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Volume 21, Number 2

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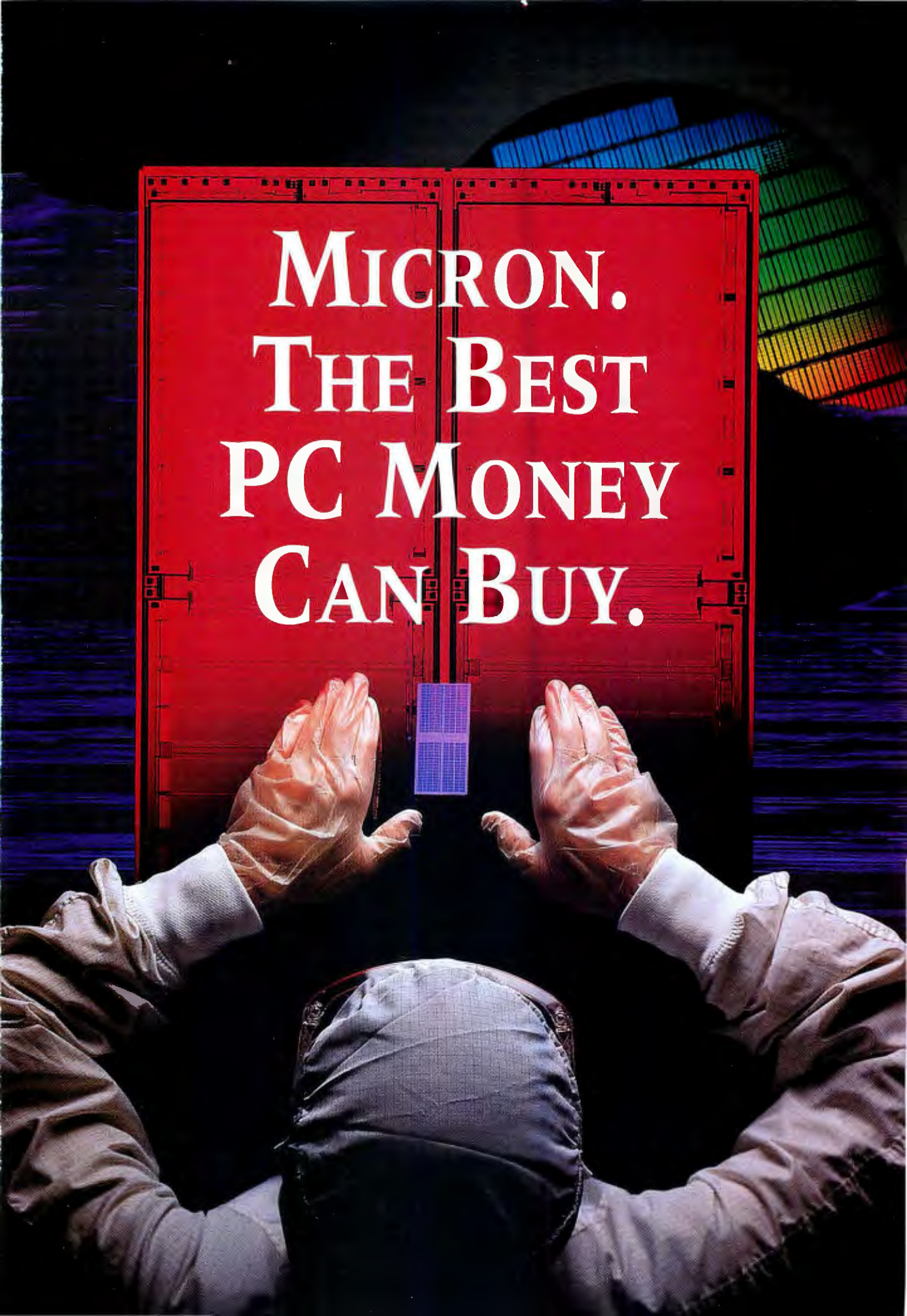
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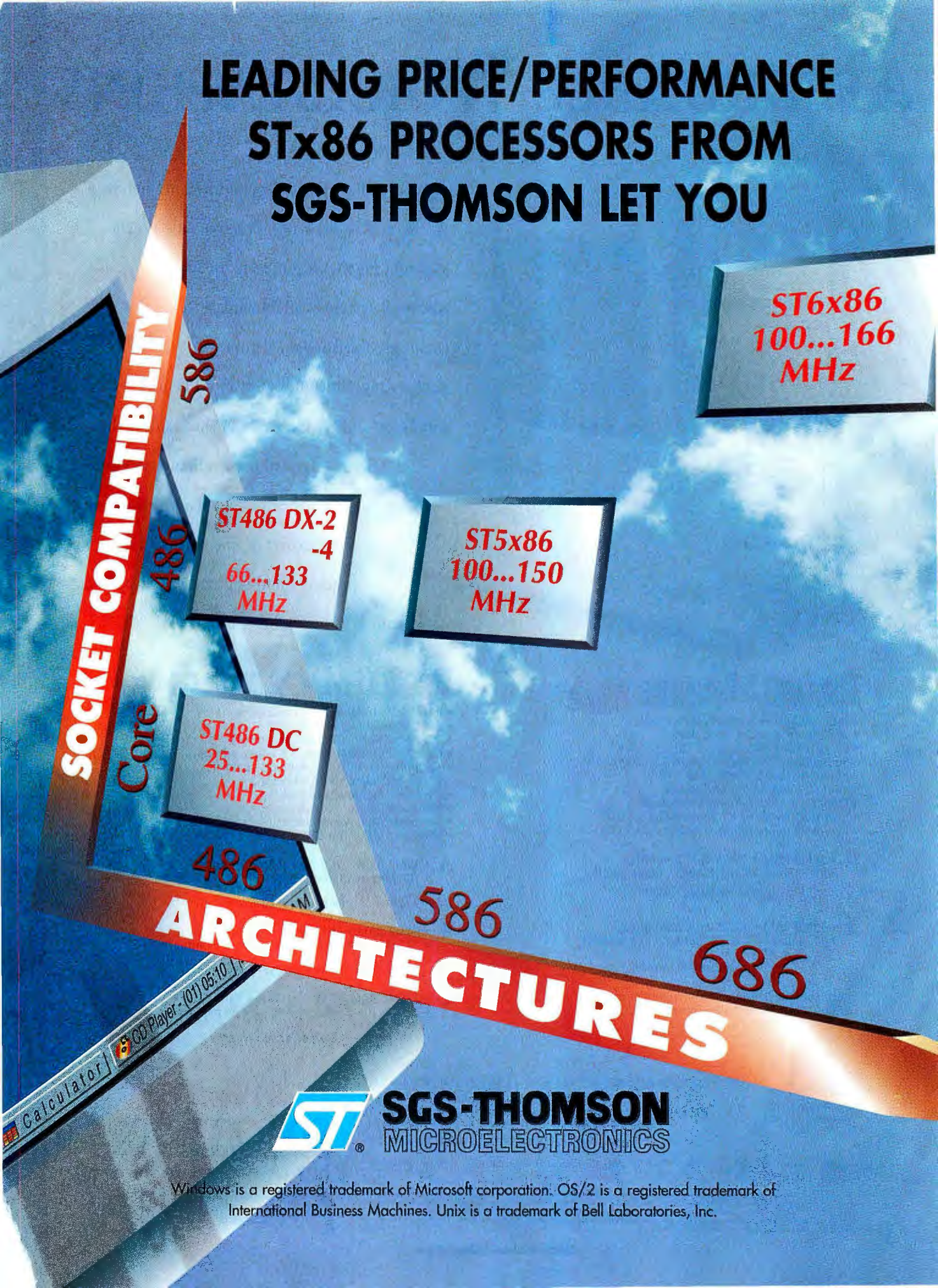
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BYTE

February 1996 VOL. 21, NO. 2

COVER STORY

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BY EDMUND X. DEJESUS

Tune in tomorrow when the Internet takes over audio and video broadcasting.

Unix Special Report

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BYTE Contents by Platform

This page presents articles according to computing platform.

DOS/WINDOWS

OS/2

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NETWORKS

Index

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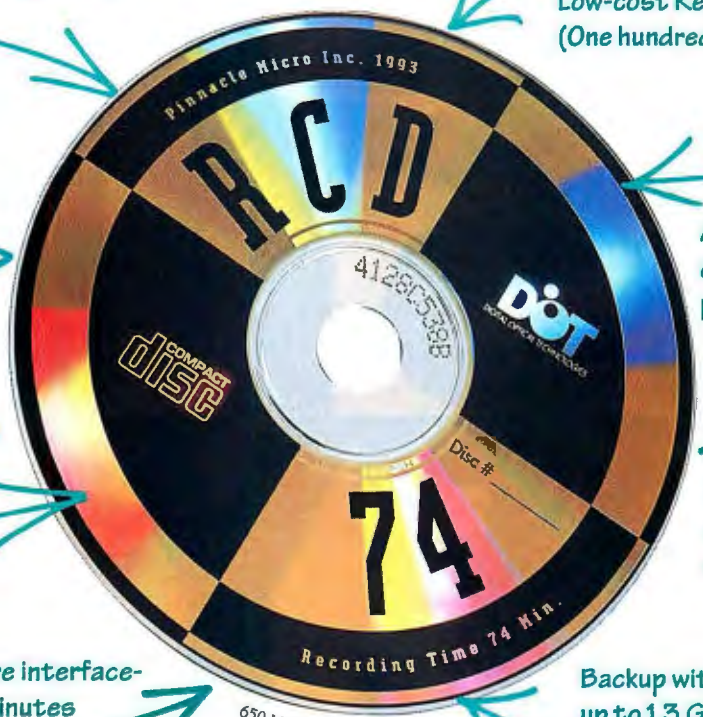

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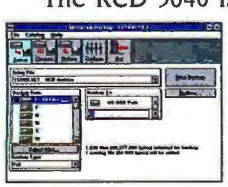

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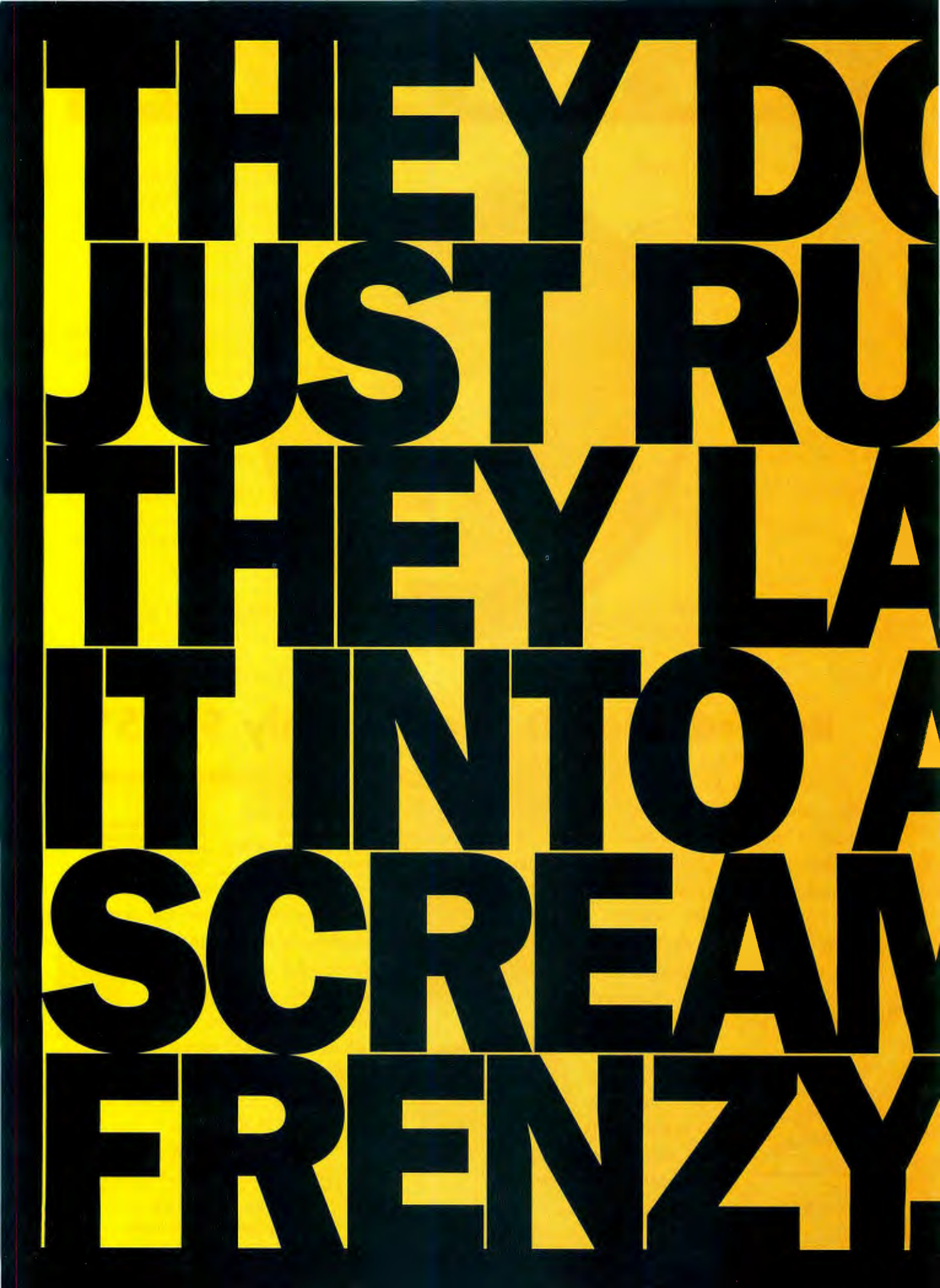
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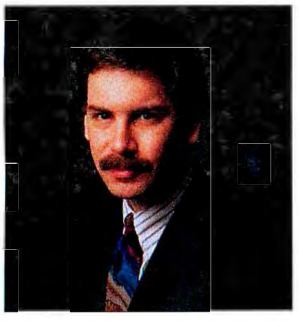

Has the PC met its match? Is the concept of stand-alone computing power obsolete? It is for some people, but not for me.

Lou Gerstner and Larry Ellison believe in it. Michael Dell does not. Bill Gates doesn't care, as long as he collects the rent. Love it or leave it, all the architects of the computer industry are clamoring about the concept of the Web PC—a low-cost, easy-to-use network terminal that, some people say, could replace the current model of power on the desktop.

It's an attractive counter to an unfortunate trend: The price of computing is going up. Pile more RAM, huge hard drives, larger screens, and multimedia hardware on top of yesterday's $3000 box, and suddenly you've got a $4000 budget-buster.

Not only is computing more expensive in parts, it's more expensive in time. Sure, you can get bare-bones functionality as soon as you unpack the thing, but after a few months of serious use, any Windows PC will be clogged with dead files and creeping toward a maintenance aneurysm.

The Web PC is supposed to change that, mainly by using the Internet (or whatever the Internet evolves into) as the repository for the bulk of its code—OS, applications, and data. Things won't get messed up as quickly, because end users won't be able to clog their own computing arteries. Software will be distributed over the 'net. OSes will be upgraded at some central office. And you'll be able to access your data from anywhere—like you do TV programming.

For some home users and a lot of office workers, the concept works. Say you support 100 workers in your office. Why should you have to support 100 instances of a platform that contains an OS, applications, utilities, and complex, convoluted hardware, when all most users do is word processing and E-mail? Why not, instead, move toward a variant of terminal-based computing, where professionals maintain the central repository of power and software, and meter it out as a resource to those who need it?

That's the image that proponents of the Web PC are trying to sell us. Like I said, it works for a large group of home users and office workers. But there are problems with the model. First, it's unworkable today. Second, there are many people for whom the model will never work. Third, there's the huge cultural addiction to the private ownership of technology, which I won't even begin to dissect here.

Technically, here's why the model doesn't work today: In a word, it's bandwidth. Moving an OS and large applications across the Internet just isn't feasible with today's phone lines or even with residential ISDN. However, once cable companies start to offer high-speed cable modems, this problem may be solved. And inside a company, the terminal model does work: Even basic, cheap, 10-Mbps Ethernet is fast enough for the majority of everyday corporate applications.

The real issue, though, is the cost of bandwidth. Even when the infrastructure is in place to support the Web PC model, people will still have to pay for connectivity. It may simply be less expensive to load down a high-powered PC with the code you need, instead of loading it over the 'net each time you want to use it. As complicated as a PC is, it works pretty well for a lot of people. Warts and all, a PC or a Mac is an efficient repository for advanced software.

Moreover, a lot of people need to work while untethered from any network. Look at the Laptop Brigade on your next airplane trip. Until each airliner gets a high-speed link to the 'net, portable-computing users will remain tied to their notebooks. In that case, and in many similar situations, the current PC model looks like the only solution.

The whole concept of the Web PC is so crucial—and is evolving so fast—that we've changed our editorial calendar to address it. We're working on a feature about the topic that will run next month. This month, we're covering an equally important topic: *the* growing use of the Internet to supplant broadcasting. The two trends are closely related, of course. So pay attention. The fabric of computing is changing as we watch. ■

RAPHAEL NEEDLEMAN, EDITOR IN CHIEF
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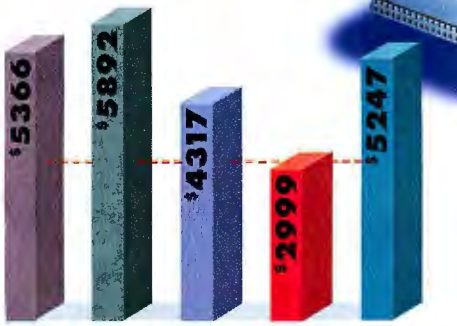

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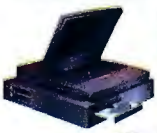

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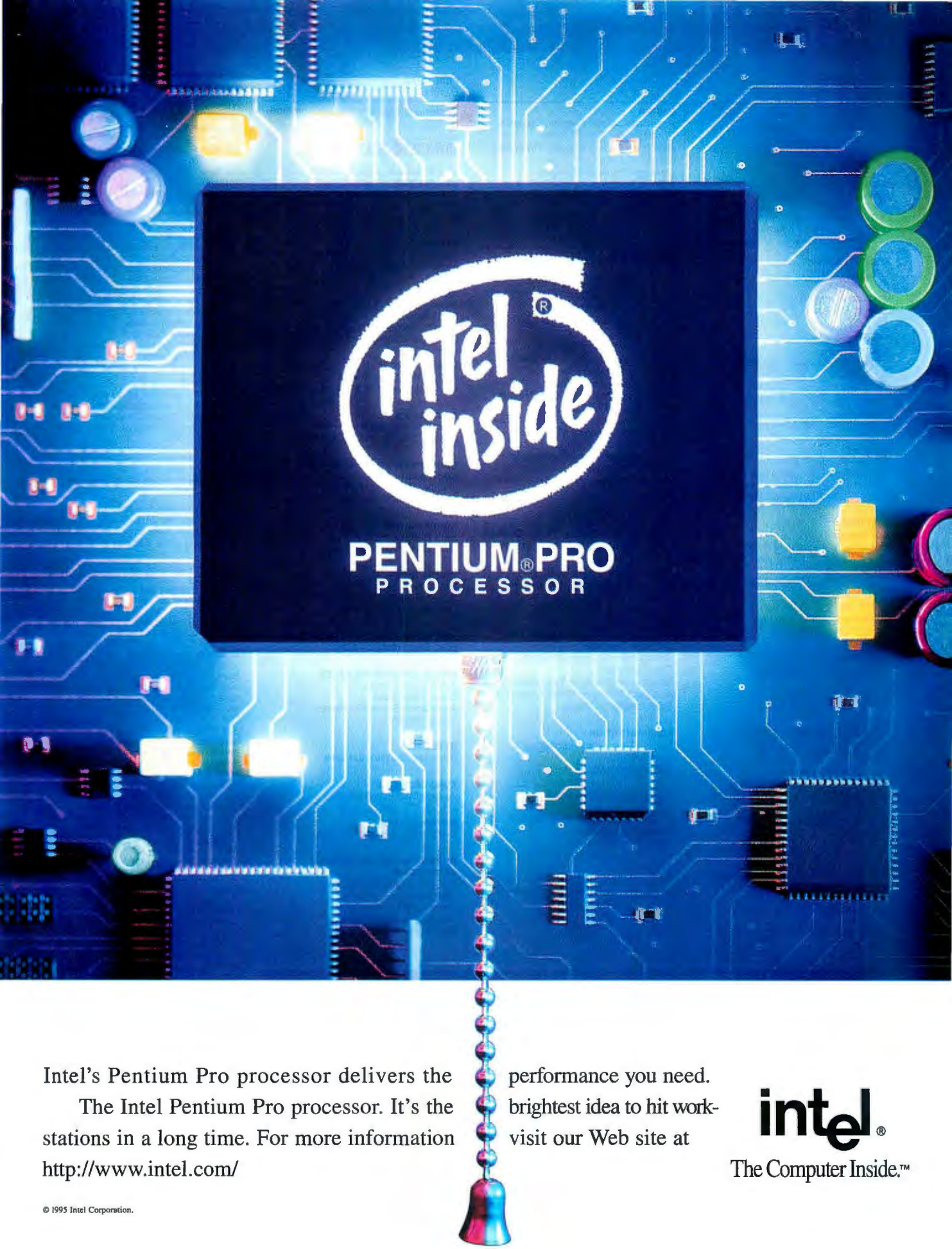

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SyncMaster	15GLi	17GLi	17GLsi
Flat Square CRT	15"	17"	17"
Dot Pitch	.28	.28	.26
PC Compatibility	1280x1024@60Hz	1280x1024@60Hz	1280x1024@80Hz
Mac Compatibility	1024x768@75Hz	1024x768@75Hz	1152x870@75Hz
Color Temperature Selection	•	•	•
UltraClear Coating™	•	•	•
Limited Warranty	3 Years	3 Years	3 Years

Actual viewable areas are 13.8" (15GLi) and 15.75" (17GLi and 17GLsi).

"We were impressed with the picture quality and feature sets of both units, and their relative value makes them top choices."

PC Magazine – Sept. 12, 1995, on the SyncMaster 17GLi and 17GLsi monitors.

PC MAGAZINE EDITORS' CHOICE™

September 12, 1995
Samsung SyncMaster 17GLi

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SAMSUNG

New Back-UPS® Pro™ PnP itself the first time you use

Experts agree: Windows 95 demands APC protection

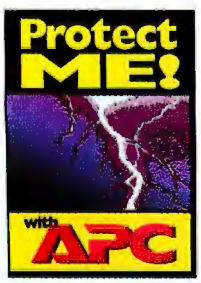
If you're using a computer, few things are more certain than power problems. If you haven't yet had a blackout, lost a hard drive, or toasted a modem, you will. It's almost a statistical certainty.

No surprise that *PCWeek* showed power problems such as blackouts, brownouts, and surges accounted for almost as much data loss as all other factors combined, or that a leading accounting firm attributed the largest single cause of computer downtime to—you guessed it—bad power.

MULTI-TASKING MULTIPLIES YOUR RISK OF *"THE BIG ONE"*

Multi-tasking operating systems like Windows 95 let you open and manipulate multiple files and applications at the same time. That's why, unfortunately, as *PC Magazine* says "When Windows 95 does crash, it's a horrible mess..."

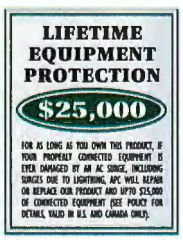
Moreover, if you are "wired" to the Internet, an on-line service, or dialing into the office, you'll discover that phone lines are common paths for surges taking the express route direct to your motherboard.



In short, if you still don't have proper protection (that $5 surge strip doesn't count) it's time to protect yourself before you kick yourself. Experts agree: If you choose not to decide on proper protection now, the next time you see this ad may be too late.

ROI IN THE BLINK OF AN EYE

More than 4,000,000 smart computer users protect against the inevitable with the affordable: award-winning power protection from APC, including the UPS that's winning praise the world over: the Plug n Play Back-UPS Pro. Ask them and they'll tell you: One prevented problem is all it takes to pay for proper power protection many times over.



BACK-UPS PRO PNP UPSS FEATURE:

- Instantaneous battery backup protects your data against a total loss of power.
- Automatic Voltage Regulation (AVR) provides the edge you need for full protection against extended brownouts or overvoltages without draining the battery.

MORE THAN 4,000,000 SATISFIED USERS SAY "PROTECT ME! WITH APC"

CLOCKWISE: " I'm an electrical engineer, and understand what's needed to protect a Pentium-class machine. I recommend these to everyone I know," says Jim Rawnick. "I especially like the Back-UPS Pro because it compensates for voltage irregularity without kicking over to battery."

"We've had great experience with APC," says Gordon Zellers. "The Back-UPS Pro has great features: it tells you if the battery is getting low, and they're user-replaceable with no hassle. As a small business, our computers and phones are vital to us. So is APC protection..."

"As a Fortune 500 company, we've used APC for at least 6 years," says Matt Lazar of Phelps-Dodge subsidiary Columbian Chemicals Co. "The new Back-UPS Pro PnP is easier to use than ever and is now our preferred UPS for our corporate PC's."

- CellGuard™ intelligent battery management dramatically extends battery life with fast recharge and deep discharge protection. Battery diagnostics warn you before problems occur and batteries are quickly and safely user-replaceable without needing to shut your system down. (Batteries last 3-6 years under normal use).
- $25,000 lifetime repair/replace guarantee against surge damage to your equipment (see details).
- Built-in phone line/10Base-T network cable surge protection for a bulletproof response to anything Mother Nature or Murphy's Law sends in your direction.

So don't wait for the school of high shocks to teach you an expensive lesson. Ask for APC today.

FREE software!

You get safe automatic shutdown, power event recording for power quality analysis, real-time UPS status, and certified Win95 compatibility for quick and easy installation.

Currently supports Windows, Windows 95, Windows NT, Windows for Workgroups and OS/2.

pays for it

"[With Windows 95]..Users have more data at risk than ever before... A UPS is quickly becoming a must... "
ComputerLife

"Don't take chances. Get the ultimate protection... from APC." **PCWorld**

Designed for Microsoft Windows 95

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Microsoft

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PC Computing

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Choosing the right APC protection

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Back-UPS PRO

Advanced PC Protection: For Pentium, 486, Win 95, and Business Applications

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650PNP	(Includes software)	$419	17 min
1000	(software not included)	$589	35 min
1400	(software not included)	$759	74 min

*Runtime shown is for typical Pentium desktop system and may vary with your actual load. Note: Back-UPS 200 not recommended for Pentium systems

Back-UPS

Basic PC Protection: For 286, 386, Entertainment, and Education

Volt-Amp Rating		List Price	Runtime*
200	(software not included)	$119	-
280	(software not included)	$139	7 min
400	(software not included)	$199	13 min
450	(software not included)	$254	24 min
600	(software not included)	$359	31 min
900	(software not included)	$529	47 min
1250	(software not included)	$689	75 min

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The Story Works!

"How Software Doesn't Work" (December) provided a very good overview of the ills that software is heir to, and concise advice on how to avoid some of them. One approach, rediscovered every few years since the mid-1960s, is to document the software before any code is written. Many managers have found that writing user manuals at the start of a project has extensive benefits. Software tool suppliers claim their products make software development fast, painless, and foolproof. It isn't, and I doubt it ever will be. Articles like yours are a reminder that tools and technology are no substitute for careful development management.

Rod McIntosh Shand
West Vancouver, B.C.

Computer magazine editors complain about software quality and the increase in the number of bugs. Your article "How to Build Reliable Code" (December) offers an excellent way to combat this problem. Small vendors will profit by producing more reliable code—less time on technical support, more time to thoroughly test new features—and more reliable code allows them to compete with large software houses. Your comments on features and documentation are right on target!

John A. Jackson
President & CEO
LWE Research, Inc.
73353.121@compuserve.com

Recent problems with the nation's air-traffic control system have been hardware problems and cannot be attributed to software, as you would have your readers believe. I am working with a dedicated team to replace the IBM 9020e subsystem you cite with a modern processor retaining as much of the original software as possible. That this is a legacy system should indicate that the software on it, no matter how old, is extremely reliable. Claiming our collision-avoidance algorithms are unreliable is another example of ignorance, since our Conflict Alert software runs on a fast, modern CPU. While some of our software may have had its start in the 1970s, we have continually upgraded and improved its capability using methods that ensure quality. We cannot and will not make changes to the system just because it's fashionable or because the current software is "old." Would you want us to switch platforms right now and run the air-traffic control system on Windows 95?

Mark Kelsey
Kelsey Software Consulting
Northfield, NJ
MARKelsey@aol.com

The age and shortcomings of the 9020e computers and other hardware used in the air-traffic control system are well documented. We never said "collision-avoidance algorithms are unreliable." Rather, we discussed outdated hardware and last summer's failures in our story about software reliability because the complexity of developing and testing a new generation of software is one of the reasons hardware upgrades have been delayed. We used the air-traffic control example, and many others, to show how widespread is our reliance on software that controls critical systems.

—Alan Joch, senior editor

Party Crasher

I rely on your usually excellent articles about operating systems, but in "Crashing the Party" (Special Report, November), the statement "In both Windows 3.1 and 3.5, available memory can also become exhausted if more than 100 threads or processes are launched simultaneously" is simply false and appears to indicate confusion about the difference between threads and processes and how modern operating systems provide multitasking. Further, if what you wrote were true, it would not introduce "the slim possibility of another sort of calamity" but a very frequent crashing, because on NT it is very easy to have more than 100 threads running.

Jim Reynolds
jreynold@tarun.mitre.org

You are right—we managed to suggest that processes and threads required like amounts of memory. We should have limited that statement to processes. Windows NT treats processes and threads similarly in that it allocates a certain amount of physical memory for each process or thread object created, but it requires significantly less memory to support a thread. *—Eds.*

Menu, Please . . .

In your review of HTML tools ("Web Publishing Made Easier," December), you say "there's no way to add rows or columns to a table besides using a text editor ... and then reimporting the new text file into HotMetal." You missed the Markup/Edit_Table menu, obviously. In the screen shot on page 173, you say "[Spider's] window is more representative of the Web page." Perhaps you missed the View/Hide_Tags and View/Hide_URLs menu, too? I did like your point about a Windows 95 bug making it nearly impossible to import other formats: I assumed Rich Text Format import just didn't work. I transferred HotMetal Pro to another computer running Windows for Workgroups, and the import worked flawlessly.

Gene Saunders
Senior systems engineer, SunSoft
Gene.Saunders@Central.Sun.COM

P6 Weakness

What a wonderful world we live in. Microsoft's benevolent influence is so great that you counted the P6's 32-bit optimization as a technological disadvantage ("CPU Scorecards," November).

Dean Roddey
Dean_Roddey@FIDO.qmi.mei.com

The P6's optimizations for 32-bit code are not a disadvantage. But the chip's poor performance when running 16-bit code will be a distinct disadvantage to anyone using Windows 95, Windows 3.1, DOS, or 16-bit application software. There's nothing wrong with tuning a next-generation processor for 32-bit code, but Intel could have achieved good 16-bit performance as well, and without major sacrifices.

—Tom R. Halfhill, senior editor

I am in no way distressed that Intel's P6 chip shows weakness when running 16-bit code. Intel should abandon unnecessary functionality and produce chips with less than 100 percent compatibility with its earlier chips. The result would be an ideal chip for workstations running Win-

We want to hear from you. *Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458; or you can send E-mail via the Internet or BIX to editors@bix.com. Letters may be edited.*

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In fact, *New Media* magazine was so impressed with the Filepro Performance 4207 that they voted it the top A/V disk drive performer in the 4 GB category.

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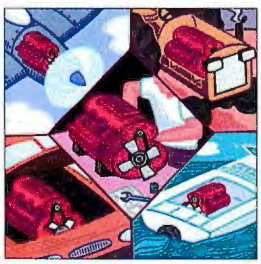
Circle 603 on Inquiry Card.

dows NT or Unix and the basis for the next generation of Intel chips—a pure 32-bit, flat-model CPU, with binary compatibility for all Win32 and OS/2 applications.

Phil Jollans
Wolfratshausen, Germany
100275.2756@compuserve.com

While your suggestion would reduce the complexity of the P6 (Pentium Pro) and probably increase its performance, another result would be howls of protest from x86 users. Intel's best argument in favor of the x86 is its backward compatibility with existing software. If you take that away, there would be no reason to buy an x86 chip instead of a RISC chip. It will be interesting to see if Intel can maintain full x86 compatibility in the new processor it is designing with Hewlett-Packard.



—Tom R. Halfhill, senior editor

Tourist or Native?

Although BYTE consistently demonstrates high editorial standards, we noted with concern that your Special Report "And One for All" (November) contained inaccurate statements about our product, XVT. In particular, author David Linthicum told readers our product was not native and that its functionality reflected only the small set of capabilities common to all the GUIs supported. As our product is a thin-layered API that calls the native windowing system, this statement is incorrect.

When the article says XVT does not contain such features as MDI and geometry management, it is clearly incorrect again. Our products contain both these features, as well as many other features not common to all supported platforms, including portable help, printing, data structures, MVC implementation, font selection, and a set of common dialog boxes, to name a few.

Dave Locke
Director of Marketing, XVT Software
davel@xvt.com

I did not intend to attack XVT or other portable tools but to enlighten developers on the trade-offs involved when building portable applications. The article did not state that XVT was "not native," only that lowest-common-denominator (LCD) portable tools are not able to support all native features to remain portable. For instance, page 2-1 of the "XVT Platform-Specific Book for MS Windows" states: "If ... you need to provide some native-platform GUI functionality not available in the XVT Portability Toolkit, then the ... code that provides that functionality will be non-portable." MDI does not appear in the "XVT Portability Toolkit Reference" index but is listed in Appendix A: "Non-Portable Attributes, Escape Codes, and Functions" of the "XVT Platform-Specific Book for MS Windows." The fact is, you can't be all things to all platforms and still provide portability. While I discussed LCD from a conceptual standpoint, using XVT as an example, I also stated that "most tools fall somewhere between the LCD and emulation approaches." That includes XVT.

—David Linthicum

The Price Isn't Right

In the December Lab Report ("16 Pentiums High on Win 95"), our Austin PowerPlus 133 was fortunate enough to win Best Overall designation. Unfortunately, the system price we quoted BYTE ($3807) was well below the actual cost. We apologize for this error.

Don E. Gross
Director of marketing communications
IPC Technologies

FIXES

The Gopher protocol and software were developed at the University of Minnesota, not at the University of Michigan as we mistakenly reported in "How to Build an Internet App" (Programming column, December). In the same article, we located the Weather Machine Gopher server (wx.atmos.uiuc.edu) at the University of Indiana; in fact, it is located at the University of Illinois at Urbana-Champaign.

Due to a copy-editing error in "BYTEmark Bug Bashed" (December), we defined LU as logical unit. The correct expansion is lower/upper, which describes the way the original matrix is decomposed into upper and lower triangular matrices.

In "Phone Lines Stymie V.34 Modems" (November), the area code for U.S. Robotics was incorrect. The correct number is (708) 982-5151.

In "How Software Doesn't Work" (December), we described the IBM 9020e mainframe as a vacuum-tube machine. The 9020e is based on IBM System/360 technology and uses no vacuum tubes. ■

Our engineers blew out a few pocket protectors on this one.

Sam "Guru" Miller,
Manager, New Product Development

To say that ViewSonic's new SonicTron™ 21" (19.5" viewable) monitor has a great picture hardly does it justice. Actually, it's better than great. Even the most particular CAD/CAM/CAE users and desktop publishers are staring in wide-eyed amazement.

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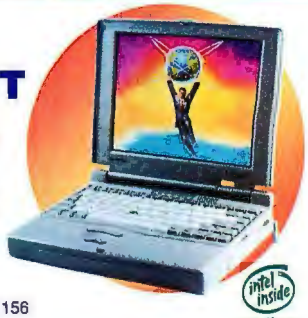

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New Media Wave Jammer sound card 216.71
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Simple Tech SCSI adapter 103.26
Simple Tech 170MB hard drive 378.61
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NEWS & VIEWS

PC PROCESSORS

Win 95 Roars with Pentium-Class PCs

Intel's relentless drive to make the Pentium the PC standard for running mixed 16-/32-bit software continues, but its competitors aren't far behind

DAVE ANDREWS AND DAVE ROWELL

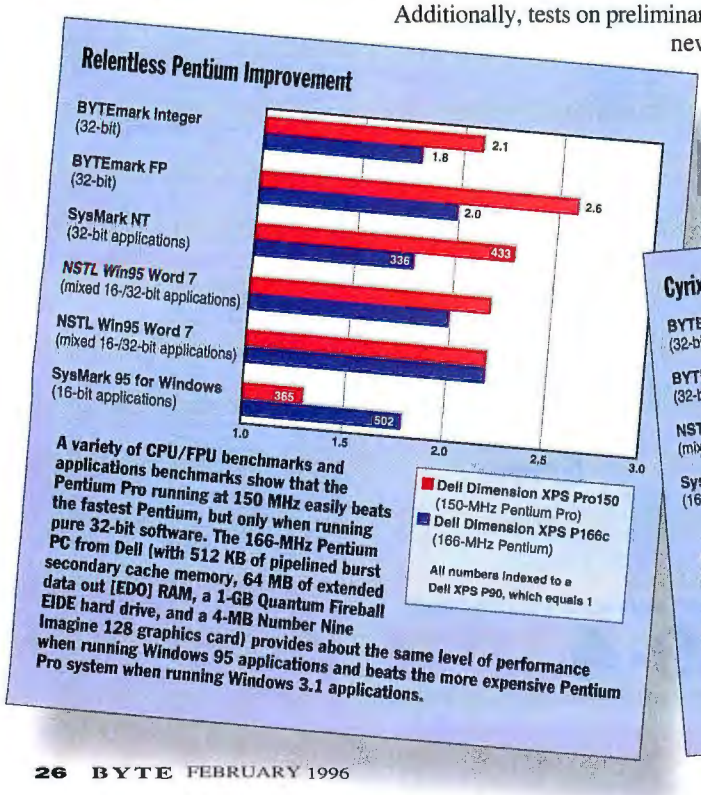
New processors from Intel, Cyrix, and NexGen will provide the best solutions for running 16-bit Windows and mixed 16-/32-bit Windows 95 applications compared to Intel's more expensive Pentium Pro. Although the Pentium Pro ushers in new levels of x86 computing power when running pure 32-bit Windows NT applications (see "Pentium Pro Makes NT Fly" on page 155), a variety of tests confirm that Intel's top Pentium (running at 166 MHz) provides equal or better performance at a lower price when running Windows 3.1 and Windows 95 applications.

Additionally, tests on preliminary reference computers with the new 6x86 processor from Cyrix (Richardson, TX) indicate that the 6x86 will compete well against Intel's Pentiums. The first 150- and 166-MHz Pentium-based PCs will be available early this year. Cyrix expects the first 6x86 processors to ship in this quarter.

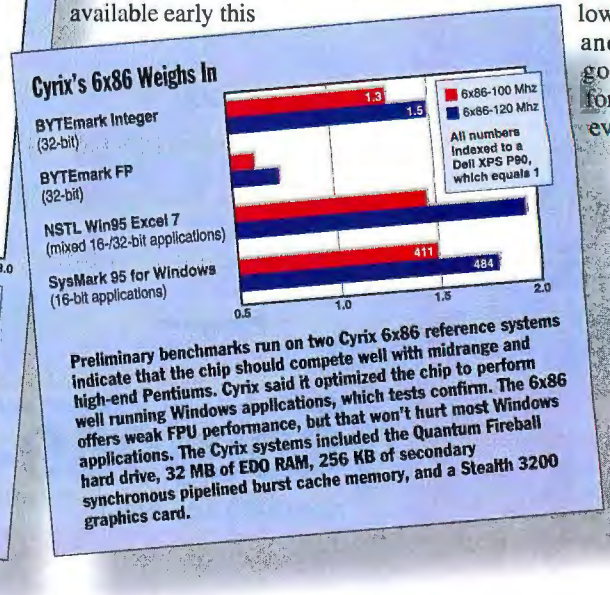
Intel's latest Pentiums will be priced aggressively. Traditionally, Intel introduces its highest-powered chips in a family at the $900 to $1000 price range. But the 150- and 166-MHz Pentiums will sell for $547 and $749 each in quantities of 1000.

Cyrix will price its 6x86 competitively as well. The company had not announced final pricing for the 120-MHz version of the chip at press time, but the 100-MHz 6x86 will sell for $540 each in quantities of 1000. Also, NexGen (Milpitas, CA), another Intel competitor, has released new versions of its Nx586 processor. NexGen's P120 ($303 each) and P133 ($447 each) processors, which are clocked at 120 and 133 MHz respectively, should compete with midrange Pentiums.

When running pure 32-bit software, the Pentium Pro is still the king in the x86 world. However, its poorer performance when running a mixture of 16- and 32-bit software means that Intel's best processor for running 16-bit and mixed 16-/32-bit software is the Pentium, and that chip will soon have stronger competition. To protect its market share, Intel is pricing the Pentium aggressively, and Intel's competitors must react by pricing their chips aggressively, too. That means higher-powered PCs at lower prices, and that's good news for PC users everywhere.



A variety of CPU/FPU benchmarks and applications benchmarks show that the Pentium Pro running at 150 MHz easily beats the fastest Pentium, but only when running pure 32-bit software. The 166-MHz Pentium PC from Dell (with 512 KB of pipelined burst secondary cache memory, 64 MB of extended data out [EDO] RAM, a 1-GB Quantum Fireball EIDE hard drive, and a 4-MB Number Nine Imagine 128 graphics card) provides about the same level of performance when running Windows 95 applications and beats the more expensive Pentium Pro system when running Windows 3.1 applications.



Preliminary benchmarks run on two Cyrix 6x86 reference systems indicate that the chip should compete well with midrange and high-end Pentiums. Cyrix said it optimized the chip to perform well running Windows applications, which tests confirm. The 6x86 offers weak FPU performance, but that won't hurt most Windows applications. The Cyrix systems included the Quantum Fireball hard drive, 32 MB of EDO RAM, 256 KB of secondary synchronous pipelined burst cache memory, and a Stealth 3200 graphics card.

MULTIPLATFORM COMPUTING

PowerPCs Still a Spec on the Horizon

"The waiting is the hardest part," according to a song by Tom Petty, and that's what users will have to do now that Apple, IBM, and Motorola have released the PowerPC Platform specification. A number of hardware vendors, including Canon Computer Systems, DayStar Digital, FirePower Systems, IPC Technologies, Pioneer Electric, Power Computing, Radius, and Zenith Data Systems, say they will release platform-compliant systems, but most of them won't appear until the second half of this year.

Meanwhile, Intel and other developers of PC-compatible processors continue to bring new levels of affordable computing power to the PC desktop. The PowerPC Platform (formerly known as the Common Hardware Reference Platform, or CHRP) provides an open industry standard that can host a variety of OSes. The standard provides plug-and-play capabilities through the Open Firmware boot environment and the Peripheral Component Interconnect (PCI) 2.0 bus.

The PowerPC's bi-endian addressing capabilities will let it run the Mac OS, Windows NT (but not Windows or Windows 95), AIX, Solaris, OS/2, and NetWare. This will allow you to run one OS and then—after rebooting the system—another one. Big companies may want to purchase a large number of systems with the same base configuration and let each department run the OS of its choice.

Although the PowerPC alliance consists of several powerful companies, analysts say it will be difficult to compete directly with Intel. "It's very risky and costly to go head-to-head with Intel, which will fight to the death to maintain its market share," says Mike Griffith, senior analyst at In-Stat (Scottsdale, AZ), a market research firm. "The PowerPC has established beachheads in the workstation and Apple markets, but these are two areas that Intel hasn't focused on."

Although performance is important, Griffith maintains that the PowerPC alliance will have to compete with Intel on a number of fronts, including production capacity, distribution, sales, and marketing. Intel's aggressive pricing will make this task even harder, he says.

"Unless it is considerably faster, cheaper, and more open to more things, I am not sure it will attract a lot of interest," says Dan Maude, president of Beacon Application Services (South Natick, MA), a developer of accounting, payroll, and production systems for Fortune 500 companies. "Most of what we do is Unix or NT, and the client is usually Windows. Fortune 500 companies tend to be a cautious bunch, the plumbing is already in place, and the plumbing's not really leaking."

Other administrators embrace the PowerPC Platform concept wholeheartedly, however. "Standardizing on a hardware reference platform will let us reduce costs and time to repair," said one vice president at a large investment bank in New York City. "Having a machine that can perform double or triple duty makes sense, and a common hardware platform will make it easier to service systems at our international offices."

—Tom Thompson and DA

POWERPC PLATFORM HIGHLIGHTS

- **A minimal system has a PowerPC processor, 8 MB of RAM, 4 MB of OS ROM, an RS-232 serial port, and an IEEE-P1284 parallel port. Desktops and portables (but not servers) are required to have 16-bit stereo.**
- **8 KB of nonvolatile RAM is required to store system configuration information. Systems hosting more than one OS may require more.**
- **DMA and an Open Programmable Interrupt Controller to handle device interrupts are required.**
- **In a compromise to both Mac and PC vendors, the specification supports SCSI and IDE, IBM PS/2 and Apple Desktop Bus (ADB) mouse interfaces, and 16550-compatible and SCC (Mac-specific) serial ports. A Mac I/O ASIC handles Mac-specific I/O.**
- **The standard defines a common hardware architecture but allows room for differentiation.**

INTERNET

Web Forces Change

In his book *The Road Ahead*, Bill Gates predicts that the Internet will transform businesses worldwide. His words were prophetic for Microsoft: Shortly after the book's publication, the company announced a series of initiatives to incorporate the Internet into its products, including the surprise announcement that it would license Sun Microsystems' Java for incorporation into its products. This announcement marked a rare departure for the company, sanctioning a product that it did not buy or develop.

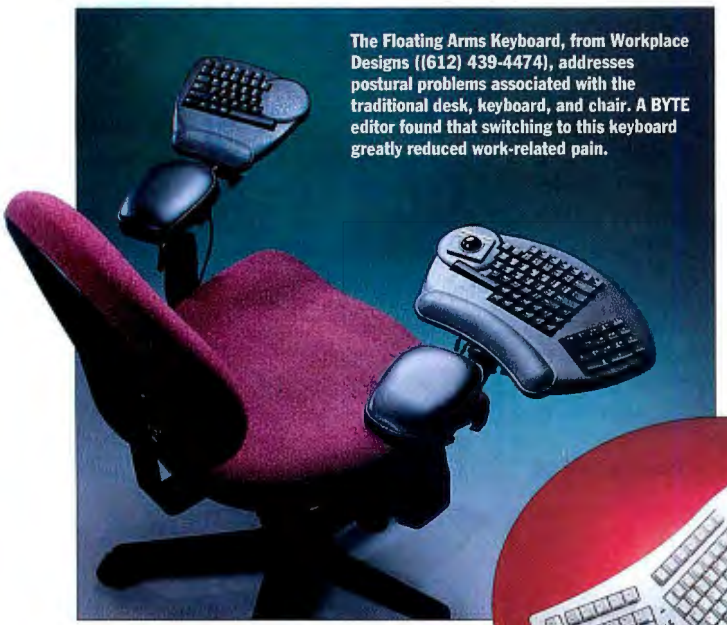
Other companies—ranging from personal finance and groupware vendors to on-line services—are also changing their business strategies to incorporate the Internet. One benefit to consumers will be cheaper software. Some resellers that sell expensive, specialized software like CAD won't sell low-price programs, so software vendors are selling direct over the Internet.

THE WEB MADE THEM DO IT

BEFORE	AFTER	WHY
Lotus charged $155 for its Notes Desktop run-time client.	Lotus lowered the price of the Notes Desktop client to $69.	Lotus is feeling pressure from less expensive Web-based groupware.
Intuit's Quicken provided electronic banking via private networks and partner banks.	Intuit will offer banking over the Internet and America Online: it doesn't require Quicken.	Rather than make money off low-margin software only, Intuit also gets a small fee per transaction.
Cadkey (Windsor, CT) sold expensive CAD programs only through VARs.	Cadkey will supplement its VAR channel by selling less expensive CAD software over the Internet.	VARs that profited by selling expensive CAD software wouldn't sell less expensive products.
Microsoft's code-named Blackbird content-authoring program supports the Microsoft Network only.	A new version, called Internet Studio, will let you create content for MSN and the Internet.	Developers believed Microsoft's strategy constricted them to MSN.
CompuServe's on-line service was separate and distinct from the Web.	Users can choose from a range of Web browsers to access the Web via CompuServe.	CompuServe makes its money charging connect fees for Internet access, not on its browser. Users complained the previous policy was too restricting.

ERGONOMIC COMPUTING

Alternative Input Spells Relief



The Floating Arms Keyboard, from Workplace Designs ((612) 439-4474), addresses postural problems associated with the traditional desk, keyboard, and chair. A BYTE editor found that switching to this keyboard greatly reduced work-related pain.

Users report that Microsoft's Natural Keyboard, which has separate keys (for each hand) that are angled inward toward the back of the keyboard, puts wrists in a better position and can help reduce the risk of RSIs.

Users are flocking to ergonomic keyboards and other input devices, despite the lack of research proving that these devices prevent or cure repetitive strain injuries (RSIs). User feedback indicates that ergonomic keyboards, mice, and furniture provide relief from crippling hand, wrist, and arm disorders. However, keyboard research "is in its infancy," says Dr. Barbara Silverstein, who led OSHA's failed effort to draft a standard to help prevent workplace RSIs.

"If anyone thinks they are making a definitive statement about the value of the alternative keyboard in treating someone or in preventing disorders, that's stretching the current data," says Dr. David Rempel of the University of California, San Francisco. "Ergonomic keyboards reduce some of the known RSI risk factors," he concludes, but that is "as far as we can go."

While researchers debate the effectiveness of alternative keyboards and other devices, others argue that evidence hasn't even proved that standard keyboards cause RSIs. Attorneys defending IBM argued successfully in four trials last year that scientific evidence does not prove that standard keyboard designs cause RSIs, striking at the heart of the claims filed on behalf of thousands of injured workers.

Understanding keyboards is a complex research task. "That is because the problem is multifactoral," says Cathy Mishek O'Brien, president and CEO of Workplace Designs (Stillwater, MN), which sells the Floating Arms Keyboard. "It's hard to account for the many variables in workplace conditions, environment, and posture. Another variable is workplace stress."

Buyers, meanwhile, are not waiting for a conclusive study. In just over a year, Microsoft (Redmond, WA, (206) 882-8080) sold nearly 1 million Natural Keyboards. Smaller companies also are seeing gains. Company officials at Marquardt Switches (Cazenovia, NY, (800) 282-3746 or (315) 655-8050; miniergo @marqswitch.com), which sells the MiniErgo keyboard, and DataHand Systems (Scottsdale, AZ, (602) 860-8584), vendor of the DataHand keyboard, say that business is brisk and is getting better every day.

Despite the lack of long-term research, anecdotal evidence from users indicates that ergonomic input devices can provide relief. Some editors at BYTE have suffered from injuries such as chronic tendinitis. They have seen improvement when switching from standard keyboards to alternative devices, including the ones pictured on this page. But the switch in keyboard was not the only change: The editors also used better posture, took more breaks, performed stretching exercises, and, in some cases, took anti-inflammatory medicine. All of these changes make it difficult to attribute the improvement to the alternative keyboards alone.

Other users say they have found similar improvement, although some declined to be named. "I make my living at the computer," said one user. "I don't really want prospective employers to remember me as a cheerleader for the RSI-impaired."

In a survey of registered users of the Natural Keyboard, 83 percent said the expectation of improved comfort was the top reason for purchase, says Keith Kegley of Microsoft's hardware accessories group. Microsoft also gathered data on user expectations concerning injury prevention, but company lawyers are discussing how to present it, Kegley says. Microsoft avoids making medical claims for its product. It even pastes a warning on the Natural Keyboard about the risk of developing RSIs.

With many keyboard-related RSI lawsuits pending, the makers of alternative devices are wary when they describe their products' benefits. All the vendors tout improved comfort. Some of them advertise reduced pain, using case studies of injured workers. None say their products will guarantee risk-free computer work. "We don't look at ourselves as a mouse vendor, we are an RSI problem solver," says Steve Wang, president of Contour Design (Lowell, MA), developer and vendor of the Contour Mouse. "However, we also say, 'If you feel pain and discomfort using this mouse, stop using it immediately.'"

The Contour Mouse (Contour Design, (800) 977-1000; fax (508) 937-2722; contour@usa.net) comes in three different sizes. One user, a CAD drafter, says the pain he felt in the top of his hand when using a traditional mouse disappeared when he switched to the Contour Mouse.

—Rob Dieterich

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"(Watcom C/C++) delivered the fastest executables we saw in this roundup."
PC Magazine, April 11, 1995.

PC MAGAZINE EDITORS' CHOICE
April 11, 1995
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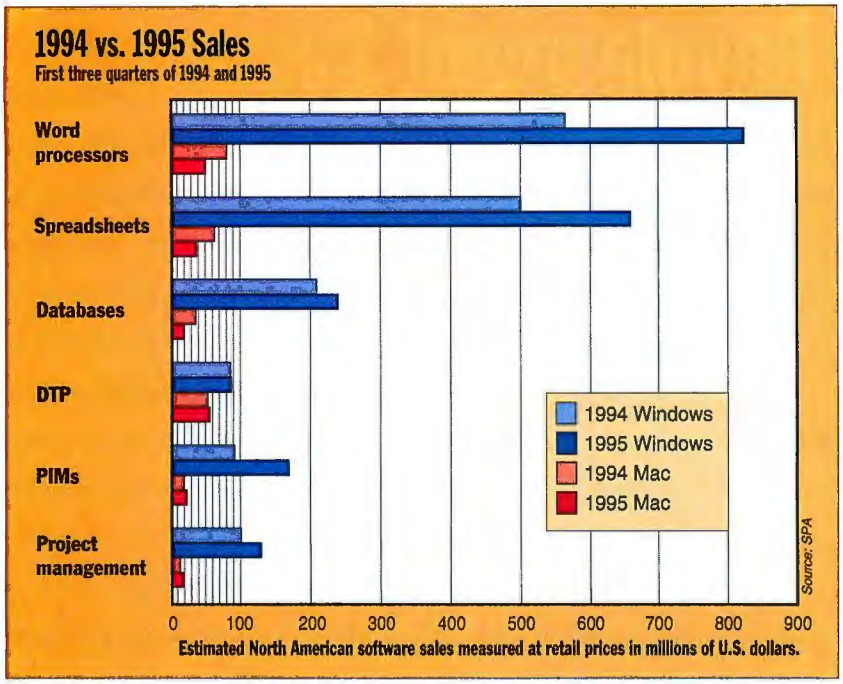
SOFTWARE TRENDS

Windows Business Applications Up, Mac Down



Sales of Windows applications grew by 47 percent while Mac sales declined by 13 percent in the first three quarters of 1995 compared to the same period in 1994, according to the Software Publishers Association (Washington, DC), a trade association of desktop software companies. Sales of Windows applications were fueled in part by the first wave of Windows 95 upgrades, says Anne Griffith, research analyst at SPA. Sales of Mac business applications such as spreadsheets, word processors, and presentation graphics experienced a drop (see the graph) compared to 1994, when many Mac users upgraded to native PowerPC applications. "Nothing spectacular in Mac business applications has been released since then," Griffith says.

Finance, project management, and personal information managers (PIMs) saw healthy increases for the Mac and Windows. The biggest declines were in DOS applications. Except for the entertainment category, sales of DOS applications were down in every category. DOS sales dropped 37 percent overall.

MOBILE COMPUTING

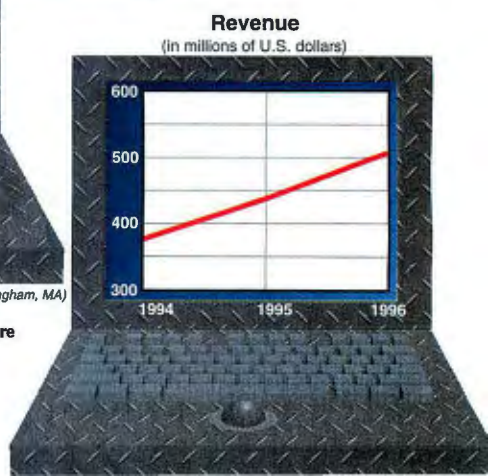
Notebooks Take on Rugged Challenges

Notebooks are taking a field trip. Users who need a notebook or hand-held PC that can run multiple applications while withstanding stressful environmental conditions are buying rugged portables in increasing numbers (see the chart).

Several factors are driving this trend, according to officials at companies such as Badger Computers (Tampa, FL, (813) 972-6597), Dolch (Fremont, CA, (510) 661-2220), fieldWorks (Eden Prairie, MN, (612) 947-0856), Itronix (Spokane, WA, (509) 624-6600), and Texas Microsystems (Houston, TX, (713) 541-8200). Users in the military, heavy construction, transportation, utilities, and other professions are migrating to notebooks, which run applications ranging from word processing to custom data acquisition (for more information, see "Keep the Data Moving," December 1995 BYTE). These rugged computers can withstand high and low temperatures, water, dust, vibration, and other nasty conditions.

Not all rugged computers are alike, however. Some can withstand harsher conditions than others, and some offer extraordinary modularity. For example, fieldWorks offers a line of modular notebooks that let you remove any part (e.g., the screen, hard drive, or keyboard) should it become damaged and get a replacement the very next day, rather than wait several weeks while the notebook is in for repair. Officials at the company say they are thus finding new buyers in mobile professionals who want a modular, rugged notebook that can easily withstand the harsh conditions of careless baggage handlers and other dangers typically found in the business world.

