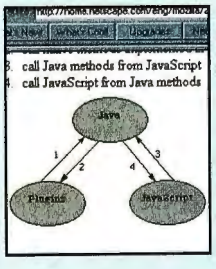
All this is a lot to consider when deciding whether to switch from 2.0. We'll move to 3.0 because the Back button finally works the way it should. B

Rex Baldazo is BYTE's technical editor for software reviews. You can reach him at **rbaldazo@bix.com**

TECH FOCUS

Where Plug-Ins Connect

Navigator's new LiveConnect feature enables Java, JavaScript, and Navigator Plug-Ins to interact. The following calls are allowed: 1) to Java methods from Plug-Ins; 2) to native methods implemented in Plug-Ins from Java; 3) to Java methods from JavaScript; and 4) to JavaScript from Java methods. JavaScript and the Navigator Plug-Ins have to communicate with each other through Java.



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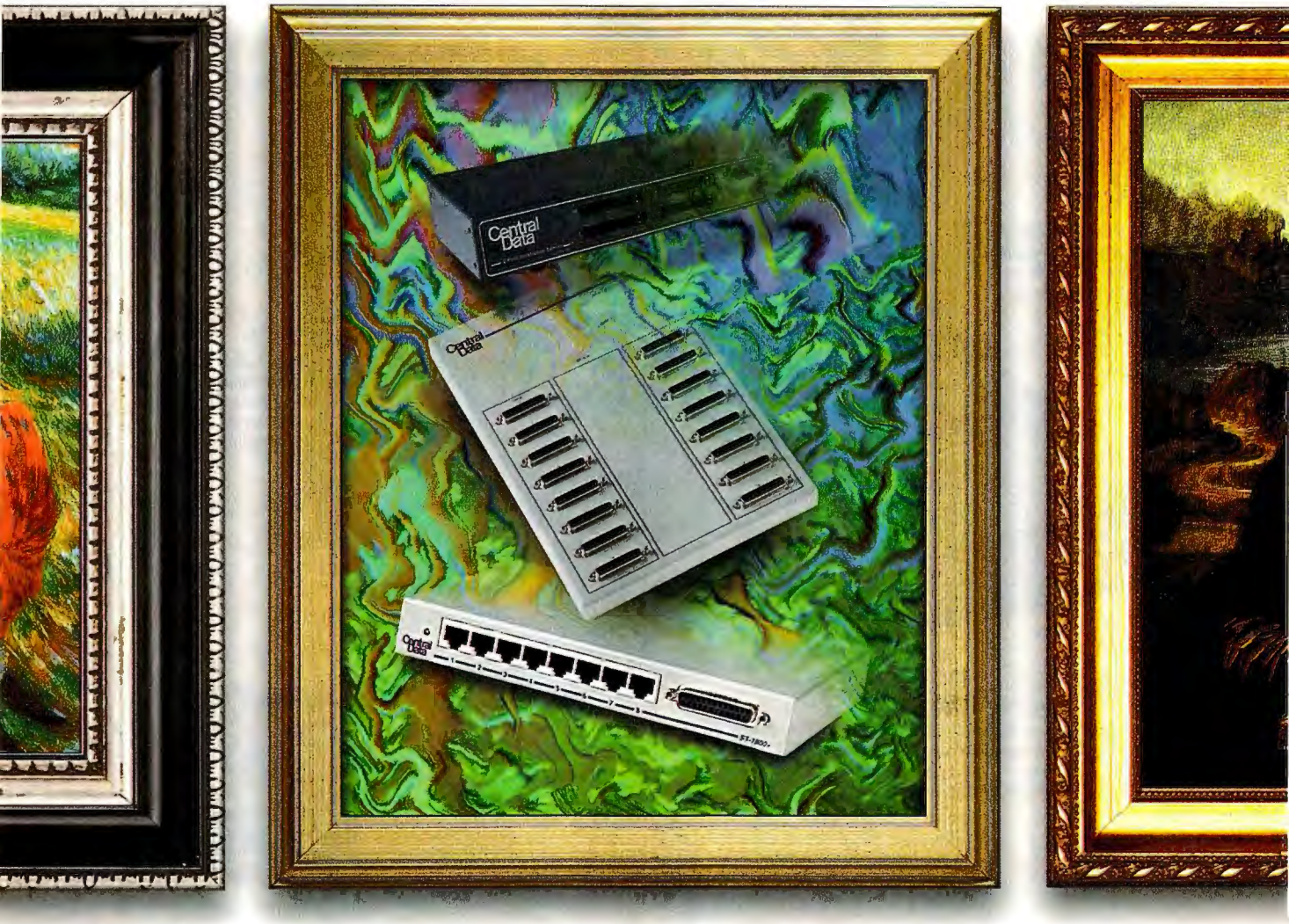

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IBM's new ThinkPad 560 packs a lot of features and power into its sleek frame—but not without compromise. ***By Dave Andrews***

ThinkPad Proves You Can Be Too Thin

IBM's thin new ThinkPad 560 packs a ton of features into its 4.1-pound package, but not enough to match those of standard notebooks. While this affordable machine doesn't address everyone's portable-computing needs, it will be very attractive to mobile workers who want to combine portability with an easy-typing keyboard and a big, bright screen.

The ThinkPad 560's 12.1-inch active-matrix screen and expansive keyboard will make you forget many of the horrors that subnotebooks inflicted upon us two years ago. The system also has an 810-MB standard hard drive (1.08 GB is an option), a choice of 100-, 120- or 133-MHz Pentium CPU, and memory expandability up to 40 MB. On the other hand, the floppy drive is external, and there's not yet a way to fit a CD-ROM drive into a notebook that measures only 1.2 inches thick.

The ThinkPad 560's delightful 800- by 600-pixel screen gives you about the same viewing real estate as a 14-inch desktop monitor (you can also get a less expensive

The thin ThinkPad 560 and the thick ThinkPad 760CD.

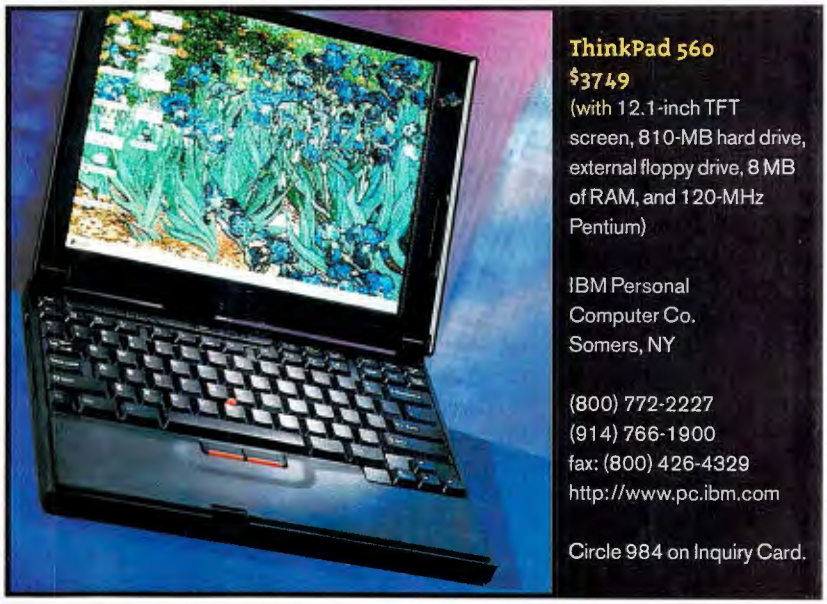
100-MHz configuration with an 11.3-inch passive-matrix screen). The screen is such a dominating component in the new thin form factor that IBM had to use an especially rigid hinge with a stiff action to keep the screen propped open. The company also put the heavier elements of the 4.1-pound notebook, such as the hard drive and lithium battery pack, near the front to counter the weight of the display and to keep the notebook from toppling over while in operation.

Another big benefit is the unit's full-size keyboard (11 inches from the Caps Lock to the Enter key). We found it easy to type on, compared to the cramped layouts of subnotebooks of past years.

IBM has eliminated many of the compromises associated with small notebooks, but not all. The most noticeable lack is internal drive options. There's no internal CD-ROM or floppy drive. If you need to get data off a floppy disk, you have to use an included external 1.44-inch drive that cables to a special port. (At least you don't have to turn off the unit when you attach the external floppy drive.) For reading CD-ROMs, you have to invest in a third-party device. Furthermore, IBM's resurrected subnotebook lacks an integrated modem.

Nor does the ThinkPad 560 deliver other multimedia extras, such as a video-in port or built-in stereo speakers. For video-in, you have to use a PC Card solution (the 560 has two Type II PC Card slots). The system's tinny speaker is underneath the keyboard and offers only a modicum of multimedia support.

Still, this ThinkPad goes just about anywhere that paper goes. And it doesn't weigh a whole lot more. B



ThinkPad 560
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The ThinkPad 560's 12.1-inch active-matrix screen and expansive keyboard will make you forget the horrors of subnotebooks past.

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

Dave Andrews is a BYTE news editor. You can reach him at **dave.news@bix.com.**

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

Power Computing's 180-MHz Mac clone reveals the power of RISC. By Tom Thompson

Move Aside, Mac

As the first Mac OS licensee, Power Computing must stay nimble to grab market share. So far, so good. As Apple ships its 150-MHz Power Mac 9500, Power Computing counters with its 180-MHz Mac-compatible PowerTower.

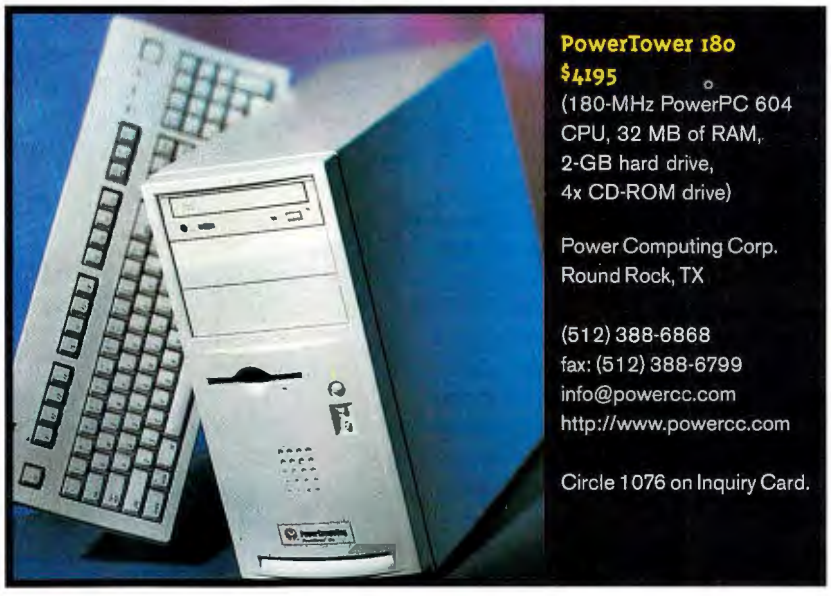
A standard PowerTower 180 includes a 180-MHz PowerPC 604 RISC processor, 512 KB of L2 cache memory, 32 MB of RAM, a 2-GB SCSI hard drive, a built-in video subsystem with 2 MB of video memory, and two Ethernet connectors (10Base-T and Apple's attachment unit interface [AUI])—enough to satisfy the most demanding power user. The price isn't bad either: $4195 as reviewed. The PowerTower's mini-tower chassis provides three 5¼-inch storage bays (a standard quad-speed CD-ROM drive occupies one bay) and three PCI expansion slots.

The PowerTower 180 employs Apple Power Mac 7200 ASICs, which provide only a 64-bit data path, while the Power Mac 9500 ASICs have a 128-bit data path with memory interleaving. Power Computing chose the 7200 ASICs because they can operate at 60 MHz (a good 3× match for a 180-MHz CPU), while the 9500 ASICs top out at 50 MHz.

The PowerTower 180 arrived with Apple's System 7.5.3 and a generous selection of software, including ClarisWorks 4.0, Now Utilities 6.0, Intuit's Quicken SE, and other applications. (We disabled the bundled Connectix Speed Doubler software accelerator to properly assess system throughput.) Several weeks of heavy use with a wide assortment of Mac software proved the system's Mac compatibility.

Running Mac software at 180 MHz is intoxicating. Multitasking Claris's MacWrite Pro and Netscape's 2.0 browser while downloading files with Aladdin's SITcomm telecommunications program proved quick and smooth. We had no network problems using TCP/IP applications through either a corporate DHCP server connection or by a dial-up connection using FreePPP 2.5.

Editing complicated 3-D graphics in Adobe Dimensions 2.0 was effortless, and operations in Adobe Photoshop 3.0.4 simply flew. Where a Power Mac 9500/132 might slow to a crawl managing file-filled folders, the PowerTower ran the Mac File Manager's emulated 680x0 code effortlessly.



PowerTower 180
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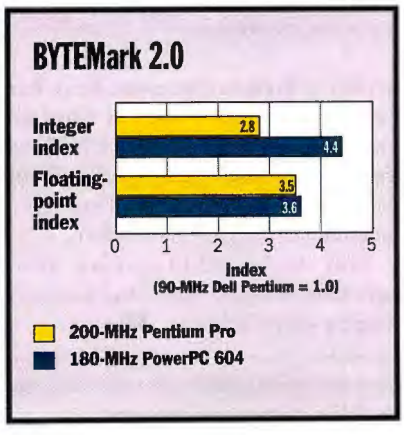
Fast file and image manipulation make the PowerTower 180 a multimedia author's dream machine.



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

Even though the PowerPC 604 trails a 200-MHz Pentium Pro by 20 MHz, it posted far better integer performance and similar floating-point performance. Its combined file- and image-manipulation capabilities make the PowerTower a multimedia author's dream machine. B

Tom Thompson is a BYTE senior technical editor at large and author of The PowerPC Programming Kit *(Hayden Books, 1996). You can reach him at* **tom_thompson@bix.com.**

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

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Windows NT offers industrial-strength security features. ***By Jim Reynolds***

Air-Tight Windows NT

Windows NT offers features that meet the practical security requirements of businesses. For everyday users, NT restricts who uses the computer and controls what each authorized user does. For administrators, NT provides tracking and auditing capabilities, enabling network managers to monitor who attempts to use a particular computer and what each user attempts to do.

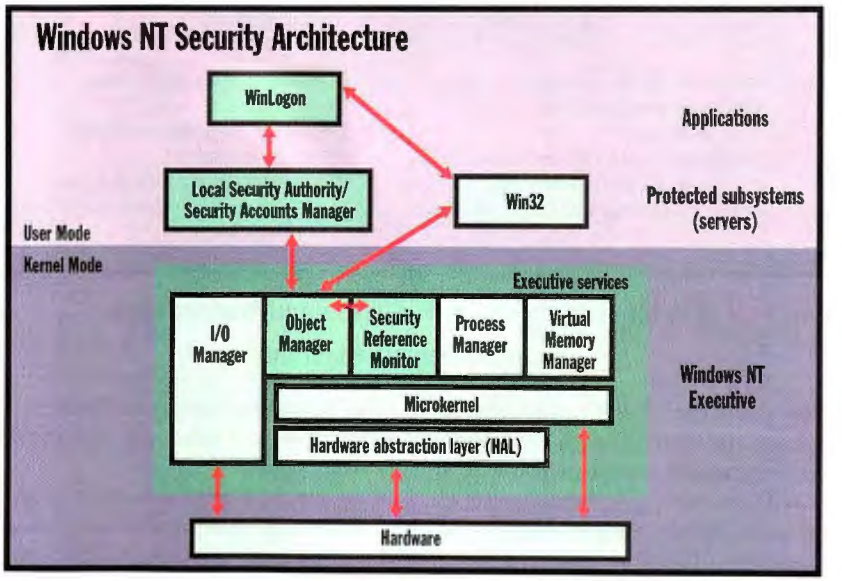
These security features match very closely with the requirements described in the Department of Defense's "Orange Book" for the C2-level of security "assurance" for commercial computer products. Microsoft decided very early in NT's development to achieve C2-level security status for the OS, to meet the requirements of certain Defense markets.

Security Architecture

Microsoft engineers designed Windows NT to be a portable OS with minimal dependence on a processor's unique hardware features. However, all NT implementations rely on the processor to provide two execution modes: kernel and user. Kernel mode, as its name implies, is used by the privileged OS code, including the kernel, to protect system data. Code running in this mode communicates directly with the hardware. Code executing in user mode must use OS calls to modify system data and access the hardware.

Windows NT consists of an executive and several protected subsystems (also called servers). The executive lies atop the hardware abstraction layer (HAL) and operates in the kernel mode. Above the executive lie the subsystems that interact with users and execute in user mode. User processes execute only in user mode and must make requests to the subsystems in order to obtain access to the computer's facilities.

The security components of NT consist of two parts that execute in user mode: WinLogon and a protected server called the Local Security Authority (LSA). The LSA relies on the Security Accounts Manager (SAM) and two executive components, the Object Manager and the Security Reference Monitor (SRM), to determine access privileges and obtain system resources (see the figure "Windows NT Security Architecture").



The Object Manager and the Security Reference Monitor protect system resources.

Although NT is not object-oriented in the broadest sense, it treats all of a computer's resources as objects, and access to all objects is handled by the Object Manager. Files, memory, processes, and more specialized resources like semaphores and I/O completion ports are all objects. This uniform approach simplifies the implementation of security features and provides greater assurance that they work properly. The Win32 environment subsystem must ask the Object Manager on behalf of a user to create, open, close, delete, or perform whatever operation is appropriate to the particular type of object.

NT associates a security ID with every user, and every object has an access control list (which may be empty) that specifies which users or groups of users are allowed to work with the object. Before NT performs any operation, the Object Manager checks with the SRM to determine if the user has the permissions or rights required to perform the operation on the object.

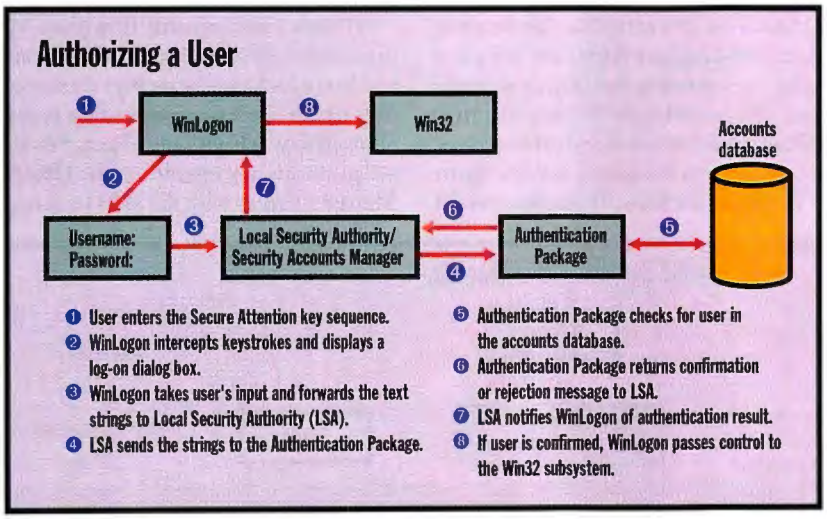
Authentication

Identification and authentication are the most fundamental security features of an OS. To log onto NT, you press a familiar key combination: Ctrl-Alt-Del. This actually implements a feature—called Trusted Path—required by the Orange Book. This requirement assures the user

that if she presses the so-called Secure Attention Sequence first, the resulting prompt for username and password is from the OS and not from some spoofing program written by a malicious user. The user must identify herself with a username and authenticate herself, typically with a password. NT is sufficiently modular that a more sophisticated authentication mechanism can be implemented; for example, the administrator could substitute a retinal scanner. (See "Authorizing a User" for a summary of the log-on sequence.)

Every user belongs to one or more groups, and a few special groups are built in. Each group has a name and a set of user rights. Users have the rights of all the groups they belong to, plus any special rights granted to that particular individual. These rights are assigned collectively when the administrator makes a user a member of a defined group.

There are roughly two dozen user rights, including the ability to define printers, add hardware (such as Ethernet cards) to the system, and shut down the computer. Each user acquires a set of rights, either from the groups she belongs to or by the administrator specifically granting them.



NT's log-on process prevents an unauthorized user from entering the system.

Auditing for Attacks

Because no system is absolutely secure, administrators need to be able to determine if their system has been the target of an attack, or has been vulnerable to the misadventures of a nonmalicious user. In the case of NT, auditing policy is set and controlled with the User Manager.

The User Manager provides an easy interface to specify the level of auditing. Because the auditing process contributes to system overhead, the amount of audit information to be captured has to be carefully weighed in consideration to overall system requirements. NT divides audited user actions into seven categories, including file and object access, logging on and off, and exercise of user rights. Actions within each category can be audited for success, failure, or both. For example, you may not want NT to produce an audit record every time a user logs on, but you'd want to record unsuccessful attempts to log on. Similarly, you'd probably record unsuccessful attempts to access files or directories—such activities indicate malicious snooping.

You use the Event Viewer to examine audit records. It allows examination of three different logs: system events, application events, and security events. Each event record is time-stamped, and both the process and the user attempting the operation are identified. A log is an object just like every other resource controlled by NT, and therefore it has an access control list associated with it. By default, only members of the Administrators group can examine the security log. With the Event Viewer, an authorized user can control important aspects of the logs. Particularly important from a security point of view and required for C2-level rating is the ability to guarantee that no security event records can be lost. Logs, naturally, are limited to a certain length, and by default are overwritten when full. In special situations, the administrator can prevent overwriting the log by forcing a system shutdown when the log is full.

Object Reuse

Underlying all of NT's logical objects are physical RAM and disk space, both of which are continually being recycled for new processes and files. Object reuse is a security requirement that prevents a user from accessing the remains of another user's work, particularly when the OS creates new objects from previously used resources.

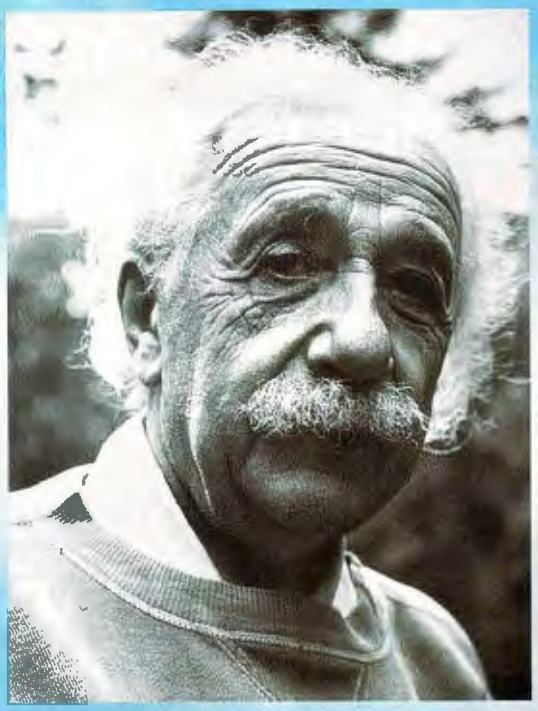
Long-time DOS users are well aware that "erasing" a disk file doesn't clear the file's contents from the hard disk: It simply marks the region on the disk as unused. Other users can examine this region's contents, provided another process hasn't already written over the same area of the disk. Secure systems require that such a scenario isn't possible. When NT creates a new object (either memory or file) for a user, it is empty of data. That is, the OS clears the object of its previous data or assigns it a zero-length size.

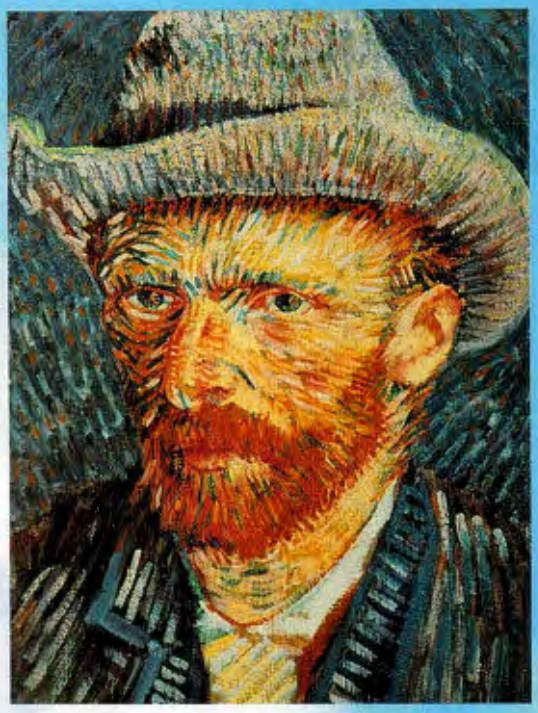
For file objects, NT prohibits you from reading past a file's logical end-of-file marker and thus possibly peeking at data from an erased file. Also, if you have the right to extend the file, NT overwrites that area on disk before granting access to it.

When a program allocates memory, NT first clears the section of RAM that a newly created memory object will occupy. This prevents a user from probing random locations in RAM, searching for the vestiges of documents or file buffers that might contain confidential information. Of course, because of NT's security mechanisms, processes can access only blocks of memory granted to them.

NT is a reasonably secure general-purpose OS. As an indication of this, in August 1995, the National Security Agency granted Windows NT 3.5 C2-level approval. Its security features make it comparable to Digital Equipment's VMS and superior to Unix. NT provides a unique combination of security and convenience that is long overdue in the personal computer world. B

Jim Reynolds was a member of the National Security Agency's Windows NT evaluation team. He also participated in the evaluation of three other commercial OS products for the "Orange Book" program. You can reach him at **reynolds@mitre.org**.





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A new revision to this management protocol addresses performance issues and corrects some flaws. By William Stallings

Patching the Cracks in SNMP

In 1988, the Internet Engineering Steering Group (IESG) released the first version of the SNMP specification. Its goal was grand yet practical: to provide an easily implemented, low-overhead foundation for multivendor network management of routers, servers, and other network resources. As a public standard, the original version of SNMP (now known as SNMPv1) rapidly became the most widely used vendor-independent network management scheme.

As SNMPv1 gained widespread use, some deficiencies became apparent. These included a lack of manager-to-manager communication, the inability to do bulk data transfer, and a lack of security. The IESG sought to remedy them by revising the specification. In 1993, it issued version 2 (known as SNMPv2) as a set of proposed Internet standards. However, it has not received widespread acceptance. That's because while the functional enhancements have been welcome, developers found the security facility for SNMPv2 too complex.

The IESG worked on an enhancement to SNMPv2. It completed the task in January and announced the revised standard as SNMPv2c. This version employs the SNMPv1 message wrapper, with its use of the community concept, which has a simple password-based security model. This "administrative framework" for SNMPv2 is termed community-based SNMPv2, which explains the *c* suffix.

The results of this effort have been one minor success and one major failure. The minor success is the tune-up of the functional aspects of SNMPv2. The major failure is in the area of security. SNMPv2c's password-based approach to security is anything but secure. The IESG was unable to resolve the issue, and two competing approaches emerged.

The first approach is User-Based Security Model for SNMP, or SNMPv2u. SNMPv2u takes a minimalist approach to providing security and is centered on capabilities provided by the agent. (An agent is a software package running on any system that is to be managed, such as PCs, workstations, bridges, routers, servers, and hosts.) SNMPv2u provides the basic elements for network management security, namely, the ability to authenticate managers and provision for confidentiality of exchanged messages. (A manager or management system is a desktop computer running management software and operated by a user.)

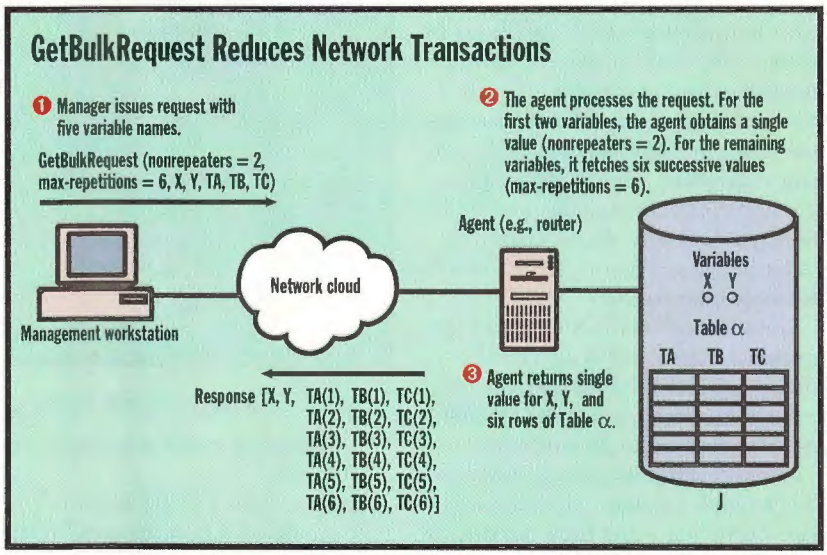
The second approach is SNMPv2*. This more ambitious approach adds to SNMPv2u features implemented at the management station and deals with issues of remote configuration not addressed in SNMPv2u. SNMP is able to remotely configure an agent to include new Management Information Base (MIB) objects.

Because of this schism, the IESG will revisit the SNMP security matter. For this reason, we will instead look into the performance areas that the standard fixes.

Data Transfer Enhancements

SNMPv1 can generate considerable traffic when managers communicate with agents. That's because a single SNMPv1 transaction can exchange only a limited amount of data, forcing management workstations and agents to often generate multiple transactions. The result is a heavy load on the network.

To help streamline these exchanges, SNMPv2 adds a new command, `GetBulkRequest`. `GetBulkRequest` targets the one area of information exchange capable of generating the most traffic: retrieval of tables. A table represents a related set of information about a resource (e.g., a router) or activity (the traffic over a TCP connection). It is organized as a collection of rows of variables, with



This new SNMPv2c command lets a network management program obtain information from a remote agent with only one transaction.

each row having the same sequence of variables.

With SNMPv1, you could retrieve information from such a table only one row at a time. If a manager had to see an entire routing table, he or she needed a tedious series of get/response transactions, one for each row.

Using `GetBulkRequest`, a manager can retrieve the entire table with one transaction and even retrieve additional nontable information in that same transaction. Suppose a manager wants to retrieve a router's entire routing table plus the variable `sysUpTime`, so that it could associate a system time with the retrieved table. The manager issues a `GetBulkRequest` command that lists the variable `sysUpTime`, plus the variables that correspond to each of the fields in the table.

`GetBulkRequest` also includes two parameters. The `nonrepeaters` parameter indicates how many of the listed variables are to return just one value. In our example, there is only one such variable, `sysUpTime`, so `nonrepeaters` is set to 1. The `max-repetitions` parameter indicates how many rows of the table are to be retrieved. If the manager knows the number of rows in the table, `max-repetitions` is set to that value. Otherwise, the manager makes an educated guess and, if necessary, issues additional `GetBulkRequest` commands to get additional rows. (See the figure "GetBulkRequest Reduces Network Transactions" for more information.)

Another feature of SNMPv2 that improves the efficiency of data transfer is the nonatomic `Get` command. Management stations in both SNMP and SNMPv2 use `Get` to obtain the value of one or more variables. In SNMPv1, if a `Get` command lists multiple variables, and if the agent can't return a value for even one of those variables, the entire command is rejected. SNMPv2c's nonatomic `Get` command allows partial results to be returned (hence the term *nonatomic*). This lets the agent return those values that it can and ignore the rest of the command. Again, this improves efficiency by reducing the number of exchanges across the network.

Cooperation Among Managers

Another major concern users had with SNMPv1 was the difficulty in providing manager-to-manager cooperation. The only reliable way to send information between managers was through vendor-specific mechanisms. This isn't a practical solution for networks made up of a mix of machines from different vendors. As the number of end-user systems and networks in an enterprise network configuration grows, it becomes impractical to manage the system from one network management station. Many users would like to see a decentralized management strategy, in which there may be one or a few top-level manager stations, each controlling a number of lower-level manager stations that are responsible for their portion of the network.

To support manager-to-manager cooperation, SNMPv2 introduces an `Inform` command. A manager uses `Inform` to send unsolicited information to another manager. For example, through `Inform`, a manager notifies another manager when an unusual event occurs, like the loss of a physical link or an excessive rate of traffic at some point in the network. Such unsolicited notifications provide an ideal tool for configuring a decentralized network management scheme.

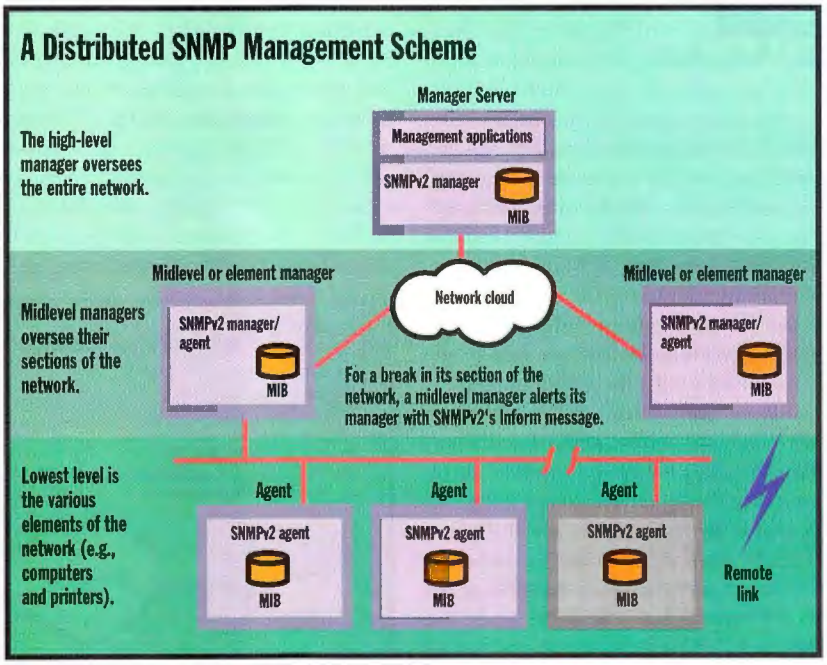
Higher-level managers need not concern themselves with the details of remote parts of the network until a local event that requires central attention occurs. For example, the local manager can use `Inform` to alert the central manager that a part of its subnet has disappeared. This ability for one manager to alert another is lacking in SNMPv1.

"A Distributed SNMP Management Scheme" illustrates one kind of network configuration possible with SNMPv2.

SNMP's Future

When and whether the security portion of SNMPv2 gets resolved is anyone's guess. As mentioned earlier, the IESG will revisit the issue. Because the project will start at the requirements level, it's a chance to begin with a clean slate and resolve the security issue once and for all.

Meanwhile, the functional enhancements provided in SNMPv2c should attract wide support. The technology is stable, and the cost of implementation is low for those who have implemented network resources using SNMPv1. We can expect to see a wide array of offerings from software and equipment vendors. For example, IBM announced a version of SystemView, its AIX network management software, that is compliant with the new protocol and supports the SNMPv2u security mechanism. B



By use of a new Inform command, SNMPv2c lets a local manager notify a central manager of important network changes.

William Stallings is a consultant and a frequent contributor to BYTE. Recent books include SNMP, SNMPv2, and RMON, *2nd ed. (Addison-Wesley, 1996) and* Local and Metropolitan Area Networks, *5th ed. (Prentice-Hall, 1996). He can be reached at* **ws@shore.net.**

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A variant of this RISC processor targets the embedded-applications market. ***By Tom Thompson***

The PowerPC Goes Consumer

Ask someone where you would most likely find a PowerPC RISC processor, and the reply would probably be, "a desktop computer." This is a valid answer, since most of the PowerPC's visibility comes from high-speed desktop systems, such as Apple's Power Macs and Power Computing's Mac clones.

But you can also find the PowerPC working as an embedded processor in laser printers or network adapter cards. The PowerPC's use in embedded systems shouldn't come as a surprise. This RISC processor's throughput is ideally suited for the computing demands of today's 32-bit computer peripherals.

The PowerPC's foray into the embedded market isn't new. IBM introduced the PowerPC 403, a microcontroller version of the processor, in April 1994. One of the latest variants of this design, the 403GB, features a PowerPC core that dispatches two instructions at a time. However, its very sophistication, combined with the physical footprint required to support separate address and data buses, makes the 403 a poor fit for cost-sensitive consumer electronics or hand-held devices.

Enter the PowerPC 401GF. While it retains many high-performance features of its predecessor, it does so with a slimmed-down RISC core. A multiplexed bus interface reduces the chip's footprint; in addition, at 2.5 V, it consumes only 40 milliwatts at 25 MHz. This makes the 401 ideal for custom embedded-processor applications in the low-cost consumer-electronics market.

The Small yet Smart Core

The 401GF gets both its smarts and its processing brawn from a 32-bit RISC processor core that's code-compliant with the PowerPC 60x family. Called the 401 core, it sports a surprising number of 60x processor features, as shown in the figure "The PowerPC 401 RISC Core" below.

It has 32 32-bit general-purpose registers (GPRs), several special-purpose registers (SPRs), an ALU, multiply and divide hardware for 32-bit integers, a barrel shifter, and control logic that supervises data flow and code execution in the core. The 401GF also has static-branch-prediction logic, similar to that used by the PowerPC 601 and 603, to improve code performance.

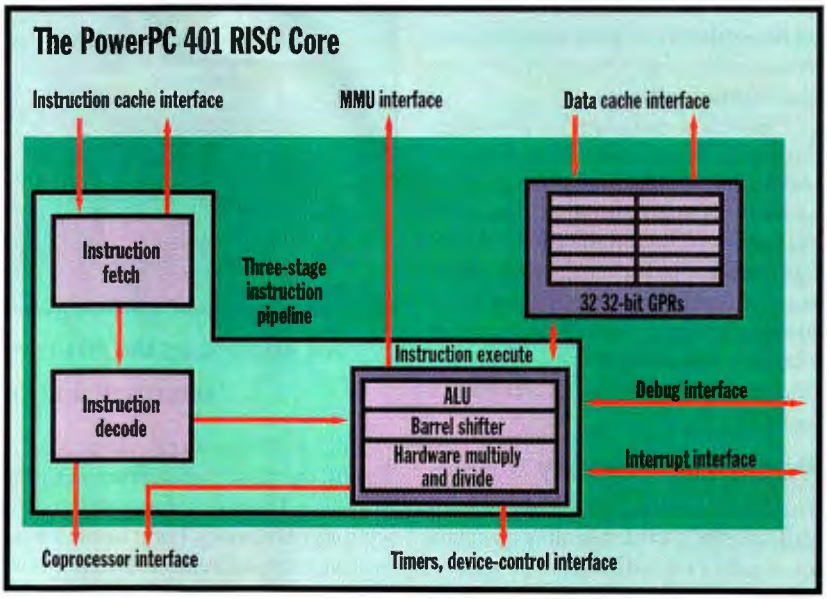
The 401 core has a three-stage pipeline (instruction fetch, instruction decode, and instruction execute) that boosts code throughput. These pipeline stages also expose some of the decoded instructions for use by other function units, such as the 401GF's memory management unit (MMU).

But certain design compromises were made to reduce the 401 core's transistor count, thereby reducing its power consumption. For example, the 401 core does not have an FPU.

Moreover, while the 60x family has multiple execution units that can operate on two or more instructions concurrently, the 401 core executes a single instruction at a time. While this trade-off constrains the 401 core's performance, it also eliminates the large number of transistors required for buffers, reservation stations, and other logic needed to support the concurrent operation of the execution units.

The end result is a RISC core that is comprised of only 85,000 transistors and is physically very small. Using 0.5-micron, triple-level-metal CMOS fabrication technology, the 401 core occupies only 4.5 square millimeters on a die.

IBM also offers custom solutions, in which the 401 core and optional function units can be fabricated into an ASIC that is targeted for a specific design. The 401GF represents such an implemen-



The 401 core has a three-stage pipeline.

tation, with its data and instruction caches, MMU, several timers, and peripheral interface.

Embedded Power

The heart of the 401GF consists of three tightly coupled function units: the 401 CPU core, the data-cache unit (DCU), and the instruction-cache unit (ICU), as shown in the figure "The PowerPC 401GF Architecture" at right. The 401 core, in tandem with the bus-interface logic, can field misaligned data on load/store instructions. This capability allows programmers to tightly pack data or code and conserve RAM, which is a high-cost item for embedded applications.

Both of the 401GF's cache units have data arrays, tags, and control logic for addressing and cache management. The 401GF uses a Harvard architecture and has a 1-KB data cache and a 2-KB instruction cache. (Custom 401GF implementations can be fabricated with caches up to 16 KB in size.) The small size of these caches is offset by the performance gained through the cache's two-way set-associative organization.

The DCU uses a copy-back strategy during cache operations to reduce bus traffic. This means that writes to main memory occur only for those data items that get modified in the cache. These updates take place when the altered data must be purged from the DCU in order to make room for new data. Control bits in the data-cache-control register can disable the cache for specific sections of memory.

Managing Memory

The 401GF has a sophisticated bus-control unit (BCU) that handles transfers among the external bus, the caches, and the registers within the processor core. The BCU can be programmed to handle a mix of 8-, 16-, or 32-bit devices. For example, in a set-top box, the BCU might use 8-bit accesses to fetch instructions from inexpensive 8-bit ROMs while performing 32-bit accesses to update a bank of DRAM that acts as a frame buffer.

The BCU has a programmable read/write burst mechanism that allows it to work with burst-mode ROMs and with page-mode DRAM to expedite cache-fill and flush operations. The BCU handles big-endian or little-endian byte ordering and supports transfers between it and external bus masters. This combination of programmable bus width, endian addressing modes, and read/write functions allows the 401GF to easily integrate with any type of peripheral or memory device, a plus for any design.

WHERE TO FIND

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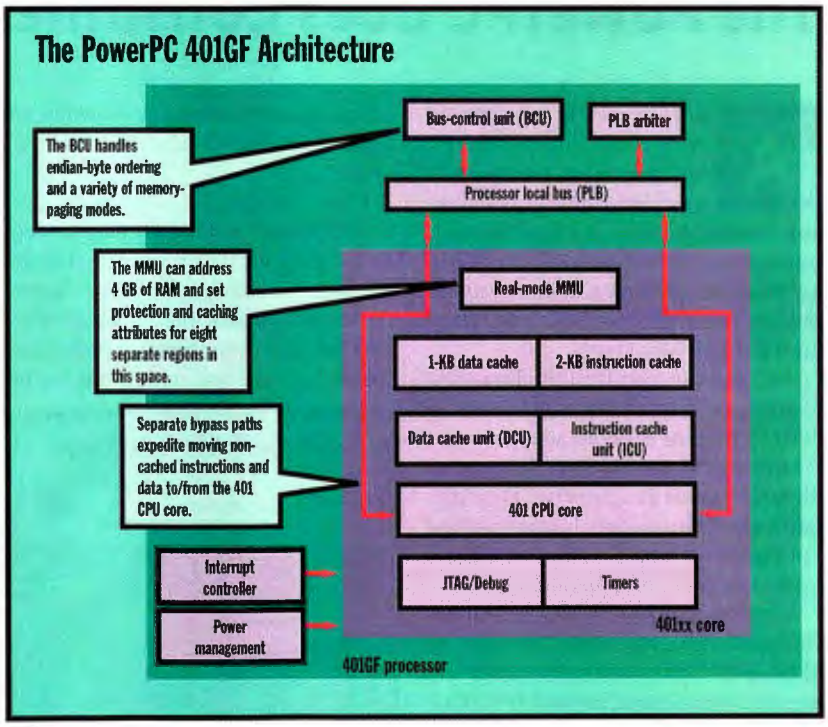
http://www.chips.ibm.com



The 401GF uses the 401 core plus function units that handle interrupts and memory management.

The 401GF has a real-mode MMU. That is, the MMU handles memory protection and assigns access attributes to sections of memory, but it doesn't perform memory-address translation. (A virtual-mode MMU that addresses translation and memory paging is available for special purposes.)

Conserving Power

The 401GF uses a fully static CMOS design. This allows the processor clock to be switched off, putting the processor to sleep for power savings, yet the contents of its registers and its internal state are preserved. The 401GF can resume where it left off when an external event switches on the processor clock.

The 401GF has a programmable clock multiplier with ratios of 1:1, 2:1, 3:1, and 4:1. This lets the 401GF operate internally at higher clock rates for better performance while the system runs at a lower, less power-consuming frequency.

Like the PowerPC 603, the 401GF can selectively disable the clock to idle function units, which can further reduce power consumption. Also, you can issue commands to the SPRs so that the processor enters one of three power-conservation modes (nap, doze, or sleep).

At 25 MHz, the 401GF typically consumes 40 mW; it can be as little as 0.015 mW when it's in sleep mode. At this frequency, the 401GF can execute 44,000 Dhrystones per second, or 26 Dhrystone MIPS (DMIPS). Also, 50-, 75-, and 100-MHz versions of the 401GF will be available later this year as 3.3-V parts.

IBM has a library of various function units (e.g., a virtual-mode MMU, a digital signal processor or floating-point coprocessor, and a serial I/O interface) that you can add along with a 401 core to create a custom ASIC for a specific design. You can even add your own specialized logic, thus producing a high-performance 401-based ASIC for unique embedded applications. B

Tom Thompson is a BYTE senior technical editor at large. He has a B.S.E.E. degree from the University of Memphis. You can reach him at **tom_thompson@bix.com**.

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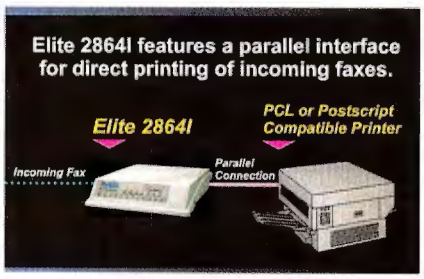

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A guide to using the Pentium's new multimedia instructions.
By Jonathan Khazam and Bev Bachmayer

Programming Strategies for Intel's MMX

Developing fast applications for Intel x86 processors is, in general, not difficult. However, an understanding of the processor's architecture makes the difference between a fast application and a slow one.

Intel processors that offer MMX technology add a new dimension to code development. The MMX technology is a set of highly optimized instructions for multimedia tasks that's included in Pentium processors scheduled to ship later this year. (For more on MMX, see "x86 Enters the Multimedia Era," July BYTE.) Software development cycles being what they are, developers need to start considering now where and how these MMX instructions can boost the performance of their applications.

Planning Considerations

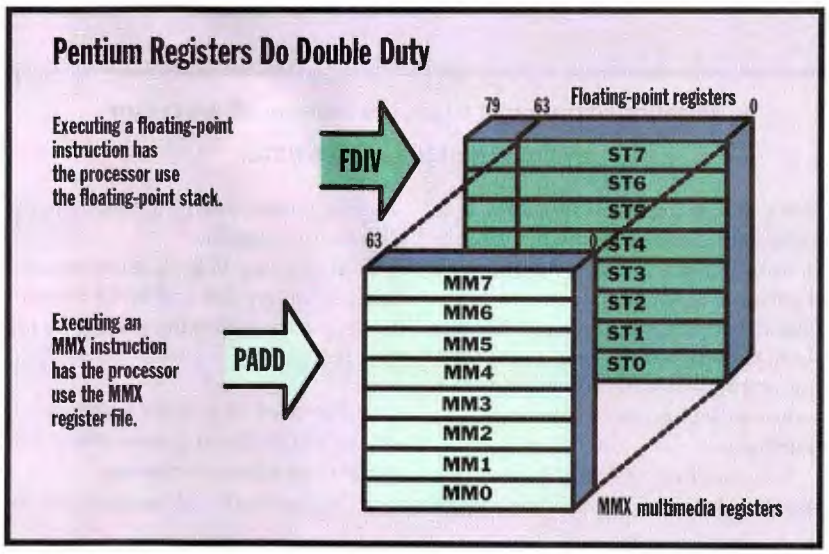
Before changing a line of code, the first thing you should do is profile your application. *Profiling* is the process of linking special libraries into your program or using system utilities to measure where your program spends most of its execution time.

Generally, you want to work on those code segments that are computationally expensive or that take a sizable percentage of the application-processing time. In multimedia and communications applications, such code sections typically include filters and speech-compression algorithms, video-display routines, and rendering routines.

In general, such routines consist of small, repetitive loops that operate on 8- or 16-bit integers. It is these routines that yield the greatest overall performance increase when converted to MMX-optimized code.

Such algorithms need to be analyzed for their fit with MMX instructions. The MMX technology adds 57 new op codes, designed to do high-speed arithmetic, logical, and comparison operations on packed data. As mentioned above, these MMX instructions offer the best support for 8- and 16-bit integer data types.

In some cases, it's possible to improve an algorithm's performance by rewriting it to use MMX instructions. For example, suppose a multimedia algorithm uses integer data. The first step is to use a profiling tool to identify which parts of the algorithm consume the most processor cycles. Once such "hot spots" are identified, you rewrite these code sections to use MMX integer instructions.



Register aliasing prevents you from using MMX and floating-point instructions at the same time.

Floating-Point or Integer?

If an algorithm employs floating-point data, you should determine why it was used. Floating-point math is typically employed for one of two reasons. The first is for performance, since floating-point multiplies are about three times faster than standard integer multiplies in the Pentium. The second reason is that the algorithm in question requires a large range or lots of precision in its results.

If the algorithm uses floating-point math to obtain better performance, then it's certainly a candidate for conversion to MMX integer code. On the other hand, if the algorithm requires the range or precision that floating-point data offers, further investigation must be done. Can the algorithm's data values be converted to integer while maintaining the required range and precision? If so, you might rework the algorithm to take advantage of the MMX instructions.

When writing MMX code, it's important to keep in mind that the processor aliases the 64-bit MMX registers over the 80-bit floating-point registers, as shown in the figure "Pentium Registers Do Double Duty" above. This sleight of hand allows the addition of eight 64-bit, directly addressable MMX registers without adding any new processor states or

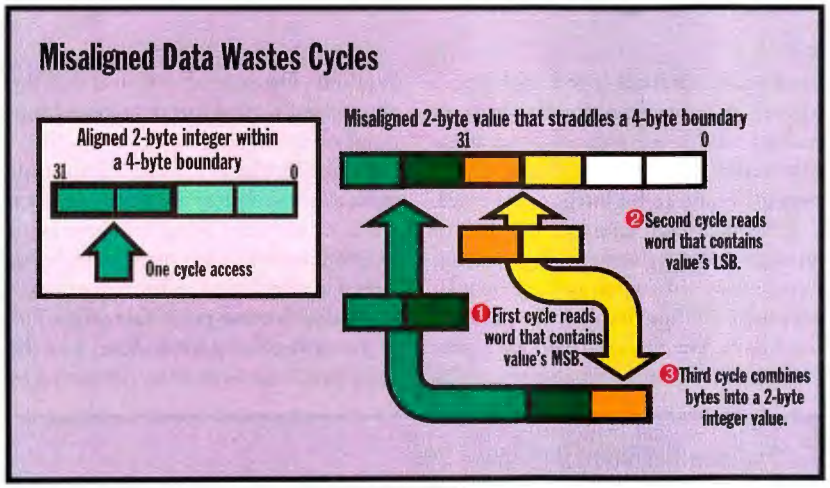
compromising software compatibility.

Because the registers are physically the same, however, you can't store both floating-point data and packed-integer data in the same register at the same time. In addition, there's a small amount of processor overhead (several tens of clocks) when switching between floating-point and MMX instructions. To keep this overhead from sapping application performance, don't intermix floating-point and MMX code at the instruction level. If an application frequently switches between floating-point and MMX instructions, then you should consider extending the period that the application stays in either the MMX instruction stream or the floating-point instruction stream; this procedure will better amortize the switching overhead.

Because floating-point convention specifies that the floating-point stack be cleared after use, it's important to clear the MMX registers before issuing a floating-point instruction. The EMMS instruction is designed for just this purpose; it clears the MMX registers and sets the value of the floating-point tag word to empty (i.e., all 1s). This instruction is the MMX technology's equivalent of popping floating-point values off the stack to leave it empty. The EMMS instruction should be inserted at the end of all MMX code segments to avoid a floating-point overflow exception.

When writing an application that uses both floating-point and MMX instructions, use the following guidelines for best results.

- Partition the MMX instruction stream and the floating-point instruction stream into separate segments.
- Exit the MMX code section with the floating-point tag word empty (via the EMMS instruction).
- Leave the floating-point code section with an empty stack.
- Don't rely on the contents of the MMX or floating-point registers across context switches.



Misaligned data can triple the number of processor cycles required to fetch data.

Data Alignment

Data alignment is critical to optimal performance on Intel processors. Misaligned accesses add costly extra clock cycles to data-access times and sap performance. To see why this is so, see the figure "Misaligned Data Wastes Cycles" at left. If, say, a 16-bit integer value straddles a 4-byte boundary, it triples the number of cycles required to access the data.

This problem is easily solved by simply respecting data alignment. Many compilers let you specify the alignment of variables using compiler controls. If a manual alignment of the variables is required, typically when allocating memory blocks on the fly, you can use the following C algorithm to force alignment. This routine aligns a 64-bit variable on a 64-bit boundary. Once it's aligned, every access to this variable saves three clock cycles (versus an unaligned access) on a Pentium processor.

```
if (NULL == (new_ptr = malloc
  (new_value +1)* sizeof
  (var_struct))mem_tmp =
  new_ptr;mem_tmp /= 8;
  new_tmp_ptr = (var_struct*)
  ((Mem_tmp+1) * 8);
```

As a matter of convention, compilers allocate anything that's not declared `static` on the stack. When making use of such volatile 64-bit data elements, it's important to ensure that the stack is aligned. The C code in the listing "Maintaining Stack Alignment" (at left), when placed in the function's prologue and epilogue, can force stack alignment.

As you can see, using MMX technology to speed program execution is fairly straightforward. More on MMX technology, instructions, and coding techniques can be found at the uniform resource locator (URL) http://www.intel.com. B

Maintaining Stack Alignment

```
Prologue:
        push    ebp             ;save old frame ptr
        mov     ebp, esp        ;make new frame ptr
        sub     ebp, 4          ;make room for stack ptr
        and     ebp, 0FFFFFFFC  ;align to 64 bits
        mov     [ebp],esp       ;save old stack ptr
        mov     esp, ebp        ;copy aligned ptr
        sub     esp, FRAMESIZE  ;allocate space
```

... callee saves state, etc.

```
Epilogue:
```

... callee restores state, etc.

```
        mov     esp, [ebp]
        pop     ebp
        ret
```

Jonathan Khazam is the program manager for Intel's MMX technology program. Bev Bachmayer is a senior programmer in Intel's code-optimization group. You can contact them at **Jonathan_Khazam@ccm.sc.intel.com** *and at* **Bev_Bachmayer@ccm.imu.intel.com**, *respectively.*

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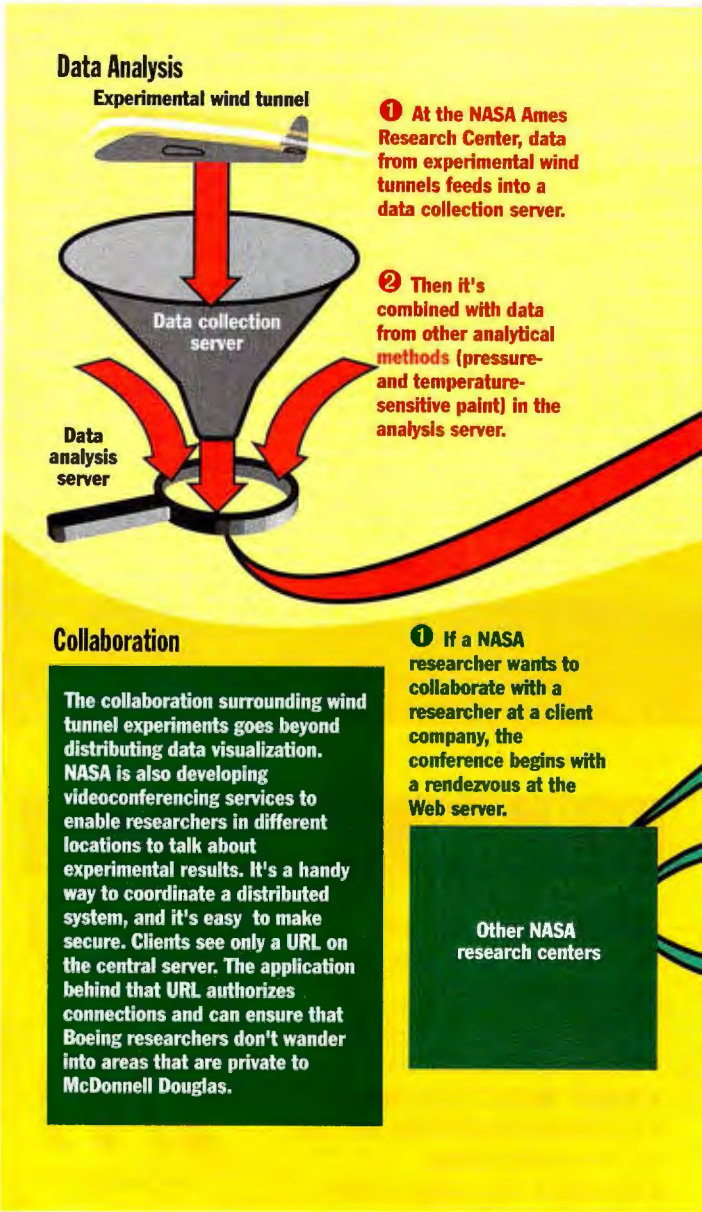
Your Business Needs the Web

Web-smart, platform-independent applications are jump-starting a Golden Age of software development.

By Jon Udell



Can you really run your business on the Internet? You can't afford not to. As the planetary IP network increasingly connects your company to customers and business partners, the only question is: How can you best exploit the new opportunities?

Last year the World Wide Web looked like a great platform for electronic publishing. This year it became something far more profound: a planetary operating system. It's a primitive OS, to be sure, but so was MS-DOS when the IBM PC kicked off that great wave of software innovation. The Web's Common Gateway Interface (CGI), a sort of INT21 for the '90s, has created another tsunami. And this time, applications aren't confined to stand-alone Intel processors. They run on all kinds of computers, and they share code and data with computers anywhere.

The network really is the computer, finally. How can you use it? We've divided the answer into four parts. First, we explore the unique dynamics of the Web computing platform. Then we discuss how to integrate legacy systems with the Web. In part three we evaluate techniques for building Web server-based applications. We wrap up by exploring how Java, Sun's executable Web-page scheme, and ActiveX, Microsoft's OLE-replacing component scheme, will transform Web clients.

How to Exploit the Web's Dynamic Nature

Here's a Web application in its most basic form: You view a Web page in a browser, click on a hyperlink, and receive a new page from an application running on the server. From this simple model flow a number of obvious and not-so-obvious business benefits. First, the obvious ones:

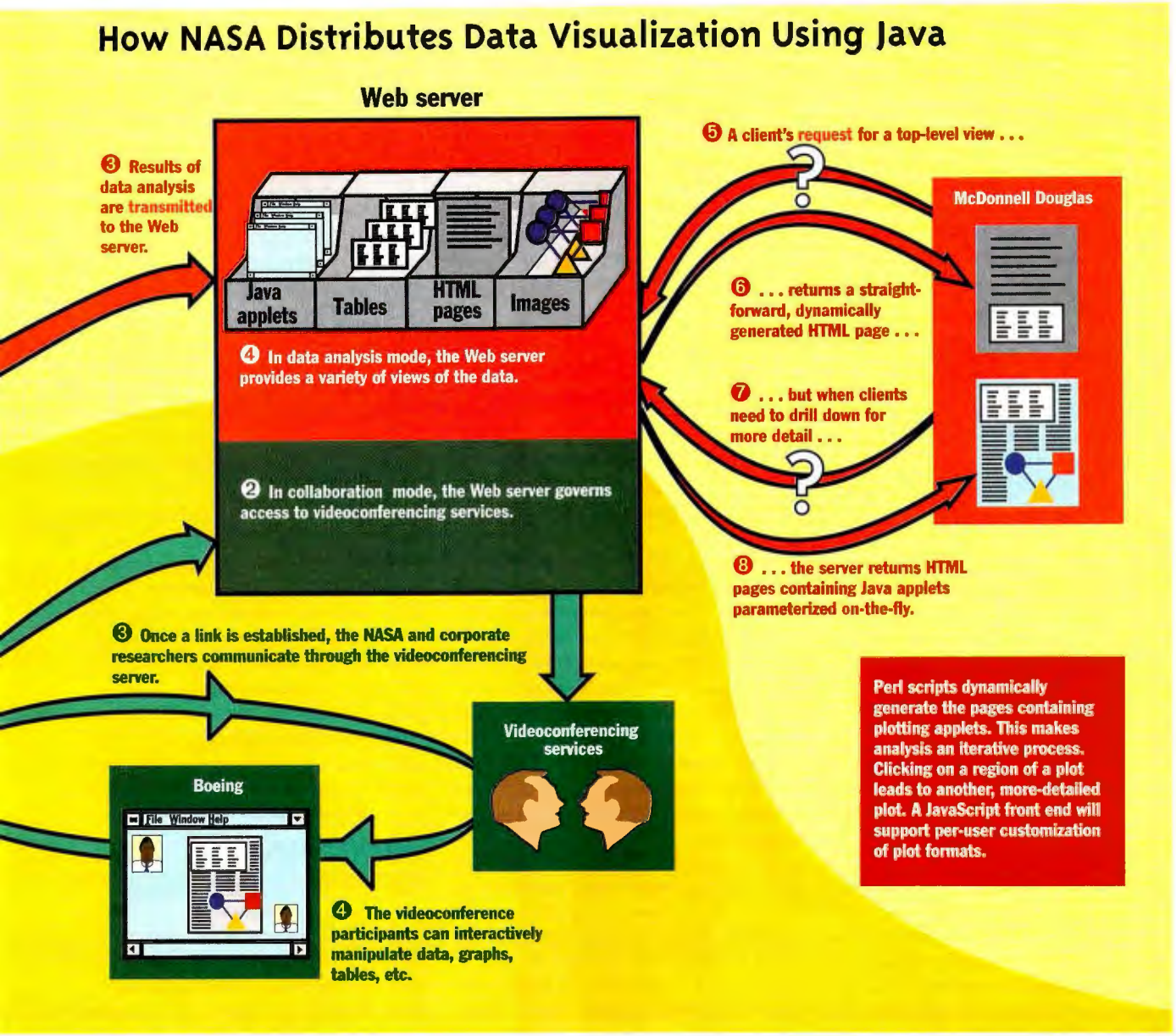
Platform neutrality. A Macintosh, PC, or Unix browser can receive the same page in the same way from a Macintosh, PC, or Unix server.

Global availability. The browser and the server can be anywhere in the world—inches or continents apart, it makes no difference.

Automatic software distribution. The browser is (at least in first-generation Web applications) a universal client. No other software is needed. Given just the address of a Web application, any browser anywhere can run it. Users always run the current, latest-and-greatest version of that application.

And here are some subtler benefits to running your business on the Web:

Distributed computing can be easy. One application running on the BYTE Site (http://www.byte.com) augments our postcard-based reader service system. Pre-Web, you circled numbers on a "bingo card" and sent it to a fulfillment house called IMS. This company tallied these requests for product



information and relayed them along with your name and address to vendors. The vendors in turn sent their product literature back to you. Now you can use a Web form to do the same thing. When IMS first proposed this Web scheme, the plan was to locate both the form and its companion CGI script on IMS's Web site. But when we needed to tweak the form we had to fetch it, then pass it back to IMS. Unnecessary! Now the form lives on the BYTE Site, and its script lives on the IMS site. I can tweak the form as needed as long as I preserve its interface to the script; that is, the names of the form variables and the URL of the script that processes the form.

Here's another example: The BYTE Site has evolved into a village of Unix and Windows NT servers. They partition the work of the site among them. One pumps out static Web documents; one runs CGI scripts; others provide mail, conferencing, application, and database services. None of this division of labor is obvious when you visit the site. URLs bind multiple servers into a cohesive whole.

We tend to think of distributed computing as a hard problem that even expensive middleware and unfathomable APIs can't always solve. The Web's dynamics turn that assumption on its head. Its simple and accessible programming model puts all sorts of practical distributed applications within reach of average developers using minimal tools.

Better still, you can partition applications across companies as well as across servers within your company. BYTE's collaboration with IMS was an example of ad hoc business-to-business network computing. In 1994 such a thing would have been difficult to imagine. In 1995, thanks to the evolution of the Web, it just happened—effortlessly.

What about the heavy artillery of distributed computing: transaction-processing monitors, object request brokers (ORBs), remote procedure calls (RPCs), and the rest? All this stuff still matters—more than ever before given the size of the audience to which Web applications play—but you can do simple things in a simple way.

You can support more users than you think. The Web's connectionless, page-at-a-time style of interaction can support lots

of users—internal and external to your business. Every day, over 3500 visitors fetch more than 300 MB of data from our site's document server (an Alpha AXP/150) and run more than 2000 instances of scripts on its application server (a dual Pentium-90). These are not big numbers by Internet standards. But we haven't hit any real bottlenecks yet, other than bandwidth.

Can you imagine saying the same thing about a LAN client/server setup running on equivalent hardware? Thanks to HTTP's statelessness, you can cheaply deliver applications that serve thousands of users on your company's intranet and many more worldwide.

You can build customized, data-driven applications. Hypertext Markup Language (HTML) can express the basic widgetry of GUI applications—radio buttons, drop-down lists, multiline text boxes—and browsers can render those widgets. Is an HTML form a document or an application? Well, it's both, and more. Think of it as an active document, or a document-centric application. Either way, your browser's View Source function reveals that under the covers it's just an ASCII text file. People can write HTML texts quite easily. So can programs. Mixing human- and machine-written HTML leads to powerful synergies.

The BYTE Site's first application was a feedback form. I wrote a template for the form. Then I wrote a program to instantiate the template for each of the 5000 BYTE articles available on our site. When you comment on an article, the site presents a form specific to that article, then routes your feedback to the editors responsible for that article.

That's only the beginning. "Applications will reduce to sets of HTML pages that contain components," says Jeremy Allaire, president of Allaire (http://www.allaire.com), a vendor of tools that integrate Web applications with databases. Servers will build their business applications on the fly, selectively inserting and configuring components to match the user's identity and circumstances. It sounds like science fiction, but it's fast becoming reality. The corporate clients of NASA's Ames Research Center—Boeing, McDonnell Douglas, and other aerospace companies—use Web browsers to analyze wind-tunnel data collected at NASA (see "How NASA Distributes Data Visualization Using Java"). Pages generated for these clients contain Java applets used to visualize the data. NASA's system decides at run time which applets to insert into the pages, and how to parameterize them, according to the access privileges of each corporate client and the interests of each individual user.

Four Reasons Why the Web Is Essential

✔ **It's open:** The Web is platform-neutral and global, and Web browsers function as universal clients.

✔ **It's resourceful:** Using the Web, you can update the look and the capabilities of legacy applications.

✔ **It's efficient:** Web-server applications are becoming simpler to create and faster to use.

✔ **It's dynamic:** Java and ActiveX can help you quickly build information-rich and customizable client applications.

You can find the information you need. It's been a truism that white-collar workers spend a shocking percentage of their time looking for documents. Suddenly that's changed. Last week I was looking for the latest Open Database Connectivity (ODBC) spec. Digital's AltaVista found it on the Net faster than I could have found it in my office on some CD. It also found the ODBC driver upgrade I needed and pointed me to Usenet discussions about the upgrade.

Successful application of full-text search on a planetary scale is so new that its implications have yet to sink in. "Not long ago, relatively few people had ever used full-text search," says Tim Bray, OpenText's cofounder and senior vice president of technology. "Now 40 million people use it on a regular basis."

The next frontier is fielded search. It's available now in a limited way on the Internet. In AltaVista, for example, you can issue the query "applet:spreadsheet" in order to find pages with Java spreadsheet applets. The <applet>..</applet> pair defines an implicit field, enabling a precise search for pages that actually contain Java spreadsheet applets, rather than ones that merely mention spreadsheet applets. In a recent BYTE Site survey we learned that aspiring Java programmers desperately want some sample code. AltaVista's "applet:" trick created a virtual Java code library out of thin air.

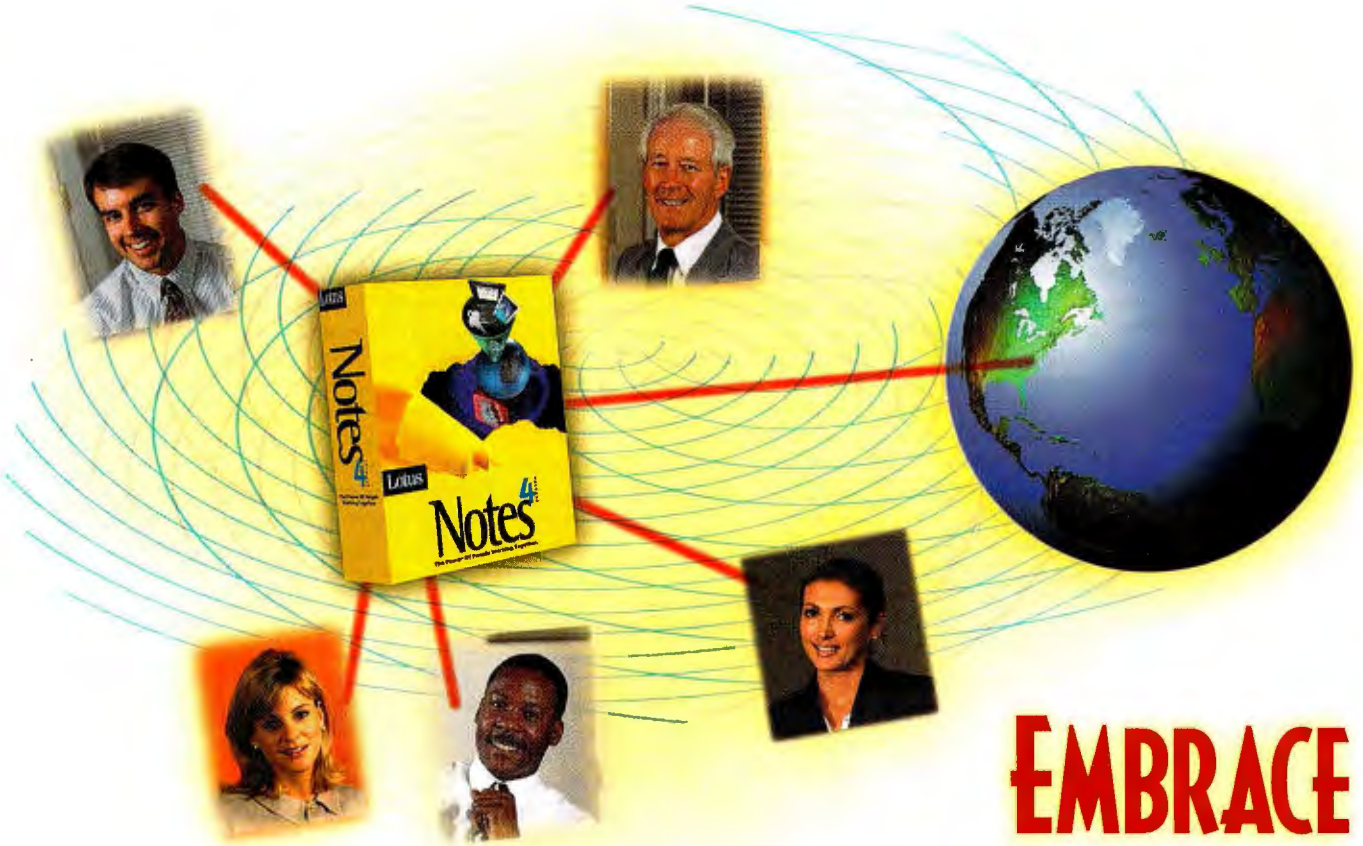
If the accidental structure that just happens to exist in the Web's document pool can yield such interesting results, what might intentional structure accomplish? The sky's the limit. On Qualcomm's intranet, 4500 employees share engineering and project-management documents using OpenText's LiveLink Intranet. A version of OpenText's Internet Web crawler scans and indexes documents. Users inject new documents into the system using LiveLink's work-flow manager, a Web application that's equally accessible to the 2000 PCs, 2000 Macs, and 500 Unix workstations in the company. As it receives documents, it tags them with user, date, and project fields. This additional structure vastly improves search capability, especially since many of the engineering documents don't translate to HTML and store as PDF files instead.

Integrating Legacy Systems

The Internet's frenzied evolution is redefining the term "legacy system." A few years back, the term referred to the mainframe application you replaced with a PowerBuilder and Sybase client/server solution running on a LAN. Today, as likely as not, it's the client/server system itself that your company is targeting for recycling—this time into a Web-based business application.

Some pioneers today are going all the way, building client and server logic using pure Java and/or ActiveX (formerly OCX) technologies. Yet if you scratch the surface of most major Web applications, you'll find some familiar items: middle-tier logic written in 3GL or 4GL languages, talking to transaction services or talking directly to data stores.

Why put a Web face onto an otherwise unmodified legacy application? First and foremost: To let business customers serve themselves. Federal Express drove home the point when it exported its mainframe-based package-tracking application



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Domino is code name for the new server technology which transforms Lotus Notes into an interactive Web applications server, allowing any web client to participate in Notes applications securely. Domino bridges the open networking environment of Internet standards and protocols with the powerful application development facilities of Notes. The new Notes server provides businesses and organizations with the ability to rapidly develop a broad range of business applications for the Internet and Intranet.

...and More

Lotus' InterNotes™ Web Navigator delivers 'Team Surfing'. Much more than just a browsing tool, it's Internet access integrated into the core Notes environment. Features like Web Tours and Recommended Pages allow users to share Internet experiences and resources, thus sharing valuable knowledge and adding to team collaboration.

Other Notes Internet products and services include InterNotes News for managing USENET access, Notes Network Information Center for direct Notes-to-Notes communication, Lotus Notes:Newsstand™ for subscription-based publications over the Internet, and more.

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For more information on how you can embrace the Internet with Lotus Notes, and to get your copy of Domino, explore Lotus on the Word Wide Web at www.lotus.com or call 1-800-828-7086, ext. C177*.

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The Firewall Dilemma: Too Few Locks, Too Many Doors

People who've used TCP/IP networks for a long time find the current fuss over intranets, firewalls, and the Internet a bit perplexing. It's all just good old IP networking, right? Well yes, but when a cozy community becomes a bustling megalopolis, people have to lock their doors. The problem is that every single node of a TCP/IP network is a door. McGraw-Hill, BYTE's parent, is busily installing 10,000 of these doors. Unfortunately, there is not yet a practical way to lock them all, so like many companies, McGraw-Hill locks the one that connects its global private WAN to the Internet. That's the only rational choice today, and I'm grateful for it, but it still stinks. When I recently moved BYTE's LAN behind McGraw-Hill's firewall, all sorts of things broke: POP3 mailbox access, NNTP conferencing, RealAudio, and every other non-HTTP application.

We have gotten RealAudio back again, and I'm working with McGraw-Hill's provider, ANS, to restore POP3 and NNTP. It's all doable with the right combination of packet filters and application gateways. But while you can bless a whole series of protocols and applications with the ability to penetrate firewalls, that won't solve the two real problems:

Problem #1: *There are no safe protocols.* If you think HTTP is benign, think again. Simson Garfinkel, author of *Practical UNIX and Internet Security*, sketches out several ways to attack a firewall that's permeable only to HTTP. Here's one: Convince people to download a Netscape plug-in that silently relays secrets to a rogue server outside the firewall. "The plug-in could do anything at all, even run a packet-sniffer on your LAN," says Garfinkel.

Problem #2: *There are too many doors.* A perfect firewall is not the answer. Just about any Mac, PC, or Unix workstation can bypass the firewall by dialing the Internet directly. You can't police them all. Insiders, sometimes knowingly, represent the worst threat.

Beyond Firewalls: The Virtual Private Network

IPsec, now in gestation, looks like a good answer. It's a secure form of TCP/IP, encrypted from end to end. The first crop of implementations, built by firewall vendors, are now entering the interoperability test phase. They will enable secure use of any standard IP application for business-to-business networking. Why is that important? The Web is hot, but there is much more to distributed computing—sockets, remote procedure calls (RPCs), Internet inter-ORB protocols (IIOPs). You would like to be able to do all these things safely on the public Internet.

Firewall-based secure IP will not, however, deter deliberate or accidental sabotage from behind any of the firewalls participating in this kind of virtual private network. What would? Desktop-based secure IP. The kind of end-to-end encryption that's available now at the application level—between secure Web servers and Web browsers, or between Notes servers and Notes clients—could, in theory, migrate down into the TCP/IP stack on your workstation. Any IP application could then communicate securely within and across corporate boundaries. But don't hold your breath. Gateway implementations of secure IP have yet to prove themselves computationally and administratively feasible. Desktop implementations are even further off.

Coping Strategies

While you're waiting for secure IP to arrive, here are some interim solutions:

Piggyback on HTTP. When you have only a hammer, everything looks like a nail. Likewise when the Internet industry decides that HTTP is the "safe" protocol, every application starts to look like an HTTP application. "We're taking higher-level protocols like DCOM and putting them on top of HTTP in order to get through firewalls," says Bob Muglia, Microsoft's vice president for development tools. "It's crazy, but HTTP has become a legacy thing like MS-DOS."

Use Lotus Notes. A Notes network riding on top of the Internet can be a highly secure virtual private network for geographically dispersed employees and business partners. To reach customers outside the Notes environment, use Internotes WebPublisher to export access to data and applications.

Encrypt your e-mail. This is currently harder than it should be. Implementations of Pretty Good Privacy (PGP) have been available for years, but none yet integrate into popular mail programs such as Eudora and Netscape Navigator. A number of e-mail vendors now plan to support an alternative scheme, Secure Multipurpose Internet Mail Extensions (S/MIME), but no S/MIME mailers are available yet, either.

What's the holdup? Nobody wants to get busted for violating U.S. restrictions on export of cryptographic technology, says Simson Garfinkel. Still, it's likely that secure mailers will soon be prevalent. Secure SMTP will be a useful transport for many applications.

Exploit other secure applications. Netscape has added secure socket layer (SSL) support to its news server and client. Kerberos-enabled versions of mail, FTP, and other applications are available. These kinds of solutions lack the universality that makes standard Web applications so appealing. But they do exist.

to the Web. Anderson Windows plans something similar for its inventory system, built using Forte Software's client/server toolkit. Today, Anderson Windows has to pay an employee to run the Forte application on behalf of customers. "That's inefficient if you need a $6 part but it costs [Anderson Windows] $60 to look it up for you," says Ed Horst, director of product marketing for Forte.

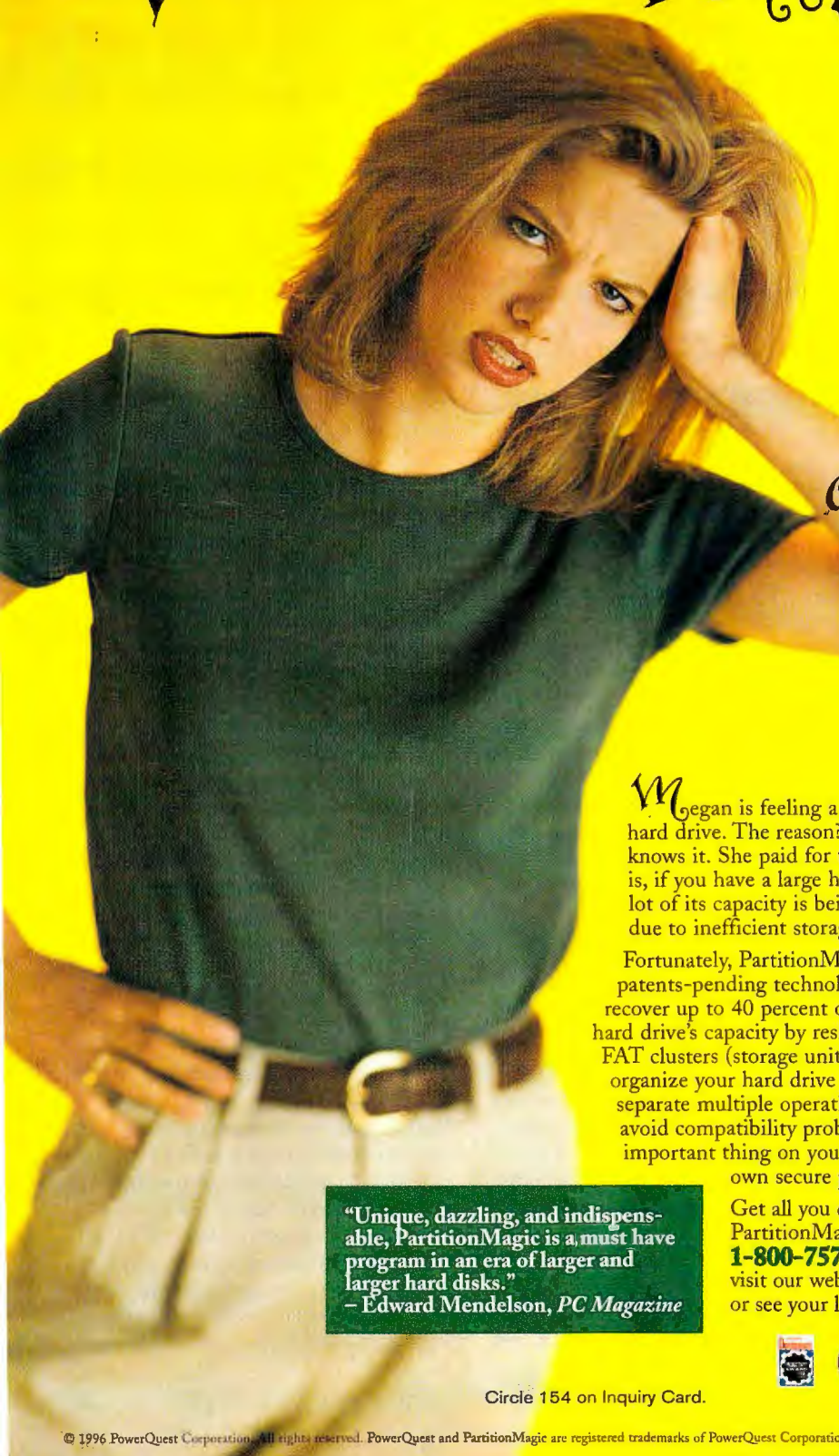
Anderson Windows and other businesses now aim to create dual-mode applications. In this model, a less-functional Web version exports a simple self-service capability directly to customers. The full-featured LAN client/server version remains available to employees, who can spend less time acting as application gateways and so (one hopes) more time on nonroutine customer service. Both versions share common middle-tier services such as pricing logic. In concept, this approach resembles the computer telephony systems that companies use to let customers serve themselves via interactive voice response.

Put on the Best Web Face

Ponytailed Web design consultants in expensive suits will tell you your Web application must use frames and Java-enabled animation to attract an audience. Fire them. The name of the game is access. Southwest Airlines recently fielded an application you can use to book flights over the Web (see http://www.iflyswa.com/). "We found that most of the world is running Windows 3.1 at 640 by 480," says senior engineer Steve Taylor. "We set the bar at Netscape 1.2 because people want to book flights, not download browsers."

On the other hand, if you can dynamically adapt to the user's (that is, the potential customer's) browser, you should. JAM/WEB, which Web-enables applications built using JYACC's (http://www.jyacc.com/) three-tier development tool JAM, will emit JavaScript to perform client-side data validation if the browser is capable. "On Netscape 1.x, we know we can't do that," says Charles McGuinness, JYACC's director of technical marketing,

"I want more out of this relationship."



"I need 100% commitment from my hard drive."

Megan is feeling a little snubbed by her computer's hard drive. The reason? It's holding back on her, and she knows it. She paid for the whole hard drive. But the truth is, if you have a large hard drive, a lot of its capacity is being wasted due to inefficient storage methods.

"PartitionMagic uses the power of partitions to recover up to 40 percent of your hard drive's capacity."

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"so we fall back to plain HTML and validate on the server side."

Appropriate Technology

Almost any kind of tool can support a Web business application. I wrote my first non-Perl Web application using Next's WebObjects on a Dell P90. I've always liked Objective-C and the Next libraries but could never effectively deploy applications built this way. Now I can.

Object Design Inc.'s ObjectStore manages the complex fare and schedule data that supports SouthWest Airlines' flight-booking application. Transactions still go back to the legacy reservation system, but ODI's object database handles fare and schedule queries a lot faster than the legacy system could.

A business application built with JYACC's JAM can straightforwardly convert into a replicated, load-balanced, fault-tolerant Tuxedo service. JAM/WEB extends these Tuxedo benefits to Web clients.

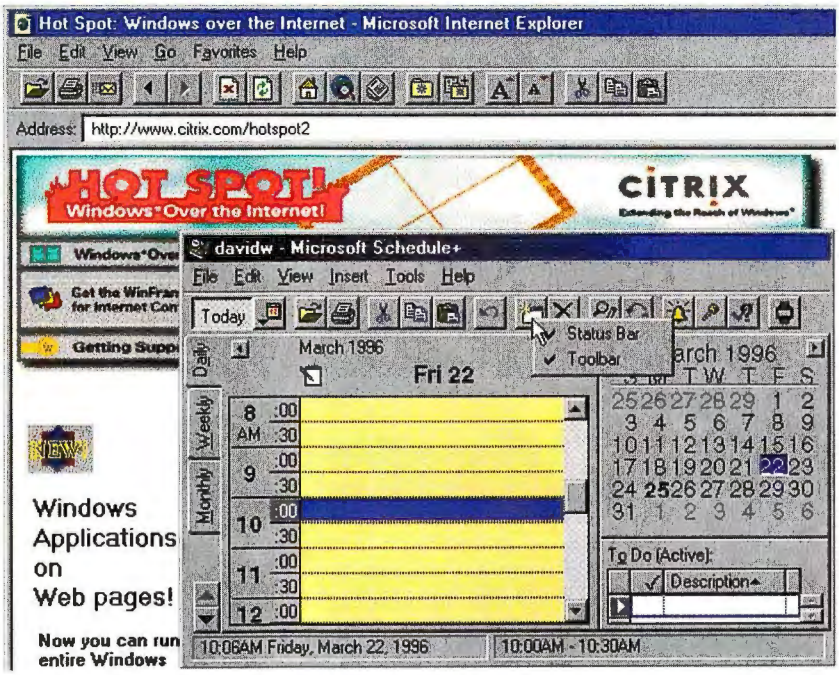
Lotus Notes, with InterNotes WebPublisher, supports many of the Web development projects tackled by Entrevision, a Canadian systems integrator. "Now that WebPublisher supports interactive forms as well as static pages," says Entrevision partner Steve Carroll, "it's the ideal development tool for the Web."

WebObjects, ObjectStore, Tuxedo, Notes—the list could go on forever. When you need to squeeze more life out of legacy data and applications, pick the tool that works best. If it doesn't have a Web adapter yet, wait a month.

A Different Thin Client

The Web's explosive growth owes much to the thinness and universality of browsers. Mosaic or Netscape, plus an IP link, was all your Mac, PC, or Unix workstation needed to access everything the Web could offer. Still, as anyone who has recently downloaded a Microsoft or Netscape browser knows, both thinness and universality are now endangered. The disk and RAM footprints of these browsers grow at an alarming rate. As browsers acquire more moving parts (plug-ins, downloadable applets and controls), they begin to suffer from the same problems that plague desktop OSes: memory strain, configuration conflicts, unreliability.

There's no stopping progress. Integration of advanced client-side componentry into browsers is a good and necessary thing. Nevertheless, you'd like to have the option to deploy real GUI business applications over the Web without heaving so much complexity over the wire to the client. The answer is nothing new: Use a remote GUI. The application runs on box A, but the application's GUI displays remotely on box B. X Window is one way to project a GUI application through a network. The remote GUI approach is fine, provided that the application you want to run is an X application and there is enough bandwidth between the X client and server (X needs a lot of bandwidth).



Citrix WinFrame lets you use Windows—in this case, Microsoft Schedule is running—remotely over the Web.

A newer and more mainstream option is Citrix's WinFrame. This is a multiuser implementation of Windows NT. WinFrame features remote GUI projection over the Web or a LAN to DOS, Windows, and (soon) Mac clients. This setup needs less bandwidth than X, and it plays all Win16 and Win32 applications. The latter run natively on the application server, exploiting the DLL architecture of most Win32 programs to share code across many concurrent instances. Add the Citrix client (a 122-KB download) to your browser and you can launch server-side Win32 applications that display on the client, either in the browser or in a separate window.

How might you actually apply this technology to your business? Suppose your field sales force enters their orders into a Lotus Approach application, generates reports, and e-mails those reports to headquarters. You've been meaning to convert to a client/server application to eliminate the data transfer step. A Web-style intranet application is one option—but you have to create it. Alternatively you might use Citrix's WinFrame to colocate the existing Approach application with its data at headquarters and project its GUI to the remote sales force.

Can you scale this business solution? Sort of. You're constrained by the number of concurrent sessions the application server can push. You wouldn't use this approach to let visitors to your public Web site search your inventory. But for a private application with a few dozen concurrent users, it might be just the ticket. Citrix has announced a clustering solution that will spread the processing load across a farm of application servers. If this pans out, your sales-force application could scale to hundreds of users or more.

Can you manage this solution? Absolutely. It plays on a minimal client—a 2-MB 386/20 running Windows 3.1 works as well as a 16-MB Pentium 90 running NT. The machine needs only the universal Citrix client and a network link. When you upgrade the application, it's automatically available to everyone. These are exactly the benefits that, we may soon be complaining, Web browsers used to deliver. *continued*

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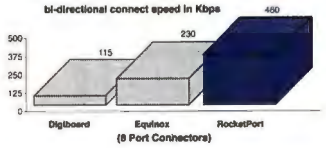

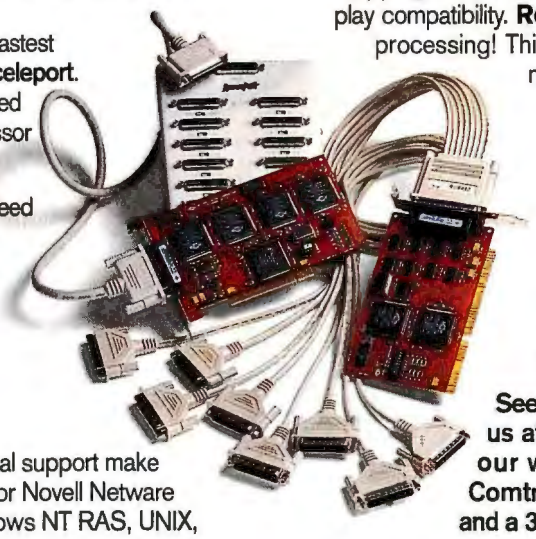

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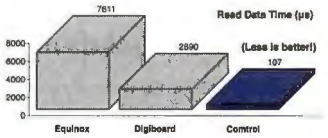

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Building Web Server-Based Applications

Pre-Web, there were really two kinds of programs. Console applications read text from and printed text to a character-mode console; GUI applications read events from a queue and painted text and graphics on a bit-mapped screen. A Web application is a curious mixture of these styles. It reads and writes text just like a console application does. But the text it writes—HTML—describes how to render text and graphics on a bit-mapped screen. A Web application is, from this perspective, something like a PostScript driver.

Perl was the language of choice for first-generation Web-server applications, in part because its powerful string-processing features make it a snap to create and manipulate HTML texts. Other reasons were free availability on all platforms, rapid development thanks to interpreted execution, and direct support of IP network APIs including sockets.

As Web developers became more ambitious, and as traffic to Web sites grew, the Perl method began to show signs of strain. When you run a CGI program that's implemented in Perl, you're subject to two bottlenecks. First, you have to launch a process in which to run the Perl interpreter, which in turn runs the Perl program. Creating that process once an hour or once a minute is not a problem, but creating it 10 times a second is. Next, you have to wait for the Perl program to send back the page it generates as output. Waiting for a 20-line Perl script that does something simple is not a problem, but waiting for a 2000-line script that does fancy stuff is.

Break the CGI Bottlenecks

Solutions are at hand for both of these bottlenecks. To eliminate process-creation overhead, Web server vendors have created APIs that your back-end applications can use to share a process with the Web server. Netscape's Netscape Server API (NSAPI), Microsoft's Internet Services API (ISAPI), Apache's modules, and O'Reilly's WebSite API (WSAPI) all provide you with ways to shoehorn applications into the server's address space.

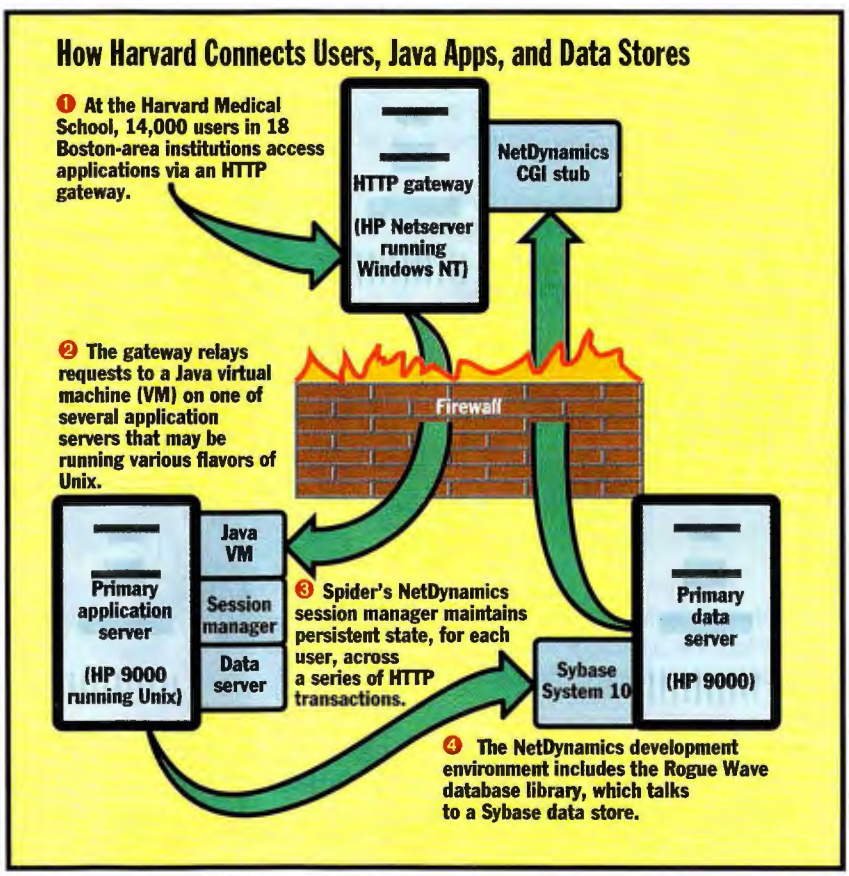
Vendors of Web server-based applications that comply with these mechanisms like to make extravagant performance claims. But it's not so simple. It is expensive to create a process. It's much more expensive, though, to load a monster application into that process. The solution here is to divide the application into two parts. The user invokes a transient, lightweight stub. It transmits a request to a long-running daemon process (Unix) or service (NT) which does the real work. This translates into real speed. "We saw a 10x improvement when we went to this [stub-and-daemon] architecture," says Nanda Kishore, vice president of engineering for Spider Technologies. How does this compare to the API approach? "Converting to NSAPI and ISAPI yielded only another 25 percent improvement."

Server-Side Java

Perl can benefit from both methods. There are ISAPI and Apache-module versions of Perl, and Perl's support for sockets lends itself to the stub-and-daemon architecture. But is it the best real-world solution for running your business application? When CIO Dan Moriarty decided to Web-enable client/server applications for some 14,000 Harvard Medical School users, he wiped the slate clean. "You can do lots of clever things in Perl, and we did," says Moriarty, "but it's not a manageable long-term solution to problems of recoverable transactions, security, and data validation." An exhaustive search led his team to Spider Technologies' NetDynamics. It runs Java applications on a dedicated application server, within a framework that connects those applications robustly to users and to data stores. (See "How Harvard Connects Users, Java Apps, and Data Stores.")

Two key points sold Moriarty on NetDynamics. First, it offers a productive 4GL-like tool that generates accessible and extendable Java code. Second, it provides Java wrappers around session management, security, and database services, so they, too, can be modified or replaced.

Is interpreted Java really an improvement over interpreted Perl on the server? Moriarty bets that Java won't remain interpreted for long. Compilers are coming that will make Java applications nearly as fast as C++ applications. And he knows how large-scale software development can benefit from the modern features that Java offers. Safe memory ranks high; Java is a pointerless language that automatically reclaims storage. Exceptions are first-class objects, and the compiler strongly encourages using Java's elegant exception-handling mechanism. You can write threaded programs and, equally important for server applications, modules that are thread-safe. With Java's synchronized



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keyword you can declare methods, or even individual variables, to be critical sections. And you can do so portably, without reference to the OS-specific APIs usually needed to make modules reentrant.

Understanding Java and ActiveX

Web pages have always been active documents. But they're about to get a lot more active as Java applets and ActiveX components begin streaming down the wire to the latest Netscape and Microsoft browsers.

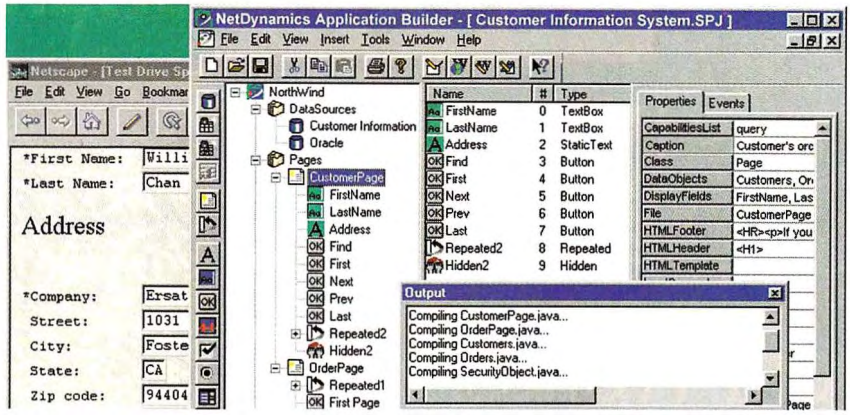
There are two levels where developers can add client-side behavior to a Web page: scripts and components. On the scripting front, Netscape's Navigator offers JavaScript, and Microsoft's Internet Explorer will have VBScript. Given a script on an HTML page, either script language can interact with the page's widgets and with the browser's environment. The classic example for business is local validation. Imagine a form that collects, among other facts, your credit card number. With vanilla HTML there is no way to check the number; the whole form must go to a server-side script that checks it all at once. With JavaScript or VBScript, a client-side function can compute the card number's check digit, wire it up as the field's onExit method, and present a GUI message box in case the check fails.