Source: International Data Corp. (Framingham, MA)



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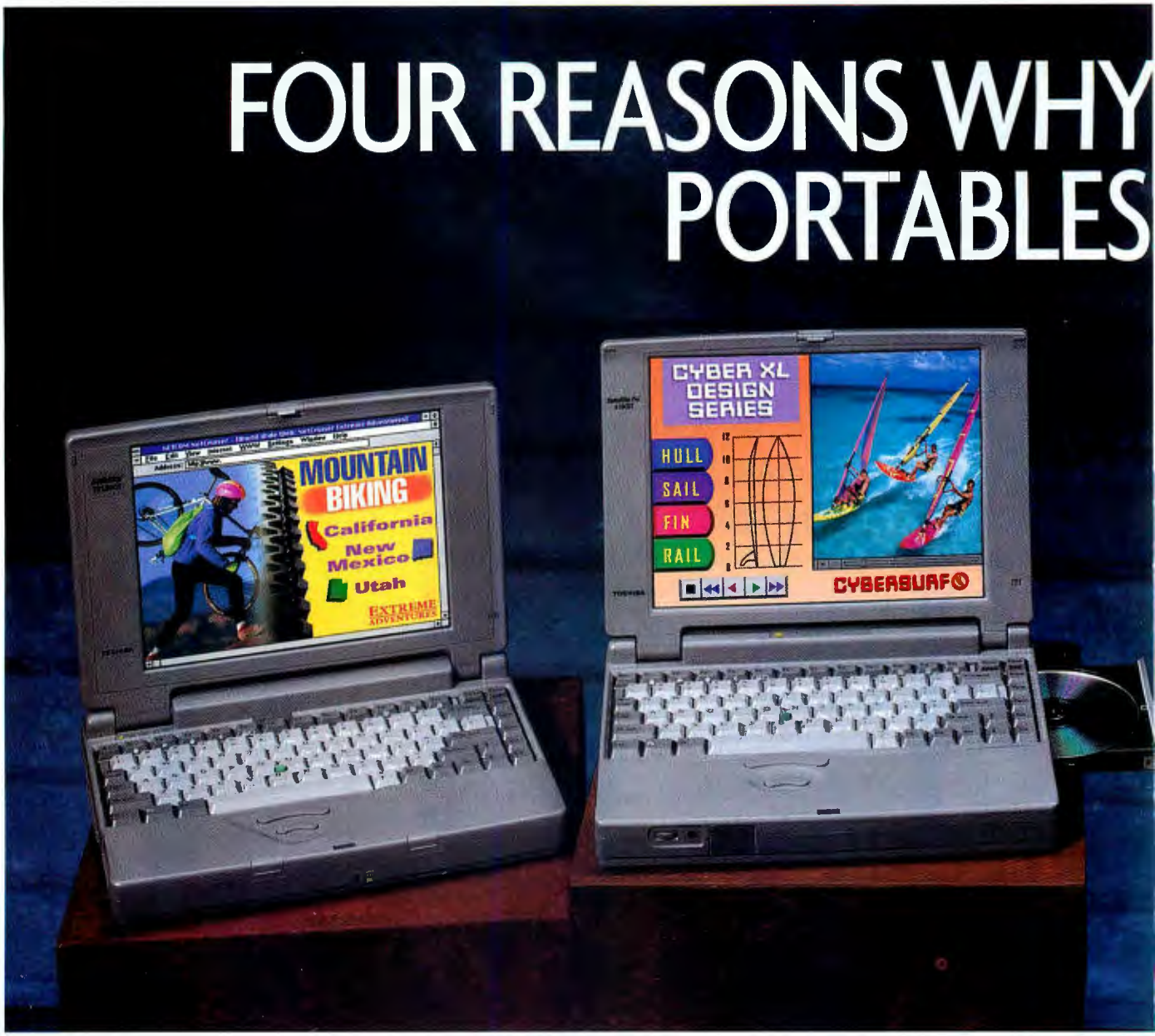

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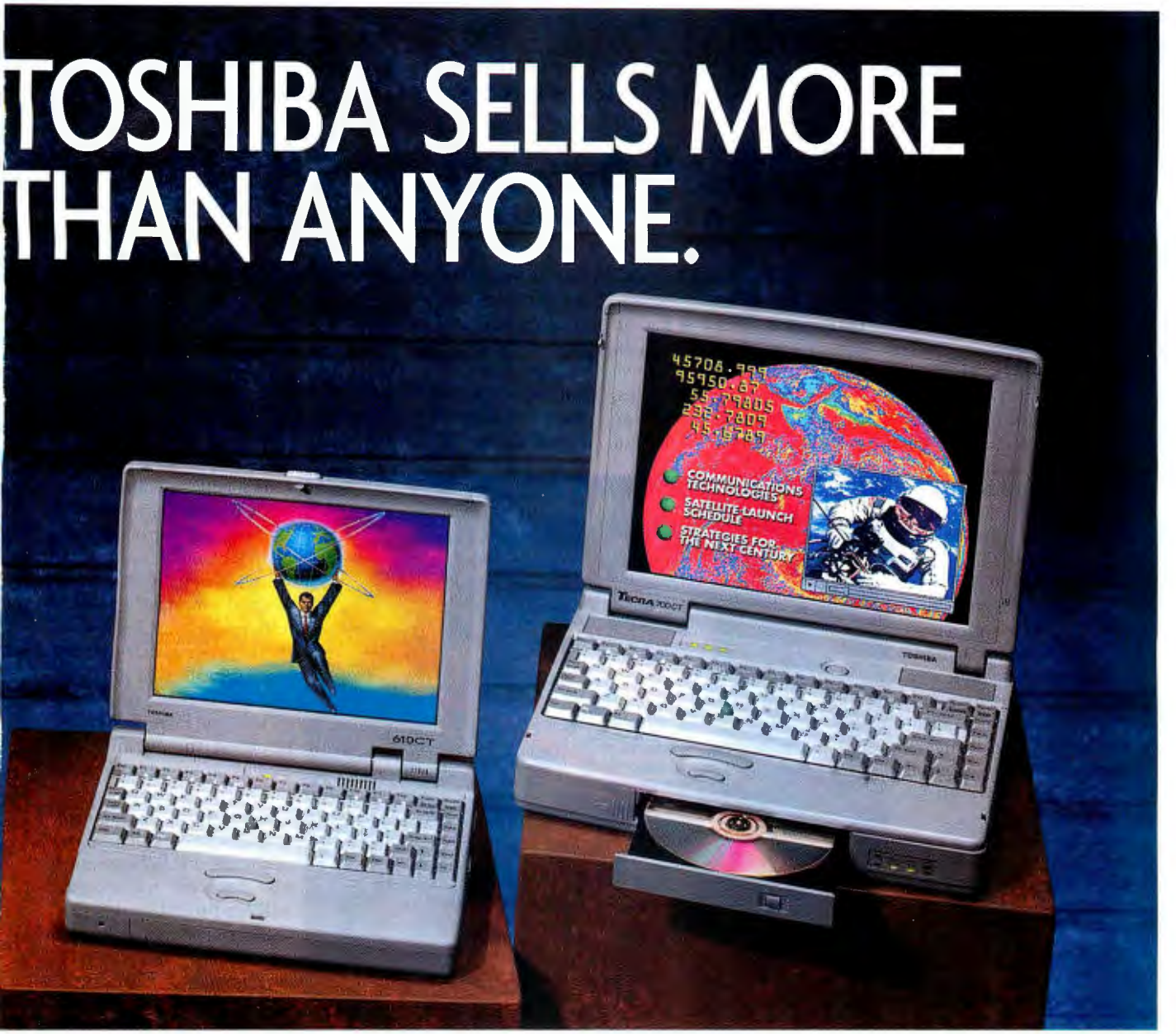

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PROJECTION DEVICES FOR PRESENTATIONS

Au Revoir, Overheads

New technologies will result in portable projection devices that integrate their own light sources and offer brighter displays. These devices will let you more easily project computer or video data onto a wall or screen for group presentations because they won't require an additional overhead projector.

Traditional projection products merge the output from three bulky CRTs into one image. These projection devices, which are often used for demonstrations at trade shows, solve niche projection needs, where long-term use, high resolution, or fast graphics are needed. But such projectors are also unwieldy and large (they can weigh 50 pounds or more).

LCD-based products have created a whole new market in the last few years for portable presentations. Products that offer the most convenience through their integrated light sources, therefore eliminating the need for a panel and separate overhead projector, should be the top sellers in this category (see the chart).

Integrated projectors resulting from a Seiko Epson/In Focus Systems collaboration typify this new breed. For example, In Focus's LitePro 580 costs less than $10,000 and weighs about 17 pounds, yet it projects bright and clear displays. "This is still a relatively small industry, and [the LitePro 580] has made a big impact," says Bill Coggshall, a projection market analyst at Pacific Media Associates (Mountain View, CA).

To generate clearer images, the LitePro 580 uses three monochrome LCDs instead of one color LCD (each LitePro LCD is filtered once, instead of filtering a single LCD three times). The three images are then recombined into a single color image.

The LitePro 580 is the first integrated projector to use LCDs fabricated with a high-temperature polysilicon process. This process supports the fabrication of driver electronics on the same substrate as the light-controlling transistors, which cuts the size of a display roughly in half. Perhaps in a year or two, companies will migrate to a low-temperature polysilicon process, which has the same advantages as the high-temperature method but uses cheaper glass substrates rather than quartz substrates.

Integrated projectors that use amorphous silicon thin-film transistors (TFTs) could also get a boost with a technology recently unveiled by Sharp called Sharp2 '96. The company's new processes increase the amount of light that can pass through an LCD (aka the aperture ratio), which permits even brighter displays.

The company has already achieved an excellent 60 percent aperture ratio (today's laptops achieve about 40 percent to 50 percent aperture ratios per pixel), but the new process will increase this to 75 percent. Integrated projectors that use this new technology with 6.4- or 8.4-inch displays are expected by the middle of the year.

A variety of new projectors based on Texas Instrument's Digital Micromirror Display (DMD) technology should also appear this year. DMDs are semiconductor chips that are made up of an array of thousands of tiny mirrors that can be tilted with the application of a small voltage. After years of development and reliability testing, TI is ramping up production to supply DMDs for a host of projection products. Market leaders In Focus, nView, and Proxima have all licensed the technology. DMDs promise high resolution and bright displays.

Allen Alley, vice president of corporate development and engineering at In Focus, says that these new technologies will lead to integrated projection products at several price-performance points. He says amorphous silicon products and single-chip DMD-based products will occupy the low end. Polysilicon LCD products will take the mid-range, and three-chip DMD projectors will occupy the high end. However, given that many technologies for integrated projectors are still under development, vendors couldn't say how quickly prices will drop.

Despite the uncertainties, analysts predict that integrated projectors will breathe new life into the projection market. Pacific Media Associates predicts that sales for all display products will increase by about 28 percent this year over 1995, compared to a 51 percent jump in integrated projection devices over the same period.

—Chris B. Chinnock

Integrated Projectors Run to Daylight

Worldwide Integrated LCD Projectors Market Estimate
(in millions of U.S. dollars at street prices)

The fastest-growing category in the projection display market is for integrated LCD projectors, according to Pacific Media Associates.

BYTE Gives Away Car to Lucky Winner

BYTE congratulates Ronald D. Bell (Green Valley, AZ), winner of our Mobile Office of the '90s Sweepstakes. He gets a ton of stuff, including a 1996 Mitsubishi Galant LS, a Tadpole P1000 notebook, Mobile Assistant Route Guidance System from Solid Computers, membership to CompuServe for one year, a cellular phone, software from Berkeley and Accent, and a PC Card from Megahertz. Happy mobile computing!

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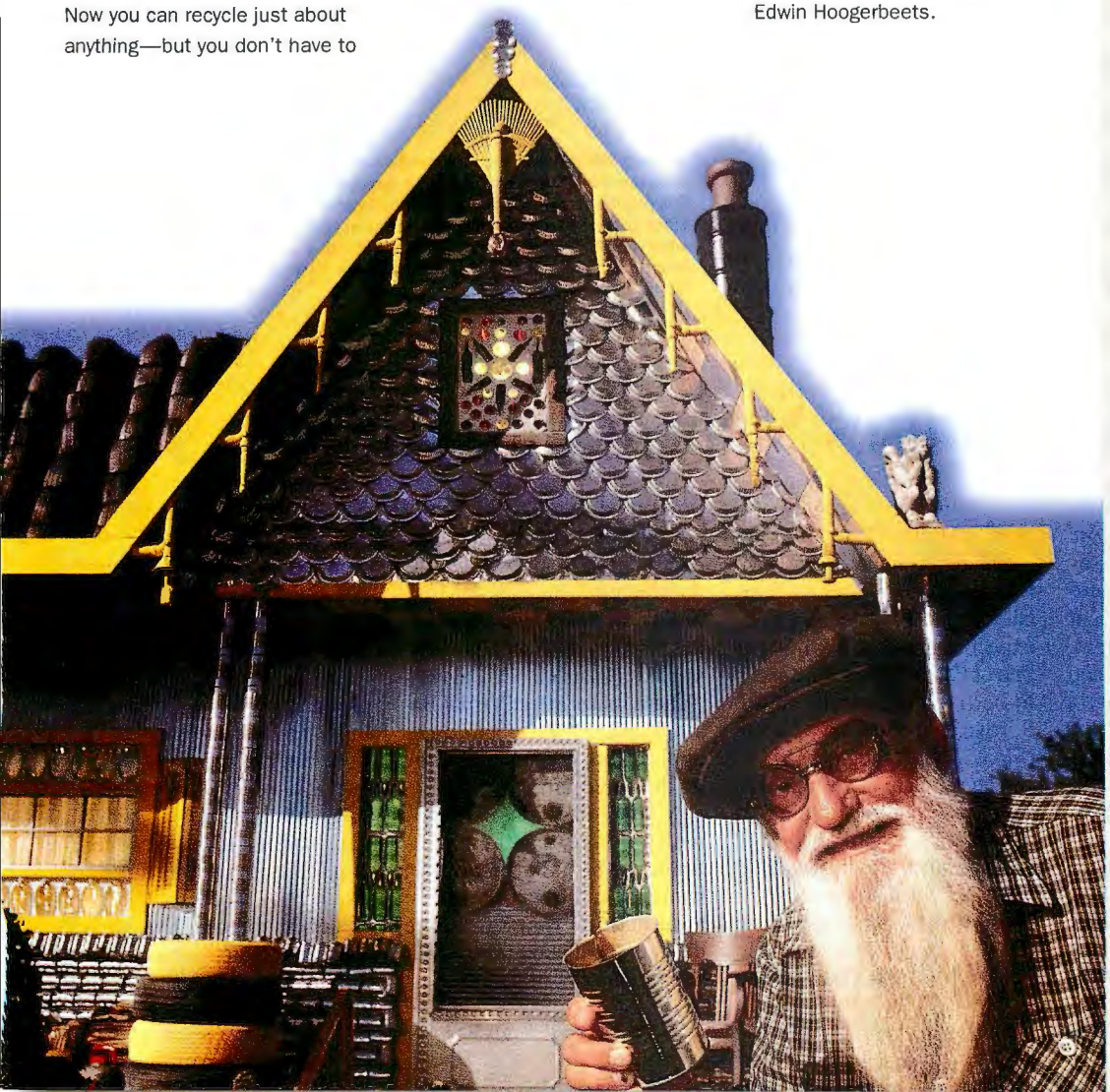

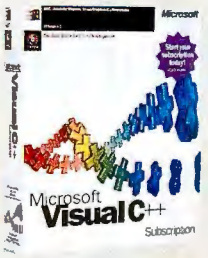

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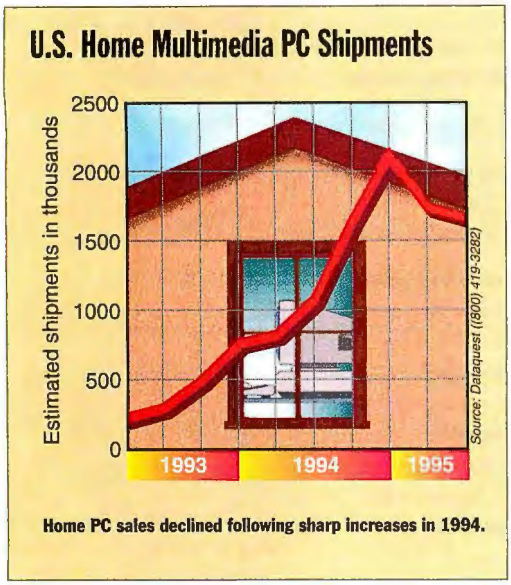


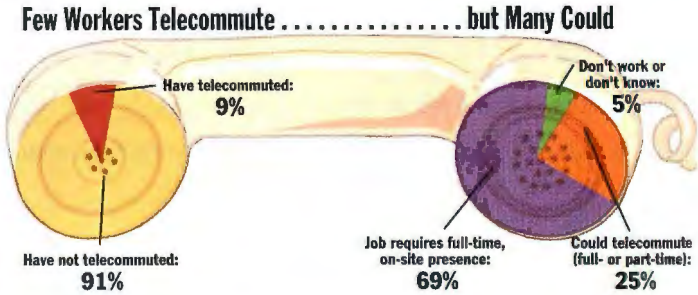
Home PC sales declined following sharp increases in 1994.

PC vendors' dreams of putting a computer in every home may take longer to realize than first expected. Common wisdom says PCs have only started to penetrate the home market and that the sales growth in recent years will continue. Not so, says Bruce Ryon, a PC analyst at Dataquest (San Jose, CA). Multimedia PC shipments in the U.S. market declined for two consecutive quarters (i.e., the first and second quarters in 1995). Furthermore, a random-dial survey of 10,000 homes shows that 66 percent said they have no plans, now or in the future, to buy a computer.

Ryon attributes the phenomenal growth in recent years of multimedia PCs to extensive corporate layoffs, which displaced workers who then began new careers as consultants and contract workers. Workers that were not laid off also bought home PCs to handle the increased work load by working at night. Ryon's advice to vendors: Focus on repeat sales to existing customers.

PC vendors should also pursue markets outside of the U.S. According to Link Resources' (New York, NY) Global New Media Consumer Study, consumer PC shipments in the Asia-Pacific Rim and European markets will outpace those in the U.S. by 54 percent in 1997 ($34 billion compared to $22 billion).

That gap will increase even more by the year 2000, when the consultancy forecasts sales of $48 billion compared to $27 billion in the U.S. Countries with relatively low PC penetration in the household include France (22 percent), the U.K. (25 percent), Japan (21 percent), Germany (30 percent), and China (7 percent). —Matt Trask



Although almost a quarter of 820 adults surveyed for *U.S. News & World Report* think they could telecommute at least part-time, only 9 percent have done so. One possible reason: 69 percent said the clearest advantage to working at the office instead of telecommuting was having access to technology such as the copier or fax machine. Having a PC at home with a scanner and fax/modem could address that problem. But 64 percent also said interaction with coworkers is a big advantage of working at the office.

SOFTWARE MAINTENANCE

Year 2000 Promises Strange Days Ahead

What's in a date? Oh, about $400 billion. That's how much analysts say will be spent worldwide addressing the notorious year 2000 date-change problem. Software vendors, analysts, and trade-show organizers offer a wide array of products and services to help organizations modify programs that now represent years as two-digit dates (e.g., 00), instead of four-digit dates (2000).

Companies with actuarial, real estate, accounting, and financial applications that make long-term calculations are modifying their programs to prevent them from breaking when they calculate long-term figures beyond 1999. A typical Fortune 1000 company can expect to spend $1 to $1.50 per line of COBOL code that needs to be fixed, according to the Software Productivity Group (SPG, Westborough, MA).

The problem isn't limited to COBOL programs running on mainframes, according to Eliot Weinman, president of SPG, whose recent conference on the problem was a sellout (the company will hold another one in March). "As a result of extensive downsizing, many companies have downloaded data from the mainframe to PC databases," he says. Mark Sokol, vice president of product strategy at Computer Associates (Islandia, NY), agrees. "These issues affect Visual Basic, PowerBuilder, and other applications as much as they do the mainframe."

Many companies have already converted their programs, especially insurance, banking, and human-resource applications that reference dates in the distant future. But Weinman says others are just now grappling with the issue, and that as the date gets closer, companies may have to farm out some program modifications to countries such as India, which have lower pay rates for programmers. "Every single company in the world is going to have to test its code," he says. But one company's problem is another's opportunity. Says Weinman, "A whole subindustry in services and consulting has sprung up around this problem."

Vendors advise buyers to be sure their new software handles its dates properly.

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MOBILE COMPUTING

New Docks Improve Commuter Computers

Notebook vendors are improving their docking stations as the percentage of users who buy notebooks as true desktop computer replacements increases. Docking stations complement notebooks by providing an easy way to access a network or external CD-ROM drive while harboring peripherals such as external monitors and speakers. But due to the relatively small percentage of users who bought a portable as their sole computing device, notebook vendors admit they sometimes focused their resources on designing a good notebook with the latest technologies first. The docking station came second.

That's starting to change, however. "We've seen interest in docking stations heat up in 1995 and that will continue in 1996," says Randy Giusto, manager of mobile-computing research at International Data (Framingham, MA). Giusto estimates that the tie-in rate (i.e., the percentage of notebooks that connect to docking stations) for all notebooks and subnotebooks will increase slowly, from 20 percent in 1994 to about 25 percent this year. But high-end notebooks can experience tie-in rates of 45 percent or more.

The new docking station that Hewlett-Packard (Palo Alto, CA) designed for its OmniBook 5000 series of notebooks typifies this trend. HP includes a variety of I/O ports on the back of the OmniBook 5000's docking system, but it paid attention to subtle details of docking-station design as well. For example, the modular stand raises the dock, which lets you easily eject the notebook without having to move the external keyboard. You can also access a docked OmniBook 5000's PC Card slots.

As more notebooks begin incorporating Peripheral Component Interconnect (PCI) for improved notebook peripheral performance, vendors such as HP, Toshiba (Irvine, CA), and Texas Instruments (Dallas, TX) are tackling the tricky technical feat of extending a PCI local-bus slot across the docking connector. "PCI is the architecture of the future," says Steve Gonzalez, senior product marketing manager for the docking solutions program at TI. "It gives better performance in the notebook. But if you don't pass the PCI signal directly out through the docking station, the performance of the PCI peripheral on the docking station itself suffers."

A new technology that could change docking-station designs is the Universal Serial Bus (USB), which should start showing up in products this year. It's an external I/O interface with a maximum 12-Mbps data transfer rate that will consolidate a wide range of ports found on the back of notebooks into one small and inexpensive (about 35 cents) connection. USB's support for hot-pluggable devices meshes well with mobile-computing needs, and its consolidation of several connectors should result in less expensive docking-station solutions. In some cases, where the docking station's main purpose is to provide a network connection, USB may eventually eliminate the need for a docking station. —DA

CODE TALK

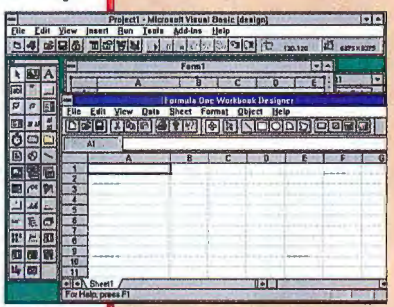
RICK GREHAN

Add Spreadsheets, Charting to Programs with Ease

Building-block-style programming just got easier, thanks to new OLE custom controls (OCXes) from Visual Components (Lenexa, KS). The company's embeddable spreadsheet, graphing, word processing, and spelling-checking controls work with Visual Basic, Visual C++, and other OCX-supported programming environments. I used two members of that group, the Formula One spreadsheet control and the First Impression charting control, with Visual Basic 4.0.

Formula One provides an easy way to add spreadsheet capabilities to your application. From Visual Basic 4.0's tool menu, you select Custom Controls, click on the Formula One checkbox, select OK, and the Formula One button appears on the toolbar. Click on the Formula One button, drag open a frame on your form, and you have a spreadsheet.

Formula One reads Excel 7–compatible files (i.e., XLS files). It also reads tab-delimited text files and Formula One's own spreadsheet format. The interface is much like Excel's; it even provides a tabbed workbook interface for handling multiple worksheets. I built a quick test program using Formula One that loaded a rather large (245 KB on disk) Excel spreadsheet from a previous BYTE Lab project. During this test, I learned that Formula One can't handle "array-style" formulas. I discovered that it also doesn't support pivot tables or solver equations.



When you adjust the width of a worksheet column in Formula One's workbook designer, you similarly change the appearance of the spreadsheet you will embed in your application.

Formula One's best feature is its workbook designer. Launched from the right-button-activated menu from within Visual Basic 4.0, the designer is a fully operative Formula One spreadsheet. However, when you change the spreadsheet in the workbook designer by adjusting the column width, fonts, or other attributes, your modifications are reflected in the spreadsheet that you've embedded in your Visual Basic 4.0 form. The workbook designer provides a handy way to adjust the look of the spreadsheet that you will embed in your application.

First Impression lets you add numerous charting options to your application. You can enter and update your data in First Impression's graphical data grid or establish a link to the Formula One control for graphing data in a worksheet or workbook. In the latter scenario, an OCX is embedded in an OCX that's embedded in a Visual Basic application. And I couldn't tell where one component ended and the other began.

First Impression provides numerous chart styles, including polar charts, 3-D surfaces with gradients, and others. First Impression's photo-realistic rendering engine lets you adjust 3-D light sources and ambient lighting to create impressive plots.

The OCXes from Visual Components ((800) 884-8665 or (913) 599-6500; fax (913) 599-6597; sales@visualcomp.com; http://www.visualcomp.com) cost $249 (except VisualSpeller, which costs $149). Each package includes 16- and 32-bit OCXes. Visual Basic custom control (VBX) equivalents cost $149 ($99 for VisualSpeller).

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CLUSTERING TECHNOLOGIES

Coming: Faster, Cheaper Optical Data Links

A new breed of optical interconnectors for linking video servers, computer clusters, and other applications will deliver the high-speed performance of fiber at less expensive prices. These new cables feature multiple channels of optical fiber with advanced lasers and optoelectronic receivers. Such devices should become commercially available this year. They will allow 400-Mbps point-to-point data transmission on each channel.

Today, fiber-optic systems are for the most part used for long-distance telecommunications links, communications backbones, and data WANs.

Copper cable will continue to be the best choice for many applications. For example, 50-ohm twin-axial copper cable can handle 150 Mbps over 100 meters, or up to 500 Mbps for less than 10 meters. But if you need to operate at over 500 Mbps at distances of 50 meters or more, optical fiber provides a better solution. The strength of a signal declines more rapidly over increased distances when you are using copper cable. You can extend the distance supported by copper using repeaters that amplify a signal, but that increases the cost of the network.

Companies such as Motorola's Logic IC Division (Chandler, AZ), IBM (Yorktown Heights, NY), Hewlett-Packard (Palo Alto, CA), and others are working to reduce the cost of parallel-optical bus architectures. Much of the cost of fiber-optic links is due to their connectors and components. One way to lower that cost is by assembling multiple channels, from four to 32, into a single connector to lower the overall cost per channel. Motorola's goal, for example, is to bring the price down to the area of $150 per link, which includes two transceivers and 10 meters of ribbon.

At the heart of these development efforts is an array of lasers called Vertical Cavity Surface Emitting Lasers (VCSELs). Anis Husain, a program manager at ARPA, which has funded research efforts in this area, says VCSELs will have a similar effect upon the optoelectronics field as CMOS technology had on silicon-based electronics (CMOS allows inexpensive, low-power-consumption chips).

Unlike edge-emitting lasers, VCSELs don't need to be packaged before testing. "You can probe-test VCSELs in wafer form," says Jerry Grula, a senior applications engineer at Motorola. "This means that from an overall system standpoint, you have known good laser arrays going into the final assembly." VCSEL technology developers include Motorola, Hewlett-Packard, Honeywell Technology Center (Bloomington, MN), and Vixel (Broomfield, CO).

Current serial standards such as Fibre Channel provide data connections of 266 Mbps and 1 Gbps now, with 4 Gbps expected in two years. Fibre Channel is a good solution for server-to-storage connections. But new parallel-optical interconnectors, which proponents say won't suffer from the overhead that comes with the serialization process, should enable emerging parallel-processing and/or shared-memory applications. Says John Crow, IBM's manager of optical communications, "You could tie together the data-processing capability of several workstations scattered around a department to perform sophisticated computer simulations and modeling that today require a multimillion-dollar supercomputer."

—CBC

PARALLEL-OPTICAL INTERCONNECTORS AT A GLANCE

PROGRAM	COMPANIES	CHANNELS (TRANSMIT/RECEIVE)	DATA RATE PER CHANNEL	LENGTH
Optobus	Motorola	10 and 10	400 Mbps or higher	1 to 300 meters
POLO (Parallel Optical Link Organization)	HP, AMP, Dupont, SDL, University of Southern California	10 and 10	622 Mbps, 1 Gbps	1 to 300 meters
Jitney	IBM, LexMark, 3M	20 and 20	500 Mbps	1 to 50 meters

Blasts from the Past

5 Years Ago in BYTE

BYTE looked at version 3.0 of Microsoft Excel, the graphical spreadsheet first introduced on the Mac, which recently turned 10 years old (it shipped in September 1985). Version 3.0 for Windows added a few new features, including the Solver utility, the ability to place charts directly on a sheet, and support for OLE. It still lacked Lotus 1-2-3's support for 3-D spreadsheets (that came later). But the most impressive thing about version 3.0 was ease of use. Excel 3.0 had a host of intuitive features, ranging from the toolbar on the top that offered shortcuts to common procedures to the handy Autosum feature.

10 Years Ago in BYTE

Apricot's new 286-based PC had a 7.5-MHz processor with 1 MB of RAM and a 20-MB hard drive for $3995 (without the monitor).

Stressed-out techies today can seek solace, maybe, in Jerry Pournelle's statement in the opening paragraph of Computing at Chaos Manor: "I'll have to admit it: the hectic pace I live at *is* normal, and I'd better get used to it."

15 Years Ago in BYTE

In an overview article on voice synthesis, authors Kathryn Fons and Tim Gargagliano said the man-to-machine interface will be one of the biggest challenges facing the industry in the 1980s. It's still a challenge. Several editors have contracted repetitive stress injuries. Speaker-independent, unconstrained, continuous voice dictation continues to elude the desktop, though the latest voice-dictation systems approach that holy grail.

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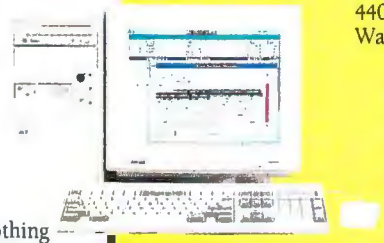
2 Multimedia Programming

Pick up any computer magazine and you'll realize that multimedia is here to stay. If you can create the kinds of contemporary multimedia programs that make everything — from shopping to education to business presentations — easier and more exciting, you can expect financial success and security.



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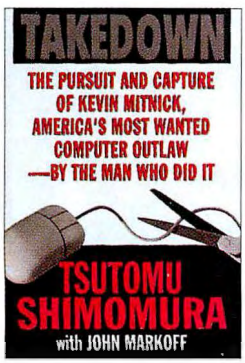
Take Home *Takedown*

JOHN MONTGOMERY

If Arthur Conan Doyle and Tom Clancy collaborated on a book, they'd probably create something like *Takedown*—except *Takedown* is not fiction. The dime version goes like this: Somebody broke into Tsutomu Shimomura's computers and stole data, including the source code for an Oki cellular telephone. Bad idea. From then on, Shimomura devotes his considerable intellect and energy to identifying the cracker (Kevin Mitnick, as it turns out), tracking him down, and capturing him.



Shimomura is not a man to mess with. When he decides that he's going to catch the cracker, he becomes single-minded. Anything that stands between him and the cracker is in trouble. In particular, when he sees what he views as incompetence and stupidity, he's the first person to call it to everyone's attention. Much of the book is about overcoming what Shimomura sees as slow-footed, ego-bound bureaucracies to make them realize that Mitnick is dangerous and must be stopped. Shimomura's vexation extends to everything from the FBI's internal politics to the Computer Emergency Response Team's refusal to acknowledge new security holes fast enough.

In fact, the technical details of how Shimomura and his team tracked Mitnick are drowned out by Shimomura's personality. Shimomura becomes obsessed with capturing the cracker. He cuts vacations short, seems to give short shrift to his new girlfriend, and deprives himself of sleep for days on end. Shimomura's fixation coupled with his powerful personality make the story fascinating reading. His character comes forth in his opinions on life, love, and technology. For example, here he dissects a close friend's personality: "It was as if there were two Julias. One was a strong, independent and adventurous woman who was trying to find what would make her happy and content. But there was another person as well, who was hamstrung by fear and feelings of inadequacy and security."

If you don't care about (or for) his opinions, you might prefer the technical details that pepper *Takedown*. For example, this description of some intercomputer spoofing: "All those aborted handshakes now made sense. The attacker had needed to be able to predict the sequence number that Osiris was sending out with each SYN. A sequence number in this case was simply an authenticator, much like the number they give you while you're waiting in line at the delicatessen, so that when it's your turn to talk to the man behind the counter he and everybody else recognize your right to proceed."

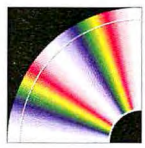
The best part of this book isn't the plot or the technical details about how Shimomura caught Mitnick, but the exposé. *Takedown* reads like a *Who's Who* of the computer industry—especially the computer security industry. As you read, you find out whose computers Mitnick invaded, when he invaded them, who denied that it happened, and who acted responsibly.

The narrative style is perfectly suited to the subject and to Shimomura's personality: very straightforward. It's likely that the book's co-author, John Markoff of the *New York Times* (and formerly of BYTE), had something to do with creating this style.

Takedown is so much like a Tom Clancy techno-thriller it's hard to believe it's not fiction. But sometimes truth is better. This is one of those times. ■

TAKEDOWN: THE PURSUIT AND CAPTURE OF KEVIN MITNICK, AMERICA'S MOST WANTED COMPUTER OUTLAW — BY THE MAN WHO DID IT
Tsutomu Shimomura with John Markoff
Hyperion
ISBN 0-7868-6210-6
$24.95

John Montgomery is BYTE's features editor. You can reach him by sending E-mail to jmontgomery@bix.com.



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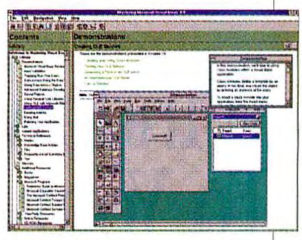
Mastering Microsoft Visual Basic is not meant for novices seeking to acquaint themselves with Visual Basic programming; it is targeted at developers upgrading to Visual Basic 4.0.

Though the main purpose of this CD-ROM is to act as a guided tutorial, it carries more than course material. Besides the tutorial, there are demonstrations, labs, sample applications, a technical reference, glossary, and more.

The technical reference includes what Microsoft refers to as the Knowledge Base—a growing collection of informative technical notes. It also contains piles of white papers, mostly taken from the Microsoft Developers network.



You'll need to be running Windows 95 or NT 3.51 or later. If you want to enjoy the audio portions of the tutorials, you'll need an MPC2-compatible sound board. (You can still run the tutorials without a sound board. Simply activate the "closed caption" window; the dialog "floats" over the demonstration and provides scrollable text that describes what's taking place.)

The material is technically nutritious. The animated tutorials are the best multimedia components in the package; in contrast, the movieolas of an expert sitting at his desk and giving high-level explanations of why you would want to leverage this or that new feature of VB 4.0 are largely inert intermissions. Still, considering all the supporting text in the library, the $99.95 price tag makes it a worthwhile investment if you need a helping hand with 32-bit Visual Basic development. **—Rick Grehan**

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All the top hardware and software products that earned a place as an Editors' Choice finalist blend technological innovation and the ability to solve nagging problems. These aren't technologies in search of a job to perform, nor do they appear here because they're the glitziest and most aggressively promoted products of the year. BYTE editors or contributors have used—and, in many cases, continue to use—each of these award-winners.

An Award of Excellence honors a hardware or software product whose technical innovation sets a new standard for products in a particular class. Award of Distinction winners are technologies that are important from a features/price standpoint but have less influence on the overall product class than Award of Excellence finalists. Awards of Merit single out products that have important features or price benefits but don't represent a shift in the product class.

The coming months will show us what hardware engineers and software developers do for an encore. Until then, here's where the technology bar currently stands.

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Awards of Excellence

APPLE POWERMAC 7500 AND 8500

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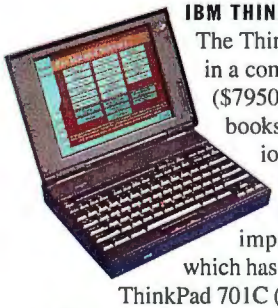
IBM THINKPAD SERIES



The ThinkPad 760CD is a true multimedia notebook in a comfortably portable form factor. It's expensive ($7950), but it clearly sets the pace for high-end notebooks, with a 90-MHz Pentium processor, lithium-ion batteries, a quad-speed CD-ROM drive, a 12.1-inch active-matrix display, infrared data transfer, and MPEG decoder hardware. Also impressive is its sibling, the ThinkPad 755CV, which has a built-in presentation panel. The more svelte ThinkPad 701C (aka Butterfly) unveiled a unique sliding keyboard that opens up to desktop-keyboard size. Combined with a sharp 10.4-inch screen, this portable established a new level for ergonomics.

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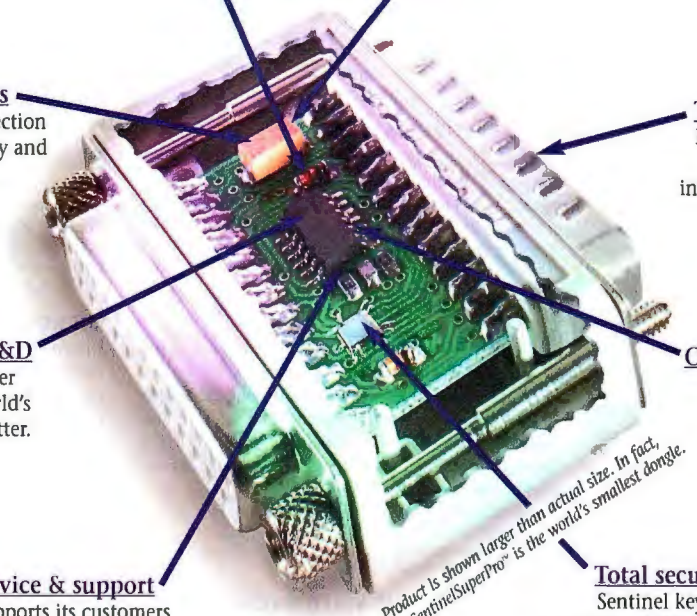

A substantial investment in R&D
In 1994 alone, Rainbow invested over $4,500,000 in R&D to make the world's leading software protection even better.

Compatible with your software
Our partnerships with Apple, Microsoft and IBM mean Sentinel protects software for any hardware or operating system.

Product is shown larger than actual size. In fact, the SentinelSuperPro™ is the world's smallest dongle.

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Rainbow supports its customers with offices and distributors in more than 40 countries.

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Sentinel keys are available with proprietary ASIC technology, multiple EEPROM cells or even a microcontroller – giving you the world's best software protection.

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Why this dongle protects more software than all others combined!

Over 7 million Sentinel® keys protect software worldwide. In fact, 55% of all protected software has a Sentinel key, from Rainbow Technologies.

Today, software piracy is at an all-time high. If you're selling software without protection, you're losing sales and revenue.

Start protecting your software investment. Stop software piracy with Sentinel, then watch your sales and profits increase.

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Sentinel is easy to implement, transparent to your end-users, and backed by the world leader. When you need on-time delivery and global support, you need Sentinel.

Only Sentinel gives you leading-edge technology, ISO 9002 certified quality and over 99.985% reliability.

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Awards of Distinction

APPLE COLORLASER 12/600 PS

Color laser printing keeps getting better and easier. Apple's second-generation color laser printer doesn't require separate developer and toner cartridges. An automatic color calibrator and PhotoGrade technology enable the ColorLaser 12/600 PS to produce near-photo-realistic color.

Contact: Apple Computer, Inc., Cupertino, CA, (800) 776-2333 or (408) 996-1010; http://www.apple.com.
Circle 1162 on Inquiry Card.

APPLE MACINTOSH SYSTEM 7.5.2

For PCI-based Power Macs. Features an improved 680x0 emulator, faster disk I/O, and Open Transport networking architecture.

Contact: Apple Computer, Inc., Cupertino, CA, (800) 776-2333 or (408) 996-1010; http://www.apple.com.
Circle 1163 on Inquiry Card.

APPLE POWERBOOK 5300C

The PowerPC comes to the PowerBook with a 100-MHz 603e processor. The 5300c has a PC Card slot.

Contact: Apple Computer, Inc., Cupertino, CA, (800) 776-2333 or (408) 996-1010; http://www.apple.com.
Circle 1164 on Inquiry Card.

APPLE QUICKDRAW 3D

QuickDraw 3D will do for 3-D graphics what QuickTime did for video. It delivers a consistent file format for 3-D and a standard 3-D API.

Contact: Apple Computer, Inc., Cupertino, CA, (800) 776-2333 or (408) 996-1010; http://www.apple.com.
Circle 1165 on Inquiry Card.

APPLE QUICKTIME VR

Apple's groundbreaking technology for displaying panoramic views on Windows PCs and Macs.

Contact: Apple Computer, Inc., Cupertino, CA, (800) 776-2333 or (408) 996-1010; http://www.apple.com.
Circle 1166 on Inquiry Card.

AT&T'S PLAN 9

A distributed OS that pushes the envelope for multiprocessing systems. Plan 9 supports Intel x86 (including Pentium), Mips, Sun SPARC, and Motorola 680x0 processors.

Contact: AT&T, Warren, NJ, (908) 580-6444.
Circle 1167 on Inquiry Card.

AUSTIN DIRECT POWERPLAY² 133

The sexiest of three PowerPC 604–based systems we tested. Runs two 133-MHz 604 processors.

Contact: IPC Technologies, Austin, TX, (512) 339-3500; http://www.ipctechinc.com.
Circle 1168 on Inquiry Card.

BORLAND DELPHI

Once you use Delphi, you may never go back to your old development tool. This Windows-based rapid application development (RAD) tool has an object-oriented Pascal compiler and debugger, a visual-design environment, and strong database-access tools. Delphi is a tool for developing prototypes and converting them into commercial- and corporate-grade products.

Contact: Borland International, Scotts Valley, CA, (800) 233-2444 or (408) 431-1000; http://www.borland.com.
Circle 1169 on Inquiry Card.

BROOKTREE BTV MEDIASTREAM

The best architecture we've seen so far for integrating multimedia data on PCI-based systems. Brooktree's BtV MediaStream chip set converts video, graphics, and audio data into small packets that stream across a high-speed internal bus.

Contact: Brooktree Corp., San Diego, CA, (800) 228-2777 or (619) 452-7580; http://www.brooktree.com.
Circle 1170 on Inquiry Card.

DESKSTATION RAPTOR 3

One of the first systems to effectively use the scary Alpha 21164 chip. We tested a 275-MHz unit; a 300-MHz unit is now available. The innovative Uniflex architecture accepts Alpha or Mips CPU modules.

Contact: DeskStation Technology, Lenexa, KS, (800) 793-3375 or (913) 599-1900; http://www.dti.com.
Circle 1172 on Inquiry Card.

DIGITAL EQUIPMENT'S STORAGEWORKS ARRAY 230

Reliability that doesn't break your budget: a high-speed disk-array subsystem with a sixth-drive "hot spare" and a relatively low price ($12,183). The Array supports redundant and hot-swappable power supplies and fans.

Contact: Digital Equipment Corp., Maynard, MA, (800) 786-7967 or (508) 841-7000; http://www.dec.com.
Circle 1173 on Inquiry Card.

FAST ELECTRONIC VIDEO MACHINE LITE

Still the best analog video-editing system for Windows. You can use it to mark clips on your analog videotapes and then add digital special effects, transitions, and titling with the VM software. Once you've settled on a reel, Video Machine compiles it all by controlling the decks automatically.

Contact: Fast Electronic, Foster City, CA, (800) 248-3278 or (415) 345-3400.
Circle 1174 on Inquiry Card.

HEWLETT-PACKARD HP-UX 10.0

Unix gets stronger than ever for business-critical computing. HP-UX 10.0 simplifies network management and offers a new suite of system-administration tools.

Contact: Hewlett-Packard, Santa Clara, CA, (800) 752-0900 or (408) 246-4300; http://www.hp.com.
Circle 1175 on Inquiry Card.

HEWLETT-PACKARD LASERJET 5SIMX

HP's encore to its pace-setting 4Si network printer, the 24-ppm 5SiMX is faster, less expensive, and produces higher-quality output than its predecessor. It's also one of the first printers to support standard SNMP Management Information Base (MIB), which makes it easier for network administrators to manage print services.

Contact: Hewlett-Packard, Santa Clara, CA, (800) 752-0900 or (408) 246-4300; http://www.hp.com.
Circle 1176 on Inquiry Card.

INTERGRAPH TDZ-400

Impressive. This first Pentium Pro system can handle two 150-MHz P6s with its high-end Intergraph GLZ1T 3-D card.

Contact: Intergraph Computer Systems, Huntsville, AL, (800) 763-0242 or (205) 730-5441; http://www.intergraph.com.
Circle 1177 on Inquiry Card.

INTERLEAF CYBERLEAF

A quick way to convert existing documents into Hypertext Markup Language (HTML) format for publishing on the World Wide Web. More than just an HTML editor or authoring utility, this Unix-based program manages large repositories of documents as well as updates to—and links between—documents.

Contact: Interleaf, Inc., Waltham, MA, (617) 290-0710; http://www.ileaf.com.
Circle 1178 on Inquiry Card.

MEGAHERTZ ALL POINTS PC-CARD MODEM

Connectivity anywhere, in one convenient package, from your laptop.

Contact: Megahertz Corp., Salt Lake City, UT, (800) 546-5464 or (801) 320-7000; http://www.xmission.com/~mhz.
Circle 1179 on Inquiry Card.

MICROSOFT WINDOWS NT 3.51

Microsoft's best OS gets better. NT 3.51 supports the PowerPC, NT File System (NTFS) file compression, and PC Card devices. NT 3.51 Server's License Manager tracks product-license compliance across multiple servers.

Contact: Microsoft Corp., Redmond, WA, (800) 426-9400 or (206) 882-8080; http://www.microsoft.com.
Circle 1180 on Inquiry Card.

MICROSOFT WINDOWS 95

What does it offer besides a hyperactive marketing engine and its own theme song? Multithreading, 32-bit preemptive multitasking, memory protection, and an expanded user interface with true folders and a Start button. As a client for NetWare and Windows networks, it includes NetBEUI, IPX/SPX, and TCP/IP.

Contact: Microsoft Corp., Redmond, WA, (800) 426-9400 or (206) 882-8080; http://www.microsoft.com.
Circle 1181 on Inquiry Card.

MORSE TELECOMMUNICATION'S SLACKWARE PROFESSIONAL LINUX 2.3

A 32-bit Unix OS with system-administration capabilities. The product includes application development software, such as the TCL scripting language, and the PC X Server production package. All this for $50.

Contact: Morse Telecommunication, Long Beach, NY, (800) 606-6773 or (516) 889-8500; http://www.morse.net.
Circle 1182 on Inquiry Card.

POWER COMPUTING POWER 100

Macintosh clones have finally arrived. The Power 100 gets kudos for being first and for being truly Power Mac compatible.

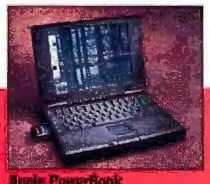
Contact: Power Computing Corp., Austin, TX, (800) 999-7279 or (512) 258-1350; http://powercc.com.
Circle 1183 on Inquiry Card.

POWERQUEST PARTITIONMAGIC 2.0 FOR DOS AND OS/2

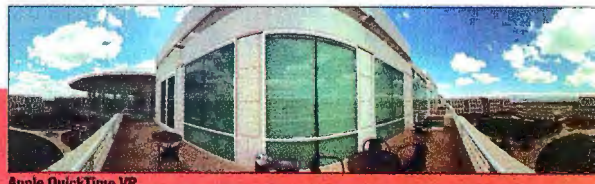
A godsend for anyone who needs to manage disk space in a multi-OS environment. PartitionMagic breaks the old rules, which said that to repartition a drive you had to back up all your data, delete the existing partitions, and then create and format the new partitions.

Contact: PowerQuest Corp., Orem, UT, (800) 379-2566 or (801) 226-8977; http://www.powerquest.com.
Circle 1184 on Inquiry Card.

Borland Delphi


Apple PowerBook


Power Computing Power 100


Apple QuickTime VR

Awards of Merit

QMS 3225 PRINT SYSTEM
Blazing. A 32-ppm, 400-dpi network printer that offers duplex printing, a built-in hard drive, and a 200,000-page monthly duty cycle.
Contact: QMS, Inc., Mobile, AL, (800) 523-2698 or (334) 633-4300; http://www.qms.com.
Circle 1185 on Inquiry Card.

QNX SOFTWARE QNX WITH PHOTON
A boon for those creating personal-digital-assistant (PDA), data-acquisition, and process-control applications. Photon enhances the venerable QNX real-time OS by giving developers a resource manager that creates a graphical event space and manages regions and events within that space.
Contact: QNX Software Systems, Ltd., Kanata, Ontario, Canada, (800) 676-0566 or (613) 591-0931; http://www.qnx.com.
Circle 1186 on Inquiry Card.

SANYO GVR-S955 PROFESSIONAL VIDEO DECK
All the features you need in a "prosumer deck"—computer control, SMPTE time-code support, S-Video in and out, Super-VHS, and bundled drivers for Windows and the Mac—at a breakthrough price of under $4000.
Contact: Sanyo Fisher Corp., Chatsworth, CA, (818) 998-7322.
Circle 1187 on Inquiry Card.

SECURE COMPUTING'S SIDEWINDER
An Internet firewall system (hardware and software) that was the first to offer networks comprehensive, military-grade protection against outside unauthorized intrusion.
Contact: Secure Computing Corp., Roseville, MN, (800) 692-5625 or (612) 628-2700; http://www.sctc.com.
Circle 1171 on Inquiry Card.

SUNSOFT SPRING 0.0.0.5
Give talented developers freedom, and the results can turn out to be most impressive. This fully object-oriented OS allows applications to access objects anywhere on a network. Solaris will benefit from Spring's key technical elements, including doors (i.e., entry points to Unix-like processes where Spring objects reside), distributed memory management, and universal naming capabilities.
Contact: SunSoft, Mountain View, CA, (415) 960-3200; spring@sun.com; http://www.sun.com/technology-research/spring/index.html.
Circle 1188 on Inquiry Card.

TOSHIBA PORTÉGÉ 610 CT
A 90-MHz Pentium in one of the smallest, easiest-to-carry packages on the market.
Contact: Toshiba America Information Systems, Irvine, CA, (800) 334-3445 or (714) 583-3000; http://www.toshiba.com.
Circle 1189 on Inquiry Card.

VOCALTEC INTERNET PHONE
We encourage proposed standards for true two-way communications over the Internet, but kudos to VocalTec for pushing the first wave of Internet-audio technology into the mainstream. The company deserves credit for its technology and also for jump-starting the category.
Contact: VocalTec, Northvale, NJ, (800) 843-2289 or (201) 768-9400; http://www.vocaltec.com.
Circle 1190 on Inquiry Card.

APPLE POWER MAC 9500
The first Power Mac to use the 604 chip, this is also the first Power Mac to offer PCI.
Contact: Apple Computer, Inc., Cupertino, CA, (800) 776-2333 or (408) 996-1010; http://www.apple.com.
Circle 1191 on Inquiry Card.

BROOKTROUT IP FAX ROUTER
The IP Fax Router saves communications charges by routing faxes over IP networks and the Internet.
Contact: Brooktrout Technology, Inc., Needham, MA, (800) 333-5274 or (617) 449-4100.
Circle 1192 on Inquiry Card.

CITRIX WINFRAME
WinFrame runs Windows applications remotely over the Internet. Our World Wide Web site depends on it.
Contact: Citrix Systems, Inc., Coral Springs, FL, (800) 437-7503 or (305) 755-0559.
Circle 1193 on Inquiry Card.

HUMMINGBIRD'S EXCEED 5 FOR WINDOWS NT
A cleverly designed X Window System server (and more) for Windows NT. Exceed came into its own by offering full 32-bit NT support. It provides the look and feel of NT and the functionality of a robust X system.
Contact: Hummingbird Communications, North York, Ontario, Canada, (416) 496-2200; sales@hcl.com.
Circle 1194 on Inquiry Card.

IBM OS/2 WARP CONNECT
The network-optimized version of OS/2 Warp; it provides connectivity to diverse servers, including IBM LAN Server, Windows NT Server, and NetWare, as well as TCP/IP and remote-access clients. Supports NetBIOS, Token Ring, FDDI, and TCP/IP- or IPX-on-Ethernet networks.
Contact: IBM, Armonk, NY, (800) 342-6672 or (914) 765-1900; http://www.ibm.com.
Circle 1195 on Inquiry Card.

INTEL'S PENTIUM PRO
A good design, but its poor 16-bit speed is a drawback.
Contact: Intel Corp., Santa Clara, CA, (800) 538-3373 or (408) 765-8080; http://www.intel.com.
Circle 1196 on Inquiry Card.

IQ SOFTWARE'S IQ/OBJECTS
This product brings reusable drag-and-drop objects to the querying/reporting process. You can preview data and then drag it into a report-design-in-progress.
Contact: IQ Software Corp., Norcross, GA, (800) 458-0386 or (770) 446-8880.
Circle 1197 on Inquiry Card.

JABRA EARPHONE
An innovative design. Jabra melded an earphone with a built-in microphone for the computer-telephony-integration (CTI) market and applications that use voice recognition.
Contact: Jabra, San Diego, CA, (800) 327-2230 or (619) 622-0764; http://www.jabra.com.
Circle 1198 on Inquiry Card.

LEXMARK MEDLEY 4X
A top performer among the first generation of multifunction (printer, fax, copier, scanner, and modem) printers—and the first one to offer color printing.
Contact: Lexmark International, Lexington, KY, (606) 232-2000; http://www.lexmark.com.
Circle 1199 on Inquiry Card.

MATROX MILLENNIUM
Matrox again sets the price/performance standard with the Millennium's integrated acceleration of graphics, 3-D, and video playback for under $400.
Contact: Matrox Graphics, Inc., Dorval, Quebec, Canada, (800) 361-1408 or (514) 969-6320.
Circle 1200 on Inquiry Card.

MICROSOFT SMS
A key component of Microsoft's Back Office strategy, its multiprotocol and multiple-network-OS (NOS) support are unmatched. SMS requires Microsoft SQL Server to manage all its reports and data—which can prove to be an advantage, since competitors' database and reporting features are less versatile.
Contact: Microsoft, Redmond, WA, (800) 426-9400 or (206) 882-8080; http://www.microsoft.com.
Circle 1201 on Inquiry Card.

MICROSOFT VISUAL BASIC 4.0 ENTERPRISE EDITION
The latest version of this programming environment further pushes the envelope for producing custom applications. With 4.0, developers can create OLE components and deploy them remotely.
Contact: Microsoft, Redmond, WA, (800) 426-9400 or (206) 882-8080; http://www.microsoft.com.
Circle 1202 on Inquiry Card.

MOTOROLA PERSONAL MESSENGER 100D
This wireless modem for packet-data networks takes advantage of new power management and production techniques that shrink the RF circuitry to a point where this modem fits on a single PC Card. This is a first in the wireless industry.
Contact: Motorola, Inc., Wireless Data Group, Schaumburg, IL, (800) 233-0877 or (708) 576-5771; http://www.motorola.com.
Circle 1203 on Inquiry Card.

NETWORTH MICRO 10/100 HUB
A switching hub where every port is an auto-sensing 10-/100-Mbps Fast Ethernet port. This is in stark contrast to the majority of switching hubs, which typically offer switched 10-Mbps ports to each desktop and one or two 100-Mbps ports to connect servers.
Contact: NetWorth, Inc., Irving, TX, (800) 544-5255 or (214) 929-1700; http://www.networth.com.
Circle 1204 on Inquiry Card.

NOVELL NETWARE 4.1 SMP
NetWare 4.1 SMP is a NetWare loadable module (NLM) that runs on a NetWare 4.1 server and allows NetWare 4.1 to take advantage of multiple processors in the same server. For users moving from NetWare 3.x to 4.1.
Contact: Novell, Inc., Provo, UT, (800) 453-1267 or (801) 429-7000; http://www.novell.com.
Circle 1205 on Inquiry Card.

SOFTWARE PUBLISHING ASAP FOR WINDOWS
A small, simple presentation program that fits on one floppy. ASAP doesn't offer everything that full-blown presentation programs do, but it offers everything you'll probably need.
Contact: Software Publishing Corp., Santa Clara, CA, (800) 234-2500 or (408) 986-8000; http://www.spco.com.
Circle 1206 on Inquiry Card.

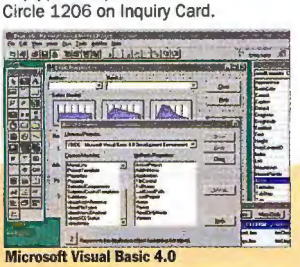

Intergraph TDZ-400


QMS 3225 Print System


DEC Array 230


Power Mac 9500


Jabra Earphone


Microsoft Visual Basic 4.0


Lexmark Medley 4x

Think Big. Start Small.

Introducing BayStack. Because you don't have to be big to need big

10Base-T Hub. Up to 10 segments and 260 ports in each managed stack.

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network technology.

Access Node Router. Full protocol support and high availability for remote offices.

BayStack. Big. Small. No matter what size your network, it has a lot riding on it. So to be certain it can handle the load, build it with BayStack.

BayStack has it all: routing, switching, 10Base-T hubs, 100Base-T hubs and network management—all in one stackable system, all based on open standards. You can put together exactly what you need, using the same technology we build into the world's largest networks.

It's the perfect way to build a robust network, because all BayStack products are scalable, both within the stack and through high-speed uplinks.

Plus BayStack has big-network reliability, with redundant links, Dial Back-up and redundant power. And with Optivity®, you can manage all the components as a single unit—even remote sites. Even with optional RMON.

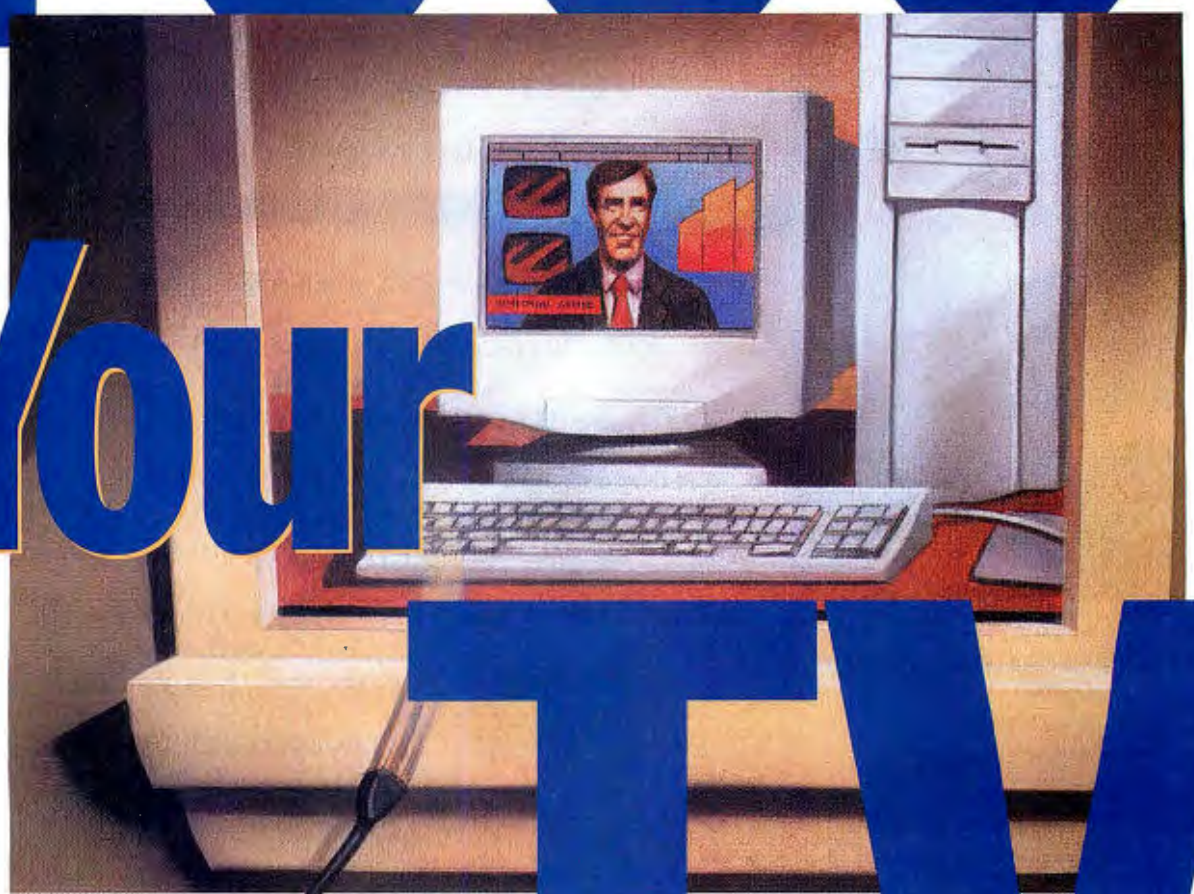
And get this: it costs less than you'd expect. So call **1-800-8-BAYNET EXT. 27** for a free BayStack video and brochure. Because when you build with BayStack, your network has the potential to really take off.

Bay Networks

The Merged Company of SynOptics and Wellfleet

Circle 218 on Inquiry Card.

TOSS Your TV



How the Internet will replace broadcasting

EDMUND X. DEJESUS

Five-hundred cable channels. Scheduled pay-per-view events. Interactive TV on demand. Who cares?

Try an *unlimited* number of channels. Whatever you want, whenever you want it. From anywhere on the planet. For free.

Internet broadcasting will bring real-time audio and video—radio and TV—to modest desktop machines over ordinary phone lines. Not download-for-20-minutes-and-play-later clips, but audio and video streaming through the wires in real time.

Internet broadcasting is overcoming technical obstacles like the narrow bandwidth of phone lines, the limits of compressing multimedia data, and the vagaries of Internet packet transmission.

The selection of multimedia available over the Internet is surprisingly varied, considering that some of the technologies that support it are only about a year old. You can listen to live and recorded news and sports from huge networks like ABC, CBS, ESPN, and NPR. You can watch live news video feeds from NBC. You can tap into music from major recording companies and fledgling bands. And, as with all things Internet, you can find home-grown, impossible-to-categorize sights and sounds with all the immediacy of real time.