On the component front, Navigator offers Java, and Internet Explorer supports ActiveX. Given an HTML page referring to a component, either browser can fetch it, allocate a display region for it, and run it. The classic business example is a spreadsheet widget. Rather than deliver raw data in an HTML table, furnish analysis—as a spreadsheet, linked to a data source and including analysis rules and procedures. That's a job for Java or ActiveX. Both of these approaches offer the two essentials for Web businesses: network APIs to fetch the data and GUI APIs to render it.

How Java Beats ActiveX

You can't actually compare Java, a programming language, to ActiveX, a component framework. The real comparison is between the components that play in Netscape browsers versus those that will play in Microsoft browsers. You are likely to prefer Java-style components if:

1) You prize portability above all. To deliver applications to the widest browser audience, Java's the ticket. The Java-enabled browser's virtual machine (VM) plays an applet's bytecodes identically on x86, PowerPC, Alpha, PA-RISC, and SPARC CPUs. The Java abstract windowing toolkit (AWT) likewise renders GUI widgetry in system-appropriate ways on Windows, Mac, and X Window systems. For NASA's Dave Korsmeyer, a senior software engineer, the portability requirement mandated Java to distribute wind-tunnel data analysis to Windows PCs, Macs, and SGI, HP, and Sun workstations.



Spider Technologies' NetDynamics lets you run Java applications within a framework that connects those applications to users.

2) You value a common object-oriented language for components and glue. OOP fans have rightly pointed out that VBX and OCX components sacrifice inheritance for reuse. The same is true for their successors, ActiveX components. With the HTML component in Microsoft's Internet Control Pack, for example, you can create a simple Web browser with a single line of Visual Basic code. Try it! But there's a trade-off. Although you build the component with C++ classes, you can't extend those classes. You can only twiddle its exported properties, and call its exported methods, using Visual Basic, Access, or another ActiveX-aware host. An interface separates the language that implements components (C++) from the language that glues them together into applications (VB). This was an intelligent decision by Microsoft, kicking off an entire component industry. But it was a trade-off nevertheless.

Enter Java. Sun's language designers evidently paid close attention to the debate raging over inheritance vs. interfaces. The result: a language that embraces both. Java supports single inheritance, and its library includes a Component class (ancestral to Window, Dialog, and Frame) that you can extend using inheritance. But Java also supports interfaces. Suppose you extend Dialog to create a class TaxDialog with subclasses 1040Dialog and 1040EZDialog, each having its own special data-validation logic. You can define a TaxDialogValidator interface and implement it once for each subclass of TaxDialog. This is simpler and cleaner than OLE/COM's technique to avoid the multiple inheritance hassle. Unlike OLE/COM, with no implementation inheritance, 1040Dialog and kin do inherit common look and behavior from TaxDialog. Anyone who faces the challenge of maintaining a system with bales of business-vital forms will appreciate this powerful and intensely practical application of OOP.

There's more. The OLE/COM/ActiveX model sharply divides component builders from component assemblers. The former build black boxes using C++, the latter wire black boxes together using VB. Again, there is a trade-off in this productive division of labor. You must decide up front how much to encapsulate in the component, and how much to leave for the glue language. Unfortunately, that's hard. But if functions can migrate both into and out of the component as a project evolves, that's helpful. A common language for components and glue makes this possible. NextStep programmers have been exploiting this synergy for years. Java programmers will, too.

How ActiveX Beats Java

You are likely to prefer ActiveX components if:

1) You want the fullest exploitation of Windows APIs. Cross-platform GUI frameworks are problematic at best, and Java's AWT is currently nowhere near the best. In

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environments where Windows rules, ActiveX is compelling. UCC, a Dutch consultancy, has been working with Siemens on a large distributed car-sales application built from OCX components wired together using VB 4's remote OLE automation. Nico DeVries, manager of UCC's client/server division, sees ActiveX as the natural extension of this model. The OCX componentry already delivers rich Win32 behavior on the client side and robust communication with SQL data sources. ActiveX promises to simplify the distribution of components by automatic download.

2) You value a common component-oriented framework for LAN and Internet applications. Today these two breeds stand far apart. But the Internet is really just a very big and very slow LAN. ActiveX components ride on a support layer that unifies these two kinds of network. Services include caching, reliable data transfer over slow links, and a single namespace for LAN and Internet resources.

Microsoft is defining a sophisticated two-tier component architecture. On one level, an application is made of components that talk to each other, to LAN resources, and to Internet resources. On another level, containers manage classes of data and the applications that render those data types. Internet Explorer 3.0 and the next Windows 95 shell, code-named Nashville, will be two such containers. Nashville will be a universal browser in which all top-level views are dynamically generated HTML pages, Microsoft says. You'll be able to bookmark c:\foo.doc the same way you bookmark http://www.foo.com/foo.doc and view either in a directory-tree listing à la the current Win 95 Explorer. Click on either, and the shell will transfer control of its document-viewing pane to Word (or another application that supports this data type and complies with the DocObject interface that enables this kind of containment). Suddenly you're viewing *and editing* a LAN *or Internet* document. This scheme promotes OLE 2.0 in-place editing from the application level to the system level. And it globalizes the sources of data you can edit.

A Few Caveats

Neither of these technologies is fully cooked yet. What Java lacks most glaringly is the sophisticated component framework that the Windows platform has evolved. You can write components in Java, but it's unclear how you will package and distribute them, or what VB-like assembly environment will support them. One intriguing possibility: VB. Microsoft has worked aggressively to support Java. The Java VM in Internet Explorer 3.0 now packages Java classes as COM objects. This, Microsoft claims, will allow bidirectional interoperability between ActiveX and Java components. The newly defined ActiveX scripting architecture, moreover, will enable containers to control embedded components using any compliant script engine—initially VB, VBScript, and JavaScript, but potentially full-blown Java. Microsoft might be able to define the framework that Java components play in. "This is the critical issue for Java at this juncture," admits Miko Matsumora, a JavaSoft software engineer. JavaSoft is working to define an alternative, Windows-neutral component architecture for Java.

What ActiveX lacks most glaringly is portability. Internet applications are, almost by definition, groupware applications that connect people to each other and to information. You wouldn't install a phone system that reached only 90 percent of your people or your customers. And you probably won't want similar constraints on an Internet-based software system that you deploy company-wide or globally. A "Download Windows 95 now to view this Web page" button just won't cut it.

Because ActiveX is a descendant of OCX, which relies heavily on the Microsoft Foundation Class (MFC) library and Win32, any hope for portable ActiveX components would appear to hang on the portable implementations of these subsystems. And while Win32 and MFC libraries exist for Mac and Unix systems, they don't yield first-class applications. Microsoft claims, however, that ActiveX components don't depend on Win32 and MFC. Doug Donzelli, vice president of engineering for NetManage, codeveloper of Microsoft's Internet Control Pack, confirms half this claim: "It's true: The Internet controls do not call the MFC DLLs." How is this possible? Magic Wand, an alternative application framework, supports creation of non-MFC-dependent components. Still, portability of ActiveX componentry remains speculative.

The Age of Possibility

Two years ago, deployment of information-rich, platform-neutral, dynamically customized applications on a global enterprise scale seemed an impossible dream. Today it happens routinely.

Microsoft and Netscape are battling to dominate the new era. But unlike past OS wars, they're fighting this one on the common ground of Internet protocols and standards. Decades in the making, those protocols and standards really work—and they're improving every day. Every CIO and engineering VP interviewed for this story echoed the same sentiment: The software business is reborn. ■

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

Java and ActiveX

JAVA PROS	CONS
Portable	Cross-platform GUI framework in rough shape
Same language for components and glue	Component framework is missing
Can use inheritance and interfaces	For advanced programmers only
Multithreaded reentrant applications, robust exception handling	For advanced programmers only

ActiveX PROS	CONS
Components fully exploit Win32	Won't run in Mac or Unix browsers
Easily assembles applications	Can't extend components with inheritance
Can use Access and Visual Basic	No threading, synchronization, or exception handling
Applications can integrate desktop and Internet resources	Presumes Windows and Microsoft Foundation Class support for DocObject model

The Elements of Design

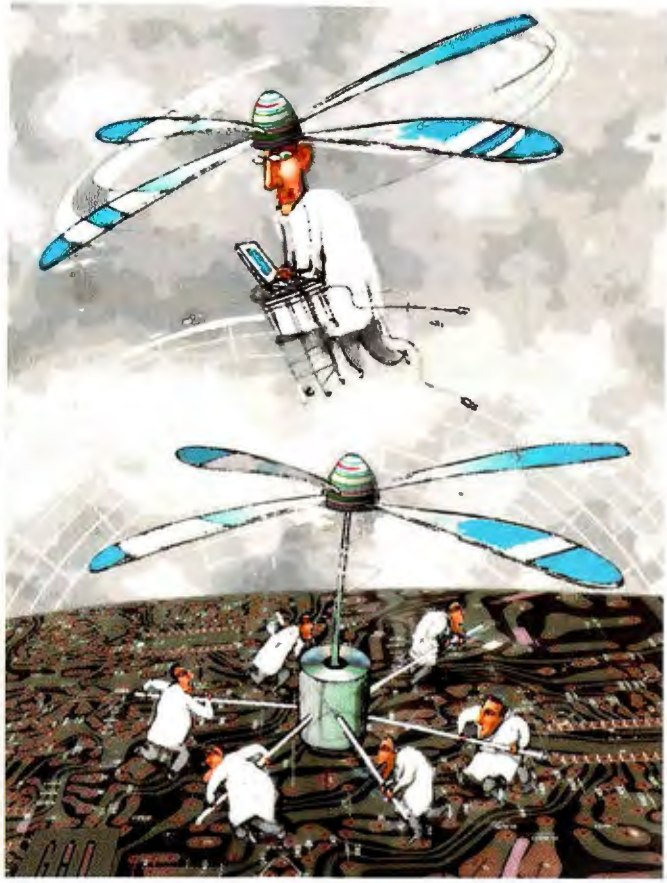
An inside view of how innovative individuals produce technology breakthroughs.

By Tom Thompson

Genius is 1 percent inspiration, 99 percent perspiration.
—Thomas Alva Edison

The inspiration and perspiration associated with painstaking research was a solitary affair during Edison's time. The famed inventor worked on his own in an equipment-packed laboratory. Today, however, the image of the dedicated innovator working away in a cluttered but cozy laboratory has apparently gone the way of Edison's original carbon-filament light bulb. Modern research projects often cost megabucks, must offer a clear return on investment potential, and require armies of researchers operating exotic—and expensive—equipment.

It makes you wonder: Does only big-budget research drive the breakneck pace of breakthrough technology and products in the computer industry today? Or is there still room for the lone individual to make a significant contribution?



We toured several research facilities to see how new products come to be and to get a glimpse into the creative process itself. The megabucks stereotype is partially true: Basic research into, say, new disk drive technology requires some major-league funds. However, other improvements, such as new ways for a drive to pack more data onto a disk, are sometimes the work of a single person. Novel and common innovations alike, ranging from low-cost digital video cameras, to new hard drive designs, to more comfortable pointing devices for notebook computers, originated with an individual or a small group of people.

Edison's rule still holds true: Innovative designs still need inspiration and plenty of perspiration. These days, the perspiration might involve adapting a new design for mass production or convincing others that an idea has merit. But the creative person usually does not work in isolation: Close communication among everyone involved in a product's development is essential. This combination of inspiration, perspiration, and communication figures prominently in the following stories.

Just Do It

Sometimes just finding a new way to do something takes a great deal of perspiration. Ted Selker, an IBM Fellow who works on user-system ergonomics research at IBM's Almaden Research Center, knows about this firsthand.

One of Selker's projects was to improve the pointing device on IBM's notebook computers. Selker's research started in neurophysiology, but his doctorate thesis on adaptive help systems betrays his interest in improving the way in which people work with their computers.

Notebook pointing devices presented many problems. A mouse requires a flat surface to operate—a scarce commodity on an airline seat. It also means you lose the use of a second hand on the keyboard—you have to move one hand from the keyboard to work the mouse. Because of the latter problem, Selker decided that any pointing device had to go on the notebook's keyboard.

Because of its proximity to the processor and hard drive, the pointing device would absorb a lot of heat. The best design for such an environment was a square polycarbonate post with four strain gauges, one on each side. The four sensors that measure how much the post flexes also cancel out the effects of heat expansion. Thus was born the TrackPoint.

Figuring out exactly where to place the device was tough. On top of that, some initial research showed that if the TrackPoint functioned simply as a joystick, it made a poor pointing device.

Clearly, a better control algorithm for the device was just as important as its location on the keyboard. Selker came up with a modified TrackPoint that could be tested, changed, and moved in minutes, which helped speed up the user-testing process. These

ILLUSTRATION: VICTOR GAD © 1996

tests measured how quickly and accurately people could make selections with a TrackPoint for a given control algorithm and keyboard position. It took another seven years to determine the algorithm's proper speed and control constraints before the TrackPoint became a practical replacement for the mouse. The extensive testing also determined the TrackPoint's final keyboard location, surrounded by the *G*, *B*, and *H* keys. Test results had shown that this position would save nearly a second of work time compared to grabbing a mouse.

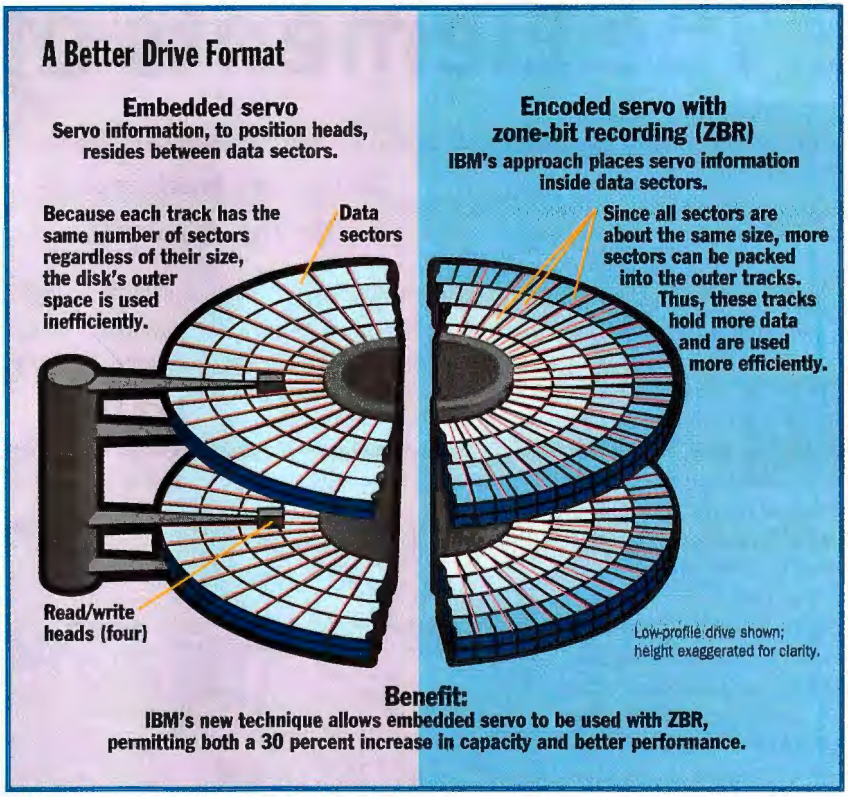
Selker got another idea while doing a presentation—or at least while trying to. Certain companies made LCD panels that you could place on an overhead projector to display a computer presentation. Selker wondered, why not use the notebook computer's own LCD screen for this purpose? When he asked display vendors about this, he was told that it probably wasn't possible to isolate the LCD panel from the backlight.

Still thinking that the idea was sound, Selker literally took matters into his own hands. He bought a ThinkPad, went to the workshop, and sawed the back panel off the display. The results weren't stellar, but they proved the concept. After three months of refinements to address wiring and heating problems, Selker had a working model. The result was the ThinkPad 755CV, the mobile presentation notebook that lets you remove a panel from the back of the display to turn it into an overhead-projection panel. "To make an idea succeed, sometimes you have to ignore convention and try," explains Selker.

Packing a Platter

Steve Hetzler, who is also at the IBM Almaden Research Center, researches disk technology to look for ways to increase capacities. He doesn't develop specific products, but instead explores the arcane elements of a drive's architecture that might permit it to store data more efficiently. While his background as a physicist might seem an odd fit for this line of research, Hetzler considers it an advantage. He didn't have any preconceived notions about the myriad physical, electrical, and design solutions that IBM's development and manufacturing teams had come to rely on over the years. "So, I looked in other directions for ways to improve storage capacity," he says.

One of the first things that Hetzler looked at was how a drive uses its servo information. Such information exists as magnetic patterns on the drive platter that the drive uses to position the read/write heads accurately at the proper location on the platter for read/write operation.



An open mind helped an IBM researcher find a way to save hard drive servo information within the data.

In a hard drive, data is stored in sectors, arranged around concentric circles, or tracks, on the platter. When the drive processes a read/write request, it first moves the head to the track that contains the desired sector. The drive then waits for the platter to rotate the appropriate sector under the heads.

Until recently, there were two dominant methods for storing servo information. The *dedicated servo* approach reserves an entire side of a platter for just the servo information. All the drive heads move in unison to the same location on their respective platters. This scheme offers many benefits, including high performance and the ability to accommodate any data format. But it also has its faults. Dedicating an entire side of a platter for just servo information consumes significant capacity on 2½-inch drives, since they have only two or three platters.

The second approach, called *embedded servo*, places servo information between the data sectors on each track of every platter. This approach is well suited for low-profile drives, since every surface can store data. The drawbacks are that the embedded servo information consumes about 10 percent of every surface and, since each track must have the same number of data sectors, this limits the number of sectors per track.

These drawbacks didn't seem practical to Hetzler. His radical approach: Encode the servo information *inside* the data sectors. This eliminates the constraint that the servo information must be between the data sectors and thus supports more-varied data formats.

Housing the servo information within the data also presented other opportunities to improve storage capacity. Until a few years ago, a drive had a fixed number of sectors per track. This can waste space, because the sectors on the outermost tracks will be longer than those near the platter's center. However, by using *zone-bit recording* (ZBR), a sector approximately the same size as those placed on the innermost tracks can also be used on the outer tracks. Adjacent tracks using the

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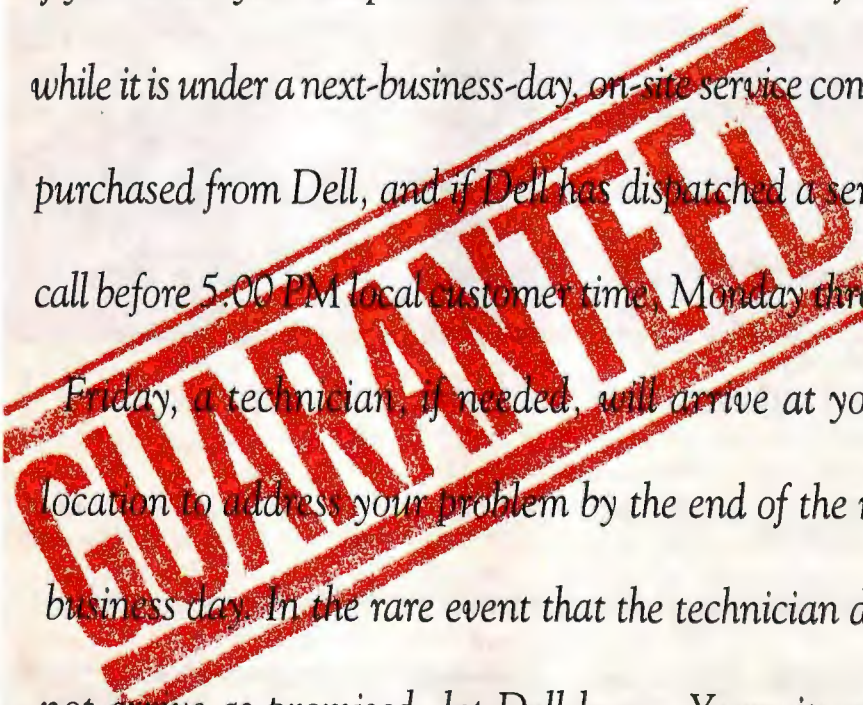

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same-size sector are then organized into groups called *zones*. Because the outer tracks hold progressively more sectors, this tighter packing can increase the platter's storage capacity by 30 percent.

As advantageous as ZBR was, it had long been limited to dedicated servo drives, because the number of servo locations between data sectors also changed from the inner zones to the outer ones. As mentioned earlier, this was a major disadvantage for low-profile drives, since the additional capacity obtained via ZBR would be lost by the use of one platter surface to hold the dedicated servo information.

Hetzler's method of placing the servo information within data sectors let the 30 percent capacity advantage of ZBR be combined with the benefits of embedded servo, as shown in the figure "A Better Drive Format"on page 80NA 2. Drive performance also improved, since the number of servo locations was no longer limited by the number of data sectors.

"We achieved a result where the drive designers could now bring the capacity advantage of ZBR to low-profile drives, which would most benefit from it," Hetzler says. "We also set the stage for the demise of dedicated servo by closing the performance gap." This approach is now used in hard drives almost universally.

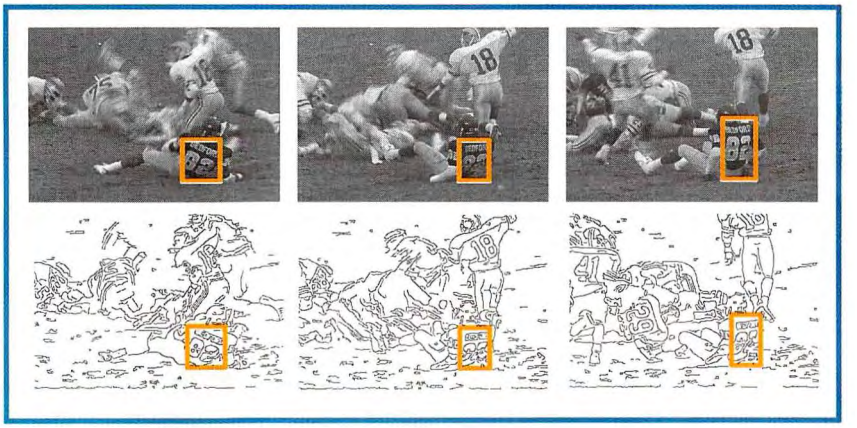
Better Machine Vision

Processing visual information requires a third of the human brain. This comes as no surprise to researchers of machine vision: It's a formidable task to get a computer to recognize and match objects.

Dan Huttenlocher, a principal scientist at Xerox's Palo Alto Research Center (PARC) and an associate professor at Cornell University, has been looking into ways to accomplish practical image comparison in computers for years. One of the fundamental machine-vision problems he tackled was getting computers to isolate and recognize an object on a cluttered background, such as a gear on a conveyor belt littered with other parts.

The problem boils down to extracting content from image data. However, looking at separate bits isn't enough. You have to use an image's bit patterns to derive information about objects in the image.

One commonly used technique relies on *eigenspace analysis* to compare images. This technique uses matrix algebra to represent the components of an image. These matrix operations can also perform



A hunch led a Xerox PARC researcher to the Hausdorff-distance technique, which adapts itself for object tracking (inset).

rapid comparisons between data arrays (i.e., other images). The technique is sufficiently refined so that a photo of a robbery suspect obtained from a surveillance-camera image can quickly match a police database of digitized mug shots. However, the eigenspace technique isn't sound when you use partial images, such as when a suspect's face is partially hidden—or, in the case of machine vision, when a sprocket partially covers a vital gear.

Huttenlocher had a hunch that a geometric solution to the problem was possible. "I have these hunches to pursue a subject for no logical reason. Sometimes they're accurate, and other times they're not," he explains. To see if his intuition was onto something, Huttenlocher's next step was to immerse himself in the subject. "I took geometry books out of the university library and skimmed through them. From the condition of some of those books, I could tell that they hadn't been opened for decades," he recalls.

Huttenlocher eventually came across a concept called the *Hausdorff distance*. This mathematical technique compares point sets in topology. "Once I understood the theory, then the image-recognition capabilities fell out," he says. The original Hausdorff-distance equations were not very tolerant of missing data, but Huttenlocher modified them so that they worked with median values rather than maximum and minimum values. These modified equations are effective enough that they can produce beneficial results even when some data points are missing.

Using the Hausdorff-distance technique first requires reducing images to black and white to obtain edge information. The algorithm uses this information to determine how closely the images match by measuring how close certain groups of pixels in one image are to similar groups of pixels in a second image.

This differs from other pattern-matching algorithms that compare how many pixels directly overlap. With these algorithms, partial images can thwart the matching process. The enhanced Hausdorff-distance measurement, because it works with pixel *groups*, can employ partial images and still obtain a match. Furthermore, successive images can act as the starting point for new image comparisons as long as the object's shape does not change drastically (see the illustrations above). This makes the Hausdorff-distance measure ideal for such applications as remote surveillance and visually guided navigation.

The Low-Cost Camera

Connectix's low-cost digital gray-scale camera, the QuickCam, was the result of the achievement of a simple goal. Scott Fought, a Connectix software lead and video maven, wanted a low-cost video digitizer. "At the time, you had to pay over $1000 for such equipment," he recalls. "However, I'm of the opinion that if you can't buy it, then you build it." This idea ultimately got Connectix, known for its software utilities, into the hardware-peripheral business.

To make the device as inexpensive as possible, the engineers discarded many preconceptions about digitizing video. According to Jon Garber, Connectix's chief technical officer: "A typical digitizing rig consists of a video camera and an expan-

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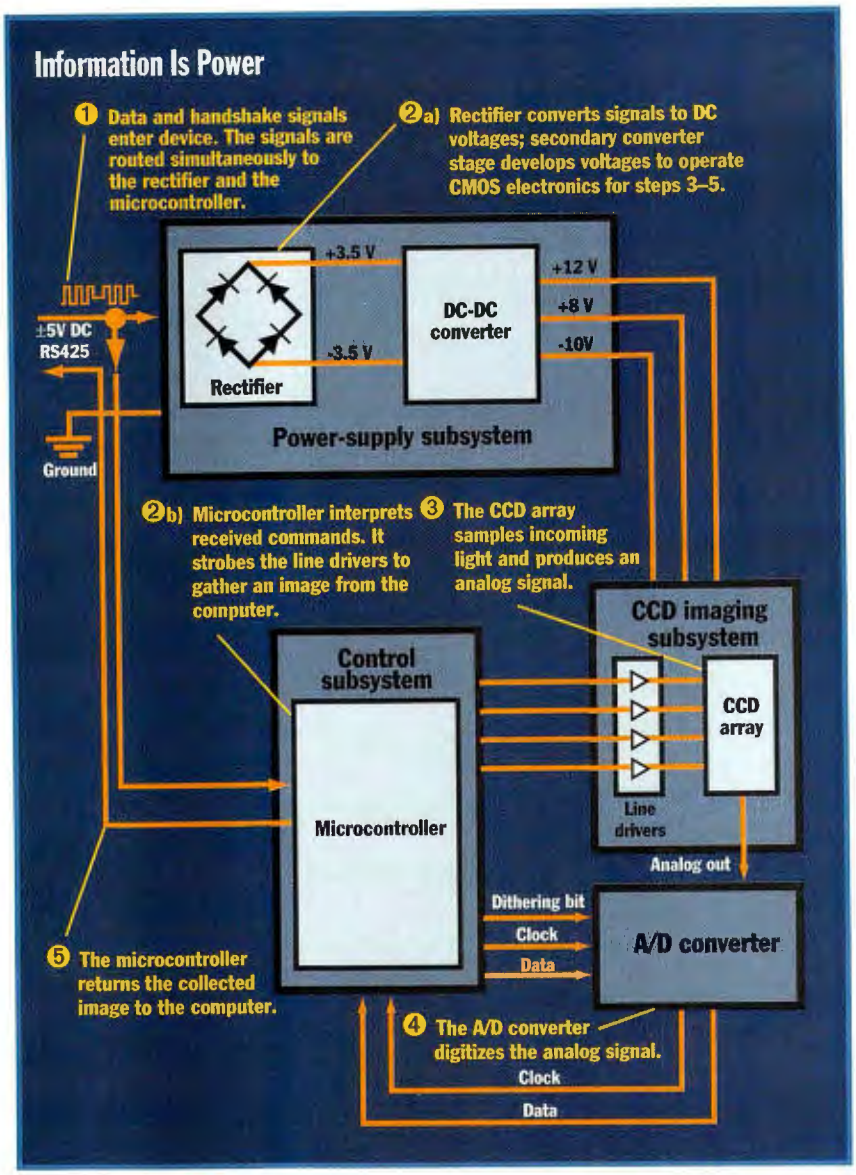
sion board. The camera uses a charge-coupled device [CCD] to capture images at 30 frames per second. A mess of electronics converts this digital signal into an analog NTSC signal. The expansion board then converts this analog signal back into digital bits. That's crazy—and expensive. Why not try to keep the signal in a digital format?"

With that realization, Connectix's engineers reduced the QuickCam hardware to a CCD array, an inexpensive A/D converter (since the CCD's output was an analog signal), and support logic. Garber and Fought agreed on a frame size, and this determined the type of CCD to use. The frame rate became simply a factor of the device interface's transfer rate (serial for the Mac, parallel for PCs).

The design was further simplified when the two discovered that the power demand of the QuickCam's hardware was small enough that they could eliminate the power supply. Instead, the periodic command pulses that order the camera to return image data power the device (see the figure "Information Is Power" at right). Since the command pulses are part of a handshake protocol, they occur often enough to keep the camera running.

According to Fought, they prototyped the initial design by writing a hardware simulation, which explored the feasibility of the design and also let Fought prototype the device driver. When a real hardware prototype was ready, Fought used this same driver to talk to the hardware. Once the computer and the camera began communicating properly, he enhanced the driver to add the data-streaming capabilities that a live digital video feed would require. "You have to start small and then build on top of these core building blocks," he explains.

Communication and negotiation were essential in the design of the QuickCam and of its successor, the Color QuickCam. For example, in the Color QuickCam, the CCD array presents the RGB data in an odd order. After some debate, Garber and Fought decided that the hardware had enough spare cycles to handle the required byte-swapping. This spared the software driver of this task, which improved its performance. On the other hand, to get a sufficiently sensitive blue signal out of the CCD, Garber had to boost its gain. This fix in turn distorted the red signal. After some dickering and tests, it was decided that the driver could perform the color restoration on the fly with a minimal impact on the frame rate.



Close communication between hardware and software engineers was key in the development of QuickCam, a low-cost video camera.

Fostering Innovation

These successes all share some common characteristics. First, cross-disciplinary expertise can be an asset. You're more likely to try new ideas when you're not so close to the technology, and thus unaware of its alleged limits.

Second, success takes perseverance. As both Huttenlocher's and Selker's experiences show, you might have to worry at an idea for a long time. Or you might have to champion the idea, going so far as to create a working model if possible. In some cases, writing a simulation can help nail down some of the design issues and help make your case.

Third, communication can be essential. It might be as simple as a software engineer talking to a hardware engineer, as in the case of the QuickCam.

Finally, a good-spirited workplace is a must. Garber sums up the situation best: "Innovation on demand just isn't possible. You've got to make the environment—and the work—fun." B

Tom Thompson is a BYTE senior technical editor at large. You can reach him by sending e-mail to **tom_thompson@bix.com.**

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Is ATM Ready to Catch Fire?

Technology advances and falling prices may turn ATM's potential for high-speed communications into corporate reality.

If Broadway's Annie grew up to be a network administrator, she might cynically start singing "Tomorrow" every time someone mentioned asynchronous transfer mode (ATM). After years of hearing about the technology's potential, it's easy to conclude widespread corporate acceptance of ATM is "only a day away."

Nevertheless, there are signs of change. What's different this time around? Key technologies have matured to make ATM worthy of consideration for near-term networking strategies.

First of all, switches and adapter cards now offer a wider range of data rates—from over 1 Gbps down to 25.6 Mbps—which means network administrators can match bandwidth to the specific needs of each network segment. Some corporations are finding that this scalability makes ATM an efficient way to replace central mainframes with distributed client/server clusters or to give select workgroups the bandwidth they need for multimedia applications. To decide if the time is right for you to explore this technology, see "Are You Ready for ATM?" on page 85.

If you decide that ATM is part of your near-term plans, you'll need to assemble the right hardware and software components for this switched-network architecture. The good news is that you no longer need to be Daddy Warbucks to afford ATM switches and adapter cards. Some of the latter, for example, now sell for prices within the range of expensive Ethernet cards (see "Virtually Well Connected," page 93).

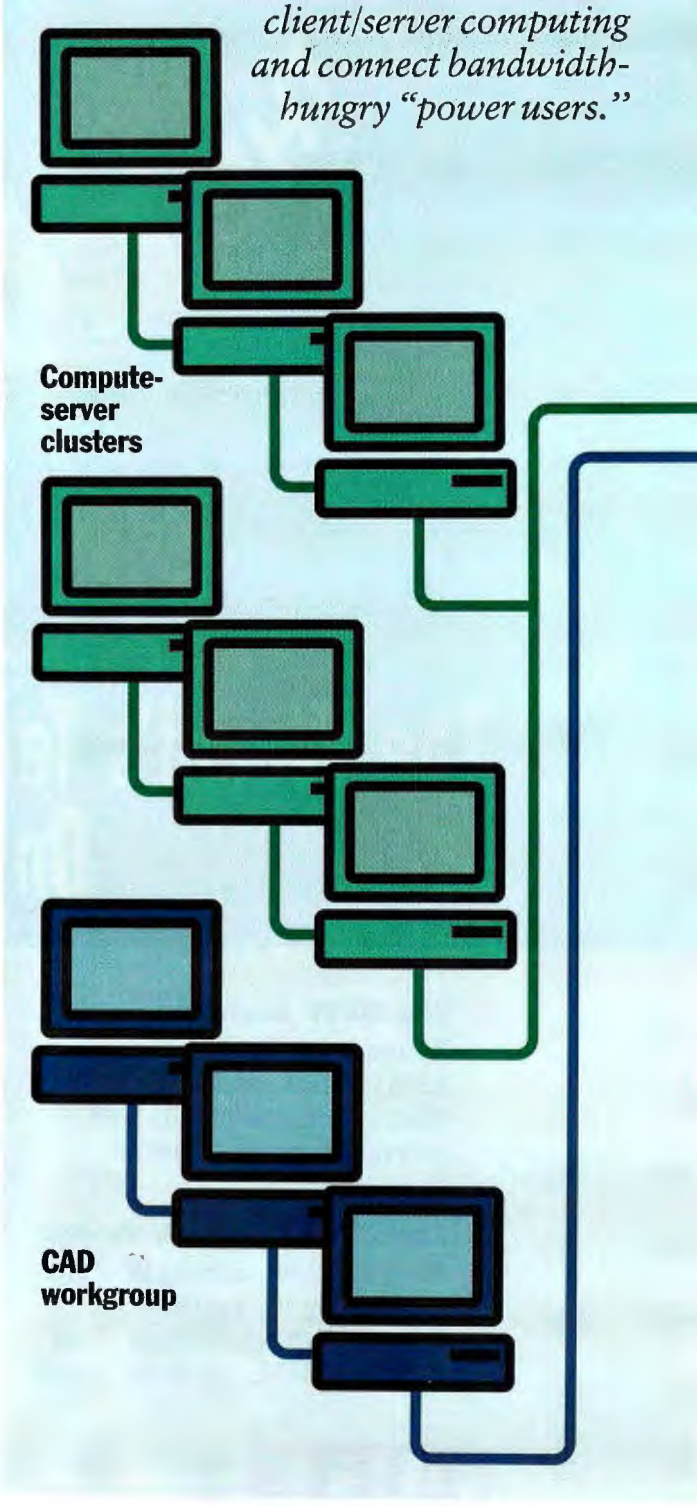
But don't conclude that economics has been the only stumbling block to widespread acceptance of ATM. There is still a dearth of applications that can take full advantage of ATM's characteristics. One big problem is the continuing lack of a standard API that developers can write to for cross-platform applications. We're still waiting for this programming target. But in the meantime, three alternatives exist to help you tie Windows, NetWare, or Unix clients into an ATM network. "Teach Your Apps to Speak ATM," on page 97, tells you what tools are available for each environment.

In the end, large-scale ATM implementations will not be here tomorrow. A year or two from now is more likely. But the rehearsals for the big time may finally be coming to an end.

–By Alan Joch

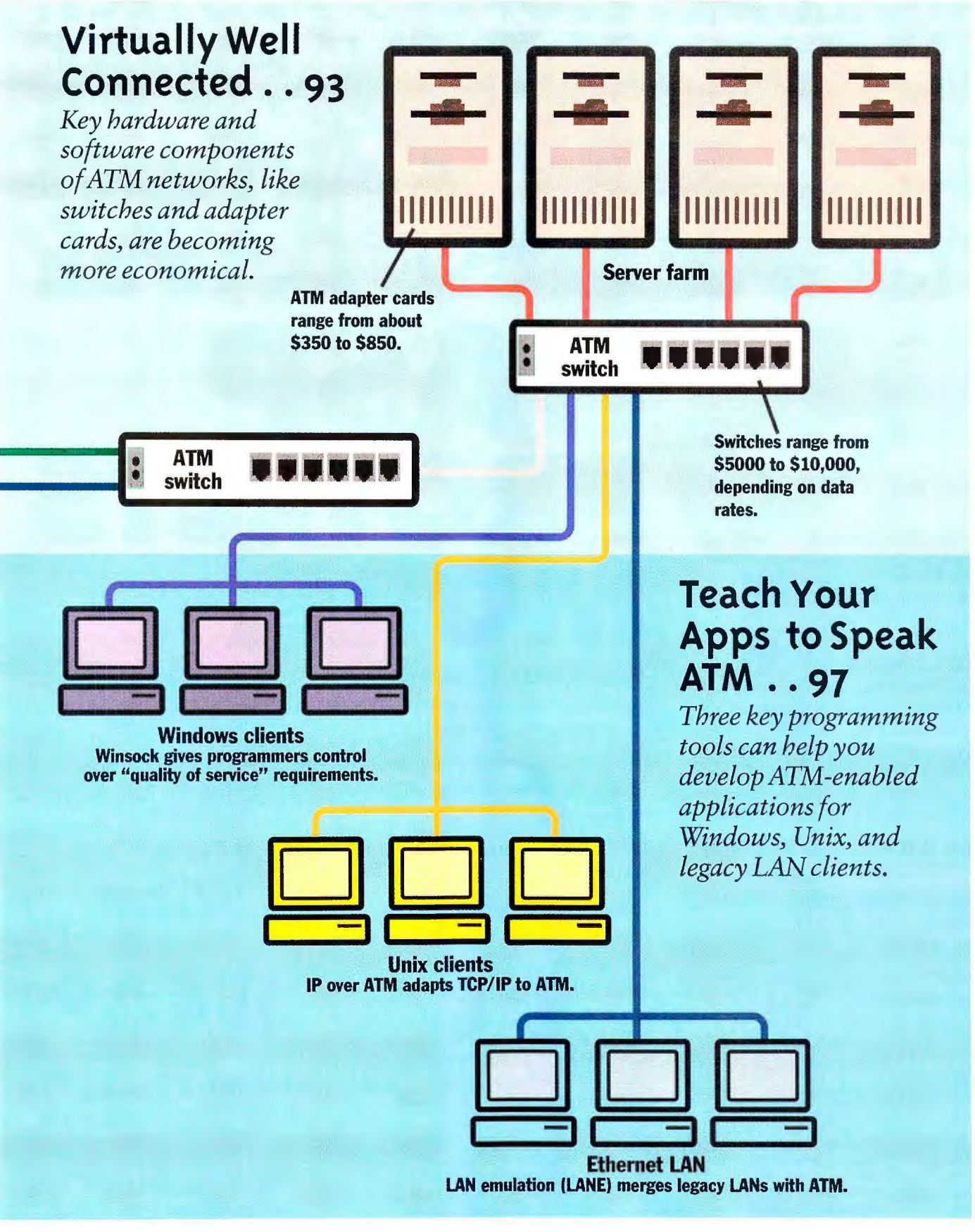
Are You Ready for ATM? . . 85

ATM can provide the infrastructure for distributed, client/server computing and connect bandwidth-hungry "power users."



Virtually Well Connected . . 93

Key hardware and software components of ATM networks, like switches and adapter cards, are becoming more economical.



Teach Your Apps to Speak ATM . . 97

Three key programming tools can help you develop ATM-enabled applications for Windows, Unix, and legacy LAN clients.

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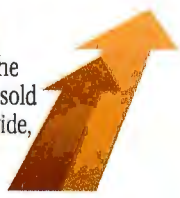

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Pioneers are using ATM. Here are five reasons why you might want to join the pack. ***By Lane F. Cooper***

Are You Ready for ATM?

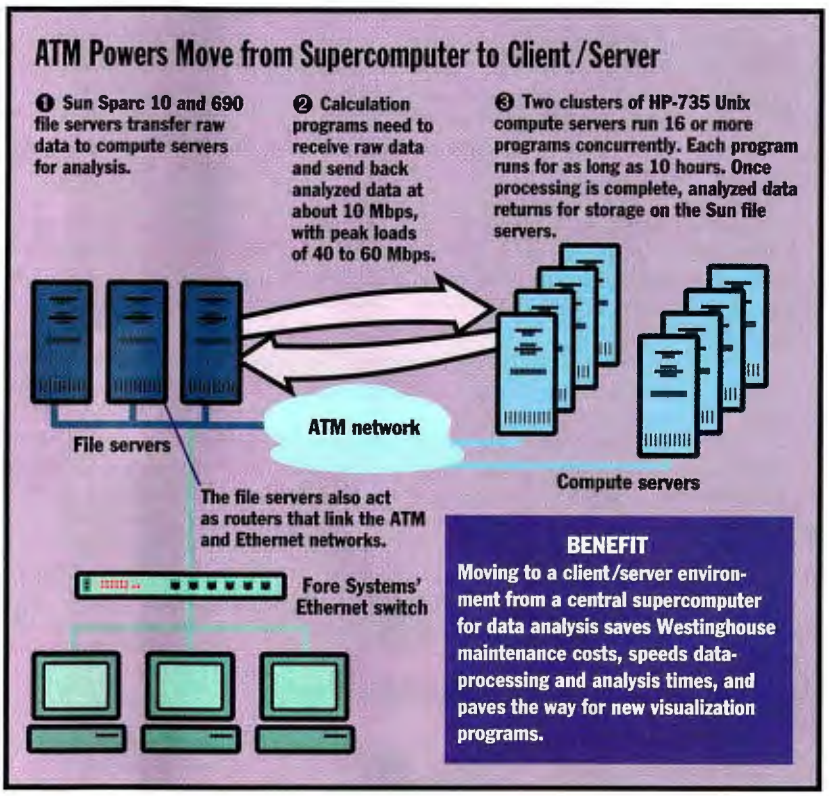
Voice ... video ... distributed client/server computing.... Many Fortune 1000 network managers are losing sleep over how they'll handle burgeoning network traffic and gigabytes of data. Simply throwing more bandwidth at the problem isn't a total solution because not all demands on the network are equal. For instance, most e-mail and data-file transfers can cope with latency. On the other hand, multimedia applications require a guarantee of a minimum level of performance throughout a session.

Asynchronous transfer mode (ATM) promises broadband speeds that surpass 1 Gbps, as well as quality-of-service guarantees that make multimedia viable. Add to that the technology's ability to absorb different access technologies—whether it be Ethernet, frame relay, or Fiber Distributed Data Interface (FDDI)—on a single network, and you get the attention of corporate network managers.

But we've all heard the promises of ATM proponents for years. Even now that many of the initial standards issues have been resolved, ATM remains mainly a tool for telecommunications service providers to increase backbone bandwidth and pave the way for consolidating voice, data, and video onto a single network.

This leaves corporate network managers still asking, "When will ATM make *our* lives easier?"

For pioneering network administrators, the answer may be, "Now" (see the text boxes "ATM Goes Stratospheric" on page 86, and "ATM Energizes Distributed Computing" on page 88). To help large corporations implement ATM today, there will be a continuing wave of new ATM products and services for LANs and WANs this year. These products include everything from cheap 25.6-Mbps adapter cards to switches with built-in Ethernet ports for quick links to existing LANs (see "Virtually Well Connected" on page 93). Nevertheless, ATM still requires the pioneer spirit. Widespread corporate implementations of ATM probably won't happen until 1998 and later, when we will see hardware and software applications that will better integrate heterogeneous networks into new ATM infrastructures (see "Teach Your Apps to Speak ATM" on page 97). Should you be an ATM pioneer and make ATM part of your short-term plans? Or should you plan for ATM as a technology for the future? The following questions can help you find the answers for your company.



ATM is a technology for today at a Westinghouse division that designs nuclear power plants.

Question # 1: What can ATM offer to reduce bandwidth bottlenecks that traditional LAN technologies cannot provide?

Traditional LAN technologies primarily support store-and-forward data transfers. These technologies use connectionless routers. That is, no circuit is set up for the data exchange. Instead, the sender launches data, which finds its way to the receiver on a "best-effort" basis. Consequently, when network performance degrades because of congestion, everybody—and every application—shares the pain.

ATM is a connection-oriented technology. Because it was designed for telecommunications carriers to support voice connections, ATM can establish *virtual circuits,* which reserve dedicated amounts of bandwidth for the duration of the session. This ability guarantees that bandwidth will be available when needed,

and this separates ATM from technologies like FDDI and Fast Ethernet, which also offer broadband access.

By setting aside bandwidth for discrete connections, you can use ATM to better manage the different types of traffic going over the network without overinvesting in bandwidth infrastructure. For instance, for the people within your company who are simply exchanging e-mail messages or transferring text documents (this is perhaps the majority of your traffic), network management software will let you set aside relatively small amounts of ATM's scalable bandwidth.

The remaining bandwidth then becomes available for resource-intensive applications like videoconferencing, which needs perhaps 3 Mbps for the remainder of the session. With bandwidth locked in for the video sessions in

ATM Goes Stratospheric

Major players in the petroleum industry's trade association, the American Petroleum Institute, have deployed a shared asynchronous transfer mode (ATM) network over which members can gather, process, and exchange oil-exploration data. The research project, known as ATM Research and Industrial Enterprise Study (ARIES), uses Comsat World System's ATM service, which deploys very small aperture terminals (VSATs) for high-capacity links to the Intelsat system of geosynchronous satellites.

"Gathering and processing seismographic data is a very expensive undertaking," says Susan Miller, director of advanced business applications at Comsat World Systems. "There is a tremendous amount of information that they have to get from their exploration ships and have processed at several supercomputing centers in the U.S.," she adds.

Amoco, the originator of the project, searches for oil by mapping the earth with complex seismic computer programs that generate files of gigabyte to terabyte size. This data often comes from remote sites ranging from fields in Siberia to ships at sea. Amoco must move this data from the remote sites to central data-processing sites in the U.S., including the Minnesota Supercomputer Center in Minneapolis.

Traditionally, data communications between ships at sea and processing centers have used what can only be described as the world's most expensive sneakernet. Exploration ships collect information from promising locations, transfer the data to reels of magnetic tape, and fly them via helicopter to onshore facilities for processing (see the figure below). It can take days for the data to travel over leased lines to other supercomputing centers for analysis. Because the distribution process takes so much time, exploration ships usually don't stay in the exploration area awaiting the results of the analysis and instructions on where to proceed next.

Amoco's network currently uses time-division multiplexing (TDM) technology with a mesh of T1 links that serve 400 domestic and nearly 50 international nodes. Four networks are mapped over the physical TDM network for Systems Network Architecture (SNA) traffic, voice traffic, X.25 links, and routed data traffic. Amoco's LAN environment supports TCP/IP, DECnet, and Fiber Distributed Data Interface (FDDI) for LAN backbones.

When the data arrives at the supercomputer center, Amoco's researchers in Tulsa, Houston, and suburban Chicago use the network to gain remote access to seismic modeling and simulation applications. These applications produce large volumes of output, for which ATM may well be suited.

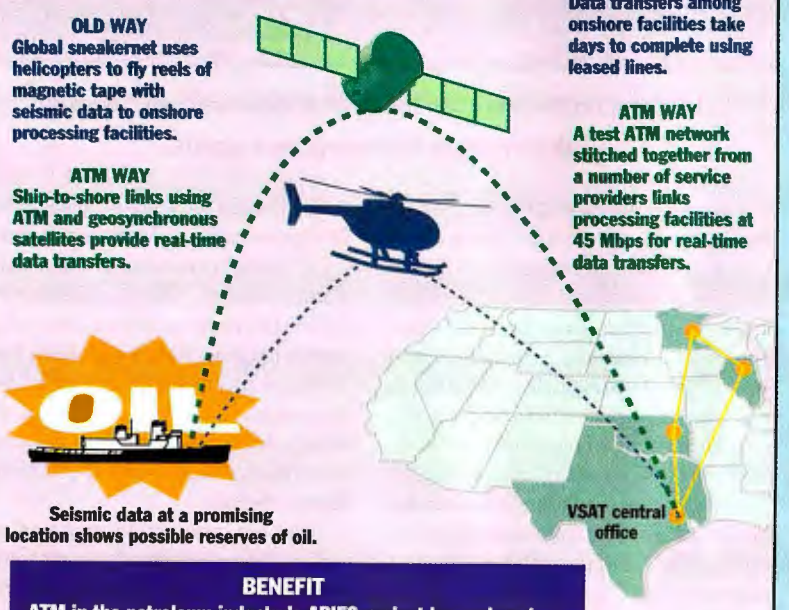
ARIES is testing terrestrial connections that link together all the project's computing facilities at 45 Mbps using an ATM network supplied by a number of service providers. Added to the land-based network is the ship-to-shore link using the Comsat ATM link accelerator to collect and distribute data in real time. "ARIES participants are having to reduce the cost of oil exploration—one of their major cost centers—by a factor of 2 to 4 times, depending on how well they can make the ATM network run.

"Better communications may make it possible to reduce our cycle times dramatically for oil exploration," says David R. Beering, who is codirector of the ARIES project. "Instead of sending a crew to the field to make expensive test drills, we want to do more [work] on the computer. Doing so could increase our probability of finding oil, because we will have better information about where to drill."

In addition to reducing exploration time and the associated costs, Amoco will use the project to test ATM as a way to enhance its corporate telecommunications network. The $25 billion energy company runs operations throughout the world over an enterprise-level network that typically doubles in size every 10 months. Ethernet, token ring, Fast Ethernet, and FDDI simply aren't up to the task of handling this mushrooming data load. As a result, Amoco's telecommunications experts are evaluating ATM's ability to provide bigger data pipelines to help the company more efficiently fill its oil pipelines.

–Barry Nance and Lane F. Cooper

Big Oil Replaces World's Largest Sneakernet



Seismic data at a promising location shows possible reserves of oil.

BENEFIT

ATM in the petroleum industry's ARIES project has reduced costs, cut exploration cycle times, and helped one oil company expand its telecommunications networks.

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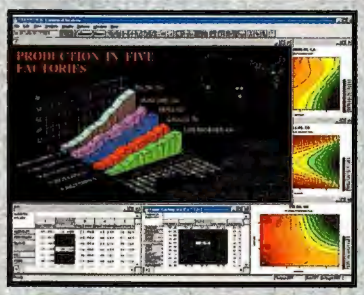

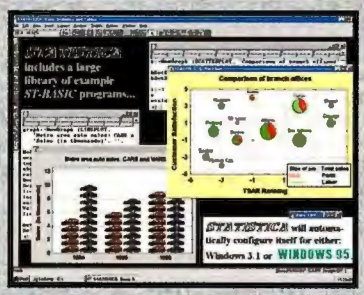

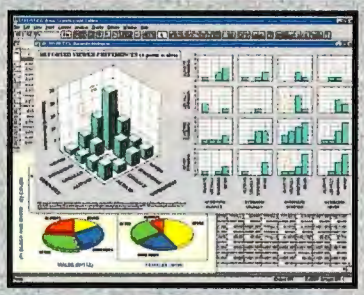

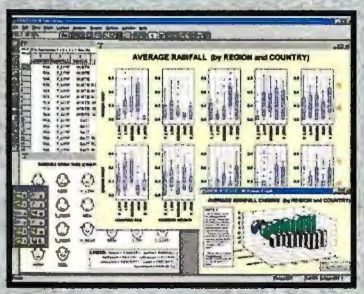

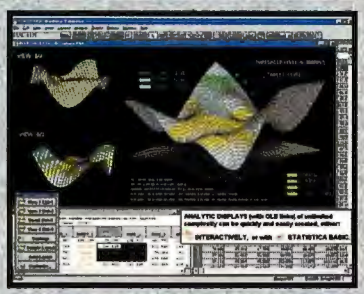

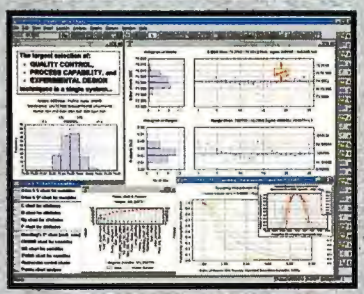

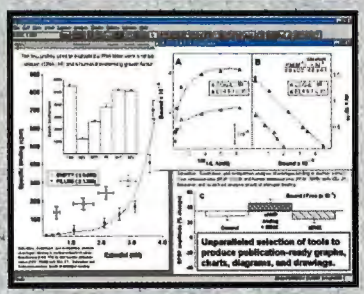

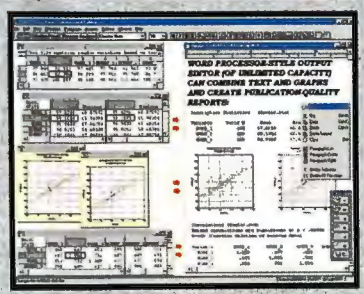

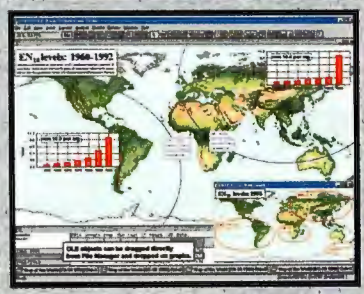

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a virtual circuit, nothing that occurs on the rest of the network can degrade the quality of the connection.

Question #2: If and when we commit to ATM, how do we begin the transition from our existing network?

The best first step is to ATM-enable discrete high-performance groups within the enterprise. Thus, you might equip the LANs in resource-intensive workgroups, like engineering design or radiology, with ATM adapter cards and then bridge the souped-up LANs to the rest of the corporate network.

Question #3: During the transition process, how do we integrate the alphabet soup of platforms, protocols, and OSes we have in our legacy networks?

Downsizing, mergers, and the natural evolution of networks all mean that network managers must combine ATM with myriad technologies and protocols that were originally designed to be supported by a dedicated infrastructure.

One of the problems with integrating different protocols onto a single network is that some network technologies can obtain and use available backbone bandwidth better than others. For example, when you roll TCP/IP traffic into a trunk with IPX, it tends to effectively starve the IPX traffic of bandwidth. Since much of the current networking technology is connectionless, it is difficult to identify and assist the lower-performing protocols on the backbone. From a multiprotocol management standpoint, the challenge is to make sure everybody's traffic gets where it needs to go within predictable performance parameters.

The bandwidth guarantees associated with ATM's connection-oriented characteristics come into play here. Besides being able to set aside bandwidth for different traffic types (voice, text, or video) or applications (workgroup computing or videoconferencing), ATM's virtual circuits can guarantee that each protocol has enough access to backbone network resources to serve your work force.

How do you make sure everyone gets the resources they need? You simply define a virtual circuit for TCP/IP, IPX, DECnet, Systems Network Architecture (SNA), or any other protocol to let it coexist on the same corporate backbone.

Each protocol then has fair access to any free bandwidth that may be available on the trunk at any particular time. Most ATM switch vendors sell protocol-specific cards that you can insert into a switch on your corporate backbone and manage a multiprotocol network. Increasingly, this approach could also support voice data and help computer telephony integration (CTI) tear down the wall that exists between the telephone and data networks.

Question #4: How does ATM fit in with the mix of technologies that link remote workers to central offices?

If you're struggling to integrate workers who routinely dial in to the corporate LAN via regular voice-grade copper wires, there is some good news. The shift by public telecommunications companies from analog to digital technology means that most central office switches that are operated by the service carriers are already digital. Basic rate ISDN, which supports 64 Kbps, is more widely deployed than ever before, and newer Digital Subscriber Line (DSL) technology promises to help boost performance for telephony and data transmissions.

ATM may combine with these technologies to provide high-speed connectivity using the existing copper telecommunications infrastructure. For example, US West earlier this year launched a trial to see if DSL can support speeds of 768 Kbps to 1.544 Mbps, or faster, using digital modems. Results aren't in yet, but the telephone line in this trial is transporting data using the new digital technology to access the carrier's ATM backbone.

continued

ATM Energizes Distributed Computing

Westinghouse Electric Corp.'s Energy Systems Business Unit (ESBU) is evaluating asynchronous transfer mode (ATM) as a way to lower the overall cost of client/server computing. The ESBU's Nuclear Technology Division, which is based in Monroeville, Pennsylvania, is an engineering services organization that helps design and maintain nuclear power plants. Until recently, it used a supercomputer to automate its computationally intense design and maintenance tasks.

To take advantage of distributed client/server computing, Westinghouse transferred the computing tasks onto a network of Unix workstations (see the figure "ATM Powers Move from Supercomputer to Client/Server"). The company uses ATM to link the workstations because ATM could supply sufficient bandwidth to carry the gigabytes of data that the division handles. The network has several compute servers, which execute engineering software in batch mode. Each computer program runs for as long as 10 hours. The first processing step transfers many large files from file servers to the compute servers. As it finishes its calculations, hours later, each program stores larger data files (hundreds of megabytes) back on the file servers.

The resulting data traffic calls for a network capable of supporting both high average bandwidths and occasional usage peaks. Each calculation program needs to store and retrieve data at a rate of about 10 Mbps, with peak loads of 40 to 60 Mbps. Sixteen or more programs may run concurrently. The network currently consists of two clusters with four compute servers each.

The division uses both Hewlett-Packard P735 and Sun Microsystems' Sparc 10 and 690 workstations. The HP workstations act as compute servers, and the Sun Sparc workstations act as file and data servers. The Sun workstations also operate as routers that link the company's Ethernet LANs to the ATM network via Ethernet switches from Fore Systems.

The decision to move from a supercomputer environment to a distributed architecture was primarily based on cost. Maintaining and operating the supercomputer drained millions of dollars per year, an expense the company wanted to reduce without sacrificing timeliness. In addition, the distributed client/server architecture lends itself to interactive applications, a direction Westinghouse wants to take with its networked desktop computers. The batch-mode supercomputer doesn't fit into the company's plans for computing within the Nuclear Technology Division.

Today, the applications are still mostly batch-processing programs. However, the company plans to develop interactive applications using visualization software. The fast ATM network, the designers say, will be part of the batch-to-interactive software development transition because the new software will generate even more data than the old batch-mode programs did. Westinghouse expects to build database front-end software, with a graphical look and feel. Engineers will then be able to view the results visually, instead of having to interpret hard-copy numbers.

–Barry Nance

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Companies that are attached to the broadband network can support peer-to-peer connections between remote users and the LANs, as well as pay for the use of the carrier's ATM backbone to interconnect with other LANs in the region.

The early interconnections between DSL and ATM technologies are not symmetric. In other words, there is a significant capacity difference between upstream (to the network) and downstream (to the remote PC) traffic. But there should still be plenty of bandwidth to support communications between an enterprise network and a remote location. For example, Asymmetric Digital Subscriber Line (ADSL) supports between 64 and 640 Kbps going upstream, with 1.5 to 6 Mbps going downstream.

WHERE TO FIND

American Petroleum Institute
Washington, DC
(202) 682-8000
http://www.api.org/news/226proj.htm

Westinghouse Energy Systems
Monroeville, PA
http://www.esbu.westinghouse.com

Question #5: How can ATM tie together our international operations?

Whether your international presence is large or small, you face the challenges of keeping in touch with subsidiaries and customers that are several time zones away and perhaps in countries where only rudimentary telecommunications infrastructures exist.

One strategy is to use ATM via satellite to connect international and geographically remote operations. Beginning this September, Comsat World Systems will offer a two-tiered ATM service that will provide intermediate- and high-bandwidth services to common carriers and multinational network customers. Some of its services will use very small aperture terminals (VSATs), which are highly portable earth stations that can handle high-capacity links to the Intelsat system of geosynchronous satellites.

The integration of ATM into these VSAT networks will enable remote facilities to exchange massive amounts of multimedia information, including voice, with terrestrial networks for real-time access to corporate applications. Currently, the ATM Research and Industrial Enterprise Study (ARIES) project conducted by the American Petroleum Institute is investigating a land-and-satellite-based network that uses ATM for oil exploration (see the text box "ATM Goes Stratospheric").

Status Check

Today, large-scale ATM implementation is primarily the work of long-distance and regional carriers and Internet service providers that need a wide range of services over a single network infrastructure. If you need large amounts of bandwidth and guaranteed resources, ATM products and services will help you become a corporate pioneer. Otherwise, it may be best to wait two to four years before you start your company's network down the road to becoming ATM-enabled. B

Lane F. Cooper is a writer specializing in broadband-network technologies. You can reach him by sending e-mail to **lcooper404@aol.com** *or on BIX c/o* **editors@bix.com.**

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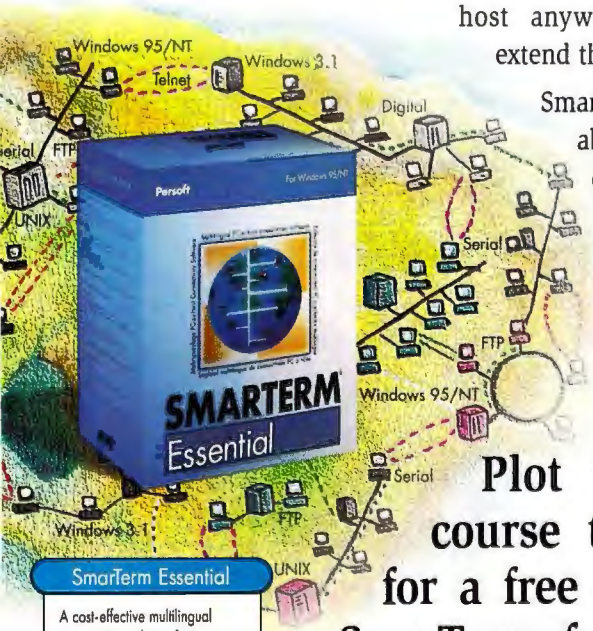

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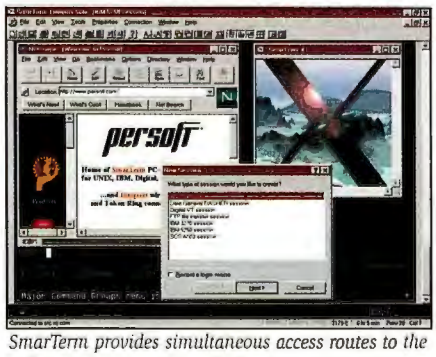

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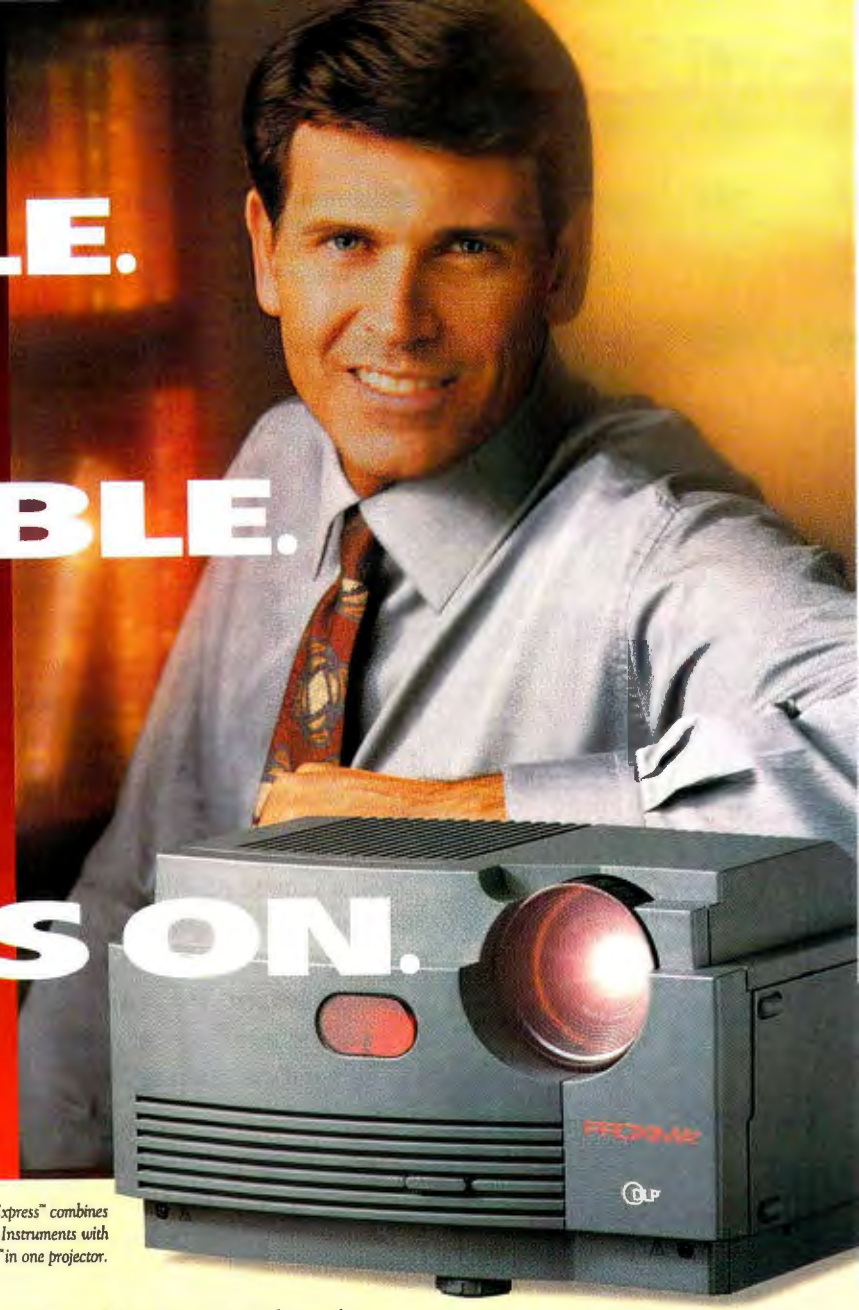

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Virtual circuits make ATM intriguing. Here's what to consider before implementing them. By Alan Joch

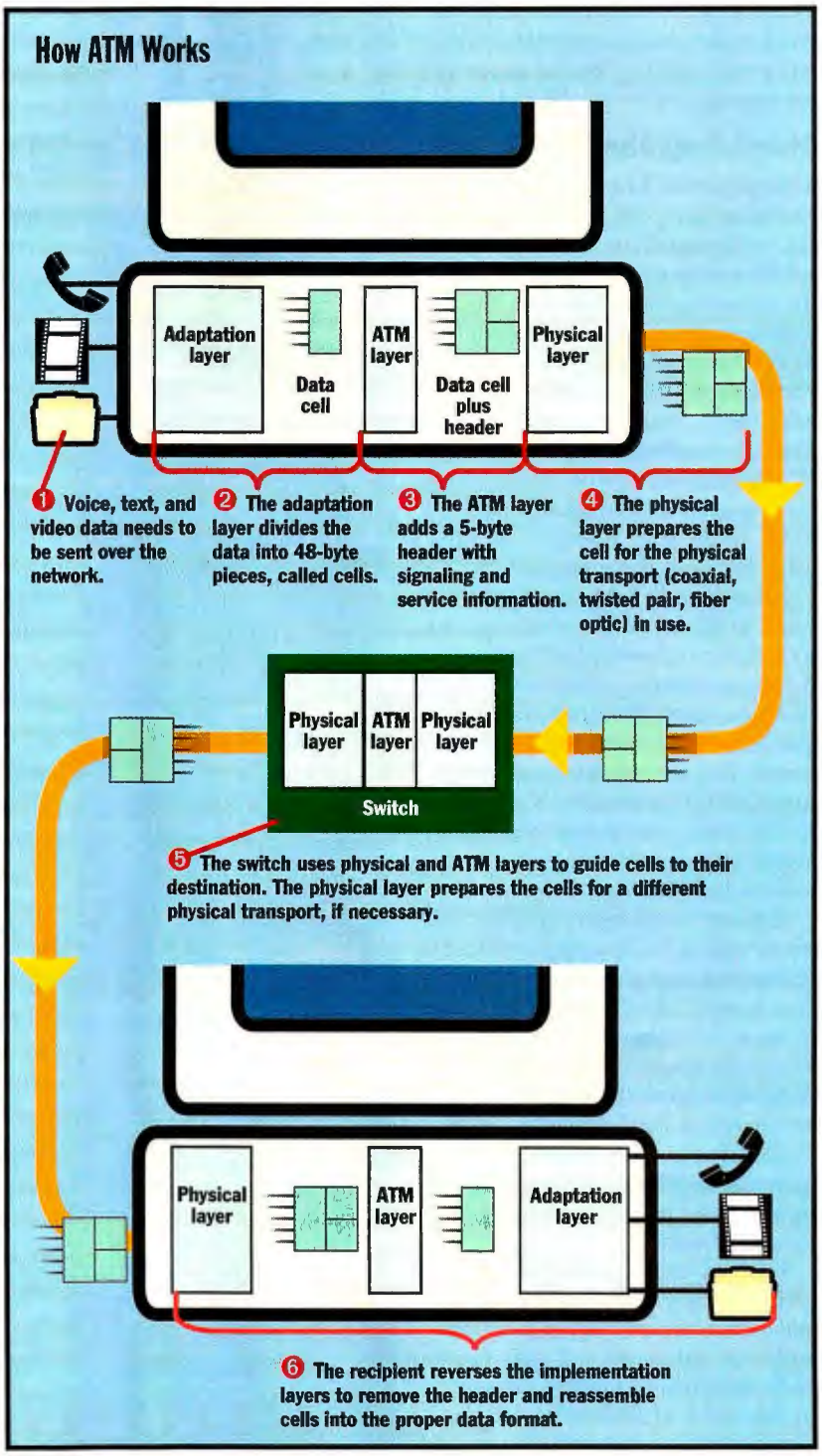
Virtually Well Connected

Connections. Boil down all the promises, technical analyses, and marketing hype surrounding asynchronous transfer mode (ATM) and that one word explains why ATM has a decent shot at replacing today's Ethernet and token-ring networks.

Connections in the ATM context mean that when you send data from your workstation to someone else's, you use an ATM switch to establish a direct link between you and the recipient. In principle, it's like making a telephone call (see the figure at right). The link, known as a virtual circuit in ATM parlance, can be a permanent connection between computers that communicate regularly, or network management software can let administrators establish a connection that lasts only as long as it takes to transmit some data.

By contrast, so-called "connectionless" networks, like Ethernet and token ring, link individual workstations to the network but not to each other. This means that when you send data to someone, you launch it onto a shared network bus—along with all the other traffic everyone else has sent out there—with instructions for where the data is supposed to go. Rather than being analogous to a telephone call, data transport over traditional LANs is more like sending a delivery truck onto an expressway.

Why is ATM and its connection-oriented approach beneficial? First, it means you can dedicate a sustained level of bandwidth to the transmission; traffic from everyone else on the network doesn't horn in to delay or interrupt your communications. This is known as "quality of service," and within the ATM specification, you can negotiate different service levels. For example, under the service level that's called *available bit rate* (ABR), the ATM network tries to provide sufficient bandwidth, but there is no guarantee that there won't be disruptions. *Constant bit rate* (CBR) is a level of



service that provides a continuous and specific amount of bandwidth throughout the session. You might specify ABR when you're sending large text files, while CBR would be necessary, for example, during a videoconferencing session.

Second, ATM gives you plenty of bandwidth. The technology provides from 25.6 Mbps to 1 Gbps, which can be scaled as needed for a particular application. Third, ATM promises to be a single network technology to handle all data types—text, audio, video, and graphics—for transmission over LANs and WANs.

Stumbling Blocks

ATM proponents have been making these promises for years, but so far only telecommunications service providers have found compelling reasons to deploy the technology on a large scale. Corporations have hesitated to commit to ATM because of high costs. For example, as recently as 18 months ago, a 155-Mbps ATM adapter card cost about $1400, or roughly the price of a midrange PC. The good news is that adapter cards with the same data rate cost about $850 today, while new 25-Mbps cards offer prices below $400 in some cases.

Other rays of hope for ATM have begun to shine. Just over a year ago, the ATM Forum released the LAN emulation (LANE) specification, which standardizes how legacy LANs, like Ethernet and token ring, can communicate with ATM networks. This gives managers the ability to gradually migrate select workgroups to ATM rather than having to initiate an abrupt changeover from one network technology to another.

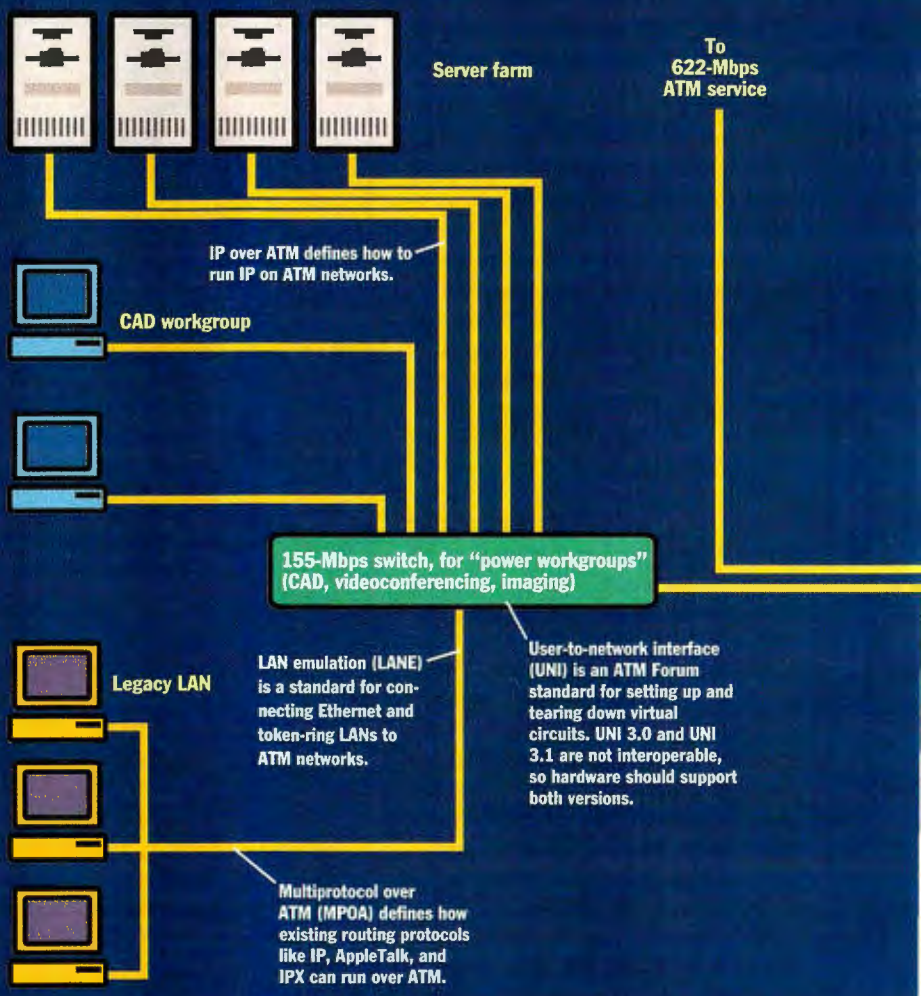
ATM implementation also hasn't had smooth sailing because designers of competing technologies haven't been napping. For example, 100VG-AnyLAN offers 10-Mbps or 100-Mbps data rates with the advantages of a switched architecture and dedicated bandwidth. Adapter cards cost as little as $200. Fast Ethernet, or 100Base-T, also offers 10 or 100 Mbps, although it uses a shared, rather than a switched, architecture, and it doesn't provide for dedicated bandwidth.

Switched Ethernet and switched token ring use the existing protocols but let administrators provide guaranteed bandwidth for multimedia and other heavy-duty applications thanks to more-sophisticated hubs. However, the switched versions of both technologies hit the same 10- and 16-Mbps bandwidth limits, respectively, as their predecessors.

What You'll Need

ATM backers counter by saying that competing technologies are just souped-up versions of legacy technologies. They may be good in the short haul, but long-term strategy argues for a new technology built from the start for high band-

Key Components



ATM Management Software

The best ATM software lets administrators easily set up, maintain, and tear down virtual circuits. ATM software also helps you remotely configure the network and monitor performance.

What to consider:

- Are switched virtual circuits and switched virtual paths supported?
- Can you create virtual workgroups?
- Can it automatically reestablish permanent and switched virtual circuits if broken?
- Does it support SNMP and management information bases (MIBs)?
- Does it work with your network management software (i.e., Openview, Netview)?
- Can you view virtual circuits graphically?
- Can you track peak traffic, average traffic, and other performance statistics?
- Does it support your client platforms?
- What quality-of-service parameters does it support?
- Manage switches from different vendors?

Representative vendors:
Cisco Systems (http://www.cisco.com)
Fore Systems (http://www.fore.com)
UB Networks (http://www.ub.com)

width, scalability, and flexibility in handling multiple types of data. Some corporations are heeding this message. As you make your move, or plan your move, to ATM, you'll need to understand some of the key components. The figure below provides some idea of things you have to consider when you start specifying ATM switches and adapter cards, as well as the management software that lets you set up, maintain, and disassemble your virtual connections. B

*Alan Joch (**ajoch@bix.com**) is BYTE's senior editor/features.*

Workgroup Switches

Switches are the command centers for ATM's connection-oriented approach to moving data cells along virtual circuits. Prices range from $5000 to over $10,000 depending on data rates and number of ports.

What to consider:

- Does the data rate (i.e., 622 or 155 Mbps) match your needs?
- How many ports are standard and how many more can you add as your network grows?
- How many cell buffers come standard?
- How many Ethernet or token-ring ports are standard?
- Does it support the following:
  - UNI 3.0 and UNI 3.1?
  - LAN emulation (LANE)?
  - Private network node interface (P-NNI)?
  - IP over ATM?
  - Multiprotocol over ATM (MPOA)?
- Does it support permanent and switched virtual circuits?
- Does it support SNMP and your network management software?

Representative vendors:

ATM Inc. (http://www.atminc.com)
Bay Networks (http://www.baynetworks.com)
Cisco Systems (http://www.cisco.com)
Fore Systems (http://www.fore.com)
Fujitsu (http://www.fujitsu.com)
General DataComm (http://www.gdc.com)
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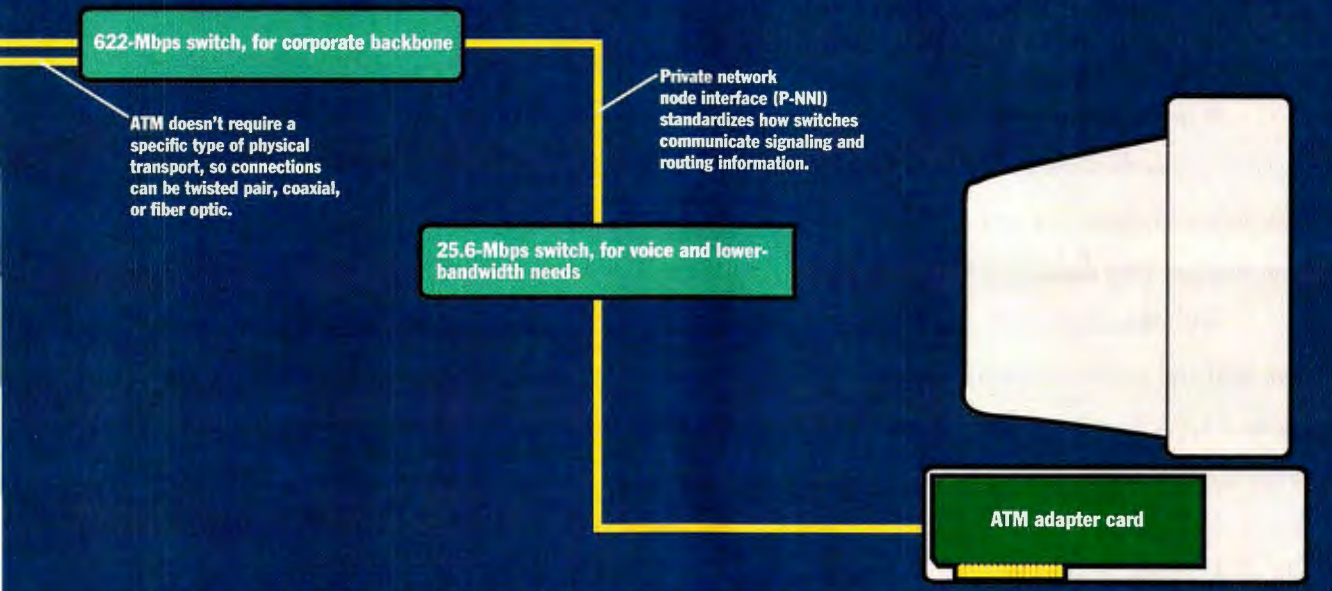

ATM Adapter Cards

Interface cards connect workstations to the ATM network typically using unshielded twisted-pair wiring or OC-3 fiber. Prices start at about $350 for 25.6-Mbps adapters and $850 for 155-Mbps cards.

What to consider:

- Does the data rate match your application?
- What bus types are supported?
- What is the size of the buffer memory?
- Are there LEDs to show loss of signal and link integrity?
- Does it support permanent and switched virtual circuits?
- Does it support UNI 3.0 and UNI 3.1?
- Are there client drivers for Windows, NetWare, OS/2?

Representative vendors:

Adaptec (http://www.adaptec.com)
ATM Inc. (http://www.atminc.com)
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TRAVELING SOFTWARE

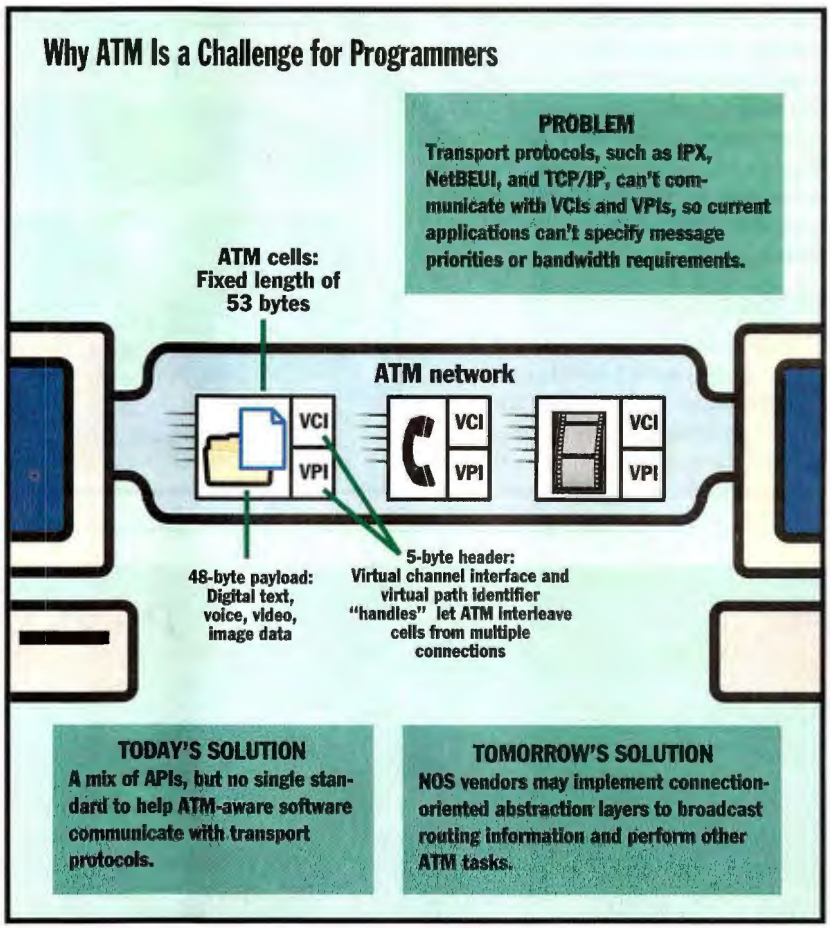
There is no single API for writing ATM-enabled software. Here are the tools you can use. By Barry Nance

Teach Your Apps to Speak ATM

What does it take to write software that's enabled for asynchronous transfer mode (ATM)? You have to create programs that handle time-critical data, rapidly deliver data through a network cable to other computers, and share the network cable with concurrent video and audio streams. The problems come when your application has to tell the underlying network the priority of the message or the bandwidth needed to send it. In a perfect world, a standard API would handle this task and programmers would concern themselves only with writing the application. But today's ATM world is far from perfect.

For the time being, we can't rely on any single API for every situation. The soon-to-be-released WinSock 2.0 will advance the current WinSock specification by adding ATM-specific extensions; the existing LAN Emulation (LANE) environment provides an IEEE-802 media access control–layer (MAC) interface for non-ATM-aware IPX, NetBEUI, and TCP/IP running on ATM networks; and the recently developed IP over ATM specification (outlined in RFC 1577 and RFC 1483) adapts TCP/IP for ATM networks.

Of course, you can eschew standards and marry your code to a particular hardware vendor's network adapter design—each vendor offers a proprietary interface that your software can use. But in a rapidly changing technology segment like ATM, you'd better be sure you've found true love before you tie the knot.



Programmers don't have an easy way to write applications that take advantage of ATM's connection-oriented networks.

ATM Advantages

There are a number of advantages for applications that truly speak ATM. First, programmers can write applications that mix voice, text, and video together as needed. ATM-enabled applications can run without any delays caused by concurrent network traffic. A new generation of software will use ATM to let computers share data without the pretense of mapped phantom drive letters, phantom folders, and phantom file systems.

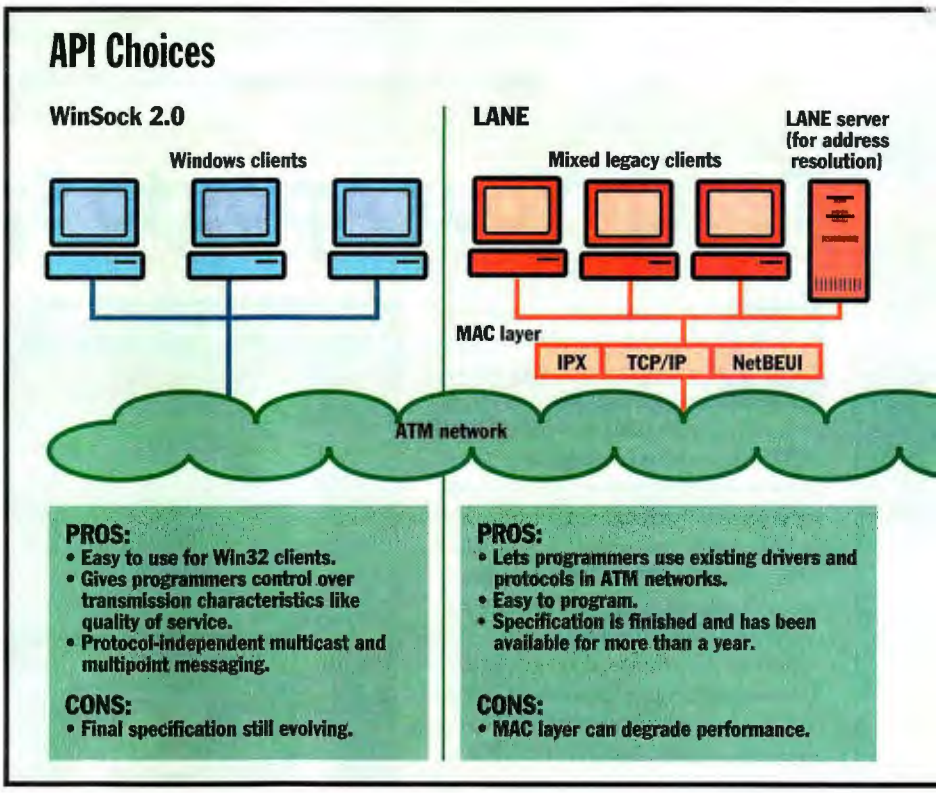
Why do we need a new generation of software to handle ATM? Because ATM is a connection-oriented protocol that contains a connection identifier in every cell header (see the figure "Why ATM Is a Challenge for Programmers" above). ATM establishes a link between two computers to transfer data. Traditional networks, including Ethernet, are connectionless: Systems communicate over a network bus rather than via direct connections. The connection identifier explicitly associates a cell with a given virtual channel on a physical link. The connection identifier consists of two subfields, the virtual channel identifier (VCI) and the virtual path identifier (VPI). The VCI and VPI allow ATM hardware to multiplex, demultiplex, and switch cells throughout a network. VCIs and VPIs are connection handles, not addresses. ATM assigns them at each segment (the link between ATM nodes) when an application creates a connection, and the VCI and VPI exist for the duration of the connection. ATM can asynchronously interleave (multiplex) cells from multiple connections by keeping track of VCIs and VPIs.

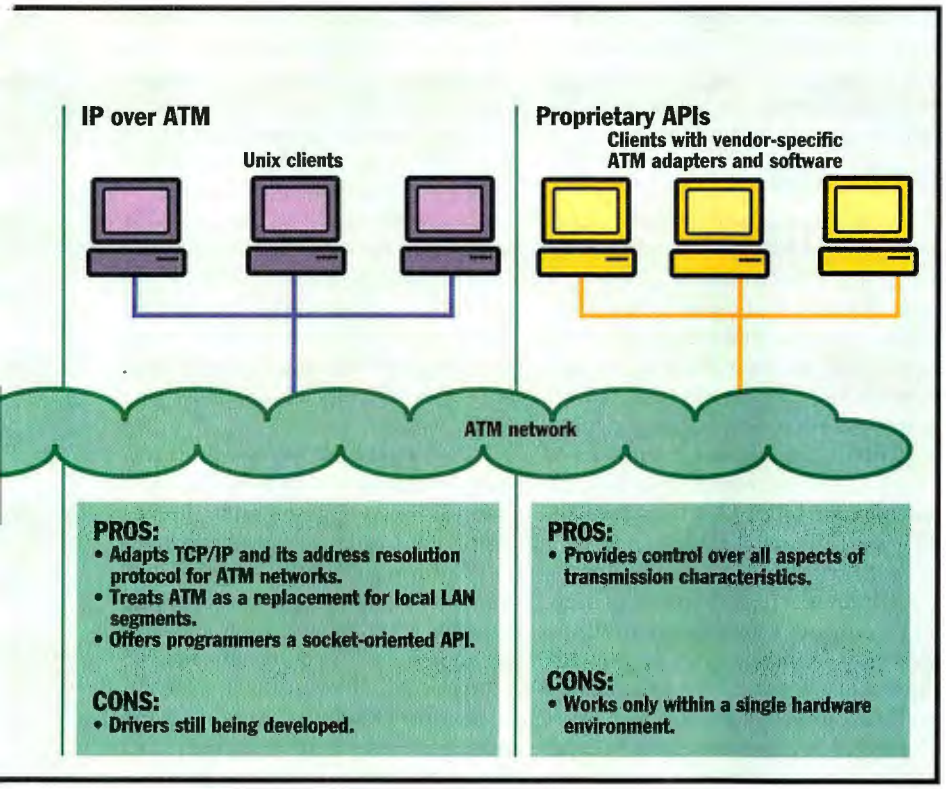
continued

At present, transport protocols such as IPX, NetBEUI, and TCP/IP and their APIs do not understand VCIs and VPIs. Applications have no way to tell the underlying network the priority of the message or the bandwidth needed to send it. Network-operating-system (NOS) vendors are working on these issues. Both Microsoft and Novell have announced plans for connection-oriented abstraction layers that are likely to broadcast routing information and service advertising packets more frugally over ATM and to optimize packet sizes for ATM's cell-oriented architecture. Both efforts should make ATM-aware programming easier in the future. Until then, WinSock 2.0, LANE, and IP over ATM are the best choices.

WinSock 2.0

Microsoft and Intel codeveloped WinSock 2.0, the new 32-bit edition of the popular WinSock interface. For compatibility with version 1.1, WinSock 2.0 includes the standard WinSock calls that let you create communications links, send





and receive data over those links, and take down the links at the end of a session. To support ATM, WinSock 2.0 accommodates quality of service, which lets applications negotiate required service levels for bandwidth and latency as well as use socket grouping and prioritization. Version 2.0 also permits protocol-independent multicast and multipoint message transmission.

In WinSock 2, the `bind()` and `WSPBind()` functions use a `sockaddr_atm` data structure to register a Service Access Point (SAP). A SAP is a software connection point that behaves in many ways like a socket. The data structure contains information about incoming connection requests. SAP registration lets WinSock match an incoming connection request SAP to the SAP of a listening socket. For point-to-point connections, the `sockaddr_atm` data structure also lets you specify the destination SAP for calls your program makes to the `connect()`, `WSAConnect()`, and `WSPConnect()` functions. For point-to-multipoint connections, you use the same data structure in

calls to `WSAJoinLeaf()` and `WSPJoinLeaf()`. The WinSock 2 specification natively supports ATM point-to-point and point-to-multipoint connection setup and teardown.

To handle ATM, WinSock 2 introduces the notion of a socket group as a means for an application (or cooperating set of applications) to tell an underlying service provider (i.e., a dynamic library or device driver) that all sockets in a particular set are related and that the resulting socket group has certain common ATM attributes. These ATM attributes include relative priorities of the individual sockets within the group, as well as a group quality of service specification. For example, applications running on different ATM nodes that want to exchange streams of multimedia data can give an audio stream a higher priority than a video stream.

You use the `WSASocket()` and `WSAAccept()` functions to explicitly create or join a socket group, and you can use `getsockopt()` to retrieve socket-group IDs.

WinSock is a relatively easy specification for programming. However, we probably won't see a final specification until early next year. Even then, WinSock will work only for Windows, so if cross-platform applications are important for you, you need to find another API.

LAN Emulation

While WinSock 2.0 offers a new ATM-aware API, LANE focuses on making existing applications run on ATM. LANE is particularly suited for helping ATM act as a LAN backbone for Ethernet or token-ring hubs, bridges, switching hubs, and routers. LANE specifies ways for LAN traffic to flow between client computers and an ATM-attached file server without the need for a separate router. To do this, the specification hides ATM from the LAN nodes, so that each client and server uses a non-ATM-specific protocol stack.

LANE doesn't replace routers or routing: It provides a complementary MAC-level service. This service works with the MAC-layer switching that occurs in the hubs and wire closets of large LANs. The MAC-layer service also provides interoperability between current applications and ATM networks. It also lets you use existing drivers and popular LAN communications protocol APIs, such as NetBIOS, TCP/IP, and IPX. However, LANE does not take advantage of ATM's potential to provide particular connections with a higher quality of service.

The specification describes how ATM can take on the appearance of a legacy physical layer medium, such as Ethernet or token ring, by providing a layer of software that translates, for example, among your program's NetBIOS calls, or your program's IPX calls, and the underlying ATM network.

LANE defines the way the three primary characteristics of IEEE-802 LANs (connectionless transmissions, broadcast/multicast messages, and hard-wired MAC addresses) work over ATM networks, which are connection-oriented, use point-to-point messaging, and have network-defined telephone-number-like addresses. An address-resolution protocol within LANE discovers the ATM address corresponding to a given MAC station address (whether the station is

ATM-attached directly or connected via Ethernet/token ring) and constructs a virtual circuit between the end points. For broadcast and multicast IEEE-802 packets to travel over the network, a LANE server uses point-to-point circuits inbound and point-to-multipoint circuits outbound to direct the traffic. The LANE specification details the packet formats and packet encapsulations necessary for ATM to pretend to be some other physical layer, and it defines how an ATM adapter in a host can present an Ethernet or token-ring logical interface to the protocol stack in that host.

LANE can slow down your communications links because it's an extra insulating layer of software, but existing IPX, NetBIOS, and TCP/IP programming techniques work with LANE, and it is readily available.

IP over ATM

Based on work by the Internet Engineering Task Force (IETF) and others, two recent RFCs have helped IP become ATM-aware. The specification defines how to put IP packets and ARP requests directly into protocol data units and convert them to ATM cells. This is necessary because IP does not recognize conventional MAC-layer protocols, such as those that are generated on an Ethernet LAN.

RFC 1483 defines the encapsulation of IP datagrams, while RFC 1577 specifies how IP-oriented address resolution works on ATM. Both standards treat ATM as a direct replacement for the local LAN segments that connect IP nodes and routers in a non-ATM IP-based LAN. In its discussion of address resolution, RFC 1577 defines an ATM-oriented protocol for logical IP subnets (LISes). Within a LIS, IP addresses map directly into ATM Forum's (Foster City, CA) UNI 3.0 addresses.

From a programming point of view, you'll interface to IP over ATM with a socket-oriented API similar to the version 1.1 set of standard WinSock function calls. These calls let you open sockets to establish TCP/IP communications links, send and receive messages across those links, and tear down the links when you're finished.

IP over ATM makes better use than LANE of larger packet sizes and handles unicast traffic more efficiently. However, IP multicast traffic will likely require tunneling over ATM (i.e., encapsulation of multicast packets inside broadcast messages), which might make IP over ATM less efficient than LANE.

Vendors are currently developing drivers for IP over ATM, which means you won't be able to use it right away. When it's available, IP over ATM will be as easy for programmers to use as WinSock.

Three Choices

Once you've made your API selection, there's one more issue you need to address: ATM is new enough that you'll also need to make sure your hardware manufacturer can supply the drivers for your chosen approach. ATM programming isn't perfect, but these technologies are steps in the right direction. B

Barry Nance is a BYTE consulting editor and has been a programmer for 25 years. You can reach him at **barryn@bix.com**.

We test data storehouses that feature at least one tape drive, gigabytes of storage space, and more.