Strike Up the Bandwidth

Pumping full-motion video over the Internet is not a fun task. Do the math. A 1024- by 768-pixel display (good for a monitor, lame for a movie) with three colors at 8 bits apiece, running at 30 frames per second, means at least 566,000 Kbps hurtling down the wire. Real-time audio is simple by comparison. CD-quality sound generally consists of 16-bit samples, 44,100 samples per second, for a mere 706 Kbps. Digitized phone-quality speech is only 64 Kbps (8-bit samples, 8000 samples per second).

Houston, we've got a problem: Even the best plain old telephone system (POTS) can handle only about 100 Kbps of data. Worse, today's modems top out at 28.8 Kbps, and tomorrow's products don't look much better. Current and next-generation modems are already hitting a ceiling in the 30- to 40-Kbps range, says Nicole Toomey Davis, product line manager for modem vendor Megahertz (a subsidiary of U.S. Robotics). Clearly, you aren't going to be putting out many fires with this soda straw.

Fortunately, there are alternatives to ordinary phone service. Unfortunately, access to those alternatives varies. So does their cost. Everybody has analog POTS. The price and availability are certainly right, but, as the math shows, you can't fit much down the narrow pipeline that POTS provides. Signaling (status information about the modem link, for example) may be in-band, chewing up yet more bandwidth.

A step up from POTS is ISDN. While many people still think of ISDN as technology I Still Don't Need, it has a lot to offer the Internet broadcaster and broadcastee. ISDN is an international telecommunications standard for transmitting voice, video, and data over digital lines. Circuit-switched bearer channels (B channels) carry voice and data at nominal rates of 64 Kbps. (Actual rates in the United States are 56 Kbps due to the way older equipment handles switching.) A separate data channel (D channel) of either 16 or 64 Kbps carries control signals that would, with POTS, take up in-band bandwidth. (For actual phone service, the dedicated D channel carries information relating to special features like call forwarding or call waiting. This dedicated D channel also enables ISDN modems to connect to each other more quickly than analog modems.)

There are several varieties of ISDN service. Basic Rate Interface (BRI) has two B channels and one D channel (written 2B+D in ISDN shorthand), for a theoretical total of 144 Kbps and an actual rate of 128 Kbps. That's nearly five times the bandwidth of a 28.8-Kbps modem. In North America, the ISDN Primary Rate Interface (PRI) has 23 B channels and one beefed-up 64-Kbps D channel (23B+D) for a total of 1544 Kbps. This is equivalent to a T-1 line, over 50 times the bandwidth of a 14.4 modem, and well into the CD sound range (but still nowhere near the capacity needed for raw video). In Europe, the ISDN PRI has 30 B channels and one D channel (30B+D), for a breathtaking 2048 Kbps—equivalent to the European E-1 line service.

T-1 is a fast (1544 Kbps) but point-to-point mechanism: Your T-1 box talks only to one specific T-1 box somewhere in the world, and it is always talking to that box. With ISDN, you can dial up any other ISDN site just as with a phone: It's a so-called "cloud" architecture, just like the phone system. You dial into the phone company cloud, and someone somewhere somehow gets your ISDN call. Other T carrier systems include T-1C (3152 Kbps), T-2 (6312 Kbps), T-3 (44,736 Kbps), and T-4 (274,176 Kbps). As with ordinary phone service, T-1 transmits 8000 frames per second; the difference is that a T-1 frame is 193 bits long, enough for 24 8-bit samples and one synchronization bit. This is serious firehose territory.

The big kahuna of bandwidth is asynchronous transfer mode (ATM), a cell-switching technology. ATM rates begin at 1544 Kbps, spiral up through 25,000 Kbps and 155,000 Kbps, winding up at 622,000 Kbps today and will maybe go beyond that tomorrow. ATM uses small, fixed-length,

53-byte cells (kind of like packets). The 5-byte header contains a CRC code for error control, address information, and priority control codes. The lower 48 bytes contain the data. Since the cells are of fixed length, switches can be very fast.

While ATM may sound like broadcast bandwidth nirvana, it has some problems. First, ATM is not universally available. Second, the standards are not yet clear. Third, it's expensive. Many analysts predict that the next three to five years will see changes that fix these problems.

But wait. Phone companies aren't the only ones with firehoses to every home and office. Cable companies want you to access the Internet through their cables (essentially bypassing their own programming). To do this, you need 1) a cable company that is actually supplying Internet access and 2) a cable modem. AT&T, Intel, Hybrid Networks, Hewlett-Packard, LANcity, Motorola, and Zenith Data Systems sell cable modems for several hundred bucks apiece. Speed reportedly is at least 500 Kbps, and there are claims of up to 30,000 Kbps. Clearly, cable would be a very convenient solution for people with access to such a provider, but you'd have to buy the cable modem and appropriate software, and pay the additional cable fee.

Compression: The Big Squeeze

Raw bandwidth is one thing. What you do to optimize it is another. Recently, you could have tuned in to Scott Cook, CEO of Intuit, as he gave a speech in New York. The broadcast was live, in somewhat-real time, and would have come to your computer using Xing Technology's StreamWorks video and audio software. No ATM. No T-1. No ISDN. Just a vanilla 14.4-Kbps modem.

The image with this approach is about 3 by 4 inches, rather Impressionistic in its graininess, and changes every four or five seconds. Sound is AM-radio quality. But, like a dog talking with a lisp, it's impressive, even if imperfect.

How can sound and video pour through such a pitiful spigot as this? The answer begins with compression.

Data compression is all over computers, of course. You routinely ZIP or Stuff-It unruly files to save room. Your hard disk may well be a compressed drive. Your modem probably compresses data before transmitting it. What makes Xing's—and VocalTec's Internet Wave and Progressive Networks' RealAudio and VDOnet's VDOlive—compression and decompression remarkable is that it happens in near-real time. Instead of the typical download-and-run method of getting multimedia data from a network, your computer opens a connection to the server and starts decompressing and playing the data it's offloading over the wire.

But the constraints on this compression/decompression are heavy. Since what we want is watchable video and listenable music, the compression must deliver fairly high-detail results. Very lossy algorithms lose too much, while lossless algorithms like Lempel-Zev don't compress enough. Both the compression and decompression algorithms must be very fast to permit live broadcasts, which eliminates super-crunch algorithms that take too long.

And since compressed packets will travel via Internet, with no guarantee of arrival, later packets can't depend on previous packets. This excludes many efficient algorithms that are based on lookup tables of symbols and their expansions.

In fact, variable compression rates based on access method—more for a 14.4-Kbps modem and less for an ISDN line—make the most sense. For example, RealAudio's claimed compression rates range from 8:1 to 22:1 depending on the access method.

Don't think that compression by your modem is going to bail you out. As Mike Peterson, product manager for Megahertz, points out, "You can't compress already-compressed data very much: possibly by 50 percent but not more."

And because you don't want users to have to buy any new hardware, you have to

ISDN: Operators Standing By

For most people in the United States, ISDN is becoming a fairly easily available option. There are finally people at the local phone company who won't say "What?" when you mention ISDN. Some form of service is available for most locations, especially around cities. And prices are descending into reasonable reach.

ISDN availability and cost do vary widely from place to place. Surprisingly, most addresses already have the four wires required to carry ISDN service: The phone company, in its farsighted wisdom, routinely installs four wires to an address, even though ordinary phone service requires only two. In New York and New England, NYNEX provides "local" access (for those whose local telephone office—within 3 miles—is wired for ISDN already), "virtual" access (which routes ISDN through a suitably wired non-local-but-nearby office), and "special assembly" access (for everyone else). In Massachusetts, a local residential connection will cost $100 to $150 to install and $25 per month; a commercial connection is $200 to $250 and $36 per month. Non-local access costs much more. The first minute of each local call is as little as 2.6 cents, and each remaining minute is 1.6 cents ($1 per hour). NYNEX representatives say business is "brisk."

Promptus Communications offers ISDN cards with a variety of features for servers and standalone computers, including this Multiline BRI ISDN card.

In California, Pacific Bell's rates are similar. Local calls outside business hours are free to residential users, and PacBell waives the installation fee if the service continues for more than two years. Representatives say business is booming and equipment prices are falling.

The connection from the ISDN line to your computer is through an ISDN card. These cards are available from vendors including 3Com, Hayes, IBM, ISDN Systems, ISDN*tek, Motorola, Zyxel, and Promptus Communications. Street prices are generally in the $300 to $1000 range. "ISDN is becoming the method of choice for Internet access, given its direct digital connectivity and rapidly increasing availability," says David C. Marble, director of marketing for Promptus. "The availability of the two switched 64-Kbps lines themselves and of ISDN communications devices [PC cards and stand-alone devices] is making this a hot transport technology for the Internet."

With ISDN becoming such a widely available option, we'll have to start saying "It's a Simple Decision Now."

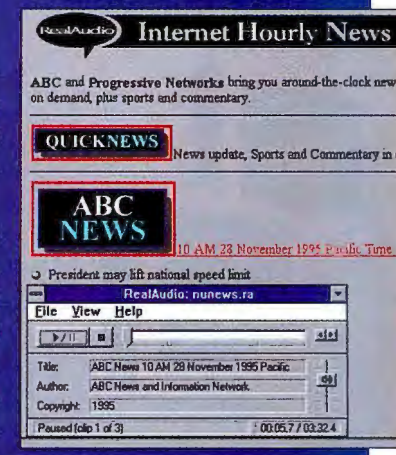
choose a software-only solution that will run on standard desktop platforms. No cheating with fancy dedicated decompression chips.

With these kinds of constraints, it's no wonder that vendors tend to depend on prior work. VocalTec, for example, has built on its experience with lossy algorithms gained from its Internet Phone (I-Phone) product as well as previous chip products. Human speech has all kinds of features that permit efficient lossy-but-satisfactory compression. For instance, we may pause slightly between words: That's dead air, and no need to record it. We speak in a narrow range of frequencies, and the full dynamic range, from whisper to scream, can be reduced without much loss of understanding. And usually only one voice is speaking at a time.

Music is much tougher. There may be no pauses (rests) at all in a musical piece. Multiple sounds are the norm, not the exception. The frequency (pitch) range and dynamic range of instruments in a single piece—indeed, at a single moment—can be wide. There can be a soft piccolo and a screeching guitar at the same time.

The result is that spoken words—a news report, sports play-by-play, lecture, sermon, interview, and so forth—generally sound pretty good on on-line "radio" broadcasts. It's the music that sounds like a warbly AM station.

GET REAL-TIME



Live RealAudio made its public debut on September 5, 1995, with the broadcast of the Seattle Mariners–New York Yankees baseball game. ABC Radio News was the first to provide live newscasts on the Internet.

The RealAudio player is bundled with Microsoft's Internet Explorer, Spry Mosaic, and Spyglass Enhanced Mosaic. Users have downloaded more than half a million players, and there are nearly 200 Web sites using RealAudio.

The Live RealAudio System server software runs on Pentium PCs (with a sound card) under Windows 95 or Windows NT. RealAudio servers can transmit to other secondary servers in order to multiply the number of simultaneous users. The server's architecture serves multiple clients without running an additional process for each connection; this reduces the load on the host machine. Multiple servers can run on the host. RealAudio version 2.0 servers automatically scale output quality to the user's bandwidth, from 14.4 Kbps to ISDN.

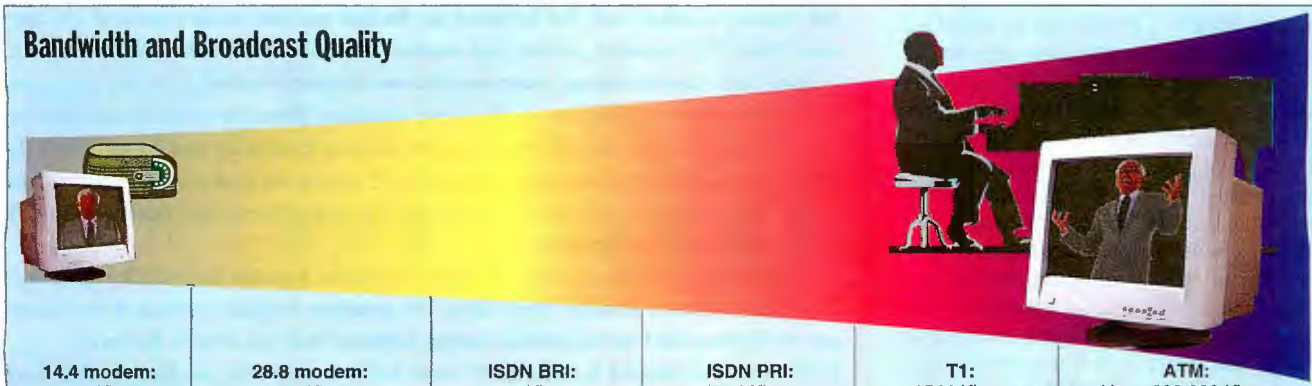
RealAudio 2.0 also allows you to embed codes (including URLs) in a data stream. You can construct applications that perform preprogrammed actions during transmission. One possibility is to show compressed still images during audio transmission, like a narrated slide show. Another possibility, during sports play-by-play, would be to bring a player's statistics up on screen. The RealAudio data stream, with its time-based structure, acts as the timer or clock for events to occur. An open API allows third-party developers to create new compression algorithms and applications.

MPEG and Beyond

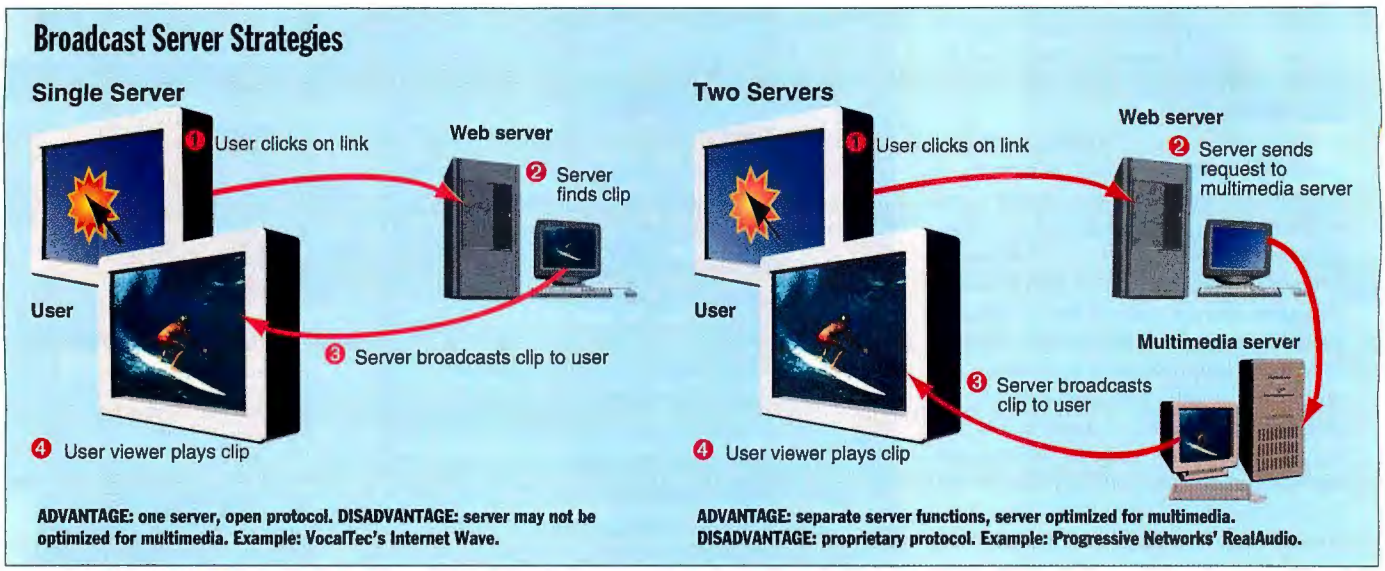
Video compression's standard is MPEG encoding. One nice thing about video is that often, large portions of a scene are unchanged from frame to frame. A succeeding similar frame can be stored with a symbol meaning "ditto" or "ditto except this arm moved." Thus, MPEG compression is about three times more compact than a sequence of, say, JPEG-compressed frames. The more similar the frames, the more compact the result. A fixed-mount camera view of a lecture will compact smaller than an action movie would.

Since you can't depend on the arrival of a previous packet before decompressing the current one, however, MPEG isn't ideal for Internet transmission. MPEG uses discrete cosine transform (DCT) algorithms that, like fast Fourier transforms, essentially decompose data into sets of wave frequencies. The compression process retains only certain principal frequencies and discards less important ones. You lose some detail in the process. (Then again, you lose some detail whenever you record reality.) The question is whether the level of detail retained is sufficient for your purpose. Merely seeing another person's face updated occasionally may suffice for a videoconference or a lecture,

Bandwidth and Broadcast Quality



14.4 modem: 14.4 Kbps, AM-quality sound, small jerky video	28.8 modem: 28.8 Kbps, FM mono-quality sound, or AM-quality sound with embedded stills	ISDN BRI: 144 Kbps, FM stereo sound, low-end videoconferencing	ISDN PRI: 1544 Kbps, CD sound, MPEG-quality video	T1: 1544 Kbps, CD sound, MPEG-quality video	ATM: Up to 622,000 Kbps, CD sound, broadcast-quality video, virtual reality applications



while extreme detail is preferable when watching movies or deep technical information. MPEG-1 supports 320 pixels by 240 pixels of three-color, with 8 bits per color at 30 frames per second, and CD-quality sound. (Some vendors use MPEG-1 to compress video for CD-ROMs.) MPEG-2 is an emerging standard intended to reproduce full-screen, broadcast-quality video and sound.

MPEG-1 generally requires more processing to encode video than to decode it, making live video more difficult to compress compactly. The maximum MPEG-1 compression is about 200:1, but 50:1 is more typical. Thus, maximum MPEGed video might require bandwidth of under 4000 Kbps to be useful. Drop to black-and-white and you're in the high ISDN, low T-1 ballpark.

MPEG-2 is even more TV-oriented than MPEG-1. MPEG-2 knows how TV "frames" interlace, for example. Picture quality is better with MPEG-2, also. But the bandwidth problem makes good-enough MPEG-1 preferable to MPEG-2 as a distribution compression scheme.

New compression tools, such as wavelets or fractals, will find use in Internet broadcasting. (See News & Views, December '95, page 34.) Microsoft and Intel are reportedly using wavelet technology in their respective "Blackbird" and Indeo products. Some research projects have produced nearly 500:1 compression of video, but not in a commercial product—yet. Since compression techniques continue to change and improve, it is important to retain the flexibility afforded by software-only solutions. It is also important to be able to swap the compression algorithm in browsers and other software, should a hot new one appear.

Safe and Sound

The main application of real-time compression on the Internet is speech. In hearing normal speech, it doesn't bother us much if we occasionally don't catch every syllable. It may be mildly annoying, but we generally interpolate what the person probably said. It's different with music. Missed notes disrupt enjoyment. Since the Internet doesn't guarantee that packets containing music are going to arrive in time to play (or even that the packets are

WE DON'T NEED NO STINKING COMPUTERS

If the idea of using a $3000 computer as an AM radio or a low-end TV bothers you, you're not alone. In fact, you're part of a whole market niche emerging to take advantage of the broadcasting available on the Internet—possibly without computers.

Compaq has already indicated interest in producing a new computer that would not be a general-purpose machine. This box would be intended exclusively for navigating the Internet, the World Wide Web, and on-line broadcasting transmitted there.

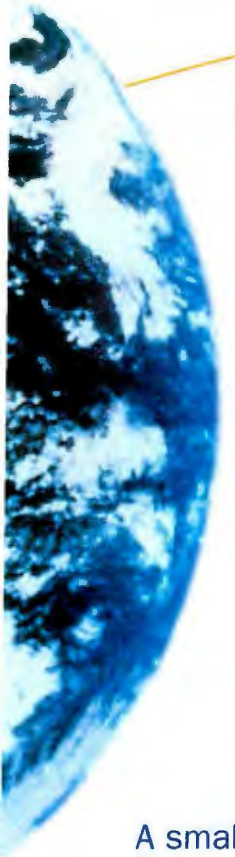
The idea is that such a computer would probably cost around $500. The low price would be attractive to families and individuals currently cut off from the Internet due to prices in the thousands of dollars for standard all-purpose desktop computers. The price would be made possible by using lower-end CPUs and other components.

Compaq isn't the only vendor with such a machine in mind. Sun is interested in a similar machine—with a twist. The hardware for the Sun machine would consist of not much more than CPU, keyboard, screen, and modem. What about software? That's the twist.

Using Sun's Java technology, users could access programs resident on server computers. Part of the software would run on the user's machine. When the program was finished, it would simply vanish. That would reduce the need for hard disks and floppy drives. Developers are already producing Java applets that people can download and run on their computers. Sun would apparently provide the Java end of things and team up with a PC maker to produce the hardware.

Philips and partners are taking a different approach: a device that will allow TV sets to access the Web over standard phone lines. The prototype includes a standard modem and one of Philips's CD-I set-top boxes, running software that can browse the Internet from a CD-I disc. The product is expected to come out in Europe first and then the U.S. Such an approach capitalizes on the near-ubiquity of television sets and telephone service. The result would give people access to computer-hosted data and broadcasting—without a computer: a boon for some, a disturbing return to the dumb terminal for others.

NASA launches Fortran PowerStation from Alabama desktop.



No, it isn't science fiction; the folks at NASA really do run compute-intensive programs on their PCs. The secret is new Microsoft® Fortran PowerStation 4.0. It brings UNIX workstation-caliber performance to the desktop without workstation premiums.

Each day, Dr. Stephens (seen below) and his colleagues at the NASA Marshall Space Flight Center download terabytes of data from orbiting satellites. The data is then fed into PCs for analysis, using massive models written in Fortran. This helps them make the cosmos, well, less cosmic. It also helps them make their operating budget less of a black hole.

Since it's built expressly for 32-bit platforms like Microsoft Windows® 95 and Windows NT™ operating systems, Fortran PowerStation 4.0 delivers true multithreading, preemptive multi-tasking, and symmetrical multi-processing. And with language extensions for IBM,® DEC,™ and Cray, migrating legacy code is never a problem.

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WHERE DO YOU WANT TO GO TODAY?™

going to arrive at all), music is a problem on the Net. How can the audio provider ensure that customers aren't getting stuck listening to portions out of sequence or, worse, to dead air?

The basic problem has to do with the Internet as a delivery medium. Yes, it's a fast, scaleable, packet-switched network. But it is not designed to handle isochronous (continuous time-based) information. The Transmission Control Protocol (TCP) endeavors to guarantee packet delivery, but delays in delivery may occur when a server retransmits a packet to a client, or when waiting for the client to acknowledge receipt. On the other hand, the User Datagram Protocol (UDP) does not take the precautions TCP does to guarantee delivery. UDP ships out a stream of packets with as little delay as possible, risking the occasional lost packet. Neither guarantees throughput rates or latency periods. Which protocol do you choose?

VocalTec's Internet Wave uses TCP. Packets should all show up, but some may be late. One way to deal with late packets is with a sufficiently large buffer—VocalTec uses a predictive cache. If enough music has accumulated in the buffer, the late packet may show up before its turn to play. Internet Wave then inserts it into the sequence and the listener is none the wiser. If there are more extensive or systemic delays in packet delivery, the sound breaks up more seriously. It's like the sound of an AM car radio when you drive under a bridge.

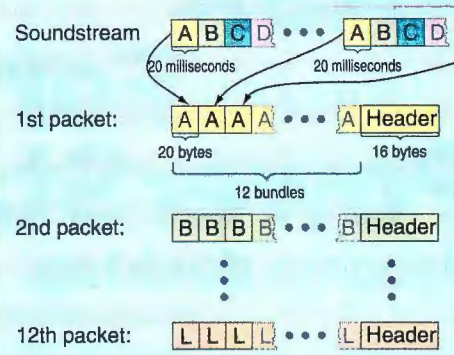
Progressive Networks' RealAudio uses UDP. Packets arrive quickly, but the delivery can be less reliable. To compensate, RealAudio interleaves the information. It takes about 3 seconds of sound and divides it into 144 bundles of 20 milliseconds each. Then it distributes the bundles among 12 packets. The first bundle goes in the first packet, the second in the second, proceeding until the thirteenth bundle goes back in the first packet, the fourteenth in the second, and so on. Each packet thus consists of twelve 20-ms bundles, plus an information header. With this scheme, if a packet vanishes, you don't lose a full quarter-second of sound; instead you lose 20 milliseconds every quarter of a second for about 3 seconds (or until the errant packet shows up). Such a disruption is minor compared to a quarter-second gap.

There's another difficulty with using Hypertext Transport Protocol (HTTP) as a transport for audio: The Web isn't inherently bidirectional. When viewing a video or listening to music, you may wish to rewind, fast-forward, or resume playing, just as you do with a VCR. Problem is, HTTP does not support return commands.

There are several ways around this. VocalTec sticks with HTTP, implementing user control with a Common Gateway Interface (CGI) file on the HTTP server. With CGI, a program or script can run on the server and return output to the client. (A common example of this is the result of a search you perform on Yahoo or Lycos that returns an HTML-format page for your perusal.) In this case, user input triggers a program on the server that carries out the request.

The alternative is to not use HTTP. For example, RealAudio has its own protocol and its own separate nonWeb server to field requests for RealAudio transmissions. This separate server can actually be located on the same physical machine as the host Web server. The RealAudio protocol supports bidirectional communication between client and server. Thus, to fulfill a request from a client to the Web server, the Web server triggers a request to the RealAudio server, which then returns the material to the client. One can imagine third-party RealAudio servers dedicated to fielding requests from Web servers handling clients. The upside of this is a separation of logical server functions, and the employment of protocols especially suited to the situation, namely, transmitting

RealAudio's Packet Interleaving



Bundles 20 milliseconds long interleave into twelve packets: the 1st, 13th, 25th, etc., go into the first packet; 2nd, 14th, 26th, etc., go into the second packet, and so on. If a packet vanishes, only 20 ms of sound every quarter-second is missing, rather than a full quarter-second.

PLAYING MIME GAMES

The Internet was not set up to handle audio and video broadcasting. It was built mainly for sending and receiving text messages and files. The standard for this is the Simple Mail Transfer Protocol (SMTP), the TCP/IP protocol that controls E-mail transmission. Somehow, the transmission of audio and video has to fit within that architecture.

Specifically, your browser may not have come with the capability to handle some of the audio and video streams now available over the Internet. No big surprise, since the formats for these data types are new. This is where Multipurpose Internet Mail Extensions (MIME) comes in. MIME is the mechanism for defining new formats to travel within the Internet's TCP/IP protocol. These are extensions to the SMTP format that define how to treat other types of data. The Internet Engineering Task Force developed MIME specifically for handling new media types on the Net. You want your browser to support MIME.

Built-in MIME capabilities already include provisions for seven types of data: plain text (with lines and messages of any length, but no word processor formatting); audio; video; still images; message (which can point to the actual message somewhere else); multipart messages (with each part possibly having a different type); and application-specific data (with lots of latitude to define subtypes).

Each of these types can have a number of subtypes, and this is where the action is. An application designer typically defines a new subtype, which essentially serves as a flag to use the application's own "viewer" for that subtype. While an audio application might define a subtype of the audio type, and a video application might define a subtype of the video type, there is no hard and fast rule for this. Many applications simply define a new application subtype. For example, VocalTec defines an application/vocaltec-media-desc subtype, while Progressive Networks defines an audio/x-pn-realaudio subtype.

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sound. The downside is it means another server to maintain and a proprietary protocol to understand.

I'll Be Your Server This Millisecond

So, what would you put into a server that's supposed to be feeding a gush of video onto the Internet? A fistful of screaming RISC chips? Enough memory to build a dozen desktops? Not bad for a start. But the real secrets of designing servers to pump video are in some unglamorous places: internal bandwidth, hard drive performance, and the operating system.

Sun Microsystems, for example, has an operating system that's fine-tuned for on-line broadcasting. "We use a special version of Solaris, optimized for real-time I/O," explains Steven Kleiman, chief architect at Sun. This special multithreaded OS has a streaming driver (called a "bit pump") in the kernel. In most systems, I/O is something the operating system can't predict and requires a complex structure of interrupts to handle. In Sun's MediaCenter family of servers, the OS treats I/O as a regularly recurring process. The operating system schedules the I/O to get the most bandwidth from all the subsystems, including the hard drives. Because this is not a general-purpose OS, but one optimized for high-bandwidth I/O, it can get out of the way of a lot of the processing.

"In Sun's experience," says Anne Schowe, general manager of Sun's interactive systems group, "serving video stresses the internal bandwidth more than the CPUs." Sure, Sun offers multiple CPUs (the 1000E model has four SuperSparc+ chips), but there is minimal central processing going on. The main activity is disk-to-output, as much and as fast as possible.

How to speed disk access? The main answer lies in RAID technology. Sun's RAID level 4 system can handle multiple I/O requests from an appropriately enabled operating system (like the tweaked Solaris). With multiple Fast SCSI-2 2.1-GB drives streaming data simultaneously, the video flows nicely. The top-of-the-line 1000E moves the bits at 400,000 Kbps (equivalent to about 100 MPEG-2 streams or 270 MPEG-1 streams).

Becoming an audio broadcaster on the Internet requires far less sophisticated, and less costly, hardware. Audio-server software, like Internet Wave or RealAudio, will run on a high-end 486 or Pentium PC.

What's Out There?

This ability to broadcast with modest equipment has astonishing implications. How much lucre would it cost to have your own local radio station? That's why there aren't that many. But if the entry requirements for global Internet audio broadcasting are in the mere thousands of dollars, we may see an explosion of audio broadcasting sites. With more than 500,000 Web sites up now (a figure increasing at a stag-

ANYONE CONNECTED TO THE MBONE?

The MBone (multicast backbone) is a collection of Internet routers that support the Internet Protocol (IP) multicast routing protocol. A network within a network, the MBone can carry live audio and video on the Internet. The multicast (i.e., one-to-many) aspect allows one computer to send the same data to many computers. Those helpful folks at the Internet Engineering Task Force created the MBone in 1993 to do videoconferencing on the Net.

Currently there are about 2000 MBone-using sites, and the MBone itself is doubling in size every six months or so. Some observers expect the originally experimental multicasting features to percolate Internet-wide by the turn of the century. The software itself is free and available for downloading.

So why doesn't everyone use the MBone for easy videoconferencing and easy listening? Possibly because you need a heavy-duty Unix workstation and a T-1 line to get started on video. A mere 56-Kbps line will do if all you're after is audio. But MBone eats bandwidth: An Internet backbone line that can handle millions of ordinary computer transactions, like E-mail, can carry only about 100 MBone sessions.

Still, you can find some interesting things on the MBone if you can pony up for the hardware. The London-based World Radio Network puts international shortwave broadcasts on line, for example. The House of Blues in Los Angeles broadcasts concerts. Sun Microsystems transmits its periodic Sunergy symposia for those without a satellite hookup.

You can find more information about the MBone (and the software needed) at http://www.best.com/~prince/techinfo/MBone.html. Material about multicasting in general is at http://hill.lut.ac.uk/DS-Archive/MTP.html.

AT&T PARADYNE'S BANDWIDTH REVOLUTION

Phone lines that carry 6312 Kbps. That's the promise of AT&T Paradyne's new GlobeSpan transceiver chip set. GlobeSpan uses a technology called asymmetric digital subscriber line (ADSL) over ordinary phone lines, eliminating the bother of rewiring the entire planet with fiber-optic cables. The one-way data speeds would be up to four times as fast as a T-1 line and about 400 times faster than a 14.4 modem. Return bit rates would be about 64 Kbps (hence the "asymmetric").

Besides a leased GlobeSpan modem, of course, your telephone company would also have to incorporate the technology at its end. Telephone companies reportedly are eager to do this, and some have suggested that GlobeSpan service could be available as early as this summer.

GlobeSpan is built on ADSL and the related technology, high-bit-rate digital subscriber line (HDSL). ADSL uses one unshielded copper wire pair, up to 18,000 feet. HDSL, in turn, is based on the 2B+D flavor of Basic Rate ISDN and uses two full-duplex pairs of unshielded copper wires, up to 12,000 feet. Doubler units can boost this distance two or three times.

A related technology, symmetric digital subscriber line (SDSL), may be even more attractive to some users, says Garrick Case, a spokesperson for AT&T Paradyne. SDSL allows two-way bandwidth on the order of fractional T-1. This would allow, for example, live videoconferencing at home. AT&T Paradyne will support ADSL, HDSL, and SDSL within the same chip set.

With this kind of bandwidth, on-line providers are thinking of producing their own programming. If the modem and service are inexpensive enough, the Internet will become far more attractive as a medium for audio and video broadcasting.

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gering rate), even if only one-hundredth provide some real-time audio capability, we're talking about 5000 new broadcasters whose message is audible anywhere on the planet at any time. That's significant.

What kinds of broadcasting are we likely to see? Currently, the best uses for Internet audio involve speech, and there are plenty of possibilities. News organizations like ABC, NBC, and NPR are already posting live news broadcasts. They and others are also providing interviews, weather, and editorial content. Sports play-by-play makes a lot of sense. Whereas current sports broadcasting is usually local, the theory being that no one in California wants to follow the Boston Red Sox, Internet sports broadcasting would allow fans to tune in from wherever they are. Yes, you could be in Singapore and listen to the Sox blow the pennant.

Educational and other social purposes may become important. Schools can transmit lectures. Political speeches go out live. Radio drama. Language lessons. Anything spoken can be put on the Web.

Although not the highest-quality music distribution medium, Internet broadcasting of music definitely has its place. Bands who used to make demo tapes can now have Web pages where listeners can sample their sounds. Radio stations are already simulcasting some of their programming on the Internet. Record companies could post samples for fans to check out.

Due to the current low frame rates of Internet video—and that will improve only as compression and bandwidth do—you're not likely to be watching *The Brady Bunch* on a Web site anytime soon (thank goodness). The best application areas are those where nonmoving pictures will work. A university lecture. Remote monitoring.

One surprising possibility is videoconferencing for the masses. White Pine Software's CUSeeMe can hook up multiple video-camera-equipped locations using 14.4-Kbps modems. The users see multiple windows of everyone in the conference, with images updating every few seconds. Sure beats flying.

Businesses can use existing video capabilities for some interesting additional purposes. Rather than distributing training videos to a hundred locations, you can post the video on a server where employees can log in at their convenience; this would be especially valuable for sales staff who need to familiarize themselves with a new product line rapidly. But customers could also browse on-line animated catalogs that deliver a narrated demonstration. Anything that the much-maligned slide presentation can do, existing video capabilities can do on the Internet, in real time, at the user's convenience and control.

Unleashing audio and video on the Internet may degrade be the whole Net's performance may degrade as a result. No one really knows the long-term effects, but it will hasten the need to upgrade the Internet infrastructure. Commercial users

TOUR THE SIGHTS AND SOUNDS

You'll need 1) a Web browser, 2) access to the World Wide Web, and 3) "viewers" for your browser. All the vendors here are providing their basic client software for free.

WHITE PINE SOFTWARE'S CUSEEME

Download the viewer (for Mac or Power Macintosh or 486 PC with Windows) from http://www .wpine.com. Check out live camera feeds from Cornell University (the CU of CUSeeMe), Kent State, NASA, and White Pine itself. Internet addresses are contained in the software.

VOCALTEC'S INTERNET WAVE

Download the viewer (for 486 PC with Windows, Win 95, or NT) from http://www.vocaltec.com/iwave.htm. Then you can check out some tunes and news.

Home page for the band I Forget: http://www .sarabande.com/iforget/iwave /cant.htm

Blues music: http://www .adtek.com/audio/

KOL Israel news from Jerusalem in English and Hebrew: http://www.artificia .com/html/news.htm

African djimbe drums: http:// www.huntana.com/montana/ iwave_drum.html

PROGRESSIVE NETWORKS' REALAUDIO

Download the viewer (for Macintosh or Power Macintosh or 486 PC with Windows) from http://www .RealAudio.com. Then you can check out sports and news.

Sound clips from ESPN: http: //espnet.sportszone.com :80/editors/studios/

ABC Radio news: http://www .abcradionet .com

National Public Radio news: http://www.realaudio.com/ contentp/npr.html

National Football League highlights: http://www .RealAudio.com/ contentp/ rabest/cbsnfl. html

XING TECHNOLOGY'S STREAMWORKS

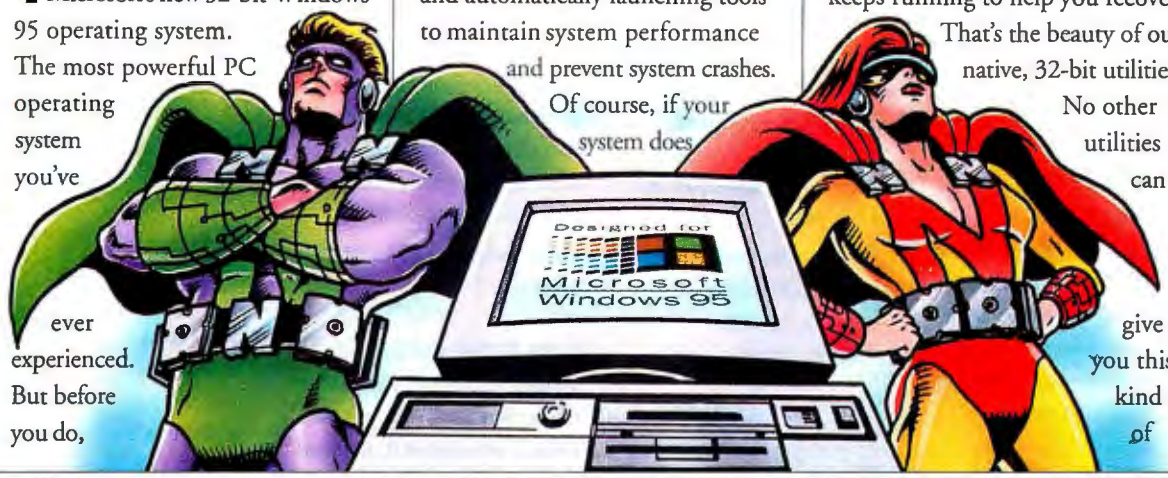
Download the viewer (for Mac or Power Mac or 486 with Windows) from http://www.xingtech.com. Then you can check out Ottawa's CFRA radio station, Taiwanese folk music, KWBR radio in California, and NBC's live video feed (all the addresses are included in StreamWorks).

VDONET'S VDOLIVE

Decently paced inline streaming video over even slow (9600-bps) modems. Go to http://www.vdolive.com

Sample du jour: http://www.vdolive

You're ready to make the move to Microsoft's new 32-bit Windows 95 operating system. The most powerful PC operating system you've ever experienced. But before you do,



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UNERASE®
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NORTON SPEED DISK™
Automatically optimizes drives and reduces future fragmentation using 32-bit technology.

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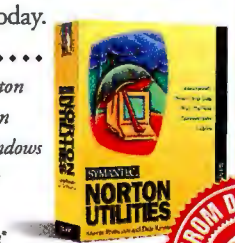

FROM DAY ONE
NORTON
FOR WINDOWS 95

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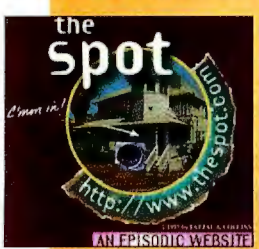
WAIT! THERE'S MORE!

Webheads do not live by ordinary audio and video alone. There are other types of broadcasting on the Internet.

SOAP ON THE WEB

What would a medium be without soap operas? The Spot is an ongoing on-line soap starring attractive twentysomething housemates and friends in California, of all places. Although there is no actual video of the action, text, graphics, and sound clips move the story along. You can eavesdrop on certain "private" conversations with RealAudio. Since the Internet is nothing if not interactive, fans can send E-mail to Spot characters and even suggest scenes and plot developments. The site gets more than 60,000 hits a day and may lead to other on-line episodic shows.



http://www.thespot.com for the top page

http://www.thespot.com/thespot/spot-speak/spotspeak.html for RealAudio sound

THE WEB, GATEWAY TO YELLOWSTONE

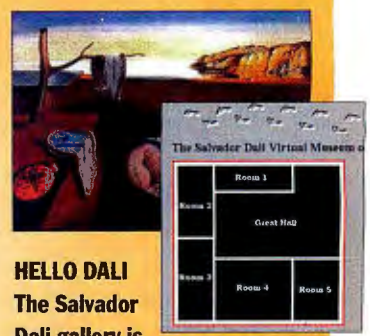
You probably don't have time each day to drop by Yellowstone National Park and do a little fly-fishing. But you certainly have time to visit the Yellowstone Virtual AdVenture page. Once there, you'll want to check out the scenic vistas (GIFs), relax by the bubbling streams, and pick up pointers from your guide (Al Beatty, via RealAudio). You can stop at Utah's Green River or Idaho's Henry's Fork later. Maybe tomorrow.

http://www.virtualadventures.com

BACK TO THE GARDEN

There's this garden in California somewhere, with a video camera pointed at it, feeding images of it (the garden) to the Web every few seconds or so. And there's this robot arm that can water the garden, getting its instructions from you via the Web. This is not your ordinary TV.

http://trapper.usc.edu/cgi-bin/gard-image/G?



HELLO DALI

The Salvador Dali gallery is laid out like a museum, with different virtual rooms to explore, each containing images of the artist's imaginative and challenging paintings. Be sure to clean those ants out of your watch before leaving.

http://www.nol.net/~nil/dali.html

THE WEB IS LIKE A BOX OF CHOCOLATES...

A different Forrest Gump quote every time you access this page. Mama never said the Internet would be like this.

http://gump.sgi.com/

of Internet broadcasting for internal purposes may want to use one of the service enablers like Concentric Network. These private Internet-accessible services can provide guaranteed levels of bandwidth and security that the Internet cannot. That will be attractive to businesses who want the convenience of putting company information on-line but don't want people outside the company accessing it.

Tune In...When?

"No future." "Who wants that?" "Commercially and financially impossible." No, these aren't comments about the prospects for Internet broadcasting. They are the opinions of Lord Kelvin, Harry Warner (Warner Brothers), and Lee deForest on the future of radio, motion pictures with sound, and television, respectively. Sure, right now Internet television is a jerky black-and-white postage stamp. But commercial TV began with a rotating plastic statue of Felix the Cat. Could you extrapolate from that minimalistic presentation to current television's dominant cultural and commercial influence?

You may have missed out on Samuel Morse tapping out, "What hath God wrought?" and Alexander Graham Bell yelling, "Mr. Watson. Come here. I need you." But you are present at the dawn of the Internet Broadcasting Age. Keep your browsers tuned. ■

Edmund X. DeJesus is a senior technical editor at BYTE. You can send E-mail to him at edejesus@bix.com.

Where to Find

AT&T Paradyne
Largo, FL
(813) 530-2000
http://www.paradyne.att.com

Concentric Network
Cupertino, CA
(408) 342-2808

Megahertz
Salt Lake City, UT
(801) 320-7000
http://www.xmission.com/~mhz

Progressive Networks
Seattle, WA
(206) 447-0567
http://www.prognet.com

Promptus Communications
Portsmouth, RI
(401) 683-6100
http://www.promptus.com/promptus

Sun Microsystems
Mountain View, CA
(415) 960-1300
http://www.sun.com

VocalTec
Northvale, NJ
(201) 768-9400
http://www.vocaltec.com

White Pine Software
Nashua, NH
(603) 886-9050
http://www.wpine.com

Xing Technology
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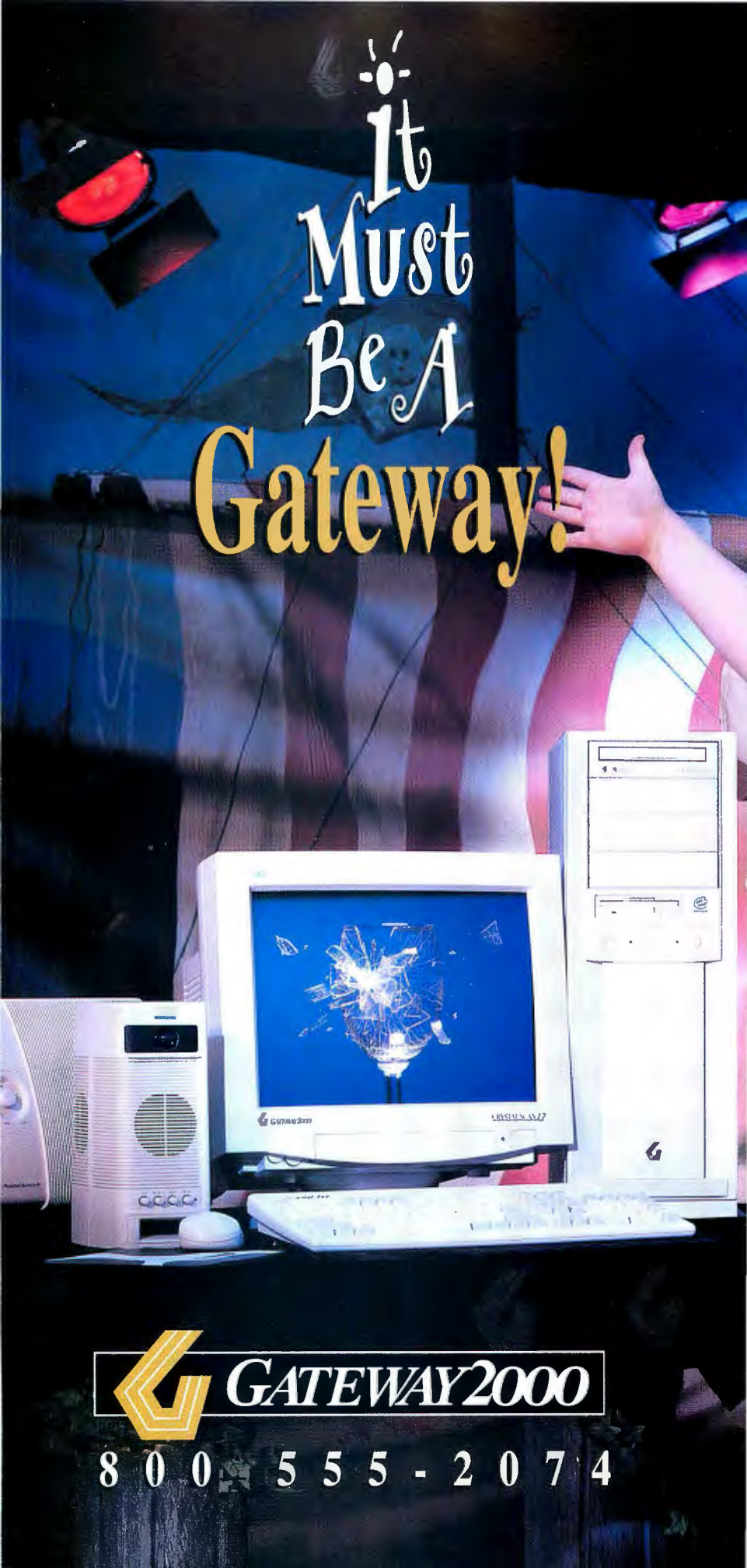
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Bravo! You'll leap to your feet when you experience all the powered-up features of the P5-166XL. This impressive system is built standard with 16MB EDO performance DRAM, 256K pipelined burst cache and 2GB hard drive for unbeatable performance. In fact, we expect our P5-166XL to blow all other Pentium processor-based PCs off the map!

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Could we possibly enhance your multimedia experience more? Yes! Now our P5-166XL, and all Gateway 2000 Family PC™ multimedia systems, also include MPEG (Moving Picture Experts Group) data compression technology. Not only will MPEG technology provide superior stereo sound, it also gives you incomparable full-screen, full-motion video right from your CD-ROM drive. Video from MPEG multimedia applications will be smoother, and soon all your favorite movies will be available on CD! The P5-166XL also includes a super-fast 6X CD-ROM drive for the latest CD-ROM drive technology available.

The P5-166XL adds all these performance features to a Matrox® 2MB WRAM graphics accelerator with MPEG video scaler. So now your 3-D graphics and multimedia applications will run with incredibly smooth video playback.

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Your TelePath 28.8 fax/modem includes Gateway's Information Highway communications CD, featuring a user-friendly interface and easy-to-use tutorial of included trial memberships to CompuServe®, Prodigy®, America Online® and Reuters Money Network. You'll also receive GNN (Global Network Navigator) for easy access to the Internet.

Software Diva

And for the grand finale: The P5-166XL has the *best* software bundle found *anywhere* with Gateway's Ultimate Software Bundle! It includes MS Office 95, Professional Edition and Gateway's Generations II Software Collection for use with the Windows 95 operating system. It's all you'll ever need for business applications in the Windows 95 environment, *and* for the most complete, updated versions of the latest and greatest multimedia applications, most optimized for Windows 95. A gaming pad is included in the Ultimate Software Bundle for use with all your entertainment software. Call and ask how you can upgrade other Gateway 2000 systems to get the Ultimate Software Bundle.

Primo Gateway Gold Premium

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All Gateway professional Pentium® processor-based systems have EDO performance DRAM, and most come standard with pipelined burst cache. These features will give you a faster, more cost-effective means to great performance. And for extraordinary levels of performance, Gateway's P5-133 Professional system includes the ultra-fast 133MHz Pentium processor and is standard with 16MB EDO performance DRAM and 256K pipelined burst cache. Gateway utilizes EDO and pipelined burst cache memory technologies for the best performance — *anywhere.*

All your heavy-duty business applications will run at top speed with the industry's latest 6X CD-ROM drive, standard on the P5-133. This CD-ROM drive performs 50% faster than a 4X CD-ROM, and with 6X technology you'll be ready for tomorrow's complex software applications. Renowned for unconventional wisdom when it comes to value, Gateway 2000 brings you the P5-133 Professional system for just $2,949!

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Gateway PCs include the Microsoft® Windows® 95 operating system, and our Professional models all tout MS Office 95, Professional Edition or MS Works 95, both compatible with 32-bit performance and backward compatibility for 16-bit applications. When you buy a system from Gateway, we'll also give you a choice of operating systems. Whether it's MS-DOS® and Windows for Workgroups, Windows NT, or Windows 95, Gateway 2000 will meet all your computing needs.

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Presenting the Best Performance in the Industry!

For the fifth consecutive year Gateway 2000 swept the *Computer Shopper* Best Buy awards! We're proud to announce that *Computer Shopper* readers awarded us with these coveted *Computer Shopper* awards: Best 486 Desktop (486DX2-66), Best Pentium Desktop (P5-133XL), Best Multimedia PC (P5-120 Family PC multimedia system), and Best Overall Computer Systems Supplier!!

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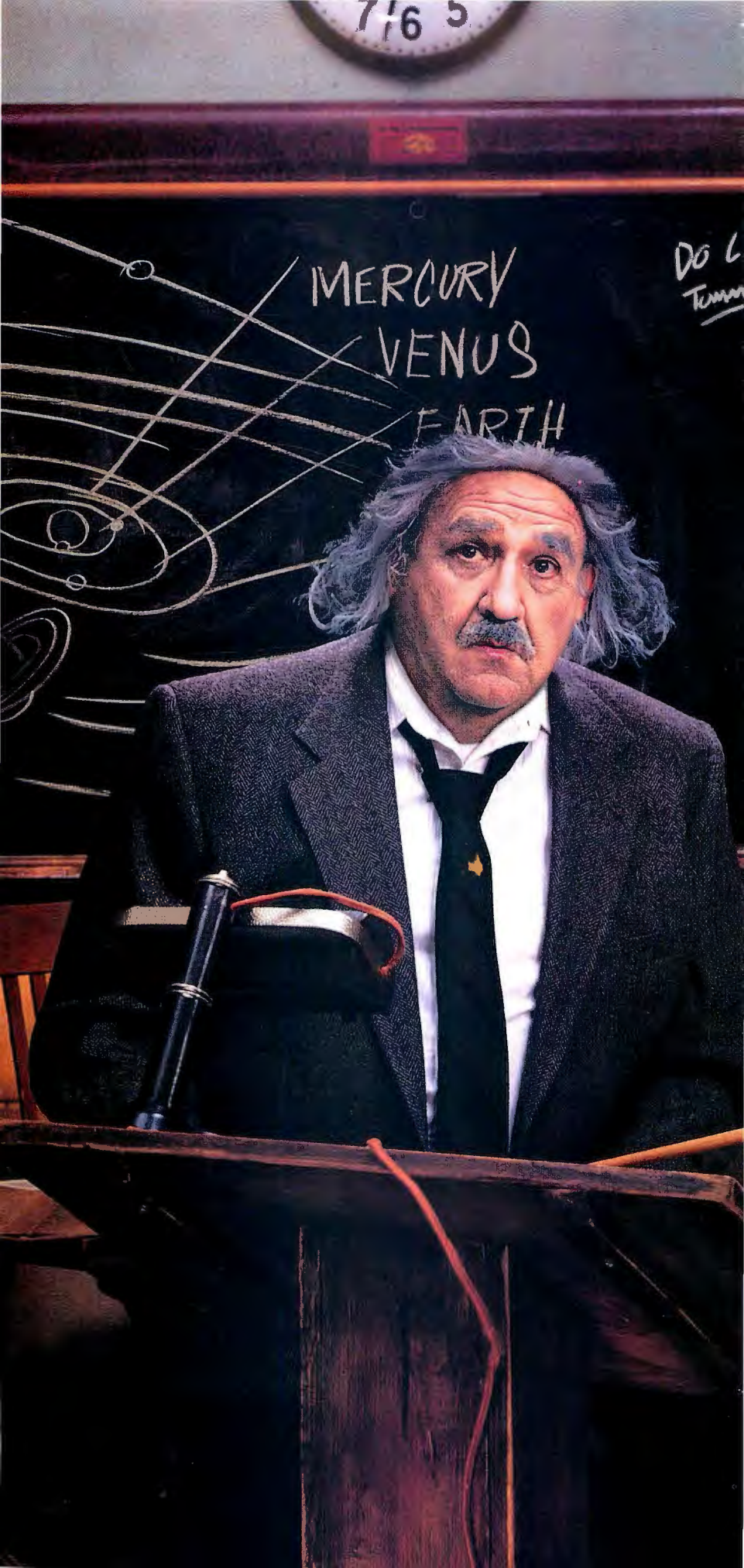
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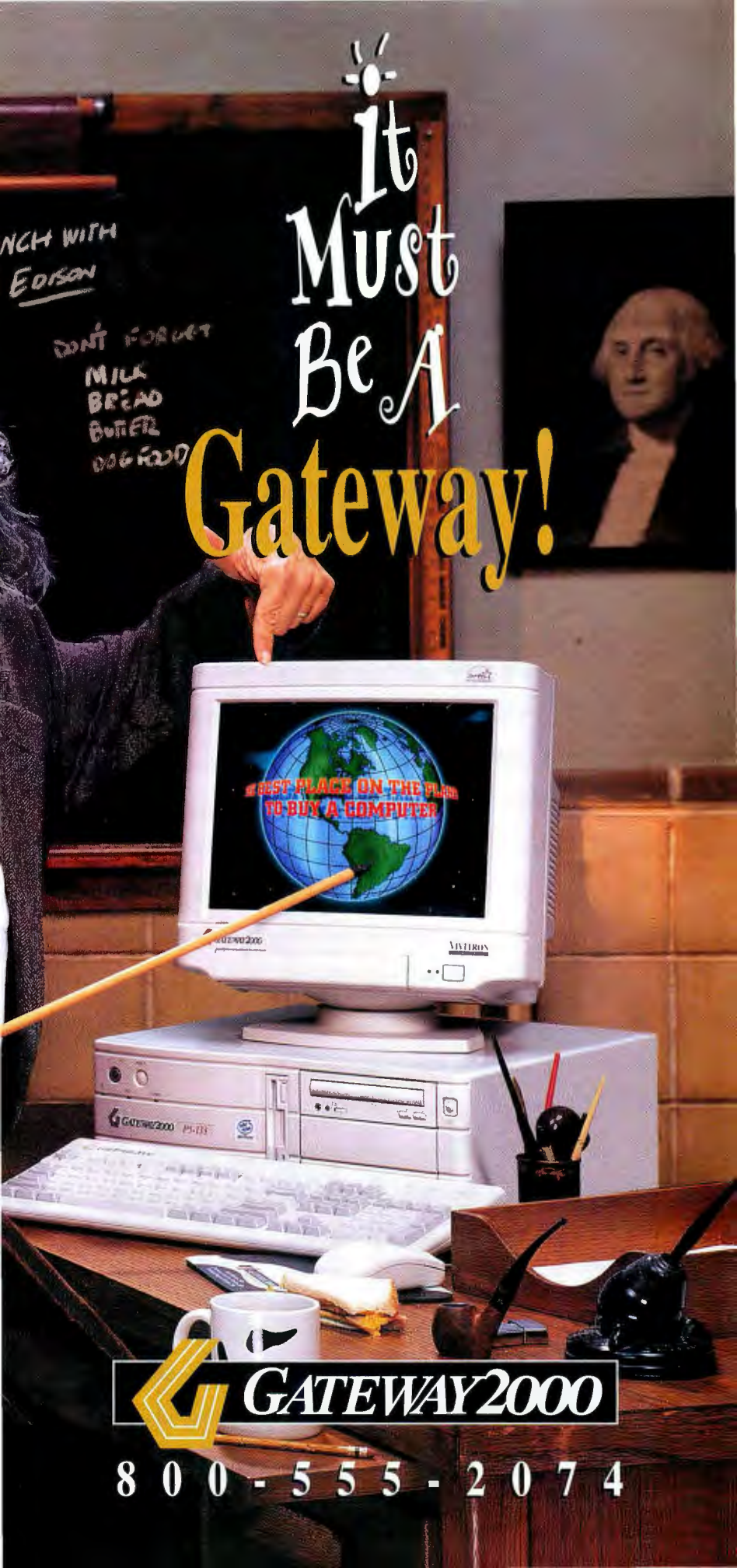
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High-Flying Performance Features

To achieve the high throughput and superior performance your intense applications require, we've included a 2GB SCSI hard drive on the Gateway G6-200. SCSI technology offers better performance in workstation environments. The SCSI interface allows you to connect up to seven internal SCSI devices, so you can expand like never before. The G6-200 also includes the Adaptec® 2940 PCI Ultra SCSI controller card. Combine all this with 64MB DRAM and your workstation applications will fly!