By Jim Kane, Dorothy Hudson, and Maggi Bender

12 Tape Libraries for Network Backup

Anyone who's gazed into the shell-shocked eyes of an overworked network administrator can see that LAN gurus need more than two hands to get the job done. It's always one disaster after another: Either the network needs to be resurrected from the dead or some neophyte user can't figure out how to access e-mail. On top of the daily emergencies is the omnipresent need to back up the network on a regular basis. The 12 tape libraries we tested provide some salvation from this time-consuming task by automating network backup.

We tested two 8-mm tape libraries, three digital-linear-tape (DLT) units, and seven 4-mm tape auto-loaders that have at least one tape drive, a magazine to hold the tapes, and the robotics (usually a jukebox setup) to move the tape between the magazine and a drive. Once you set up the tape library and install the tape-inventory software, the network administrator sets a backup schedule and simply changes the magazine once per week or month. Without one of these devices, you have to manually swap tapes during backups.

Our roundup includes a hodgepodge of units that range from Seagate's internal 4586 NP ($2471) to ADIC's Scalar 458 2000XT ($50,995 as tested), which is a DLT-based tape library housed in a waist-high cabinet that can back up 4 TB of data. The DLT libraries offer the most capacity per cartridge. These cartridges provide an uncompressed capacity of about 10 GB, compared to about 4 GB for the 4-mm tape drives and about 5 GB for the 8-mm helical-scan tape drives. The higher-end tape auto-loaders have multiple drives; this provides such benefits as concurrent operations, fault tolerance, and increased throughput.

To evaluate these products, we ran tests (see "Test Specs" on page 109) that measure how fast each tape library could back up and restore 920 MB of data spread out through a file-directory tree. We also checked the tape libraries for usability and features, and then we picked winners in each technology category. We didn't examine server-backup software, but we list what applications the tape libraries support in the features table on page 110.

BYTE BEST
TAPE LIBRARIES

Exabyte 218 4mm Tape Library
takes the lead with its ability to back up multiserver networks.

Exabyte 210 8mm Tape Library
wins with the best performance, features, and ease of use.

Overland Data DLT Library Xpress/LXB 2210 Base Module
comes out on top with its 300-GB capacity and fast backup and restore times.

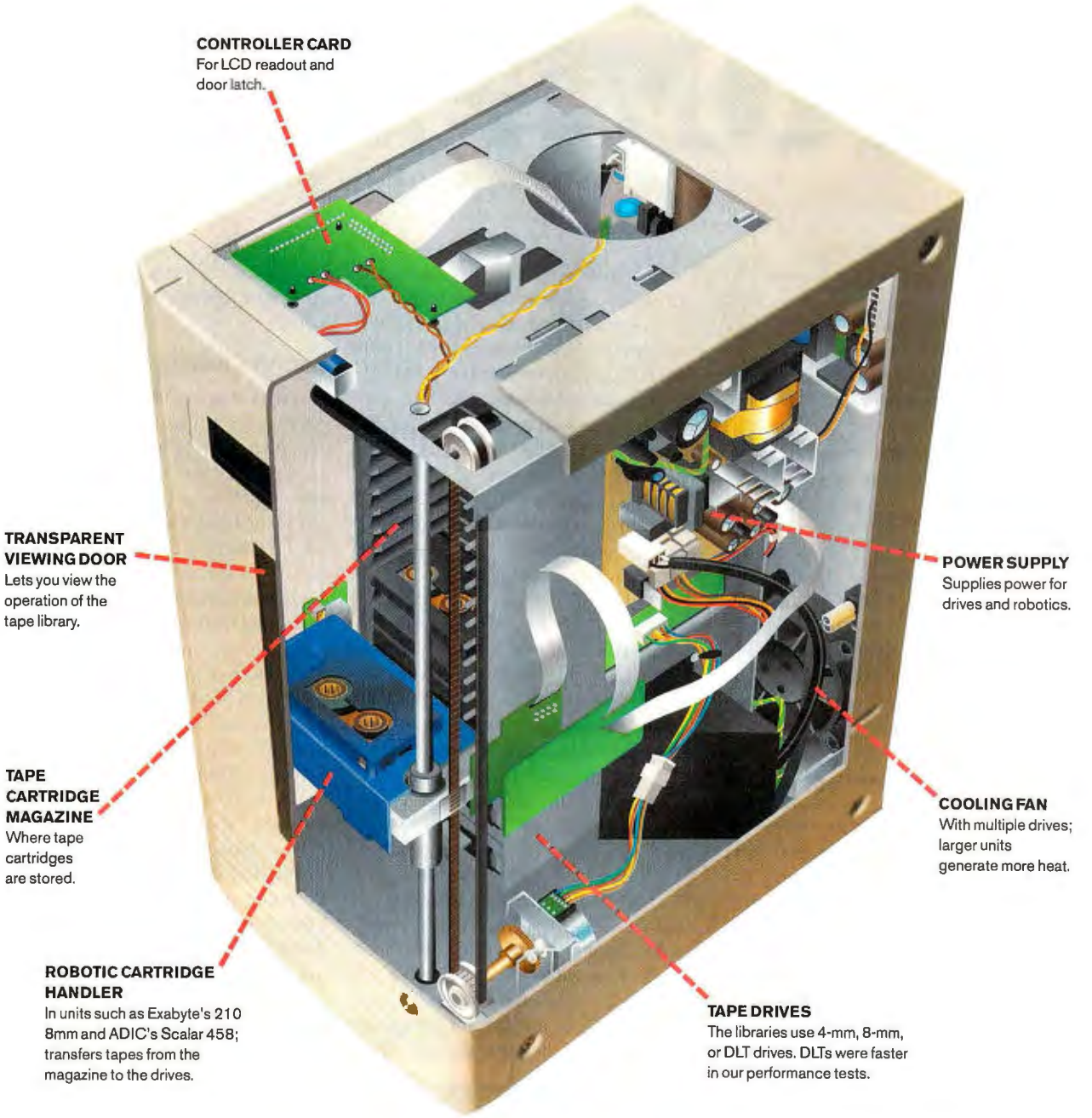
4-mm (DAT) Libraries

The seven 4-mm drives that we tested (sometimes called DAT because of Hitachi's original DAT format) are standardizing on the DDS-2 (digital data storage) format for the tiny tape cartridges. This format was developed to let data transfers occur in SCSI-2 burst mode. DDS-2 doubles the density of the previous DDS format for 8 GB of storage on a 120-meter tape, but it maintains full DDS functionality and ensures full backward compatibility to the DDS and DAT 4-mm tape formats.

Four of the higher-end DAT tape libraries that we tested are in the $8000 to $11,000 price range—Aiwa's AL-D220 AutoLoader ($7995), ADIC's VLS (Virtual Library System) 4mm ($9295), the DATa-ray 32 from Storage Solutions, Inc. (SSI; $9995), and the Exabyte 218 4mm Tape Library ($11,500)—and have multiple tape drives for reading multiple cartridges. This multitasking capability is important when you consider that, in theory, SSI's DATa-ray 32 could significantly reduce backup times if all five DAT drives were moving data at the same time. The Aiwa, ADIC, and Exabyte products have two tape drives each.

The Aiwa AL-D220 supports 17 4-mm tape cartridges in an upright chassis for 136 GB of data with 2:1 data compression enabled. The Exabyte 218 4mm Tape Library is a stand-alone unit that supports 19 4-mm cartridges for 152 GB of compressed storage. As its name implies, the SSI DATa-ray 32 can store 40 GB of data and offers excellent expandability, thanks to its stackable design. ADIC's VLS 4mm is a desktop device that can hold 15 cartridges for 120 GB of data; a robotic cartridge handler slides on a track in front of the tape magazine to enable you to move the cartridges back and forth to the tape drives.

The three remaining 4-mm tape libraries are single-drive units that provide back-



up on a much smaller scale. Hewlett-Packard's SureStore 12000e ($3510), Micro Design International's SCSI Express 2000DC ($3595), and Seagate's 4586 NP are no bigger than a shoebox. The Seagate 4586 NP (formerly a Conner product) is so small that it fits inside a PC, but it still backs up 96 GB of data.

DLT and 8-mm Libraries

DLT is gaining market share in the LAN segment of the industry because it offers higher capacities and is faster than the 4- and 8-mm tape libraries. In contrast to helical-scan technologies, DLT drives' serpentine recording method places data in longitudinal tracks. As a result, the drives can read and record multiple channels of data simultaneously. The tapes also supposedly have a 30-year shelf life, which matches that of magneto-optical storage.

Quantum's DLT 2500XT ($4995) is a single-drive tape library with a five-cartridge magazine that you slide into the front panel for 150 GB of backup with 2:1 compression. It's the lowest-priced DLT tape library we tested. Overland Data's DLT Library Xpress/LXB 2210 ($15,495) offers 300 GB of backup in a rack-mountable case with a front-loading tape magazine. ADIC's Scalar 458 2000XT is the big daddy of all the tape libraries; it supports about 4 TB of data when its 48 cartridge bays are maxed out.

The Exabyte 210 8mm Tape Library ($13,325) and the Qualstar TLS-4220 ($12,500) have dual 8-mm Exabyte-manufactured tape drives. The Exabyte 210 8mm can hold 11 cartridges in its snap-in magazine, for 154 GB of compressed data storage. Qualstar's TLS-4220 supports two 10-cartridge magazines, for 280 GB of stored data.

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Best Overall

TAPE LIBRARIES

It's hard to pick one tape library as best overall—DLT, 4-mm, and 8-mm units have different recording formats and serve different needs. With this in mind, we broke down our winners into the best DLT, 4-mm, and 8-mm tape libraries so that we could compare the units on an even playing field.

4-mm Choices

The Exabyte 218 4mm Tape Library, our best-overall 4-mm choice (see "Lab Results" on page 105), dispels the commonly held belief that 4-mm tape libraries are merely entry-level backup solutions. With its voluminous 152-GB storage capacity, this dual-drive-configured tape auto-loader can back up multiserver networks.

The tape library rated closest to the Exabyte unit in this category is ADIC's VLS 4mm, a dual-drive desktop system with a 120-GB data capacity. This dual-drive capacity lets you retrieve files on one drive while backups are running on the other drive. The VLS 4mm received one of the highest usability ratings because its removable, 15-cartridge FastPort magazine is easy to load and unload; it has a clear and concise user's manual; and its status indicators are easy to understand.

HP's SureStore 12000e and Micro Design International's SCSI Express 2000DC are two strong, compact DAT tape libraries with 48-GB capacities. They both have HP-manufactured drives and thus have similar performance numbers. They are supported by leading network-backup applications vendors, such as Cheyenne Software and Seagate Software (formerly Arcada and Palindrome). The only inconvenience with these smaller drives is that you can't see if a tape is stuck inside the loader; however, the HP tape library has an informative LCD panel that keeps you abreast of what's going on.

DLT Choices

The DLT market is really heating up. Currently DLT tape drives account for about 7 percent of the tape-library market, but industry analysts predict that number will surge to 26 percent by the turn of the century. HP, one of the market leaders in DAT tape storage, recently threw its hat into the DLT arena and offered its first DLT-based products. Unfortunately, however, we didn't receive a product in time for this roundup. It looks like DLT is a technology worth keeping an eye on.

Overland Data's DLT Library Xpress/LXB 2210 is our best-overall choice among the DLT tape libraries because of its strong features and ease of use. Like Overland's unit, Quantum's DLT 2500XT and ADIC's Scalar 458 2000XT use Quantum-manufactured drives that afford the best performance among the three media types we tested. Because these DLT tape libraries have similar performance numbers, the choice comes down to how much network data you need to back up.

The ADIC Scalar 458 2000XT ($50,995) is the most expensive tape library that we tested, but it has four tape drives and offers the greatest capacity, with almost 4 TB of total storage in its huge 58-cartridge cabinet. At $4995, the Quantum DLT 2500XT is a much more modestly priced mini-library, with five cartridges for 150 GB of backup. Quantum's desktop device uses an elevator mechanism to provide cartridge access between the tape drive and the cartridge magazine, while the other DLT drives use robotic cartridge handlers.

8-mm Choices

The two 8-mm tape libraries in our roundup are huge, freestanding units that support enterprise-wide backup needs. Both use Exabyte-manufactured tape drives, so their performance in our backup and restore benchmarks were almost identical. The Exabyte 210 8mm Tape Library ($13,325) came out slightly ahead of Qualstar's TLS-4220 because of its higher usability and features scores.

However, the Qualstar TLS-4220 ($12,500) has several advantages over Exabyte's product in a head-to-head comparison. The TLS-4220 holds 20 cartridges, compared to 11 cartridges for Exabyte's 210 8mm. The TLS-4220 also offers great expandability options. It's only the third member of Qualstar's wide-ranging TLS-4000 product family. Therefore, if your data-storage needs expand, you can upgrade to Qualstar's TLS-46120, a monster of a tape library that has six drives and 120 cartridges, for over 1.6 TB of backup. The TLS-4220 has an intuitive control panel, and you can lock the cartridges inside the case for data security.

TAPE TECHNOLOGIES AT A GLANCE

DLT
- One of the hottest technologies in the tape-backup industry.
- 40-GB-per-cartridge compressed capacity.
- Serpentine recording technique places data in longitudinal tracks for high-speed backup and restore performance.
- 30-year shelf life is ideal for archiving data.

4 mm
- An older helical-scan technology, where tape is laid down in angles.
- Smallest form factor of the three technologies.
- Native capacities of 2 GB or 4 GB.
- The latest DDS-2 format provides double density.
- Stores 8 GB of data on a 120-meter tape.
- Not as fast as DLT but offers exceptional cost per megabyte.

8 mm
- Another helical-scan technology that offers an excellent price/performance ratio.
- 8-GB native capacity and 16 GB with 2:1 compression.
- Offers performance similar to that of 4-mm drives.
- Technology will get a performance/capacity boost when Exabyte's 40-GB, 6-MBps Mammoth tape drives filter to OEMs.

LAB RESULTS

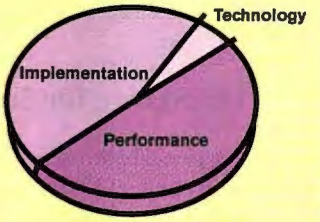
TAPE LIBRARIES RATINGS

BEST OVERALL–4-MM

Exabyte 218 4mm Tape Library

The Exabyte 218 4mm Tape Library ($11,500) ably performs automated backup and restore functions, file migration, and archival storage for networks. It's one of the few 4-mm units that has dual drives, which raises its price but adds fault tolerance and concurrent operations (i.e., it can perform reads and writes at the same time). You can add an optional bar-code reader ($1150) to help you keep track of and quickly retrieve the 152 GB of DDS-2 backup in the unit's 19-cartridge magazine library.

WEIGHTING



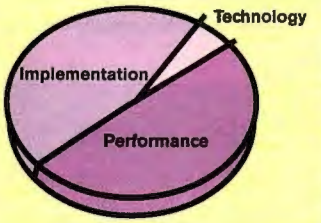
	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	FEATURES	USABILITY	OVERALL RATING
Exabyte 218 4mm Tape Library	**$11,500**	★★★	★★★★	★★★★★	★★★★	★★★★	★★★★
Hewlett-Packard SureStore 12000e	$3510	★★★	★★★★	★★★★★	★★★★	★★★★	★★★★
ADIC VLS (Virtual Library System) 4mm	$9295	★★★	★★★★	★★★★★	★★★	★★★★	★★★★
Micro Design SCSI Express 2000DC	$3595	★★★	★★★★	★★★★★	★★★★	★★★	★★★★
Aiwa AL-D220 AutoLoader	$7995	★★★	★★★	★★★	★★★★	★★★	★★★
Seagate 4586 NP	$2471	★★★	★★★	★★★	★★★	★★★★	★★★
Storage Solutions DATa-ray 32	$9995	★★★	★★★	★★★★	★★★	★★★	★★★

BEST OVERALL–8-MM

Exabyte 210 8mm Tape Library

Exabyte's 210 8mm Tape Library ($13,325) uses two Exabyte EXB-8505 XL drives and moves 11 8-mm cartridges containing 154 GB of backup with a robotics cartridge handler. This provides easy-to-manage automated backup for large networks and midrange systems. The SCSI-2 tape library offers easy front access with its stand-alone desktop cabinet, as well as keylock security. Exabyte bundles excellent documentation with the tape library, which earned a high usability score because it's easy to snap the tape-cartridge magazine in and out.

WEIGHTING



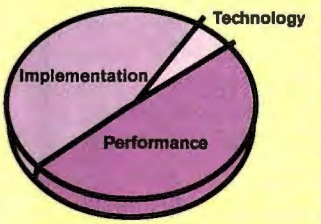
	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	FEATURES	USABILITY	OVERALL RATING
Exabyte 210 8mm Tape Library	**$13,325**	★★★	★★★★	★★★★★	★★★★	★★★★	★★★★
Qualstar TLS-4220	$12,500	★★★	★★★★	★★★★★	★★★	★★★★	★★★★

BEST OVERALL–DLT

Overland Data DLT Library Xpress/ LXB 2210 Base Module

DLT tape libraries are becoming a hot spot among tape backup solutions because they provide high-speed, high-capacity, high-reliability backup. Overland Data's dual-drive DLT Library Xpress/LXB 2210 ($15,495) is no exception, with its 300-GB backup capacity and fast backup and restore times. The tape library affords wide flexibility for customizing tape backup solutions because it supports a wide range of network OS (NOS) platforms and third-party backup applications.

WEIGHTING



	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	FEATURES	USABILITY	OVERALL RATING
Overland Data DLT Library Xpress/ LXB 2210 Base Module	**$15,495**	★★★★	★★★★	★★★★★	★★★★★	★★★★★	★★★★★
ADIC Scalar 458 2000XT	$50,995	★★★★	★★★★	★★★★★	★★★★	★★★★	★★★★
Quantum DLT 2500XT	$4995	★★★★	★★★★	★★★★★	★★★	★★★★	★★★★

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

PHOTOGRAPHS: STEVE BELKOWITZ © 1996

Details

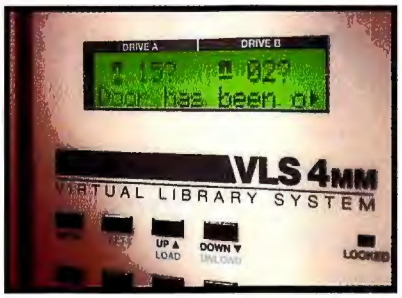
Scanning Reduces Tape-Access Time

Several of the tape libraries (e.g., ADIC Scalar 458, Exabyte 210 and 218, Overland Data DLT, and Qualstar TLS-4220)

we reviewed have standard or optional bar-code scanners that make it easier to keep tabs on your tape cartridges. These scanners read labels that you stick onto the data cartridges, and the tape's content is recorded in your software-library application's inventory. When it comes time to grab a cartridge to restore data, the tape auto-loader can recognize it in seconds, which is much better than having to read all the labels to find the right cartridge.

LED Status: Too Small

We might be nitpicking here, but the ADIC VLS 4mm's tiny strip of an LED is so small that you can't read all the status information without scrolling across the display. The tape library needs either a bigger LED or smaller print.



Just Drop It in the Mail Slot

You don't have to open up the ADIC Scalar 458 2000XT and the Qualstar TLS-4220 to insert a tape; you just feed it into the face of one of these big tape libraries. You can put cartridges in any of the Scalar 458's 10 open slots below the front control panel and then program what internal slot they are to be sent to. The TLS-4220 has one available tape slot at the top of the unit.

Data Backup over the Phone

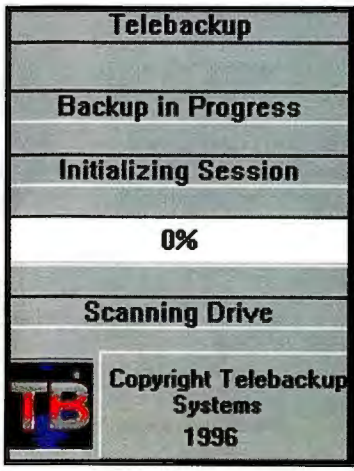
You've ordered Chinese takeout and pizza over the phone, so why not call to order data backup? This spring, Canadian-based Telebackup Systems, Inc., released a software package that backs up hard drives over standard telephone lines. TSI is currently licensing the technology to Internet service providers (ISPs) and telephone utilities, which will offer the backup service to any modem-attached user.

TSI's CEO Byron Osing says that value-added service providers will most likely charge a monthly fee of between $15 and $20 for daily backups of a PC. So far, TSI has reached an agreement with Toronto-based Hookup Communications, a large ISP, to utilize the technology. Osing says that many U.S. health-care providers have expressed interest in the off-site storage solution. Telebackup can perform daily backups on as many as 2500 standard PCs per day.

Of course, using a telephone line to make daily backups of a hard drive makes most people think twice. It can take up to 10 hours to initially back up a 1-GB hard drive over the telephone lines, but Osing says that Telebackup can detect the files used during the day and back them up in approximately 5 to 10 minutes. It does this using a cyclic redundancy check (CRC), which is a method for verifying data transmission by comparing numbers at the sending and receiving ends. You can restore single files from the off-site provider or get a complete off-site CD-ROM copy of your hard drive in case of hardware theft or a disk calamity.

The Telebackup service is limited to DOS and Windows 3.x, 95, and NT on the client side, but Osing says that the company will soon extend it to OS/2 and other platforms. Targeted at small businesses and home users, Telebackup poses no threat to on-line tape-library storage. TSI, however, plans to spin off a LAN-backup product later this year.

–John McDonough



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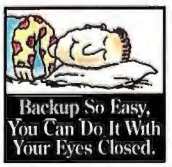
Very Compatible
Works with DEC, Sun, SGI, HP, IBM RS/6000, AS/400, PCs and compatibles and more.

Fast and Easy
Back up 1.1 TB unattended in less than 8 hours using library management software for UNIX, VMS, Novell and more.

High Speed
Back up over 20 MB per second.

Store up to 4.2 TB at over 20 MB per second.



Hungry for high performance tape backup? TTi's Q Series Digital Linear Tape (DLT) libraries are a very tasty solution. The Q Series comes packaged in two configurations, including 2 or 4 drives, providing random access of up to 60 data cartridges. That's a whopping 4.2 TB with data transfer speeds exceeding 20 MB per second! In addition, with the Q Series you can choose from 3 tape drive types: DLT 2000XT, DLT 4000 or DLT 7000.

The Q Series is compatible with a wide variety of library management software packages for UNIX, VMS, Novell and more. It's perfect for Hierarchical Storage Management (HSM) applications and standard network backup. And of course, the Q Series is backed by a full 2 year warranty.

The Q models come in desktop and desk-side versions, featuring an intelligent LCD operator panel which displays library activity and drive status. The Q Series is plug and play compatible with DEC, Sun, HP, SGI, IBM AS/400, IBM RS/6000, PCs and compatibles and more. Are you ready to get a taste of the fastest high-capacity backup solution? Call TTi today.

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ISO 9002 CERTIFIED

Test Specs

We evaluated the performance of these 12 tape libraries by timing their network backup and restore speeds. Our testers also examined the tape auto-loaders to see which ones were the easiest to set up and then picked the units' most important features. We tested and scored each element separately and computed an overall score in each media-technology area (i.e., DLT, 4 mm, and 8 mm) by assigning a weight to each element: technology (10 percent), implementation (40 percent, which is further divided into 45 percent for features, 45 percent for usability, and 10 percent for value), and performance (50 percent).

We ran our PC-based performance benchmarks on a 120-MHz Pentium system from S.A.G. Electronics running Windows NT. We created a directory tree with 920 MB of data on the computer's hard drive; the files in the directory tree varied in size and had different levels of compression. We tested the performance of the tape libraries by backing up and restoring the directory using Cheyenne Software's ARCserve 2.01 for Windows NT. We also ran another restore test by backing up a single 115-MB directory from within the tree.

Usability scores are based on such aspects as the clarity and organization of the user's manuals. Our testers check to see whether the documentation clearly defines status-indicator functions, and we also examine the illustrations to see if they are easy to understand. In addition, we make sure the LED indicators let you know if compression is on or if the tape is dirty. Our hands-on approach to testing includes evaluating how easy it is to install the tapes and the magazine clips and how accessible the jumper switches are to get to.

For features, we weight and score the important characteristics that we believe a tape library should have. As with most products that we test, the length and coverage of a warranty are always a primary concern. It's also important to pick a tape auto-loader that supports as many network OSes (NOSes) and third-party backup software applications as possible. Finally, we consider the cost and size of the units for the budget-minded and for those who are concerned with conserving office space.

Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of its 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, Inc.*

The World of Hierarchical Storage Management

Data that's archived to off-line storage devices may rarely be needed, but network administrators still must identify, move, and maintain it. To do this effectively, they need a special method for managing off-line storage.

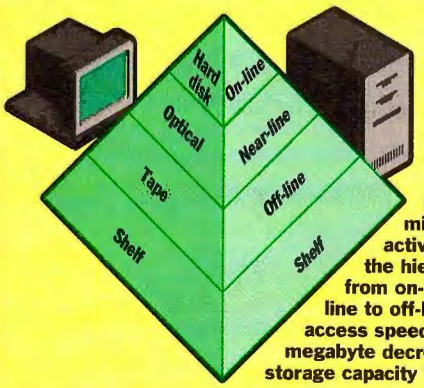
Hierarchical storage management (HSM) automatically and transparently migrates data from a file server's hard drive to less-expensive near-line or off-line storage (see the figure "Storage Hierarchy"). When files are migrated, stub files are left in primary storage as placeholders; thus, all files remain visible in the network file system, and you can still view and access them.

Five industry-accepted guidelines, or levels, help define HSM: automatic migration of files with transparent retrieval; real-time, dynamic load balancing of free disk space based on predefined thresholds; management of layers of storage hierarchy with dynamic balancing; migration of files based on data type through the use of policies; and object management support.

Several companies—including Cheyenne Software ((516) 465-4000), IBM ((800) 426-2255), Platinum Technology ((708) 620-5000), Seagate Software (formerly Arcada and Palindrome; (407) 333-7500), and Wang Software ((303) 444-4018)—support most, if not all five, levels. IBM's AdStar Distributed Storage Manager (ADSM) is one of the few storage solutions that supports a wide variety of platforms and all five HSM levels. Recently IBM announced support for Windows NT on the server side and an optional automated disaster-recovery plan. (For more on HSM-related software, see "Network Storage Economizers," March 1995 BYTE.)

With an HSM solution, you can potentially decrease physical storage expenses, reduce storage management costs, quicken data access, increase end-user productivity, optimize use of storage devices, and speed data backup. Installation and setup may be monumental, but the benefits make it well worth it. **–Susan Colwell**

Storage Hierarchy



As HSM products migrate less-active files down the hierarchy (i.e., from on-line to near-line to off-line), the access speed and cost per megabyte decrease and the storage capacity increases.

TAPE LIBRARIES FEATURES

VENDOR	ADIC Scalar 458 2000XT	ADIC VLS (Virtual Library System) 4mm	Aiwa America, Inc. AL-D220 AutoLoader	Exabyte Corp. 210 8mm Tape Library BYTE BEST	Exabyte Corp. 218 4mm Tape Library BYTE BEST
Base price (MSRP)	$39,995	$9295	$5995 (single-drive)	$6000	$5500
Price as tested	$50,995	$9295	$7995 (dual-drive)	$13,325	$11,500
Overall rating	★★★★	★★★★	★★★	★★★★	★★★★
PHYSICAL SPECIFICATIONS					
Drive manufacturer	Quantum	Hewlett-Packard, Sony, Seagate, Wang-DAT	Sony	Exabyte	Hewlett-Packard
Number of tape drives (std./max./as tested)	2/4/4	2/2/2	1/2/2	1/2/2	1/2/2
Number of tape banks (std./max./as tested)	48/58/48	15/15/15	17/17/17	1/1/1	1/1/1
Bar code scanner	Yes	N/A	N/A	Optional	Optional
Dimensions in inches (W × D × H)	19.5 × 23.5 × 40.3	17.4 × 16.25 × 8	8.125 × 12.25 × 16	9.5 × 21.4 × 22	9.5 × 21.4 × 22
Weight (lbs.)	171	32	26	78.5	78.5
PERFORMANCE					
Recording method	DLT	PRML	Helical-scan	Helical-scan	Helical-scan
Average access time (seconds)	60	<40 sec. for 120-inch tape	35 sec. for 120-mm tape	90	40
Sustained compressed transfer rate (KBps)	2500	732	1024	1000	2048
Tape length (meters)	1800	60, 90, 120	60, 90, 120	160	120
Buffer size (MB)	2	1	1	1	1
Drum-rotation speed (rpm)	N/A	2000 to 5000	4000	1831	2000
RELIABILITY					
MEBF (exchanges)/duty cycle (percent)	100,000/100	80,000/20	160,000/10	160,000/10	200,000/10
Nonrecoverable read-error rate	1×10^{17}	1×10^{15}	$<1 \times 10^{15}$	$<1 \times 10^{17}$	$<1 \times 10^{15}$
DATA RECORDING					
Maximum number of cartridges	58	15	17	11	19
Max. cartridge capacity/overall capacity with compression (GB)	70/3.96 TB	8/120	8/136	14/154	8/152
Max. cartridge capacity/overall capacity without compression (GB)	35/1.98 TB	4/60	4/68	7/77	4/76
Cost per GB	$30.35	$154.92	$117.57	$173.05	$151.32
Number of read/write heads	1	2	4	4	4
Tracks per inch	256 per half-inch tape	2790 per 4-mm tape	2791 per 4-mm tape	1638 per 8-mm tape	N/A
ADDITIONAL CHARACTERISTICS					
SCSI adapter included	✔		✔	✔	✔
Number of SCSI ports	1	1	2	1	1
Serial interface	✔				
Number of SCSI addresses necessary to use unit	5	2 for 1 drive/ 3 for 2 drives	3	Up to 2	Up to 2
Password-protected	Mailbox only	Software-dependent		✔	✔
OSES SUPPORTED					
Windows/DOS	✔	✔	✔	✔	✔
OS/2-Warp	✔	Certification in progress	✔	✔	✔
Windows NT	✔	✔	✔	✔	✔
Windows 95	✔	✔	✔	✔	✔
SCO Unix/SCO Xenix	✔	✔	✔	✔	✔
Apple A/UX		Certification in progress	✔	✔	
Other	System 7, 411 Unix Platform 1, AS-400	N/A	N/A	N/A	N/A
SOFTWARE SUPPORTED					
Cheyenne ARCServe	✔	✔	✔	✔	✔
Palindrome Network Archivist	✔		✔	✔	✔
Arcada Software Backup Exec	✔	✔	✔	✔	✔
Rexon ProServe CX/Sytos Plus					
System Independent Data Format (SIDF)			✔	✔	✔
Novell Storage Management Services (SMS)	✔		✔	✔	✔
NETWORK SUPPORT, SERVER ATTACHED[1]					
Novell NetWare 4.x	✔	✔		✔	✔
Novell NetWare 3.x	✔	✔		✔	✔
Microsoft Windows NT Server	✔	✔		✔	✔
Banyan Vines	✔	✔		✔	✔
IBM LAN Server	✔	✔		✔	✔
WARRANTY					
Warranty length (years)/coverage	2/P, L, R	2/P, L, R	2/P, L, R	2/P, L, R	2/P, L, R
FCC classification	B	B	A	B	A
Phone	(206) 881-8004	(206) 881-8004	(201) 512-3606	(303) 442-4333	(303) 442-4333
Toll-free phone	(800) 336-1233	(800) 336-1233	(800) 321-2492	(800) 392-2983	(800) 392-2983
On-line address	http://www.adic.com	http://www.adic.com	N/A	http://www.exabyte.com	http://www.exabyte.com
Inquiry number	**1063**	**1064**	**1065**	**1066**	**1067**

BYTE BEST = BYTE Best ✔ = yes; N/A = not applicable.

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

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

Hewlett-Packard Co. SureStore 12000e	Micro Design International SCSI Express 2000DC	Overland Data, Inc. DLT Library Xpress/ LXB 2210 Base Module	Qualstar Corp. TLS-4220	Quantum Corp. DLT 2500XT	Seagate Technology 4586 NP	Storage Solutions, Inc. DATa-ray 32
$3510	$3595	$10,995	N/A	$4995	$2471	$6995
$3510	$3595	$15,495	$12,500	$4995	$2471	$9995
★★★★	★★★★	★★★★★	★★★★	★★★★	★★★	★★★
Hewlett-Packard	Hewlett-Packard	Quantum	Exabyte	Quantum	Seagate/MKE	Hewlett-Packard, Wang-DAT
1/1/1	1/1/1	2/16/2	2/2/2	1/1/1	1/1/1	3/5/5
6/6/6	1/1/1	1/8/1	2/2/2	5/5/5	1/1/1	1/1/1
N/A	N/A	Optional	Optional	N/A	N/A	N/A
6.5 × 10.63 × 5.28	198 × 356 × 139 mm	19 × 23 × 8	13 × 21.3 × 31.8	16.3 × 10.5 × 11.8	5.7 × 8 × 3.2	6.625 × 10¾ × 17
11	13	70	70	35	9	20
DDS-1 & DDS-2 (tape-dependent)	DDS-DC and DCLZ	DLT	Helical scan	Serial serpentine	Helical scan	Helical scan
30/90-meter; 40/120-meter	30 to 40	45	90	68	30 to 40 (90- to 120-meter tape)	45
1020	1536	2500 to 3000	1000	2500	800	17,408
60, 90, 120	60, 90, 120	540	160	1828	90, 120	90, 120
1	1	2	1	2	1	1
5737	5737	N/A	1831	N/A	4000	5737
35,000/30	40,000/30	280,000/100	500,000/100	500,000/100	100,000/20	200,000/12
$<1 \times 10^{15}$	$<1 \times 10^{15}$	$<1 \times 10^{17}$	$<1 \times 10^{17}$	1×10^{17}	$<1 \times 10^{15}$	$<1 \times 10^{15}$
6	6	10	20[2]	5	12	5
8/48	8/48	30/300	14/280	30/150	32/384	8/40
4/24	2.6/16	15/150	7/154	15/75	16/192	4/20
$146.25	$224.69	$103.30	$81.17	$66.60	$12.87	$499.75
2	1	2	4	12	4	20
2800 per 4-mm tape	2790 per 4-mm tape	128 tracks per half-inch tape	1638 per 8-mm tape	256 per half-inch tape	2804 per 4-mm tape	N/A
	Optional	✔		✔	Optional	
1	2	2	3	✔	2	2
		✔		✔		
1	1	2 to 3 per base module	Number of drives installed plus 1	1	2	3 to 5
✔	✔	✔	✔			Software-dependent
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔		✔
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔		✔
✔		✔	✔	✔	✔	✔
✔		✔	✔	✔	✔	
N/A	N/A	Sun Solaris, HP-UX, AIX, IRIX	All Unix, VMS	N/A	N/A	N/A
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔		✔	✔
✔	✔	✔	N/A		✔	✔
✔	✔	✔	N/A		✔	✔
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔	✔
✔	✔	✔	✔	✔	✔	
✔	✔	✔	✔		✔	
✔	✔	✔	✔	IBM ADSM	✔	
1/P, L, F, R	1/P, L, R	2 (on-site)/P, L, F, R	2/P, L, R	2/P, L, R	2/P, L, R	3/P, L, R
B	B	A	A	B	B	B
Contact local HP dealer	(407) 677-8333	(619) 571-5555	(818) 592-0061	N/A	(714) 641-1230	(203) 325-0035
(800) 843-4772	(800) 228-0891	(800) 729-8725	(800) 468-0680	(800) 624-5545	(800) 626-6637	(800) 745-5508
http://www.hp.com	http://www.microdes.com	http://www.ovrland.com	http://www.qualstar.com	http://www.qntm.com	http://www.seagate.com	http://www.ssi-usa.com
1068	**1069**	**1070**	**1071**	**1072**	**1073**	**1074**

[1] Subsystem can directly attach to network server by using NLM, VAP, or server process, with driver software running under server OS and disk physically connected to server.

[2] Plus two fixed cartridge locations.

Office 95 loses some battles but wins the war against Corel WordPerfect Suite and Lotus SmartSuite 96.

By David Seachrist and Russell Kay

Microsoft's Suite Victory

There's no question who sells the most office applications and suites. Microsoft's Office 95/Office Professional won that contest long ago, leaving Lotus's SmartSuite 96 and Corel's new WordPerfect Suite/Office Professional to fight for a distant second place. However, is Office 95 your best choice? Virtually every new Windows computer today comes with one of these three suites installed, so for most people, the choice is automatic—they use what they have. But inexpensive upgrade pricing makes each package affordable to virtually every business user.

To help sort out the contenders, NSTL and BYTE examined the latest versions of all three suites. NSTL tested the Microsoft and Lotus suites, and BYTE put the Corel suite through its paces.

We are deliberately ignoring entry-level suites, such as ClarisWorks, which are aimed primarily at home and first-time users. Also, we don't cover every application in the three suites, concentrating on word processors, spreadsheets, and, to a lesser extent, personal information managers (PIMs).

Corel's New Contender

As the newest 32-bit kid on the block, the Corel WordPerfect Suite has been the object of considerable curiosity. The applications are very good, integration is reasonably good, and users will applaud new owner Corel's decision to reinstate free telephone support. (Well, the phone call to Utah isn't free anymore, but the capable help is.) This may not be the best suite, but it's technically interesting. It also offers the greatest variety of applications and extras.

In our tests, it became apparent that Corel uses more shared code, more consistently, than either Office or SmartSuite. Shared spelling checkers are commonplace; shared thesauri are much less so.

BYTE BEST
OFFICE SUITES

Microsoft Office Professional offers a world-class set of productivity applications, nosing out its two competitors. Its cross-application functions are excellent.

We tested the basic suite, which has no database product in it. The upgraded version, Corel Office Professional, includes Borland's Paradox DBMS. It should be available by the time you read this article.

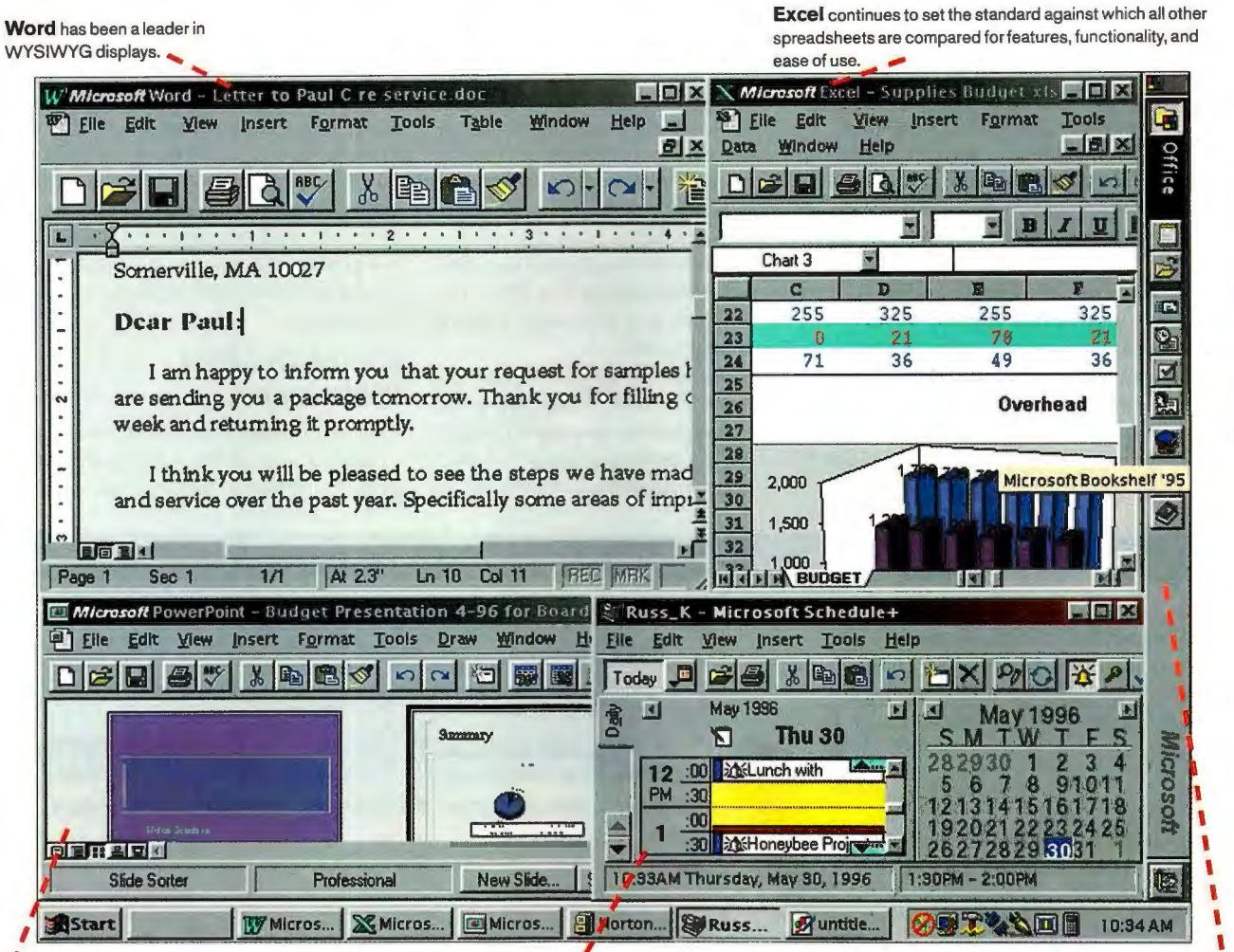
The latest WordPerfect is as good as a word processor gets. It will do virtually everything the other two can and some things they cannot. For example, when your mouse cursor is on a paragraph or a table cell, a little box icon (called a HotSpot) appears on the edge of the area. Clicking on it selects that object and brings up a menu of possible actions. This proves considerably faster and less distracting than going to the menu or toolbar. Also, WordPerfect's Reveal Codes mode has no peer for sorting out formatting problems.

WordPerfect Suite is a highly Internet/intranet-aware package. It can publish directly to Hypertext Markup Language (HTML) and Standard Generalized Markup Language (SGML), and it can read and view those formats directly. It comes with Netscape 2.01 and AT&T's WorldNet service. While they install separately, they are immediately accessible from within WordPerfect, Quattro Pro, and Presentations.

Instead of a separate toolbar, the application manager integrates into the Windows 95 taskbar. Overall, we found the suite consistent and easy to use, but it's evident that the major applications all originated as separate products. Unlike Microsoft's suite, where Word and Excel are comparable in terms of development, WordPerfect is clearly more mature and polished than the other components in its suite. For example, with WordPerfect, it's possible to rotate text inside a box, something you can't do in Word. However, Quattro Pro can't rotate a column header within a cell, while Excel can. While Quattro Pro has been enhanced, it's not quite up to its competitors.

File management is consistent from application to application, but it's less convenient than in PerfectOffice 6.1. It requires considerably more mouse action than we prefer. WordPerfect now supports e-mail routing and revision options suitable for group projects. It works well enough, but Word and WordPro are better.

WordPerfect Suite's schizophrenia about PIMs isn't so sweet, however. Starfish Software's handy Sidekick 95 is the



A strong set of applications helps Office continue to dominate its category.

basic stand-alone PIM. Unfortunately, Corel made no attempt to tie it into the suite, which has its own address-book module. To complicate things further, Corel Office Professional will include yet another PIM, Novell's InfoCentral, for a total of three.

Of course, not everything was "perfect." When we repeated setup to install an application that was omitted the first time, the setup program didn't remember which components and options we had selected previously. Thus, we had to think our way carefully through the entire process to avoid uninstalling something we wanted to keep. When we reran setup another time to check disk-space requirements, the program kept telling us to close down a running application—an unnamed PerfectScript macro. However, every time we closed it down, the setup program started it up again and then complained. Finally, while writing this review with WordPerfect, we created a table of features and went to save it as a Quattro Pro spreadsheet. Guess what: Our only options were *previous* versions of Quattro.

Corel's suite includes some useful extras. It comes with Starfish's Dashboard 3.0 and Novell's Envoy electronic-document system. The QuickTasks icon brings up an organized list (which you can modify and add to) of common tasks, such as writing a letter, calculating a loan amortization, or creating a numbered list. QuickView Plus from Inso integrates nicely with Norton Navigator and Windows 95 Explorer as well as WordPerfect Suite, considerably expanding the number of file types you can view with a mouse-click.

CorelFlow, a full-featured charting program, is included on the CD, though its installation requires another step. Finally, as we've come to expect in any Corel package, there are loads of art clips and 150 TrueType fonts. (See the features table on page 115 for a more detailed list of components.)

Lotus's SmartSuite 96

From a company that's staked its future on a groupware product, Notes, you'd

expect a desktop application suite that encourages collaboration, and Lotus's suite does deliver exceptional team functionality. Although the product's name is SmartSuite 96, the version we tested lacks a 32-bit spreadsheet and PIM/group scheduler applications. Long-overdue replacements for Lotus Organizer and Lotus 1-2-3 are due this summer.

The coexisting old/new applications in SmartSuite 96 illustrate Lotus's progress in revamping the user interface. In its 32-bit applications, you can select formatting options for data, text, and graphical objects via a floating property dialog box, the InfoBox. NSTL usability testers liked the InfoBox because it lets you preview property changes on-screen. Also, NSTL found that SmartCenter's simple and intuitive file-cabinet metaphor made it easy to learn file management tasks.

However, the real benefits of the newer Lotus applications, which are sorely missed in the older ones, are the new productivity tools: a common menu structure, a natural-language-based help system, Internet features, and collaborative-computing enhancements.

TeamMail is SmartSuite's tie-in to e-mail systems. It allows sending files or portions of files from within WordPro, Freelance Graphics, and Approach. The ease of use varies by task.

Testers found that the TeamReview features in WordPro made it easier to use than Word for electronic-document routing. WordPro's versioning feature, which allows you to maintain successive versions of a document within a single file, makes this perhaps the best choice if you need audit trails.

WordPro and Freelance Graphics allow opening and saving HTML files on a Web server out of the box. In addition, WordPro can open and save document files to an FTP server. SmartSuite 96 comes with ScreenCam, which allows you to record screen shows of computer operations. This is a great tool for support personnel to teach users how to perform software tasks by example.

Microsoft Office Professional

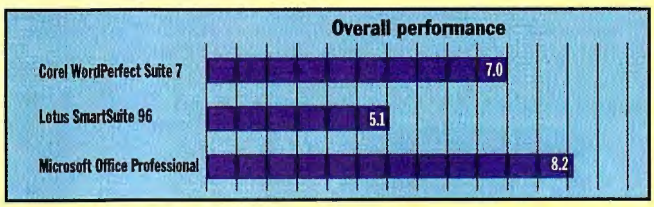
The maturity shows in this impressive set of applications. Office is now in its fourth generation (it started with version 3.0), and

OFFICE PRODUCTIVITY SUITES

BEST OVERALL

Microsoft Office Professional

This package does just about everything well. It's fast, and its powerful component applications are well integrated in a way that's transparent to users.

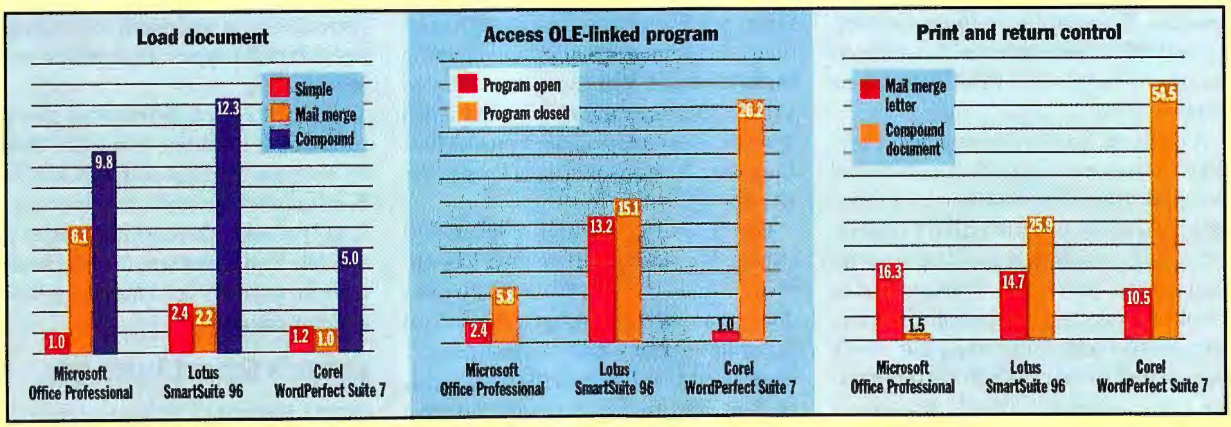


	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	OVERALL VALUE
Microsoft Office Professional and Bookshelf	**$599**	★★★★	★★★★	★★★★	★★★★	★★★★★
Lotus SmartSuite 96 Edition	$399	★★★	★★★	★★	★★★★	★★★
Corel WordPerfect Suite 7 for Windows 95	$395/ $595	★★★★	★★★★	★★★	★★★★	★★★★

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

PERFORMANCE

All tests were conducted on a Dell Dimension XPS P133c with 16 MB of RAM. The compound document contained tables and charts linked to a spreadsheet. The Corel suite took considerably longer to update links or access the linked program when it wasn't already loaded. The Lotus applications took longer to load documents of all types and to access links, at least in part because of the 16-bit components. Additional tests indicated that extra RAM sped up many of these operations. We expect that Corel can and will do more performance tuning that will significantly improve WordPerfect Suite's performance.



Microsoft has been diligent about refining it and adding impressive functions. The individual applications are first-rate and well integrated with common dialog boxes, menus, icons, and toolbars. Perhaps nothing better exemplifies Office's suiteness than the Binder.

Although this is perhaps the least-known feature of Office, it's one of the most productivity-oriented, because it lets you combine parts of documents from a variety of sources and applications into a single object, a new data type. OLE 2.0 automation in all three suites lets you incorporate into a single document objects that are created with different applications and maintain these as live links that reflect any updating from one application to another. The Binder may be Office's best-kept secret.

Office is a terrific tool for handling compound documents (see the Tech Focus on page 116 for more details). Our testers appreciated Office's flexibility in managing and accessing documents once they learned how to use the Shortcut Bar to create new documents by category and the File Binder to electronically paper-clip together related pages from different files created by different applications. Testers noted that with the start-a-new-document button, you don't need to know which application you need, only the type of document.

All the Office components are 32-bit applications, primarily ports of the last 16-bit versions for Windows 3.1, but with subtle enhancements. For example, as with the other suites, checking spelling need no longer be a separate editing process. In real time as you type, Word places wavy red lines under words that aren't in its shared spelling dictionary. A right mouse-click on a marked word provides a list of suggested alternates.

Microsoft keeps fine-tuning little things. If you type a numeral and a period at the beginning of a paragraph, Word's AutoFormat guesses that you're creating a numbered list and automatically inserts the next number in the sequence when you start the next paragraph.

When you're entering a column of value labels in a spreadsheet, Excel suggests new entries based on previous values in the column. Type *Northern division* in a column, and the next time you type *n* in that column, Excel automatically suggests *Northern division* to complete that cell. If you don't want to take that suggestion, it

FEATURES

	LOTUS SMARTSUITE 96	MICROSOFT OFFICE PROFESSIONAL	COREL WORDPERFECT SUITE
Version	None listed	95.b	7.0.0
Word processor	WordPro 96	Word 7.0	WordPerfect 7
Spreadsheet	1-2-3 release 5 (16-bit)	Excel 7.0	Quattro Pro 7
Graphics	FreeLance 96	PowerPoint 7.0	Presentations 7, CorelFlow 3
Database	Approach 96	Access 7.0	Paradox 7 (COP)
PIM	Organizer 2.1 (16-bit)	Schedule+	Sidekick 95, InfoCentral 7 (COP)
Application manager	SmartCenter	Office Shortcut Bar	Desktop Application Director, Dashboard 3.0
Shortcuts, cross-application integrators	SmartMasters	Binder	QuickTasks, QuickConnect
On-line service, Web browser	Global Network Navigator	MSN, Internet Explorer 2.0	AT&T WorldNet, Netscape Navigator 2.01
Workgroup features	TeamReview, Team-Consolidate, TeamSecurity	Routing, Word, and Excel revisions	WP revisions
Group scheduling	Optional add-in	Schedule+	GroupWise client (COP)
Macro language	LotusScript	Visual Basic for Applications, WordBasic	PerfectScript
Electronic publishing	Acrobat reader, HTML	HTML	Envoy 7, HTML
SDK included?			COP
Current version for which OS platforms (compatible version)	Win 95, Win 3.1, OS/2	Win 95, Win NT 3.51, (Mac–NoDB)	Win 95, (Win 3.1–V6)
Hard disk space (minimum/maximum installation)	74/150 MB	40/126 MB	89/360+ MB
RAM (minimum/recommended)	8/12 MB	8 (12 for Access)/16 MB	8/16 MB
APPLICATION MANAGER ENHANCEMENTS			
Add programs, folders, and documents to application manager	✔	✔	✔
Access Web URL from application manager	✔		✔
Fix application manager to top, bottom, or sides of screen	T,B	✔	B
Hide toolbar when not in use	✔	✔	✔
WORD PROCESSOR ENHANCEMENTS			
Formats as you type	FC	✔	✔
Find and replace with proper verb form		✔	✔
Edit and check spelling simultaneously	✔	✔	✔
Document section tab dividers	✔		
SPREADSHEET ENHANCEMENTS			
Graph by map	✔	✔	✔
Point-and-click temporary calculations		✔	
Automatic cell completion based on previous column values		✔	
Multiple page display in print preview	✔		
Automatic list filtering		✔	
Access database forms and reports	✔	✔	N/A
DATABASE ENHANCEMENTS			
Database design assistant	✔	✔	N/A
Query assistant	✔	✔	N/A
Report assistant	✔	✔	N/A
Data normalizing assistant		✔	N/A
Performance analysis assistant	SI	✔	N/A
Point-and-click break out of summary data into detail	✔		N/A

N/A=Not included in package tested; SI=Smart-indexing technology; V6=Version 6.1; COP=in Corel Office Professional; NoDB=No database module; FC=Format Check looks for some formatting errors; ✔=yes

vanishes when you type the next letter.

As a tool for collaborative projects, Office is useful, though not up to the Lotus standard. Specifically, Word's options for routing a document for review aren't as complete or centralized as WordPro's.

Office Professional comes with Microsoft Bookshelf on a second CD-ROM. Bookshelf contains a full dictionary and other reference works. The dictionary is integrated into Word, so you can look up definitions of words by right-mouse-clicking on them in Word and choosing the Define option. The package also has an image-manipulation program that supports TWAIN-compatible scanners.

Decisions, Decisions

If we were creating an ideal suite, with the ability to choose any components, it might look like this: WordPerfect, QuickTasks, and Sidekick from Corel; Excel, PowerPoint, Access, WordBasic, and the Office Toolbar from Microsoft; the Team features from Lotus; Adobe's Acrobat; Norton Navigator's File Manager; and Netscape Navigator 2.x. However, that's not an option in the real world—not yet, anyway.

So if we have to choose one suite, which will it be? Right now, for wide adoption, we'd settle on Microsoft's Office Professional, or Office 95 for users who don't need Access.

SmartSuite 96's current 16-bit applications downgrade its usability, performance, and versatility slightly. When the next release of SmartSuite appears, its 32-bit applications, multiplatform and workgroup capabilities, and tighter integration with Notes will make it a front-runner for many organizations.

WordPerfect Suite was very close to the others, but its spreadsheet didn't match Excel's abilities, and we don't yet know how well Corel will integrate Paradox, which is still a third-party product. Nonetheless, one of us still prefers WordPerfect over Word and for personal use opts for the Corel suite.

The bottom line: You can't go too far wrong with any of these office suites. They're all excellent products, and they keep getting better (if bigger) with each release. B

David Seachrist has tested business software for NSTL for nearly a decade, primarily in the areas of desktop publishing and graphics. You can reach him on the Internet at **dseachrist@prodigy.com** *or on BIX at* **editors@bix.com**. *Russell Kay is a technical editor on BYTE's review staff. You can reach him at* **russellk@bix.com**.

Evaluations in this report represent the judgment of BYTE editors, based in part on extensive tests conducted by NSTL, Inc., as documented in a recent issue of its monthly Software Digest *covering the Microsoft and Lotus suites. To buy a copy of that report, with its own evaluations and data, 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.*

PRODUCT INFORMATION

Corel WordPerfect Suite 7
$395/$449 (CD/CD plus disk); upgrade, $129/$179
Corel Office Professional 7
CD only, $695; upgrade, $249
Corel Corp.
Orem, UT
(801) 765-4010
fax: (801) 222-4379
http://www.corel.com
Circle 1077 on Inquiry Card.

Office Professional
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Microsoft Corp.
Redmond, WA
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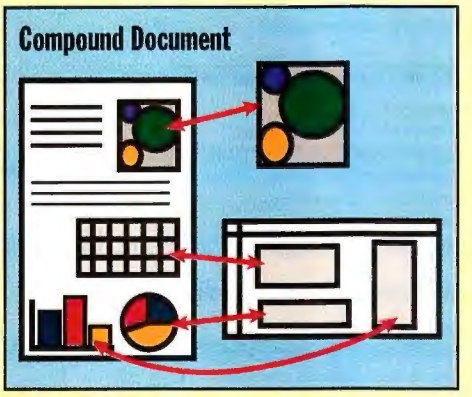
TECH FOCUS: OLE 2.0

Containing the Compound Document

In a sense, computer users have always had compound documents incorporating text, graphics, tables, and spreadsheet data. However, we assembled the elements manually, and often, for convenience, grouped similar data pages or graphics instead of putting them where they logically belonged on the page. Today's powerful integrated suites use OLE 2.0 to allow this more appropriate mixing of elements that you can print in place on color laser printers or publish to Web pages or CD-ROMs.



A document can contain text, links to graphics, spreadsheets, and other objects.

In Microsoft Office Professional, a new OLE extension called the Document Objects interface (DocObjects) allows two applications to be completely active at the same time. In previous versions of the product, when you used OLE to do an edit in place—an Excel spreadsheet that's embedded in a Word document, for example—the active object was in complete control; when you switched applications, the menu bar changed. However, with DocObjects, the two applications share the same menu bar.

DocObjects is based on a model in which an intelligent "frame" serves as a container for one or more documents. WordMail is an example of DocObjects in action. When you create a WordMail message, the header "belongs" to Mail while Word handles the text entry and editing. Pick the Edit, View, or Format menus, and you're issuing commands to Word. Pick File or Compose, and you're instructing Mail. The entire process is seamless to the user.

Another example is Microsoft Office's Binder, which is essentially a new file type: a container application, or frame, for a compound document. One of the simple but elegant options it allows is the ability to print a compound document, numbered sequentially across all pages, regardless of whether Excel, PowerPoint, or Word created any given page.

Over time, new container-type applications will appear. Indeed, today's typical Web browser is close to being a container application, with graphics, frames, tables, text, and even sound and video all working together.

JavaScript Adventures

Netscape's interpreted scripting language remains a frustrating work in progress.

By Rex Baldazo

Editor's note: Jon Udell is working on a special assignment this month (see "Your Business Needs the Web" on page 68). He will resume writing this column next month.

At the BYTE Site, navigation is always on our minds. As our article archive gets larger, being able to help people browse or do research becomes more important. On the other hand, we have to make sure that any navigation tools we add won't undo the entire site.

I was thinking about these issues recently, and an epiphany hit: Why not build a small navigation window using Netscape's JavaScript?

The reasons to explore JavaScript were obvious. Besides the potential of producing a navigation tool, I might uncover traps and pitfalls that I could apply to other JavaScript development projects. But I found no shortage of pitfalls: As I learned how to program in JavaScript, I also discovered its limitations and the disappointing state of Netscape's documentation for the language.

Not Another Java

While Java and JavaScript are related, it's a distant relationship. Java is a compiled and strongly typed general-purpose language, while JavaScript is an interpreted and specific-purpose scripting language. JavaScript's designers aimed its features directly at manipulating Web pages and at interacting with the user.

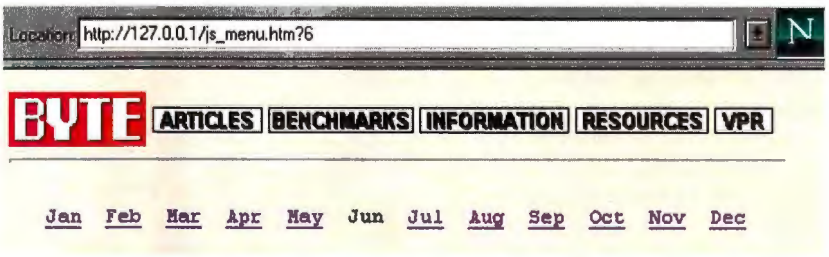
By the time you read this, Netscape Navigator 3.0 will be available. But I'm experimenting in 2.0, and, for the most part, these scripts should work in 3.0.

One of the nicer navigating ideas Jon Udell has come up with is the notion of a tabbed menu line (for an example, see our editorial calendar at http://www.byte.com/admin/edit96.htm). So, I began my grand JavaScript adventure by emulating that look in a month-picker (see the screen below). My plan was to eventually move the picker to a separate frame so that when you clicked on a month, it would update the other frame with the selected issue. But first I wanted to work in a single window.

The Hypertext Markup Language (HTML) page for the month-picker is http://www.byte.com/js_menu.htm. But you can't run the script from our server—you'll need to copy it elsewhere to play with it. More on that later.

Every time you load this page, the initial `if` statement checks to see if Navigator has passed along parameters in the search uniform resource locator (URL). The browser creates the search object if the URL is a query, such as http://www.byte.com/js_menu.htm?6. But the page itself creates these URLs in the first place.

continued

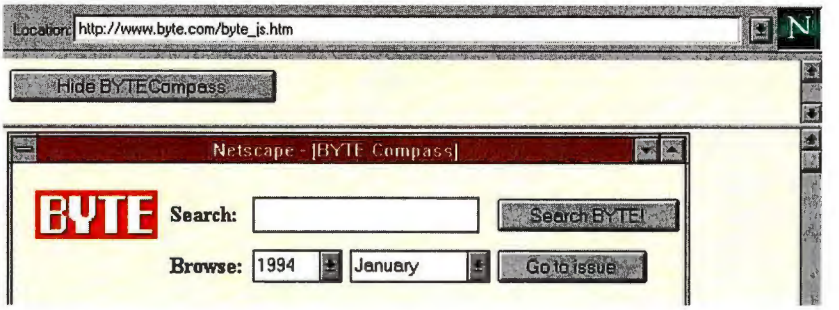


Emulate the tabbed menu line (above) in JavaScript (below), and you'll uncover technical flaws.

The PrintMonthArray Function

```
function PrintMonthArray() {
 doc = self.document;
 doc.write("<PRE>  ");
 var path = location.pathname.substring
   (1,location.pathname.length);
 for(var i=1; i<=12; i++) {
  if (CurrentMonth == i) {
    doc.write(MonthArray[i].text + "  ");}
  else {
    doc.write("<a href=\"" + path + "?" + i + "\")>" +
         MonthArray[i].text + "</a>" + "  ");}
  }
 doc.writeln("</PRE>");
}
```

PHOTOGRAPH: KELLIE WALSH © 1996



The BYTECompass offers two frames: The single button opens and closes the window; the larger frame points to search results.

The `PrintMonthArray` function (see the listing on page117) makes an `<href>` tag for each month except the one that's currently selected. The `<href>`s are circular references back to the js_menu.htm page. The search object passes a number identifying which month you clicked. The browser redraws and reinterprets the page when you click on a month, and thus updates the currently selected month.

This discussion has probably raised two questions in your mind. First, why all this coding gymnastics to do what seems to be a simple window-redraw procedure? Second, why won't this action work from The BYTE Site? The answers to both questions rest squarely on the shoulders of Microsoft and Netscape.

JavaScript's documentation describes a `document.clear()` method that I should have been able to use to clear a document. Then I would have used two other built-in methods, `document.write()` and `document.writeln()`, to redraw the document. That would have been easier, and more direct, than using the search-object contortion.

Unfortunately, I haven't been able to get `document.clear()` to work as advertised on Navigator 2.0, 2.01, or 2.02 on either Windows NT or the Mac OS. I've also tried with the Atlas preview on NT. I haven't had a chance to experiment with JavaScript on Microsoft Internet Explorer 3.0, but it will be interesting to see if Microsoft can get it to work right.

This page doesn't work on The BYTE Site, but it works just fine on most of the servers that I've tried—WebStar (both the Macintosh and the Windows 95/NT versions), Netscape's FastTrack server, and even the little Web server that comes with Microsoft FrontPage. However, when I moved it over to The BYTE Site, which is powered by Microsoft's Internet Information Server, I kept getting errors. Depending on the security configuration of IIS, I got either a 403 (execute permission denied) or a 404 (not found) error. It's clear that IIS is trying to actually execute the HTML page.

According to Microsoft, the Internet specification on how to deal with queries is open to interpretation. Most vendors have settled on a common practice, while Microsoft took its own approach. That's why my script worked on most other servers but failed on Microsoft IIS. But bowing to the pressures of the market, version 2.0 of IIS will adhere to industry practice. The next version of IIS will ship with NT 4.0, so it may not be available when this article sees print, although you may be able to download a beta version from Microsoft's Web site.

One last point before we leave this script. You will notice that I use a little `MakeArray` function to create an array of objects. Navigator 3.0 provides a true array object, but for backward compatibility I'm using the older method.

BOOKNOTE

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Building a Compass

Having my client-side script fail to execute on the Microsoft IIS server unnerved me. But I had gained enough confidence in JavaScript to create the BYTECompass.

For this project, I decided I'd go whole hog, complete with frames and floating windows. The BYTECompass itself is a floating window that allows you to either browse articles by issue or run a search of BYTE's article archive. You can try out the BYTECompass by visiting http://www.byte.com/byte_js.htm.

When you point your browser at this file, the main window of your browser divides into two frames (see the screen above). The upper frame, which I call the *menu frame*, has a single button that you use to open or close the BYTECompass window. The lower frame points initially at the normal BYTE Site home page. As you select items in the BYTECompass, this lower frame points to the selected issue or search result. Thus, I call it the *art frame*, short for article frame.

This little navigation aid fulfills my main goal because it doesn't require any reworking of the existing BYTE Site. It's a totally transparent add-on for those who have a JavaScript-capable browser.

The byte_js.htm page has the functions to open and close the BYTECompass window. This page also has the code that draws the button in the menu frame. The frameset in byte_js.htm (see the listing "Main Frameset" on page 120) points the menu frame to a document called blank.htm. That page is essentially an empty HTML page, except for a single JavaScript statement invoking the `CallBack` function in the parent document.

The `CallBack` function could actually reside in the blank.htm document, but it's in the byte_js.htm document for historical reasons. I had tried to create a function using built-in methods, such as `document.clear`, that would draw on the blank document defined by blank

WHO DO YOU TRUST WITH THE TRANSMISSION
in your Teutonic sports coupe?
An expert mechanic or Ed from the corner Gulf station.
Your gall bladder?
A surgeon or some guy fresh from medical school.
Hmm. Tough choice.

Now imagine you're a business trying to cope in today's "ever-so-wired" world. Sure, you know the problems and opportunities. But which IT products offer the best solutions is Greek to you.

Once again, an expert is called for.

So you get him in your office (he works for you, after all) and say, "Hey, this convergence of computing and communications thing is driving me nuts. You're the technology expert, find me some answers."

And he comes back a month or so later with all the right solutions and products. And you say, "How did you do that so fast?"

And the expert says, "BYTE."

And you wonder how much he knows about transmissions.

▽

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.htm. But as I mentioned earlier, `document.clear` doesn't work as advertised, so I couldn't get this to work properly.

The answer was to use the history object. Each frame in a window has a history object, which stores the URLs of all the pages that have been displayed in that frame. Using the `history.go` method, you can tell a frame which page in its history list to display.

By using a value of zero as the argument to `history.go`, you tell the frame to reload the current document. In my case, reloading blank.htm into the menu frame causes the `CallBack` function to be called again. It can then check to see the status of the BYTECompass window—and from that determine whether to print a "Show BYTECompass" or "Hide BYTECompass" label on the button.

When you close the BYTECompass window, it notifies the parent document, which updates the Show/Hide button. The `onUnload` event is the trigger that tells the BYTECompass window that it's been closed. I use the `onUnload` event to run the `ImDead` function (see the listing "The Self-Destruct Function" below).

The `onUnload` event is one of the built-in events, and of course there's a matching `onLoad` event. It's important to realize that `onLoad` and `onUnload` are associated only with body and frameset tags. In other words, you can't have a table object that uses the event. However, it's easy enough to have the body object use the `onUnload` event to perform some task for the table object.

The `ImDead` function has a couple of statements to check whether certain objects are non-null. There are two possibilities: You've either closed the BYTECompass window directly or moved the main browser window off the byte_js.htm page.

If the BYTECompass window has been closed directly, it nulls out the handle to itself (it appears as if the `window.close()` method doesn't do this automatically, so I included the code to do it in my function), and it then uses the history object of the menu frame to force a reload. The menu frame then updates the menu button with the correct label.

But if the user has moved off the byte_js.htm page, the `KillCompass` function in byte_js.htm forces the BYTECompass window to close. As it closes, there's an `onUnload` event that will, as in the previous case, call the `ImDead` function. But if `ImDead` then tries to manipulate objects in the parent window, they no longer exist and you'll get error messages. Thus, the `if` statements are *protective*—they make sure there are objects to manipulate before trying to manipulate them.

Main Frameset

```
<frameset rows="10%,*" onUnload="KillCompass();">
  <frame src="/blank.htm" name="menu" scrolling="auto"
    marginwidth=8 marginheight=8>
  <frame src="http://www.byte.com/" name="art"
    scrolling="auto" marginwidth=0 marginheight=0>
</frameset>
```

The frameset points to an HTML page with a single JavaScript statement that invokes the callback function in the parent document.

Tips and Tricks

There are a couple of nifty tricks I stumbled upon as I was playing with JavaScript. First, it can get difficult at times to figure out which built-in object you should be using, especially since there are so many aliases for so many objects. So, it's useful to dump out the properties of an object and see what's going on:

```
var info;
for (var i in obj)
  {info += i + " = "
  + obj[i] + "\n"; };
```

I apologize about all the semicolons—some of them are extraneous, but I just put them in to be safe. Anyway, this will iterate over an object and return a string with all the properties. I then use a little function window to print this as preformatted HTML to a trace window.

The other trick is hidden frames. If you use a frameset such as `<frameset rows ="10%, 90%, *">`, the third and final frame will not actually be displayed on the browser. It *is* there—if you move your mouse over the bottom of the display window, it should turn into a double-headed arrow. This will let you grab the border and lift it so you can actually see the third frame.

So why would you want a hidden frame? I've sometimes used this hidden frame as a way to attach code, such as my trace/debug functions, to a page. Then when the page finally works, I simply alter the frameset to remove the hidden page. You can also use this as a way to preload graphics in the background.

The more I've used JavaScript, the less enamored with it I've become. I spent several years as an Ada programmer; say what you will about the language, but if the *Language Reference Manual* (LRM) says that Ada behaves a certain way, then, by God, it *always* behaves that way.

The same cannot be said of the JavaScript documentation from Netscape. Call me old-fashioned, but I expect a vendor's own documentation to at least be correct, and ideally complete as well. If you can't get a feature like `document.clear()` to work, then remove it from the documentation so people won't try to use it. B

The Self-Destruct Function

```
function ImDead() {
  if (rootWin.parent != null) {
    rootWin.parent.BYTECompass = null;
    if (rootWin.parent.menu != null)
      { rootWin.parent.menu.history.go(0);
  };
}
```

The ImDead function in the BYTECompass uses a couple of statements to check for non-null objects.

For the past year, technical editor Rex Baldazo has worked with BYTE's New Media group to help develop The BYTE Site. He recently moved to the reviews department. He can be reached at **rbaldazo@bix.com.**

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Beyond Benchmarketing

Finding the right benchmark test and interpreting the results isn't as straightforward as it seems.

By Rich Grace

"Gee, I get a Norton SI of 200 and 15,000 Dhrystones. Why are my Windows screen updates so slow?" If you've had this experience, you already know that computer benchmarking is an inexact science. But that doesn't mean it's worthless. You can potentially save thousands of dollars and hundreds of hours by basing a critical decision on properly interpreted benchmark results. The trick is telling the difference between benchmarking and benchmarketing.

It's not exactly unheard of for vendors to provide misleading or exaggerated benchmark results. Sometimes it's an honest mistake. In other cases, vendors deliberately modify their products to fool popular benchmark tests. That's why the key to interpreting benchmarks isn't just to glance at the results. It's not the results that really count—it's how the tester obtained those results.

You also have to understand what a particular benchmark is actually testing, and what things are beyond its ability to measure. It's precisely these tedious but crucial details that marketing managers leave out of their cheerful advertisements and sales sheets. By themselves, raw numbers miss the point and provide much less insight than many people think.

But used correctly, benchmarks can help you make the right decisions when buying computer equipment. And they can help you fine-tune your system once you have it running.

At their best, benchmark programs can provide the following information:

- Realistic estimates of raw performance
- Potential performance when running a mix of real-world applications
- A specific subsystem's contribution to overall performance
- Whether a system will "break" or crash when processing heavy workloads
- The performance of very large systems that would otherwise be impractical to test or predict.

Compiler Tricks

Benchmarking is an incredibly diverse field. You can download some benchmark programs from the Internet for free and run them on your PC in a few minutes, while others cost tens of thousands of dollars and require the efforts of an entire MIS department to run successfully.

You can't always judge a benchmark test by the slickness of its packaging. Some of the most important ones don't come on a neatly shrink-wrapped, ready-to-run disk. For instance, to run the Standard Performance Evaluation Corporation (SPEC) benchmarks or Neal Nelson's Business Benchmark, you must compile a sprawling mass of source code into executable programs targeted for your computer. To some extent, therefore, these benchmarks test the efficiency of the compiler as well as the system.

Benchmark programs supplied as source code are vulnerable to exploitation because optimizing compilers that extract every ounce of performance from a CPU can show blazing results that are out of line with real-world applications. For example, some vendors have accused Intel of exaggerating the performance of its microprocessors by compiling the SPEC92 programs with heavy optimizations. That's one reason the new SPEC95 tests enforce tighter restrictions on compiler optimizations. When you're evaluating the results of a benchmark that's available in source code, be sure to find out if the compiler was typical of those used to build real applications on that platform, and ask how the code was optimized.

The SPEC benchmarks are a classic case of a widely known test that had to be scaled up in complexity and size to match the growth of today's systems. With the recent dramatic increases

in processing power, some CPUs could execute SPEC92 programs in a matter of seconds, and the entire program sometimes fit inside the CPU's primary (level 1) instruction cache. This led to distorted results that didn't accurately represent real-world software.

With the new SPEC95, a complete run might require several days instead of several minutes. CINT95 and CFP95 (the SPEC consortium's new integer and floating-point processor tests, respectively) run on a much larger memory model than previous versions, requiring 64 MB of RAM for each test. (See "Bringing Benchmarks Up to SPEC," April BYTE.)

The baseline results, called SPECint_base95 and SPECfp_base95, are aggregate performance statistics with minimal compiler optimizations. The more widely quoted SPECint95 and SPECfp95 numbers are peak results that allow heavier optimizations. Although SPECint95 and SPECfp95 indicate the best possible performance you might get from a system or CPU, it's the baseline results you should pay attention to—especially if you're running off-the-shelf software that you didn't compile yourself. If a vendor won't provide SPECint_base95 and SPECfp_base95 results, you should be able to find them at SPEC's Web site.

SPECint95 and SPECfp95 peak numbers shouldn't be more than about 30 percent above the baseline numbers. If the spread is much wider, find out which compiler and optimization flags the vendor used. (SPEC requires vendors to report this information.) A wide spread between the baseline and peak numbers is a strong clue that off-the-shelf software probably won't deliver peak performance.

Also, be sure you understand what these tests are measuring. SPEC numbers indicate the raw computational power of the processor and its memory subsystem when running typical business and scientific computing tasks. CINT and CFP programs don't specifically measure such things as disk I/O, the speed of video redraws, or the performance of other subsystems. Different caching schemes (e.g., set-associative versus pipelined bursts) and different memory architectures can have a direct impact on results.

Bigger Benchmarks

To measure the performance of larger systems and servers, Neal Nelson's Business Benchmark and AIM's Suite VI and Suite VII programs offer two different approaches. Nelson focuses on government and large corporate users, and his unique programs run on everything from Pentium PCs to mainframes. AIM, meanwhile, tries to ensure the accuracy of its benchmark results by exercising an unusual degree of control over the testing procedures.

Nelson's benchmarks don't apply harmonic or geometric means to generate a single summary result. Instead, each of the 30 subsystem tests yields its own measurements, expressed as throughput under increasing load and degradation under increasing load. As the benchmark programs increase the load levels, they measure the response of the system against a reference computer (configured by Nelson) of comparable power. The results are quite easy to understand (see the graphic on the next page).

AIM rigorously controls its Suite VI and Suite VII benchmarks. You must purchase a job mix on an encrypted tape and load it onto your system. At that point, AIM uses a remote access program to take control of your machine and run the test. In this way, AIM monitors the system configuration and the benchmark reporting, effectively eliminating any shenanigans.

The Suite VI and Suite VII tests generate reports for each type of job mix. You can break down the results into three key numbers: peak performance, sustained performance, and job timing index. (These numbers apply to both workstations and multiuser systems.) The peak performance test simply measures the highest number of jobs per minute the computer can handle. The sustained performance number provides a more realistic estimate: It shows the highest level of performance a particular system can attain before it begins to suffer performance hits (such as an enforced pause before the system can service a process).

AIM's job timing index is crucial because it shows potential differences in the amount of time concurrent jobs take to complete. AIM likens this statistic to a hundred-yard dash. If 10 equally matched runners crossed a finish line at the same time, their job timing index would be 100. On a computer, this would mean that all equally balanced, concurrent tasks would take the same amount of time, which is desirable. If one task finishes behind the others, the index goes down. The closer a system's index is to 100, the better. It indicates the level of efficiency that users can expect to see during everyday use,

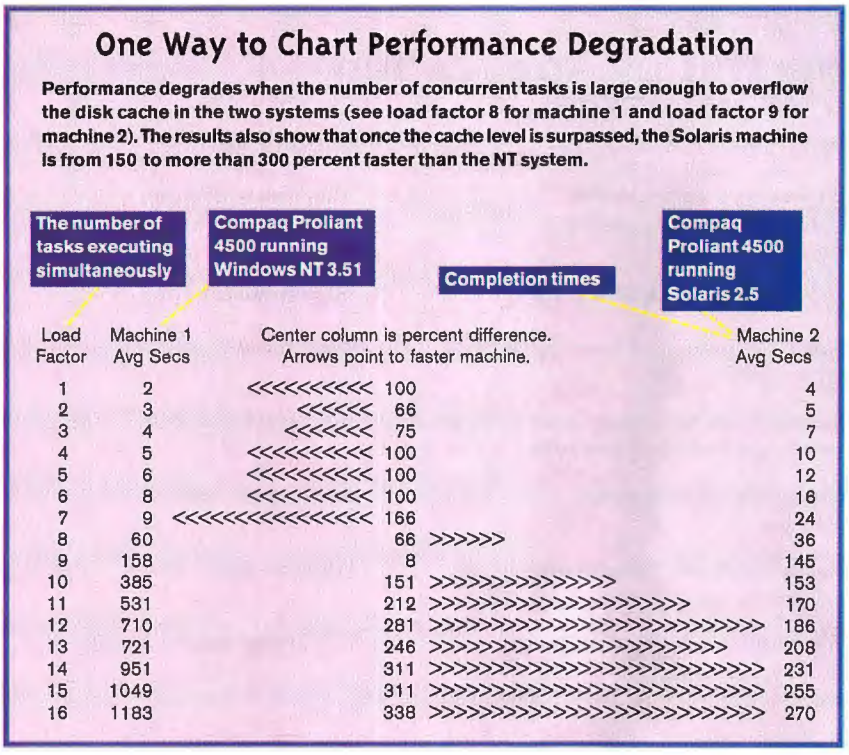
Benchmark Boo-Boos

The history of benchmarking is rife with political and technical squabbles, and sometimes outright cheating. Here are a few examples.

- **Fooling WinBench.** When the market for Windows video cards took off a few years ago, some vendors weren't happy with their WinBench results. With about 200 video cards on the market, manufacturers wanted their products to stand out. So a few of them embedded WinBench acceleration code directly in their ASICs or ROMs. This produced blazing benchmark scores, but provided no real benefit to users. Benchmark publisher Ziff-Davis was forced to change WinBench and go on the alert for similar tricks.

- **Intel's SPEC92 snafu.** Last January, Intel announced it had overstated the SPECint92 ratings for its Pentium and Pentium Pro microprocessors by an average of 10 percent. For example, Intel rated the 200-MHz Pentium Pro at 366 SPECint92 when the correct rating was 320.2. What happened? Intel compiled the SPEC92 benchmark programs with a beta version of an in-house C compiler. An error caused exaggerated results when running the 023.eqntott program. Within weeks, Intel issued correct results and noted that the error does not affect SPECfp92 or SPEC95 ratings.

- **BYTEmark gets bitten.** Late last year, BYTE discovered that its BYTEmark test sometimes reported inaccurate results. Lead developer Rick Grehan traced the problem to the way the C compiler's malloc( ) function allocated memory for arrays of 8-byte floating-point values. In some cases, malloc( ) returned a memory block that wasn't aligned on 8-byte boundaries. This turned out to be a problem when one routine in the benchmark program (a lower/upper decomposition algorithm) repeatedly accessed the nonaligned array. Because nonaligned memory accesses hit Intel x86 processors particularly hard, this led to lower-than-normal numbers for the Pentium Pro. BYTE fixed the problem by placing alignment wrapper code around malloc( ).



The Neal Nelson Benchmarks can identify performance degradation under increasing multitasking loads.

particularly under heavy loads. It's also a safeguard; AIM can employ the job timing index to detect any exaggerated results created by compiler optimizations.

Transaction Benchmarks

Raw processing power isn't the best measure of computer performance for all applications, which is why on-line transaction processing (OLTP) benchmarks are so important for evaluating client/server systems. There are two key points to keep in mind:

• OLTP systems rank among the most expensive computing investments in any enterprise, so you have a lot to gain from properly interpreted benchmarks.

• OLTP systems encompass almost every type of computer technology available, from mainframes to PCs to WANs. But you can't draw meaningful conclusions about overall performance merely by testing the individual elements of an OLTP system.

The Transaction Processing Performance Council (TPC) is the preeminent power in OLTP benchmarking. Its key program, TPC-C, has attracted its share of criticism but nevertheless remains the standard by which all other OLTP benchmarks are judged. TPC-C is so complex it takes an average of six worker months just to prepare it for a run.

TPC-C yields a critical statistic known as tpmC (transactions per minute). It balances the benchmark test's run time against the number of transactions the system executed during the run. If you notice how often DBMS developers quote tpmC statistics in their ads, you'll get an idea of how much it matters to them.

But look at the fine print. The system with the highest tpmC may also have a poorer price/performance ratio than other systems. If the ratios are fairly competitive (for example, $280/tpmC versus $300/tpmC), it doesn't matter too much. But if there's a huge gap in price for roughly comparable performance, you'll want to consider whether the difference is worth the cost for your application and whether it's worth paying alot more money for that extra speed.

Repeatable response times are a key requirement for OLTP systems. During a TPC-C test, the system must service 90 percent of all vital transactions in 5 seconds or less. If the system can't deliver that level of performance, the workload is too heavy and the tester must scale it down. Be sure to check for correct transaction structuring, proper scaling of databases, and complete documentation of results. A full TPC-C report can fill 150 pages.

PC Benchmarks

Ziff-Davis's WinStone and BAPCo's SYSmark allow people to test their PCs using the programs they're apt to actually use. A major difference between the two is that WinStone is free; BAPCo's latest offering for Windows NT costs $495 on a CD-ROM. (A Windows 95 version is in development.) SYSmarkNT is the first true 32-bit application benchmark for PCs.

SYSmarkNT's application mix is the same for systems based on Intel x86, Digital Alpha, Mips Rx000, and IBM/Motorola PowerPC processors. Administrators may finally be able to settle some arguments about whose system is the fastest when it comes to running common business software. Then it comes down to price/performance ratios and your intended application. Is it worth spending $15,000 on an Alpha workstation to run Microsoft Word and Excel a little faster?

Unlike the case with previous versions of SYSmark, you can run the NT version with any level of color depth and screen resolution, so you can mirror the way users really work on their computers. You can compare your system's composite results against those of the reference system, which is a 50-MHz 486 with 64 MB of RAM, an EISA video card, and a 1.2-GB SCSI hard drive. The baseline index for this system is 100.

Ziff-Davis's WinStone is exclusively for x86-based systems. Although it can run on Windows 3.1 and Windows 95, WinStone is a 16-bit benchmark that uses a mix of 13 major Windows applications in four categories: word processing, spreadsheet, business graphics, and database. Each category contributes to the WinStone composite score. (A 32-bit WinStone should be available by the time you read this.) Widely used by PC vendors, WinStone also has a propensity to crash systems that have the slightest compatibility problems, so it's a quick way to measure reliability.

Among PC benchmarks, perhaps the most abused is Ziff-Davis's WinBench and Graphics WinMark. The question "What's your WinMark?" has plagued trade-show exhibitors for the last five years. As we've already noted, basic num-

Benchmarks by Application

Benchmark	Best Application	Contact Info
AIM Suite VI	Tests Unix workstations. Reports peak and sustained performance in jobs/minute. Imaging, CAD, numerical analysis, and business applications tests.	**http://www.aim.com**
AIM Suite VII	Tests Unix servers; results in jobs/minute. Database, file server tests.	**http://www.aim.com**
BAPCo SYSmark	Applications test for PCs. Cross-platform. NT tests available now; Windows 95 version in development.	**http://www.bapco.com**
BYTE BYTEmark	Low-level tests designed to compare performance across hardware platforms. Reports scores using a 90-MHz Pentium as the baseline system.	**http://www.byte.com**
NSTL InterMark Suite	Combination of low-level and application-level tests. Cross-platform. Customizable.	**inmark@nstl.com**
Neal Nelson's Business Benchmark	30 subsystem tests to simulate multiuser, multitasking workloads. Includes context-switching, memory-access, and disk I/O tests.	**(312) 755-1000**
SPEC SPEC95 suite	CFP95 tests math and scientific functions; CINT focuses on engineering and midrange business tasks. The SPEC suite is centered on Unix; an NT version is due this summer.	**http://www.specbench.org**
TPC-C	For high-end transaction processing. Results reported in transactions/minute. Final result is measured against the total cost of the system being tested.	**http://www.tpc.org**
Ziff-Davis WinBench	For graphics, disk, and CD-ROM tests.	**http://www.pcmag.com/pclabs**

bers mean little. If you're testing a video card, you have to account for a wide array of variables, including the computer's CPU, the amount of RAM, and the size of the secondary CPU cache; the display's color depth, screen resolution, and refresh rate; the video card's RAMDAC and accelerator ASIC; and the number of Windows API calls that the card maker puts into silicon.

Always be suspicious of video card makers who report results without providing a complete description of the system's configuration. (Since WinBench provides more than 400 tests, reporting can be complex and demanding.) You can also consider the Graphics WinMark a good test of the stability of the video drivers for a display card.

BYTE's BYTEmark distinguishes itself from strict PC benchmarks like WinBench because it's written in ANSI C, so it's platform-independent. Although BYTEmark is considered a synthetic benchmark in the sense that it's not composed of real-world applications (such as BAPCo's SYSmark), it's based on algorithms widely found in popular engineering, multimedia, and business applications. All 10 programs in the BYTEmark suite report their results in terms of iterations per second, but their problem-solving nature sets them apart from the typical repetitive loops in smaller benchmark programs. Instead of repeatedly performing simple calculations, the BYTEmark programs use sample data to generate results that closely approximate the performance of real applications.

Currently, the BYTEmark baseline is a 90-MHz Pentium system, which has an adjusted score of 1. So if a system scores 1.5 on the BYTEmark scale, it's 50 percent faster than a Pentium-90. Since you can download the BYTEmark source code as well as the executables, you can create a BYTEmark executable with your preferred compiler on any platform. Of course, this also means that anyone can manipulate the results by using various optimization flags, so beware of vendor BYTEmark numbers that don't specify the compiler or the optimizations that were used.

Another cross-platform benchmark is NSTL's InterMark Suite. The suite includes low-level tests for subsystem and peripherals performance, as well as scripts that run standard business applications. You can also update and customize the suite with NSTL's plug-ins.

The Benchmark Treadmill

New applications for computers are cropping up all the time, and users need some way to compare the performance of different products and systems. For example, Web servers have different requirements than other types of servers, so tests that specifically measure the delivery of Web pages are inevitable. So are benchmarks that measure the performance of Java applets and applications in different run-time environments. BYTE will release a Java port of BYTEmark, designed to test performance of the Java run-time environment, by the time you read this. When Sun releases its Java processors next year, we'll need benchmarks to assess them, too.

There's no end to the technical and political debates over benchmarks. But the role of benchmarking in the decision-making process is secure. B

Rich Grace is the author of The Benchmark Book *(Prentice-Hall, 1996). You can reach him at his Web site at* **http://www.rgrace.com.**

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UltraSCSI Doubles Speed

High-performance mass storage rests on three legs: size, speed, and standards. As hard drive technology makes predictable but substantial gains in capacity and speed, SCSI standards adapt to keep up. Eventually, current parallel-bus SCSI will give way to emerging serial-bus SCSI standards such as Serial Storage Architecture (SSA) and Fibre Channel–Arbitrated Loop (FC-AL). Right now, however, UltraSCSI is the bus of choice for hooking hard drives to mainstream servers.

ADAPTEC

RATINGS

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

The UltraSCSI host adapters we review here provide a bandwidth of 40 MBps, using wide 16-bit devices on a 20-MHz bus. We tested three commercial state-of-the-art PCI-based UltraSCSI host adapters from Adaptec, BusLogic, and QLogic. We also looked at an OEM card manufactured by Symbios Logic (see the text box "On the OEM Front" on page 130). Besides 40-MBps throughput, all the adapters feature drivers for DOS/Windows, Windows NT, NetWare, OS/2, and Unix.

Each adapter features both internal and external 68-pin connectors for wide devices as well as a single 50-pin internal connector for 8-bit devices. (For reliable operation, however, you can connect to only two of the three available connectors.) Thanks to jumperless configuration via ROM-based, menu-driven setup programs, physical installation is relatively simple. You plug the card into an available PCI slot and apply power to the system. The PCI slot must support bus-master transfers. Automatic termination is also a standard feature that worked well on each of the adapters we tested.

Narrow SCSI is an 8-bit-wide bus that supports up to eight devices, one of which is the host adapter. At any one time, only two devices on the bus can exchange data at a rate of 5 MBps. Wide SCSI increases the width of the bus to 16 bits, doubling the throughput to 10 MBps. Fast SCSI increases the bus clock to 10 MHz, raising throughput to 10 MBps for 8-bit devices and 20 MBps for 16-bit devices.

BUSLOGIC

RATINGS

TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★
PERFORMANCE	★ ★ ★

UltraSCSI represents a further doubling of the bus clock for data transfers to 20 MHz. (For compatibility reasons, SCSI commands themselves still clock at 1 MHz.) Like fast SCSI, UltraSCSI comes in both 8- and 16-bit flavors, also known as Fast-20 and Fast-40, respectively. There are also differential and dual-channel UltraSCSI cards. The cards we test here are 16-bit, single-channel, single-ended devices. Physically, an UltraSCSI host adapter can support up to 15 devices, including up to seven 8-bit narrow devices if you provide the appropriate connectors. For wide UltraSCSI devices, the limit is currently eight.

QLOGIC

RATINGS

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

Adaptec AHA-2940 Ultra Wide — BYTE BEST

ADVANTAGES
+ Full SCSI ID range
+ Comprehensive documentation
+ EZ-SCSI and Corel bundled software

DISADVANTAGES
- NetWare setup needlessly complex
- Ultra speed disabled by default

The Adaptec AHA-2940 Ultra Wide ships with an extensive array of software and excellent documentation. Like the other cards we tested, it's a good performer. On the downside, we found setup and use unnecessarily technical.

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

Wide UltraSCSI host-adapter cards double your bandwidth to 40 MBps. ***By Robert L. Hummel***

By default, the 2940 Ultra Wide is configured as SCSI ID 7, the highest priority on the SCSI bus (see the Tech Focus). The card also supports the SCSI specification in its ordering of SCSI ID priorities (7–0 have higher priority than 15–8). Adaptec indicates that the card supports the SCSI Configured Automatically (SCAM) protocol to automatically assign SCSI IDs to compatible devices, but it disables this option by default. We did not test SCAM.

The 2940 Ultra Wide includes the ROM-based, menu-driven SCSISelect configuration utility with which you configure the card and run utilities to perform a surface scan or format on your SCSI disks. The card's default configuration enables support for wide devices but disables support for fast UltraSCSI bus speeds. To take advantage of full 40-MBps wide UltraSCSI bandwidth, you must manually set this option. Adaptec's assumption is that users will be attaching older SCSI devices.

Adaptec supplies the card with the complete set of drivers for its 7800 family of adapters, which includes the 2940 Ultra Wide. Installation of the drivers for NetWare 3.1x was straightforward except for one annoying aspect. To uniquely identify one of possibly multiple SCSI adapters installed in a system, you must manually calculate a slot number to provide as an argument to Adaptec's NetWare driver. The description of the procedure takes over a page in the user's manual, involves several sessions of hexadecimal-to-decimal conversion, and requires you to edit your STARTUP.NCF file after installation.

This procedure makes using the 2940 Ultra Wide needlessly complex and error-prone. Because the setup program knows the required information, the amount of additional code required for it to perform the slot-number calculation and display the result clearly on the setup screen would be trivial. Forcing you to perform this exercise even when installing a single host adapter is inexcusable.

BusLogic FlashPoint LW

ADVANTAGES

+ Marginally better performance

DISADVANTAGES

- Awkward setup program
- Host ID greater than 7 not supported
- No 800-number technical support

BusLogic (now a division of Mylex) ships its FlashPoint LW card with driver support for a wide variety of OSes. The card performed similarly to the others, but several quirks in its setup and operation made configuration range from difficult to nearly impossible.

Like the other host adapters, the FlashPoint LW comes configured as SCSI ID 7 by default. However, unlike other true 16-bit SCSI devices, which you can set to any ID from 0 to 15, it is impossible to configure the FlashPoint LW for SCSI IDs greater than 7. A call to BusLogic's technical-support line did not produce an explanation of this limitation or a description of the proper priority relationship between UltraSCSI IDs.

AutoSCSI, the FlashPoint LW's ROM-based, menu-driven configuration utility, was difficult to use efficiently. You must manually enable support for 40-MBps wide UltraSCSI speed, for example. And to do so, you must forge your way through no fewer than five menu levels. After making any changes for a single device, AutoSCSI requires that you back out of the menu system before you can save them. Switching to another device using PageUp or PageDown while in the View/Modify Device Configuration window, as prompted by the menu screen, discards all changes you've made for the current device—without warning. You must configure each device individually in this tedious manner. *continued*

TECH FOCUS: SCSI IDS

Setting Priorities

The UltraSCSI specification lets you attach up to 16 devices to a single cable, though currently you can put only eight 16-bit-wide UltraSCSI drives on a bus. You must also set each device with a unique SCSI ID (0–15). Because they share a single data channel, however, only one device can take charge of the bus at a time. When two SCSI devices vie for control of the bus, their SCSI IDs determine who wins according to a priority scheme.

The highest-priority ID on the SCSI bus is 7. You normally assign this ID to the host adapter. Next in priority, from highest to lowest, are IDs 6–0 and then 15–8. (For 32-bit SCSI devices, though none are yet available, IDs continue to decrease in priority from 23–16 and then 31–24.)

The justification for this odd sequence is backward-compatibility between older narrow (8-bit) and newer wide (16-bit) SCSI devices. SCSI devices signal on the appropriately numbered data line to assert their ID, which is why an 8-bit bus supports only eight devices. Because IDs greater than 7 are invisible to narrow-SCSI devices, all devices with IDs greater than 7 must yield to ensure that a conflict doesn't occur on the bus.

Although it provides backward-compatibility, this priority scheme can have a negative impact on overall system performance. Narrow—and therefore slower—devices, because of their lower ID numbers, will automatically preempt use of the bus by faster wide devices with addresses greater than 7.

QLogic Fast SCSI PCI Ultra-W

ADVANTAGES
+ Full SCSI ID range
+ Ultra speed enabled by default

DISADVANTAGES
- No SCAM support

QLogic's Fast SCSI PCI Ultra-W ships with a full range of drivers, and its straightforward configuration program made setup easy. For out-of-the-box compatibility with older SCSI devices, the Fast SCSI PCI Ultra-W comes configured as SCSI ID 7 but supports the full range of 16-bit SCSI IDs. The documentation gives no information relating SCSI ID to bus priority. This adapter does not support SCAM.

The QLogic card has the standard fast SCSI cable limits of 9.8 feet (3 meters) for four or fewer UltraSCSI devices and 4.9 feet (1.5 meters) for five or more UltraSCSI devices. Curiously, the installation guide provides no upper limit for the number of supported UltraSCSI drives

The Fast SCSI PCI Ultra-W's ROM-based setup program, Fast Util, saves time by setting the default value of all options to produce maximum performance with UltraSCSI devices. The installation guide lacks any screen shots of the setup program, however, to orient you when describing the available options. We also found some discrepancies in the default settings that are reported in the installation guide.

Driving Performance

To evaluate each adapter's ability to deliver data, we equipped a 133-MHz Gateway Pentium PCI system with 64 MB of RAM and Novell's NetWare 3.12 server software. (Testing under NetWare 4.01 gave essentially identical results.) A custom 1.5-meter UltraSCSI cable attached an eight-drive array of 2-GB Seagate ST32155W Hawk UltraSCSI hard drives to the test card's 68-pin internal SCSI connector. The first seven of these drives were assigned SCSI IDs 0–6. The eighth drive received SCSI ID 8. Host-adapter IDs were left at their default value of 7. This arrangement assigns the host adapter the highest priority on the SCSI bus, according to the SCSI specification (see the Tech Focus).

We used Symbios Logic's IOBench SCSI benchmark program (the IODTest portion) to measure the performance of the host adapters. Although IOBench is a NetWare loadable module (NLM), it doesn't run across a network, and IODTest avoids use of the NetWare file system. As a result, limits of the network topology or file-system cache did not impact the results. IOBench ignores any partition information on the drives being tested. We set the maximum number of outstanding requests per drive to 10.