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Workstation Wonderland with Windows NT Workstation

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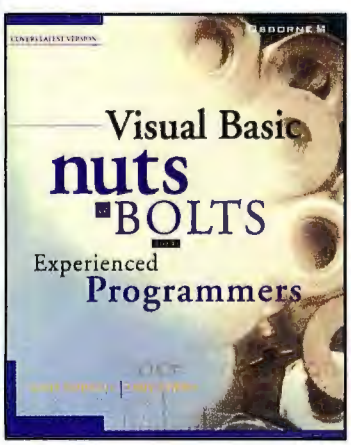

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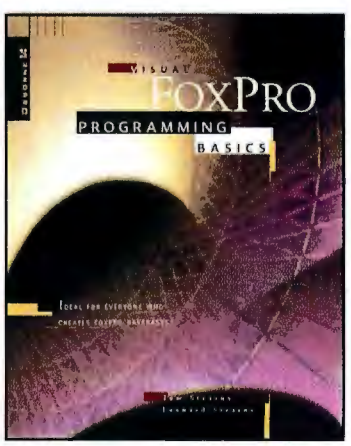

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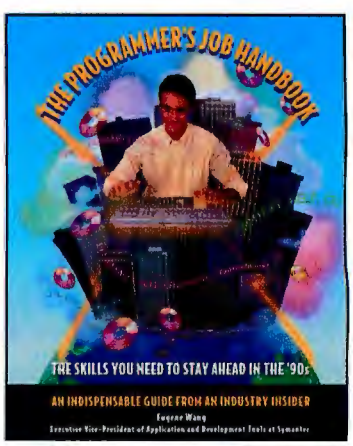

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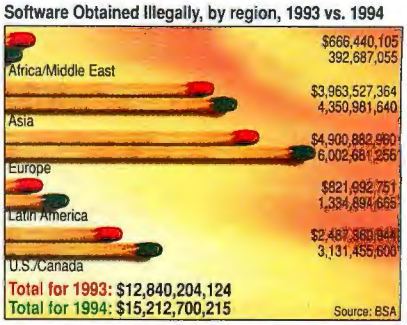

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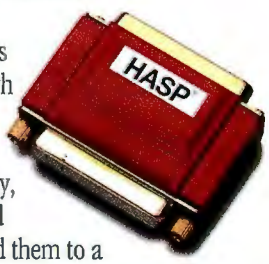

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Ease of Learning	9.1	7.1	8.8	7.7
Ease of Use	8.3	7.2	6.8	6.3
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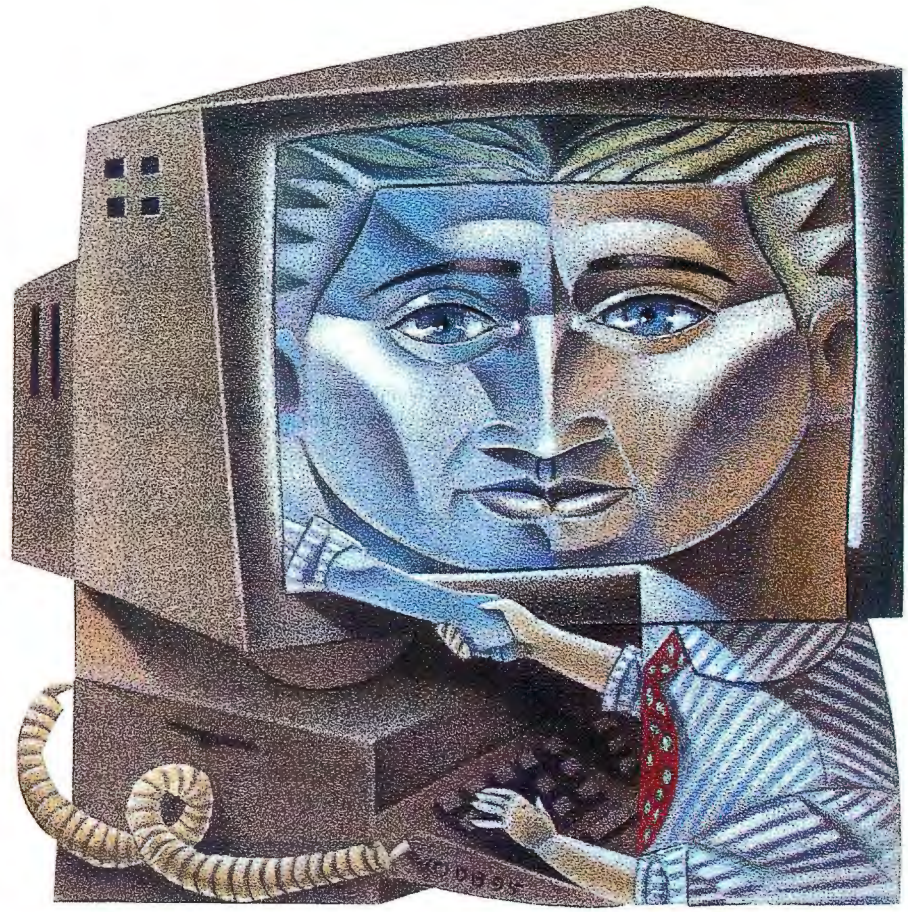
Agents and Avatars

TOM R. HALFHILL



D. B. JOHNSON © 1996

Are on-screen personifications the wave of the future, or just a silly fad?

Coming soon to a screen near you: *You.* Or at least a facsimile of you. It's called an *avatar*: a graphical image of a user—representing yourself or someone else—on a computer screen. Think of an avatar as your alter ego in the virtual world of cyberspace.

Another kind of avatar is sometimes called an *agent*, a *character*, or a *bot*. This is a graphical personification of a computer or a process that's running on a computer.

Avatars are controversial creatures on the cutting edge of user interface design. They're supposed to provide new ways for people to interact with their computers and with other users on a network. By simulating the social interaction of real life, avatars try to present an environment that's more familiar than graphical desktops and command-line prompts.

Although limited forms of avatars have been with us for years in videogames, they're rarely seen in other kinds of software. Now that's all starting to change. Last year, Microsoft introduced Bob, an add-on for Windows in which animals and other fanciful characters lend assistance to novice computer users. Some new services on the World Wide Web are making heavy use of avatars. There's even a business groupware product that creates a virtual office populated with employee avatars. And you'll find avatars popping up everywhere in movies, TV shows, and books.

Is this the future? Or is it a fad? Some experts predict that avatars will be a common sight on the computer screens of tomorrow. Others say they're too limited and might even be socially destructive. But one thing is clear: Avatars are the focus of intense research in academic and corporate design labs. You'll probably meet one soon.

Stranger Than Fiction

The driving force behind avatars is the ongoing search for an interface that's easier and more comfortable to use, especially for the millions of people who are still computerphobic. "One of the biggest barriers for beginners, we've found, is the intimidation factor," says Kathleen Schoenfelder, product manager of Microsoft's Social Interface Group, which designed Bob. "We've seen people in our usability tests who literally break down in tears."

The earliest computer users were engineers and programmers who were fairly comfortable with command-line prompts. Today, most users are professionals who are fairly comfortable with graphical desktops. But a metaphor based on files and folders means nothing to a five-year-old, and the abstractions of menus and icons are difficult for even some adults to grasp. Avatars can put a friendly face on an inscrutable machine.

"People have gone through thousands and thousands of years of evolution that have made us hard-wired for social interaction," Schoenfelder points out. "Characters and avatars take advantage of that hard-wiring."

Avatars won't necessarily replace menus, icons, and other elements of GUI computing. Instead, they'll play the role of helpful assistant or guide. Proponents think avatars are tailor-made for

the growing virtual communities of on-line services and networks.

The avatar bible is *Snow Crash*, a cyberpunk novel by Neal Stephenson (Bantam Books, 1992). In this near-future story, computer users conduct business in a virtual world called the Metaverse, a successor to today's Web. The Metaverse has streets, office buildings, houses, stores, bars, mass transit, and just about everything else found in the real world—including real people represented by highly realistic avatars.

So admired is *Snow Crash* that one new company—Black Sun Interactive, which makes tools for creating virtual worlds—named itself after the Metaverse cafe where hackers hang out. Another company, Worlds Inc., is building a virtual world on today's Web that's closely patterned after the Metaverse. Worlds is also working with IBM to create digital libraries that allow users to retrieve information and view artifacts in 3-D virtual space.

A good example of this technology is Worlds Chat, the company's virtual chat room on the Web. It's basically a graphical version of the multiuser dungeons or domains (MUDs) that have been popular on the Internet for years. You can download the free Worlds Chat software by linking to www.worlds.net.

When you run the software, it lets you choose an avatar from a gallery of figures. Then you enter a virtual space station occupied by other avatars. Each avatar represents another person somewhere on the Web. You can maneuver your avatar with the mouse, and you can talk to people by typing messages on your keyboard. It's a virtual cocktail party.

Microsoft recently opened a virtual chat room for members of the Microsoft Network (http://www.msn.com). The client software, which requires Windows 95, lets you create your own avatars with different facial expressions.

This technology was pioneered in the 1980s by an on-line service called Habitat, for the Commodore 64. Now it's moving to a whole new level. Worlds is currently beta-testing a new service known as AlphaWorld; it has 140,000 square miles of virtual territory in which users can construct their own buildings and communities. AlphaWorld will even have virtual stores and banks where people, via their avatars, can transact real-world business.

The commercial aspects of AlphaWorld demonstrate that avatars aren't just for fun and games. Proponents believe businesses will benefit from this technology, too.

Worlds Chat, a virtual chat room on the World Wide Web, lets you choose from an extensive gallery of avatars. A much larger virtual world is now under construction.

The Virtual Office

For two years, employees at Chiat/Day Advertising in New York have been using prototype groupware that simulates a virtual office on a network of Macs and Unix workstations. The groupware environment, called Oxygen, was designed by Art Technology Group, a Boston-based spin-off of MIT's Media Lab. Later this year, the developers plan to introduce a commercial version of Oxygen that can support hundreds of thousands of users across WANs and the Internet.

Oxygen contains virtual rooms where employees can work on group projects. To share project-related information, for example, someone leaves a file icon in one of the virtual rooms. Other people can enter the room and retrieve the file without knowing exactly where on the LAN the file really resides. Employees can even dial into the virtual office from a laptop on the road. To set up a conference call, they simply click on the avatars of the coworkers they want to include; Oxygen is tied into Chiat/Day's Rolm PBX.

The avatars in Oxygen are disembodied faces. Employees are free to use digitized photographs, or any graphics they want, for their avatars. "Just as people like

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to personalize their offices with pictures of their dog, we wanted to give them the ability to personalize their images," explains Jeet Singh, cofounder and CEO of Art Technology Group. "Like maybe today I feel like Superman. Or maybe I feel like an alligator."

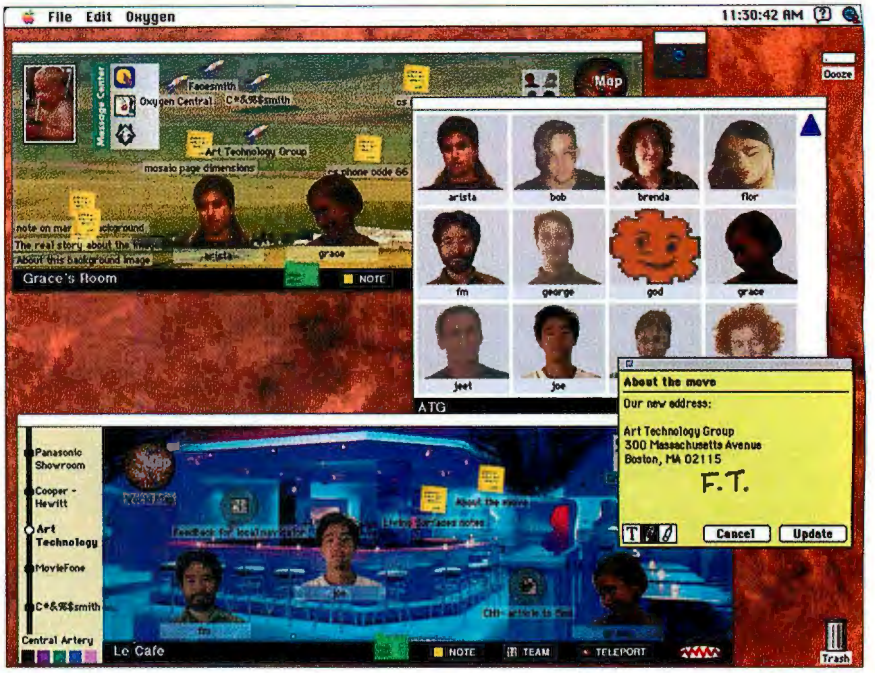
However, this raises one of the several controversies about avatars: reality versus role-playing. A realistic avatar might help you identify another person you meet in virtual space, but someone could also wear an avatar as a disguise. What if an employee impersonates another employee? What if someone chooses an avatar that other workers find distracting, disgusting, or politically incorrect? Most businesses would frown upon someone who showed up for work every day in a Halloween mask; should avatars be allowed to flout the corporate dress code?

Singh has considered this problem. "Some companies might say, 'You cannot change your avatar, you must use the official picture we took when we hired you.' Other companies won't care. When this software is running at IBM, all the avatars will probably be wearing ties and blue suits."

Of course, masquerading is rampant in on-line chat rooms. People who wouldn't dare to cross-dress in real life frequently pose as the opposite sex while on-line. In Worlds Chat, the avatar gallery lets you indulge your fantasies by posing as anything from a businessman to a butterfly. Before long, there may even be class distinctions between avatars. In *Snow Crash*, users who log onto the Metaverse from cheap public terminals appear as pixelated, monochrome avatars derisively referred to as "black-and-white people." Will tomorrow's status-seekers hire artists to draw custom avatars adorned in Armani suits and wearing Rolex watches?

Bob Rockwell, chief technology officer of Black Sun Interactive, thinks people will gradually address these issues by inventing new social rules for avatars. In recent years, people have developed new conventions for E-mail that are slightly different from the rules that govern how they handle written correspondence or phone calls. Rockwell says avatars will likewise spawn their own social etiquette.

"For instance, lurking is necessary," says Rockwell. "Smart users lurk for a while in a chat room before they shoot their mouths off. But lurking at a real-world cocktail party is considered impolite. Lurking is eavesdropping. We need a way to represent lurking on-screen, maybe with grayed-out avatars, so you'll know people are there but aren't actively participating."



Oxygen, an experimental groupware program used by Chiat/Day Advertising and developed by Art Technology Group, represents employees as face-only avatars who can meet in virtual offices.

Revenge of the Turing Test

Agents, bots, and characters raise even more questions. Already, some people in virtual chat rooms occasionally mistake a computer-controlled bot for a human-controlled avatar—which might say more about the intelligence of the beholder than it does about the bot. But some people don't think it's funny. Designers are keenly aware that many people react negatively to personifications of computers.

"Some people are very strongly against it because they feel it's misleading, that a computer is not a human, and that to give a computer a human appearance could mislead the user into giving false attributes to the machine," says Don Norman, a user interface expert and vice president of Apple's Advanced Technology Group.

Apple took great pains to design a generic-looking face for its PlainTalk speech-recognition software. Moreover, the PlainTalk face doesn't personify the computer; it's really a cue that tells users when the PlainTalk software is ready for commands or when it can't recognize a command. "It doesn't pretend to have any intelligence," says Norman.

The ideal user interface, he says, makes the computer invisible, not more visible. If you're writing a letter, you see a notepad; if you're balancing your bank account, you see a checkbook. Norman thinks today's interfaces are far too complex, and that avatars threaten to add still more complexity by interposing another layer of indirection between users and their tasks.

Nevertheless, avatars have an allure that won't go away. If nothing else, they'll probably thrive in the new chat rooms on the Web. And the engineers who are designing virtual worlds around avatars can't resist the temptation to improve upon reality. If the mood seizes you, why not appear as a man-eating plant? Why ride a bus when you can use a transporter? Why wait in line at the bank if an agent can transact your business on-line?

"We have to design the virtual worlds to make as little as possible impossible," says Rockwell of Black Sun, "and as much as possible possible." ■

Tom R. Halfhill is a BYTE senior editor based in San Mateo, California. (His avatar lives on a private island in the South Pacific.) You can reach him on the Internet at thalfhill@bix.com.

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DMV Hits Pothole

CHRISTINE WHITE

Scandal! After six years and $49 million in expenses, the California Department of Motor Vehicles (DMV) ditched its new computer system. Then fingers pointed and heads rolled. The loss outraged taxpayers: It was, after all, their $49 million.

Lost between the accounting and the posturing of elected officials (a hot contest for governor between Pete Wilson and Kathleen Brown) was the technology. What really happened at the DMV? Was it a waste of taxpayer money? Where did abandoning the project leave the DMV? And is there a silver lining in the DMV's current business-process-reengineering project?

Janis Saxon, strategic-business officer, and Glenn Wilson, chief of EDP services, are rescuing the California Department of Motor Vehicles' scuttled computer-upgrade scheme by turning to business-process reengineering.

PHOTO: DAVID G. TOERGE © 1996

On-Ramp to Computerization

The California DMV started computerizing in the late 1960s. Its terminals, located at central headquarters, 172 field offices, and three telephone centers, are all linked to the state of California's IBM 3090-600J mainframe via the state's closed CalLink/CalNet system. Since now-standard transaction monitors, such as IBM's CICS, weren't available in the 1960s, the DMV developed its own, calling it Real Time Control (RTC).

At the same time, the DMV was also running applications on IBM Series/1 minicomputers. The core DMV applications are Vehicle and Vessel Registration, Driver Licensing, and Occupational Licensing. Additional applications interact with other agencies and DMV partners (e.g., insurance companies and car-rental firms). All applications are written in Event Driven Language (EDL), a proprietary DMV language, and all use the mainframe as a back end.

The back-end applications are written in assembly language and COBOL. The database itself is written in VSAM, and the DMV customized the database index structure in-house to accommodate its evolution from older database structures.

Using EDL and RTC, DMV programmers computerized the DMV's business rules of the 1960s; this included all the paper flow and manual steps required. What may seem a short-sighted way of developing applications today was standard practice then.

Nineties Business, Seventies Computers

Today the DMV is a big business. Its 1993/1994 fiscal-year revenue of $5.2 billion would have ranked it in the Fortune 100. It handles more than 25 million registered vehicles, 24 million driver's licenses, and 94,000 occupational licenses; processes more than 1 million on-line transactions a day; and has business "partnerships" with public and private organizations. One such partnership authorizes auto clubs to issue license plates, stickers, and registration cards to their customers.

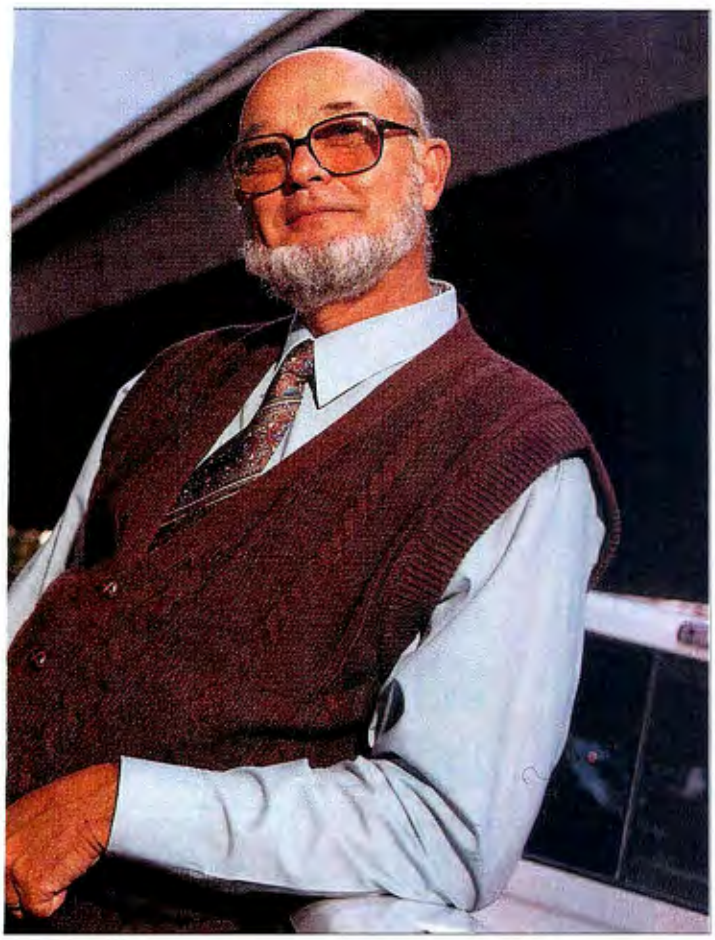
The IBM Series/1 computers now represent a functional-but-obsolete technology. They are no longer sold by IBM, are difficult to get parts for, and have dwindling technical support. Not surprisingly, as the DMV grew, it started shopping for replacements that would continue to deliver subsecond response times.

Growth may be the biggest challenge that the DMV has ever faced. Says DMV spokesman William Madison, "The legislature hands projects to the DMV: driver safety, voter registration, collecting Social Security numbers for the Absent Parent Program [child-support enforcement]. We're the agency that contacts the customer first." The DMV keeps files on 87 percent of the adult population in California. And the numbers keep growing.

Why is growth a concern? Because applications that computerize paper processes don't allow for growth and change. For example, information about a motor-vehicle accident is added as a subrecord to the main record, so separate reports about the same accident (done by the highway patrol and insurance companies) create two accident subrecords instead of one.

Another problem: Since the DMV database is not relational, developers must create any cross-references, such as those between a driver's license number and a vehicle-registration number, with "keys." Some key-handling "overlays" run every time a record is open. For example, if you change the address on your driver's license, overlays run to change your vehicle-registration number, notify your voter registrar, and update the California Law En-

The California Department of Motor Vehicles abandons a major money-losing computer upgrade and begins business-process reengineering



forcement Telecommunications System (CLETS). Growth is a big problem for a system not explicitly set up for growth or change.

Shopping for a New Computer

The DMV's technology department, known as Electronic Data Processing (EDP), had been in maintenance mode for years when the time came to find a new system. An EDP group started evaluating and testing new minicomputers and databases. With several technical challenges (listed below), the group arrived at what seemed a logical solution.

Challenge 1: An inflexible database structure. Fixed-length records and subrecords make accurate record-keeping tremendously labor-intensive.

Challenge 2: Maintenance worries. Business rules in the Driver Licensing application and VSAM database were in undocumented, unstructured, customized assembly language programs. Modifying, updating, and integrating applications were all slow.

Challenge 3: Development difficulties. Software development environments on the front-end IBM Series/1 minicomputer and the back-end mainframe system were dissimilar. The result: new applications were developed outside the Driver Licensing system.

The one sterling quality of the current system was its fast response time. When the project started, response times had increased slightly, but they were still at subsecond speeds. With all the customers at DMV field offices, all the phone calls the DMV handled, and all the business partners that were accessing the system continuously, maintaining fast response time was critical.

A logical solution: Build a system to replace the Series/1 minicomputers and provide database services, too. The EDP group projected the redevelopment to cost $30 million. After testing several systems, the group settled on a new minicomputer from Tandem: a new system with an untried OS and a proprietary database. The Tandem benchmarked twice as fast as the Series/1, a result of doing fetches against its own database.

In 1987, the DMV awarded Tandem the computer and OS contract, with the stipulation that EDP would create all the applications with the aid of consultants. In 1990, the DMV took delivery of the new Driver's License (DL) systems from Tandem. The DL application is on-line and interactive, and it accesses the mainframe database in real time. The DL system has 14 modules and subsystems, with many interfacing with other systems in U.S. and Mexican states, as well as in Canadian provinces.

The Road Map

Things then began to fall apart. One goal had been to set up a relational database between driver's license numbers and vehicle-registration numbers that law-enforcement officers could check with one query. EDP began by transferring the Address Search module of the DL system to the Tandem computers.

Two hitches quickly became clear. Changing the application and the database without changing the business rules would not support the increasing complexity of the DMV's activities at the desired response rate. And it was going to cost more money to make it work.

Simply moving the subrecords, overlays, and spaghetti code had increased the average response time to 4 or 5 seconds, five times slower than the speed of the old system. In 1992, Tandem and the DMV assessed the cost to complete the DL project properly. The answer: $73 million—over twice the original estimate.

DMV director Frank Zolin was not happy. He assembled IT

LESSONS LEARNED

✔ Avoid "technology for technology's sake": New Tandem systems were faster than obsolete IBM Series/1 minicomputers, but their response time was actually slower.

✔ Involve staff at an early stage: Reengineering requires the people who know the work flow to be involved from the beginning. Changing processes might achieve more than speeding up existing practices.

✔ Consider the future: Watching impending projects helps ensure more flexible processes and procedures.

✔ Watch the connections: Changes in business processes can affect interaction with other agencies and companies.

✔ Business benefit: The bottom line must be reducing response time, returning information faster, and improving the interaction between systems and people—regardless of the technology.

(information technology) experts, including Glenn Wilson, chief of the division of EDP services, to find a fix that would let the Tandem systems outperform the current system and enable the rest of the project to move forward.

Five months later, in March 1993, the team found the fix. However, it would cost $175 million—more than five times the original estimate. Zolin chose to stop the Tandem development and start looking elsewhere. But his decision called in the government watchdogs. The investigators then called in independent auditors to account for money spent. The auditors found no wrongdoing by EDP and put the project's cost at $49 million.

A Total Loss?

So what happened to the $49 million? Some of it went to pay the people working on the project—sharp people who discovered a problem that no one had previously known about: You cannot make a new system with antiquated business rules.

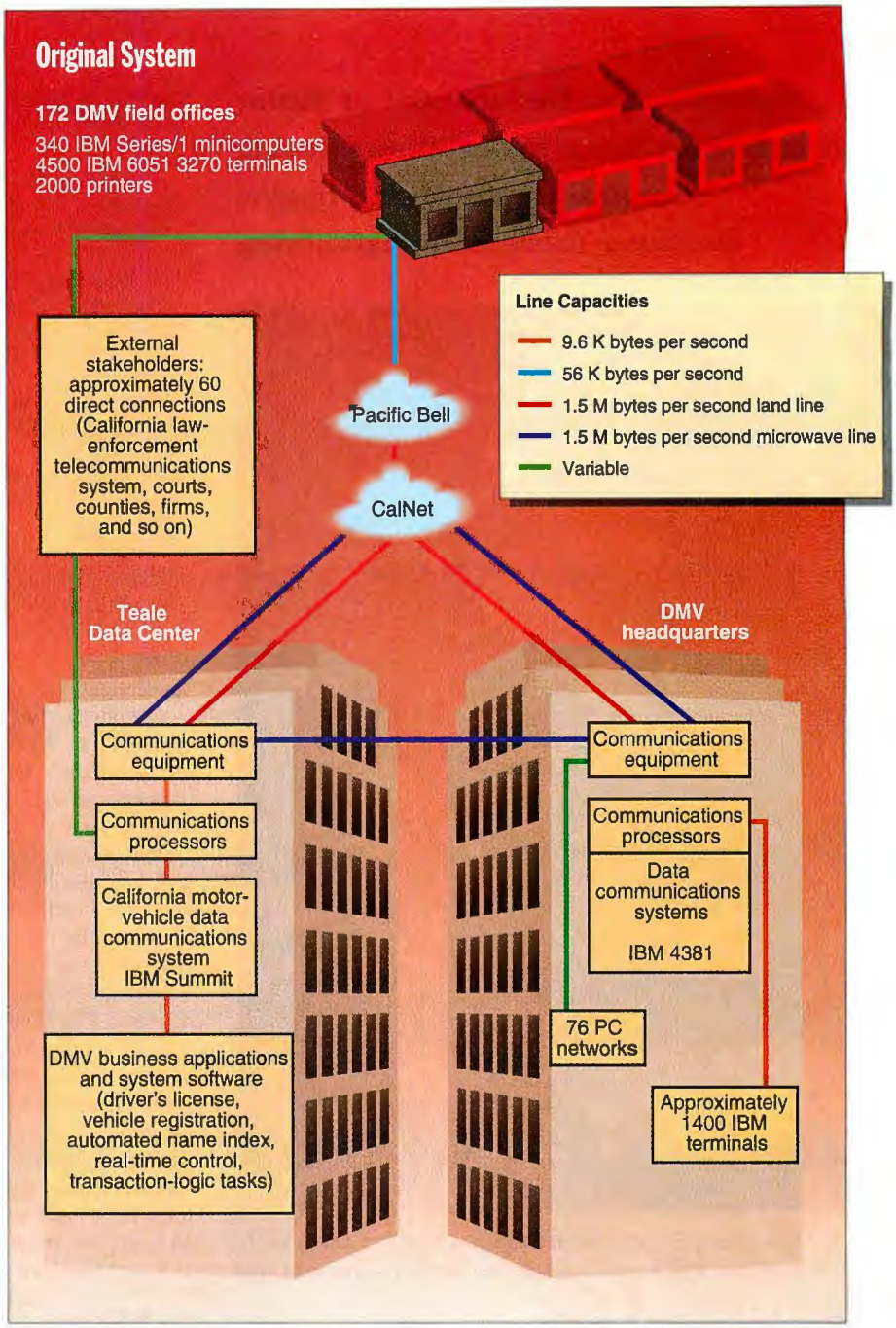
The $49 million also paid for computers performing a useful purpose at the state's Teale Data Center, where law-enforcement agencies can search for addresses and related information. With daily updates from the mainframe database, this system improved the average inquiry-response time from one month to one day.

That $49 million also bought new high-tech driver's licenses, with a magnetic stripe on the back encoding all the information from the front. The new DL application, when deployed, will read card information into the system. Meanwhile, the information is available to anyone with a three-line magnetic-stripe reader. According to Wilson, several California employers now use driver's licenses for employee security badges or time cards.

Rearview Mirror, High-Beam Headlights

"Data is a resource, not a driver, for business," says Janis Saxon, newly created DMV strategic-business officer and liaison between EDP, IS (information systems), and field offices and customers. "We have to look at the big picture. Not only is it technically feasible, but will it make a business benefit? Will it reduce response time?," she adds.

Saxon and Wilson both point to one beacon—business rules. Before a new DMV system can come into place and make a difference, the DMV has to redefine its 1960s business practices. The task force for this job is a mix of personnel from different divisions within the DMV. Many members are longtime DMV employees who know what it's like to stand behind the counter and talk to the customers.



The DMV's data center is very centralized. The Teale Data Center holds most of the data. It shares it over leased lines with the DMV headquarters and uses CalNet to share data with most DMV offices.

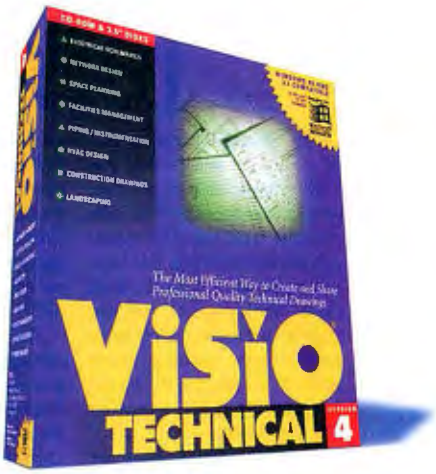
In May 1995, The Warner Group consulting firm suggested to the DMV a standard business-reengineering plan consisting of three phases. Phase 1 is to analyze current business processes and identify target processes for redesign. Phase 2 is to do detailed analysis and redesign of those processes identified in Phase 1. Phase 3 is to implement the redesigned process.

To reduce risk and costs, the DMV is committing to one phase at a time. Phase 1 will last from six to eight months, with some small, but critical, projects to prove that it's the right approach.

Road Fork: Technology or Business Rules?

The DMV's decision to forestall technology and redesign its business is unusual, if not risky. The DMV has many business partners; can it afford to stand still as its partners update their own technology and the total computer environment changes?

"Architecture doesn't matter to me," says Saxon. "What I care about are the benefits." Benefits are important goals for



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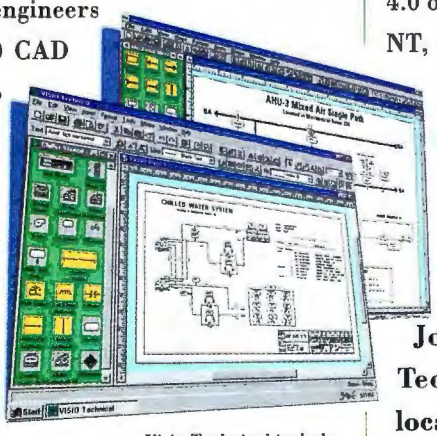

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Wilson, too. And EDP has started working to deliver a big benefit-oriented service: making the DMV more accessible.

Currently, most contact with the DMV is done through the mail, and the system is amazingly efficient. By color-coding and routing, the DMV handles mail rapidly and deposits most checks the same day it receives them. But mail requires manual handling. The DMV now has an Internet location, accessible from the state of California home page (http://www.ca.gov/dmv/), where you can find information and even download the *California Driver Manual* in several different languages.

Yet another task that requires manual handling is dealing with changes of address. But an on-line change-of-address form, which the DMV developed together with Oracle, is coming. To change your address, you enter your driver's license number and other pertinent information. Twice a day, a flat file will pass to the DMV's main database through a gateway.

The DMV is also working with the state of California to place DMV information on kiosks located throughout the state. It's also considering building ATM-like machines outside DMV field offices to allow customers to conduct some transactions via the machines. The kiosk program is temporarily on hold due to lack of funding.

Wilson's EDP group is also testing technology and more efficient ways of working with current applications. Because the DMV doesn't plan the rollout of its new system to occur for five years or more, finding ways to leverage current technology is important. In the EDP lab are computers running OS/2, AIX, and emulators to access the applications and data. Wilson is trying to determine whether PCs or workstations are better solutions than terminals. He carefully avoids the phrase "client/server," asserting that the architecture to be used has yet to be decided on.

Data communications is another area that the DMV is working on. CalNet/CalLink, the statewide network that all agencies use, currently has 52-Kbps circuits that the DMV accesses via 9600-bps modems. The state is upgrading its circuits while the DMV buys new modems.

The Road Ahead

Reengineering the DMV's business rules isn't going to be easy. California not only has the most driver's licenses and vehicles of any state in the country, it also has the most diverse population. Examining the way in which DMV officials interact with customers—and with the data they handle—requires a fresh eye. And emerging from the taint of a "scandal" requires a legislature with an open mind.

"We couldn't be in a better position for change," says Saxon. "The state has a new IT department and CIO. We're redesigning the statewide procurement process to speed up purchases, and streamlining government services. We're reclassifying IT people, seeing who has which skills and who needs retraining," she adds. Last October, a set of strategic values and principles that was first set forward in June 1993 was to get an update. All processes will be redesigned against those strategies.

While Saxon keeps an eye on the business end, Wilson looks toward the technology that will soon become commonplace. He sees graphics, imaging systems, and forms and work-flow management as tools that will lift California's DMV business rules into the twenty-first century. ■

Christine White is a freelance writer based in Sacramento, California. She has written extensively about computers and technology. You can contact her on CompuServe at 71075.2673@compuserve.com or on the Internet or BIX at editors@bix.com.

DMV's Air Bag

California's Right to Privacy Act requires that your name, address, and other personal information can't be made available from any state agency without your knowledge. This law—and concerns that people might change traffic citations, reregister vehicles, or even maliciously delete driver's license numbers—has inspired the construction of a tremendous security system around the DMV's databases.

Most of the DMV's business partners use DMV data for lookup or validation purposes. Rental-car agencies, for example, use it to check driver's licenses. Other business partners, such as insurance companies, report to the DMV system.

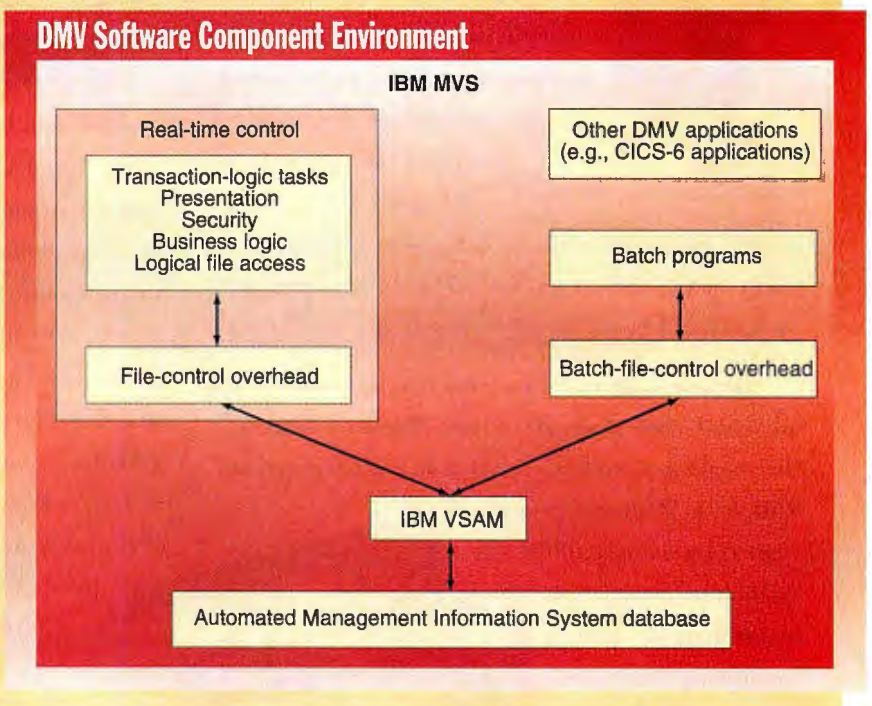
One security point: Only a driver's license number or vehicle-registration number can be used as a lookup key. Another security point: Few DMV business partners interact directly with the DMV's database. Some use an intermediate computer containing only pieces of the database. All systems use on-line transaction processing (OLTP) and queuing.

The DMV business partner's application queues a query to the database (e.g., Does this person have auto insurance?). A gateway computer gets the query, closes the queue, and then opens another queue and puts the query there. The DMV database gets the query and returns the answer in the same three steps.

As a result, there is never an open pathway between the business partner's system and the DMV's database. Furthermore, transactions waiting in the queue do not disappear if any one computer happens to go off-line.

New DMV applications undergo extensive testing—first on an *individual unit*, then on a closed system, then on an integrated system, and finally in a production environment. New applications are disseminated statewide overnight.

New Internet applications, such as the change-of-address form, present their own challenges. "Nobody talks about the security of a testing environment on the Internet," says Glenn Wilson, chief of the division of EDP services. The DMV's test and integration model won't work for Internet applications, but the DMV sidesteps this with an "Internet" that's completely within the DMV. By mimicking a production environment, it can discover shortcomings or security breaches in the application.



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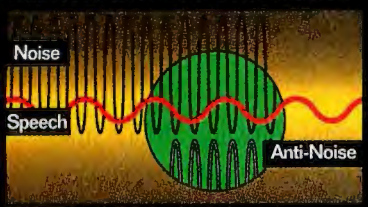

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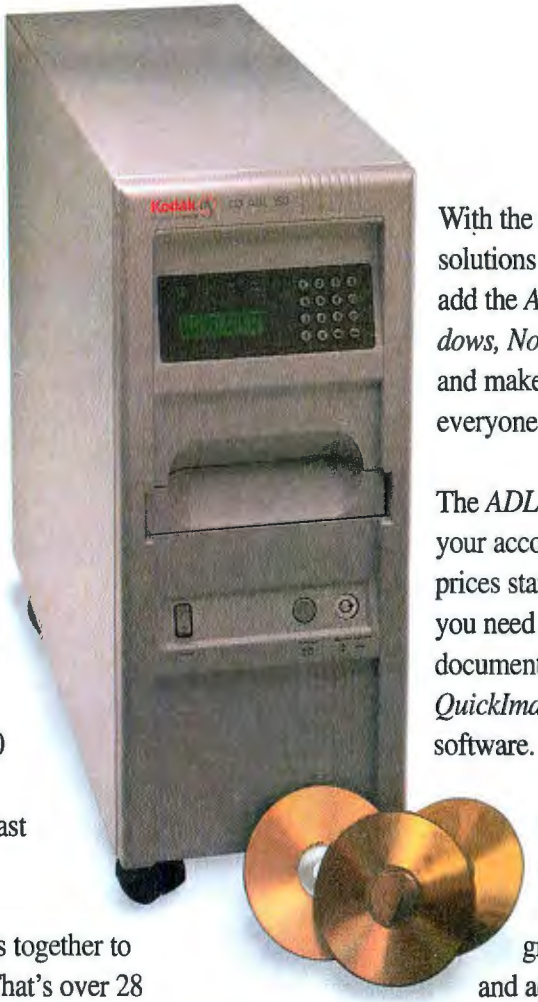

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MERGING VOICE & DATA

While we wait for ATM—the ultimate voice/data integration service—emerging technologies now allow voice traffic to share today's commonly used data lines

Motor oil and water don't mix, and when you put them together, you ruin them both. Such is also the traditional thinking behind mixing voice and data on the same lines.

But tradition is expensive when it means leasing separate data and voice lines. Wouldn't it be much cheaper to pay for a single, unified communications line? Voice/data integration is the holy grail of networking.

Cost is the driving force that compels organizations to merge their separate voice and data networks. After all, it's cheaper to pay for one line every month than two. Large corporations have known this for a while. In the past, only large organizations used voice/data integration, and only to link large regional centers. Typically, data centers in these locations shared information over private leased-line networks, and phone traffic between sites got a free ride over this corporate backbone. Such connectivity, however, was limited to only a handful of sites.

Today, many organizations want to extend this type of voice- and data-line sharing to smaller sites—even down to individual users working in their homes or on the road. There are now several cost-effective ways to do this.

First, when it comes to connecting a single user, there's voice over the Internet. Many companies already consider the Internet an extension of their backbone. The logical extension of this approach is to use the Internet to carry voice conversations. In Nathan Muller's article "Dial 1-800-Internet," we explore some of the underlying technologies that make this possible.

Second, there's the issue of connecting users in remote offices to a corporation's other offices. Many companies use frame-relay services to carry data between remote locations because of the economics of the service. With such capacity already installed, companies are starting to use these same links to carry voice traffic between sites. In "Voice Gets Framed," Christine Heckart and Beth Gage look at the issues and discuss the technologies that let voice share a frame-relay line with data.

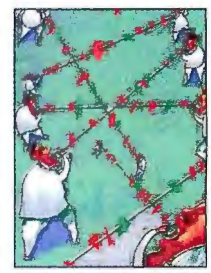
Finally, there's the issue of home users who need more bandwidth and better connectivity to their colleagues. We look at the emerging alternatives for the home user in "ISDN: Give Up and Go?"

The goal of all voice/data integration approaches is to reduce telecommunications charges by squeezing bandwidth out of data links. However, there's another business incentive to integrating voice and data—the need to share information in a more natural way.

Basically, all voice/data integration technologies provide a mechanism for collaborative work. Instead of users sending a spreadsheet over a data connection and calling a colleague to discuss it, it's possible for two users to see the same file, make annotations, and talk about the changes.

In the future, asynchronous transfer mode (ATM) may be the best way to carry voice and data traffic on a single network. But it will be years before most companies reap the benefits of this high-speed networking technology. In the meantime, the technologies discussed in the following three articles will play a major role in helping people work better together. ■

—Salvatore Salamone, News Editor



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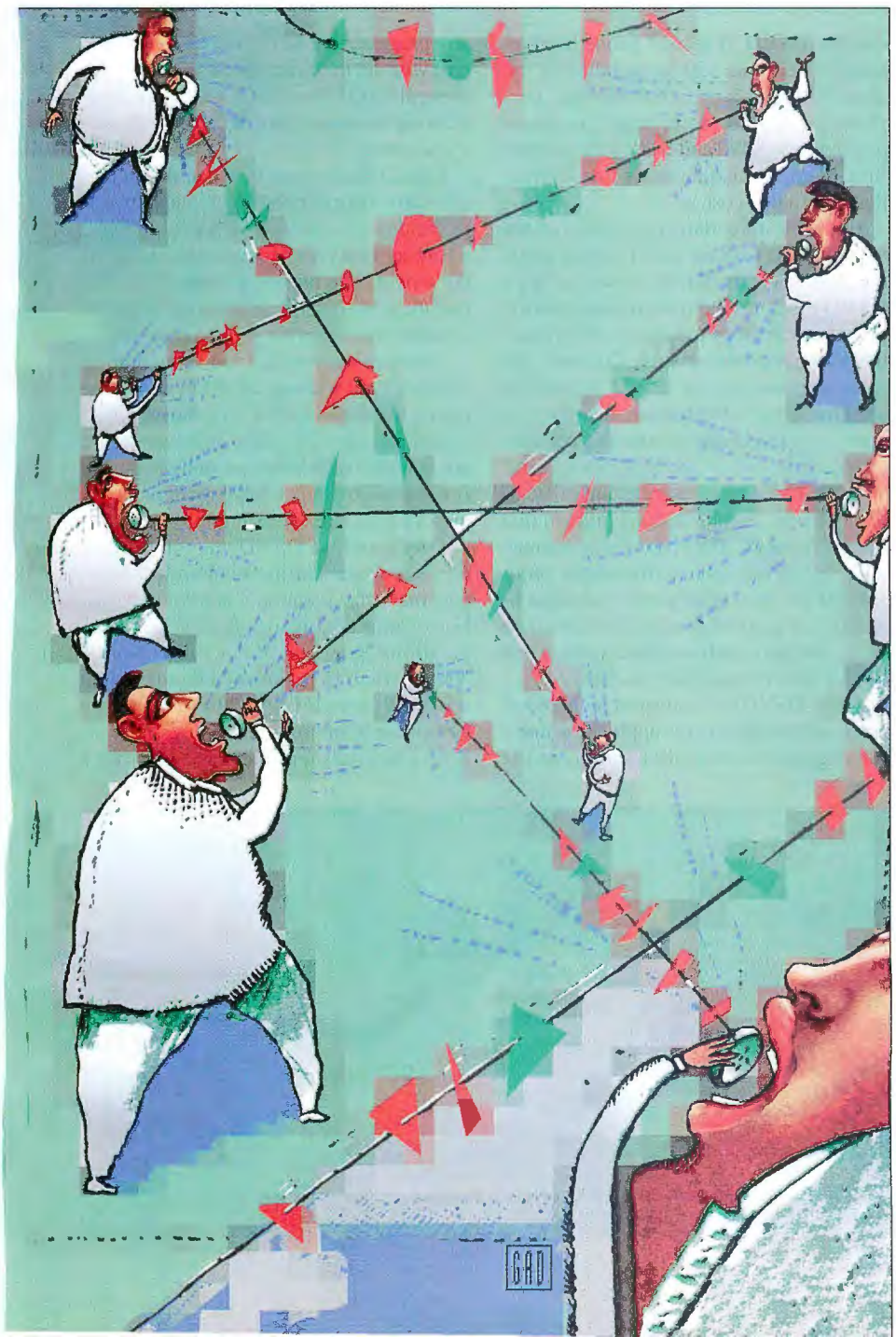
ISDN: GIVE UP AND GO?

New line-sharing technologies that use existing phone lines promise to deliver the benefits of voice/data integration to small offices and home offices

SALVATORE SALAMONE



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Waiting at a cross street in Manhattan each morning for a bus that makes limited stops is always a trying experience. Eventually, there comes a point when, after passing on five buses that make local stops, I decide to cut my losses and take the next local bus, even though the limited bus speeds my trip and gets me to work much faster.

Many companies face a similar situation when it comes to delivering voice and data to users at home, in remote offices, or on the road. They'd truly like to use ISDN, the ultimate voice/data integration service. But there comes a point where, after years of waiting for ISDN's deployment, these companies also decide to take whatever alternative comes along that will get the job done.

Until recently, there were few practical alternatives to choose from. Fortunately, two line-sharing techniques—Digital Simultaneous Voice and Data (DSVD) and Asymmetric Digital Subscriber Line (ADSL)—are emerging.

DSVD and ADSL both operate over unshielded twisted-pair cabling—the common wiring that runs to every home and office—and thus eliminate one problem that has limited ISDN's use. Specifically, many users have found that to get ISDN service, they must install new lines to their home—not a trivial task. In some cases, users actually have to dig a trench from the curb to their house to get the regional telephone company to install the ISDN line.

Using existing phone lines is about the only thing these two techniques have in common, however. DSVD and ADSL are quite different and are targeted at different markets (see the table "What's My Line?" on page 76).

A Modem with a Twist

DSVD is a modem technology that lets you run voice and data over a single telephone line. The only requirement is that

the users at each end of a DSVD connection must have a modem that supports it.

DSVD is a protocol that modem vendors add to a V.34 modem. Products that support DSVD, such as those from Boca Research, Creative Labs, and U.S. Robotics, convert voice to a digital format and compress this signal to about one-eighth the size of the analog signal.

The modem mixes the stream of digital voice with data from any communications application running on a PC or Macintosh (see the figure "Two in One" below). The combined signal then travels over the public telephone network, just like it does with any modem. At the receiving end of a link, the modem separates digitized voice traffic from the data and then decompresses it and converts it back to an analog voice signal.

Once a connection is made, the users at each end of the link have a channel that supports voice and data sharing. Thus, a person on one end of a call can pick up a telephone connected to the modem and talk with a person on the other end of the link—all while transferring files and data over the same link. A DSVD modem operating at 28.8 Kbps for data only will typically transmit the data at a rate of 19.2 Kbps when voice traffic is traveling over a line.

No Free Lunch

DSVD modems typically cost approximately $100 to $200 more than comparable V.34 modems. But this cost difference could quickly be made up when you consider the alternative: installing a second telephone line to your home or office. If you do the math, you can easily make a case for DSVD. A second phone line typically costs about $50 for installation and about $10 to $15 per month for basic telephone service. So, in two years, you would pay between $290 and $410 for that extra line. (There's also monthly line charges that add to this cost.)

But while it's certainly possible to make a compelling case for DSVD based solely on cost, this is the wrong reason to buy a DSVD modem. The right reason is to exploit the technology to improve the productivity within an organization. Currently, the most common uses of DSVD technology are providing better technical support to users in the field and conducting collaborative work.

In the first case, a user having difficulties can have a help-desk technician dial into his or her PC. Both parties can maintain a phone conversation to discuss the problem. At the same time, the help-desk technician can transfer system files, examine them, edit them, and download updated versions to the remote user's machine.

Since DSVD is a transport technology and is independent of the application that's running over it, a help-desk staffer can use any program that he or she has used in the past without modification. This means, for example, that the technician can run any existing remote-control or file-transfer utility program.

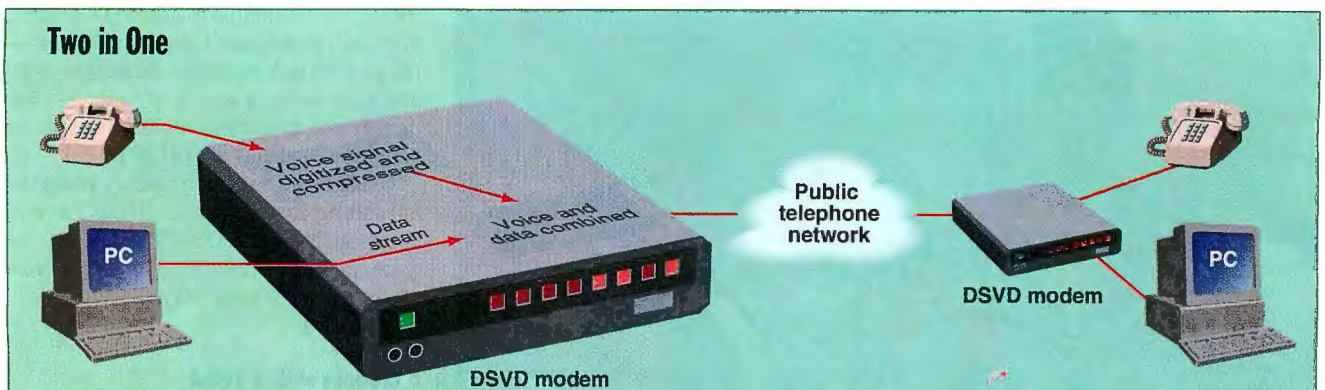
DSVD is also useful when doing collaborative work. Existing whiteboard applications can run over DSVD modems, allowing two users to annotate a shared document. The twist with using DSVD is that these two users can also talk about the annotations using the single phone line.

You can accomplish the same type of collaboration without DSVD by using two phone lines, one for the whiteboard application and one for voice. However, there are many times where a second phone line is not available—in a hotel room or a busy airport terminal, for example.

Don't confuse DSVD with other types of voice-/data-sharing modem technologies that offer seemingly similar services. For example, consider Radish Communications Systems' VoiceView. VoiceView, which first appeared bundled with a Boca Research 14.4-Kbps modem, is a computer telephony technology that allows you to talk and exchange data over a

WHAT'S MY LINE?

LINE-SHARING TECHNIQUE	TYPICAL USE	WHY YOU SHOULD USE IT	WHY YOU SHOULDN'T
DSVD	• Collaborative work • Help-desk support	• Improve user collaboration on projects • Provide assistance to users on the road	• To save money you'd pay for a second phone line
ADSL	• High-speed Internet access • Delivery of video and multimedia services to the home or small office	• Give home users World Wide Web–site access • Give on-line users a way to dial out while surfing the Internet	• To provide a high-speed link between two users for collaborative work



A DSVD modem uses a single phone line to carry both voice and data traffic between two users.

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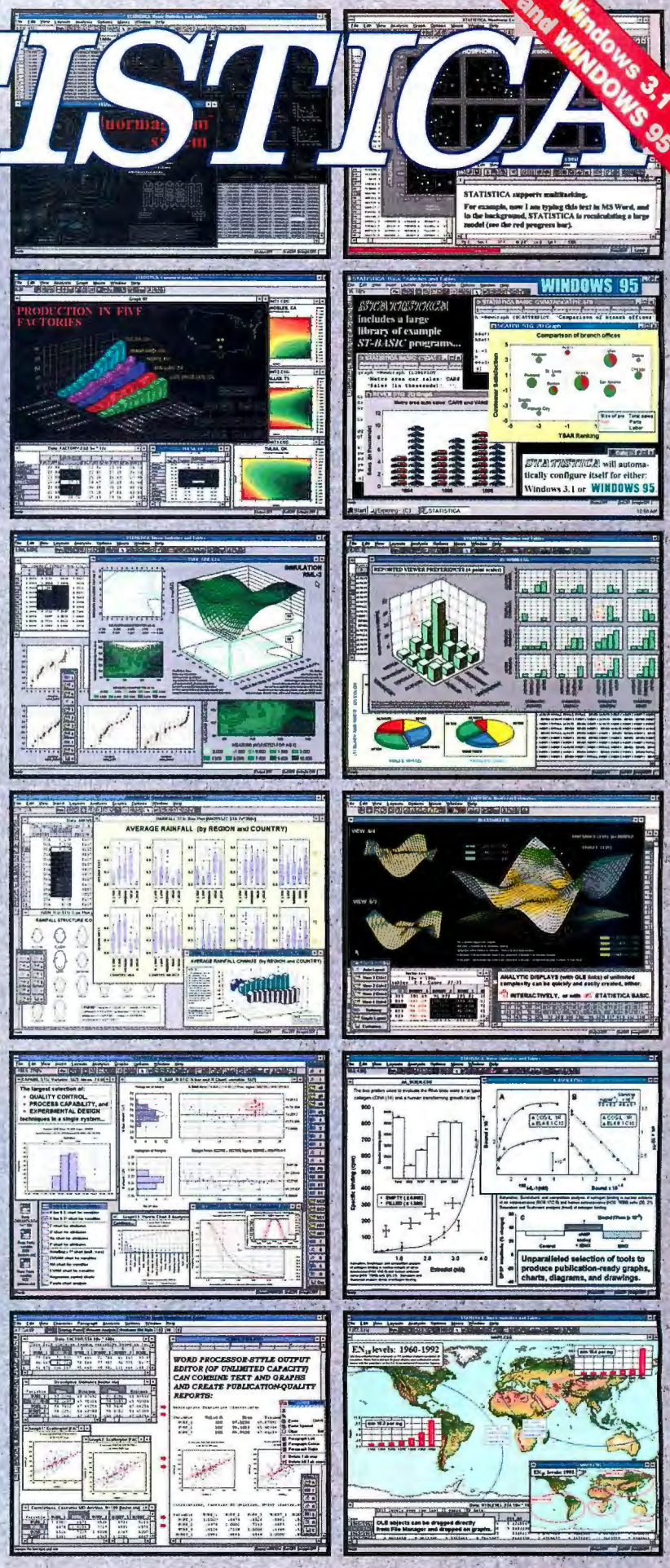

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single analog phone line. Unlike DSVD, VoiceView performs these transfers one at a time instead of simultaneously.

A typical use of VoiceView technology is a help desk or a computer customer-service center. A caller to the center can get on the phone with a technician and discuss a problem. The technician can instruct the user to hang up and set the PC's modem to receive a call.

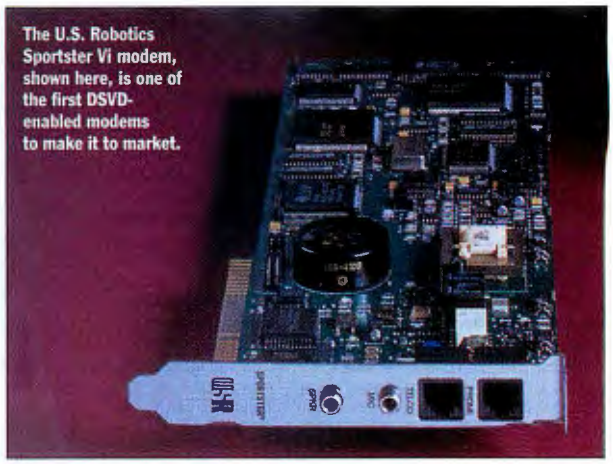
The technician then dials into the PC and can transfer the system and *.INI files to examine them. While this is going on, the user and technician can still have the phone line open for discussion. However, whenever the voice traffic starts to flow over the link, the data transfer is stopped. This switching between voice and data works fine in many applications.

While some may find this type of interaction limiting, it still gives people in different locations a way to collaborate. For example, VoiceView works with all the common whiteboard programs. And, in contrast to DSVD modems, you typically do not pay more for a VoiceView-enabled modem.

Speeding Up the Process

While DSVD gives home and mobile users better ways to work together, the ADSL line-sharing technique has a completely different use. As its name implies, ADSL offers high bandwidth in one direction and low bandwidth in the other over a single phone line.

The telecommunications industry originally developed ADSL to meet the bandwidth needs for video-on-demand services. ADSL uses signal-encoding, compression, and modulation techniques to deliver high-speed transmissions over extended distances via unshielded twisted-pair copper wiring. In a typical configuration, an ADSL system supports a downstream delivery rate of 6 Mbps while offering a 64-Kbps upstream communications channel.



The U.S. Robotics Sportster Vi modem, shown here, is one of the first DSVD-enabled modems to make it to market.

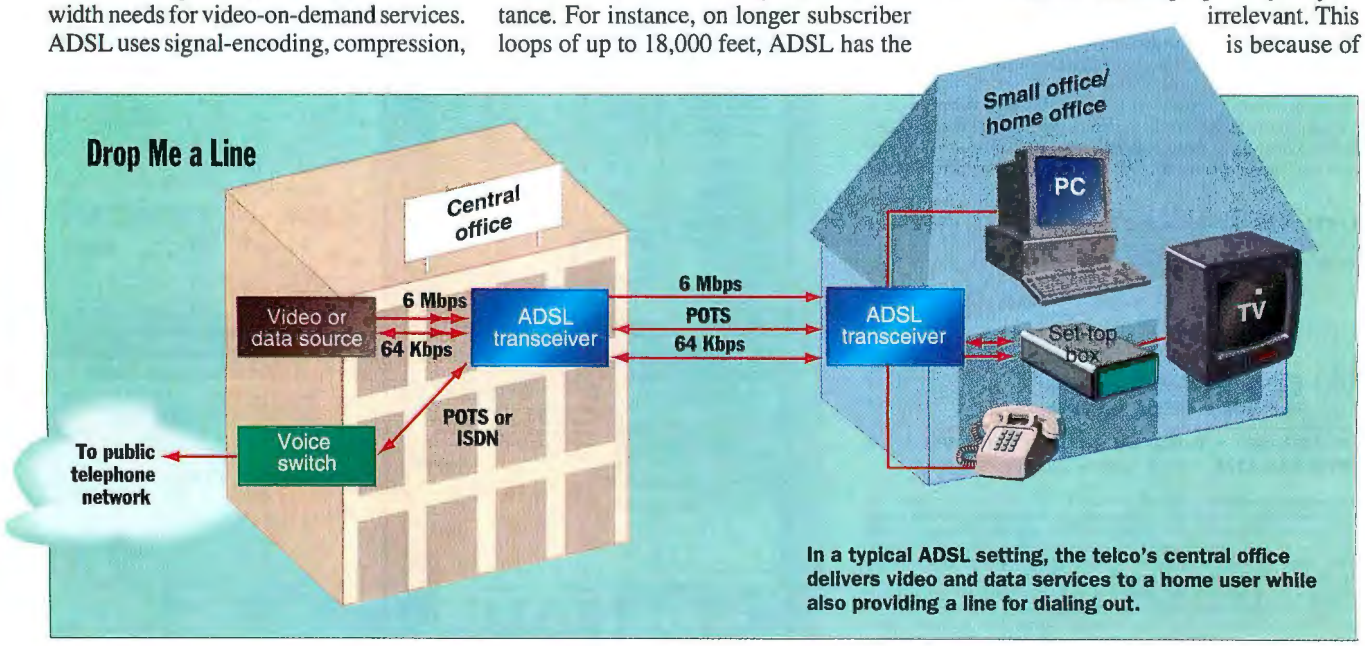
ADSL uses signal-encoding, compression, and modulation techniques to deliver high-speed transmissions over extended distances by means of unshielded twisted-pair copper wiring. In a typical configuration (see the figure "Drop Me a Line" below), an ADSL system supports a downstream delivery rate of 6 Mbps while offering a 64-Kbps upstream communications channel.

To put this delivery rate into perspective, a 6.2-Mbps downstream link can support four channels of compressed MPEG video. This means that while using ADSL, you can receive several channels of MPEG-2 encoded video while simultaneously using the upstream link to carry on a conversation or send control signals to a video server. ADSL's 6-Mbps downstream and 64-Kbps upstream rates are possible over plain-old-telephone-service (POTS) lines at a distance of 12,000 feet.