Our test matrix consisted of 12 configurations generated by changing the read/write mix (all writes, all reads, or half-and-half), size of the I/O request (4- or 64-KB blocks), and using sequential or random access. We tested each configuration once while varying the number of drives from one to eight.

Bus Saturation

Though we didn't expect to achieve the theoretical maximum UltraSCSI throughput of 40 MBps, we did get 36-MBps aggregate throughput under the ideal conditions of reading (or writing) the drive sequentially with large, contiguous 64-KB blocks (see the performance graph). Each of the UltraSCSI drives in our test setup can exchange data at about 5100 KBps under these conditions. Eight drives could potentially deliver just over 40 MBps.

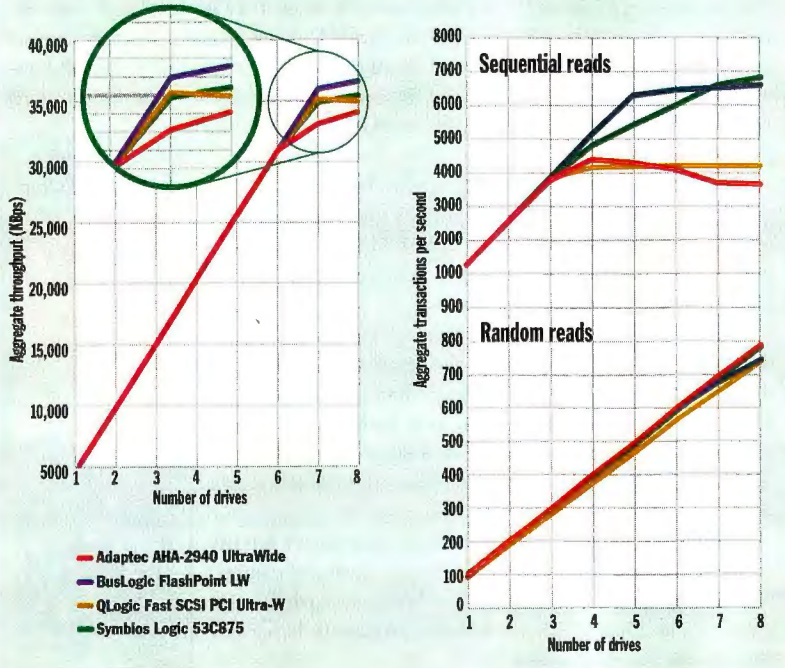
For combinations of one through six drives, all the adapters turned in comparable performances, and throughput on the SCSI bus increased linearly by about 5100 KBps per drive, as expected. Output from the FlashPoint LW increased linearly when we added a seventh drive. The remaining three adapters, however, began to show signs of bandwidth saturation, dropping the average output per drive by between 2 percent and 4 percent. Adding the eighth drive to the bus caused the throughput to level off for all adapters, indicating that the bus was operating at its maximum capacity.

Large-block sequential writes (not shown) provided slightly less throughput than reads. Aggregate throughput writing eight drives was around 1000 KBps less with writes.

With small-block transfers, the ultimate data transfer rate across a SCSI bus can be limited by the inability of the host adapter to process enough I/O requests in a timely manner. With random I/O, transactions per second scaled up linearly as we added

UltraSCSI Performance

With large-block sequential I/O, the wide UltraSCSI bus saturates at around 35 MBps.



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On the OEM Front

Integration is the watchword for today's computers. New system cards routinely include built-in interfaces for floppy and IDE drives and networking. With increasing frequency, built-in SCSI is showing up as standard equipment on high-end system boards. To ascertain how well these systems will perform, we examined a prototype PCI host adapter from Symbios Logic (Fort Collins, CO, (719) 536-3300, http://www.symbios.com).

The card is based on Symbios's 53C875 UltraSCSI chip (shown above), which is likely to show up on system boards and host adapters from its OEM customers, since it is backward-compatible with Symbios's popular 53C825 fast SCSI PCI chip. The 53C875 is compliant with PCI 2.1 and ANSI's SCSI-3 UltraSCSI standard. Its 536-byte buffer allows efficient bursts on the PCI bus of up to 128 transfers. The chip also allows host-adapter designs that can work in both 3.3- and 5-V PCI slots. In all our performance tests, the Symbios wide UltraSCSI host adapter performed as well or better than the three brand-name adapters we examined.

drives to the test (both reads and writes), showing that the drives themselves limited performance, not the bus or host adapter. When hamstrung by neither bus-bandwidth or I/O-processing limitations, all four adapters were capable and turned in roughly equivalent performance.

When we configured IOBench to read data sequentially in 4-KB (eight-sector) units, something more interesting happened due to the cards' differing abilities to concatenate sequential I/O requests into larger extents. When reading from one, two, or three drives simultaneously, all four adapters gave comparable performances, and the number of I/Os processed per second increased linearly by about 1280 I/Os per second per drive. (The SCSI bus is not processing nearly as many I/Os per second as the test indicates because of concatenation.) When we added the fourth drive, differences between the adapters became obvious.

The total number of apparent I/Os per second processed by the Fast SCSI PCI Ultra-W leveled off at approximately 4200 I/Os per second for four drives. Adding more drives decreased the I/Os per drive, but the total I/Os processed by the adapter remained nearly constant. With the 2940 Ultra Wide, total processed I/Os per second increased slightly to a maximum of 4416 when we added the fourth drive. However, adding additional drives decreased aggregate processing to a low of 3670 I/Os per second for eight drives.

The FlashPoint LW distinguished itself in this configuration, showing a linear increase in the number of I/Os processed as we connected up to five drives. The processing rate leveled out when we added six or more drives, reaching a maximum of 6589 apparent I/Os per second for eight drives. The Symbios adapter also turned in good performance in this configuration, slowing down sooner but not leveling off. The total number of I/Os processed begins to flatten out when the eighth drive is added. Nonetheless, the Symbios adapter is the winner in this test by processing 6811 apparent I/Os per second.

The short-block sequential results probably represent I/O saturation as opposed to throughput saturation. Even though they're interesting, they do not have much application to real-world performance.

What to Buy

If your hard drive use involves the typical mix of reads and writes in a range of block sizes, you'll be hard-pressed to measure any practical performance difference between the host adapters tested here. Choosing the wide UltraSCSI adapter that's right for you should boil down to a combination of price, support, and compatibility with existing hardware. Here again, we're hard-pressed to make a decision. In all cases, we found setup software less than satisfactory for the tested adapters.

Adaptec's 2940 Ultra Wide includes the most complete list of features, but it also has the highest price. The lowest-priced card, BusLogic's FlashPoint LW, is feature-poor, while QLogic's Fast SCSI PCI Ultra-W is in the middle in terms of price and features. B

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

PRODUCT INFORMATION

AHA-2940 Ultra Wide $375
(kit with cables, drivers, and EZ-SCSI software)
Adaptec, Inc.
Milpitas, CA
(800) 934-2766
(408) 945-8600
fax: (408) 262-2533
http://www.adaptec.com
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Fast SCSI PCI Ultra-W $349
(with drivers and Corel SCSI-2 software)
QLogic Corp.
Costa Mesa, CA
(800) 867-7274
(714) 438-2200
fax: (714) 668-6950
http://www.qlc.com
Circle 1082 on Inquiry Card.

FlashPoint LW $279
(kit with internal cables, drivers, and bundled software)
BusLogic, Inc.
Santa Clara, CA
(408) 492-9090
fax: (408) 492-1542
http://www.buslogic.com
Circle 1083 on Inquiry Card.

Ratings Discussion

Technology:
The UltraSCSI technology in these adapters is very good and advances the state of the art for SCSI adapters. It is not breakthrough technology. Instead, it's evolutionary.

Implementation:
The 2940 Ultra Wide has the most complete list of features: the full range of IDs, SCAM support, a complete driver collection, and ancillary software. We believe that this makes it the best implementation by a thin margin.

BusLogic's implementation was the poorest. The card's ROM-based setup program is poorly designed and difficult to use efficiently. The card claims to support SCAM and ships with a complete set of drivers, but no unessential software.

QLogic has the middle-of-the-road implementation, providing an adequate ROM-based setup program and the necessary drivers. Although QLogic supports IDs from 0 to 15, the version we tested does not support SCAM.

Performance:
All adapters/drivers turned in approximately equal performance under the vast majority of circumstances. We believe that the differences that surfaced in a few cases of sequential IO, although interesting, would not have much application to real-world performance.

Microsoft SQL Server 6.5 aims high—and usually hits the mark. By Mark Hettler

SQL Server: The Sequel's Better

SQL Server 6.0, released last summer, marked the first distinctively Microsoft version of the database management product following the split with Sybase, the original developer. On the heels of that upgrade comes version 6.5.

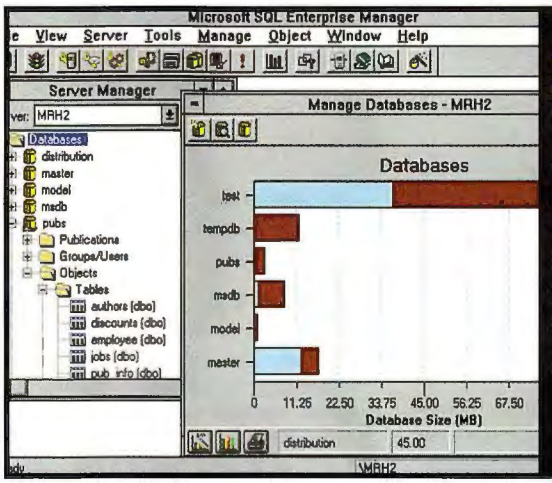
SQL Server 6.5 has enough new features to warrant a 500-page manual. These include enhancements to its enterprise-wide data management capabilities, new tools for publishing data on the Internet, and features that extend the power of database procedures.

Managing Multiple Servers

Microsoft has taken heat for the cumbersome way SQL Server handles data changes on multiple servers. The process, called *two-phased commit*, is a mechanism for guaranteeing that changes to multiple servers are either all committed (permanently written) or all rolled back. In phase 1, the system ensures that all servers are ready to commit; in phase 2, the servers perform the commit. SQL Server required programmers to code the two phases, rather than the database system doing it automatically.

With a new feature in version 6.5, the Distributed Transaction Coordinator (DTC), users can simply execute Transact-SQL routines that update multiple servers within a transaction. The DTC works behind the scenes to track and coordinate changes. Alternatively, a DTC client utility allows applications to associate multiple-server SQL statements with a single distributed transaction. The advantage of this client utility is that it lets applications reference each server directly. In contrast, Transact-SQL routines execute on a single server, with references to other servers limited to remote stored procedures.

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



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SQL Server lets you fine-tune database replication with just a few clicks of the mouse.

The DTC uses OLE to coordinate the servers involved in a transaction. Although SQL Server is the only resource manager with which the DTC can work, OLE will let Microsoft eventually support distributed transactions that incorporate multiple resource managers. (A resource manager is a program that manages the resources accessed in a transaction.) Each resource manager will be an OLE server, with the DTC functioning as an OLE client that uses OLE automation to control the server's behavior.

SQL Server's Enterprise Manager provides an intuitive point-and-click interface for setting up replication among multiple servers. Individual tables on a server are made available by "publishing" them; other servers then "subscribe" to a published table. Administrators can specify that changes should be replicated immediately after they happen or according to a schedule. Anyone who has dealt with the complexities of Sybase's Replication Server or Oracle's various replication options will appreciate the simplicity of Microsoft's approach.

New in version 6.5 is the ability to replicate to other databases besides SQL Server. This feature, called *heterogeneous replication*, uses Open Database Connectivity (ODBC) to transfer data from SQL Server to such databases as Access and Oracle. Because SQL Executive monitors changes to the data that is to be replicated and schedules the data transfers, replication in the other direction (from other databases to SQL Server) is not supported. You can't, for example, enter data into departmental Access databases and have SQL Server replicate the changes to a central location.

Internet Support

The Web Assistant that's included in SQL Server 6.5 is one of two tools introduced by Microsoft this year for producing Web pages that incorporate database contents. The other one is the Internet Database

Connector (IDC), part of Microsoft's separate Internet Information Server (IIS).

While the IDC runs on the Web server and "pulls" data from the database, the Web Assistant "pushes" data from the database to the Web. The Web Assistant has a wizard that lets Web-page designers enter selection criteria and formatting information; designers can also use templates similar to those the IDC uses. Although the resulting pages are static, rather than generated on the fly at run time as with the IDC, SQL Executive can regenerate them periodically, based either on a schedule or whenever the data changes.

OLE Automation via Stored Procedures

Microsoft has long recognized that, no matter how powerful a database's built-in language, some operations can be performed more efficiently by other programs. A previous release of SQL Server introduced external procedures, which let Transact-SQL routines call procedures in DLLs. In version 6.5, Microsoft has expanded on this concept by providing a set of predefined stored procedures to facilitate OLE automation. You can call these procedures in Transact-SQL routines to access OLE servers and execute their automation methods.

Developers can also write their own OLE-server programs for access from within SQL Server, extending functionality in much the same way as extended procedures. OLE automation is the centerpiece of Microsoft's strategy for applications partitioning. A large part of the Visual Basic 4.0 manual for developing client/server applications deals with transferring portions of an application's functionality to OLE-server programs running on a remote machine.

Having the option of performing OLE automation from within SQL Server rather than from client applications lets the automation routine be part of built-in validation procedures. For example, a credit check used to validate a purchase might require the use of an external application to dial into a remote location to check information.

Your Mileage May Vary

In our benchmarking (see the table in the text box "Making Book on SQL Server 6.5"), we found SQL Server 6.5 to be at least as fast as, and usually faster than, version 6.0, but you'll need to benchmark your own applications to get a more realistic measure of performance. Also, tuning the database, such as setting a table to be either row- or page-locked (see the Tech Focus), can affect your results.

There is room for additional improvement in version 6.5. The graphical interface for loading data, which disappeared in the upgrade from 4.2 to 6.0, needs to be put back, and the inability to modify existing columns in tables is a major inconvenience. However, SQL Server is still head and shoulders above the competition in usability, particularly in the intuitiveness of its administration tools. It's a solid upgrade. B

Mark Hettler is a senior technical editor at NSTL, McGraw-Hill's testing facility. You can reach him on the Internet at **markh@nstl.com**.

Making Book on SQL Server 6.5

To compare SQL Server 6.5's performance with that of version 6.0, we timed queries performed on a book-order-entry database with five tables, each with anywhere from 10,000 to 100,000 records at the start of the test. First, an order transaction queried for an ISBN number, executed a three-table join to find the author, and then repeated until five books had been looked up. Records to track the order were then inserted and the inventory updated. A payment transaction looked up an order record and updated it to indicate payment.

The simple-query version of the test looked for a range of orders, returning about 2000 records each time. The five-table join query searched for a range of 200 order numbers, listing the books in each order and the author of each book. With five books per order and two authors per book, the five-table test also produced a result set of about 2000 records.

The results shown below have been normalized, with SQL Server 6.0 results equal to 1. Higher is better.

SQL Server 6.5

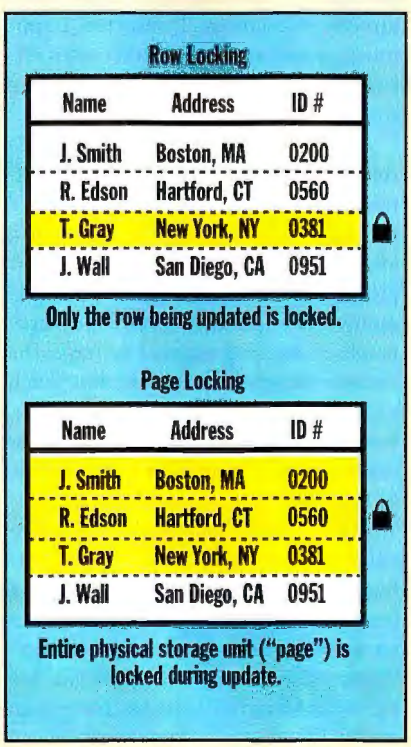
Order test (one user)	1.385
Order test (eight users)	1.106
Payment test (one user)	1.333
Payment test (eight users)	1.133
Simple-query	1.400
Five-table join query	1.417

TECH FOCUS CONTENTION

Row Locking vs. Page Locking

New in Microsoft SQL Server 6.5 is the option to use row locking rather than page locking on insert operations. Locking mechanisms prevent users from changing data that another user has already changed, until the changes are committed. Row locking locks only the row that is being changed. Page locking locks an entire physical storage unit (2 KB in SQL Server), which may include unchanged records adjacent to the changed record.

Such fine granularity minimizes the possibility of lock contention and improves throughput. However, page locking has its own benefits: Locking larger storage units requires fewer locks to manage and reduces system overhead. For updates of records in large tables, locks will likely be spread over a large-enough area and held for short-enough durations to minimize the potential drawbacks of page locking. But when multiple users insert records into a table in sequential order, several consecutive records are likely to be targeted for the same page, resulting in serious bottlenecks.



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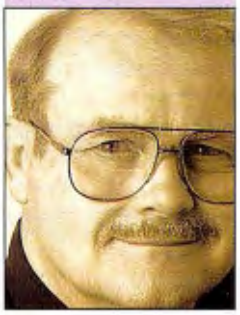

Adieu, Pentafluge... Hello, Cyrus

Jerry breaks in a new Cyrix 6x86 machine and wrestles with Win 95's System Agent and the PCI bus.

The Book of the Month is *Windows 95 Is Driving Me Crazy* by Kay Yarborough Nelson (Peachpit Press). I don't usually lead with a book, but Nelson answers questions I hadn't known to ask, as well as clearing up a number of puzzles, and her title is on target for what's been happening at Chaos Manor this month.

She doesn't answer all my questions, for instance, about the hesitations that send me up the wall. Every now and then, Windows 95 (Win 95) hangs up for a second. If I'm writing, I can type several characters before one will appear on-screen. Hunt-and-peck typists, who look at the keyboard, won't mind that, but it's unnerving to a touch-typist. A partial solution comes from reader Darwin Boyle, who dug through the Windows 95 Resources Kit to find things that Microsoft's technical experts didn't seem to know when I asked for help.

Boyle suggests that I go into Network from the Control Panel, select File and Printer Sharing for Microsoft Networks, and hit Properties. Change the setting for LM Announce to No and set Browse Master to Disabled. This does help. It seems that on a Microsoft peer-to-peer network, the computer designated as the Browse Master periodically goes out to see what new machines have been added. This speeds up browsing, but it also brings the machine to its knees while it's doing it. With a fast-enough machine you may not see the hesitation, but with a Pentium 60 or slower it's noticeable.

Alas, while that fixed some of the problem, it didn't get it all. I still have short hesitations, perhaps not as bad or as often as before, but real enough. Kay Nelson suggests that periodically Win 95 likes to talk to the disk. While doing so, it hangs up the system; and there's nothing you can do about it. The problem with that explanation is that Pentafluge uses a Distributed Processing Technology caching controller with 16 MB of cache memory, so talking to the disk is or should be as fast as talking to memory.

I may never know why I get these hesitations because I'm about to change machines. Pentafluge is "only" a Pentium 60. That was state of the art when we built him, but it's way behind the curve now, even with the caching controller speeding up disk access. The machine is solid enough that I can attach a big SCSI string to it: the Pioneer DE-SH7101 read/write external optical drive in addition to the Maxoptix T3-1300 optical drive already built in, a Pioneer DRM-624X six-pack CD-ROM changer, and a good digital audiotape (DAT) drive.

We've been testing the Cyrix for about a month now, and we've found two glitches.

The CD-ROMs I use most, especially Microsoft Bookshelf, the Oxford English Dictionary, and Grolier's Encyclopedia, reside on the DRM-624X. This is a triple-speed unit, which is a bit slow for multimedia, but it's good enough for text retrieval across an Ethernet. The only problem with the DRM-624X drive is that each CD-ROM has to be mapped as a separate drive letter.

What I really need is a system that sees the six-pack as one drive and then hunts until it finds the CD-ROM that I'm trying to access. I seem to remember that early Bureau of Electronic Publishing programs would seek through a series of drives, but that was long ago. Anyway, the notion is that Pentafluge will become a resource and backup server and go off to the cable room.

My new main machine will be Cyrus, a Cyrix 6x86-P166. Cyrus isn't quite the fastest machine in the house; that honor still belongs to the Intergraph TDZ-400, a dual Pentium Pro 150, which does graphics so fast it scares me. However, Cyrus is the fastest "ordinary" system I have.

It comes in a neat little tabletop tower that can sit right next to the monitor. There's a Matrox MGA Millennium video board—I currently recommend Matrox as the preferred video board—a Sound Blaster AWE32 card with a Cambridge Soundworks multimedia speaker system, 32 MB of memory, and a six-speed EIDE CD-ROM drive running off an Adaptec Ultra SCSI board. Cyrus came with a 17-inch CTX monitor, which is quite good. It has a steady image with no flicker and good color, but I'll replace it with my wonderful 21-inch ViewSonic Professional Series PT810. I'll also bring over my Northgate OmniKey keyboard.

We've been testing the Cyrix machine for just about a month now, and we've found two glitches. The first turns out to be endemic to all fast systems. We noticed that if they were left to themselves for a few hours, the machines would lock up. This happened to RacingCow, the Gateway 2000 P5-133XL, and then later to the Cyrix machine. Neither machine had the problem when we got it. The log showed that the problems developed just after we installed Windows 95 Plus. Great heavens, Holmes, a clue!

When you install Windows 95 Plus, the default is to install System Agent, a utility that waits for the system to be idle and

then goes out and checks your hard disk and does other system cleanup things. If that's installed in a system with a "green-machine" CPU manager (not a screen saver, but a BIOS-level power manager) that puts your system to sleep after a set period of time, then sooner or later, System Agent and the "sleep" utility are going to collide. When they do, they'll lock up your system. It can happen during long installations or file transfers.

By coincidence, I had dinner tonight with a Corel team demonstrating the new Corel intranet videoconferencing system (excellent!), and they sometimes have mysterious problems with the IBM ThinkPads they carry for the networking demonstration. I noticed they had System Agent running during the demonstration.

A partial solution is to disable System Agent. This is no great loss, because System Agent does nothing that Norton System Doctor doesn't do better. I strongly recommend that if you're running Win 95, you install and run System Doctor. Unfortunately, while that will stop lockups when the system is simply sitting idle, it will *not* prevent the stupid power manager from putting your machine to sleep during long network file transfers or downloads.

Eventually, both System Agent and BIOS-level power managers will be written by people who *use* computers instead of theoreticians, and they'll check for file transfer and communications activities as well as keystrokes; but for now, you're safer turning both those silly things off and using a screen saver.

The other problem—that the machine could lock up during a long, unattended download—is more serious and has no remedy other than not to run System Doctor. However, when I reported these problems, both Symantec and Cyrix were concerned enough that Cyrix shipped Symantec a system by Federal Express, and they got their software gurus on the case.

The Cyrix has run everything I have thrown at it, including DOS games running under Win 95.

Alas, Norton System Doctor is the other incompatibility I've found with Cyrus. There were two problems, both related to the great speed of the Cyrix 6x86-P166. One was amusing. When you shut the system down, the "IT IS NOW SAFE TO TURN YOUR COMPUTER OFF" message appears 2 seconds before Norton System Doctor is finished writing its backup information to disk. The result is that when you bring the system up the next time, it goes into safe mode. Shutting down from that lets the system come up naturally. The remedy is to count to five after the message appears.

I have no doubt that by the time you read this, you'll be able to run Norton System Doctor with the Cyrix. Stay tuned.

Those were the only glitches I had with Cyrus. Otherwise, it has run everything I have thrown at it, including DOS games running under Win 95. Two DOS games, Whiplash and ChronoMaster, wouldn't run properly on the Gateway 2000 P5-133XL as it was shipped, but they run just fine on the Cyrix right out of the box. For that matter, This Means War, which has

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managed to crash every system we've tried it on, runs faster and causes fewer problems on the Cyrix than any other system we tried it on.

I'll leave benchmarks and other systematic tests to BYTE's technical people, who can do it much better than I can. My bottom line is that the Cyrix 6x86-P166 with Win 95 is certainly fast enough for any application I have to run on it. I have enough confidence in its compatibility that next week I'll set it up as the main system here; my only real holdup is furniture, and that's just a minor problem. I'll have more next month, but I think Intel now has a serious competitor.

I'm having real problems getting PCI-bus network cards to work properly. That's independent of the machines: the problem is that the PCI bus wants to do one kind of Plug and Play management, and Win 95 wants to do another. The result can be sheer hell.

In theory, Win 95 should be able to find and recognize new hardware, assign it an unused interrupt request (IRQ) and addresses, and get everything running properly without intervention. In practice, it's a bit different.

First, many of the newer systems are pretty full. The Gateway 2000 P5-133XL came with a bus mouse, an internal modem, a sound card, and two serial ports. There was precisely one IRQ available for a network card. When we wanted to add a SCSI controller card, we had to disable one of the serial ports. Given we have both modem and bus mouse, that's no particular loss, but it turns out to be a bit tricky.

The first thing we do with a new machine is to get it on the network. I had a new Plug and Play Ultimate PCI-3000 Ethernet card from Applied Creative Technology. The Cyrix is billed as a Plug and Play machine. It seemed a fair test: insert the card and turn the machine on. It locked up to hardware reset. I took out the board, restarted, and tunneled down through Control Panel, System, to Device Manager, where I discovered that since the Cyrix came with a SCSI controller, every IRQ from 0 to 15 was in use by either the system itself or Win 95.

I'm having real problems getting PCI-bus network cards to work properly.

After the Ultimate PCI-3000 Ethernet card locked up the system, I took it out and inserted an Intel EtherExpress card on the ISA side of the bus. This time, Win 95 noticed the card, which happened to be addressed to IRQ 3. When I let Win 95 install the drivers for the card, it did so, automatically disabling COM2, which had been using IRQ 3, and all was well. Once I was sure the network worked properly with the Cyrix, I tried again to get the Ultimate PCI-3000 Ethernet card to work.

It wouldn't. The problem was that I needed to make the system set that card to IRQ 3—the only available interrupt—and it just didn't want to do it. Even putting the card into another machine and running software to force it to be IRQ 3 did not work, because as soon as it was put back, the PCI bus and Win 95 between them would reset it to something else. This isn't a Cyrix problem, nor is it the fault of the PCI card. We've had this difficulty on every PCI-bus machine that doesn't have several free interrupts.

There is a way to do it. What you must do is get into the Cyrix BIOS (press the Del key as it is booting up) and go into the menu item called Advanced Features; go

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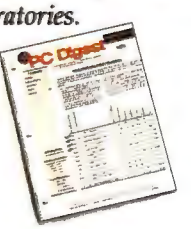

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from there to Integrated Peripherals. Disable COM2, which uses IRQ 3. Do a cold reboot—turn off the system—so that both the PCI management firmware and Win 95 know what you've done. Now you can insert your PCI-bus card, and both the PCI bus and Win 95 will know that IRQ 3 is available. Then, Plug and Play will take over, and things will proceed nicely.

I've just done that. Cyrix has a BIOS revision that frees up another interrupt. I downloaded that from the Cyrix BBS. The instructions said make a bootable floppy disk, which I did through Win 95's My Computer and the help screen; copy the BIOS revisions to the floppy disk; boot up with the floppy disk; and issue the command `Flash ecs.bin`. That took about 2 minutes. While the machine was turned off, I removed the EtherExpress card and turned on the machine. Win 95 reported that the network card wasn't working, which was hardly surprising, and then continued to boot. When it was done, I went into Device Manager and removed the Intel network card driver, turned off the machine, inserted the Ultimate PCI-3000 Ethernet card on the PCI bus, and turned on the machine.

I was expecting the worst, but in fact the system came up, the network set itself up, and everything worked splendidly, all untouched by human hands. When Plug and Play is working properly, it *really* works painlessly. Of course, it doesn't always work properly.

Pournelle's law: when installing hardware, it's important to turn off the system, not just do a warm boot. Alex found this out trying to install a D-Link Ethernet PC Card in a Texas Instruments Extensa laptop. He used the new hardware feature of Win 95, but when the network came up, the CD-ROM drive wouldn't work. The remedy was to go into the Device Manager with fire and sword, deleting all drivers, including the PC Card-to-PCI bus bridge. Kill 'em all, God will know his own. Then turn off the machine. When it comes back on, it will notice that it has unrecognized hardware and look for drivers. "Aha! I have a CD-ROM drive! Aha! There's an Ethernet card!" Eventually, it will reload its drivers, and this time it will have both a CD-ROM drive and a network. No other procedure seems to work.

The PCI bus was supposed to solve all our compatibility problems, but instead it has created more.

The PCI bus was supposed to solve all our compatibility problems, but instead it has created more. It's the same with Plug and Play, and the reason is the same in both cases: there's a lot of legacy hardware out there, and making provision for that to work involves compromises that can cripple modern stuff.

There's no way around the shortage of IRQs with present-generation equipment. SCSI tries, but it's very often one more way to make you crazy. You can reduce the danger of insanity when setting up SCSI strings by using Granite Digital SCSIVue Gold Diagnostic Cables. About half the trick to SCSI is getting the termination right, and 90 percent of what's left is being sure you

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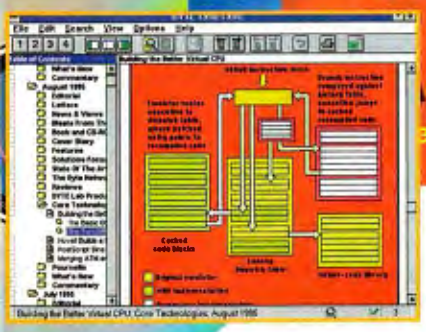

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don't have cable problems. Granite Digital cables always work, and the blinking lights tell you right away if you've got termination and a good connection. If you often do SCSI, get Granite Digital cables.

The real remedy to the interrupt shortage will be the universal serial bus (USB). Unfortunately, this will take more than a new card; it's probably going to have to be built onto the motherboard. Then we'll need peripherals that can use it. When it's done, though, you'll be able to add digital video cameras, scanners, sound dictation systems, game controllers, and all kinds of stuff to your system without having to get inside the box and without going through the IRQ hell.

At least that's the way USB enthusiasts talk, and you can believe as much of it as you want to. I want to believe it all, but I do wonder if I haven't heard this song before....

Game enthusiasts, rejoice! You don't have to wait for USB to have multiplayer game controls. Advanced Gravis Computer Technology is shipping The Ultimate Team Sports Set. This is a hub that connects to the game port on your sound card (or your motherboard if you have that kind of machine). Install the software, and you can connect up a joystick and a pair of game controllers. Actually, you can run up to four controllers; I've tested it with only two because that's all I have.

These are the kind of two-hand game controllers all the kids use, with a round button that functions as a joystick for your left thumb, a bunch of buttons for the right, and triggers for both index fingers; they're guaranteed to have a steep learning curve for adults. There are several configurations, all "standard" in the sense that every game fanatic seems to understand them instantly. Once you've learned to use these controllers, you can play two-person games like Mortal Kombat; or you can use just one of them to really control an electronic pinball game.

That's the good news. The bad news is that most games, including the PC version of Mortal Kombat, aren't aware of the multiple joystick hub. Apparently, it wouldn't be hard to recompile two-person games that now use different parts of the keyboard to control the action to make use of this system, but I don't know how many companies will actually do it.

This will become obsolete when we get USB. With USB, you could have half a dozen game controllers connected to the same system. And then someone can write a multiplayer version of Doom....

It isn't often that I get a program so complex that I can't even list all its features, much less describe them; but Wall Street Analyst 2-CD from Omega Research has managed it. This probably isn't the ultimate in stock-charting and analysis software, but it's not likely that anyone but a mathematician will want anything more; and there's no guarantee that a mathematician can get better results.

There are two approaches to stock-market investments. Brokers have their own terminology, but I call them "real-world factors" and "trend analysis." Real-world factors include what the company makes, how efficient it is at making and selling it, and factors that influence supply and demand, for example, weather and climate.

Some brokers call the other method "technical factor analysis." It's a system based on predicting the future by analyzing the past, and in its pure form, what the company makes or whether it makes anything at all, is irrelevant. The important

things are ratio and trend lines. In the old days before computers became common, this was done by drawing lines on charts of the stock's past history and trying to extrapolate trend lines into the future. There were all kinds of rules of thumb having to do with the technical factors of the market, such as the ratio of railroad stocks to industrials. It all sounded very complicated, but it wasn't, and you could learn most of the technical theory in a week.

Then in World War II, military-operations research people developed all kinds of mathematical techniques for predicting the future based on a chart of the past. The intention was to develop ways to predict where an airplane would be at the time an antiaircraft shell could get to an interception point, and the problem was sufficiently complex that some of the first high-speed computers were developed to solve the equations in time to do any good. It wasn't too long, though, before market analysts got interested in the same techniques, and thus was born a new era in market analysis.

The new theories also spawned some science fiction clichés, such as the boy with the computer who is able to manipulate the market and end up owning the earth. The author of that story didn't consider what might happen if everyone on Wall Street also had a computer.

That is the situation today, and since many of the technical analysts use the same techniques and often the same analytical software, it's hard to get much of an edge by doing market trend analysis. It's even harder to get an edge you can act on in time to do you any good; after all, many of your opponents have a direct wire to a floor trader, and they'll get their orders in while you're trying to call your broker.

If, after you've thought about that, you still want to try your hand at technical market analysis, the best bet I know of is to get Wall Street Analyst 2-CD and spend some time with it. Spend enough time, and you'll know quite a lot about the subject. All the analytical tools are in the package, and the instructions, while sometimes tedious, are complete. You'll learn about buy and sell factors, and you can call on the built-in expert systems to check your work. There's other software that will watch for trends and alert you when buy or sell conditions have been met. You'll learn about support and resistance lines, and all the other technical stuff that fascinates Wall Street analysts. *continued*

The best part is that you can do all this without risking a cent beyond the cost of the software; meaning you can develop a system and test it before you jump into the market. There's always the chance your system will work perfectly until the day you invest real money. None of that will be the fault of the software.

Wall Street Analyst 2-CD is the best and easiest-to-use technical market-analysis program I have seen. They have really worked at it. The CD-ROM version gives you the complete stock history of a large number of companies, including Microsoft and Apple. It's fun to superimpose their charts. Then you can add IBM and finish by looking at the trends for a fertilizer company. The result should be instructive. Highly recommended as software.

The game of the month is SSI's Fantasy General. This is a tactical-level game with a long story scenario. It's turn-based, so you have plenty of time to decide how to proceed. I found it restful after some of the more frantic real-time war games. It's not quite as addictive as This Means War, but for compensation, there's no random sabotage factor, and while it will crash when run under Win 95, it doesn't do that often. Each episode of the game takes under an hour, but there are a *lot* of episodes. I haven't finished it yet, but I intend to.

A good companion to *Windows 95 Is Driving Me Crazy* by Kay Nelson is *Optimizing Windows 95* by Lenny Bailes (Osborne-McGraw-Hill). This is more for reference than light reading, and unfortunately they chose to go with more pages of text instead of a better index and an analytical table of contents; meaning that there's more in it, but finding what's there can be difficult. It's still well worth having.

The book of the month is *Expiration Date* by Tim Powers (Tor Books). It's a typical Powers story: well-researched details of a world that you'd swear is modern Los Angeles, but it clearly isn't, since in the first chapter the protagonist finds a vial containing the ghost of Thomas Alva Edison. I don't think you'll be bored.

The CD-ROM of the month is Critical Mass: America's Race to Build the Atomic Bomb, from Corbis. This is a well-done history of how the atomic bomb was developed. It also includes lessons in the basic science involved. Of necessity, it emphasizes some of the Los Alamos people while ignoring others, but the selections have been done reasonably well.

Corbis is "Bill Gates's other company"; like all Corbis products, this one is slick and easy to use. It has a sophisticated interface. There's one problem: it will *not* run on a networked CD-ROM drive. The disk has to be in a drive native to the machine running it. That may be a problem for educational institutions.

As usual, you can find more of this column on the BYTE Web site. You might also want to check out http://www.earthlink.net/discontinuity, where John C. Dvorak and I argue critical issues. 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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PageWiz compact scanner	124.71
ScanMaker E3 color flatbed	373.31
ScanMaker E6 color flatbed	556.49
ScanMaker III color flatbed	1888.54

UMAX

Vista-S12 PCPro2	241.18
Powerlook II PCPro2	2277.93

VISIONEER

PaperPort VX	274.84

MULTIMEDIA AND CD

Creative Labs

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Sound Blaster 16/3D value edition IDE	94.63
Sound Blaster AWE32 PnP	222.43
ADS TV Superscan 2 PC to TV converter	292.20
ADS TV Elite Pro w/remote mouse	199.15
Altec Lansing ACS500 surround system	299.39
Connectix QuickCam for Windows	86.05
Connectix Color QuickCam for Windows	226.29
Diamond Multimedia Kit ULTRA 8X CD	333.73
JBL Media series speakers 10 watts	183.98
JBL Media series speakers 20 watts	174.47
Microsolutions 4X CD parallel	236.16
Microsolutions 6X CD parallel	296.67
Microsolutions 6X CD w/sound parallel	385.45
Minolta Snappy video still capture	195.98
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NEC 6Xe 6X CD external	335.85
NEC 4x4 4X CD 4-disc changer external	188.53
NEC 4Xc 4X CD 7-disc changer external	342.15
Pioneer DRM624X 4X CD 6-disc changer external	294.93
Panasonic 4X CD 5-disc changer internal	299.00
Panasonic portable 4X CD SCSI	399.00
Panasonic 4X CD w/speakers SCSI-2	499.00
Sony PRD-150 portable Discman® PCMCIA Type II	342.86
Sony 4X CD SCSI-2 internal	159.70
SunMoonStar 6X CD internal	178.41
SunMoonStar 6X CD portable	259.37
Toshiba 3701B 6X CD SCSI internal	239.78
Turtle Beach TBS-3001 4X CD 3-disc changer	167.80
Turtle Beach Tropez Plus 32	219.11
Yamaha YST M-15 10 watt speakers	69.63
Yamaha YST M-15 45 watt satellite system	169.86

MONITORS

Mag Innovision DX1595 PnP 15" .28mm	374.14
Mag Innovision DX1795 PnP 17" .26mm	858.44
Mag Innovision DX15T 15" .26mm	405.80
Mag Innovision DX17T 17" .26mm	715.47
Mag Innovision MXP17F 17" .26mm	809.48
Mag Innovision MX21F 21" .28mm	1484.25
Magnavox CM2099 14" .28mm	252.29
Magnavox CM2015 15" .28mm	329.19
Magnavox CM1215 15" .28mm	369.77
Magnavox CM4018 17" .28mm	636.08
Magnavox CM5600 20" .27mm	1242.00
Magnavox 20CM64 20" .31mm	1013.19
NEC M500 15" .25mm	526.24
NEC XV15+ 15" .28mm	473.13
NEC XV17+ 17" .28mm	799.84
NEC XP21 21" .28mm	1943.57
NEC XE21 21" .28mm	1864.03
Samsung 17GLi 17" .28mm	749.00
Samsung 17GLsi 17" .26mm	919.00
Sony Multiscan 15sx 15" PnP .25mm	395.53
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Sony Multiscan 17sfII 17" PnP .25mm	775.83
Sony Multiscan 17seII 17" PnP .25mm	976.41
Sony Multiscan 20sfII 20" PnP .30mm	1835.53
ViewSonic 15GS 15" .27mm	405.80
ViewSonic 17GS 17" .27mm	651.18
ViewSonic Optiquest V775 17" .26mm	684.72
ViewSonic 21PS 21" .25mm	1579.68

VIDEO BOARDS

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ATI Graphics Xpression ISA 2MB	129.56
ATI Graphics Xpression PCI 2MB	129.21
ATI Graphics Xpression VLB 2MB	157.14
ATI Graphics Pro Turbo ISA 2MB	261.66
ATI Graphics Pro Turbo PCI 2MB	261.23
ATI Graphics Pro Turbo VLB 2MB	219.20
ATI Graphics Pro Turbo PCI 4MB	400.00
ATI Video Xpression PCI 2MB	166.23
Diamond SpeedStar Pro ISA 1MB	93.68
Diamond Stealth64 3240XL PCI 2MB	305.29
Diamond Stealth64 Graphics 2120 PCI 1MB	81.36
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Ascentia P30 5/100 8MB 800MB 11.3" dual-scan 4X CD.3349.81
Ascentia P30 5/100 8MB 1.2GB 11.3" dual-scan 4X CD..3829.18
Ascentia P50 5/133 8MB 800MB 11.3" active 4X CD.4221.60
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822-5/100 16MB 1.2GB 28.8K bps 6X CD....1595.19
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826-5/150 16MB 2.1GB 28.8K bps 3 disc 6X CD..2134.15
828-5/166 16MB 2.1GB 28.8K bps 3 disc 6X CD..2224.90

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MS 5100 5/100 16MB 1.2GB.....1665.04
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MS 5133 5/133 16MB 1.2GB.....1775.70
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MS 5166 5/166 16MB 2.1GB 6X CD.....2525.43

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MS-T 5133 5/133 16MB 1.2GB.....1877.82
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LTE 5000 5/75 8MB 810MB 11.3" dual-scan..3264.57
LTE 5000 5/90 8MB 810MB 10.4" active.....3648.77
LTE 5100 5/90 8MB 810MB 10.4" active.....4032.97
LTE 5100 5/90 8MB 810MB 10.4" active 2X CD..4417.17
LTE 5200 5/120 8MB 1.35GB 10.4" active 4801.37
LTE 5280 5/120 16MB 1.3GB 11.3" active....5185.57
LTE 5300 5/133 16MB 1.3GB 12.1" active....5761.87

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Deskpro 5100 5/100 16MB 1.2GB.....1824.95
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Deskpro 5133 5/133 16MB 2GB 4X CD.....2632.90
Deskpro 5150 5/150 16MB 1.2GB.....2214.80
Deskpro 5150 5/150 16MB 2GB.....2327.80
Deskpro 5166 5/166 16MB 1.2GB.....2429.50
Deskpro 5166 5/166 16MB 2GB.....2796.75

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HP OmniBook 5000CT 5/120 8MB 1.2GB 10.4" active..6015.06
HP OmniBook 5000CTS 5/120 16MB 1.2GB 10.4" active.4855.37
HP OmniBook 5500CTS 5/133 16MB 1.3GB 12.1" active 5893.24

NEC

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Versa 4050H 5/90 8MB 810MB 10.4" active ..4098.00
Versa 4080H 5/120 8MB 1GB 10.4" active 4399.00

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SENS 810 5/100 8MB 1.3GB 12.1" active 6X CD.3799.00
SENS 810 5/120 16MB 1.3GB 12.1" active 6X CD 4299.00
SENS 810 5/133 16MB 2.1GB 12.1" active 6X CD 4589.00

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Extensa 560CD 5/75 8MB 810MB 10.4" dual-scan 4X CD..2442.29
Extensa 560CDT 5/75 8MB 1.2GB 10.4" active 4X CD..3369.03
Extensa 570CD 5/100 8MB 810MB 11.3" dual-scan 6X CD..2694.07
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365X 5/100 8MB 810MB 10.4" dual-scan.....2495.00
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365XD 5/100 8MB 810MB 10.4" dual-scan 4X CD.2799.00
365XD 5/120 8MB 1GB 11.3" dual-scan 4X CD.3299.00
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PC700 5/133 16MB 1.2GB 5 bays 2616.00
PC700 5/166 16MB 1.2GB 5 bays 3161.00

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ML320.....315.50
ML321.....445.15
ML380.....222.74
ML395.....1005.83
ML520.....387.94
ML521.....509.02
ML590.....445.72
ML591.....683.67
Pacemark 3410..1323.72
OL600e.....399.00
OL610e/PS.....683.66
OL810E.....755.42
OL1200.....877.38
OKIJET 2010.....267.33

Canon

BJ30 mono.....268.50
BJC70.....293.66
BJC210.....199.00
BJC610.....429.00
BJC4100.....269.00
MultiPASS C2500 printer/copier/scanner/fax.....598.23

EPSON

DFX5000 Plus....1385.48
DFX8000.....2333.18
FX870.....289.45
FX1170.....376.56
FX2170.....499.00
LQ570+.....248.25
LQ870.....443.03
LQ1070+.....383.04
LQ2170.....595.00
LX300.....165.41
Stylus 1500.....995.00
Stylus Color II.....279.00
Stylus Color IIs.....189.19
Stylus Pro color ...449.00
Stylus Pro XL color1799.00

LEXMARK

4039 10 Plus 10ppm.....1037.81
Color JetPrinter 1020.....177.97
Color JetPrinter 2070.....286.75
Optra E 6ppm.....542.17
Optra LX+ 16ppm.....1049.39
Optra R+ 8ppm.....1253.82
WinWriter 150c thermal inkjet.....229.50

Panasonic

1150.....129.88
2023.....178.91
2130.....284.39
2135 color.....247.58
3123.....256.51
KX-P6100 Laser....278.44
KX-P6500 Laser....446.59

TEXAS INSTRUMENTS

microLaser 600.....686.89
microLaser Pro/8.....1186.85
microLaser PowerPro/12.....1342.66

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HP DeskJet 340 portable inkjet printer.....293.84
HP DeskJet 600C color inkjet printer.....158.42
HP DeskJet 682C color printer.....329.00
HP DeskJet 820Cse color printer.....399.00
HP DeskJet 855Cse color printer.....499.00
HP LaserJet 5L printer.....479.00
HP LaserJet 5P printer.....851.83
HP OfficeJet inkjet fax/copier/printer.....499.22
HP OfficeJet LX inkjet fax/copier/printer.....578.82
HP OfficeJet 350 inkjet fax/copier/printer/scanner 599.00

COSTAR

LabelWriter XL WIN.....158.82
LabelWriter XL Plus WIN.....218.81

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Maxtor

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1.6GB Fast-ATA.....281.51
2.0GB Fast-ATA.....291.47

CONNER

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850MB Fast-ATA...192.50
1.08MB IDE.....213.62
1.08 Fast SCSI-2..281.10
2.14GB Fast SCSI-2.555.34
4.29GB Fast SCSI-2961.74

Seagate

545MB Fast-ATA...174.06
631MB Fast-ATA...174.06
1.08GB Fast-ATA2205.41
1.08GB Fast SCSI-2253.46
1.6GB Fast-ATA2..291.47
2.0GB Fast SCSI-3..826.12
2.1GB Fast ATA-2.299.00
2.14GB Fast SCSI-2.782.64
2.14GB F/W SCSI-2.804.38
4.29GB Fast SCSI-2.981.98
9GB Fast SCSI-22086.07

WESTERN DIGITAL

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Caviar 853MB EIDE.....167.21
Caviar 1.62GB EIDE.....283.26
Caviar 2.1GB EIDE-2.....556.79
Caviar 2.5GB EIDE-2.....491.67

CONTROLLERS

Acculogic SIDE-3+ w/on-board BIOS.....37.18
Acculogic SIDE-4+ w/par 2 serial game.....27.74
Acculogic SIDE-4VL EIDE 16550 serial.....58.24
Adaptec AVA1505 SCSI-2 CD Kit.....48.32
Adaptec 2842 VLB SCSI-2.....239.11
Adaptec 1542CP SCSI Master Kit.....257.93
Adaptec PCI Ultra Wide SCSI Kit.....299.10
Adaptec Power Storage ISA Kit.....609.46
Adaptec Power Storage PCI Kit.....499.17
Promise EIDE2300+ VLB 4HD on-board BIOS 16550 .49.47
Promise EIDEMAX ISA 2HD on-board BIOS.....25.81

MODEMS & COMMUNICATIONS

BOCA

Online Express 14.4 internal w/fax.....46.82
Online Express 14.4 external w/fax.....67.87
V.34 28.8 internal w/fax.....147.46
V.34 28.8 external w/fax.....209.64

Hayes

ACCURA 144 internal w/fax.....78.05
ACCURA 144 external w/fax.....92.23
ACCURA 288 V.34 internal w/fax.....156.88
ACCURA 288 V.34 external w/fax.....168.69
OPTIMA 288 V.34 internal w/fax.....359.56
OPTIMA 144 external w/fax.....371.72
OPTIMA 288 Business Modem.....335.82

MOTOROLA

14.4 VoiceSURFR internal.....61.09
14.4 VoiceSURFR external.....112.86
BitSURFR ISDN adapter internal.....263.97
BitSURFR ISDN adapter external.....363.64
BitSURFR Pro ISDN terminal adapter.....348.03
ModemSURFR V.34 28.8 internal.....145.53
ModemSURFR V.34 28.8 external.....161.58
OnlineSURFR V.34 28.8 internal.....176.25
OnlineSURFR V.34 28.8 external.....178.74

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14.4 Mini-tower w/fax.....79.03
V.34 28.8 internal w/fax.....141.13
V.34 28.8 Mini-tower w/fax.....159.04

PUREDATA

SatisFAXtion 400 14.4 internal.....269.28
SatisFAXtion 500 28.8 internal.....359.98

U.S. Robotics

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14.4 external w/fax.....113.62
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V.34 28.8 external w/fax.....184.45
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Voice V.34 28.8 external w/fax.....212.13
Winmodem V.34 28.8 internal w/fax.....142.75

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V.34 28.8 external w/fax.....273.51
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I modem ISDN V.34 faxmodem external.....652.64

ZOOM

V.34 28.8 faxmodem internal.....122.31
V.34 28.8 faxmodem external.....159.94
V.32bis 14.4 Voice Speakerphone internal.....114.98
V.34 28.8 Voice Speakerphone internal.....159.84

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MICROCOM

DeskPorte 28.8P V.34 external.....232.74
DeskPorte 28.8S Fast V.34, external.....172.16

Supra 288 faxmodem internal.....168.17
Supra 288 faxmodem external.....193.74
SupraExpress 288FNP internal.....123.48
SupraExpress 288FNP external.....141.13
Supra Simple Internet 288i internal.....129.54
Supra Simple Internet 288i external.....129.95

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AMERICAN POWER

Back-UPS Office.....129.50
Back-UPS Pro 280 PNP.....148.51
Back-UPS Pro 420 PNP.....241.32
Back-UPS Pro 650 PNP.....286.55
Smart-UPS 700.....342.89
Smart-UPS 1000.....496.46
Smart-UPS 1400.....634.19
SurgeArrest Personal.....18.45
SurgeArrest Professional.....26.88
SurgeArrest Network.....29.46

TRIPPLITE

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BC PERS 420.....119.49
BC PERS 600.....164.25
BC PRO 550.....181.42
BC PRO 650.....211.56
BC PRO 850.....275.86
BC PRO 1050.....369.20
Isobar 4 outlet.....34.98
Isobar 6 outlet.....46.78

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OmniSmart 280 PNP.....133.93
OmniSmart 450 PNP.....184.75
OmniSmart 675 PNP.....234.21

PC CARDS

3Com Etherlink III.....156.76
3Com Etherlink IIIC combo.....438.42
Adaptec APA1460 SCSI-2.....265.28
Hayes EZJack 14.4 w/fax.....163.48
Hayes EZJack V.34 28.8 w/fax.....219.00
IBM 14.4 modem.....63.65
IBM 28.8 data/fax modem.....258.11
IBM Ethernet adapter 10BT.....123.67
IBM Token Ring 16/4.....287.29
Linksys Ethernet combo.....135.70
Megahertz 10BT Enet adapter w/XJACK.....134.83
Megahertz 28.8 V.34 data/fax w/ XJACK.....259.96
Megahertz 28.8 V.34 cellular w/XJACK.....269.67
Megahertz 28.8Enet cellular w/XJACK.....404.10
Megahertz 28.8/Enet combo cellular w/XJACK 427.94
Motorola Montana 28.8 cellular.....231.95
Motorola Manner 28.8 data/fax & LAN cellular..466.52
New Media Bus Toaster SCSI-2 host.....183.89
New Media Wave Jammer sound card.....221.41
Simple 14.4 modem + voice.....98.70
Simple 28.8 Communicator cellular.....169.89
Simple 28.8 Communicator.....247.79
SMC EtherEZ 28.8/Ethernet 10BT.....419.08
SMC EtherEZ 28.8/Ethernet combo.....458.76
USR Sportster V.34 28.8 with DataView.....243.27
Xircom Ethernet 10BT.....139.23
Xircom Ethernet combo.....182.53
Xircom Ethernet+modem 14.4 10BT.....266.19
Xircom Ethernet+modem 14.4 combo.....306.65
Xircom Ethernet+modem 28.8 10BT.....287.13
Xircom Ethernet+modem 28.8 combo.....419.08
Xircom Token Ring 16/4.....409.70
Zoom V.34 28.8 data/fax cellular.....201.80

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Intel OverDrive DX4/75.....138.66
Intel OverDrive DX4/100.....178.74
Intel OverDrive Pentium 63MHz.....189.27
Intel OverDrive Pentium 83MHz.....189.27
Intel OverDrive Pentium 120/133MHz upg for 560, 566 339.11
Intel OverDrive Pentium 125MHz upg for 575.339.11
Intel OverDrive Pentium 150MHz upg for 5/90.414.84
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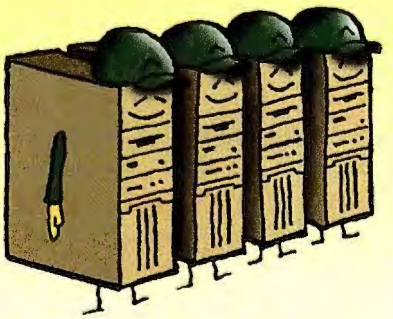

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T2150CDT	DX4/75	4/540MB+CD+SOUND	$stock
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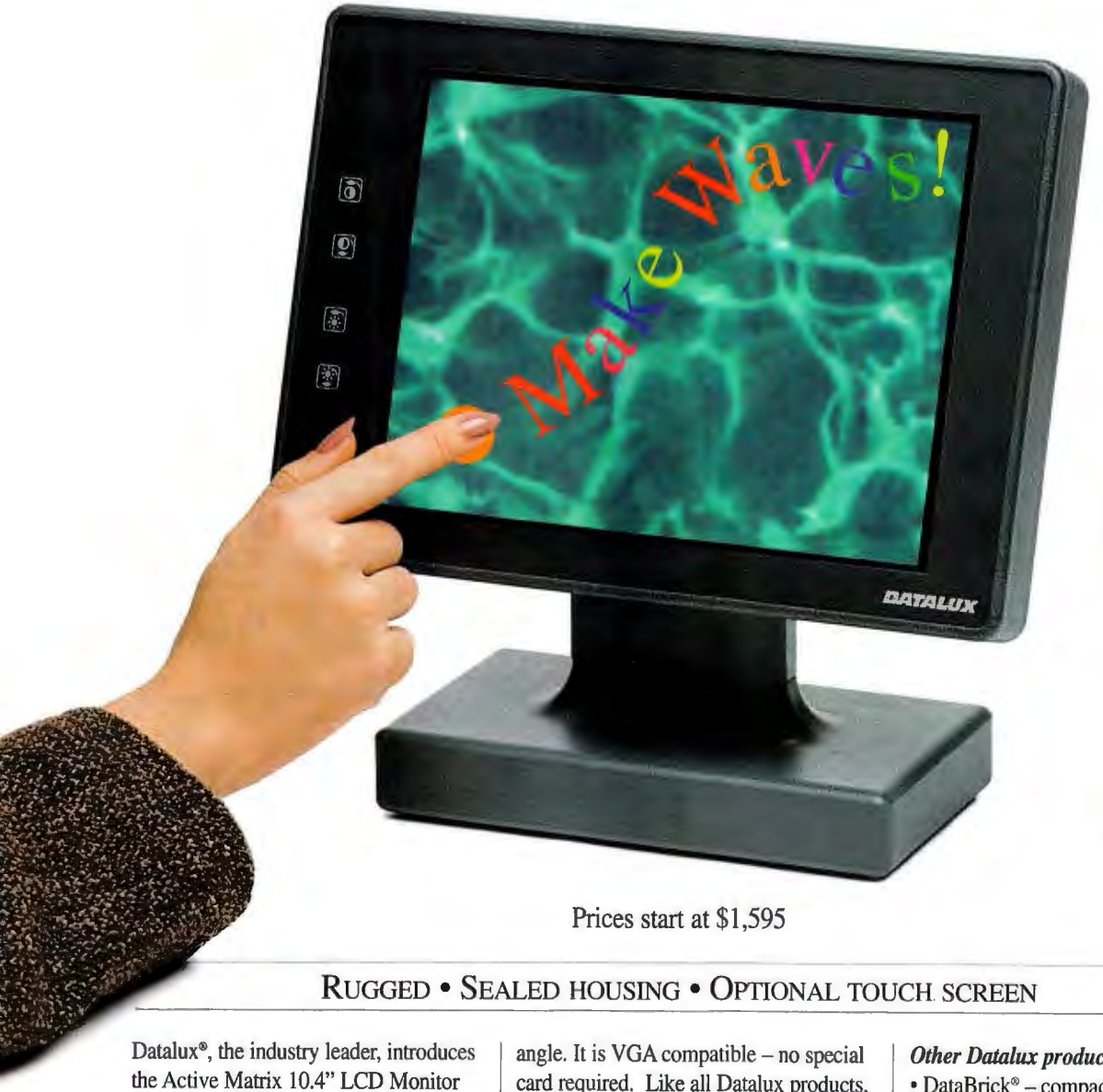

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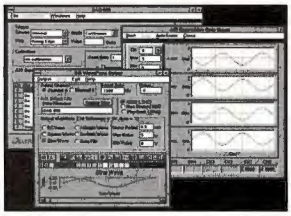

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Pioneer	DRU124X	4.4X	140ms	$109	$199
Plextor	PX43CE	4.5X	130ms	$239	$329
Teac	CD56S	6X	160ms	$235	$325
NEC	CDR512	6X	150ms	$249	$339
Plextor	PX63CS	6X	145ms	$279	$369
Philips	PC80S	8X	195ms	$239	$319
NEC	CDR1410	8X	145ms	$259	$349
Toshiba	XM5601B	8X	145ms	$269	$359
Plextor	PX83CS	8X	115ms	$415	$505

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Toshiba	XM5522B	6X	170ms	$89	$104
NEC	CDR1300	6X	145ms	$99	$114
Teac	CD56E	6X	110ms	$119	$134
Teac	CD58E	8X	110ms	$129	$144
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Pioneer	DRM-624X	6	4.4X	190ms	$299
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6X	160ms	Teac	$1439	$2439
6X	150ms	NEC	$1559	$2629
6X	145ms	Plextor	$1699	$2899
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8X	145ms	NEC	$1559	$2629
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Sound Image Pro 35 Watts [SPEAKERPRO] $129

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SCSI	Speed	RPM	Brand	Model	Price
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1080MB	11ms	5400	Seagate	ST51080N	$249
1280MB	12ms	5400	Quantum	FB1280S	$276
2050MB	8.5ms	7200	Micropolis	MC4221	$544
2050MB	8.5ms	7200	Micropolis	MC4221AV	$600
2147MB	**9ms**	**5400**	**Micropolis**	**MC4421**	**$444**
2147MB	9ms	5400	Seagate	ST32155N	$559
2147MB	8ms	7200	Seagate	ST32550N	$675
2150MB	8ms	7200	Quantum	XP32150	$630
4290MB	8ms	7200	Seagate	ST15150N	$989
4290MB	9ms	5400	Seagate	ST15230N	$905
4294MB	**8.9ms**	**7200**	**Micropolis**	**MC3243**	**$859**
4294MB	8.9ms	7200	Micropolis	MC3243AV	$945
4300MB	8.6ms	7200	Quantum	XP34300	$900
9091MB	12ms	5400	Micropolis	MC1991	$1840
9091MB	12ms	5400	Micropolis	MC1991AV	$1959
9080MB	11ms	5400	Seagate	ST410800N	$1880
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1050MB	8.5ms	7200	Quantum	XP31070W	$509
2050MB	8.9ms	7200	Micropolis	MC4221W	$630
2050MB	8.9ms	7200	Micropolis	MC4221WAV	$689
2147MB	8ms	7200	Seagate	ST32550W	$675
2150MB	8ms	7200	Quantum	XP32150W	$680
4294MB	8.9ms	7200	Micropolis	MC3243W	$945
4294MB	8.5ms	7200	Micropolis	MC3243WAV	$1035
4294MB	8ms	7200	Seagate	ST15150W	$1065
4300MB	8.6ms	7200	Quantum	XP34300W	$959
9080MB	11ms	5400	Seagate	ST410800W	$2029
9100MB	12ms	5400	Micropolis	MC1991W	$1929
9100MB	12ms	5400	Micropolis	MC1991WAV	$2049

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4-8GB	Seagate TST8000	$399
	• 4mm DAT DRIVES •	
2GB	Hewlett Packard C1534	$609
2GB	Seagate C4320RT	$599
2-4GB	Seagate C4324RP	$679
2-4GB	Hewlett Packard C1536	$699
4-8GB	Seagate C4326NP (DDS2)	$859
4-8GB	Hewlett Packard C1533A	$879
24-48GB	HP External 6 tape loader C1553AX	$2379
	• 8mm DAT DRIVES •	
3.5-7GB	Exabyte EXB8205XL	$1269
7-14GB	Exabyte EXB8700LT	$1149
	• QIC •	
800MB	$141	
1GB	$159	
1.7GB	$219	
3.2GB	$249	
4.4GB	$259	

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SCSI	$85	$40	$54
WIDE SCSI	$129	$64	$75

IDE HARD DRIVES

IDE	Speed	RPM	Brand	Model	Price
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639MB	11ms	4500	Western Digital	AC2635	$170
850MB	10ms	4500	Western Digital	AC2850	$179
850MB	14ms	4500	Quantum	TB850A	$179
1080MB	11ms	5400	Seagate	ST51080A	$190
1084MB	14ms	4480	Maxtor	M71084A	$195
1090MB	**11ms**	**4500**	**Fujitsu**	**M1614T**	**$175**
1250MB	15ms	3600	Quantum	BF1250A	$189
1280MB	12ms	5400	Quantum	FB1280A	$216
1280MB	10ms	5200	Western Digital	AC21200A	$205
1282MB	10.5ms	5400	Seagate	ST51270A	$195
1330MB	12ms	4480	Maxtor	M71336A	$205
1624MB	10ms	5200	Western Digital	AC31600	$235
1625MB	10.5ms	5400	Seagate	ST31640A	$249
1626MB	12ms	4480	Maxtor	M71626AP	$235
1700MB	11ms	4500	Quantum	SR31700A	$236
2004MB	12ms	4480	Maxtor	M72004A	$279
2100MB	10ms	5200	Western Digital	AC32100	$299
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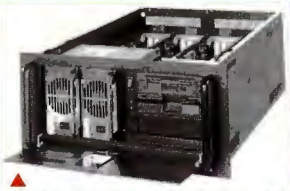

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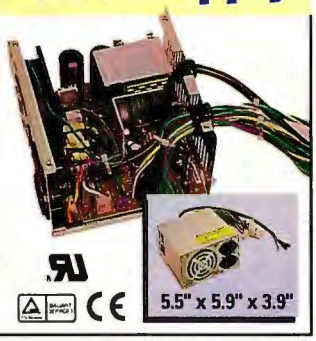

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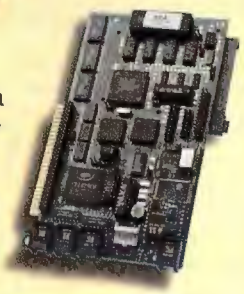

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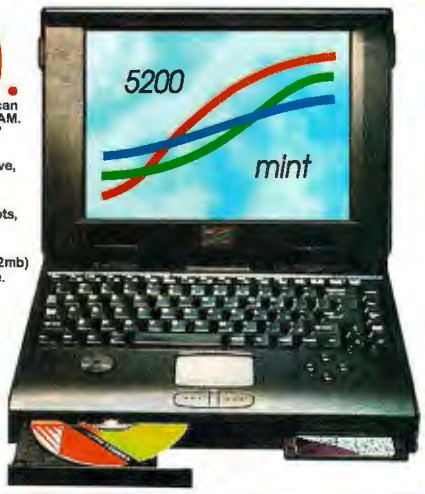

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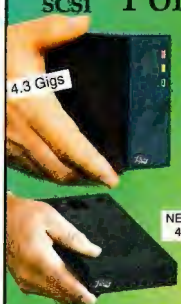

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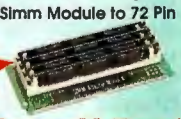

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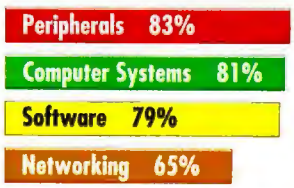

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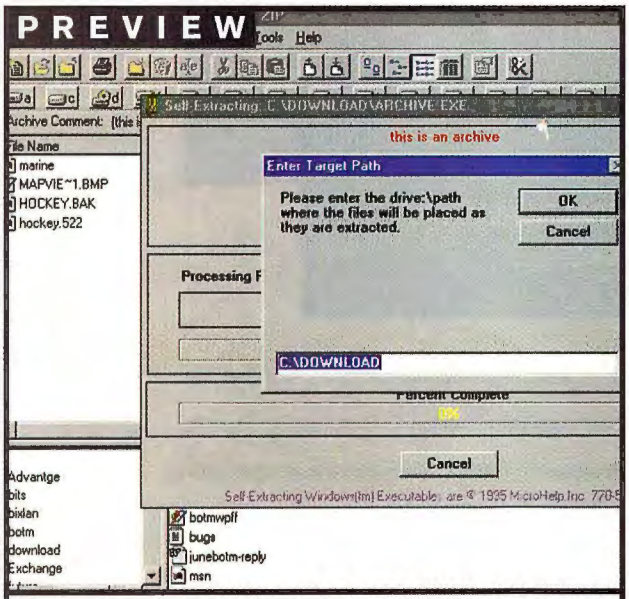

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A Helpful Windows Compression Utility

Whether you're backing up files or sending and receiving e-mail, sooner or later you'll need to compress and decompress your files. Several utilities on the market help you manage files that are compressed using the popular ZIP file format, but a new one from MicroHelp also addresses other formats that you may encounter on the Internet, such as TAR, G-zipped TAR, UUencode, and LZW. You can also UUencode files.

MicroHelp's Zip saves time in zipping up files for zapping over the Internet with its built-in Explorer interface. This lets you browse your PC and network directories from within the Zip Explorer instead of having to open the Windows 95 Explorer and drag and drop files to a new archive. Zip's time-saving interface lets you drag and drop files directly into a new archive.

Once you've created a new archive of compressed files, Zip's options make it easy for the person who receives your compressed files. You can build a self-extracting archive with a variety of options for the archive recipient, including prompting the user for a destination path prior to extraction (see the screen), automatic overwriting of files during extraction, and others. Other features of the program include support for backing up compressed files and the ability to view, edit, and run downloads without unzipping the archive. Whether you use Win 3.1 or Win 95 (MicroHelp Zip supports both), this compression utility is worth checking out. **–Dave Andrews**

Business

Lotus Notes Version of Act

ACT FOR NOTES (SINGLE-NODE CD-ROM, $249.95; 10-node license pack, $2250) helps workgroups and individual workgroup members manage contacts, activities, notes, history, and correspondence. Through Lotus Notes, Act for Notes supports multiuser databases, document-level security, and database replication.

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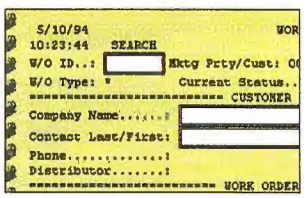
Business Information Publishing Toolkit

BASED ON WALL DATA'S ACTIVEX ARchitecture for the 32-bit Windows desktop, Arpeggio Viewer ($150 per user), Arpeggio for the Desktop ($500 per user), and Arpeggio for the Developer ($650 per user) provide an integrated solution for database access, query, data transfer, report generation, and information publishing across an enterprise network. You can integrate data access and publishing capabilities into custom applications programmed in languages such as C/C++, PowerBuilder, and Visual Basic.



Contact: Concentric Data Systems, Westborough, MA, (800) 915-9255 or (508) 366-1122; http://www.walldata.com.
Circle 1031 on Inquiry Card.

Software Search Suite

INTERMEZZO (FROM $20,000, DEPENDING on configuration) combines a text-search engine, an image-search engine, NameTag Automatic Indexing software, a Mac or Windows client API, and a Netscape interface

ISDN seems to be experiencing a resurgence of interest, and we're seeing an increasing number of product announcements for it. Meanwhile, the parade of products for the Web continues.

for enterprise-wide, multimedia access to heterogeneous information. After you build queries, Intermezzo translates them into the native search formats of selected databases and distributes them to search servers. Databases can be local to a client, accessible on LANs and WANs via TCP/IP, or Internet-accessible through Z39.50.
Contact: SRA International, Arlington, VA, (800) 511-6398 or (703) 558-4700; http://www.sra.com.
Circle 1032 on Inquiry Card.

CAD

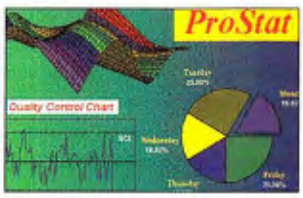
AutoCAD LT for Windows 95

NOW YOU CAN EXCHANGE DATA WITH WINDOWS applications that support OLE. AutoCAD LT for Windows 95 (about $469) provides OLE 2.0 container and server support. It also allows you to create electronic files from paper drawings; use a template to input data; and create, edit, and import large bodies of text. In addition, you can graphically view the effects of changes while you're creating or modifying text styles; see a thumbnail view before opening your drawing; copy all or a subset of one object's properties to another object; and run several sessions of AutoCAD LT simultaneously on the same machine.
Contact: Autodesk, Inc., San Rafael, CA, (800) 228-3601 or (415) 507-5000; http://www.autodesk.com.
Circle 1033 on Inquiry Card.

Engineering

Statistics and Graphics Package

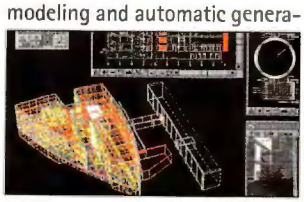
AVAILABLE IN 16- AND 32-BIT VERSIONS, ProStat for Windows ($299) provides sorting and ranking tools; descriptive statistics; nonparametric, ANOVA, and post tests; regression, correlation, control-factor, and cluster analysis; time series; mathematical transformations; numerical integration and differentiation; and fast Fourier transforms. You can exchange data to and from most file formats and export graphs into popular graphics formats.



Contact: Poly Software International, Salt Lake City, UT, (801) 485-0466; http://www.polysoftware.com.
Circle 1034 on Inquiry Card.

Architectural Modeling

AVAILABLE FOR DOS AND WINDOWS ON Intel-based systems as well as on DEC Alpha AXP, Power Mac, and SGI machines, MicroStation TriForma ($5325) provides 3-D conceptual modeling and automatic generation of drawings, specifications, and cost estimates. The single-building model integrates architectural structures, parametric doors, windows and openings, walls and cavity walls, floors, roofs, parametric stairs, and construction materials.



Contact: Bentley Systems, Inc., Exton, PA, (800) 236-8539 or (610) 458-5000; http://www.bentley.com/.
Circle 1035 on Inquiry Card.

Six AEC CD-ROMs

SOFTDESK'S SIX SPECIAL EDITION CD-ROMs provide AutoCAD applications for particular architectural, engineering, and construction disciplines. They include the Softdesk Civil/Survey Special Edition II CD ($6000); the Softdesk Architectural Special Edition CD ($3000); the Softdesk Building Services Special Edition CD ($3000); the Softdesk Imaging Special Edition CD ($3000); the Softdesk Structural Special Edition CD ($3000); and the Softdesk Process & Power Special Edition CD ($3000).
Contact: Softdesk, Inc., Henniker, NH, (800) 763-8337 or (603) 428-5267; http://www.softdesk.com.
Circle 1036 on Inquiry Card.

The Web

Web-Based Client/Server Applications

USING THE WEBCRUSADER SOFTWARE family (from $75), you can combine Web browsers with mission-critical information-systems (IS) applications to create secure, real-world intranets. The core components include desktop-to-database security, high reliability and redundancy, authentication and privacy, audit trails, high availability, access control, management for large networks, and location transparency.
Contact: Gradient Technologies, Inc., Marlborough, MA, (800) 525-4343 or (508) 624-9600; http://www.gradient.com.
Circle 1037 on Inquiry Card.

VRML Authoring Tool

SITESCULPTOR ($49.95) HELPS YOU BUILD VRML worlds for home pages on the World Wide Web. The Windows program offers 3-D modeling tools, such as true CAD solid modeling,

NURBS surface creation, and Boolean operations, and authoring tools, such as light sources, texture mapping, and a texture-materials library. Support for DXF and polygonal file data-translation capabilities lets you incorporate graphics from other design programs, as well as SPIN and ANIMATE controls.
Contact: Cadkey, Inc., Windsor, CT, (800) 395-3208 or (860) 298-8888; http://www.cadkey.com.
Circle 1039 on Inquiry Card.

Web-Server Software

WITH WEBWORX ($999), YOU CAN CREate basic Web pages, database-interactive Internet Web sites, and Internet service providers, all from a single PC. The package includes the Linux OS; HTTP Web-server software with CGI and multiple domain-name capability; the Perl programming language; C/C++ compilers; programming utilities;

other languages; and Web-browser software that supports HTML and other Internet protocols.
Contact: WorkGroup Solutions, Inc., Aurora, CO, (303) 693-3321; http://www.wgs.com.
Circle 1038 on Inquiry Card.

Utilities

Boost CD-ROM Performance

CD-ROM EXPRESS ($79.95) EMPLOYS hard disk space to store frequently used CD-ROM sectors. Because disk storage is nonvolatile, the program can also preserve these sectors from one session to another. The program, for use with DOS and Windows, tunes itself to your hardware, applications, and usage patterns and coexists with Microsoft SmartDrive and other hard disk caches. In addition, the software is compatible with SCSI, IDE, and proprietary one-, two-, three-, quad-speed, and faster CD-ROM drives.
Contact: PC-Kwik Corp., Beaverton, OR, (800) 274-5945 or (503) 644-5644; http://www.teleport.com/~gnome/pckwik.htm.
Circle 1040 on Inquiry Card.

Software Docking Station

SOFTDOCK (ABOUT $124.95) PROVIDES transparent access to network files and applications even when you aren't connected to the network. The program is protocol independent, and it works with major network OSes (NOSes). While you are docked, SoftDock checks the server to make sure that replicated files are current. If you modify network files while undocked, the SoftDock program automatically synchronizes the client and the server when you redock.
Contact: NetStream, Inc., Carnegie, PA, (412) 276-9600; http://www.netstream.com.
Circle 1041 on Inquiry Card.

SOFTWARE UPDATE

An ActiveX control for creating, editing, viewing, and printing diagrams, **InterAct 1.5** provides an expandable palette with default shapes, lines, and arrows; and Internet support, which lets you design diagrams that let users navigate and jump to Web pages and associate Web pages with entities in a diagram. As a 16/32 DLL or 16/32 OCX, $395 each; as a 16/32 DLL and OCX, $495.
Contact: ProtoView Development Co., Cranbury, NJ, (800) 231-8588 or (609) 655-5000; http://www.protoview.com.
Circle 1042 on Inquiry Card.

A program for integrating text and mathematics, **Scientific WorkPlace 2.5** provides a Mathematica link, 32-bit processing under Windows 95 or NT, a Multiple Document Interface (MDI), a new style editor, hypertext links, and support for Western European and some Eastern European languages. CD, $595; floppy, $630.
Contact: TCI Software Research, Las Cruces, NM, (800) 874-2383 or (505) 522-4600; http://www.tcisoft.com/tcisoft.html.
Circle 1043 on Inquiry Card.

The **TK Solver Release 3** mathematical modeling software offers OLE 2.0 support for linking and integrating TK objects with Microsoft Office documents; external function calls; Wizards; and a Greek character palette. $299.
Contact: Universal Technical Systems, Inc., Rockford, IL, (800) 435-7887 or (815) 963-2220; http://www.uts.com.
Circle 1083 on Inquiry Card.

HARDWARE

Accessories

Cordless Mouse with Customizable Buttons

DESIGNED FOR USE WITH WINDOWS 3.X and 95, RemotePointPlus is an infrared pointing device with three system components: a cordless, hand-held transmitter; an infrared

receiver; and the VersaPointPlus Windows software. In addition to 360-degree cursor control and dual click-button support, RemotePointPlus ($199.95) provides four customizable buttons to give you one-touch, on-the-fly access to up to 15 user-assigned presentation tools, software launches, and media effects.
Contact: Interlink Electronics, Camarillo, CA, (800) 340-1331 or (805) 484-1331; http://www.interlinkelec.com.
Circle 1045 on Inquiry Card.

Point-and-Shoot Digital Camera

THE POWERSHOT 600'S (ABOUT $949) 570,000-pixel CCD sensor produces a 24-bit image in 16.7 million colors at an optical resolution of 832 by 608. The digital camera uses a Canon auto-focus f/2.5 7.5mm lens and offers through-the-lens autofocusing and a built-in automatic flash from 8 inches to 12 feet. In place of conventional film, the PowerShot 600 uses 1 MB of internal memory to store up to 18 images and can store up to 72 images with an optional 4-MB compact flash memory PC Card.
Contact: Canon Computer Systems, Inc., Costa Mesa, CA, (714) 438-3000; http://www.ccsi.canon.com.
Circle 1046 on Inquiry Card.

Desktop Surge Protection

A DESKTOP POWER-CONTROL DEVICE, THE Switcher 2000 Plus ($49.99) provides protection-status indication, recessed power switches, three-line fusing, and six protected outlets, one of which is unswitched for devices that need continuous power.
Contact: Newpoint Corp., San Diego, CA, (800) 639-7646 or (619) 677-5700.
Circle 1047 on Inquiry Card.

Communications

ISDN Communications for the Home Office

A DIGITAL COMMUNICATIONS MANAGER, Front Desk ($1395) equips your home office with the capabilities of PBX-level call handling, call routing, voice mail, remote access to faxes, single-number "find me" capabilities, and high-speed data communications. Call-handling capabilities include two simultaneous voice, fax, or data calls; up to 16 phone numbers; caller ID; call screening; call waiting; and up to

eight office modes. Voice/fax messaging features include up to 10 mailboxes, up to 30 minutes of voice-message storage, up to 40 pages of fax storage, and remote voice/fax message retrieval.
Contact: Jetstream Communications, Inc., San Jose, CA, (408) 777-4300; http://www.jetstream.com.
Circle 1048 on Inquiry Card.

LAN/Modem PC Card

DESIGNED FOR MOBILE COMPUTERS THAT are equipped with a Type II PC Card expansion slot, the PCMCIA LAN-modem Card ($499) allows con-

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The big online services seem

preoccupied by who has the most users online; I want to be treated as a person, not a statistic.

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You can log into BIX for free to try it out. When you do this you get 5 hours to look around during the month you sign on. After that, you will be billed a subscription fee of $13 per month, and communications fees as low as $1 per hour, depending how you access BIX. A fixed–fee billing plan is available for people who don't like the notion of a clock ticking while they're logged in. We encourage you to log in by telnet to bix.com or x25.bix.com.

To sign up for the free BIX test drive, dial (800) 695-4882 or dial (617) 492-8300, enter ***bix*** when prompted and enter ***bix.ra*** at the Name? prompt. A step by step procedure will get you logged on to BIX. The same procedure works if you telnet to bix.com or x25.bix.com.

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Circle 450 on Inquiry Card.

AMD 5K86-P75
$75

Circle 1044 on Inquiry Card.

AMD, Inc.
Austin, TX
(800) 222-9323
(512) 385-8542
http://www.amd.com

The K5's Debut

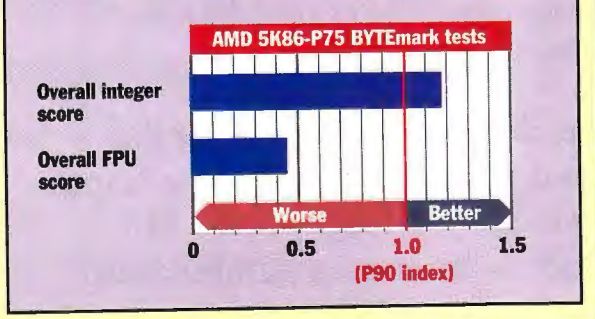
A 75-MHz version of AMD's long-awaited Pentium competitor, code-named the K5 and now officially called the AMD5K86-P75, came to BYTE housed in a generic, midrange office system. To test the widely held prediction that AMD's chip would run 30 percent faster than a same-speed Pentium, and to see how its shrunken die size (resulting from AMD's new 0.35-micron process) effects this prediction, we ran our BYTEmark CPU tests. The 5K86-P75's integer score, 20 percent faster than that of a 90-MHz Pentium—44 percent faster when factoring in the speed difference—confirmed the prediction. Its integer scores are on par with those of a P90, although all the FPU-based results lag by more than half (see the figure below).

Touted as a fifth-generation CPU, the 5K86's superscalar, superpipelined design also has sixth-generation traits, including a quad-issue pipeline with six parallel execution units and a four-way CISC/RISC decoder unit; out-of-order and speculative execution; dual reservation stations for each execution unit except the FPU; and register renaming. (For more architectural details, see "CPU Scorecards," November 1995 BYTE, and "AMD vs. Superman," November 1994 BYTE.) Soon after the chip's release in late April, AMD already had a respectable list of K5 customers, including Acer, Atrend, CyberMax, Epson, ICL, and Luiski.

With Windows 95 hardware certification, a standard P54C pinout, a compelling price ($75 for the AMD-P75 and $99 for the AMD-P90, versus $106 for 75-MHz Pentiums and $134 for P90s), and plans to ship 100-, 133-, and 150-MHz versions by the end of the year, AMD may finally enjoy some of the waning low-end Pentium corporate market.

–Selinda Chiquoine

AMD's P75 Excels at Integer Tasks



current operation of a 10Base-T Ethernet LAN adapter with a V.34 fax modem. The 10Base-T Ethernet adapter is IEEE 802.3 compliant and supports speeds up to 10 Mbps. The modem supports data speeds up to 28.8 Kbps (with V.42bis compression) and fax speeds up to 14.4 Kbps.
Contact: Linksys, Irvine, CA, (800) 546-5797 or (714) 261-1288; http://www.linksys.com.
Circle 1049 on Inquiry Card.

Direct-Connect PC Card Phone Jack

NOW CONNECTING YOUR PORTABLE TO A phone line is as simple as popping open SimpleJack on the 28.8 Communicator and plugging in a standard RJ-11 phone cord. The 28.8 Communicator with SimpleJack ($279) provides MNP 10-EC and TX-CEL cellular-correction technology for calling over a cell phone. Communications software for Windows 3.1 and 95 allows you to access the Internet as well as send and receive faxes and data.

Contact: Simple Technology, Santa Ana, CA, (800) 474-6753 or (714) 476-1180; http://www.simpletech.com.
Circle 1050 on Inquiry Card.

Videoconferencing Fax Modem

WITH THE SMARTLINK MWAVE DOCUPAL V.34 multimedia DSVD fax/modem ($439), two or more users can view and revise the same document on-screen simultaneously from various workstations. The modem can transmit data at speeds up to 28.8 Kbps, with maximum throughput up to 115.2 Kbps. It also offers a full-featured phone and digital answering machine with remote message retrieval. Sound Blaster–compatible audio/MIDI functions support music, voice-over, and 3-D effects.
Contact: Archtek America Corp., City of Industry, CA, (818) 912-9800; http://www.archtek.com.tw.
Circle 1051 on Inquiry Card.

ISDN PC Card

THE DIVA T/A (TERMINAL/ADAPTER) PC Card ($495) combines ISDN communications at speeds up to 128 Kbps with a plug-in modem for PCs and Macs. The card provides an ISDN Basic Rate Interface with two B channels and one D channel, supporting full COM-port speeds up to 128 Kbps with concurrent use of both B channels. The card supports PPP and SLIP and, with rate adaptation, it can also handle asynchronous protocols.
Contact: Eicon Technology, Inc., Dallas, TX, (214) 239-3270; http://www.eicon.com.
Circle 1052 on Inquiry Card.

External Modems

AVAILABLE IN LED AND LCD MODELS, Quicktel II modems include internal speakers, internal microphones, and jacks for external speakers and microphones. The modems include the V.34 DSVD/Speakerphone modem (LED version, $349; LCD version, $399) and the V.34 Speakerphone/Data/Fax/Voicemail modem (LED model, $299; LCD model, $349).
Contact: Logicode Technology, Inc., Camarillo, CA, (800) 735-6442 or (805) 383-2500; http://www.logicode.com.
Circle 1053 on Inquiry Card.

Multimedia

Multimedia Upgrade Kit for Laptops

WITH THE PORTASCSI MULTIPORT PORTable Multimedia Kit (battery-operated version, about $599; PC-powered version, about $499), you can add a quad-speed CD-ROM, a 16-bit audio PC Card adapter, and speakers to your laptop or notebook PC. The kit is MPC-II compliant and has a dedicated bus for the

CD-ROM drive for smoother multimedia playback.
Contact: Portable Systems Solutions, Inc., Phoenix, AZ, (602) 437-9103; http://www.portascsi.com.
Circle 1054 on Inquiry Card.

Peripherals

"Portable" SVGA Projector

THE LITEPRO 620 ($10,000 TO $12,000) features Texas Instruments' Digital Light Processing technology, a Harman International JBL audio system, the Kodak Color Matching System, and modular architecture. The 21-pound projector has a resolution of 800 by 600 pixels, and it supports full-motion video with a contrast ratio of 125:1 and NTSC, PAL, and SECAM video standards. The unit's Smart Remote features backlit buttons for controlling a PC

or Mac from up to 40 feet away, and the CableWizard allows you to easily connect your computer, audio, mouse, and monitor loop-through to the LitePro 620.
Contact: In Focus Systems, Inc., Wilsonville, OR, (800) 294-6400 or (503) 685-8888; http://www.infs.com.
Circle 1055 on Inquiry Card.

10X CD-ROM Drive

WITH ITS INTERNAL 5¼-INCH, HALF-HEIGHT form factor, the 10Xtreme ($299) IDE CD-ROM drive has a 1.5-MBps data rate, a 650-MB capacity per disk, a 300,000-page text capacity, a 1000- to 40,000-image capacity, a 1- to 48-hour audio capacity, and a 1- to 5-hour video capacity.
Contact: Pinnacle Micro, Inc., Irvine, CA, (800) 553-7070 or (714) 789-3000; http://www.pinnaclemicro.com.
Circle 1056 on Inquiry Card.

Convertible Printer

THE MULTIPASS C2500 (ABOUT $599) starts with bubble-jet printing and combines plain-paper faxing, 200-dpi monochrome scanning, 360-dpi copying, and PC fax capabili-

ties in one product. You get 720- by 360-dpi four-color printing on a variety of media, as well as up-to-5-ppm monochrome printing.
Contact: Canon Computer Systems, Inc., Costa Mesa, CA, (800) 848-4123 or (714) 438-3000; http://www.ccsi.canon.com.
Circle 1057 on Inquiry Card.

Write CDs with Your Mac

AN EXTERNAL CD-RECORDABLE DRIVE FOR the Mac, the CDMaker ($1095) lets you write your own CDs on a 650-MB CD. The product features 300-KBps transfer rates and supports single-session, multisession, and track-at-once writing methods.
Contact: CMS Enhancements, Inc., Anaheim, CA, (800) 327-5773 or (714) 517-0915.
Circle 1058 on Inquiry Card.

Up to 56 CD-ROMs on One Host Adapter

MDI'S EIGHT-HIGH CD-ROM TOWERS ($4095 to $5095) come with quad- or six-speed drives and SCSI Express software. The towers offer up to 1000-KBps data transfer rates, a 135-ms random-access time, a 120-ms random-seek time, and a 256-KB buffer, based on drive selection. They support CD-XA, CD-I, Video CD, and Multisession Photo CD and run in Novell, OS/2, Windows NT, and Mac environments.
Contact: Micro Design International, Inc., Winter Park, FL, (407) 677-8333; http://www.microdes.com.
Circle 1059 on Inquiry Card.

2-MB PocketJet Printer

THE LATEST POCKETJET PORTABLE PRINTER supports letter- and legal-size page printing and comes with 2 MB of memory. The direct thermal-print technology produces 300- by 300-dpi text and graphics. LaserJet IIP (PCL4) emulation enables you to print most Windows, OS/2, and DOS applications. The 2-MB PocketJet can print up to 3 ppm, depending on paper size and print density, and up to 35 pages on a full battery

charge. The Letter/Legal/2-MB PocketJet print system kit ($649) includes a rechargeable nicad battery, a universal AC adapter/charger, a parallel interface cable, a printer carrying case, and letter-size thermal paper.
Contact: Pentax Technologies Corp., Broomfield, CO, (800) 543-6144 or (303) 460-1600; http://www.pentaxtech.com.
Circle 1060 on Inquiry Card.

Systems

200-MHz Quad Pentium Pro Servers

YOU CAN CONFIGURE THE ALR REVOLUTION Quad6 200/256 with up to four Intel Pentium Pro processors for high-traffic, enterprise-wide server applications. Available with a 166- or a 200-MHz processor, the Revolution Quad6 incorporates 64 MB of ECC RAM, expandable to 2 GB; a 1-MB PCI graphics adapter; EISA-bus technology; and a dual PCI bus. The floor-standing tower

(from $14,495) offers 15 expansion slots; a double-wide chassis with 13 externally accessible storage bays; and ALR InforManager, which safeguards system operation by monitoring and reporting key operational data. The rack-mountable server (from $16,495) includes five shared PCI/EISA slots, redundant power supplies, 12 drive bays, and ALR InforManager.
Contact: ALR, Inc., Irvine, CA, (800) 444-4257 or (714) 581-6770; http://www.alr.com.
Circle 1061 on Inquiry Card.

Business Desktop and Minitower PCs

THE ACERPOWER SYSTEMS COME WITH 100- to 166-MHz Intel Pentium processors; Triton II PCI chip sets; 8/16 MB of EDO DRAM; 256 KB of pipeline burst cache; 1.2- to 2.0-GB hard drives; 2/4 MB of video memory or 0.5 MB of DRAM; Desktop Management Interface support; and Windows 95, NT, or Windows for Workgroups. The desktop chassis (from about $1275 to $2750) contain three ISA and two PCI expansion slots and four storage bays. The minitower chassis (from about $1350 to $3225) contain three ISA and four PCI expansion slots and seven storage bays. Options include 15- and 17-inch monitors, eight-speed CD-ROM drives, and a 16-bit Creative Labs sound card.
Contact: Acer America Corp., San Jose, CA, (800) 733-2237 or (408) 432-6200; http://www.acer.com/aac/.
Circle 1062 on Inquiry Card.

Web Phones

How universal is the Web? With the arrival of a new generation of digital cell phones, it will be just a phone call away. You can book a flight, check on a package, get a stock quote, or phone in a sales order to any public or intranet server attached to AT&T's Cellular Digital Packet Data (CDPD) wireless Internet-access service (which will be fully commercial in early 1997). And the handsets will cost little or nothing more than garden-variety cellular models.

MobileAccess Phone
Mitsubishi
Personal Mobile
Communications
Division
Sunnyvale, CA
http://www
.mitsubishi.com

UPLink Client and UPLink Server
Unwired Planet
Redwood City, CA
(415) 596-5200
http://www
.uplanet.com

Internet Phone
(code name)
AT&T Wireless Services
Wireless Data Division
Kirkland, WA
(800) 552-3373
http://www
.airdata.com

Emerging CDPD digital-cell-phone networks will carry IP packets to and from Web servers that use Unwired Planet's UPLink Server software. The servers run UP's Hand-Held Device Markup Language (HDML).

Netscape Navigator won't do here. Instead, Unwired Planet's UPLink Client browser software is embedded in special cell phones from AT&T and Mitsubishi. This browser translates HDML tags into a four-line display format.

With HDML, the Web-page designer creates "soft" buttons, assigned on the fourth line of the display, for interactive Web browsing. Each button activates a link on the server. Users can also enter data in forms with the alphanumeric phone keys.

DELL® LATITUDE® LM P100SD
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- NEW Multimedia Notebook
- ★ **11.3" SVGA Dual Scan Color Display**
- 8MB RAM/540MB Hard Drive
- 256KB L2 Cache
- ★ **Options Bay accepts 4X CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery**
- ★ **PCI Bus with 128-bit Graphics Accelerator**
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- Smart Lithium Ion Battery
- ★ **Touchpad/IrDA-1 Port**
- Under 7 pounds*
- Extendable 1 Year Warranty†
- ★ ***Upgrade to 16MB RAM, add $249.***
- ★ ***28.8 XJACK®/Cabled Modem, add $259.***

Business Lease: $104/Mo.
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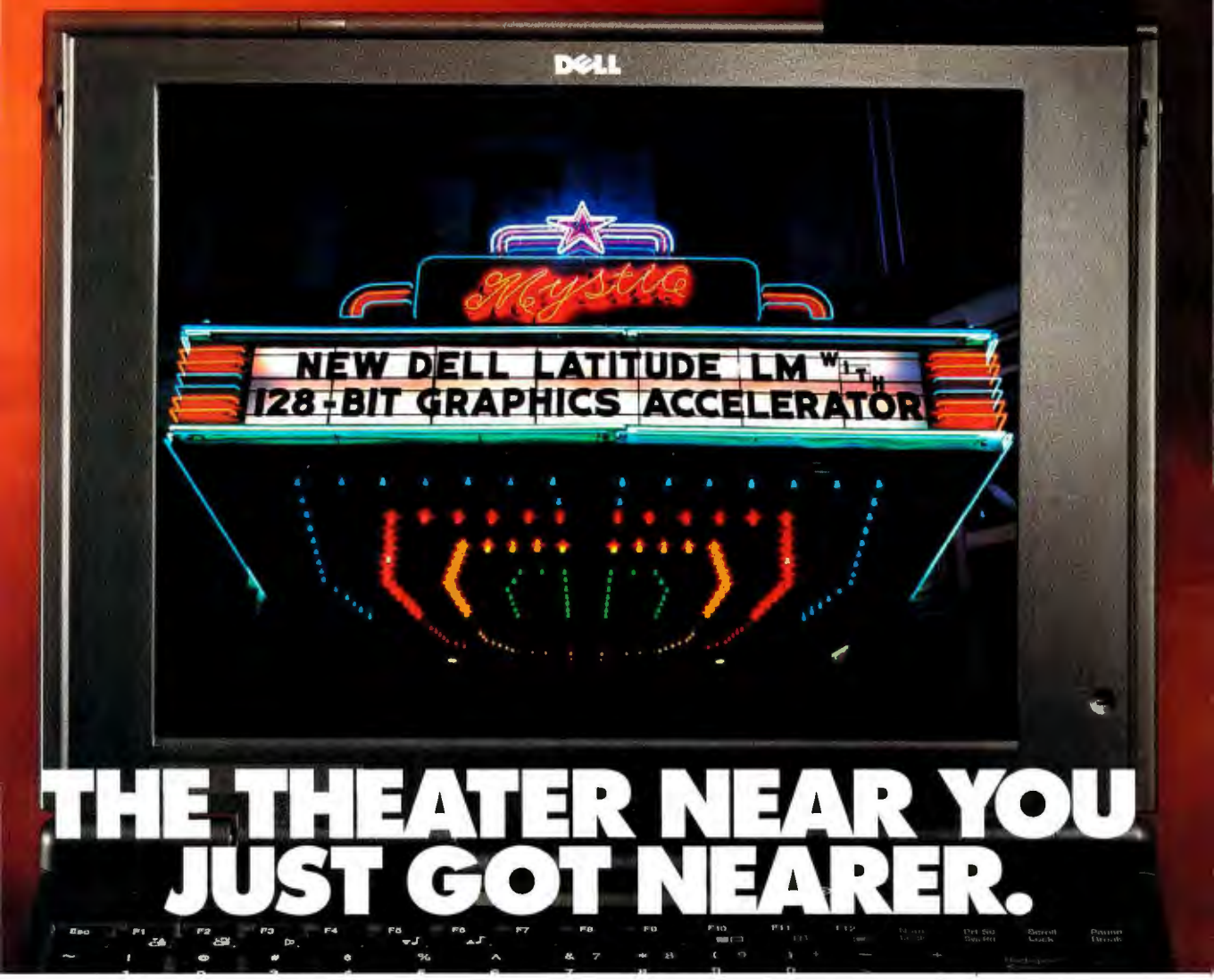

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Introducing the Dell® Latitude® LM notebook. The multimedia notebook with graphics so impressive, it's like having a theater on your lap. Boasting MPEG software and the Neo-Magic 128-bit graphics accelerator, it delivers video so clear you can run film clips in your presentations. The SVGA (800x600) screen lets you see even more of a good thing. And what's more, this system's built around Dell's Lithium Ion battery. Which means your graphics can dazzle crowds for hours and hours.

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- 11.3" SVGA Active Matrix Color Display
- 8MB RAM/540MB Hard Drive
- 256KB L2 Cache
- PCI Bus with 128-bit Graphics Accelerator
- Integrated 16-bit Sound with Built-in Dual-ported Speaker
- Smart Lithium Ion Battery
- IrDA-1 Port
- 19mm Optical Trackball
- 3.5" Floppy Drive
- 6.1 Pounds
- Extendable 1 Year Warranty†

★ *Upgrade to a 1.2GB hard drive, add $400.*
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$3899‡
Business Lease: $140/Mo.
Order Code #800047

133MHz PENTIUM PROCESSOR
DELL LATITUDE LM P133ST

- NEW Multimedia Notebook
- 12.1" SVGA Active Matrix Color Display
- 8MB RAM/540MB Hard Drive
- 256KB L2 Cache
- Options Bay accepts 4X CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery
- PCI Bus with 128-bit Graphics Accelerator
- Integrated 16-bit Stereo Sound
- Smart Lithium Ion Battery
- Touchpad/IrDA-1 Port
- Under 7 Pounds*
- Extendable 1 Year Warranty

★ *Upgrade to a 1.3GB hard drive, add $400.*
★ *2nd Lithium Ion Battery, add $249.*

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- Integrated 16-bit Stereo Sound
- Smart Lithium Ion Battery
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- 8X EIDE CD-ROM Drive
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- 16MB SDRAM Memory
- 256KB Pipeline Burst Cache
- 2.5GB Hard Drive [12ms]
- 15LS Monitor (13.7" v.i.s.)
- 9FX Motion Graphics Accelerator with 2MB VRAM
- 8X EIDE CD-ROM Drive
- MS Office Professional with Bookshelf for Windows 95
- Integrated Sound Blaster 16 Sound
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- 64-bit PCI 2MB DRAM Video
- 8X EIDE CD-ROM Drive
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