ADSL's coding techniques present a trade-off between delivery rate and distance. For instance, on longer subscriber loops of up to 18,000 feet, ADSL has the ability to deliver T1 (1.544-Mbps) downstream rates.

One bone of contention in the industry has to do with signal encoding. Many carriers have opted for AT&T Paradyne's Carrierless Amplitude/Phase (CAP) modulation technique. CAP is implemented in an ADSL transceiver that has been licensed by more than 15 international equipment suppliers. Meanwhile, the ANSI standard for implementing ADSL specifies a different technique, which is known as discrete multitone (DMT) encoding. DMT proponents include Aware, which is an ADSL transceiver provider, and Analog Devices. These two firms have teamed up to develop an ADSL chip set that implements DMT encoding for ADSL.

With most new technologies, standards are an issue. With ADSL, however, the issue of standard versus proprietary may be irrelevant. This is because of



In a typical ADSL setting, the telco's central office delivers video and data services to a home user while also providing a line for dialing out.

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the way in which the user receives ADSL service. With ADSL, the connection is between the user and the telephone company's (telco's) central-office equipment. And the only way to use the service is for the telco to supply you with an ADSL unit. This guarantees interoperability between the device located in your home or office and the telco's equipment.

While ADSL devices may seem similar to modem technologies (where standards are indeed important), they are closer to cable-TV set-top boxes. When modems make a connection, they negotiate and settle on a transmission scenario that is the best one available on the two devices—for example, a transfer rate of 28.8 Kbps and compression turned on.

Why the Fuss?

Before ADSL, all other approaches (including fiber-to-the-home, fiber-to-the-curb, and hybrid fiber-coaxial systems) to delivering high-bandwidth services, such as video on demand, posed a high-cost, high-risk situation for the telcos. As a result, telcos didn't deploy such systems in low-density areas or areas where they figured the "take rate" (i.e., the percentage of customers subscribing to a service) would be low.

Since the ADSL service runs over the existing copper subscriber loop, ADSL overcomes the risk to the telcos. If more lines are needed, installing POTS wiring is a low-risk, low-cost venture for a regional telco to undertake. And the provisioning in the central office is minimal. While it's hard to get firm numbers from telcos, several have estimated that it would cost approximately $500 to configure a line and supply each user with the equivalent of a set-top box with a high-speed data port for a PC, a telephone jack, and a connection for a TV. Telcos could very easily make that amount back in a year through leasing fees for the boxes and monthly charges for services delivered over the system.

High Speed in a Breeze

While the Asymmetric Digital Subscriber Line (ADSL) technique is quite useful for cybersurfing and video on demand, its asymmetric bandwidth does not lend itself well to other applications, such as high-speed remote LAN access, digital imaging, and high-quality videoconferencing. As a result, AT&T has developed a similar technology, called Symmetric Digital Subscriber Line (SDSL).

As the name implies, an SDSL system delivers the same bandwidth in both directions of a communications link. Like ADSL, SDSL should be easier to deploy than ISDN because it uses existing phone wiring and requires very little change in a telephone company's central office. Thus, it should be available in more locations. When SDSL service becomes available (it's due out later this year), users will get to choose from several data-transmission rates, ranging from 160 Kbps to 2.048 Mbps.

Currently, AT&T plans to offer three rate/distance combinations. A 160-Kbps link running over plain-old-telephone-service (POTS) copper wire will be available at central-office-to-customer-premises distances of up to 23,000 feet. Higher data-transmission rates require shorter distances between the central office and the user's location. A 400-Kbps service can travel up to 21,000 feet; a 2.048-Mbps service can reach distances of up to 8000 feet over *POTS*.

The three flavors of SDSL are designed for different remote-office-connectivity scenarios. For example, you might use a 160-Kbps service to set up an ISDN Basic Rate Interface (BRI) data channel to a location. Such service would be useful to a company rolling out an ISDN-based desktop videoconferencing service to its remote offices in an area where ISDN is not universally available. Those sites with ISDN service could use that; those without would use SDSL.

The 400-Kbps service is ideal for sites that require speeds higher than 160 Kbps. Today, such sites might run moderate-quality conference-room videoconferencing systems (which typically operate at 384 Kbps) over a fractional T1 line, a half-dozen shared 56-Kbps Digital Data Service (DDS) lines, or several multiplexed ISDN lines. This SDSL service will allow companies to link more sites since, in theory, it should be easier to have an SDSL connection installed than any one of the alternative services.

Similarly, the 2.048-Mbps service might be used to deploy high-bandwidth applications, such as digital imaging or virtualization, into those sites that companies previously couldn't justify connecting at such high data rates.

A Bright Future

This year should see many DSVD-product and ADSL-service announcements. We should also see glimpses as to where each technology is likely to be headed in the next few years.

For DSVD, the big challenge is making multipoint connections. Today, only point-to-point connections are possible. In an ideal world, a mobile or home user could simply dial in to a LAN and conduct collaborative work with several different people. With ADSL, the issue is how to deliver other types of services, such as high-speed Internet and LAN access.

In all cases, the coding and modulation technologies devised for DSVD and ADSL are all aimed at using a telephone system that is ubiquitous and easy to add to (a point that other high-speed technologies have ignored). Thus, users aren't waiting out in the cold for the latest and greatest service to reach their home or office sites. ■

Salvatore Salamone is a BYTE news editor based in New York and author of Reducing the Cost of LAN Ownership *(Van Nostrand Reinhold, 1995). You can reach him on the Internet or BIX at ssalamone@bix.com.*

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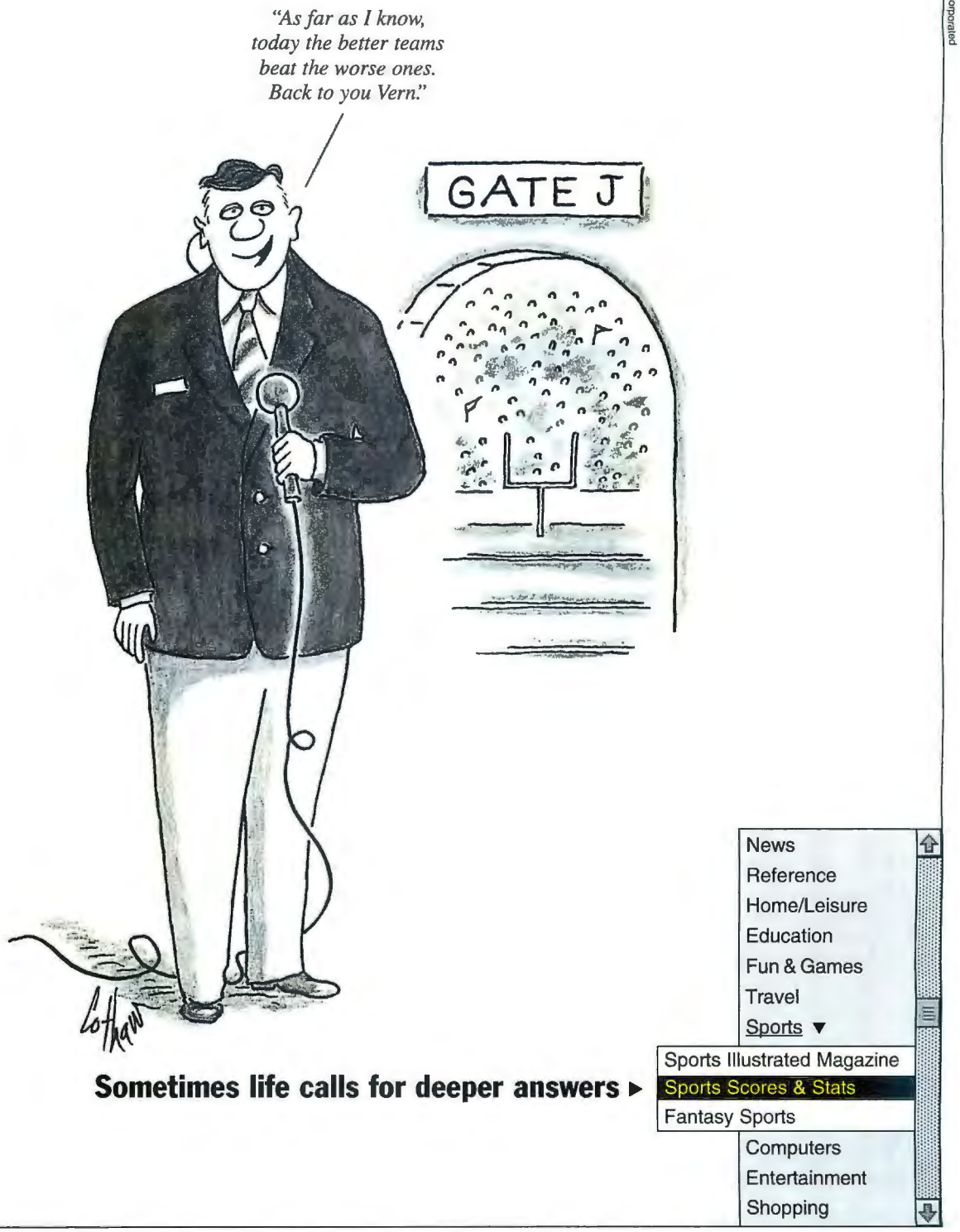

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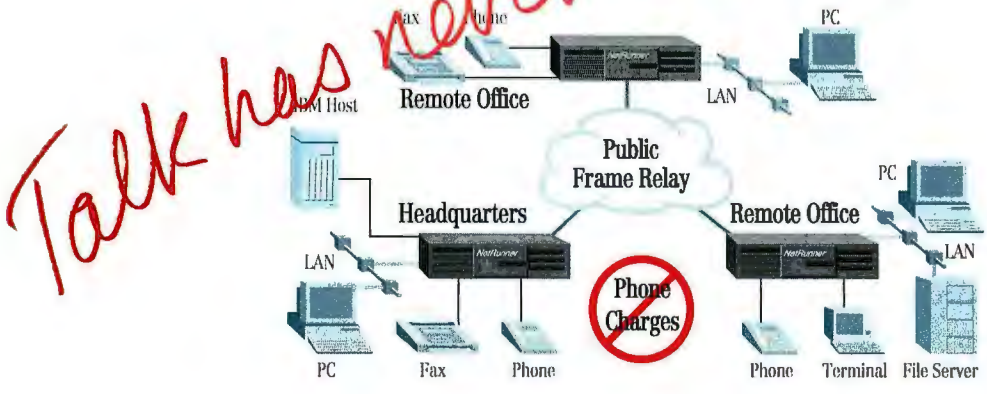

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With new software, you can talk business over the Net and avoid long-distance charges

NATHAN MULLER

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If you really want to save money on long-distance calls, you might want to check out a new telephone giant that's offering communication services worldwide. It already has about 30 million subscribers. Some experts predict it will have more than 200 million by the end of the decade, making it the fastest-growing network of all time. And it won't drive you crazy with idiotic commercials about paltry savings on long-distance calls.

If you haven't already guessed, the new telephone giant is the Internet. With special phone software, you can now call virtually anywhere, anytime, and talk for as long as you want—free! You're not even charged extra on your Internet account.

Internet phoneware opens up a whole new realm of communications. Telecommuters can call the office to discuss work assignments and project status. Small companies and the branch offices of larger companies can leverage their existing Internet connections for phone conferencing. Soon, phoneware will be a key integral component of the collaborative computing environment, enabling you to share documents and mark them up while exchanging ideas with your colleagues—all over the Internet.

Since Internet phoneware vendors provide their own directory servers, organized by topic as well as by name, it's easy to establish new business contacts. You can even set up your own topic group, making it easier for others with similar interests to find you. You can also establish unlisted directories for exclusive use by business colleagues and family members. All this makes setting up an Internet phone connection as easy as clicking on a name, E-mail address, or IP address.

Internet phone software lets you place calls anywhere in the world and converse in real time. Provided, of course, the person you want to talk with has an Internet connection and the same phoneware. The

voice quality is acceptable most of the time, even on international calls. However, from time to time you can expect variations in the quality of the voice signal.

Such variations are due to the processing delay that results from encoding and decoding speech at each end of the connection. There is nothing that can be done right now to reduce the inherent delay of the Internet, which varies according to the amount of traffic at any given time and the distance the signal must travel. Yet, even with such occasional delay, most users say the voice quality is acceptable. Typically, the quality is about the same as or a little better than what you get with a speakerphone. At worst, it's about the same as having a conversation over a poor-quality satellite link. Users are willing to accept this variability because they are saving the expense of a long-distance call.

Reaching Out

Calls over the Internet are appealing because of the potential cost savings. You can talk with people in any country without having to worry about racking up a sky-high phone bill. If you already have a sound card and microphone, adding phone software is well worth the money. All the commercial phoneware products cost less than $100, and some are even available on the Web for evaluation. If you don't have a sound card and mic, this might be the reason you need to buy them.

Phoneware can run in the background with its window minimized, just like fax software, allowing you to work in other applications. When an incoming call comes through, you get a notification tone. Clicking on the phone application's icon opens the user interface, which displays the caller's name. You can then choose to answer or ignore the call. If you don't happen to be running the phone software when a call comes through, the software will notify the calling party that you are not connected. If you're already engaged in a conversation when a call comes through, or you don't want to accept the call, the calling party will get a busy signal. With Camelot's DigiPhone, you have the option of sending an E-mail message to a busy or unconnected party, letting them know you called. And with VocalTec's Internet Phone, on-screen messages let you know if someone's line is busy or not connected when you tried to call. If you couldn't take a call, Internet Phone displays a message telling you who called.

STARTING POINTS FOR QUALITY AUDIO

CONNECTION SPEED	SAMPLING RATE
9600 bps	4000
14,400 bps	6000
19,200 bps	8000
28,800 bps	11,000

How It All Works

Typically, the vendor of an Internet phoneware package maintains a directory of users on a server. The server's only role is to let users locate each other through a directory organized by name or by topic of interest. Conversations occur directly between users, without going through the software provider's server (see the figure "Making the Voice Connection" below).

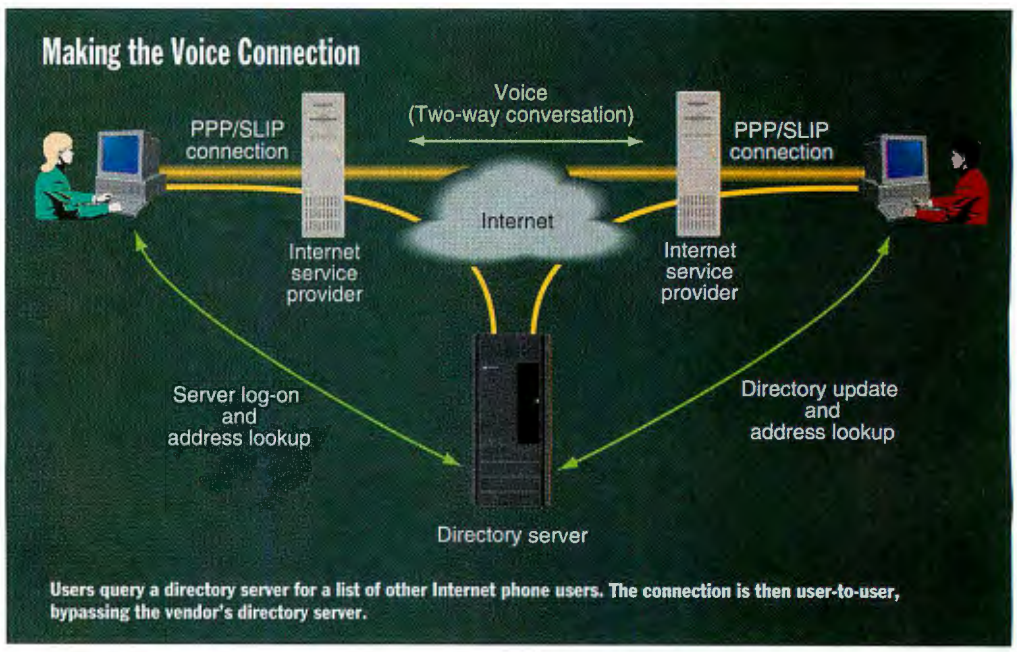
In the case of VocalTec's Internet Phone, the server's directory updates itself continuously to reflect who is on-line at any given time. Each Internet Phone user periodically receives this information. This allows you to pick names off the list and initiate a call. VocalTec has 15 user-selectable directory servers on its own Internet relay chat network.

Other vendors handle directories in various ways. With DigiPhone, for example, you must request a directory, which is updated daily. You receive the directory via E-mail and have to do some cutting and pasting to build your own phone books. Quarterdeck uses a network of WebTalk servers for its directory service, which logs on-line callers and facilitates connections.

Once you've selected a person to call and connected, the Internet phoneware does a number of things. As you speak into the sound card's microphone, the software samples the incoming audio signal and digitizes it. The phoneware then compresses the signal. In Windows-based products (the majority of current offerings), the program typically inserts software-based compression between a Winsock 1.1-compliant TCP/IP protocol stack and the Windows driver for the PC's sound equipment. The compressed packets are transmitted via TCP/IP over your communication link to the remote party.

At the other end, the Internet phoneware assembles the packets of compressed audio in the right order. The software on the receiving end decompresses the signal and plays it through the speakers attached to the sound card. The phoneware compression algorithms compensate for much of the Internet's inherent delay. Specifically, while a computer decompresses packets and plays the audio signal, remaining packets have time to traverse the Internet.

Phoneware vendors use a variety of compression algorithms to minimize bandwidth consumption over the Net. The Internet Telephone Company's WebPhone uses two audio-compression algorithms:



Users query a directory server for a list of other Internet phone users. The connection is then user-to-user, bypassing the vendor's directory server.

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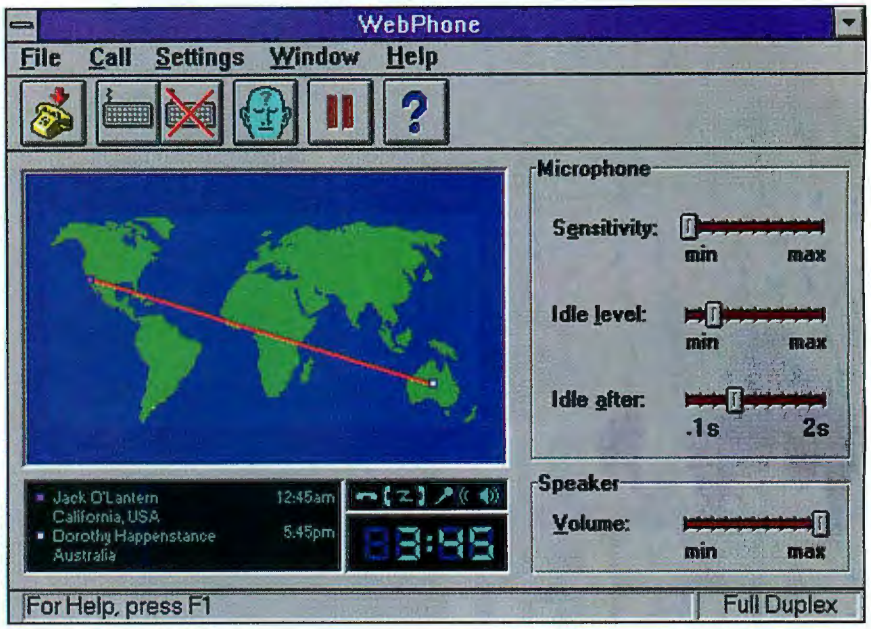
Global System for Mobile communications (GSM) and TrueSpeech. GSM is the European standard for digital cellular communications. It provides close to 5:1 compression of raw audio with an acceptable loss of quality when decompressed. TrueSpeech is a product from the DSP Group (Santa Clara, CA). It can compress raw audio at up to 18:1 with an imperceptible loss of quality after decompression. WebPhone uses GSM compression when installed on a 486-based computer and TrueSpeech on a Pentium computer. Offering a high compression ratio, TrueSpeech is more CPU-intensive than GSM, so it requires a faster processor to compress the same audio signal in real time.

VocalTec uses a proprietary compression scheme in its Internet Phone product that squeezes raw audio data down to 7.7 Kbps. Users have the option of adding VocalTec's VC Card to reduce bandwidth consumption further, to about 6.72 Kbps. The VC Card provides the added benefit of off-loading the compression chore from the computer's main processor. The compression scheme is designed so it can be used on a variety of hardware platforms, regardless of processor type, notes Lior Haramaty, VocalTec's cofounder.

In addition to handling compression, Internet phoneware also deals with the issue of packets arriving out of order due to delays getting across the Net. When the packets of compressed speech travel over the Internet, they may not all arrive at the destination in time to be reassembled in the proper sequence because of delays. If you were dealing with ordinary data, late or bad packets would simply be dropped and the host's error-checking protocols would request a retransmission of those packets. But this approach cannot be applied to packets of compressed audio without disrupting conversations, which are supposed to be conducted in real time. If the connection drops only a small percentage of the packets, say 2 to 5 percent, the users may not notice the gaps in their conversation. As much as 20 percent of the packets can be lost and the conversation still be intelligible, according to VocalTec's Haramaty. He says, however, that his company uses an algorithm that employs predictive analysis techniques to reconstruct lost packets, thereby minimizing this problem for Internet Phone users.

Fine-Tuning the Phone

You can adjust many of these products to further improve voice quality. You can fine-tune the sampling rate and compression level to a modem's speed to improve sound. For example, while the average delay on the Internet is generally not a serious problem, frequent instances of clipped speech can be quite annoying. If this occurs, you can reduce the sampling rate until smooth speech resumes.



Internet Telephone Company's WebPhone allows you to adjust microphone sensitivity and idle level on screen.

With DigiPhone, for instance, you can dynamically adjust recording and playback quality in response to the speed of your modem connection. You can start your manual tuning process by connecting at the default sampling rate, then increasing the sampling rate by increments of 500 bytes per second; the increments can be smaller or larger depending on your preference. When you're finished, DigiPhone will renegotiate the connection at the higher sampling rate. You can continue to increment the sampling rate until the other party's speech begins to break up, then back down until it's clear again.

You can set the sampling rate from 4000 to 44,000 bytes per second, depending on the capabilities of your sound card. In general, the higher the speed of your modem connection, the higher you can set the sampling rate (see "Starting Points for Quality Audio" on page 84).

There are trade-offs between voice-signal quality and bandwidth. A high sample rate gives better quality but at the cost of increasing the bandwidth you need. If you're working with a slow modem (9600 bps), you can select a lower sampling rate to use less bandwidth. However, decreased bandwidth comes at the expense of sound quality. If you have a higher-speed modem (say, 28.8), you can select a higher sampling rate to get better sound.

In conjunction with the sampling rate, you can set the compression level. With a slower modem, you can select a high compression level for better performance, but with some loss in sound quality. With a higher-speed modem, you can select a lower compression level for better sound.

Fun for Everyone

Commercial Internet telephone software is available for Windows, Macintosh, and OS/2. There are also shareware products for Unix. Camelot, VocalTec, the Internet Telephone Company, and Quarterdeck offer Windows 3.1 products. For these products, you need a 486 or comparable hardware with at least 8 MB of RAM.

Camelot has the one commercial Internet phone product for the Macintosh (the e-phone, acquired from New Paradigm Software). The Internet Telephone Company's WebPhone works under OS/2 (in addition to Windows 3.1 and Win 95). And Quarterdeck's WebTalk runs under all Windows environments, including NT.

There is currently no commercial phoneware for Unix. However, there are some shareware products, such as the Vat, which is for high-end Unix machines with direct TCP/IP connections (you can download the program via FTP from cs.ucl.ac.uk/mice/videoconference/vat).

Most of the Internet phone products

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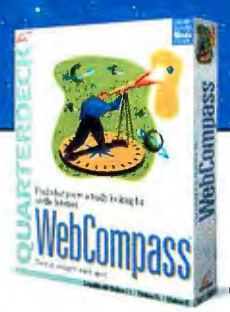

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need a TCP/IP connection (SLIP or PPP). For audio, you will need a standard sound board and a plug-in microphone. The speakers that came with your sound card are probably good enough.

The item that deserves the most attention is the modem. At 9.6 Kbps, conversations over the Internet are fairly intelligible, but clipping is a problem. At 14.4 Kbps, voice quality is substantially improved and a normal conversation is possible, especially when both parties have full-duplex sound cards. At 28.8 Kbps, sound quality can rival that of conventional telephone connections. However, quality is often determined by factors you may not be able to control, such as delay on the Internet, the other party's equipment and settings, and the way people speak (for example, letting their voice trail off at the end of sentences, causing voice activation to idle prematurely).

Even if you have good equipment and the best software, high-quality sound can be difficult or impossible on a consistent basis. You may find yourself spending more time adjusting settings and asking the other party "Uh, can you hear me?" than actually discussing the business at hand. And you might have to tamper with these settings every time you make a call. Don't throw away your phone yet.

Product Information

DigiPhone $89
DigiPhone Deluxe $149.95
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(Multi)Party Time

If you want to see what graphical user interfaces will look like in the 21st century, grab a copy of ITC's WebPhone. It allows you to use the mouse in drag-and-drop fashion to set up such features as lines, parties, and voice mail.

At this writing, only WebPhone supports multiparty calls (multicasting). The trial version of WebPhone allows only point-to-point calls. When you buy the software, ITC sends you a registration file for your WebPhone directory to serve as the key that activates all the features, including the capability to converse with up to four parties at once. Even then, a new caller can still leave you voice-mail.

This multiparty feature will be available soon from other vendors. Camelot, for example, began shipping its DigiPhone Deluxe last October. It adds conference calling, speed dialing, and voice messaging. It also features a graphical Web browser, E-mail, FTP, and Telnet. And, like DigiPhone, it's LAN/WAN-compatible.

VocalTec's Internet Phone provides real-time statistics that can help you determine the quality of your Internet connection. The Network Statistics window gives you a count of incoming and outgoing packets, the average round-trip delay of packets, lost packets on the way to your system, and lost packets on the way to the other person's system. The window also displays send errors, which is the number of packets not sent due to a TCP/IP, modem, or CPU problem. New Paradigm Software's e-phone program provides similar statistics in graphical form.

Future Direction

The number of Internet phoneware users is growing rapidly. With continued refinements in the underlying technologies, it promises to become the next Netscape-like killer application. Industry observer Jeffrey Pulver, who produces *NetWatch*, a Web magazine that tracks trends on the Net (http://www.pulver.com/netwatch), estimates that at least 500,000 copies of phoneware have been distributed as of last October. Three million to 4 million copies will be distributed during the next 12 to 18 months, he predicts. "This has the potential to grow into a multibillion-dollar business, depending on how the communications industry, telcos, and businesses decide to play together," says Pulver.

The next step in the development of phoneware is to integrate it into collaborative computing environments. This is the course Quarterdeck is taking with WebTalk. In the first release of the product, Quarterdeck has integrated WebTalk with its Mosaic Web browser. In future releases, Quarterdeck says, it will provide an "inking" capability that allows users to view and mark up the same document and talk about it over the Internet before posting final copies on private Web servers or distributing it via E-mail. Not only will the participants benefit from a single graphical user interface to carry out multiple tasks, there is no additional overhead expense in doing so.

"Once we add in the ability to share documents, we will be positioned to offer a desktop collaborative-computing solution that essentially saves the time, hassle, and cost of faxing and overnight delivery," says Michelle Messina, Quarterdeck's director of remote-computing products. "This will not only simplify the way people work, it will help them complete transactions in real time."

NetManage is thinking along the same lines as Quarterdeck but is approaching things in a different manner. The company licensed its InPerson desktop videoconferencing application from Silicon Graphics in 1994 and now bundles it and other Internet applications within its Chameleon Enterprise for Windows. InPerson includes a whiteboarding capability that enables users of Windows PCs and Silicon Graphics workstations to collaborate on projects in real-time conferencing sessions. In addition, the package supports Hypertext Markup Language 3.0 extensions in WebSurfer, the company's Web browser.

Clearly, we're going to see document sharing integrated with audio and video capabilities. This technology will let businesses collaborate over the Internet. The underlying technologies are not yet mature enough for mainstream, day-to-day business use. But based on the fast pace of innovation, it won't be long before Internet connections and the collaborative applications running over them assume mission-critical importance. ■

Nathan Muller has written more than 800 technical articles and 11 books on computer, communications, and management topics. His latest book is The Webmaster's Guide to HTML *(McGraw-Hill). You can reach him at nmuller@ddx.com.*

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VOICE GETS FRAMED

Many companies know that frame relay is an economical way to carry data. Now they're *learning* it can cut their telephone charges, too.

CHRISTINE HECKART AND BETH GAGE

VICTOR GAD © 1996

While there may be no such thing as a free lunch, frame-relay users are finding they can get the equivalent of a free dessert. Over the last few years, frame-relay service has proven to be an economical way to send corporate data between an organization's offices. Now, users are eyeing it as a way to piggyback telephone traffic over the same access lines at no additional cost. That can save a company quite a bit of money that it would ordinarily spend on long-distance phone calls within the corporation.

Frame-relay service is a circuit-switched digital-transmission technology that is similar to X.25. However, it is more efficient because it skips the error-correction techniques of X.25 to reduce overhead and achieves speeds of 2 Mbps (high-layer protocols handle errors). And unlike the fixed-length cells of asynchronous transfer mode (ATM), frame relay uses variable-size packets. Thus, it can dynamically adjust size according to the type of traffic.

Early frame-relay services were meant almost exclusively for interconnecting LANs, because that was just about all the first networks were capable of. Doing anything but data meant you were crazy or ignorantly optimistic. In fact, transporting voice traffic over frame-relay networks used to be a huge faux pas. Or, more specifically, in the early days of the market, most people thought that voice over frame relay was "a hu gefa uxp a (clipped s)." Most didn't believe it would work, or at least not very well.

When frame-relay service first became available, only one type of premises equipment could support it: the router. Routers are good at handling data, but they are not geared for handling voice.

A Maturing Process

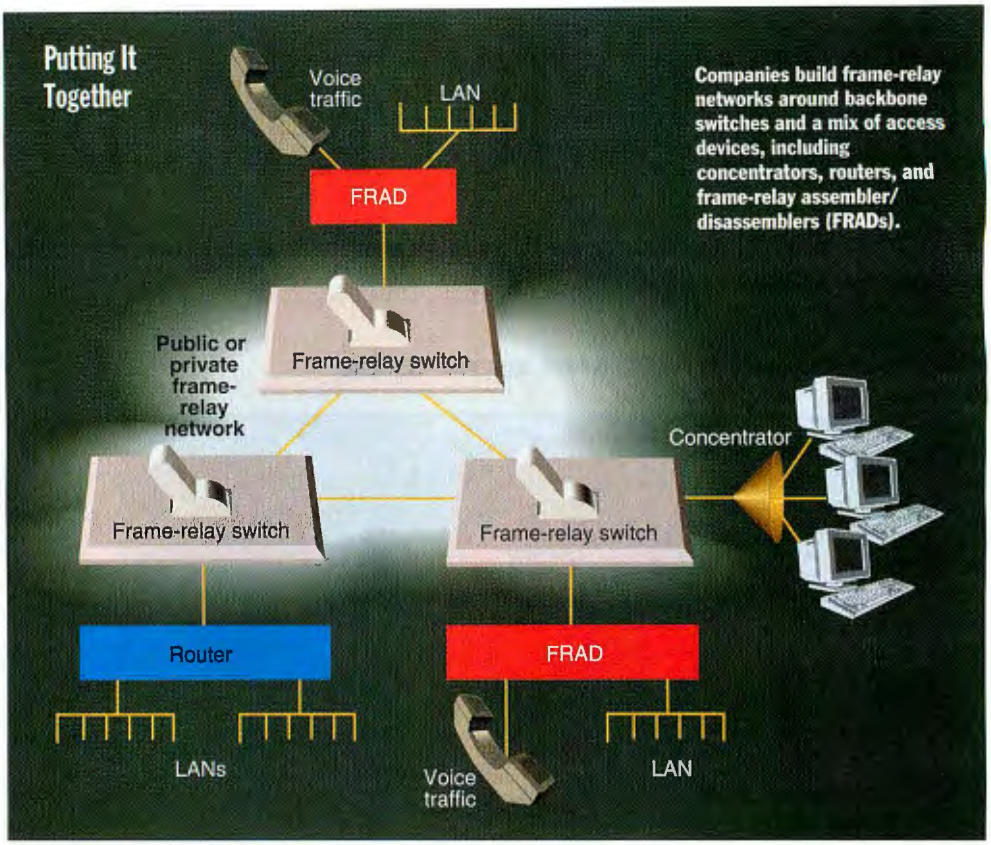
However, frame relay has matured in the past four years, from both a service offering and an equipment perspective. The

Voice Gets Framed

average user finds that previous cardinal sins are now on the forgiven list. Carrying time-sensitive traffic is now a serious consideration for many companies. Things such as voice over frame relay and Systems Network Architecture (SNA) over frame relay are quite possible.

What makes voice over frame relay possible is the frame-relay assembler/disassembler (FRAD). They come from such vendors as ACT Networks, Micom Communications, and Motorola. FRADs are the frame-relay counterpart to X.25 packet assembler/disassemblers (PADs) in that they aggregate and convert traffic into frame-relay packets for transmission over a frame-relay network (see the figure "Getting the Traffic Aboard" on page 92).

A typical frame-relay network uses FRADs or routers in each of an organization's branch offices or remote sites. The sites can be linked over a private frame-relay network or over a carrier's public frame-relay network (see the figure "Putting It Together"). Permanent virtual circuits (PVCs) carry data between two locations.



While the technical obstacles to delivering voice over frame relay may be removed, sometimes it is not possible for a reason that is often harder to overcome: corporate politics. Data purists argue that voice has no business on the data networks, that the networks were not designed for this purpose, and that the whole network will come crashing to the ground if all these "unauthorized" applications start sharing the bandwidth.

To a certain degree, such arguments have merit. Frame-relay networks are not designed to differentiate between applications, specifically the unique needs of one application versus another. For example, they cannot prioritize voice traffic over data, so that voice packets get there sooner to allow for more natural speech flow. (ATM is designed for this purpose. It will offer carriers substantially more options for integrating voice and data applications on the same network.)

However, frame relay is here today. It's a mature technology that is widely available and extremely affordable. Many users have it installed, and in a flip-flop of network design from the 1970s, voice can ride for free over the data networks with relatively minor adjustments to network configurations.

Sound Business

Voice over frame relay is appropriate for small- to medium-size companies. You can cost-justify the frame-relay network based on the data applications, such as carrying LAN and SNA traffic (see "Pruning Branch-Office Problems," July 1995 BYTE). Voice calls can essentially ride the network for free between locations connected by the frame-relay network. The savings can be tremendous.

Because of the nature of frame-relay networks, voice over frame relay is best at on-net communications (i.e., connecting sites on the frame-relay network). It is not now suited for calling off-net, although future changes in standards and new frame-relay technologies could make that possible.

Consolidating voice onto a frame-relay network does not make sense for companies with huge voice networks. Fortune 1000 companies, for instance, probably can't justify the additional cost for premises equipment that will handle voice traffic and the cost for bandwidth to support many simultaneous intercompany calls. They are better off using private-line networks and/or virtual-private-network (VPN) services. These offer low cost for high volumes and provide a high level of sophistication.

Bonacker and Leight, a food-brokerage company using an ACT Networks FRAD, consolidated its voice, fax, LAN, and terminal-to-host data traffic over a single frame-relay network. The company reduced its telephone expenses by 35 percent, even after increasing its network bandwidth from 9.6 to 56 Kbps.

Internationally, it is even easier to cost-justify voice over frame. International connections and toll calls are so expensive that even some larger companies may save money by using the frame-relay network to carry international voice traffic.

Banco do Brasil, also an ACT customer, needed connectivity to 26 countries on four continents. Integrating the on-net voice and fax calls into a frame-relay network provided a savings of $4 million a year on the phone bills alone. This savings resulted in a six-month payback on the cost of the WAN.

The incremental cost to add 16 to 32 Kbps of bandwidth—which on a frame-relay network is called the committed

information rate (CIR)—is typically between $10 and $50 per month, depending on the carrier. The FRADs that support voice over frame relay normally offer options for compression, which means a single conversation will need between 4 and 16 Kbps while in progress.

Getting Down to the Details

Voice traffic turns out to be similar in many respects to data traffic—both can be described as bursty and intermittent. An individual voice conversation consists of *speech bursts*. There are certain points in a conversation where there is little silence, such as in the middle of a sentence. Speech bursts are separated by short or long periods of silence, such as the pauses between sentences.

When put together, these conversations represent an intermittent traffic stream to the network, at least for smaller companies. At certain times, several long-distance conversations may be occurring simultaneously. At other times, no one will be using the phone for making long-distance calls to other on-net locations.

The important issue that must be resolved to send voice traffic over a frame-relay network is controlling the amount of delay that a packet experiences when traveling across the network. Voice traffic is not as tolerant of delay as data traffic. Most people begin to notice delay when it reaches 100 milliseconds.

Delay can occur in several places within the network. The customer premises equipment, the physical transmission facilities, and the frame-relay switches all add a measure of delay. Delay due to the transmission of the signal is estimated to be 1 ms per 100 circuit miles. The frame-relay network will add between 3 and 10 ms of delay per switch, but this is carrier-dependent and worth asking about when choosing a frame-relay provider. In general, voice transport should not be a problem for domestic networks, but internationally, the transmission delay can become annoyingly noticeable.

Supporting voice traffic on frame relay requires equipment that has the correct interfaces and support for voice-related functions, such as echo cancellation, silence detection and suppression, and fax detection and demodulation.

Voice applications include interconnecting PBXes, use of off-premises extensions (OPXes), private-line auto-ringdowns (PLARs), and connecting to the Public Switched Telephone Network (PSTN). The FRAD vendor should support two- and four-wire Ear and Mouth (E&M), Foreign Exchange Office (FXO), and Foreign Exchange Station (FXS) interfaces, as well as standard T1 and digital T1 interfaces.

The FRAD will packetize the voice traffic, prioritize it above the data traffic, and interleave the two traffic streams. Once in the network, the voice and data traffic are treated exactly the same.

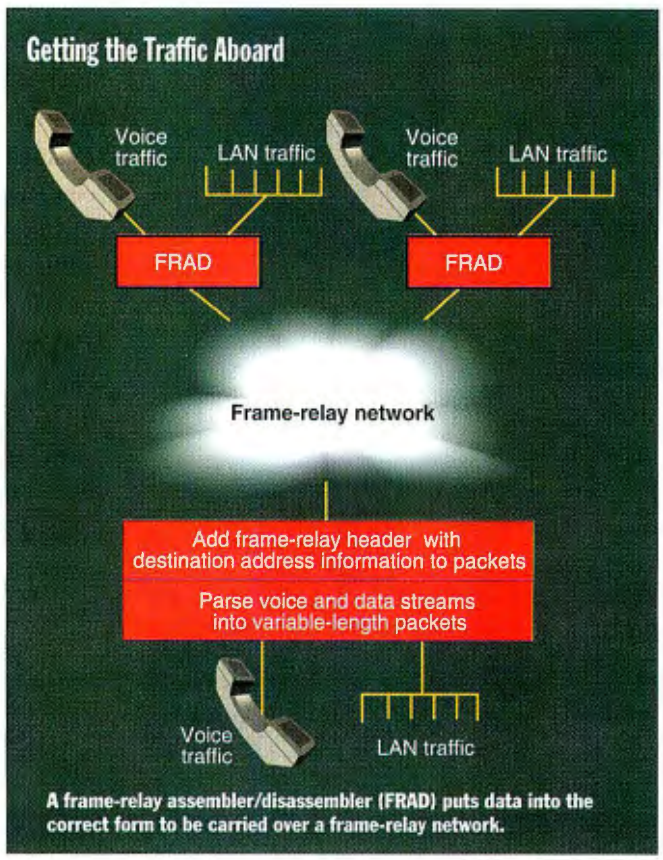
The Public vs. Private Debate

On private frame-relay networks, consolidating voice onto frame relay is simple because you already know the key facts that affect performance: the number of switches that a circuit goes through, the circuit mileage, the network topology, and how the equipment handles voice.

Using a public frame-relay network is different because you have more uncertainty. You will need to fine-tune your premises equipment. Public frame-relay networks meet traffic requirements on a first-come, first-served basis. The first-served traffic is counted toward the CIR, while the remainder is marked discard eligible (DE). If both voice and data are handled within the same PVC, the voice traffic needs to be sent to the network ahead of the data traffic.

Successfully supporting voice traffic on a frame-relay network requires the premises equipment to do at least three things: Segment long data packets to let voice traffic through more quickly, prioritize voice applications before data, and set the DE bit for noncritical data traffic.

If voice and data applications share the same network, and you neglect to do these three items, a voice packet may get "stuck" in a switch queue waiting for a large file or data stream to be transmitted. The frame-relay premises equipment must be able to segment large data frames into smaller frames. But the equipment must be intelligent enough to know to do this only when a voice packet is waiting to be transmitted. In that way, a higher-priority voice packet always gets priority and is transmitted even though the system might be in the process of transmitting a large file.



A frame-relay assembler/disassembler (FRAD) puts data into the correct form to be carried over a frame-relay network.

Priorities

Voice packets must get priority over data, but without introducing unacceptably long delays in transmitting the data traffic. Network users do not want the data network to slow down whenever someone picks up the phone. Therefore, the premises equipment must have priority buffer queues. High-priority traffic would be assigned to the high-priority buffer and would be transmitted before traffic waiting in the other buffer queues.

For example, imagine a situation linking the branch offices of a bank. Voice traffic shares a line with traditional LAN application file transfers and transaction-oriented SNA traffic. A teller who is updating a customer's account through an SNA session with a host computer in the bank's corporate headquarters should not have to

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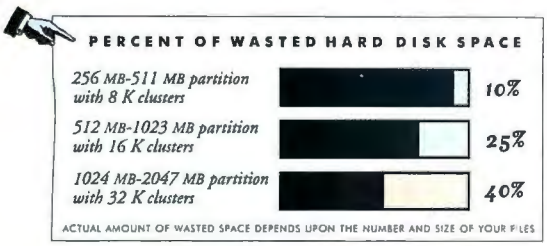

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STATE OF THE ART Voice Gets Framed

wait a significantly longer time for the transaction to be completed whenever someone makes a phone call to another branch office. Similarly, the SNA-session traffic—because of its time-sensitive nature—should have a higher priority in the frame-relay switch queues over data associated with a large file transfer between sites.

An added layer of sophistication lets the network manager assign minimum throughput levels for lower-priority buffers. Put another way, you must be able to ensure that the lower-priority data cannot be denied access to the network, even when higher-priority traffic is in the queue for transmission. The lower-priority data buffer would still be allowed to send a predefined level of traffic to the network.

Another difference in handling voice versus data is that voice is more tolerant of lost frame-relay packets than data is. In other words, if packets are lost in a data transmission, they must be retransmitted. Most of a voice conversation is actually silence. That means you won't notice if some packets are dropped. And even if the connection drops some packets, there is no time for the network to retransmit—the participants will have to repeat words, if they even noticed the dropped packets.

Exploring Your Options

Frame relay has won many converts in the past year, and the market for frame-relay services is growing at an exponential rate. Many frame-relay users begin small, using it to support one or two applications. The most common uses of frame relay are for LAN and SNA applications. Once companies install a frame-relay network and it proves to be a reliable resource, they frequently begin to consolidate more applications onto it.

Service providers are still uncertain about how a large amount of voice traffic on a public frame-relay network will affect the overall performance of the network. The sensitive nature of voice makes service providers nervous, because frame-relay networks are designed to support more tolerant data applications. The concern is that users could be unhappy with the quality of the application, which could reflect poorly on frame relay.

However, carriers do recognize that voice over frame relay can provide substantial cost savings for some customers. Therefore, carriers are looking for answers to the technical questions about how voice traffic needs to be treated by the frame-relay network and if supporting high levels of voice traffic will necessitate a change in frame-relay-network design.

A handful of equipment vendors already support voice over frame relay. ACT Networks has been a leader in this field. Its integrated FRAD has separate priority queues for voice, fax, and data traffic. Voice features include toll-quality voice compression, variable rates depending on network conditions, and early congestion recognition. The compression method used by ACT supports a voice conversation over an 8-Kbps PVC. ACT's technology has been licensed by StrataCom for use in its FastPAD.

Motorola Information Systems Group recently introduced a VoiceRelay option for its 6520 and 6560 MPRouter Pro, which integrates voice options with an existing router platform. VoiceRelay also supports 8- or 16-Kbps PVCs using compression techniques, prioritizes voice over other frame-relay packets, and has an onboard echo canceler to filter out near-end echo. Fax support allows integrated fax and voice support on the same port.

Micom has added support for voice and fax over frame relay by enhancing its NetRunner router with voice capabilities. The company has integrated voice, fax, and data compression, and silence suppression support. Micom and other vendors exploit the half-duplex nature of voice communications to squeeze additional bandwidth out of frame-relay links. (Most conversations have only one person talking at a time.)

Currently, no service providers package voice-capable FRADs or routers with

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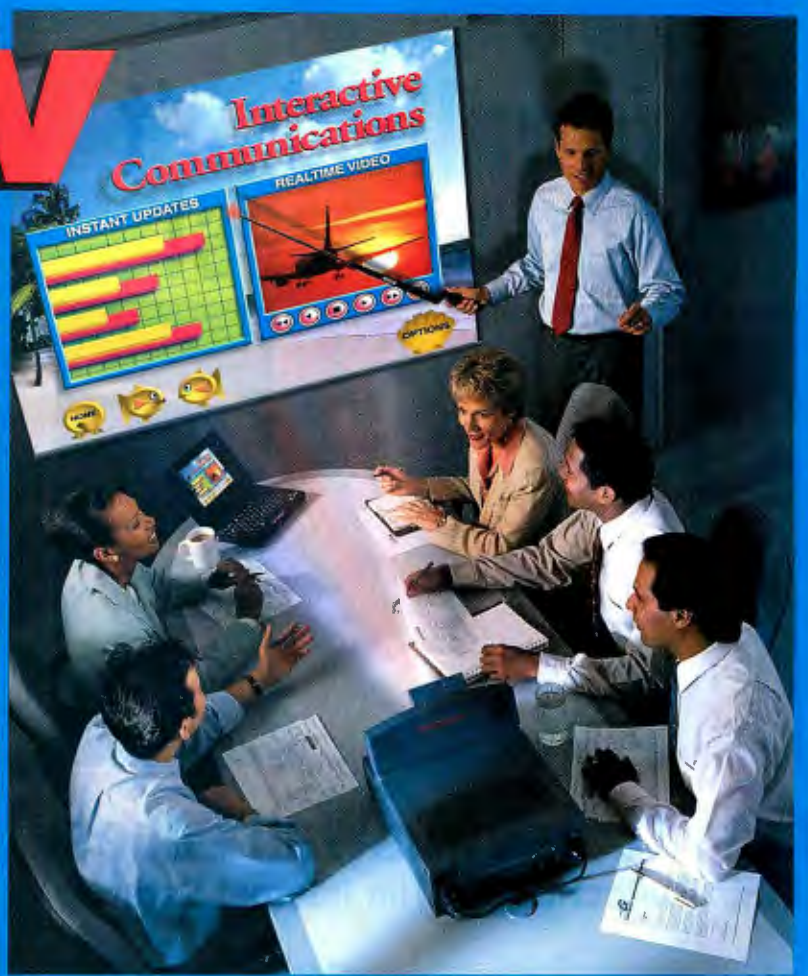

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frame-relay service. This should change this year as service providers compete to offer more value-added options with frame relay.

Competing with ATM

Adding voice to frame-relay networks blurs the line between frame relay and ATM. ATM's overhead makes it less efficient than frame relay for many data applications, but frame relay's variable-length frames are not as conducive to voice applications because they are sensitive to delay variation.

ATM's solution is to package all traffic into small, fixed-length cells. Frame relay's solution is to let the data traffic use a variable-length frame for reduced overhead but package the voice traffic into fixed-length cells.

The choice between frame relay and ATM necessitates a look at the entire network, all the applications, the connectivity speeds, and several other factors. For many small- and medium-size companies, a move to ATM will be cost-prohibitive. The value of voice over frame relay is that it lets these companies consolidate voice and data applications onto a single network for better economies of scale and cost savings.

Voice over frame relay will never be a solution for every company, but it is a good solution for many smaller companies with existing investments in frame-relay systems. As more companies gain experience with frame relay, voice applications should be one of the fastest-growing applications for the next two years.

The standards for transporting voice traffic using frame relay have not been finalized. Those equipment vendors that support this option today have done so by using proprietary technology. Most say they will support the standards once they are finalized.

Hundreds of companies are now successfully integrating voice traffic with data traffic over frame relay, and they're saving money by doing so. Regardless of whether the standards are complete or the carriers are ready, the market has cast its vote. Voice over frame relay is here to stay. ■

Christine Heckart is director of broadband services (and author of The Guide to Frame-Relay Networking*) and Beth Gage is a senior consultant in the broadband services group at TeleChoice (Verona, NJ). They can be contacted at checkart@telechoice.com and bgage@telechoice.com, respectively.*

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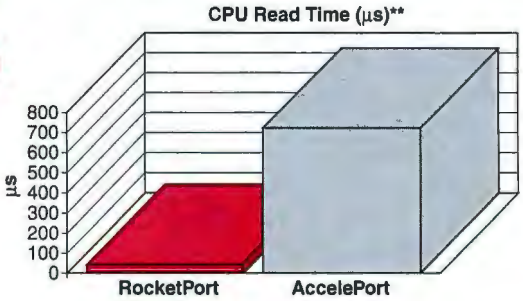

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NET PROGRAMMING FOR THE MASSES

PETER WAYNER

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Don't chuckle: TCL's creators are serious about creating the Internet's lingua franca

For the past 10 years, the vision of the future of programming has been clear: Fast, object-oriented compilers will turn C++ into lightning-quick native code. Now that compilers are becoming fast and adept at this task, a team of programmers at SunSoft is traveling back to the future by pushing an interpreted scripting language known as TCL as the next necessary tool. (TCL, often pronounced "tickle," is an acronym for Tool Command Language.) The goal is to produce a machine-independent, virus-free Visual Basic killer that will complement the Java language and allow software agents to roam from machine to machine throughout the Internet.

It's difficult to pinpoint exactly when the glory days of compilers dimmed, but it must have begun when Microsoft's Visual Basic, a stodgy, interpreted version of BASIC, soared in popularity. This software product enabled even fair-weather programmers to turn out clean and neat code.

The popularity of native compiled code took a further dive when the Internet offered everyone the chance to send programs hither and yon. Suddenly, interpreted languages such as Lisp, with built-in memory-handling ability, seemed much more elegant than combining stripped-down and hard-coded native binaries.

Missing Links

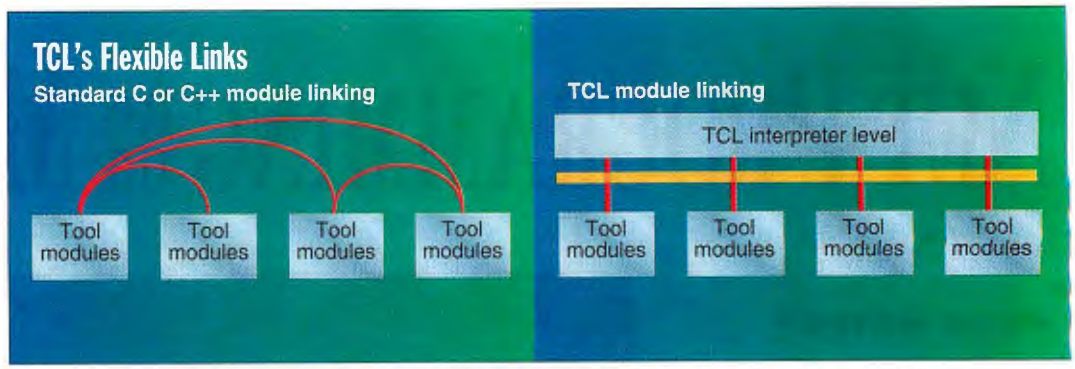
TCL's creators didn't intend for it to be a language used by agents to roam the Internet. Nor did it become popular among Unix programmers out of some nostalgia for a time when all higher-level languages were interpreted. John Ousterhout and some of his students at the University of California–Berkeley wanted to create a meta-programming language—that is, a very high-level programming language. Their goal was to develop a language that Unix programmers and others could use to build code by binding small programs into larger applications.

Ousterhout is now a Distinguished Engineer at Sun Labs and is responsible for TCL development. The language got its name because it was used to flexibly link a number of different code modules or tools written in regular high-level languages, such as C and FORTRAN.

Programmers using TCL don't call up libraries or other blocks of code through procedure calls; instead, they issue TCL command strings. A small TCL interpreter, which can be linked into the code, interprets the strings. This interpreter acts as a flexible buffer that then makes the procedure calls.

The flexibility of this approach is important. Although object-oriented programming is supposed to make it easy to reuse code, it's useful only if you stay within the narrow framework of the class hierarchy. This structure is painfully limiting, because programmers usually create it during the first several weeks of a project, when people have only a vague idea of what's needed. If you want to add a few features to a block of code or change the way in which the code exchanges data, you often need to rip apart the old hierarchy and begin anew.

TCL's flexibility can alleviate the massive turbulence caused by adding features. You don't use data structures defined by an



The interp command can set up a Safe-TCL interpreter that won't allow code to access outside files or memory. Safe-TCL interpreters can even be nested to create a hierarchy of interpreters.

object-oriented hierarchy to pass information; instead, the interpreted TCL code links modules. If you add new features or change some structure, you only have to tweak the TCL code that links the modules; you don't need to recompile the basic tool code. You can write arbitrary operations in TCL to massage the data and get it to flow neatly between different code modules. You also perform reformatting work in this "glue" layer.

Here's a simple example. Say your lab partner, Bob, writes some software that runs some lab equipment. He originally took all temperatures in Fahrenheit, so you design your code to spit out Fahrenheit temperatures. Later, Bob embraces the metric system and rewrites his interface code to take temperatures in Celsius. If you're simply linking in his code as a library, you might need to rewrite all your code to use Celsius values. If you use TCL to pass the data to his code, you can rearrange the TCL code to do the conversion on the fly. You can use a filter function to do the conversion or even use raw TCL to do the work.

You might wonder what's so difficult about changing your code module to spit out Celsius. What if some other code written by someone else in the lab also uses that module? Then that person must update his or her module. The ripple effects of forced upgrades might be great if you're a company like Microsoft, whose business success depends on staying current. But forced upgrades are a major hassle if the software is just a tool for you to get your job done. TCL alleviates the need to delve into your old code and change everything. In the above scenario, you wouldn't have any reason to resist Bob's leap forward.

This example is a bit trivial, but it shows how nice it is to have a way to glue code with built-in intelligence. C++ links compiled code with an information-transfer mechanism that simply says, "Here's the data" (see the figure "TCL's Flexible Links" above). TCL can do anything to data along the way and say, "Here's the data that I've repaginated, normalized, and converted to your specifications."

This feature can also help novice programmers. Because the language is so simple, people with only a small amount of programming experience can link modules successfully in TCL. There is, for instance, only one data type: the string. This simplistic representation slows down system code that uses data types to speed operations, but it offers no major impediment if the inefficiency is limited to code that glues things together. Simplicity is the major reason why some at SunSoft see TCL as the Visual Basic for the Internet.

Safer TCL

Several years ago, Nathaniel Borenstein and Marshall Rose recognized that TCL was more than just a tool for managing large programming projects. The two decided to build on the Multipurpose Internet Mail Extensions (MIME) standard for bundling multiple types of data into a single E-mail message. When they finished with that, they wondered, "What if we could send a program as well?"

Their solution was a modified version of TCL, known as Safe-TCL, which resists malicious programs, such as viruses, that might arrive via E-mail. Their modifications and suggestions to the original version of TCL are now incorporated into the latest version, 7.5, to emerge from SunSoft. These security modifications are crucial to taking the TCL language used by Unix hackers to link C code and turning it into the TCL language that links code throughout the Internet in a safe and virus-free way.

Borenstein and Rose picked TCL because it's a high-level language that they could implement with a small amount of code. They hoped to make it possible for people to ship forms and other interactive programs via E-mail. The recipient's E-mail application could fire up the programs without worrying whether they contained any malicious code.

They found that the interpreted nature of TCL was an asset for two reasons. First, interpreted code is easy to run on many different machines. An E-mail message with embedded TCL can run successfully on a Sun system, a PC, or a Mac because there's no binary code.

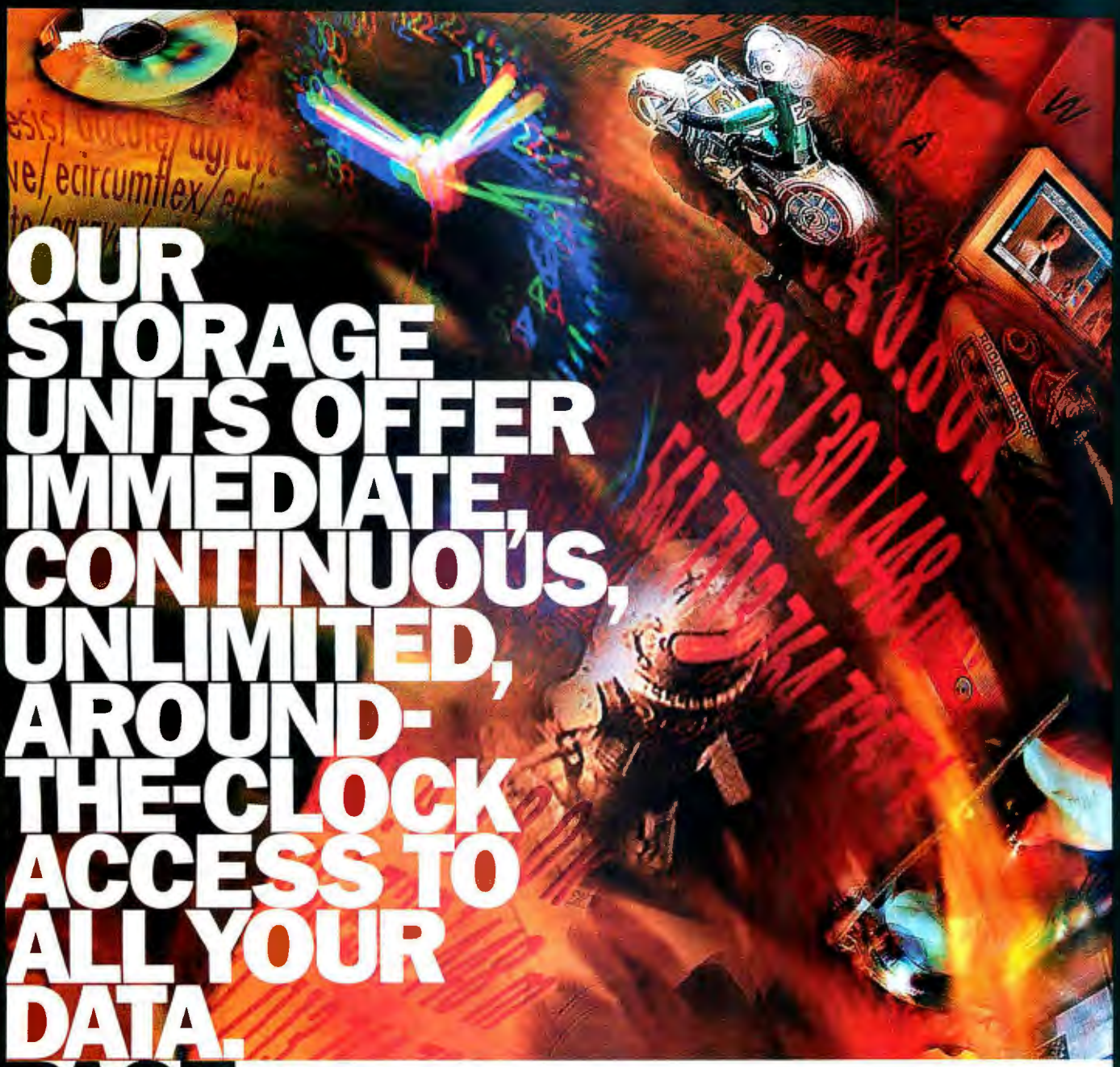
Second, and more important, programmers can make a TCL interpreter safe by arranging for it to watch the execution of code for errant instructions intended to change memory or overwrite the file system. A TCL interpreter can watch each step and make sure that an instruction is accessing only those strings or memory locations that it's authorized to use. A language like C, which gives a programmer infinite freedom to manipulate pointers, could never be made safe like this.

Version 7.5 of TCL contains a command called `interp`, which creates a new interpreter with its own name space in which code can be executed without affecting any of the outside data. Ousterhout refers to this as a *padded cell*. An incoming E-mail message or agent can be executed in its own interpreter without any danger of malicious code causing damage.

The original Safe-TCL built by Borenstein and Rose had just two interpreters: a safe one, used to contain untrusted code, and a free one that could access the system. An incoming agent would run in the safe interpreter and communicate with the rest of the system by issuing commands to the free interpreter.

If, for instance, the code running in the safe interpreter was that of a travel agent making plane reservations, it could access the customer's seat preferences stored in a file by issuing a command that ran in the free interpreter. This free command would send out plane information only and would not allow general access to files that might contain other private data. Programmers can determine which features are available to incoming agents by controlling which commands run in the free interpreter and what they do.

The model in TCL 7.5 is much more flexible than in previous versions. Each TCL interpreter can act as a master and create a slave interpreter. These slaves can be either safe or free. Each master decides what functions it offers to its slave. The



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slaves can also create their own slaves in a great hierarchy, but safe interpreters can create only new safe interpreters. This flexibility allows agents that come in the form of TCL code to exchange data with other agents by either starting them up in a slave interpreter or merely examining messages in a safe slave interpreter.

Programmers keep the interpreters safe by strictly limiting the features available to a TCL program running in them. For instance, TCL code can open, read, write, and close arbitrary files on the computer. This command is locked away from safe interpreters.

To allow an incoming TCL program to access files, you create your own file access code in the master interpreter. You can write this code so that users can access only those files located in particular subdirectories or on particular disks.

You can then make this command available in the safe slave interpreter via the alias mechanism that adds new functions to the safe-interpreter domain. The code running in the safe interpreter can use this crippled command only to access files. These extra functions are one of the principal ways in which information can be passed out of safe interpreters.

Assessing the safety features of TCL can be a long, drawn-out project. The designers of TCL 7.5 left out all the obvious ways in which a TCL program could breach the walls of the interpreter and mess up a system. TCL 7.5 blocks the file operations, the `exec` command (which lets a TCL program execute a subprocess), and access to general information about the file system and environmental variables. Information can enter and leave only through the additional functions that a programmer adds. This is why the padded-cell analogy is so accurate.

Some consider this model to be limiting. The Telescript language from General Magic (Mountain View, CA) offers a more spacious structure, complete with many extra features that make life easier for programmers. Telescript, for instance, offers a place where multiple agents can come and meet. Many sections of code can enter, meet, exchange data, and then leave this "padded cell." The system also contains a permit mechanism that controls which features are available to which agents and can even limit how an agent consumes system resources, such as CPU time or memory. None of these features is in the current version of TCL.

This more sophisticated environment can make complicated rendezvous scenarios easier to create, but it might also inadvertently add security holes. For instance, it's possible that agent A and agent B might not be able to breach the security alone, but they might be able to do so when both exist in the same place. Anticipating weird and unlikely combinations like this is difficult, and no one has any great experience in structuring such situations.

The potential for danger is not from the basic TCL or Telescript software that does the interpreting—these packages are sure to be tested extensively. The holes could emerge when programmers do a bad job of creating the functions that pass information in and out of the padded cell. Ousterhout claims that his hierarchical model offers a simpler vision that's easier for any programmer to keep secure. Jim White, the General Magic designer responsible for Telescript, believes that people want agents to communicate and that programmers will be able to successfully keep leaks from emerging. Only time and practice will determine which vision is more successful.

Programming for the Masses

TCL complements the increasingly popular Java (see "Wired on the Web," January BYTE). The latest versions run on Macs, Windows PCs, and Unix boxes. While Java is a full-featured programming language that gives programmers access to low-level details, such as threaded processes, TCL is a significantly simpler language that can act as a high-level scripting tool for linking applets. Ousterhout hopes that Java will be the tool that sophisticated programmers use to write tools and that TCL will be the high-level language that novice and sophisticated users alike will use to knit these tools together.

Ousterhout's hope that TCL 7.5 will become the Visual Basic for the Internet has plenty going for it. Anyone can incorporate TCL easily into his or her programming projects. The C code for the interpreter is freely available. The language itself is not hard to implement, nor is it particularly hard to understand. It also comes with a user-interface toolkit, called TK, that displays a consistent interface on any platform. This makes it an ideal candidate for multiplatform development.

SunSoft is actively supporting the technology, and it's only a matter of time before we see what the Internet will choose. The greatest competition for the TCL language will probably be General Magic's Telescript. While Telescript has a more sophisticated approach to agents and their interaction, TCL is free. This is a significant advantage, because the greatest advances on the Internet often come from cash-poor programmers. In any case, the short reign of the native-code-generating object-oriented compiler is about over. ■

Peter Wayner is a BYTE consulting editor based in Baltimore, Maryland. He is author of Agents Unleashed *(Academy Press, 1995), which is being retitled* Agents At Large. *His World Wide Web home page is http://access.digex.net/~pcw/pcwpage.html. He can also be contacted on the Internet or BIX at pcw@access.digex.com.*

How They Stack Up

TCL

- An interpreted scripting language.
- A tool for building agents that roam the Internet.
- Developers write code by binding small programs into larger applications.
- Adding new features to programs doesn't require recompiling the basic code.
- C code for the interpreter is freely available.

JAVA

- A full-featured programming language.
- Gives programmers access to threaded processes and other low-level details.
- TCL complements it by acting as a high-level scripting tool for linking applets.
- Java serves sophisticated programmers; TCL serves experienced and novice developers alike.

TELESCRIPT

- Offers a more spacious structure and more programming features than TCL.
- Agents interact in a secure meeting area.
- A "permit" mechanism controls which system resources are available to each agent.

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Connecting a PC or Mac to Unix? Beware: Your OS's TCP/IP might not be enough.

It took them a few versions, but Apple and Microsoft now bundle IP stacks with their OSes. Does this mean that you'll never need to consider a third-party stack? Maybe. Built-in stacks have a lot going for them, not the least of which is that they're free. But there are still those among us who need something more—say, a particular type of terminal emulation or a specific network management function. Here's a look at what third-party IP stacks have to offer.

Getting Down to Basics

The basic packages Apple and Microsoft offer are just that: basic. For most of us, these packages are enough—they enable you to do basic functions, such as configure your IP address manually or use DHCP, and they include such standards as FTP and telnet.

Windows 95's TCP/IP stack is pretty impressive. First, it's easy to install. While Windows 95 doesn't automatically detect a TCP/IP network, as the Setup Wizard does for NetWare and NT networks (where it selects such items as the correct protocol and Ethernet frame type), you can use DHCP or Microsoft's Windows Internet naming service to automatically configure your workstation for TCP/IP connectivity. Lacking these services on your network, you must enter configuration information, such as an IP address and subnetwork mask, manually.

Microsoft includes many utilities with its Windows 95 TCP/IP stack: telnet, ping, and an FTP client, for example. Additionally, you can buy the Microsoft Plus Pack to get Microsoft's Internet browser (or you can download the browser via the Internet).

The Mac TCP/IP stack is part of Apple's Open Transport networking architecture. Version 1.1 of Open Transport, which should be shipping with new Macs and Power Macs when this article sees print, offers automatic configuration via BOOTP or DHCP.

Internet access is also a straightforward process with the Open Transport architecture. That's because Apple includes MacPPP and MacSLIP, which allow you to make a PPP or SLIP connection to an Internet service provider.

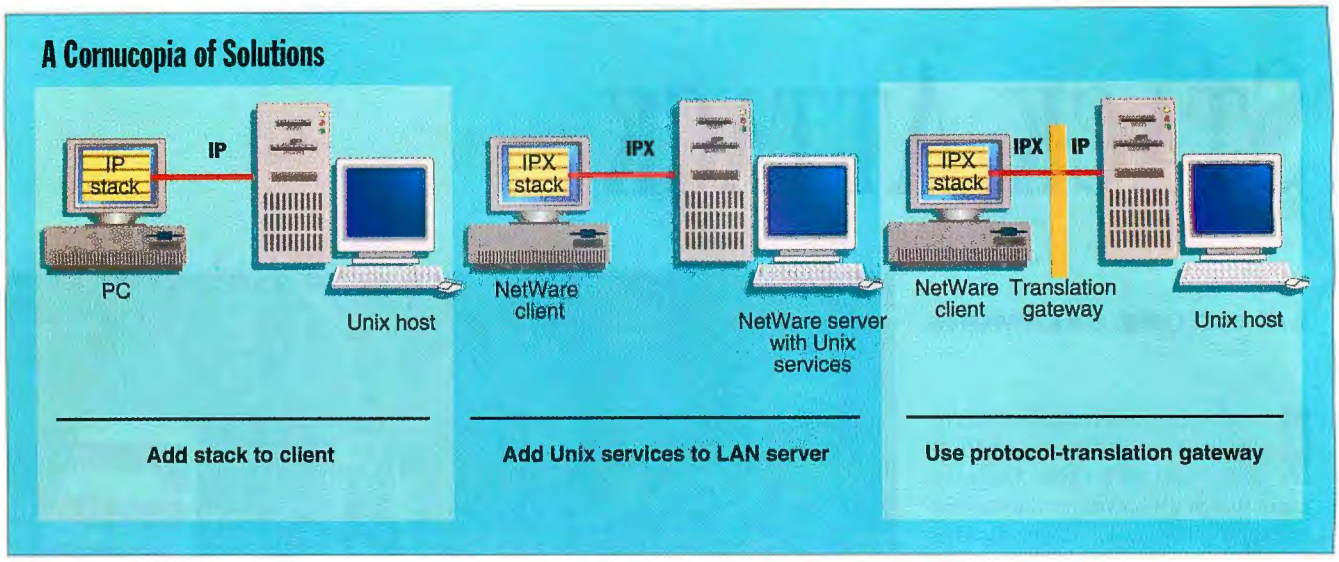
Like Microsoft, Apple does not include a browser with its OS. But an Apple Internet connectivity kit (sold separately) offers many tools for Internet access, including Netscape Navigator and Newswatch browsers, the Apple Internet Dialer, Adobe Acrobat, and Fetch FTP.

Who Needs More?

With the major OS vendors throwing in a TCP/IP stack and Internet-access tools, you'd think third-party IP-stack vendors would be posting "going out of business" signs on their front doors. But that's not the case.

Most third-party vendors concede that the level of IP connectivity offered by OS vendors is fine for home users. But they argue that it's not enough for corporations where TCP/IP is—no pun intended—the backbone of their business (see the figure "A Cornucopia of Solutions" on page 106).

Third-party IP-stack vendors say there are several reasons why people will pay for what OS vendors are giving away. First,



There are three ways to give a desktop PC or Mac access to applications running on Unix hosts: You can load an IP-protocol stack on the desktop computer, move some of the Unix services onto the LAN server, or provide a protocol-translation gateway that takes the user from one networking environment to another.

they claim that by virtue of their years of experience with IP, the basic TCP/IP utilities bundled with their stacks offer richer feature sets than the ones bundled with OS-vendor's stacks. Second, they say they typically offer more TCP/IP LAN utilities and better administrative and management tools than the OS vendors. And third, they typically do not charge for support.

But of course they'd say this—it's either that or they start thinking what Chapter 11 will be like. What follows is a look at how well their claims match reality.

Fuller Features, More Functions

Does maturity make a difference? It seems so: Many of the TCP/IP utilities offered by third-party stack vendors have had several years to mature, and it shows.

For example, Microsoft offers a character-based FTP utility for transferring files. It requires familiarity with the FTP syntax from Unix we all know and despise (Why is it that `exit` won't exit? Why must we type `quit`?). Walker, Richer & Quinn (WRQ) employs a drag-and-drop Windows-based FTP program that's rather like Windows 3.1's File Manager. And many of NetManage's basic tools are Windows-based, in contrast to the command-line utilities from Microsoft that have to be run from a DOS window.

Or consider configuration utilities. FTP Software's IP configuration program lets you fine-tune low-level TCP/IP parameters, enabling you to, for example, adjust the size of the TCP/IP window. Sure, you can do this in Windows 95—if you happen to love playing around in the Registry Editor (REGEDIT).

Macintosh users can also get richer utilities from third-party IP-stack vendors. The Wollongong Group's PathWay Access TCP/IP suite for the Mac offers scripting features in its telnet and FTP clients that allow you to automate repetitive tasks. Scripting comes in handy for backup: You can transfer important business-data files to a Unix server every day, for example.

Besides providing richer functionality in basic utilities, third-party IP-stack vendors offer utilities that make a lot of sense in a setting where TCP/IP is the backbone of a corporation. But if you're just looking for Internet access, these utilities probably don't make as much sense. For example, most IP-stack vendors also include NFS client software. Typically, the users who need NFS capabilities work in a networking environment where TCP/IP is the backbone protocol.

Terminal emulation is another weak area for built-in stacks. Sure, Windows 95 has HyperTerm, but HyperTerm doesn't support connections over network protocols—only over serial links. It's the same story on the Mac: no emulator for a network connection. Third-party stacks, on the other hand, tend to include a high-quality emulator. For instance, Frontier Technologies includes TN3270 and VT320 emulators with its SuperTCP Pro product for IBM and Digital Equipment host connectivity. Also, Pacer Software offers an extensive suite of emulators for Mac clients, and Attachmate's TN3270 emulator for the Mac includes support for AppleScript (for automating routine tasks) and drag-and-drop file transfer capabilities to an IBM host.

Another thing to consider with emulators is a vendor's range of offerings. This is an area in which third-party IP-stack vendors typically do a better job than OS vendors. Choosing a vendor that supports numerous emulations is particularly important for corporate TCP/IP users who need connectivity to numerous hosts.

First, using a single-vendor approach for host connectivity cuts training costs. That's because different emulators from one vendor all have the same look and feel. If a user currently accesses an IBM host and needs to connect to a Digital VAX, he or she is presented with the same interface on the screen.

A second benefit of using a single vendor for all your emulators is that it eliminates finger-pointing if a problem arises. For instance, you could use a TCP/IP stack from one vendor, a TN3270 emulator from another, and a VT320 from another. If a conflict occurs, who do you call?

Finally, a third benefit is that a single-vendor approach prevents conflicts from happening in the first place.

The Mason-Dixon Line

Extras like NFS and terminal emulators can often ride over any IP stack, thanks to Winsock (in the Windows arena; see the figure "Doing Windows" on page 108) and the APIs in Apple's Open Transport. As a result, you'll see some IP-stack vendors selling their utilities as add-ons to your Apple or Microsoft TCP/IP stack.

But there are some utilities that will never break away from their parent stacks. Specifically, some network management programs are intimately bound to the kernel of the IP stack and cannot run over Winsock or Mac APIs. This is another issue to consider when deciding between a free stack in an OS and a third-party stack.

continued

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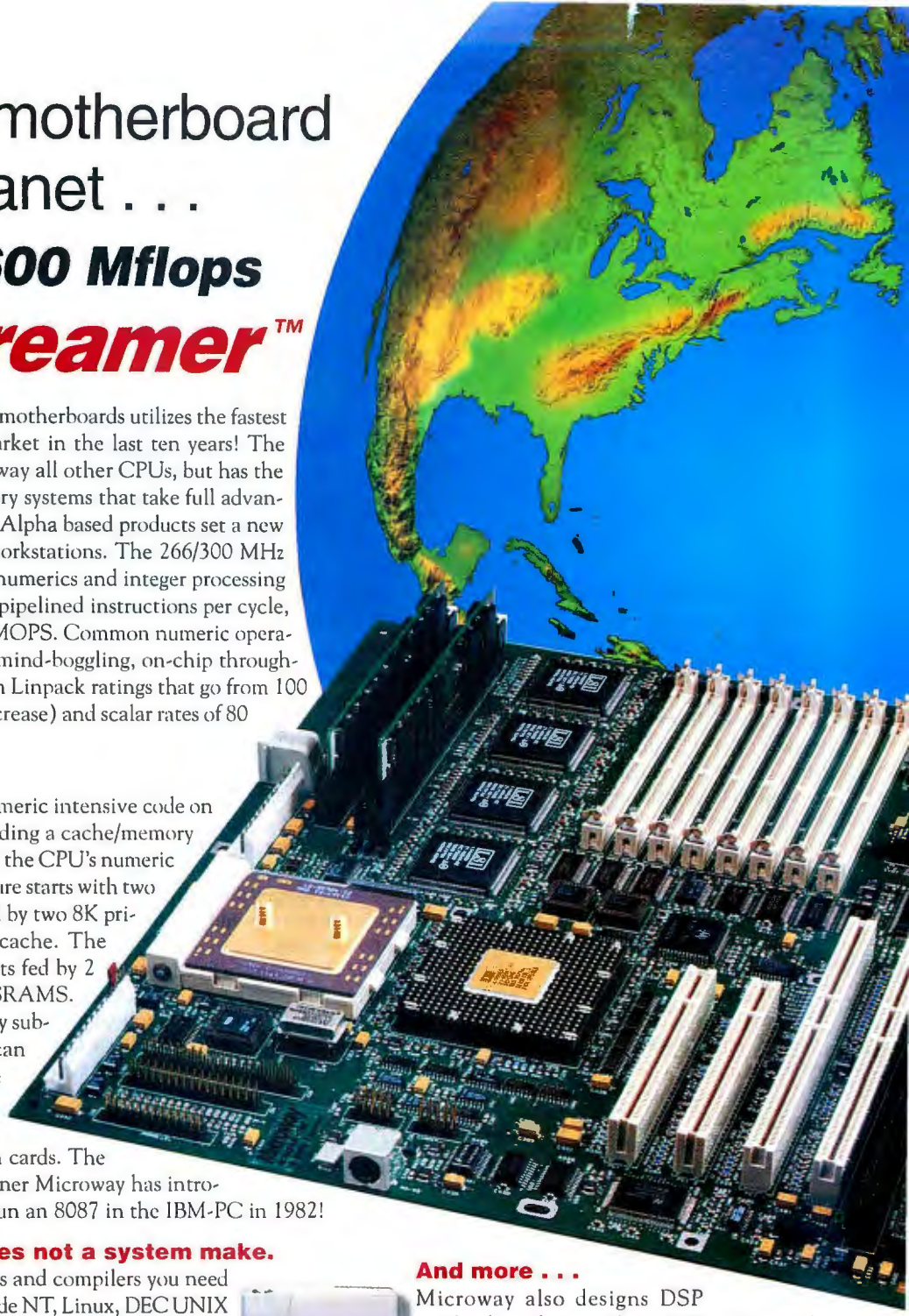

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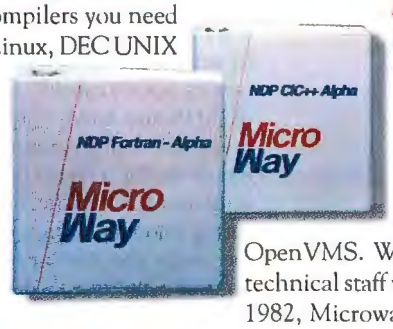

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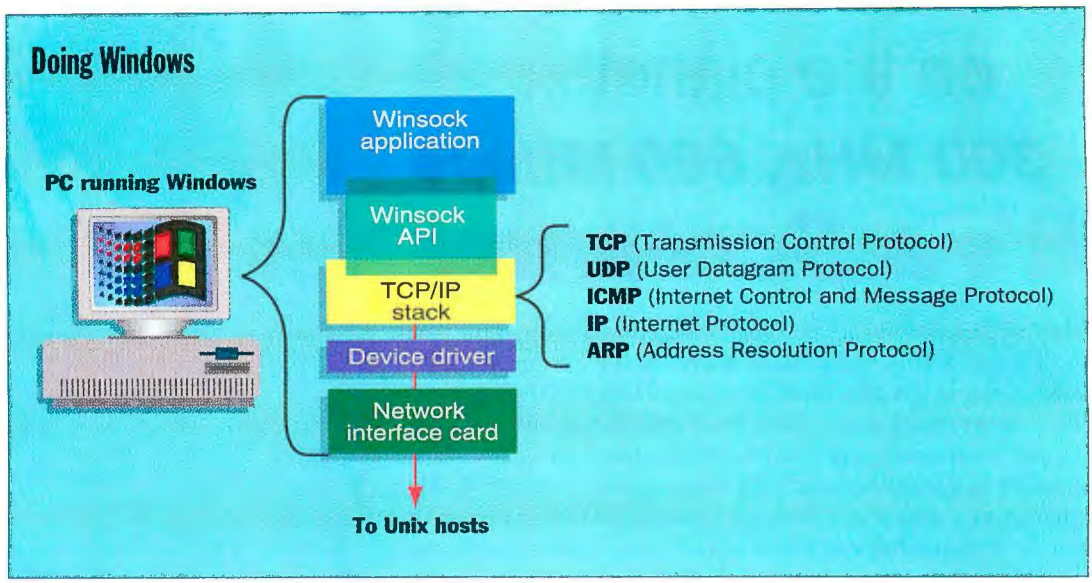
Some refer to this as the "above/below the Winsock line" issue.

"Many people look at Winsock and say, 'that's a solved problem; let's move on'," says Bruce Thompson, product manager for network applications at WRQ. "But there are many higher-level applications that require specific hooks into a stack and that do not go through Winsock."

For example, there is no API within Winsock to pass summary statistics about network traffic to an SNMP management system. For the home user, this is irrelevant, so the stacks from Apple and Microsoft are fine. For the corporate TCP/IP network, however, SNMP statistics are key to problem diagnosis.

WRQ's SNMP-based network management statistics tool is tied to its stack. Similarly, FTP Software has its own IP diagnostic tool that gathers information about TCP/IP packet traffic. And many third-party IP-stack vendors offer their own APIs for connecting their stacks to different services—the "below" in "above/below the Winsock line."

For example, FTP Software's stack allows automatic switching between serial and Ethernet connections. Usually, you have your stack configured so that a LAN connection is the default. When you want to access the Internet over a SLIP or PPP connection, you have to reconfigure to a serial connection. With MacTCP or Windows 95's IP stack, this process is manual. FTP Software's switching function detects when you fire up a dialer program to make your Internet connection, and it automatically changes the settings for you. When you terminate the call, it restores LAN connections.



The Windows Socket API shields a program developer from the complexities of the TCP/IP stack, allowing any application that conforms to the API to run over any vendor's IP stack. Additionally, developers don't have to worry about network connectivity and transport, because it's all handled in the stack.

Debate about using a free IP stack versus buying one from a third-party vendor might tone down a little after the adoption of the latest implementation of Winsock. Winsock 2, which is nearing completion, extends the Winsock specification in a number of ways that address a few of the "above/below the Winsock Line" issues.

For example, Winsock 2 will make it easier for multimedia applications to ride over a TCP/IP stack. The specification gives developers a standard way in which to access the quality-of-service (QOS) capabilities of ISDN and ATM. (QOS gives time-sensitive multimedia traffic a higher priority over LAN traffic, ensuring smooth playback of the audio and video portions of a multimedia data stream.) Winsock 2 also addresses links into wireless services, giving developers access to wireless QOS features.

Basically, Winsock 2 will let more third-party applications and utilities run over any vendor's IP stack. However, it does not address the lack of utilities bundled with free IP stacks.

Today and Tomorrow

There are some applications that just aren't offered by OS vendors. For example, most TCP/IP-stack vendors bundle an Internet browser with their stack. (Remember: Microsoft's built-in browser does not ship with Windows 95, but it's included in the Plus Pack.)

And there's one other factor that plays to corporate audiences: support costs. Most TCP/IP-stack vendors offer free support for the life of the product. Contrast that to Microsoft, which charges corporate users for support by the hour.

Again, the support issue might not be important to a user who just needs Internet access. Often the Internet-service provider helps resolve configuration and connectivity problems. But in a TCP/IP LAN environment, where connectivity is essential, free support is worth a lot.

Basically, you can view the free IP stacks from OS vendors as a good start. And many users won't need any more than that. Corporate types with large IP networks, on the other hand, will appreciate the more fully functioned utilities, advanced network-diagnostic capabilities, and free support offered by third-party stack vendors. ■

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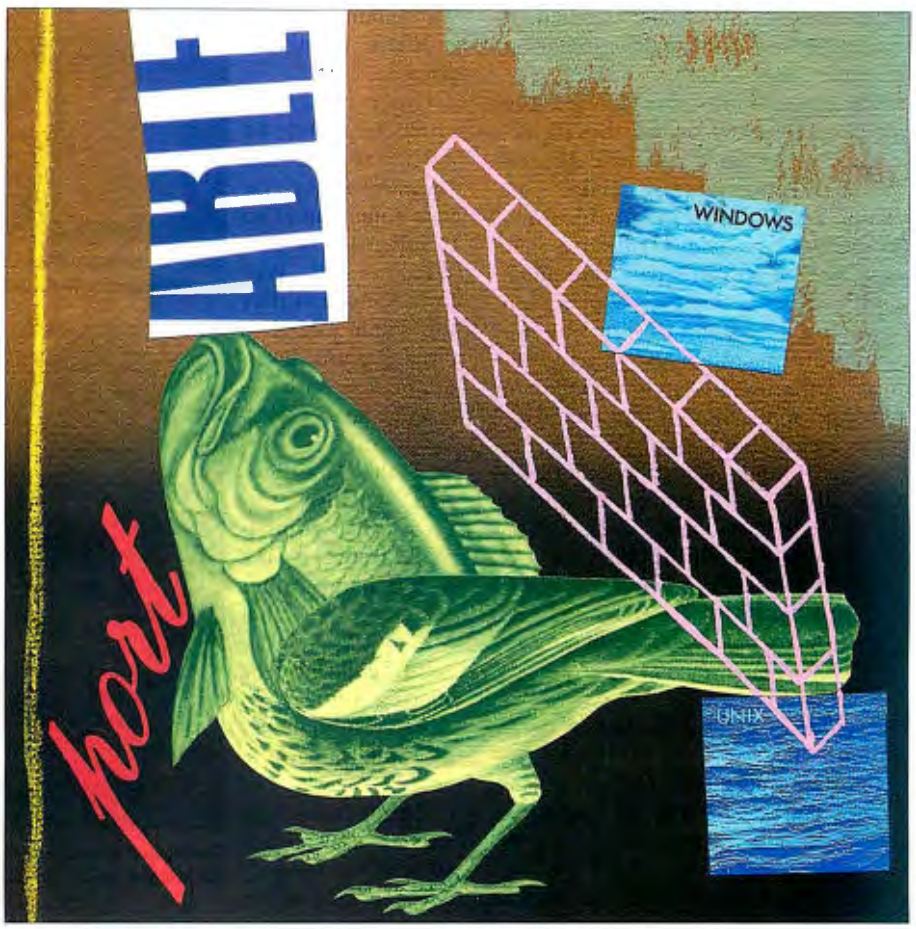

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Portable applications for Unix and Windows are a fact of life. Development problems don't have to be.

Berlin may be unified, but the wall between back-office Unix operations and Windows-run desktops hasn't crumbled to the ground yet. Unix is still the only platform for many mission-critical applications and database servers. However, these systems must interact frequently and closely with the Windows world, and applications that companies deploy on both platforms are more critical than ever.

What does this mean for you? First, you no longer can expect to spend your career in the comfort of one familiar hardware platform, OS, or programming language. Instead, you must deploy new applications—and often redeploy legacy applications—onto multiple hardware and OS platforms. Second, you must grapple with a host of new cross-platform-development problems, such as how to maintain code and resolve word- and bit-ordering issues.

If you develop applications that straddle the Unix and Windows wall, you face challenges and opportunities in spades. But the problems are by no means insurmountable. You have two main roads to take: Follow the roll-your-own approach, or take advantage of one of the many development tools designed for producing portable applications. Each alternative has its trade-offs. Here's how to make your choice.

Roll Your Own?

The courageous programmer may eschew commercial development tools when writing portable Unix and Windows applications because it looks like a way to save money. Also, you can in effect write your own applications-development environment by establishing common support routines across both platforms and writing to them. You gain control over the cross-platform layer, which is important if you have stringent requirements that can't be met by a cross-platform-development tool.

But think long and hard before going the roll-your-own route. It's a rare occasion when you need such stringent control over the cross-platform layer that you need to create your own development environment. Also, almost all programs grow beyond their initial intended use and environment. What was eminently doable for the accounting department may quickly become insupportable when the CEO tells you to deploy it across the entire corporation.

What deployment problems might you face? Most important, there's scalability. The design choices you make for a low-volume server will probably be different when you expand the program for a high-volume server. You can often use third-party tools to deal with these divergent requirements. But if you've rolled your own application, you may have to start the development process from scratch before you redeploy the application. In addition, most third-party tools support nearly every OS and hardware platform you can imagine.

This laundry list of problems may quickly convince you to invest in a third-party tool. But your decisions don't stop there. There are dozens of tools to choose from. The following three scenarios will put your choices into perspective. *continued*

SCENARIO #1: Down and dirty.

Problem: You need to develop cross-platform applications under a tight tool budget, and you have few programming resources to spare.

Solutions: Platform emulators require the least effort for programmers because emulators don't involve development. Emulators mirror the environment of one OS on another platform. Examples include Insignia Solutions' SoftWindows ($499) and SunSoft's Wabi ($225).

While programmers don't have to spend any development resources, they do have to accept some significant trade-offs with emulators. Performance often takes a substantial hit. The extent is hard to gauge because you're running on different hardware, but the hit can range from almost nil (if you're running Solaris on an Intel box) to up to 16 times as slow (if you're running Solaris on a SparcStation). In addition, Unix users have to accept using Windows applications with a non-Motif appearance and behavior.

Another simple approach is to deploy X Window System server software on Windows desktops. This works if all you need to do is run X client applications over a network. In common with using emulators, this alternative keeps you from having to write code, but you're limited to running in the X environment.

SCENARIO #2: Built for speed, not for comfort.

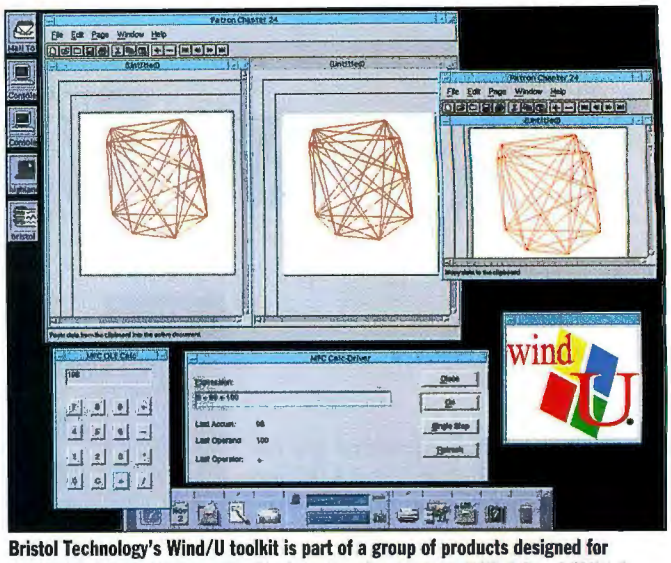
Problem: Your need for fast, quickly developed applications overrides concerns about code maintenance and user-interface (UI) transparency.

Solutions: You can create applications with native performance by running the source code through a translator to prepare it for the target platform. One example of a translator is Thomson Software Products' TeleUse/Win16. It takes C source code that uses the Motif GUI on Unix and translates it to C++ code using Microsoft Foundation Classes (MFC), which you can then compile under Visual C++ on the Windows platform.

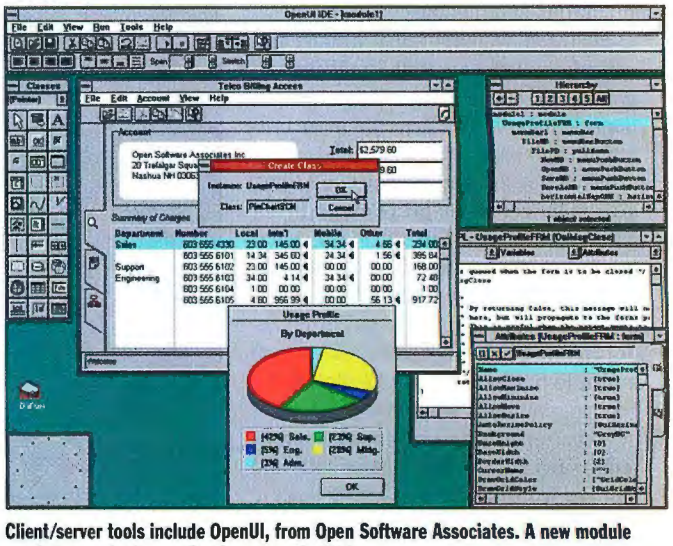
The primary drawback of such a tool is that once you've translated your Motif source, you now have two sets of source code to maintain. That's because a translator literally takes your source code and modifies the calls to the API to use a new set of calls. But you've still got your original source code using the other API.

TeleUse/Win16's translation is also less than perfect; the resulting Windows application still has a lingering Motif look and feel. Thomson's companion product, TeleUse/Win32, takes a Motif application that you developed with Thomson's TeleUse UI management system and generates a Windows NT executable file. However, this makes software maintenance a problem from that point on.

Other types of products provide an API that you can write to, or they provide emulation of an existing API (e.g., a Windows API). Willows Software offers the Twin XPDK, a cross-platform developers kit with libraries, header files, and the like, to support the Windows API on Unix platforms. The company's strategy—like that of many other companies—is that Microsoft is so influential we should all be writing to the Windows API, no matter what platform we're on.



Bristol Technology's Wind/U toolkit is part of a group of products designed for developing applications quickly. The latest version supports MFC 4.0 and OLE 2.0.



Client/server tools include OpenUI, from Open Software Associates. A new module can help you deploy applications over the Web.

Bristol Technology takes a similar approach. The most recent version of its Wind/U toolkit for porting Windows applications to Unix systems includes support for MFC 4.0, OLE 2.0 objects, and Windows 95. The OLE support is only partial, however, and currently accommodates only the OLE Common Object Model (COM). Support for OLE automation and OLE custom controls (OCXes) should appear in this quarter.

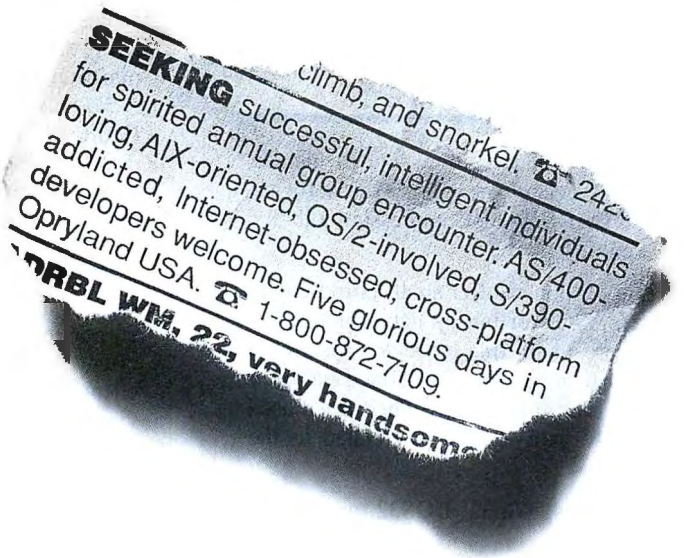
Mainsoft's MainWin Cross-Development Kit is in the same vein as the Willows and Bristol products. It lets you compile Windows applications on Unix platforms, and the resulting Unix application can run with either the original Windows look and feel or the Motif look and feel. End users can choose the look at run time.

SCENARIO #3: Point me uptown.

Problem: You need fast, low-maintenance code within a client/server foundation—at any cost.

Solutions: The most complex class of tools, cross-platform-development environments can help you design a GUI application and, in some cases, compile and test the software for you. These development tools have the advantage of leaving you with a single set of source code to compile for each target platform. If you decide to use a third-party cross-platform-development tool or environment, select one that not only supports Windows and the Unix flavors you use today, but one that will work for the applications you might need to support in the future.

How do you make your decision? Be prepared to face many cross-platform applications-development environments and tools. They include XVT Development Solution for C++ from XVT Software, Forte Software's Forte, Zinc Software's Zinc Application Framework, WNDX's WNDX GUI Development System, Liant



Software's C++/Views, and Inmark Development's zApp Developers Suite.

Also part of this group is OpenUI. One promising development is Open Software Associates' announcement of OpenWeb, an enhancement to OpenUI due this quarter. It will let you deploy client/server applications over the World Wide Web.

To make your decision even more difficult, most client/server applications-development environments provide rich cross-platform applications-building support within their charter of client/server development. Although such client/server tools require substantial investments of money, time, and expertise, most critical corporate applications will head down the client/server road at some point. Many client/server applications-development environments focus on database design and deployment. Examples include Compuware's Uniface, PowerBuilder from Powersoft, C/S Elements from Neuron Data, and Oracle's Cooperative Development Environment.

JAM, from JYACC, and Blyth Software's Omnis 7 are also mainly directed at the development of database applications. They support a wide variety of DBMSes on both Windows and Unix.

Stumbling Blocks

Even the best tools don't automatically create super applications. That's because a custom application that is critical enough for you to deploy on multiple platforms will likely require significant interaction with a variety of windowing systems, databases, or other servers. Maintaining a single code base for a cross-platform application with such complex interactions will be one of your biggest challenges.

One of the most critical design steps you'll take centers on partitioning modules into platform-independent and platform-dependent entities. Platform-independent modules shouldn't require any changes to compile on the target platform. Note, of course, that platform-independent modules may still have separate sections that are dependent on general characteristics of the target platform (e.g., word size or byte ordering).

Platform-dependent modules, on the other hand, directly call platform-specific services, such as file I/O, database access, and GUI control. In general, platform-independent modules will comprise the great majority of your code.

By building modules that provide platform-dependent services to platform-independent modules, you have created your own (and usually small) cross-platform

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applications-development environment.

You should also strongly consider using function wrappers to isolate your platform-independent code from platform-dependent code, even if you've created the code from scratch or by using a third-party tool. Wrappers save work when you make subsequent changes to your platform-dependent modules because you write your own API instead of writing directly to a third-party API.

Further complications when writing across Windows and Unix environments are data size, data alignment, and word ordering. These issues come into play when you're porting an application between Windows and Unix or when you're developing client/server applications that must work on the two platforms.

You cannot make assumptions regarding data size on each target platform because, for example, an integer may well be 4 bytes on one hardware platform and 8 bytes on another platform. Assuming you're programming in C or C++, platform-independent modules need to rely on platform-dependent header files to set up correct data types.

Data alignment can be a problem if you make assumptions about data storage that fail to take into account hardware architecture alignment requirements and the padding that a compiler might insert to conform to those requirements.

Word (and bit) ordering is critical because the Windows/Intel platform is little-endian (i.e., lowest-order byte stored first), and many Unix platforms are big-endian (i.e., highest-order byte stored first).

Things go wrong if you make incorrect assumptions about how values are stored internally. If you treat an integer only as an integer and don't try to cast it as something else (e.g., an array of bytes or an array of characters), you're fine. But if you try to use that same storage differently than you declared it and you make assumptions about how data is stored, you're in trouble. For example, assume a little-endian machine on which an integer is 4 bytes, and you stored x01020304 in an integer a and then a[0]=x04, a[1]=x03, and so forth. On a big-endian machine, it would be a[0]=x01, a[1]=x02, and so forth.

Keep in mind that you may need to write to the lowest common denominator for each platform to avoid some window controls in Windows that aren't available on a particular flavor of Unix. Similarly, you may use a less-than-ideal database because it's available on the platforms you need. Once again, this problem argues for the use of third-party tools, which have

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varying levels of support for platform-specific features.

However, end users will rightly expect the application to behave as a native application. Therefore, when you evaluate third-party tools, make sure that they can help you produce target-platform applications that not only look but behave like a native application developed solely for that platform.

Once you've ironed out the many development issues related to creating cross-platform applications, you'll face one more hurdle: how to test the program. It is awkward, inconvenient, and inefficient to use different software quality-assurance tools on Unix and Windows platforms. Fortunately, several products—such as QA Partner from Segue Software and WinRunner and Xrunner from Mercury Interactive—provide common services on both platforms. In fact, these products usually let you use the same test scripts across both Windows and Unix.

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No Panaceas

There are many third-party tools and environments you can effectively leverage in a cross-platform-development effort. But no matter how sophisticated a tool is, it won't replace the most critical element of all: careful programming techniques. ■

Denis Haskin, a senior manager for production engineering at Information Access Co., manages cross-platform-development projects. You can reach him on the Internet or BIX at editors@bix.com.

SUNSOFT'S OBJECT LESSON

JOHN MONTGOMERY

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Although SunSoft's object-oriented Spring project is ending, key features will appear in Solaris

SunSoft did something risky in 1989: It let some of its best and brightest play. The object of the game was to create a distributed, fully object-oriented operating system. In 1995, these engineers delivered. They called the result Spring, and it seems everyone who has worked with it believes that it's one of the best operating systems available.

But it was just a test. The engineers wanted to see if some of their ideas about object orientation and distribution would work. They did. And now Spring is going to pass, according to SunSoft's original plans. The work was hardly for naught: Company officials say many of the best ideas (including doors, distributed memory management, and universal naming) will appear in future versions of Solaris. But it will never be Spring again.

Open-Door Policy

One key idea in Spring is that applications can access objects located anywhere on a network. You can use the same source (and object) code to access objects within the same process, within the same machine but in different processes, and within a network of cooperating machines (called a *village*). Spring enables this distribution by keeping interobject communication abstract: Object A may ask Object B to do something, but it can't specify *how* it gets done.

From the application writer's perspective, there is only one kind of object in Spring. From the object implementor's perspective, there are two: server-based and serverless. Server-based objects can be in any address space, including the same space as the client application that called them. If the client invokes an operation on a server-based object that is not implemented in the client's address space, the kernel may be involved with the object invocation. For a serverless object, the kernel dynamically loads a shared library that implements the object's code into the client's address space. Serverless objects are primarily a performance optimization for lightweight objects like *names*.

Spring objects run in *domains* that are like Unix processes. Spring domains have an address space, and they hold information about *threads*, and they have *doors*, entry points into other domains.

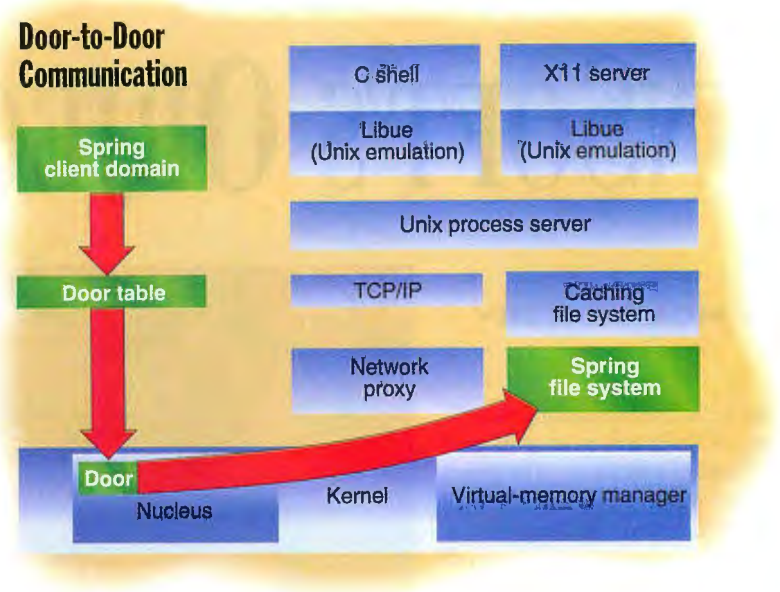
Each object contains a list of the *subcontracts* (relatives of RPC/IPC) that the object supports. Each object also contains the data the client has that the stubs and subcontract use to forward the object invocation to the proper destination, called the object's *representation*.

When a client calls a server-based object, it passes its request through a client stub. This stub *marshals* the arguments—places them into a communication buffer with enough information so that the server can figure out what's going on. The stub then passes them to the subcontract which, in turn, executes the call to the server-based object. The server-based object, for its part, has a subcontract that "unmarshals" the arguments. Then a server-side stub invokes the appropriate method on the object.

At the center of interdomain communication is the Spring microkernel, called the *nucleus*. (The entire microkernel consists only

of the virtual-memory manager and the nucleus; see "Door-to-Door Communication" at right.) When a thread in one address space invokes a door for an object in another address space, the nucleus allocates a server thread in the second address space, then passes the server thread information about the door that the thread invoked, as well as any arguments. Then the nucleus lays low until the server is done, at which point the nucleus reactivates the thread that called the server and passes it any return information.

So how does the nucleus keep track of what machine every object is on? The answer is simple: it doesn't. Instead, Spring has proxies—pointers to where objects really live. So when a Spring system starts, the proxies give each other something roughly equivalent to their root directories. Later on, the naming system can use these directories (actually called *contexts*) to locate objects on other systems. The two systems talk to each other and create a secure link over which object invocations can flow.



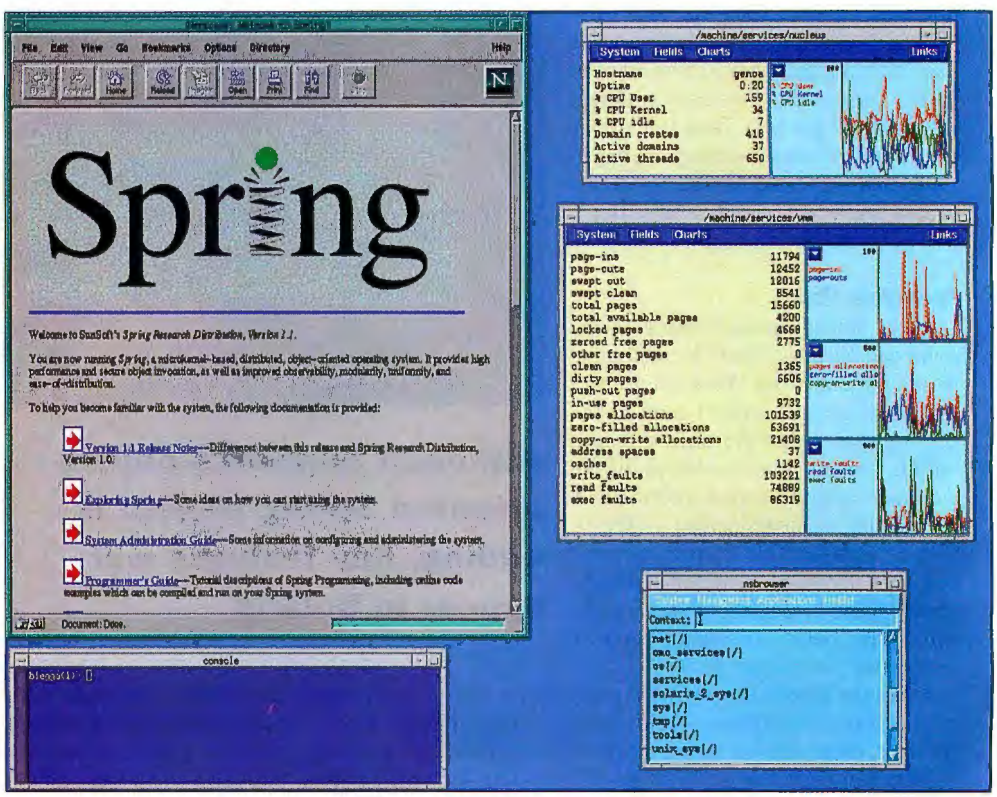
Spring uses a microkernel with only two components: a nucleus, responsible for interdomain communication, and a virtual-memory manager. Everything else runs in user space. One advantage of this architecture is that door invocation performance (shown here as a Spring application requesting a service from the file system) is extremely fast. It also means that the operating system is highly and easily extensible.

Then, when an object on machine A wants an object on machine B, the proxy takes the object reference, compares it to its table of where the object really lives, then substitutes a local object that's basically an index—a pointer to the remote object. If the client on machine A has no reference to the object on machine B, the client will usually use some naming operation to locate the object. The proxy on A will then automatically create the reference to the remote object.

Interface Definition

To ensure that objects talk to each other in consistent ways, Spring has an interface definition language (IDL) that compiles into the source-code language of your choice. The IDL is an abstract language, similar to the Object Management Group's IDL spec. Defining an object with the IDL is a matter of defining the methods you want that object to have.

Once you've written your IDL, you run it through a compiler that generates three pieces of source code: a language-specific form of the IDL interface, the client-side stub code, and the server-side stub code. The language-specific form of the IDL interface is typically a header file (for C and C++) with definitions for the methods, constants, and types you defined in the IDL. You compile client- and server-side stub code and link them into client and server programs or libraries so that objects can talk to their subcontracts.



If you think it looks a lot like Solaris, you're right—at least right now. Spring doesn't have much of a native user interface, so you interact with it mainly through Solaris's utilities and interface running in Spring's Unix-emulation mode.

When you study the syntax, IDL looks like C++. Perhaps more than Jim Mitchell, Sun fellow and Spring cocreator at SunSoft, would like. "But compromise is the price of getting a technology standard-

SPRING IN ACTION

So what *can* you use Spring for? "Spring is really good at building certain kinds of distributed services—for example, network management services," says Jim Mitchell, Sun fellow at SunSoft. "It's also for doing things like extending an OS such as Solaris to deal with other classes of machines, like clusters and supercomputers."

Spring is aimed at future computing needs, especially for Internet servers. "People are going to be building systems with lots of expandability," says Mitchell. And that expandability is going to exceed what is possible with current OS architectures. "Multiprocessing has its limits. Once you're in the 20-processor range, it doesn't go faster to add another processor," he asserts, explaining that it has do with shared memory buses and snoopy caches. "To get 100 processors, you have to go to another architecture," Mitchell says.

Right now, Spring is mostly the basis for research. The situation at Brown University is fairly typical. "We're looking at object-oriented approaches to deal with replication in distributed systems," says Tom Doeppner, research associate professor at Brown. The advantages eventually would be increased fault tolerance and performance, with dynamic load-balancing and server switching.

"We're taking advantage of subcontracts," says Doeppner. "The client thinks that it's invoking operations on the object directly, but our subcontract steps in and encodes the fact that the object may exist in several places." So when the client invokes a method, the subcontract finds a suitable server, caches the information, and continues to use the server until it's not a suitable choice anymore.

Purdue University is working on garbage-collection systems. "We have a conservative garbage collector for C and C++," says Vince Russo, assistant professor at Purdue. "And we just started working on network security for object systems," which would work at the subcontract level.

The University of California at Santa Cruz is looking into performance instrumentation for Spring. "We were very impressed [with its performance] on the door calls," says associate professor Darrell Long. "We're developing a performance monitor."

Most of this work is in the early stages, but all the university projects show promise of commercial use. It's too bad, the professors universally agree, that Spring is not headed toward becoming a commercial OS.

ized," he says. For example, an IDL interface might look like this:

```
import raw_data;

module io {
    enum error { bad_size,
illegal_offset, full,
not_available };
    exception failure { error code;
};
    exception end_of_data { };

    interface sequential_input {
        raw_data read(in long
size) throws (failure,
end_of_data);
    };
    interface sequential_output {
        void write(in raw_data
data) throws (failure,
end_of_data);
    };

    interface sequential_io:
sequential_input,
sequential_output {};
};
```

Mitchell explains why Spring needed its own IDL: "When we started this project, we wanted to make a system as open as possible, particularly not tying people to one programming language. We knew we needed strong interfaces. The only way to get it would have been to have a programming language with strong interfaces. To get both, we had one language to describe interfaces."

I Cannot Tell a libc

SunSoft never defined Spring as Unix, no matter how far you stretch the definition of Unix. Consequently, applications written for SunSoft's current Solaris operating system won't run on Spring without emulation. The emulation system that SunSoft created acts as a kind of translator, changing an application's calls into Unix services that have Spring counterparts. When Spring has no counterpart, the emulation system performs the call itself. Consistent with Spring's microkernel architecture, the whole emulation system runs in user space—it's not part of the kernel.

The emulation system consists of two basic parts: a shared, dynamic-linked library (called *libue.so*) and the Unix process server. Solaris binaries make calls to *libc*. Spring just replaces libc with libue by changing the search path. When you run a Unix application (or some other application executes it), Spring dynamically links libue instead of libc to it; the application doesn't change. After looking at every system call that the application makes, libue either maps it to a Spring function or, in the case of a function that has no equivalent (such as signals), implements it directly.

The Unix process server tracks processes and group IDs and provides services such as sockets and pipes. Since it has its hand on the pulse of Unix applications, the process server enforces Unix security semantics.

Memory's the First to Go

Spring's memory-management system is fairly simple. A client talks to an address-space object. The address space maps to a memory object—e.g., a file. These two objects are the result of the cooperation of the virtual-memory manager (VMM) and an external pager.

The VMM manages the address-space objects, while the pagers manage the memory objects. The pager supplies and stores the actual contents of a memory object to the VMM. The VMM then binds that memory object into an address space. If the memory object happens to be on a remote system, the bind operation points the VMM to a local data cache that provides the memory object's contents.

During binding, the VMM and the pager exchange two objects: the pager object and the cache object. The pager object provides methods for paging in and out memory. It uses the cache object to change the state of the cache.

So a client talks to its address-space object which, through the VMM and pager systems, manages the caching and paging of memory. Why is this approach significant? Because the memory object is separate from the pager. Since they're separate, the memory object and the pager object may be in separate domains, which can improve performance. The Spring file system, an important client of the virtual-memory system, is a good example. The file system caches all file attributes in a caching file system (CFS) on the local node. The VMM is responsible for caching the actual data. When a client is dealing with a remote file, all reads and writes go to the CFS on the local machine, and only when Spring needs to page in or out does it have to hit the remote system.

A Rose by Any Other Name

Files get one kind of name, users get another kind of name, computers on the network get yet another. Most people who are used to computers are used to the split personality of naming services. Spring is

COMPARING SPRING

Spring is unique in many ways, but it's probably most like Mach, the microkernel-based operating system developed at Carnegie Mellon University. There are two main differences. First, Mach's microkernel contains a few more functions than Spring's: process management, virtual memory, interprocess communication, and device drivers. Second, Mach uses ports to communicate between machines. Suppose you wanted a remote database. You would use a port, prepare a message for it, send it to the port, and the other end then figures out what to do. In Spring, the other end would have an IDL interface.

The other OS that comes to mind when you say "distributed" is AT&T's Plan 9. But Plan 9 isn't object-oriented. Plan 9's main goal was to extend Unix's concept that "everything is a file." So, in Plan 9, applications talk to everything as though it were a file—usually using a serial stream (e.g., a pipe or a byte stream).

In Spring, everything is an object, and you talk to every object as its IDL interface describes. In other words, in Spring, you could have an object that represents a person. Consequently, there would be an operation to find out a person's name. In Plan 9, an application would read from a data stream until it found a particular delimiter that the application knew was the start of the name, then read until it found the delimiter that meant the end of the name.

going to be a shock: Its naming service is uniform—it can bind any object to any name. In theory, at least.

The advantage is that the clients don't have to keep track of how to talk to different naming services depending on what kind of object they're calling, nor do they have to create naming spaces.

Spring's naming service binds names to objects. An object may have several different names, depending on the context in which it's used, or it may have no name at all. Since a context is itself an object, Spring may bind it to a name (resulting in a name that represents many names). To keep track of what objects are called within this compound structure, Spring creates a naming graph. For example, you may put the file system into a naming graph, linking it to another object's name space so that object can find its way through the maze of objects to locate a specific file.

The naming service has another purpose: It provides Spring with a kind of object persistence. Most of Spring's objects aren't themselves persistent (i.e., they don't always have a place on a storage medium somewhere), but names can be. (In case you're wondering, the file system *is* persistent; otherwise, you'd be unlikely to find your files after you rebooted.) So Spring can keep an object's name around, thereby keeping information about the object. Another object can find the first object through the naming service.

Using Spring

According to several users who've worked with it, you can tell that Spring is an experiment, not a commercial operating system. SunSoft's efforts have revolved around architecture, leaving elements like the user interface somewhat bereft of attention.

Tom Doeppner, research associate professor at Brown University, cites a few of Spring's shortcomings. "We have a somewhat unusual graphics option on many of our SparcStation 10s [the ZX board] that Spring did not support," he reports. Further, some aspects of performance, notably the Unix emulation, aren't very quick. Says Doeppner: "Those portions of Spring that are new technology, such as interprocess method invocation, are very fast. The not-so-new-technology parts, in particular Unix emulation, are a bit slow. Unfortunately, when one sits down to play with Spring, the first thing one notices is the speed of the Unix emulation. Since the compilers and other tools come from Unix and are run using Unix emulation, compiles and related things go fairly slowly, though the resulting code, when it uses only native Spring features, is quite quick."

Doeppner realizes Spring is a prototype: "Spring is somewhat of a memory hog. SunSoft clearly put its resources into providing functionality without worrying about memory usage. However, they were kind enough to lend us a memory upgrade."

Not everyone is happy with how the IDL turned out, either. Vince Russo, assistant professor at Purdue University, explains that the problem isn't so much with Spring but with the IDL's adherence to the CORBA standard. "I have some complaints about deficiencies in the CORBA type system," he says. The biggest complaint is that "in the Spring IDL, you can't overload methods . . . The problem I have with CORBA is that you have to pre-agree

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about everything. I would prefer a more dynamically typed language," Russo says.

High Praise

Despite any shortcomings on this level, however, everyone we spoke to about Spring had high praise for it. "From an operating-system-internals point of view, throwing away the Unix process model and introducing really fast interprocess communication is a great technological step forward," says Darrell Long, associate professor at the University of California at Santa Cruz. Long was so enthused that he was considering working on a port of Spring to Intel-based systems but didn't have the resources to do it. He estimates that a porting project like that would take about one person-year.

Purdue's Russo echoes these sentiments. "I like the fact that the object orientation is pervasive—Spring doesn't pay just lip service to objects. You use the same model for accessing all resources. It's a nice orthogonal way of looking at the OS."

Spring is an experiment, not a version of a forthcoming commercial operating system. According to SunSoft's Mitchell, "The plan is to pull out of it the best of the technology" and implement it in Solaris. Ultimately, SunSoft aims to extend Solaris and aid it in dealing with "weird" architectures such as a nonuniform-memory machine.

Product Information

Spring . . . . $75 for universities, $750 for commercial research institutions
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Mountain View, CA
(415) 960-3200
spring@sun.com
http://www.sun.com/technology research/spring/index.html
Circle 988 on Inquiry Card.

What parts of the Spring technology are going to make their way into Solaris? Doors, for one thing.

But ultimately, Spring seems bound for the bit bucket, with only parts of it surviving in future versions of Solaris. The near-universal cry from users is that that's too bad. "If it were my call, they would post the source code to the Net," says Long. "If it were made openly available, it would certainly be ported and its technology would spread. I'm really sorry to see it just sort of going away." ■

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LINUX MATTERS

TOM YAGER

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It's inexpensive, but that's only the beginning of the story

You don't always get what you pay for. You can spend $1000 or more for fully tricked-out Unix for your PC. Or for about $25, you can get Linux, a Unix variant, which is just as good for running an in-house BBS, an employee information system, a World Wide Web server, or a Usenet news server.

But economy is only a small part of the Linux story. This OS has created a troop of dedicated followers who can act like monks revering an ancient religion, complete with a geek mythology of wizards and daemons. The passion—and even fanaticism—that true believers feel for Linux creates some striking similarities with hyperloyal Amiga users (see the text box "The Sound and the Fury" on page 127).

Why do otherwise normal people become so passionate over mere software? There's no simple answer to this question. To understand Linux, you first have to understand its various pieces. Next, you must get a feeling for what it's like to actually run the OS. The technical analysis and road test that follow should help you see why Linux is not just another OS.

Something for Everyone

Most of the popular CD-ROM distributions of Linux fill three or four discs with software. There's the core OS. There are hundreds of utilities, from flat-file databases to system management. Programming languages include C, C++, Perl, and TCL. Practical programs, such as spreadsheets and text editors. Text formatting. A Display PostScript clone. Network support. Graphical applications. Games. And *tons* of source code.

The complete source code is in every commercial distribution of Linux, and this is partly what's special about the product. You can touch every line of code for every function call, every utility, everything in Linux (see the figure "Linux to the Core" on page 124). The Free Software Foundation mandates this openness with a "copy-left" license that grants users the right to modify and redistribute Linux. You can even charge whatever you like for it, but you must make the source code freely available.

Even if you don't care about the source code, Linux deserves respect because it holds nothing back. Early versions of Unix were the same way. The C compiler and a full set of utilities came with every copy. With commercialization came the brilliant strategy of unbundling: Strip down the OS and then charge users for the pieces to build it back up again.

This decidedly un-Unix-like approach didn't cause the birth of Linux, but its widespread success can be partly attributed to the bungling of commercial Unix vendors. Some companies, such as Novell (before it sold UnixWare to The Santa Cruz Operation), realized the folly of unbundling and began to sell more complete packages. But a commercial PC Unix with an unlimited user license, development tools, and server applications still costs $1000 or more. At $25 to $50 with all these features, is it any wonder that Linux is winning the favor of even commercial users?

Genealogy

Linux's roots lie in Minix, which is a public domain PC Unix. Minix had limited capabilities and device support, but its small

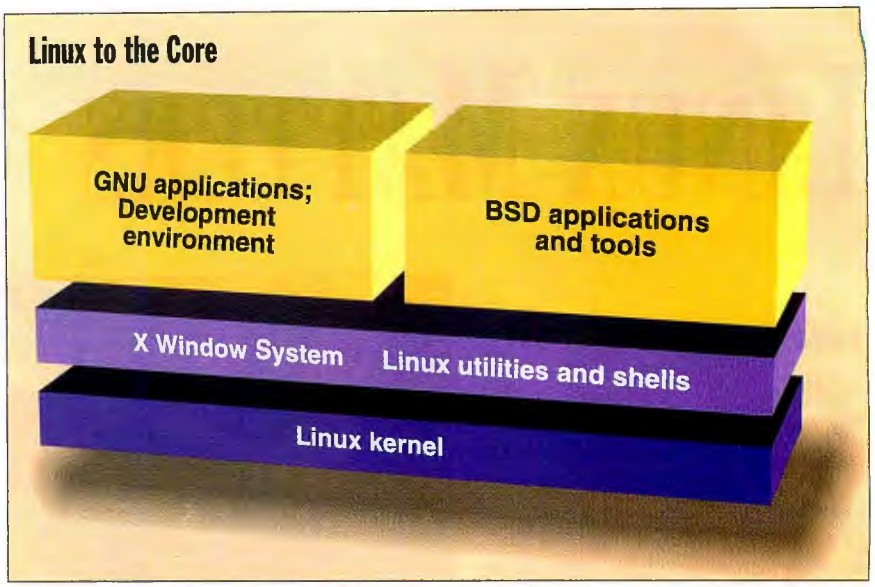
stature translated to clear, easily understood code. Minix was a popular teaching tool in computer science classes. Linus Torvalds created a Minix-like OS that came closer to real Unix in functionality and provided the OS with its name.

Before long, programmers throughout the world began contributing to his efforts by writing device drivers and adding utilities and other programs. Many of these pieces are real Unix. A large number of the utilities and much of the networking support came from BSD, the Berkeley Standard Distribution edition of Unix.

Clever programmers re-created portions of Unix code when licensing restricted redistribution of the code. In some cases, the re-creations outdid the originals. For example, the `vi` editor is done better in Linux than in other Unix versions. Some programmers are even working on the whimsically named Lesstif, a freeware clone of the Open Software Foundation (OSF)/Motif graphical interface. Linux now has an impressively complete set of commands and utilities.

Most Linux programmers keep their day jobs but still manage to crank out new releases of code every few weeks. Device support, bug fixes, and cross-platform porting take center stage in most releases. Torvalds maintains control of the kernel, while others tend to the work of combining core Linux with the utilities, tools, libraries, and other software that turns it into a Unix clone. The bundles come in *distributions*.

Between the work being done for Linux and programmers coding freeware for



The basic Linux framework evolved from work by Linus Torvalds and contributing programmers throughout the world. Commercial distributions of the OS build on this base.

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Unix in general, Linux has plenty of impressive add-ons. Samba adds NetBIOS support, allowing a Linux machine to service a LAN of Windows for Workgroups or Windows 95 clients. DOSEMU lets you run DOS programs, and Wine, while still in the works, will provide Windows 3.1 binary application compatibility.

Support for the ELF binary format is the first step toward allowing UnixWare, Solaris, and other System V PC Unix binaries to run on Linux (and vice versa). In that vein, programmers are under way with Intel Binary Compatibility Standard (iBCS) porting efforts. The objective is clear: Linux users want their OS to be both source- and binary-compatible with other commercial PC Unix OSes.

At this writing, Torvalds reports some success getting Linux running on Digital Equipment's Alpha CPU. It already runs on the Amiga and some other systems with Motorola 68000-series processors. As new ports are undertaken, the Linux kernel will become more easily portable.

Other vendors should envy Linux's record of rapid adaptation. When new drive and CD-ROM controllers, motherboards, BIOS ROMs, and other hardware appear, it won't be long before someone tweaks Linux to work with them. A notable exception is display cards. X Window System display drivers aren't easy to write, and some card manufacturers are reluctant to document low-level details of their boards for Linux's "casual programmers." Thus, while some display cards work well, others work badly or not at all. If you have any interest in Linux, you should check your system's configuration against the list of supported devices.

What's Inside Linux

- **Core OS**
- **Hundreds of utilities, from system management to flat-file databases**
- **C, C++, Perl, TCL, and Intel assembly language**
- **Application programs**
- **A Display PostScript clone**
- **Network support**
- **Games**
- **Source code for everything in Linux**

Road Test

Linux, touted by fans as a free OS, carries some costs. Only those with high-speed Internet links can afford to download it. It is there, free, if you have the time. Two U.S. sites are Sunsite (sunsite.unc.edu) and TSX-11 (tsx-11.mit.edu). (See the text box "Linux On-Line" on page 128 for a list of FTP sites carrying Linux.)

But for $25 to $50, you can pick up a set of CD-ROMs, sometimes bundled with a manual. Slackware is the most widely used and distributed version on CD-ROM. Slackware's trademark is its interactive installation program. This may lull you into thinking that installing Linux is a cinch; it's not. Just as in the old days, you need to know what you're doing or be willing to learn before using Linux.

For example, if you're running a CD-ROM drive attached to a sound card, you might be in trouble. Linux identifies some

THE SOUND AND THE FURY

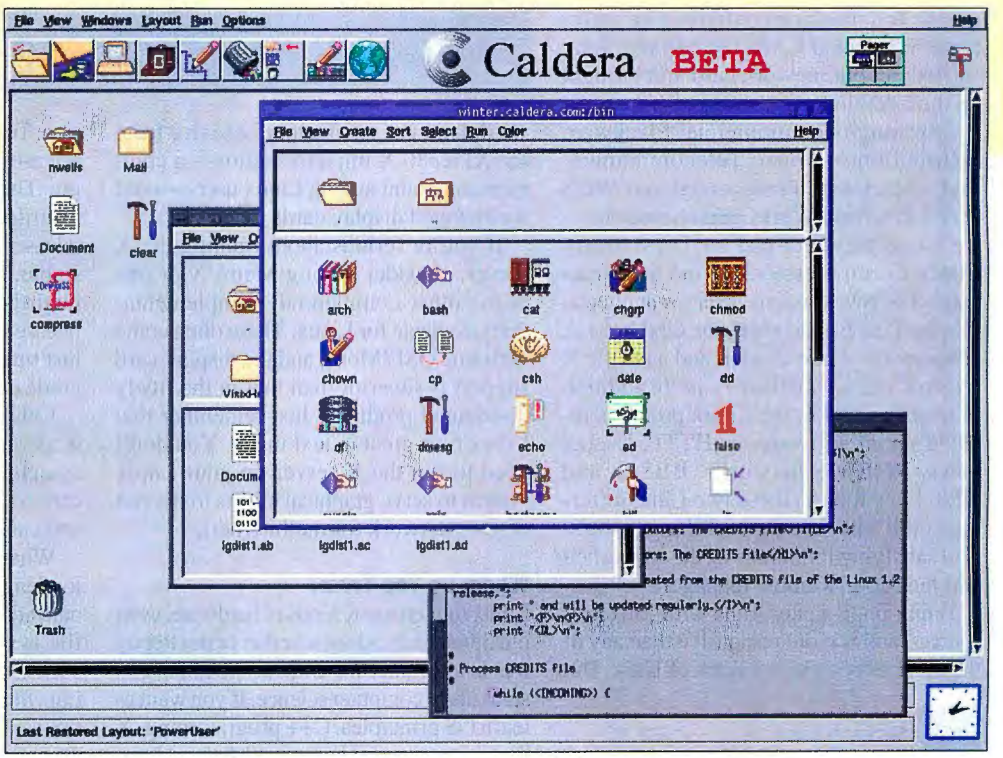
Just before the demise of Commodore, a marketing executive for the company summarized what he thought led to the Amiga's failure to capture significant market share. He minced no words: "The fanatical element among our customer base hasn't done us any favors."

The similarities between the Amiga camp and Linux users are striking. If a journalist writes an article about, say, printers, he or she may get several flaming letters from Amigoids complaining that mention of the Amiga was excluded from the review. Not only is the Amiga the best desktop publishing system on the market, they'd say, but you'd be an idiot to run anything else. And by the way, I know where you live.

Linux fanatics display similar zeal when they slam MS-DOS (MS-DOG), Windows (Windoze), Windows NT, and the people who use them. Never mind that your PC must be running MS-DOS before you can install Linux. Also, never mind that DOSEMU and Wine, DOS and Windows emulators, are among the most touted achievements of Linux developers. Flames erupt frequently on the Usenet when a heretic suggests there's another OS worth running. Heated respondents pen pages of incendiary prose in reply.

The uncivil behavior of these few loudmouths threatens to hold Linux back from the stature it deserves. As with the Amiga, many people who could benefit from trying Linux are put off enough by these displays to take their interest elsewhere. Some journalists refuse to take Linux seriously because of the regular Usenet rants, letters to editors, and angry calls to computer talk shows. Linux techno-troopers may not realize that their irrational activism plays a significant role in keeping them a minority.

We should see a taming of the rhetoric as commercial players get involved. Red Hat Linux is a publicized commercial release. Considering they cost vendors nothing, we should see Linux releases covered by proper documentation, support, and even licensed additions (e.g., OSF/Motif) while maintaining a consumer-friendly price.



New commercial versions of Linux should provide better documentation and support, as well as additional ports to familiar business applications. For example, the Caldera Network Desktop includes WordPerfect 6.0.

sound cards and supports their CD-ROM drives in many cases. But you may find that your card isn't on the list, and you'll have to try a few different drivers. Display cards are the same way. Your card might have the same controller chip as a supported card, but it might not work.

It's *much* easier to configure your hardware for Linux than to get Linux adapted to your hardware. The first step is to check your system against Linux's requirements. Linux will run on a 386-class PC or better with 8 MB of RAM, and you can install it on a hard drive as small as 20 MB. You should consider a CD-ROM drive essential. Linux supports CD-ROM drives attached to popular SCSI controllers, as well as many sound-card, IDE, and other low-cost implementations. A Sound Blaster, Windows Sound System, Pro Audio Spectrum, or compatible sound card should all work well.

Linux lets you decide how deep into its internals you want to go. You can just dip your toe in the water by loading a subset of Linux onto your DOS file system and running it from there. There is even a DOS command that loads Linux. You can also run it directly from a CD-ROM if you're just curious. But running Linux in its own partition is the only way to fully savor it. Linux includes an `fdisk` program that creates partitions for you.

Create at least two partitions: one to hold your files, and a second to hold your swap area. (Theoretically, you won't destroy data if you add partitions to your disk rather than change existing ones. However, most DOS users allocate the entire disk to DOS, so they usually have to repartition with data loss.) Swap areas are vital if your machine has 8 MB of RAM or less. The swap area should be 1.5 to 2 times the size of your physical memory. If you have more RAM, you can get away with having a smaller swap area.

Unless you're purchasing one of the rare floppy disk distributions of Linux, you need to have DOS running to begin the installation. Under DOS, you'll create two floppy disks: a boot floppy disk and a root file system floppy disk. There are several types of boot and root images, creating confusion. On one system with an Adaptec

What You'll Need

- 386-class system or higher
- 8 MB of RAM
- 20-MB hard drive
- CD-ROM drive

1542 controller, we had to use the boot image named `scsi`. The kernel on the root floppy disk is just a starting point; the real kernel, the one that will boot from the hard drive, installs from the CD-ROM.

The typical Slackware installation is a labyrinth of questions. You'll be given the option to install everything, but don't take it. You need to choose just one kernel type from several on the CD-ROM. And you must select just one display card if you plan to run X.

Linux is smart about sensing drive controllers and network cards. Smarter, in fact, than most other OSes. If you tell Slackware that you want to use its TCP/IP networking features, it prompts you for all the relevant configuration details. This is sweet: 30 seconds of prompted questions got the test machine configured on an Internet-connected LAN. On reboot, Linux sniffed out our network card and brought up the LAN link.

In testing two commercial Slackware distributions—Morse Telecommunication's Slackware Professional and WGS Linux Pro from WorkGroup Solutions—we found that both had the latest binary (ready to run) versions of the best freeware. The two versions offer great clients, like the Pine E-mail shell, the GNU `emacs` editor, the `tin` newsreader, and a terrific X window manager called `fvwm`. In addition to telnet and FTP, the Linux products include server software for HTTP, Usenet news, NetBIOS networks, BBSes, and NFS. Even though these two Linux offerings didn't license the real things, you'll find satisfying imitations of the Korn shell and the Motif window manager.

Linux boots faster, runs with lower resources, and is more responsive than any of the more expensive versions of Unix. But we did not get satisfactory behavior from the XFree86 X implementation—a common complaint among Linux users—until we changed display cards twice.

If you're serious about running the X server, consider buying Metro X or one of the other commercial X implementations available for Linux. These often come with true OSF/Motif, and the display-card support is superior than that in the freely distributed products. Just remember that Linux runs great in text mode. You don't need to run the X server on your Linux system to serve graphical clients to the rest of your network (or the Internet).

Whom Do You Trust?

Linux runs on many kinds of hardware, even old 386s, so deciding whether or not to buy it is a no-brainer for Unix aficionados and students of computer science. If you want to learn OS principles, C++ programming, X development, or Hypertext Markup Language (HTML) authoring, the better Linux distributions have all the tools you need. For businesses, Linux can turn a retired 386 or 486 system into a capable information server for internal and external users.

Can corporations afford to put their faith in an unsupported OS like Linux? Many Unix users complain about big-name OSes letting them down. Large Unix vendors often take a long time to identify and fix problems.

Linux developers boast a quick turnaround time on problems. Issues with the core OS do get resolved rapidly, but there isn't yet a painless way to patch a running system. The trick to stability seems to be to hang back a few releases from the latest version. Torvalds is explicit in classifying which releases are safe and which are in beta testing. The keepers of Slackware advise users to do a complete reinstallation for every new release. The Slackware releases feature only stable, well-established kernels, and you might be tempted to upgrade yours to a later release you see on the Internet. Unless you're just tinkering, you probably shouldn't upgrade until Slackware does.

Linux has proven itself in the field of network services, which makes it a solid choice as an Internet server for low-volume applications. It also makes a good, cheap router and can even be set up as a firewall.

What mostly keeps Linux out of the major leagues is its lack of support for enhanced system configurations. Its standard file system is quick enough, but it lacks such needed features as mirroring, striping, fault tolerance, and journaling. The OS is also limited to single-CPU systems. Torvalds is working on multiprocessor support to change this limitation.

The evolution of Linux will be fascinating to watch. If it is an alternative to overstuffed, impersonal versions of Unix, won't adding multiprocessing and all that jazz eventually make it just as unmanageable? We hope not, because in these days where everything technical is sanitized, commoditized, and idiot-proofed, it's great to know that the Linux world is still a place where the wizards can hang out. ■

Tom Yager is a writer and researcher at his private lab in North Texas. You can reach him at tyager@maxx.net or check his lab's server (sorry Linux fans, it's UnixWare) at http://www.maxx.net.

LINUX ON-LINE

Key FTP sites

Site name	IP address	Directory
sunsite.unc.edu (U.S.)	198.86.40.81	/pub/Linux
tsx-11.mit.edu (U.S.)	18.172.1.2	/pub/linux
nic.funet.fi (Finland)	128.214.248.6	/pub/OS/Linux

Mirror sites (These may not have the latest updates.)

ftp.uu.net (U.S.)	192.48.96.9	/systems/unix/linux
wuarchive.wustl.edu (U.S.)	128.252.135.4	/systems/linux
ftp.informatik.tu-muenchen.de (Germany)	131.159.0.198	/pub/Linux
ftp.mcc.ac.uk (U.K.)	130.88.203.12	/pub/linux
ftp.ibp.fr (France)	132.227.60.2	/pub/linux
kirk.bu.oz.au (Australia)	131.244.1.1	/pub/OS/Linux

Note: IP addresses and directory locations sometimes change. Choose the FTP site closest to you. If you plan to transfer several large files, wait until well after business hours in the time zone of the host system.

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Native Oracle 7 & SQL Server interfaces	Yes*	No
True object-oriented code reusability	Yes	No
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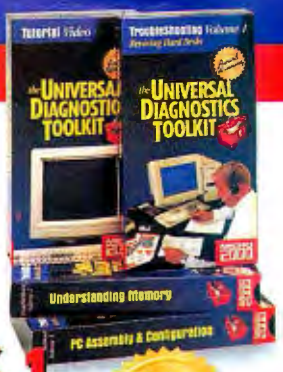

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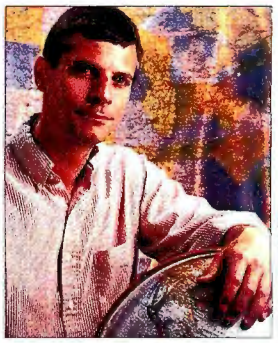


AL KARVEY @1995

Hit counts don't mean a thing. Here's how to analyze your Web server's logs to understand the size, composition, and behavior of your site's audience.

There are lies, damn lies, and Web server statistics. The most common metric—hit counts—means nothing, as I proved to myself on September 10th when I added a standard row of icons to every page of the BYTE archive. The server log for September 9th recorded 8000 hits. On the 11th, the number nearly tripled—to 21,000 hits. Was the new iconic interface attracting that much interest? Nope. Real usage of the site hadn't changed: On the 9th, the server delivered 1500 articles from the archive to 1300 IP addresses, and on the 11th, 1400 articles to 1350 IP addresses.

Why the apparent spike? When you fetch a page with, say, five icons, the server logs six hits—one for the text of the page and one for each icon. Toss in some gratuitous transparent GIFs and you can inflate your server's hit count as much as you want. That's a silly form of job security for a webmaster, of course; the real trick is to define, and then quantify, what constitutes real usage of your site. Let's look at the tools and techniques you'll need to do that.

Mining the Server Log

The de facto standard log format, pioneered by the NCSA server, contains for each hit a record of the date, the time, the URL fetched, and the IP address that fetched it. This raw data piles up quickly. The BYTE Site now cranks out almost 5 MB of this stuff every day. To begin refining it, you'll need a tool that summarizes hits by IP address and by page. Perl was born to do just this kind of reporting. Roy Fielding's wwwstat (http://www.ics.uci.edu/WebSoft/wwwstat/), a Perl script that boils down server logs, creates many of the statistics reports that you see on the Web. I run it every day on our log.

You'll want a version of wwwstat that converts IP addresses (199.125.99.2) to Domain Naming System (DNS) names (www.byte.com). Web servers record dotted numeric addresses unless you configure them to do reverse DNS lookups on incoming addresses. Servers typically offer this reverse-lookup feature but also discourage its use. Why? The `gethostbyaddr` function, which hands a numeric address to a name server and gets back a name, works slowly and unpredictably. Meanwhile, the client waits. So it's best to pump raw addresses into the log and convert them later.

The wwwstat I tried first didn't perform this conversion, so I wrote a Perl script (see "Reverse DNS Lookup in Perl" below) to do the job. Later I found that the NT version of wwwstat that comes with Process Software's Purveyor includes essentially the same code and also caches results to avoid redundant lookups.

The wwwstat code reverses the elements of each DNS name (www.byte.com, for example, becomes com.byte.www) so that sorted lists of these names cluster by domain. It also maps domains (such as au and np) to countries (Australia, Nepal). We all know the Web is global, but it didn't really sink in for me until wwwstat mapped the geographic diversity of the BYTE Site's audience. The reversed names also help sort out usage within domains. Digital Equipment, IBM, and Oracle top the list of commercial users of the BYTE Site.

REVERSE DNS LOOKUP IN PERL

```
$AF_INET = 2;
$ADDRESS_PATTERN = "[0-9]+\.[0-9]+\.[0-9]+\.[0-9]+";
while (<>)
        {
        /$ADDRESS_PATTERN/;
        @addr = split(/\./,$&);
        $addr = pack('C4'
,@addr[0],@addr[1],@addr[2],@addr[3]);
        ($name,$aliases,$type,$len,@addrs) =
gethostbyaddr($addr,$AF_INET);
        if ($name ne "")
                {       s/$ADDRESS_PATTERN/$name/; }
        print $_;
        }
```

Your Web server can probably convert dotted numeric IP addresses to Domain Naming System (DNS) names on the fly, but if you let it do this, your users will wait. Instead, do these lookups separately. Here's the essential algorithm in Perl: Read a line from the log, grab a dotted address, split it into an array, pack it into a 4-byte binary structure, and pass that to the gethostbyaddr function that's bound into most implementations of Perl.

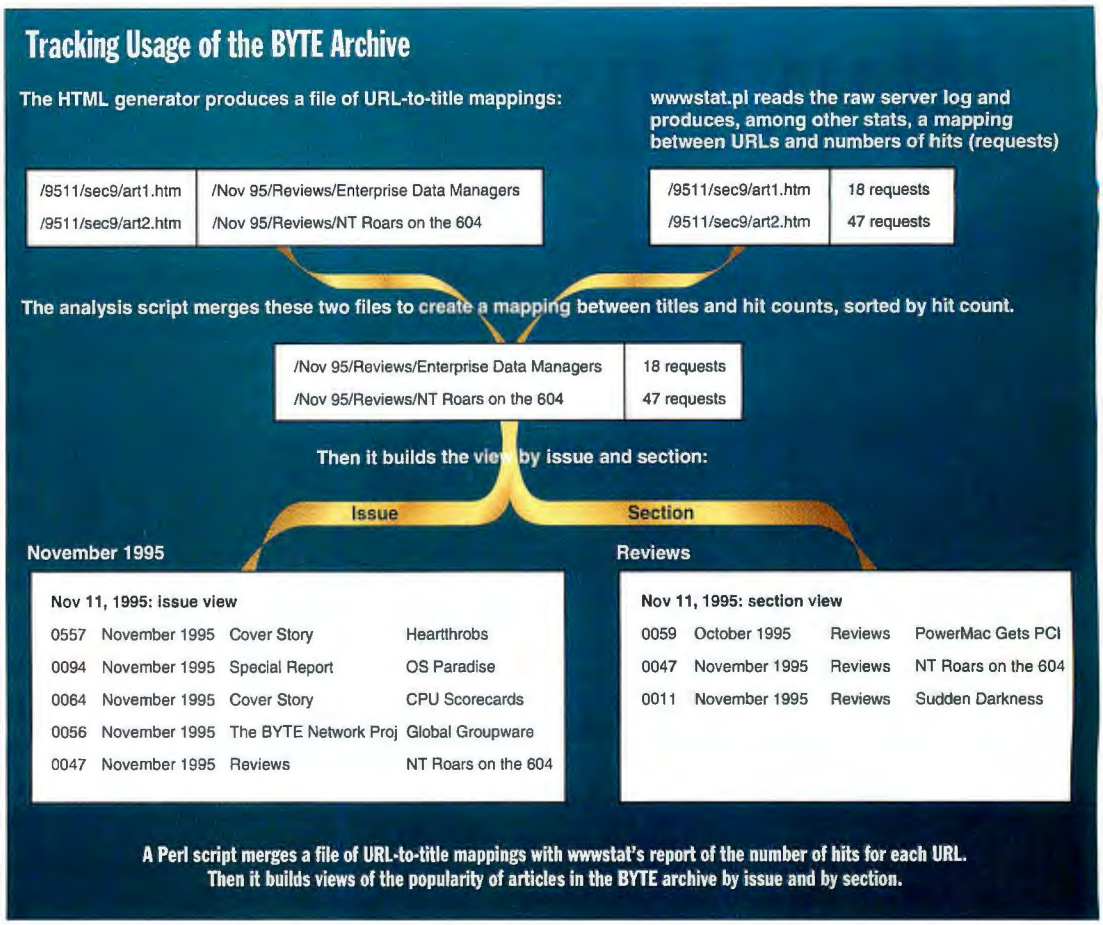
Mapping the Archive

Reports generated by wwwstat were a good start, but I wanted to know more, so I wrote some Perl scripts to further analyze the wwwstat output. Mapping the URLs in the log to titles of BYTE articles was the first task. Alert readers may remember that I promised to make my HTML generator produce meaningful URLs like /November_1995/Reviews/Enterprise_Data_Managers rather than cryptic ones like /9511/sec9/art2.htm. Well, I still haven't gotten around to it—nobody's perfect—so my HTML generator instead writes a file of map-

pings between URLs and titles. A Perl script merges this file with wwwstat's mapping between URLs and hits in order to relate titles to hits (see "Tracking Usage of the BYTE Archive").

As the script parses the wwwstat output, it uses a regular expression to filter out all nonarchive documents, and also all archive documents that aren't BYTE articles—for example, table of contents pages. I'm not interested in tracking the use of our site's navigational armature; I want to focus on the use of its content, and for us the relevant unit of content is the article.

The script also builds views by issue (e.g., November 1995) and by section (e.g., Reviews). Just as wwwstat shows us the global composition of our audience, these views show us as never before how that audience uses our content.



Each site has its own fundamental unit of content and method of organization. So you likely won't find an off-the-shelf tool that delivers this level of analysis. Fortunately, Perl's regular-expression-searching and dynamic associative arrays make quick work of custom log analysis.

IP Addresses and Users

How large is the BYTE Site's audience? Because wwwstat doesn't tally the IP addresses in the log, I wrote another Perl script to read wwwstat's output and add them up. Currently each day's log contains about 2000 IP addresses. Does that correspond to 2000 users? No, because some addresses (e.g., compuserve.com, oracle.com) represent hundreds or thousands of users.

Without mandatory registration, you cannot precisely quantify the number of users, but you can make an estimate. First you separate the DNS names found in one day's log into two groups: those that are clearly gateways to corporate networks or on-line services and those that aren't. Compute the average number of hits per IP address for the latter group of (presumably) individual users. Then use that ratio to estimate the number of users behind each of the corporate addresses in the former group. I did this with a few daily log files and concluded that the BYTE Site's user population exceeds its number of visiting IP addresses by 10 to 15 percent.

You'll want to measure not only the size of your audience but also its rate of growth. To do that, I wrote another script that reads the daily log files and reports three values for each: the number of unique IP addresses for that day, the cumulative number of unique addresses since the launch of the site, and the number of new addresses for that day (the difference between the first two). The results were shocking. On any given day, more than half the IP addresses in the BYTE Site's log represent new visitors, a pattern that's held constant through the five months of the site's existence. When I began writing this article on November 11th, 80,000 IP addresses had visited the BYTE Site. Today, December 7th, I'm proofreading this article and the number stands at 110,000. I never would have thought that one server on a puny 56-Kbps line could handle so many users. A little data mining proves that it can.

Page Tracking vs. Link Tracking

Server logs record the documents that users fetch but say nothing about how users interact with those documents. From the Resources page on the BYTE Site, for

DOWNLOADABLE SCRIPTS

You'll need to tweak these to match your own site's method of organization, but they'll point you in the right direction:

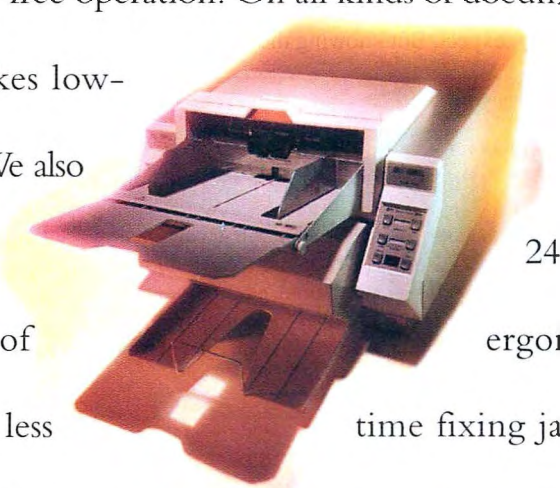
articles.pl: Reads file of URL-to-title mappings and wwwstat output, builds views of archive usage by issue and section.

loglink.pl: Writes a record to a custom log file, returns a location header.

browsers.pl: Reads a custom log file, tabulates browsers and platforms used.

If Peter Paper Pusher had a better paper pusher, how much paper could Peter Paper Pusher push?

At the risk of using another "P" word, the real subject here is productivity. And that's what makes Copiscan II scanners a natural choice. Besides raw speed, they give you jam-free operation. On all kinds of documents. And ACE Plus, a feature that makes low-contrast documents nice and readable. We also give you unlimited run-time. Up to 24 hours a day, flat-out. And a whole list of ergonomic features. As a result, users spend less time fixing jams, rescanning, and whatnot. And the scanner spends more time working. And as far as we're concerned, that makes us the best paper pushers on the planet. We have a brochure that tells you all about our scanners. For a free copy, call 1-800-SCAN-494.



BELL+HOWELL

The Document Management People

Circle 66 on Inquiry Card.

example, users can jump to any of the dozens of sites listed there. Measuring how often users follow such links is necessary for a commercial site, where the links correspond to ads. But it's useful for noncommercial sites, too. The more you know about the kinds of information your users want, the more effectively you can configure your site to provide it.

To track links, replace standard URLs with CGI URLs that call a link-tracking script. The script can append information to a custom log file, then return a redirection to the original URL. On the BYTE Site's Resources page, for example, a link of the form

```
<a href=http://www.compuserve.com
 CompuServe</a>
```

becomes

```
<a href=/cgi-bin/loglink.pl?Compu-
Serve+http://www.compuserve.com>
CompuServe</a>
```

When a user clicks on this link, loglink.pl opens a file called CompuServe and records in it these items of information about the event: the date, the time, the user's IP address (found in the CGI variable REMOTE_ADDR), and the user's Web browser (the CGI variable USER_AGENT). Then, instead of returning the standard HTTP content header ("Content: text/html\n\n") and an HTML document, it returns this location header:

```
Location: http://www.compuserve
.com
```

which redirects the browser to that URL. From the user's perspective, the link to CompuServe is immediate. But the quick detour through loglink.pl stores useful information that otherwise wouldn't be available.

Counting Browsers

Once you're set up to track links, you can conduct a browser census. The USER_AGENT variable identifies the user's browser and (directly or indirectly) the OS under which it runs. The "Site Browser and Platform Summaries" above reports on the browser population that has visited our site's Resources page. Where do these tables come from? A Perl script reads the USER_AGENT field in the link-tracking log and applies simple heuristics: Mozilla is the reported name of the Netscape browser, WebExplorer runs on OS/2, X11 implies Unix.

As the HTML standard continues to fragment, a browser summary can help you decide how much of your audience will be inconvenienced by the use of nonstandard HTML extensions. Remember, though, that even a small percentage of a large audience represents a lot of users. Lulled by Lynx's negligible 3 percent of the BYTE Site's browser population, I grew lax about including the ALT= tags that identify images to nongraphical browsers. The Lynx minority subsequently issued a prompt and vocal protest, to which I am now responding.

The platform summary offers a remarkable view of the composition of our audience. Windows dominates, as you'd expect. But knowing the relative sizes of the Unix, Mac, and OS/2 slices of our audience can help us tune our editorial mix. A detailed version of this summary further decomposes the Unix slice into its AIX, SunOS, HP-UX, Linux, and other components.

SITE BROWSER AND PLATFORM SUMMARIES

Platform summary

Platform	Hits	%
Windows	3178	0.71
UnixGUI	512	0.12
UnixText	137	0.03
Macintosh	273	0.06
OS/2	240	0.05
Accounted for	4340	0.98

Browser summary

Browser	Hits	%
Netscape	3285	0.74
Mosaic	354	0.08
Microsoft	308	0.07
Lynx	137	0.03
WebExplorer	240	0.05
NetCruiser	34	0.01
Accounted for	4358	0.98

A CGI script that tracks links on a page can also accumulate useful information about the browsers and platforms used to access that page. These tables profile visitors to the BYTE Site's Resources page.

TOOLWATCH

wwwstat
http://www.ics.uci.edu/WebSoft/wwwstat/

This tool does the first level of refinement, boiling down a 5-MB server log into a concentrated 200-KB report that summarizes page usage by IP address and URL. It's a cinch to further refine wwwstat's output for detailed and customized analysis of your site's usage.

BOOKNOTE

Public Access to the Internet
($20)
edited by Brian Kahin
and James Keller
The MIT Press
ISBN: 0-262-61118-X

Will the Internet be available to everyone at an affordable price? Should the government intervene to make it so? A series of essays explores the political, social, and economic issues at stake.

A Finger on the Pulse

A fascinating event occurred on the BYTE Site in late October. Tom Thompson's October review "PowerMac Gets PCI" suddenly rose to the top of the charts. Normally the most popular articles on the site are the cover stories; users download the current month's cover story 500 to 600 times a day. But for three days, users read Tom's review at triple that rate. Clearly some influential site (we never found out which one) deemed the article important and was referring people to it. In a week, 6000 copies of that PowerMac article went out over the wire.

In the pre-Web-server era, the same kind of thing probably happened from time to time. But if an article struck a nerve and prompted readers to photocopy and pass it around, we'd never have known. The Web's ability to monitor demand in real time connects information providers to their customers in a way that's exhilarating and also a bit scary. There's nowhere to run, nowhere to hide: If you don't understand your audience, it's only because you don't want to. ■

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

PRESENTING THE

photon™ microGUI

Breakthrough Technology for Embedded Systems

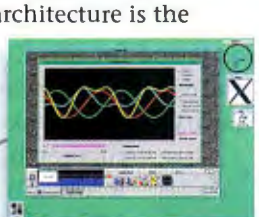
Looking for ways to achieve more with less? More performance with less hardware? More productivity in less time? More bang with less buck?

Presenting the Photon microGUI.™ QNX's full-featured windowing system that can give even your smallest PC-based realtime systems a phenomenal front end.

Breakthrough Architecture

Photon is built around a 45K microkernel and modular processes, so you can easily add or remove graphics functionality to fit your target.

The cornerstone of Photon's event-driven architecture is the QNX realtime OS. Which means Photon applications inherit QNX's scalability, message-based IPC, and network-distributed processing. The result is a realtime graphical platform never before seen in the PC world.



...a window into your embedded system from an X workstation.

At last, a window into the black box. Photon lets you monitor and control your embedded system from remote computers – even from non-QNX platforms.

Breakthrough Connectivity

Imagine being able to see into your embedded device — and control it — from a remote QNX box. Or from an X workstation. Or from a Windows-based PC.

Photon's *jump-gate connectivity*™ even lets you "beam" or transport an application from one QNX node to another!

Breakthrough Efficiency

Photon can deliver high-end, workstation-class graphics even on low-cost PC hardware. It uses memory wisely. And it comes with a low runtime price tag.

You can also expect to save development time, thanks to Photon's easy-to-use API and extensible widget library. And when you use the code-generating Photon Application Builder, you won't have to spend any time coding your interface by hand — and it won't cost you an arm and a leg either.

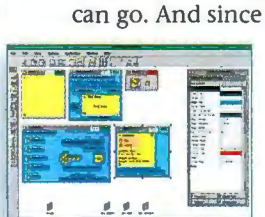
Breakthrough Performance

Imagine the power of a high-end graphics system, but with the agility of a realtime executive. With Photon's impressive drawing speeds (even across phone lines!) and intuitive UI design, your embedded PCs will look and feel like turbo-charged workstations.

...a window into your embedded system even from within MS-Windows.

Photon Takes You Places

With Photon's phenomenal performance, incredible efficiency, unique jump-gate connectivity... there's no telling how far you can go. And since Photon supports Unicode, you'll be able to take your realtime solutions anywhere in the world.



The Photon Application Builder beats tedious hand-coded GUI building hands down!

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HANDS-ON TESTING

18 GRAPHICS CARDS QUICK ON THE DRAW

Pick from among these 18 graphics cards to intensify your pixel production at high resolutions

JIM KANE AND JOHN MCDONOUGH

To satisfy users' lust for faster graphics redraws, add-in-card vendors are dealing out 64-bit cards that deliver intense colors at high resolutions. Some of the higher-end Peripheral Component Interconnect (PCI) graphics cards that we tested for this Lab Report support 16.7 million colors at resolutions up to 1600 by 1200 pixels (at 32 bits). We also tested graphics cards that come with lower resolutions and color depths at bargain-basement prices of under $200.

Just over a year ago, 32-bit graphics adapters were the norm, but now 64-bit boards have dropped in price so that you can afford to double your bus-width throughput with a quick card swap. Two boards that we tested—Number Nine's Imagine 128 Pro and AsusTek Computer's PCIV192—raise the bar even higher with broader bus widths of 128 and 192 bits, respectively.

The 18 cards tested for this Lab Report employ both DRAM and video memory to enhance performance, but Matrox Graphics takes memory a step further by using Window RAM (WRAM) with its MGA Millennium. WRAM, the latest graphics/video memory technology to come into use, is optimized to accelerate Windows drawing operations without the high cost associated with video memory. This helped the MGA Millennium to excel in our 32-bit-color InterMark benchmarks. As in our February 1995 Lab Report, most of the manufacturers of the boards we reviewed employ graphics-accelerator chip sets from S3, and vendors such as

How to use this guide

To find the best graphics adapter for your needs, follow the main headings until you come to the appropriate bus architecture and then look for the subcategory that's most relevant to your work. We grouped the graphics adapters into best-overall (a weighted combination of performance, features, and quality scores), high-resolution, 32-bit-color, and low-cost categories.

Prices shown are for the adapters as they were configured for our tests. Typically, the cost varies according to the amount, type, and speed of the installed RAM.

BEST OVERALL Elsa America Gloria 4

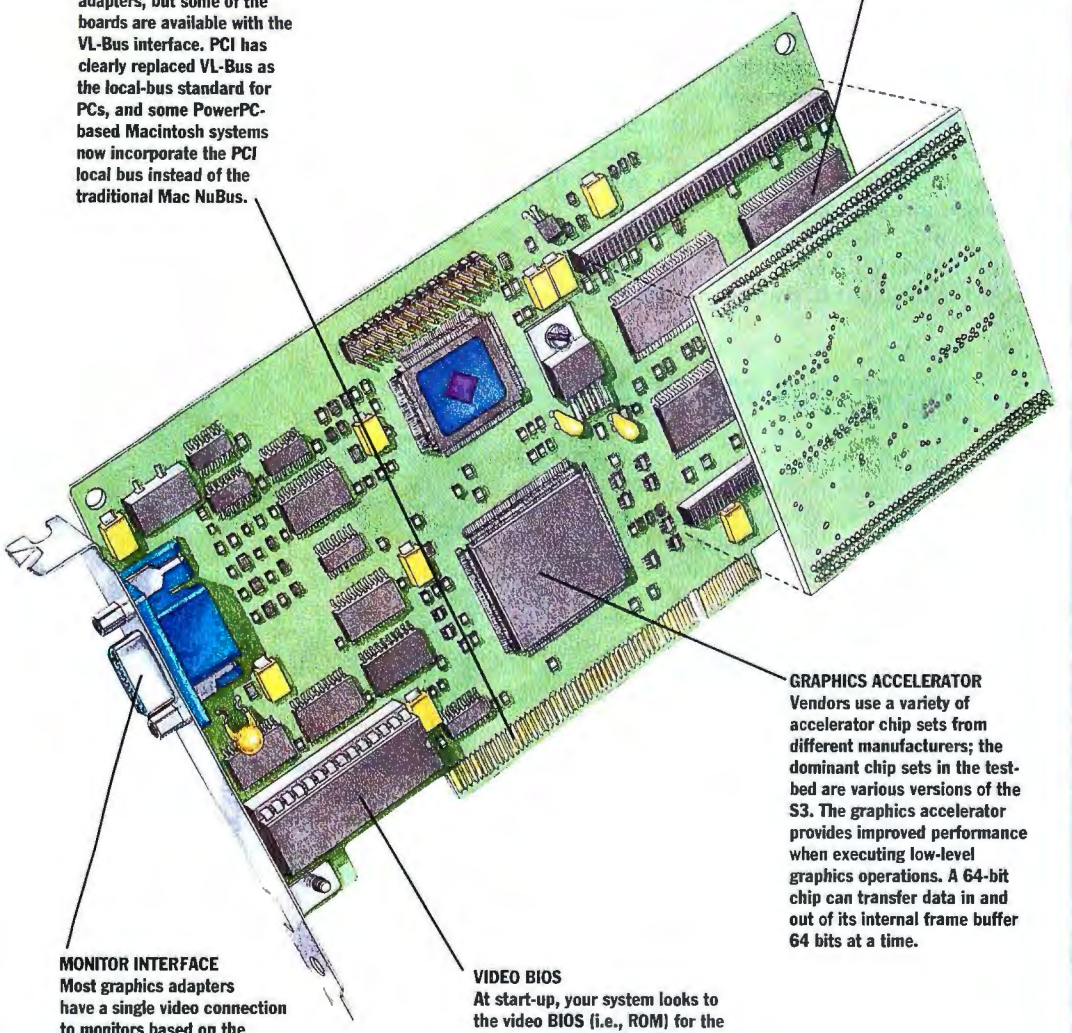
Elsa America's Gloria 4 has the second fastest InterMark performance with resolutions of 1024 by 768 pixels, as well as 1280 by 1024 pixels at 256 colors. Configured for testing at $2990, this video memory–based board costs over 10 times as much as the other boards tested here, but it utilizes a 3DLabs' Glint chip for 3-D acceleration, making it ideal for CAD users with fat wallets.

		PRICE	RAM (MB)	ACCELERATOR CONTROLLER	PERFORMANCE SCORE	FEATURES INDEX	USABILITY INDEX	OVERALL SCORE
BEST	Elsa Gloria 4	$2990	4 VRAM	S3 Vision 968	9.75	▲▲▲	▲▲▲	9.38
[illegible]	Elsa Winner 2000Pro/X-4	$545	4 VRAM	S3 Vision 968	9.79	▲▲▲	▲▲▲	9.37
[illegible]	Matrox MGA Millennium	$945	8 WRAM	MGA-2064W	9.78	▲▲▲	▲▲▲	9.35
[illegible]	STB Velocity 64 Video	$500	4 EDO VRAM	S3 Vision 968	9.7	▲▲▲	▲▲▲	9.16

Performance results are given in transactions per second: The higher the score, the more transactions an adapter was able to complete. The tests use a collection of screens from popular Windows applications. Except for the motion-video tests, higher numbers indicate better performance.

Boards rated as excellent came with installation software and clear documentation; a good rating identifies boards that can be installed without checking the documentation; fair-rated boards required a check of the user's manual; and boards that received a poor rating needed to have jumpers or interrupt requests (IRQs) reset.

Graphics Cards Face-Up



VIDEO MEMORY
Because they are dual-ported, video memory–based boards are faster than DRAM-based boards, but they also cost more. The latest graphics memory technology is WRAM, which provides fast Windows performance at near-DRAM prices because its internal buses transport data at 1.6 GBps.

BUS INTERFACE
We tested only PCI bus adapters, but some of the boards are available with the VL-Bus interface. PCI has clearly replaced VL-Bus as the local-bus standard for PCs, and some PowerPC-based Macintosh systems now incorporate the PCI local bus instead of the traditional Mac NuBus.

GRAPHICS ACCELERATOR
Vendors use a variety of accelerator chip sets from different manufacturers; the dominant chip sets in the test-bed are various versions of the S3. The graphics accelerator provides improved performance when executing low-level graphics operations. A 64-bit chip can transfer data in and out of its internal frame buffer 64 bits at a time.

MONITOR INTERFACE
Most graphics adapters have a single video connection to monitors based on the standard D-shell, 15-pin VGA connector. Some high-end boards offer RGB (i.e., BNC) connectors, and some have multiple active video connectors, allowing multiple monitor attachments.

VIDEO BIOS
At start-up, your system looks to the video BIOS (i.e., ROM) for the start-up code that identifies the graphics card and its software interrupt to control video actions. Sometimes the video BIOS is shadowed to system RAM for improved performance.

FEBRUARY 1996 BYTE BEST GRAPHICS ADAPTERS

BEST

BEST OVERALL

Elsa America's Gloria 4

Elsa built this $2990 card for bleeding-edge 3-D acceleration by utilizing 3DLabs' Glint 300SX 3-D hardware booster. It may be too rich for your blood, but it fits the bill if you have deep pockets and need razor-sharp CAD images. The video memory–based board had the second-fastest performance in our InterMark tests that emulate general-business performance.
PAGE 144

32-BIT COLOR

Matrox Graphics' MGA Millennium

Ready to try something new in your graphics accelerator? The MGA Millennium is one of the first cards to use WRAM, which is optimized for Windows applications. The MGA Millennium ($948) came loaded with 8 MB of video memory and supports a lightning-fast 200-Hz noninterlaced refresh rate.
PAGE 144

HIGH RESOLUTION

Elsa America's Winner 2000Pro/X-4

The Winner 2000Pro/X-4 is ideal for desktop publishing, image processing, and photo-realistic rendering where 1600- by 200-pixel resolutions are a must. This card combines an S3 Vision graphics accelerator and 4 MB of video memory to satisfy the true-color set.
PAGE 144

LOW COST

Actix Systems' GE Ultra 64 AV-4MB

If you don't want to spend more than $400 for a video memory–based adapter, then the GE Ultra 64 AV-4MB is just the ticket. In fact, out of the 18 cards we tested, it finished seventh in raw performance, the most important factor to consider when buying a graphics accelerator. The GE Ultra 64 supports 1600- by 1200-pixel resolution and 32-bit color at lower resolutions.
PAGE 144

ATI Technologies use proprietary Mach 64 chip sets.

The most important criterion we tested is performance. Performance results are produced via our graphics tests, which use images created from widely used applications, such as CorelDraw, Corel Presents, Excel, PowerPoint, and Word for Windows. We also required each graphics adapter to draw a variety of Windows images, ranging from straight text, to 2-D and 3-D bar charts, to complex full-color drawings.

While speed is the primary factor when purchasing a graphics adapter, it's nice to see that most of the cards come with helpful utilities for installing drivers, changing resolutions on the fly (instead of having to restart Windows), zooming in and panning around areas of a desktop, and creating virtual desktops. Videophiles will also be glad to know that some boards offer enhanced video playback with software MPEG engines or via some form of hardware assistance.

THE BEST IN

ULTRAFAST GRAPHICS ADAPTERS

Whenever someone says that he or she is updating a PC, the first components that usually come to mind are a larger hard drive, a RAM upgrade, or maybe a faster modem for Internet browsing. But the growing lust for multimedia and all its glitzy imagery has pushed 64-bit graphics adapters to the top of many users' upgrade wish lists. The boards we tested offer a wide range of options.

The lower-end cards are below the $200 mark, so now you can enjoy flicker-free screens on bigger monitors. The more expensive and faster boards use video memory, and Matrox Graphics' MGA Millennium (our best 32-bit-color choice) goes a step further by using Window RAM (WRAM).

Optimized for Windows, WRAM is the latest in graphics memory technology, and it helped the MGA Millennium to top all the other cards in our InterMark 32-bit-color benchmarks. WRAM's 256-bit-wide internal buses transport data at 1.6 GBps, resulting in fast Windows drawing operations, such as rectangular fills and color-text expansion.

Elsa America's Gloria 4 (our best-overall choice) costs a whopping $2990, but it utilizes a 3DLabs' Glint chip for 3-D acceleration. Diamond's Stealth Video 3400 XL ($569) offers 30-frame-per-second playback on a full screen instead of in a teeny window if you attach an optional MPEG daughtercard. Any video played back at less than 30 fps appears jerky, not broadcast-quality (like you see on TV or at the movies).

For our best-overall category, we combined the performance numbers of the cards at two different resolutions: 1024 by 768 pixels and 1280 by 1024, set at 256 (8-bit) colors. These resolutions and color settings are what you'll find on a typical business desktop system.

Although the Gloria 4 wins our best-overall category, STB Systems' Velocity 64 Video ($500) uses an S3 Vision 968 accelerator chip and 4 MB of extended-data-out (EDO) video memory to breeze through our benchmarks. A digital-video window control allows full-motion playback of all Display Control Interface (DCI)–compliant video clips, including Audio Video Interleave (AVI), MPG, Indeo, and Video CD. Its Windows Display Control utility provides easy switches between color depths, a virtual desktop, and a zoom window for taking closer looks at different areas of the desktop.

Number Nine's Imagine 128 Pro was also a strong performer in our lower-resolution benchmarks and second best in our 32-bit-color tests. The Imagine 128 Pro 128-bit bus width provides snappy performance. The $699 card (with 4 MB of video memory) is available with 2, 4, or 8 MB of video memory and supports 16.7 million colors at a resolution of 1600 by 1200 pixels when fully loaded with video memory.

AsusTek's PCIV192, a 192-bit accelerator, didn't perform nearly as well as the Imagine 128 Pro. The PCIV192 board uses a parallel architecture with three S3 Vision 864 graphics chips controlling RGB; each engine has its own 2 MB of dedicated

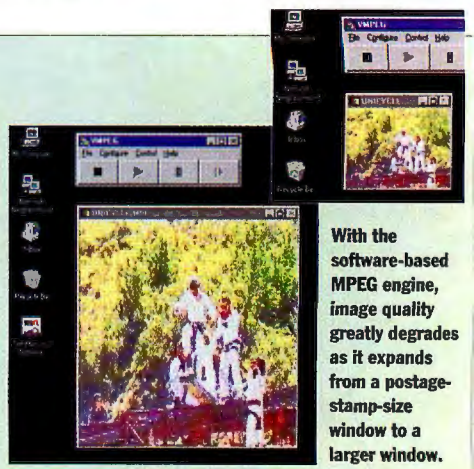
MPEG: PAY FOR PLAY

If multimedia was the consumer hot button last year, this year's clarion call is MPEG. Simply put, MPEG is a method of compressing and decompressing graphics and sound data. Video clips occupy large amounts of disk space, and MPEG compression reduces the amount of storage space needed while speeding file transfers from storage to display. While there are efficiencies in the storage and transferal of MPEG files, compression imposes a performance penalty of its own: decompression.

MPEG decompression can occur in software alone (which is sometimes called *native signal processing*), or it can use special hardware, such as digital signal processors (DSPs), to decompress files faster. Either solution adds to the cost of a computer. Software MPEG decompression is the less expensive method, because it doesn't cost much for a manufacturer to add an MPEG software driver to a motherboard or a display card. Because most systems sold today have fast Pentium processors, an efficient software MPEG driver would seem to offer the best economy, but you must decide for yourself if you want to pay for extra hardware acceleration.

While software can completely decode any given part of the MPEG data, MPEG is defined in such a way that decompression can be partial. That is, while an MPEG implementation is decoding a stream of data, the playback system (if it's falling behind) can omit some of the frames per second. Also, the playback system can partially decode some frames, generating output with a granular, lower-resolution appearance or stripe artifacts.

The most important and noticeable marker of decoder performance is the video-frame rate on playback. The nominal rate of MPEG playback is dependent on the data stream being decoded, but 30 frames per second is a standard frame rate. This rate provides the appearance of full-motion video. A significant number of dropped frames results in a noticeable drop in visual quality. The system might present the correct number of frames but only partially decompress them, which results in degraded quality. Poor decompression performance can also lower the quality of the audio track that accompanies the video.



With the software-based MPEG engine, image quality greatly degrades as it expands from a postage-stamp-size window to a larger window.

To ease your choice between hardware and software MPEG, we measured frame loss during playback. We observed that video playbacks can be maintained at 30 fps with reasonable audio reproduction on 100-MHz Pentium systems with 16 MB of RAM and the best hardware decoders.

On the other hand, even with today's high-powered systems, pure software MPEG solutions are unable to maintain full frame rates with demanding data streams. While the output frame rate of software decoders varies, depending on several factors (e.g., whether the MPEG display is full-screen or windowed, or with or without audio), we measured output rates from 15 to 24 fps.

On the same software decoder systems, the audio bandwidth reproduction is less than 12 kHz, below that of the better hardware decoders. Any given hardware decoder might, however, have noticeable limits on the quality of reproduction, such as vertical banding or granularity of output on high-resolution video systems.

While current hardware MPEG decompression is imperfect, overall it's better than software-based video playback. Current software MPEG decoders are just on the edge, with performance that's perhaps adequate for short video clips in reference works, such as a video encyclopedia. A hardware decoder is required for VCR-quality MPEG on today's systems.

—Bruce Levy

video memory. The $499 card's three-pronged approach to pixelation is slow compared to that of the other video memory–based boards, perhaps because its drivers aren't optimized for Windows 95.

The VideoLogic Graphix Star 700's ($449) and Actix Systems GE Ultra 64 AV-4MB's ($399) InterMark scores were almost identical, but the GE Ultra 64 was faster by a mere whisker. The overall edge goes to the Graphix Star 700 because it offers more features and supports higher refresh rates and more colors at higher resolutions.

Hercules's Graphics Terminator Professional ($559) was a strong performer in all our benchmarks. It incorporates an S3 Vision 968 processor with 4 MB of video memory and supports a maximum refresh rate of 150 Hz.

In our high-resolution category, we tested the add-in cards at 1600 by 1200 pixels at 256 colors, which eliminated four of the lower-end boards. Cards that support this resolution are ideal for desktop publishing, image processing, and photo-realistic rendering. VideoLogic's Graphix Star 700 and STB Systems' Velocity 64 Video outperform the Elsa Winner 2000Pro/X-4 (our best high-resolution pick), but the Winner 2000Pro/X-4 has more features.

Our low-cost category comprised only those boards with as-tested prices of under $400. At $399, the Actix GE Ultra 64 AV-4MB won this category with a strong performance score. The STB PowerGraph 64 Video follows the Actix in performance and costs just $250.

KEY

Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

BYTE BEST — GRAPHICS ADAPTERS

The stakes are high, but this card's a winner

BEST OVERALL — Elsa America Gloria 4

Elsa America's Gloria 4 has the second-fastest InterMark performance with resolutions of 1024 by 768 pixels, as well as 1280 by 1024 pixels at 256 colors. Configured for testing at $2990, this video memory–based board costs over 10 times as much as the other boards tested here, but it utilizes a 3DLabs' Glint chip for 3-D acceleration, making it ideal for CAD users with fat wallets.

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BEST	Elsa Gloria 4	$2990	4 VRAM	S3 Vision 968	9.75	▲▲▲	▲▲▲	9.38
RUNNER-UP	Elsa Winner 2000Pro/X-4	$545	4 VRAM	S3 Vision 968	9.73	▲▲▲	▲▲▲	9.37
RUNNER-UP	Matrox MGA Millennium	$948	8 WRAM	MGA-2064W	9.78	▲▲▲	▲▲▲	9.35
RUNNER-UP	STB Velocity 64 Video	$500	4 EDO VRAM	S3 Vision 968	9.7	▲▲▲	▲▲▲	9.16

For true-color graphics

32-BIT COLOR — Matrox Graphics MGA Millennium

The MGA Millennium is the only board we tested with WRAM, which provides video memory–level performance at near-DRAM prices. The MGA Millennium came loaded with 8 MB of video memory and supports a lightning-fast 200-Hz noninterlaced refresh rate. Although the $948 price tag is steep, the board has 3-D capabilities, excellent performance under all conditions, and a host of accompanying utility software, including a software MPEG video player.

		PRICE	RAM (MB)	ACCELERATOR CONTROLLER	PERFORMANCE SCORE	FEATURES INDEX	USABILITY INDEX	OVERALL SCORE
BEST	Matrox MGA Millennium	$948	8 WRAM	MGA-2064W	9.89	▲▲▲	▲▲▲	9.43
RUNNER-UP	Number Nine Imagine 128 Pro	$699	4 VRAM	Number Nine Imagine128	9.9	▲▲▲▲	▲▲▲	9.41
RUNNER-UP	STB Velocity 64 Video	$500	4 VRAM	S3 Vision 968	10	▲▲▲	▲▲▲	9.38
RUNNER-UP	Elsa Gloria 4	$2990	4 VRAM	S3 Vision 968	9.29	▲▲▲	▲▲▲	9.04

For that razor-sharp look...

HIGH RESOLUTION — Elsa America Winner 2000Pro/X-4

Elsa America's Winner 2000Pro/X-4 combines an S3 Vision graphics accelerator with 4 MB of video memory for the third-best InterMark performance in our high-end 1600- by 1200-pixel benchmarks. In true color, the $545 card maintains a refresh rate of over 100 Hz when set at resolutions of 1280 by 768 pixels. If you want to pump up performance, you can add another 4 MB of video memory.

		PRICE	RAM (MB)	ACCELERATOR CONTROLLER	PERFORMANCE SCORE	FEATURES INDEX	USABILITY INDEX	OVERALL SCORE
BEST	Elsa Winner 2000Pro/X-4	$545	4 VRAM	S3 Vision 968	9.89	▲▲▲	▲▲▲	9.49
RUNNER-UP	VideoLogic Graphix Star 700	$449	4 VRAM	S3 Vision 968	10	▲▲▲	▲▲▲	9.45
RUNNER-UP	Elsa Gloria 4	$2990	4 VRAM	S3 Vision 968	9.77	▲▲▲	▲▲▲	9.39
RUNNER-UP	STB Velocity 64 Video	$500	4 EDO VRAM	S3 Vision 968	9.93	▲▲▲	▲▲▲	9.33

When the chips are down, play this card

LOW COST — Actix GE Ultra 64 AV-4MB

The Actix GE Ultra 64 AV-4MB ($399) came with 4 MB of video memory and performed better than all the cards that cost under $400. The GE Ultra 64 supports 1600- by 1200-pixel resolution, and 32-bit color at lower resolutions.

		PRICE	RAM (MB)	ACCELERATOR CONTROLLER	PERFORMANCE SCORE	FEATURES INDEX	USABILITY INDEX	OVERALL SCORE
BEST	Actix CE Ultra 64 AV 4MB	$399	4 VRAM	S3 86C968	9.25	▲▲	▲▲▲	8.68
RUNNER-UP	STB Velocity 64 Video	$250	2 EDO DRAM	S3 Trio64+	9.17	▲▲	▲▲▲	8.62
RUNNER-UP	Boca Research Voyager 64	$189	2 DRAM	S3 Trio64	8.71	▲▲	▲▲▲	8.30
RUNNER-UP	Hercules StingRay 64/Video	$259	2 EDO DRAM	ARK 2000PV	8.08	▲▲	▲▲	7.63

VideoPort Professional™
- the complete video imaging system

VideoPort Professional lets you work in full colour, with no compression, and with a resolution limited only by the video signal itself.

The professional imaging system

If you have a portable or desktop PC with a PCMCIA card slot and access to a video source such as a VCR, camcorder, TV, microscope with video output, laser disc etc., – then all you need is the VideoPort Professional from MRT (If your PC have no PCMCIA card slot, ask for the low cost MRT PCMCIA adapter to ISA). A professional tool on hand wherever you need it, in the office, lab, studio or even on the move.

The video capture system consists of a PCMCIA card type I, a video adaptor cable, the VideoPort Professional software package and an easy-to-follow user manual.

Powerful software inside

You will be amazed at what you can do with the VideoPort Professional Imager software. This is a Windows-based image enhancement tool which allows colour correction and retouching in an amazingly easy-to-use package. You can blend, lighten, darken, sharpen, remove blemishes, change colours and cut-and-paste. All to a full video signal resolution of 800 x 600 pixels and 24-bit true colour. You have complete control over the final result. Best of all! It's quick and easy!

VideoPort Professional hardware spesifications

Card type:
PCMCIA Type I
Video inputs: PAL or NTSC, S-video, Composite or monochrome
Resolution: Adjustable up to full video signal resolution, true colour, 24-bit, 800 x 600 pixels
Capture time: 1/25 sec. (PAL), 1/30 sec. (NTSC). Complete image in one frame.
Image size: Horizontal: 66-922 pixels (PAL), 54-754 pixels (NTSC). Vertical: 42-576 pixels (PAL), 35-486 pixels (NTSC).

MRT

MRT micro as.
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USA Tel.: +1 603 465 2830 Fax: +1 603 465 2680
Germany Tel.: +49 8092 880 77 Fax: +49 8092 880 76

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Circle 109 on Inquiry Card (RESELLERS: 110).

DIAMOND'S NEW EDGE

The Diamond Edge plays specialized versions of Sega Saturn games.

In the fiercely competitive market for Windows accelerators, vendors are always looking for an edge. Diamond Multimedia (San Jose, CA, (800) 468-5846, (408) 325-7000; fax (408) 325-7070; Internet http://www.diamondmm.com) stakes new ground with the Diamond Edge 3D 3400XL. In addition to offering 64-bit graphics acceleration, hardware 3-D acceleration, digital-video playback, 16-bit wave-table audio, and a digital game port, the Diamond Edge can support two Sega video controllers for playing specialized multiplayer versions of Sega Saturn titles.

The Diamond Edge uses new 3-D technology from NVIDIA. Traditionally, 3-D effects are created with multiple polygons, usually triangles and quadrilaterals (four-sided polygons). For highly complex objects, this approach requires the transformation of a large number of smaller triangles. Combined with the processing demands of shading, lighting, and texture mapping, complex 3-D can very quickly bog down even a fast Pentium.

The NVIDIA technology creates 3-D models from a quadratic (i.e., four-sided) curved surface. Each quadratic surface has nine control points: four at the corners, four at the side midpoints, and one at the center. The control points can shape the surface either by warping it (by creating ellipses in 2-D space) or by pulling it out from the center to create complex curves in 3-D space. NVIDIA's quadratic surfaces require far fewer transformations than traditional 3-D approaches, because the surfaces can be molded to better represent a 3-D shape.

If the shape is complex, the NVIDIA engine creates additional control points to mold the quadratic surface more precisely. The Edge 3D accelerator also implements perspective correction and lighting effects in hardware for improved realism and performance. Forward texture maps are stored in host memory to lower video memory costs.

The drawback is that developers must create titles that specifically support quadratic surfaces. But once the port is done, the results are outstanding. The Virtua Fighter game we tested with the Edge 3D ran at 800- by 600-pixel resolution in 16-bit color, full-screen and fully textured at 30 frames per second, and without any noticeable jerkiness or flagrant pixelation.

You can also apply motion-video textures to 3-D objects; for example, the demo CD included a 30-fps Audio Video Interleave (AVI) video mapped onto a 3-D object that we could rotate in space. With this type of capability, future titles should display even greater creativity and special effects.

We installed the board on a 90-MHz Pentium and enjoyed all the benefits of Windows 95 Plug and Play. We popped the card into a PCI slot, connected the Sega controller bracket, and booted Windows 95. Windows 95 automatically detected the new hardware and asked for a driver. We pointed it to the installation CD, and that was it.

Prices for the Edge 3D start at $249 for 1 MB of DRAM. We tested it on a board with 2 MB of video memory. Bundled titles include Descent: Destination Saturn, Nascar Racing from Papyrus, and Virtua Fighter Remix. Other titles are in development. The Edge 3D also ships with multimedia utilities, a demo CD, and MPEG playback software from Mediamatics. —Stanford Diehl

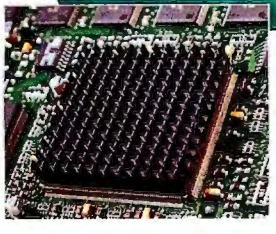
HONORABLE MENTIONS

Elsa Incorporates Glint Chip for Accelerated 3-D

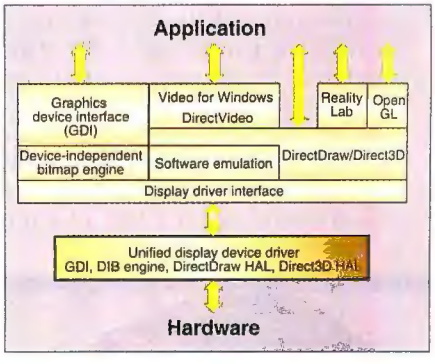
The Elsa America Gloria 4 (our best-overall card) comes with a Glint 300SX chip with a big heat sink on the board. The Glint 3-D accelerator, from 3DLabs, implements sophisticated rendering operations in silicon, including Gouraud shading, depth buffering, antialiasing, and texture mapping.

While the first high-volume 3-D market segment was games, Elsa is using the Glint chip to provide Unix workstation CAD/CAM performance on PCs. New applications, such as 3-D World Wide Web browsers and multimedia navigators, are expected to increase the need for 3-D hardware acceleration this year.

The Glint accelerator is the first chip to support the Internet 3-D graphics standard called Virtual Reality Modeling Language (VRML), which integrates 3-D viewing, navigating, and browsing on the Internet. 3DLabs has tried to cover all its API angles, because the Glint chip also supports all the rendering operations of Silicon Graphics' OpenGL, and drivers are available for Microsoft's new Reality Lab 3D and 3D Studio Max.



Of the 18 graphics cards



reviewed here, 14 support the DirectDraw API for Windows 95 (see the figure at right). With DirectDraw, graphics applications can write directly to video memory surfaces instead of making calls to the Windows Graphical Device Interface (GDI), thus avoiding the GDI bottleneck. Developers can also build pages in off-screen memory and then instruct the hardware to switch to the prebuilt screen when appropriate. To support DirectDraw, hardware vendors write a device driver that exposes the hardware's function to DirectDraw's hardware abstraction layer (HAL). Software developers then write to the HAL. This way, developers don't need to write special code to support specific graphics accelerators, and they automatically support graphics cards with DirectDraw drivers.

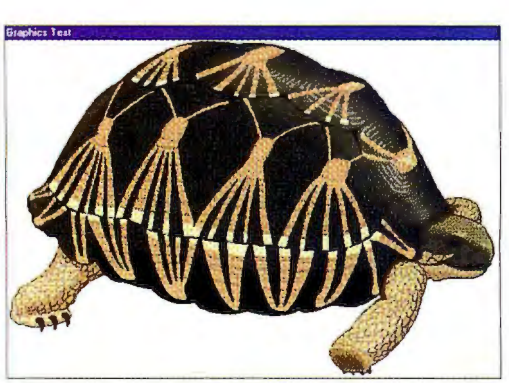
How We Tested

The 18 graphics adapters that we tested have such varied configurations and price points (ranging from less than $200 to almost $3000) that we divided the cards into four different categories: best overall, 32-bit color, high resolution, and low cost.

- *Best overall:* A combination of performance scores at 1024- by 768-pixel and 1280- by 1024-pixel resolutions with 256 (8-bit) colors; for mainstream Windows users who use general-business applications.
- *32-bit color:* 1024- by 768-pixel resolution with 16.7 million (32-bit) colors; for users who are willing to sacrifice a small amount of performance for true color.
- *High resolution:* 1600- by 1200-pixel resolution at 256 colors; for desktop publishing, image processing, and photo-realistic rendering applications that require razor-sharp resolutions.
- *Low cost:* The same parameters as best overall but with a $400 price ceiling; for users on a budget who don't require higher resolutions and cutting-edge screen-refresh rates.

To be included for testing, we required that the adapters supported a minimum of 1024 by 768 pixels with 256 colors in noninterlaced mode. They had to have a minimum of 1 MB of video memory, but if an adapter could support a larger amount of RAM, we asked the vendors to supply the greater amount.

We tested the boards in a Gateway 2000 P5-120, a 120-MHz Pentium system with 16 MB of RAM, a 1-GB IDE hard drive, and a 21-inch NEC XP21 monitor. We installed a plain VGA version of Windows 95 and then created a disk image so that the original configuration could be restored each time we switched adapters to allow for a more real-world configuration procedure.



One of the CorelDraw images NSTL uses to gauge response times for screen draws and redraws as part of the InterMark benchmarks.

Performance is the most important thing to consider when buying a graphics accelerator, so that was our primary criterion for selecting the winners. After we chose the top performers, we ranked the winners and runners-up by considering the cost (for the low-cost category), support options, usability, and unique features that the boards offered.

PERFORMANCE

To get performance scores, we tested the adapters under real-world conditions. To do this, our graphics tests use images produced from widely used applications, such as CorelDraw, Corel Presents, Excel, PowerPoint, and Word for Windows. We also required each adapter to draw a variety of Windows images, ranging from straight text, to 2-D and 3-D bar charts, to complex full-color drawings.

To guard against cheating, we designed our tests to be resilient to benchmark-optimized drivers. And, to increase the tests' accuracy, we used microsecond timing. This lets us precisely measure a single screen paint, and it avoids the necessity of drawing the same screen repeatedly (which is unrealistic and also easy to optimize in the driver).

Our Windows tests drew each of the 15 Windows application screens into both system memory and video memory using four different color modes for more than 120 tests. We also measured the time it took to refresh the screen from an image cached in memory at screen depths of 1, 2, 4, 8, 16, and 32 bits per pixel. Well-written applications cache display images whenever possible to improve response times.

FEATURES

Participating vendors supply us with responses to a lengthy survey that covers a wide range of graphics-adapter features. Some important features that we weight are the maximum resolutions and colors supported, the highest vertical-refresh rates, the number of adapters supported, and the different software-utility modules supplied with the board. We verify these responses and assign a rating based on the number of hits the board makes in the weighted categories.

USABILITY

In the ease-of-use scores, an excellent ranking was reserved for adapters with exceptionally clear and complete documentation and installation software. Adapters received a good rating if an average user could install them without referring to the manual. Boards that were rated fair required our testers to consult the documentation, and poor ease-of-use scores indicate that we had to reset some setting or jumper or consult the vendor's technical-support personnel.

Although ease of installation was a factor in our usability scores, this judgment was tempered somewhat by the fact that once you get even the most troublesome board up and running, you're likely to be concerned only about performance and compatibility for the rest of the board's life. The cards in each category are weighted 75 percent for appropriate performance results, 15 percent for features, and 10 percent for usability.

Contributors

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ROLL CALL

	ACTIX SYSTEMS, INC., GE ULTRA 64 AV-4MB	ALARIS, INC., MATINEE	ASUSTEK COMPUTER, INC., PCIV192	ATI TECHNOLOGIES, INC., GRAPHICS PRO TURBO	ATI TECHNOLOGIES, INC., GRAPHICS XPRESSION	BOCA RESEARCH, INC., VOYAGER 64	DIAMOND MULTIMEDIA SYSTEMS, INC., STEALTH VIDEO 3400 XL	ELSA AMERICA, INC., GLORIA 4
Price as tested	$399	$299	$499	$599	$219	$189	$569	$2990
Performance scores:								
1024 × 768/1280 × 1024 (8-bit)	9.25	7.83	8.44	8.75	7.55	8.71	9.10	9.75
1600 × 1200 (8-bit)	9.38	6.66	7.61	8.99	N/A	N/A	9.48	9.77
1024 × 768 (32-bit)	9.09	N/A	8.32	8.63	N/A	N/A	8.77	9.29
Usability index	7.08	6.25	6.25	7.92	7.92	8.33	7.92	8.33
Features index	6.93	5.09	7.37	6.14	5.35	6.23	7.81	8.25
Accelerator controller	S3 86C968	Alliance Pro-Motion 6410	Triple S3 Vision 864	ATI Mach 64	ATI Mach 64	S3 Trio64	S3 Vision 968	S3 Vision 968
Video DAC	TI 3026-175	AT&T 408	TI PTVP3026	ATI 68660	Integrated	S3 Trio64	TI PTVP3026	TI 3026
Video BIOS	S3 2.031	Alaris	Phoenix 1.01-08	ATI	ATI	S3	Diamond	Elsa 1.22
Video playback chip set	Integrated	N/A	N/A	ATI Mach 64	ATI Mach 64	N/A	S3 Vision 968	S3 Vision 968/ Glint 300SX
Bus connector (PCI/NuBus)	PCI	PCI	PCI	PCI	PCI	PCI	PCI	PCI
Maximum RAM/as tested (MB)	4 VRAM/4	2 DRAM/2	6 VRAM/6	4 VRAM/4	2 DRAM/2	2 DRAM/2	4 VRAM/4	12 (4 VRAM, 8 DRAM)/4
Speed (ns)	60	70	60	60	60	60	60	60
Feature connector	●	●	●	●	●	●	●	●
Supports multiple adapters	○	○	○	○	●/3	○	○	●/4
FCC classification	B	B	B	B	B	B	B	B
DirectDraw support	●	●	○	●	●	●	●	●
Maximum horizontal frequency (kHz)	104	80.5	92	80	80	79.8	96.6	110
UTILITY SOFTWARE								
Screen saver/zoom	○/○	○/○	○/●	○/●	○/●	●/●	●/● (in Windows)	●/●
Font editor	●	●	○	○	○	○	● (in Windows)	○
NONINTERLACED MODES								
640 × 480								
Maximum colors	16.7M	16M	16.7M	16.7M	16.7M	16.7M	16.7M	16.7M
Vertical refresh rate (Hz)	105	75	120	100	100	75	120	160
800 × 600								
Maximum colors	16.7M	16M	16.7M	16.7M	16.7M	16.7M	16.7M	16.7M
Vertical refresh rate (Hz)	105	75	120	100	75	75	120	160
1024 × 768								
Maximum colors	16.7M	64K	16.7M	16.7M	64K	64K	16.7M	16.7M
Vertical refresh rate (Hz)	100	75	120	100	75	75	120	109
1280 × 1024								
Maximum colors	16.7M	256	16.7M	64K	256	256	16.7M	16.7M
Vertical refresh rate (Hz)	86	75	85	80	70	75	120	83
1600 × 1200								
Maximum colors	64K	N/A	16.7M	N/A	N/A	256	64K	64K
Vertical refresh rate (Hz)	86	N/A	66	N/A	N/A	49	76	85
MISCELLANEOUS								
Warranty (years)/coverage	2/P, L, R	3/P, L, R	1/P, L, R	5/P, L	5/P, L	5/P, L, R	5/P, L, R	3/P, L, R
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Inquiry number	1115	1116	1117	1118	1119	1120	1121	1122

= BYTE Best. ● = yes; ○ = no; N/A = not applicable.

Warranty: P = parts; L = labor; R = return to customer.

ELSA AMERICA, INC., WINNER 2000PRO/X-4	FOCUS INFORMATION SYSTEMS, INC., 2THEMAX PREMIER 1000 PCI	HERCULES COMPUTER TECHNOLOGY, INC., STINGRAY 64/ VIDEO	HERCULES COMPUTER TECHNOLOGY, INC., GRAPHICS TERMINATOR PROFESSIONAL	MATROX GRAPHICS, INC., MGA MILLENNIUM	NUMBER NINE VISUAL TECHNOLOGY IMAGINE 128 PRO	NUMBER NINE VISUAL TECHNOLOGY 9FX MOTION 771	STB SYSTEMS, INC., POWERGRAPH 64 VIDEO	STB SYSTEMS, INC., VELOCITY 64 VIDEO	VIDEOLOGIC, INC., GRAPHIX STAR 700
$545	$185	$259	$559	$948	$699	$499	$250	$500	$449
9.73 9.89 9.22	7.11 N/A N/A	8.08 N/A N/A	9.15 9.68 9.59	9.78 9.63 9.89	9.27 9.74 9.90	9.38 9.86 9.07	9.17 9.71 N/A	9.70 9.93 10.00	9.22 10.00 9.21
8.33	5.83	6.25	6.67	7.92	7.08	6.25	7.92	7.92	8.33
8.25	4.39	6.32	7.81	8.16	8.51	7.98	6.32	7.28	7.46
S3 Vision 968	ARK 1000PV	ARK 2000PV	S3 Vision 968	MGA-2064W	Number Nine Imagine128	S3 Vision 968	S3 Trio64+	S3 Vision 968	S3 Vision 968
TI 3026	ATT20C490	IC Works Zoom	IBM RGB	TI TVP3026	TI TVP3025	IBM RGB 524	Integrated	IBM 524	IBM 524
Elsa 1.22	ARK Logic V1.42	Hercules	Hercules	Matrox 1.6	Number Nine	Number Nine	Phoenix/S3/ STB 1.4	Phoenix/S3/ STB 1.2	S3 and VideoLogic 1.1
S3 Vision 968	N/A	IC Works Zoom	S3 Vision 968	Matrox 1.6	Number Nine Imagine 128	S3 Vision 968	Integrated	Integrated	S3 Vision 968
PCI	PCI	PCI	PCI	PCI	PCI	PCI and VLB	PCI	PCI	PCI
8 VRAM/4	2 DRAM/2	2 EDO DRAM/2	4 VRAM/4	8 VRAM/8	8 VRAM/4	4 VRAM/4	2 EDO DRAM/2	4 EDO VRAM/4	4 VRAM/4
60	70	Varies	Varies	60	70	70	45	60	60
●	●	●	●	●	●	●	●	●	●
●/4	○	○	○	●	●	○	●/2	●/2	○
B	B	B	B	B	B	B	B	B	B
●	○	●	●	●	○	○	●	●	●
110	60.5	60	100	110	100	100	101	102	110
●/●	●/●	●/●	●/●	●/●	●/●	●/●	○/●	●/●	●/●
○	○	○	○	○	●	●	○	○	○
16.7M 160	16.7M 60	16.7M 72	16.7M 150	16.7M 200	16.7M 200	16.7M 150	16.7M 160	16.7M 160	16.7M 120
16.7M 160	64K 72	16.7M 75	16.7M 120	16.7M 200	16.7M 200	16.7M 150	16.7M 140	16.7M 160	16.7M 120
16.7M 109	256 75	64K 75	16.7M 75	16.7M 120	16.7M 140	16.7M 100	64K 120	16.7M 120	16.7M 100
16.7M 83	256 85	256 75	16.7M 100	16.7M 110	16.7M 100	16.7M 75	256 75	16.7M 85	16.7M 60
64K 85	N/A N/A	N/A N/A	64K 72	16.7M 85	64K 80	64K 75	N/A N/A	64K 85	64K 60
3/P, L, R	1/P, L, R	2/P, L	5/P, L	3/P, L, R	5/P, L, R	5/P, L, R	Limited lifetime/ P, L	Limited lifetime/ P, L	5/P, L, R
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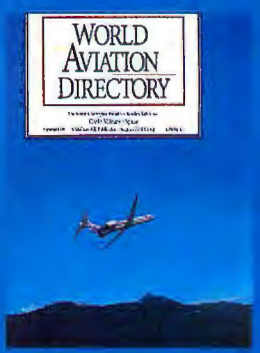

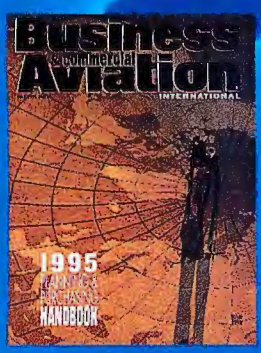

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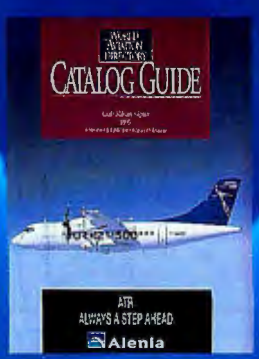

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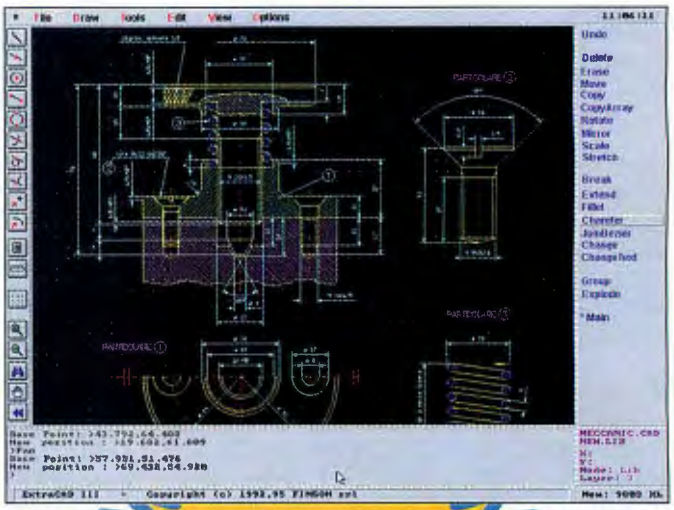

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Pentium Pro Makes NT Fly

We test the first bunch of Pentium Pro PCs and find they make great NT workstations

SELINDA CHIQUOINE AND DAVE ROWELL

The Pentium Pro has landed, and it's big news for Windows NT users. Early reports warned of dismal performance running 16-bit Windows applications (see "P6 Weakness Revealed," September '95 BYTE) and of problems with Intel's PCI chip set that would delay quad-processor server systems. But, as the BYTE benchmarks prove, the first systems based on Intel's new processor define the Pentium Pro as a high-performance platform for 32-bit software.

We tested four of the first 150-MHz Pentium Pro systems. We also tested two preproduction 200-MHz units from ALR and Dell. The FPU and integer performance of the Pentium Pro far exceeded our expectations, and its performance as the brain of a 32-bit Windows NT workstation rivals that of RISC-based systems. Intel now has a solid hand in the NT game.

Although Windows 95 supports 32-bit applications and data paths, critical components such as USER and GDI still contain large portions of 16-bit code, thus sabotaging the Pentium Pro's complex superscalar microarchitecture (see the story in this month's News & Views). To take advantage of the Pro's improved performance, you need to run a true 32-bit OS such as NT. If you're sticking with Windows 95, go with a fast Pentium, perhaps the new 166-MHz model.

The Early Pro Players

The four 150-MHz Pentium Pro systems we cover in this review come from major vendors: Dell, Digital, Gateway, and Hewlett-Packard. Dell also sent us a preproduction 200-MHz system, as did ALR (see "Pentium Pro Hits 200"). For comparison, we include test results from the dual 150-MHz Pentium Pro Intergraph TDZ-400 we reviewed last month (see "3-D Without RISC," January BYTE).

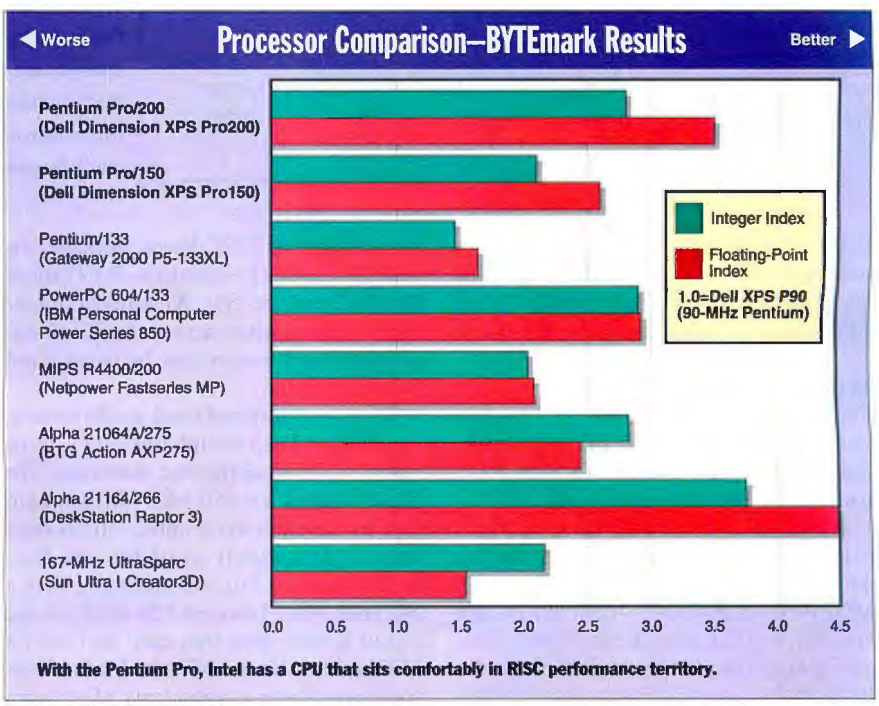
The Dell Dimension XPS Pro150 and the Gateway 2000 PG6-150 are based on Intel's Aurora PCI motherboard. Like Intergraph, engineering companies Digital and Hewlett-Packard developed their own motherboards, adding workstation-level features such as error-correction code (ECC) system memory and built-in SCSI-2 controllers. Also like the TDZ-400, HP's Vectra XU 6/150 has two 150-MHz Pentium Pros. Digital's Celebris XL 6150 keeps its single Pentium Pro chip on an upgradable processor board.

Four 150-MHz Pentium Pro systems that excel at 32-bit applications (from left to right): Dell's Dimension XPS Pro150, Gateway 2000's PG6-150, Hewlett-Packard's Vectra XU 6/150, and Digital's Celebris XL 6150. With its 128-bit-wide memory bus, HP's Vectra XU 6/150 gave the best performance scores.

LARRY DUNN © 1996

All these machines use Intel's Orion 82450 PCI chip set. The Orion provides both a PCI bridge and a memory controller. Like the Intergraph TDZ-400, the Digital system uses the GX version of this chip set, which supports up to four processors and two PCI bridges. The other systems use the KX version. The GX provides ECC protection for the data bus; the KX version doesn't. With the one- and two-processor systems reviewed here, the only potential advantage of the GX over the KX is that the GX supports four-way memory interleaving, not just two-way. Neither the Intergraph nor the Digital systems came with enough memory SIMMs to do a four-way interleave. All the reviewed PCs have a two-way interleave.

Decked out for testing with 64 MB of



With the Pentium Pro, Intel has a CPU that sits comfortably in RISC performance territory.

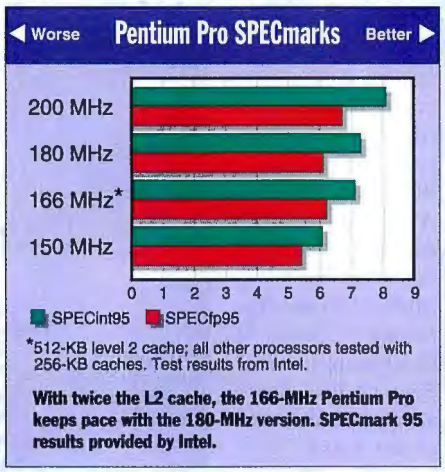
Intel Ups the Ante

Speed freaks rejoice: Faster versions of the Pentium Pro have appeared sooner than expected. Intel originally planned to introduce the new microprocessor at 133 MHz, but the low end turned out to be 150 MHz, and Intel is now producing chips that run at 200 MHz. At this rate, the Pentium Pro should hit 250 MHz by year end.

Three factors account for this progress: the Pentium Pro's superpipelined design; better-than-expected results from early silicon; and Intel's massive investment in new wafer-fabrication plants.

All modern microprocessors pipeline their instructions, a RISC technique. Like a factory assembly line, pipelining breaks processing into stages, and the CPU operates on several instructions at once with each instruction at a different stage of completion. Superpipelining uses more and shorter stages; it's like an assembly line where each worker's task is simplified. Because it takes less time to complete each stage, superpipelined CPUs can run at higher clock speeds, which yields greater instruction throughput.

While most CPUs have pipelines five to seven stages long, the Pentium Pro has a 14-stage pipe. Although longer pipelines extract greater penalties when the CPU mispredicts a branch, most instructions execute faster, and the Pentium Pro's branch prediction is more than 90 percent accurate, according to Intel. Superpipelining with shorter, less-complex stages is the reason why the Pentium Pro will always run at higher clock speeds than the five-stage Pentium chip, even when both chips use the same process technology.



*512-KB level 2 cache; all other processors tested with 256-KB caches. Test results from Intel.

With twice the L2 cache, the 166-MHz Pentium Pro keeps pace with the 180-MHz version. SPECmark 95 results provided by Intel.

Nevertheless, process technology plays a major role, too. Intel makes the 150-MHz Pentium Pro on an older 0.6-micron process, but the 166-MHz and faster versions use Intel's new 0.35-micron technology. Signals flow more quickly through the more densely packed circuits, permitting higher clock speeds. In 1995, Intel became the first company to manufacture CPUs in volume on a 0.35-micron process, and Intel is outspending everyone on new fab capacity.

To boost performance even further, Intel is also making some Pentium Pro processors with 512-KB secondary caches built into the package. That's twice as large as the 256-KB caches originally introduced. The accompanying SPECmark numbers show the result: A 166-MHz Pentium Pro with a 512-KB cache virtually matches the performance of a 180-MHz Pentium Pro with a 256-KB cache. (The 166-MHz version of the chip also has a faster memory bus—66 MHz versus 60 MHz for the 180-MHz Pentium Pro.)

Higher clock speeds and bigger caches will compensate for the Pentium Pro's relatively poor performance when running older 16-bit software. Although a fifth-generation Pentium still outperforms a sixth-generation Pentium Pro when running 16-bit code at similar clock speeds, the fastest Pentium currently tops out at 166 MHz. Future Pentiums may get a little faster, but they will never catch up to the Pentium Pro's really high clock frequencies.

—Tom R. Halfhill

PENTIUM PRO LINEUP

Core speed	150 MHz	166 MHz	180 MHz	200 MHz	200 MHz
Bus speed	60 MHz	66 MHz	60 MHz	66 MHz	66 MHz
L2 Cache	256 KB	512 KB	256 KB	256 KB	512 KB
Process	0.6 micron	0.35 micron	0.35 micron	0.35 micron	0.35 micron
Production*	Q4 1995	Q1 1996	Q4 1995	Q4 1995	Q2 1996
Price (1000)	$974	$1682	$1075	$1325	$1989

*Intel's target

RAM, a large hard drive, a 4-MB graphics card, and a 17-inch monitor, these systems go for between $6500 and $10,000. Much of that price is attributed to the RAM.

In the Lab

We tested low-level 32-bit CPU performance using BYTEmark 1.0. We benchmarked component-level performance, particularly hard drive speed, with NSTL's InterMark NT. With BYTEmark, we found that the 150-MHz Pentium Pro performs, on average, 2.6 times faster than our 90-MHz Pentium baseline system in FPU operations, and 2.1 times faster during integer operations. These results place the Pentium Pro in the same general performance range as RISC-based workstations (see "Processor Comparison–BYTEmark Results" on page 155). We found a similar improvement when we ran the 32-bit application tests, somewhere between 2 and 2.5 times faster.

To assess motherboard performance, we tried to keep peripheral subsystems comparable in all the test machines. We chose Matrox's 4-MB MGA Millennium card as the common graphics component because it's widely available and fast. Dell's Pentium Pro systems come with a Number Nine Imagine 128 card, so we tested it both with that card and with a Millennium. Under NT, the Matrox was somewhat faster in most tests. (Dell does not support the Matrox card.) Hard drive performance is a big factor we found impractical to control, although we tested the Gateway with both an EIDE and a SCSI drive. The SCSI drive gave the best overall results, though not with all applications.

To measure 32-bit application performance, Bapco's SYSmark for NT 1.0 test suite served us well (see "SYSmark NT Results" on page 162). It consists of several Windows NT-based business applications: Microsoft's Word 6.0, Excel 5.0, and PowerPoint 4.0; Welcom Software Technology's Texim Project 2.0e; and Orcad's MaxEDA 6.0.

Intel provided us with a SYSmark-like test that involves high-end NT technical

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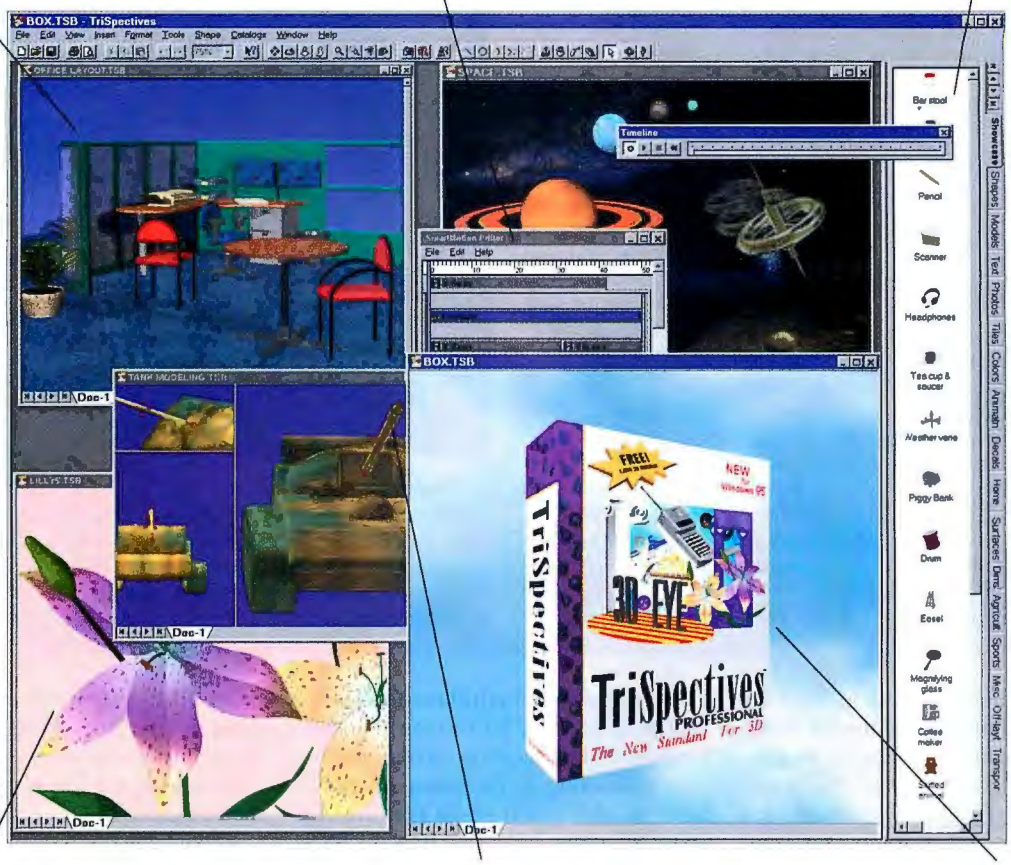

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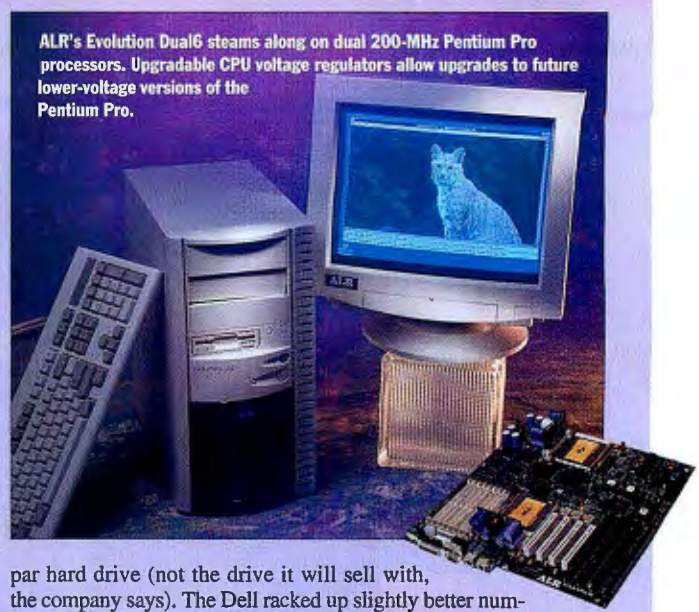
Pentium Pro Hits 200


ALR's Evolution Dual6 steams along on dual 200-MHz Pentium Pro processors. Upgradable CPU voltage regulators allow upgrades to future lower-voltage versions of the Pentium Pro.

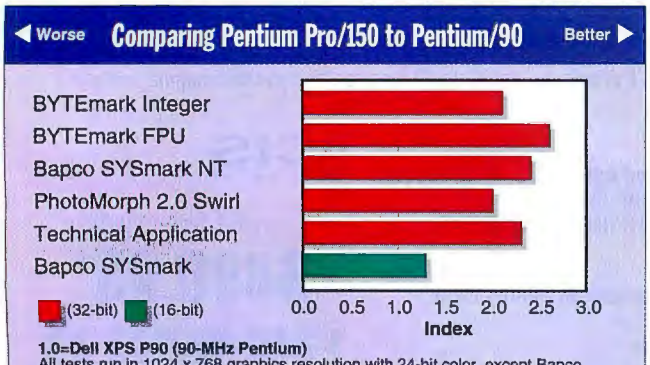
Itching to test the new Pentium Pro at 200 MHz, we benchmarked beta systems from ALR and Dell. The 200-MHz Evolution Dual6 has an ALR-designed motherboard that can hold two Pentium Pro processors. We tested a beta unit with dual 200-MHz Pentium Pros, each with a built-in 256-KB L2 cache. Befitting a workstation, the Dual6 uses ECC memory (up to 512 MB) and provides four PCI expansion slots (and four ISA slots). However, it doesn't have built-in SCSI or networking. For reliability, firmware monitors system temperature, fan operation, and motherboard voltage. Equipped with a 1-GB hard drive, dual 200-MHz CPUs, 64 MB of RAM, and a 4-MB Matrox Millennium graphics card, the Evolution Dual6 should sell for around $8500 (ALR's street price estimate).

The Dimension XPS Pro200 is a faster version of Dell's 150-MHz system, with the same Intel motherboard and the same features. With the CPU at 200 MHz, it runs its memory bus at 66 MHz. A version with 512-KB level 2 cache will follow. Dell expects the price to be around $8000 for a model with 64 MB of RAM, 4-MB Number Nine Imagine 128 graphic card, 2-GB Seagate EIDE drive, 6X CD-ROM drive, and 17-inch monitor.

As we expected, our low-level BYTEmark CPU test puts the 200-MHz Pentium Pro one-third faster than its 150-MHz brethren (33 percent faster integer performance; 35 percent faster FPU performance). Application test results were slower than we expected for both systems, mainly on the Microsoft Word and Excel components of Bapco's SYSmark NT test. ALR's beta system came with a subpar hard drive (not the drive it will sell with, the company says). The Dell racked up slightly better numbers overall, but it could also use a faster drive to stay further ahead of HP's 150-MHz system. With these new fast machines, subsystem performance (hard drive, graphics, and memory) is more important than ever.

applications: Adobe Photoshop 3.0.4 for NT; Virtual Reality Laboratory's Vista Pro 3.13, a 3-D landscape-generation program that uses fractals (it's FPU-intensive); Pixar's Typestry 2.0, which creates shaded 3-D images from normal text; and MathSoft's Mathcad Plus 5.0, a technical mathematics program with 2-D and 3-D graphical problem solving. The Photoshop component of the test takes advantage of multiple processors under NT and draws excellent performance from the dual-processor systems in this review (see the "High-End Technical Applications Index" results on page 162). Likewise, North Coast Software's multithreaded PhotoMorph 2.0 for NT let us measure symmetrical multiprocessing capabilities.

In addition to 32-bit testing under NT 3.51, we also tested 16-bit performance under Windows 3.11 using Bapco's SYSmark 95 for Windows, a test made up from Windows 3.x applications. With these 16-bit tests, a 150-MHz Pentium Pro system is barely faster than the 90-MHz Dell Dimension XPS P90 we used for comparison purposes (decked out temporarily with 64 MB of RAM and a Matrox graphics card).



1.0=Dell XPS P90 (90-MHz Pentium)
All tests run in 1024 x 768 graphics resolution with 24-bit color, except Bapco SYSmark 95 for Windows (16-bit SYSmark), which ran in 640 x 480 resolution (VGA) with 8-bit color.

While the 150-MHz Dell Pentium Pro machine provides 2 to 2.5 times the performance of the 90-MHz Dell Pentium system in all our 32-bit tests, it barely keeps ahead in the Bapco 16-bit SYSmark test for Windows 3.x.

Dell Dimension XPS Pro150

Dell's 150-MHz Pentium Pro system comes in the standard, lightweight Dimension case. With Intel's motherboard, the Dimension supports one CPU, located directly below the 200-W power supply and next to an exhaust fan. Intel's PCI motherboard provides the foundation for both the Dell and the Gateway systems, and although it doesn't support two processors, its ZIF socket allows you the possibility of an upgrade. However, neither system has upgradable CPU voltage regulators—that circuitry is soldered down—so you wouldn't be able to upgrade to future lower-voltage models of the Pentium Pro.

Though the Dell system uses parity-type SIMMs, it provides ECC capability (correct one bit, detect two) through the Intel PCI chip set. The chip set calculates ECC values and stores them in the parity bits. Eight bits is enough to store ECC with a 64-bit memory bank. (Standard ECC SIMMs do error correction internally, on the SIMM.) Dell also uses 60-nanosecond SIMMs, compared to the slower 70-ns SIMMs used in Gateway's system.

In spite of the faster memory, the Dell comes out slower than the Gateway because the Number Nine card holds it back a little, and the Gateway has a faster hard drive (SCSI). With a Matrox card, the Dell catches up to the Gateway only when the Gateway has an EIDE drive like the Dell.

Gateway 2000 PG6-150

The PG6-150 comes in a rugged full-size tower chassis with lots of room inside for drives. Gateway equipped its PG6-150 system with a fast SCSI disk drive that makes a difference in disk-intensive applications, such as project management and graphics presentation programs, allowing it to compensate for its 70-ns memory. Like the

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PENTIUM PRO SYSTEM FEATURES

	DELL DIMENSION XPS PRO150	DIGITAL CELEBRIS XL 6150	GATEWAY 2000 PG6-150	HP VECTRA XU 6/150
Processor/Memory				
CPU(s)/speed (MHz)	Pentium Pro/150	Pentium Pro/150	Pentium Pro/150	two Pentium Pros/150
Motherboard manufacturer	Intel	Digital	Intel	HP
Intel PCI chip set	82450KX	82450GX	82450KX	82450KX
Modular CPU voltage regulator(s)	no	yes	no	yes
RAM (standard/as tested/maximum, in MB), speed, error protection	16/64/128, 60 ns, ECC	16/64/512, 70 ns, ECC	32/64/128, 70 ns, none	16/64/256, 60 ns, ECC
Memory bus width/speed	64 bits/60 MHz	64 bits/60 MHz	64 bits/60 MHz	128 bits/60 MHz
Memory interleave (as tested with 64 MB RAM)	two-way	two-way	two-way	two-way
Storage				
Hard drive	2.1-GB Seagate ST32140A 3½-inch EIDE	1-GB Conner CFP1060S 3½-inch SCSI-2	2.1-GB Seagate ST32430N 3½-inch SCSI-2	2-GB Seagate ST32550N Barracuda 3½-inch SCSI-2
CD-ROM drive	TEAC CD-56E EIDE (6x)	TEAC FD-235HF SCSI-2 (4x)	Wearnes Component CDD-620 EIDE (6x)	Sony CDU-76S SCSI-2 (4x)
Drive bays	two accessible 5¼-inch, three accessible 3½-inch, two internal 3½-inch	three accessible 5¼-inch, one accessible 3½-inch, two internal 3½-inch	four accessible 5¼-inch, one accessible 3½-inch, three internal 3½-inch	three accessible 5¼-inch, two accessible 3½-inch, two internal 3½-inch
Graphics				
Graphics card/MB tested	Number Nine Imagine 128/4	Matrox MGA Millennium/4	Matrox MGA Millennium/4	Matrox MGA Millennium/4
Monitor	Dell UltraScan 17HS 17-inch color	Digital 17-inch color	Gateway Vivitron 1776 17-inch color	HP Ultra VGA 1280 17-inch color
Dot pitch (mm)	0.26	0.28	0.28	0.28
Optimal resolution (refresh rate)	1280x1024 (75 Hz)	1280x1024 (75 Hz)	1024x768 (75 Hz)	1024x768 (75 Hz)
Expansion interfaces/ports				
Expansion slots	four 33-MHz PCI (three free), three ISA (two free, one shared PCI/ISA)	three 33-MHz PCI (two free), four ISA (one shared PCI/ISA)	four 33-MHz PCI (three free), three ISA (one shared PCI/ISA)	four 33-MHz PCI (two free), three ISA (one shared PCI/ISA)
SCSI	none	integrated PCI, 8-bit Fast SCSI-2, NCR 53C810 Tolerant chip, internal and external connectors	Adaptec AHA-2940 8-bit Fast SCSI-2	integrated PCI, 8-bit Fast-20 (Ultra) SCSI-2, Adaptec AIC-7880P chip, internal and external connectors
Serial/Parallel (IEEE 1284)	2/1	2/1	2/1	2/1
Internal EIDE	2	1	2	2
Networking				
Interface	none	none	none	HP 10/100-Mbps (100VG) PCI Ethernet adapter (RJ-45)
Multimedia	Creative Labs Sound Blaster AWE32	none	none	integrated Sound Blaster 16
Pricing				
Price (as tested)	$7179	$8987	$6504	$10,225 (estimated street price)
Warranty	One year, on-site (next day)	3 years, parts and labor, first year on-site	3 years, parts and labor, first year on-site	3 years, parts and labor, first year on-site
FCC rating	A	B	B pending	A
Inquiry number	**1208**	**1209**	**1210**	**1211**

Note: Price as tested includes components listed plus Windows NT 3.51, keyboard, mouse, and 1.44-MB floppy drive.

Dell, it has four PCI slots for expansion.

A major drawback to using the PG6-150 as a serious workstation is that it has neither ECC nor parity protection for system memory. We doubt anyone will want to run a critical application on this machine with more than 32 MB of unprotected memory. That may put the PG6-150 into the category of a very hot Windows 95 machine, although new 150- and 166-MHz Pentium systems may provide equal performance for less money, given the old 16-bit code still hanging around in Windows 95.

Digital's Celebris XL 6150

With the ability to hold up to 512 MB of memory, built-in SCSI-2, and six levels of security, Digital's Celebris XL 6150 can well handle server tasks. It's also upgradeable, either by swapping the CPU in its ZIF socket on the processor card (it also has an upgradeable CPU voltage regulator) or by switching the processor card itself for one with two Pentium Pros or even one carrying a fast Digital Alpha chip.

Intel's PCI 82450GX chip set and eight

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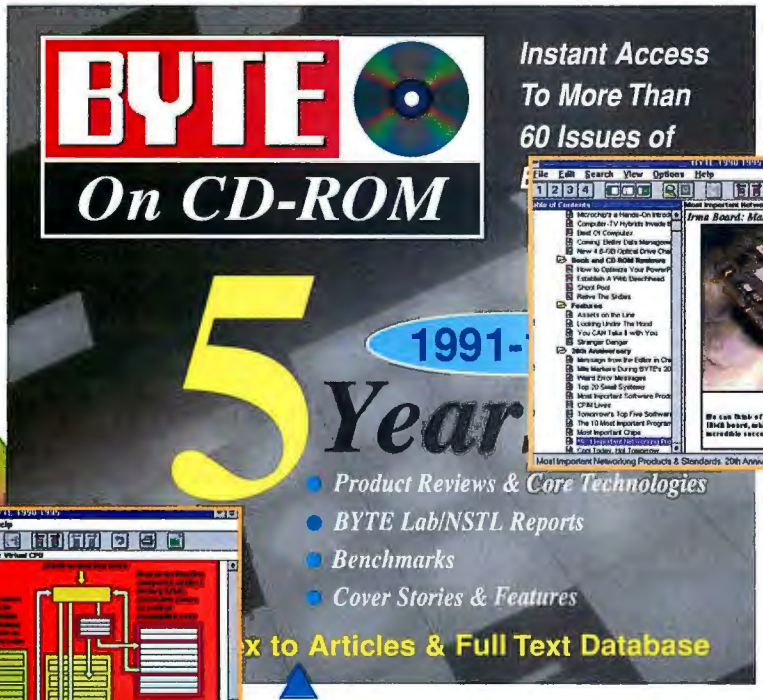

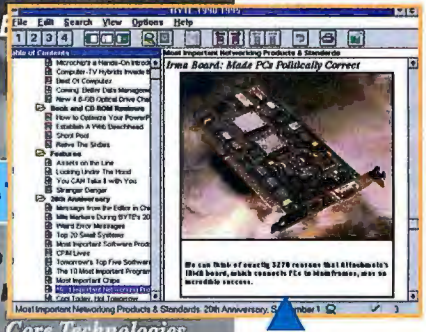

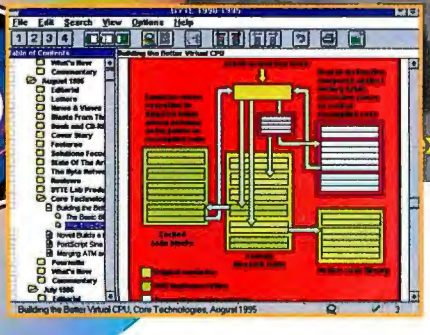

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Circle 68 on Inquiry Card.

SIMM banks reside with the CPU on the processor card. The main system board has six more SIMM banks. Like the Dell, the Digital system implements ECC through the Orion chip set. Both EIDE and SCSI-2 are embedded, but networking is not. The Celebris hangs back with the Dell in our performance tests despite a fast SCSI hard drive. The machine's use of 70-ns system memory is part of the problem, but that kind of memory doesn't seem to hold the Gateway PG6-150 back.

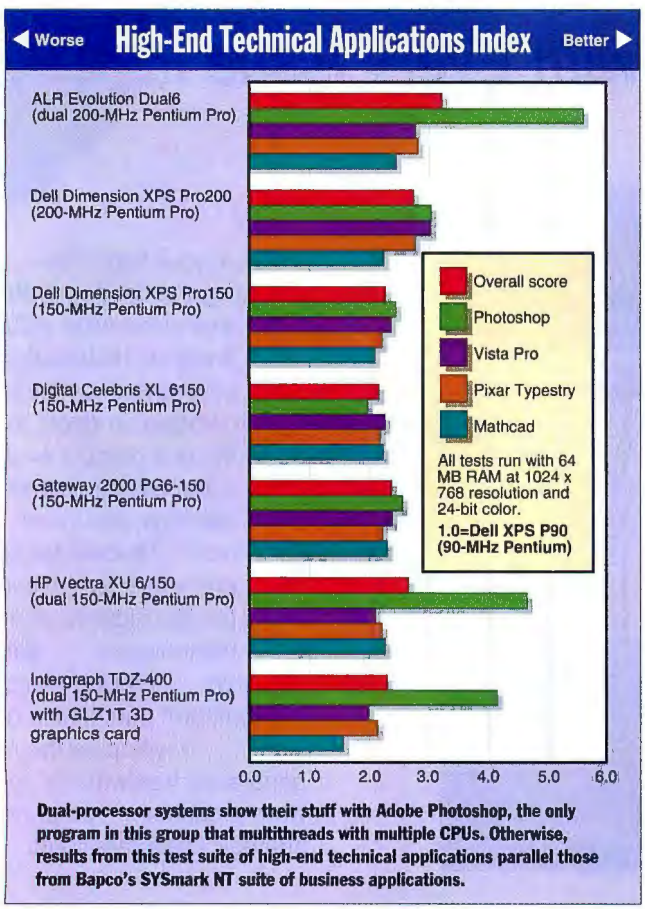
HP Vectra XU 6/150

HP's dual Pentium Pro system is the top performer in the 150-MHz class for several reasons. It has a 128-bit-wide memory bus and a very fast SCSI drive with a spin rate of 7200 rpm. It uses dual in-line memory modules (DIMMs) for system memory, which provide a 64-bit data path (compared to 32-bit for the SIMMs used in the other systems). Although Intel's Orion chip set allows a 128-bit memory path using four SIMMs per bank, it's more practical with DIMMs (two per bank).

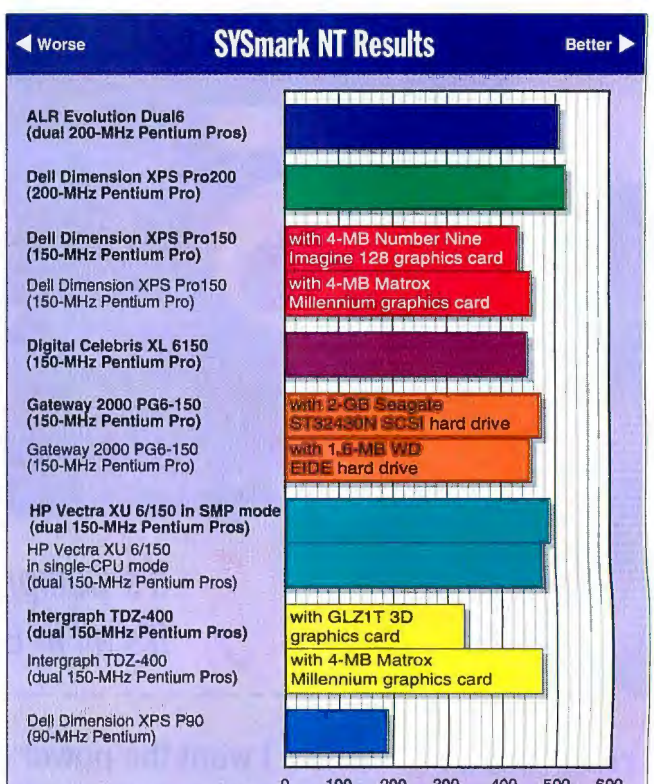
As a high-end system, the Vectra XU 6/150 provides ECC memory and built-in SCSI. The SCSI chip supports Ultra SCSI (20 MHz). HP also gives you a Fast Ethernet (100VG/10Base-T) PCI card and integrated Sound Blaster capability. The Vectra, in a mini-tower chassis, is nearly the same size as the Dell. However, the Vectra's power supply is around twice the size of the Dell's, and the unit holds two 150-MHz CPUs.

Because of its reliable design and great performance, we highly recommend HP's Vectra XU 6/150, especially if you have an application that can use two CPUs. If you don't need networking or top performance, Dell's Dimension XPS Pro150 provides a lot of power for its price. It's around $1000 less than the HP for a similar configuration. ■

Selinda Chiquoine (selinda@bix.com) is a former BYTE technical editor. Dave Rowell (drowell@bix.com) is a BYTE technical editor who handles hardware reviews.



Dual-processor systems show their stuff with Adobe Photoshop, the only program in this group that multithreads with multiple CPUs. Otherwise, results from this test suite of high-end technical applications parallel those from Bapco's SYSmark NT suite of business applications.



Among 150-MHz Pentium Pro systems, HP's Vectra XU 6/150 performed best because of its 128-bit memory bus and 7200-rpm SCSI hard drive. ALR's 200-MHz system was held back by a subpar EIDE hard drive; slow Word and Excel scores pulled its overall score down substantially. We tested all 150-MHz systems with both a 4-MB Matrox Millennium PCI graphics card and the card the system came with. With the Dell XPS Pro150, the Matrox gave slightly faster results than Number Nine's Imagine 128 card. Though Intergraph's GLZ1T card does wonders for 3-D, it slows down on standard 2-D fare. We tested the Gateway with both EIDE and SCSI hard drives (both fast); the SCSI drive was faster in some applications, slower in others, but faster overall. Though there were no multithreaded applications in this test, the HP Vectra did better in SMP mode.

Where to Find

Advanced Logic Research, Inc.
(Evolution Dual6)
Irvine, CA
(800) 444-4257
(714) 581-6770
fax: (714) 581-9240
http://www.alr.com

Dell Computer Corp.
(Dimension XPS Pro150)
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http://www.gw2k.com

Hewlett-Packard Co.
(HP Vectra XU 6/150)
Palo Alto, CA
(800) 752-0900
(303) 635-1000
fax: (800) 333-1917
http://www.hp.com

Enter the NetWare Impostor

Microsoft's File and Print Services for NetWare helps Windows NT servers slip into most NetWare environments

STEVE GILLMOR

Microsoft is offering a major enticement for NetWare network administrators to use Windows NT with File and Print Services for NetWare (FPNW), a Windows NT Server 3.51 utility that makes an NT server work like a NetWare 3.12 file and print server. With FPNW, NetWare clients can use existing NetX or virtual-loadable-module (VLM) client software to access NT server resources, including server applications. FPNW includes an enhanced Migration Tool for NetWare, which transfers NetWare user and group accounts, log-in scripts, files and directories, and equivalent security to the NT server.

Point-and-Click Installation

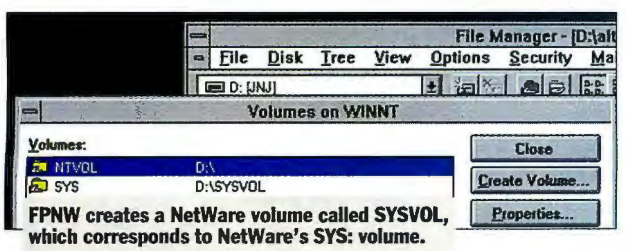
FPNW's setup program prompts for a Supervisor password, lets you specify frame types for network adapters, and creates a NetWare volume called SYSVOL on the default drive corresponding to NetWare's SYS: volume. The NetWare Supervisor account is added to the Administrator's group. You double-click on the User Manager for Domains icon and choose New User from the User menu to create or modify a NetWare-enabled account.

You use File Manager to create and share a NetWare volume, assigning file and directory permissions if you are working on an NT File System (NTFS) volume. Administrators can manage FPNW from its icon in Control Panel or via the Properties command on the FPNW menu in Server Manager. You click on the Users button to view and manage NetWare client connections to the server and specific files.

Microsoft clients can access printers that are controlled by NetWare print servers by using Print Manager to create a logical printer to represent the NetWare one. Using the Print Server command on the FPNW menu in Server Manager, you associate NetWare print servers, attached printers, and print queues to the Windows NT server printer.

NTFS-based file and directory security most resembles NetWare security, with group and user-file access controlled by permissions that are equivalent to NetWare trustee rights. FPNW does a good job of mapping directory and file rights, handling NetWare file rights such as Create and File Scan at the directory level.

You can also install FPNW's administrative tools on an NT workstation to allow remote administration of FPNW servers.



FPNW creates a NetWare volume called SYSVOL, which corresponds to NetWare's SYS: volume.

A Sturdy-Enough Bridge

FPNW does not support NetWare loadable modules (NLMs), nor does it work with NetWare 4.x (and its NetWare Directory Service, or NDS). But Microsoft is counting on the growing number of NT applications to smooth the transition.

FPNW lets NetWare users employ a single account and password to access the individual strengths of both NetWare file and print services and Windows NT application services. Moving all the way to NT becomes a small step.

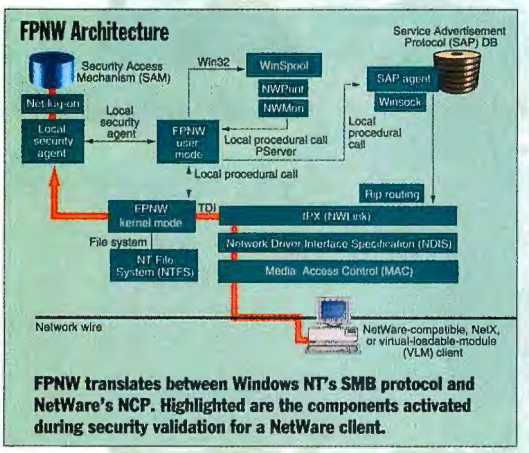
This product is a huge threat to NetWare's dominance. ■

Steve Gillmor is director of Southern Digital, Inc. (Charleston, South Carolina). You can reach him at sgillmor@aol.com.

TECHNOLOGY FOCUS

The Grand Illusionist

Here's an example of how Microsoft File and Print Services for NetWare (FPNW) causes Windows NT and Novell NetWare to map to each other, making an NT server look familiar to NetWare clients. NetWare communicates over the IPX transport protocol via NCP commands, while Windows NT Server and its clients use the SMB protocol over TCP/IP or NetBEUI. FPNW integrates with NT Server and translates between NCPs and SMBs, invoking different components depending on the type of request issued.



FPNW translates between Windows NT's SMB protocol and NetWare's NCP. Highlighted are the components activated during security validation for a NetWare client.

For example, if a NetWare client request requires security validation, it gets filtered through the NT Server before being allowed access to the NT File System (NTFS). If no security is required, the client can directly access the file system.

FPNW responds to Service Advertisement Protocol (SAP) calls as NetWare clients poll for the nearest server when they start up. You can toggle this feature using a check box in Server Manager's NetWare Properties dialog box. The FPNW server then appears when you use the SLIST command-line utility, permitting NetWare-compatible client software to log on to it.

Product Information

Microsoft File and Print Services for NetWare $99.95
(estimated retail price)
Microsoft Corp.
Redmond, WA
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
http://www.microsoft.com
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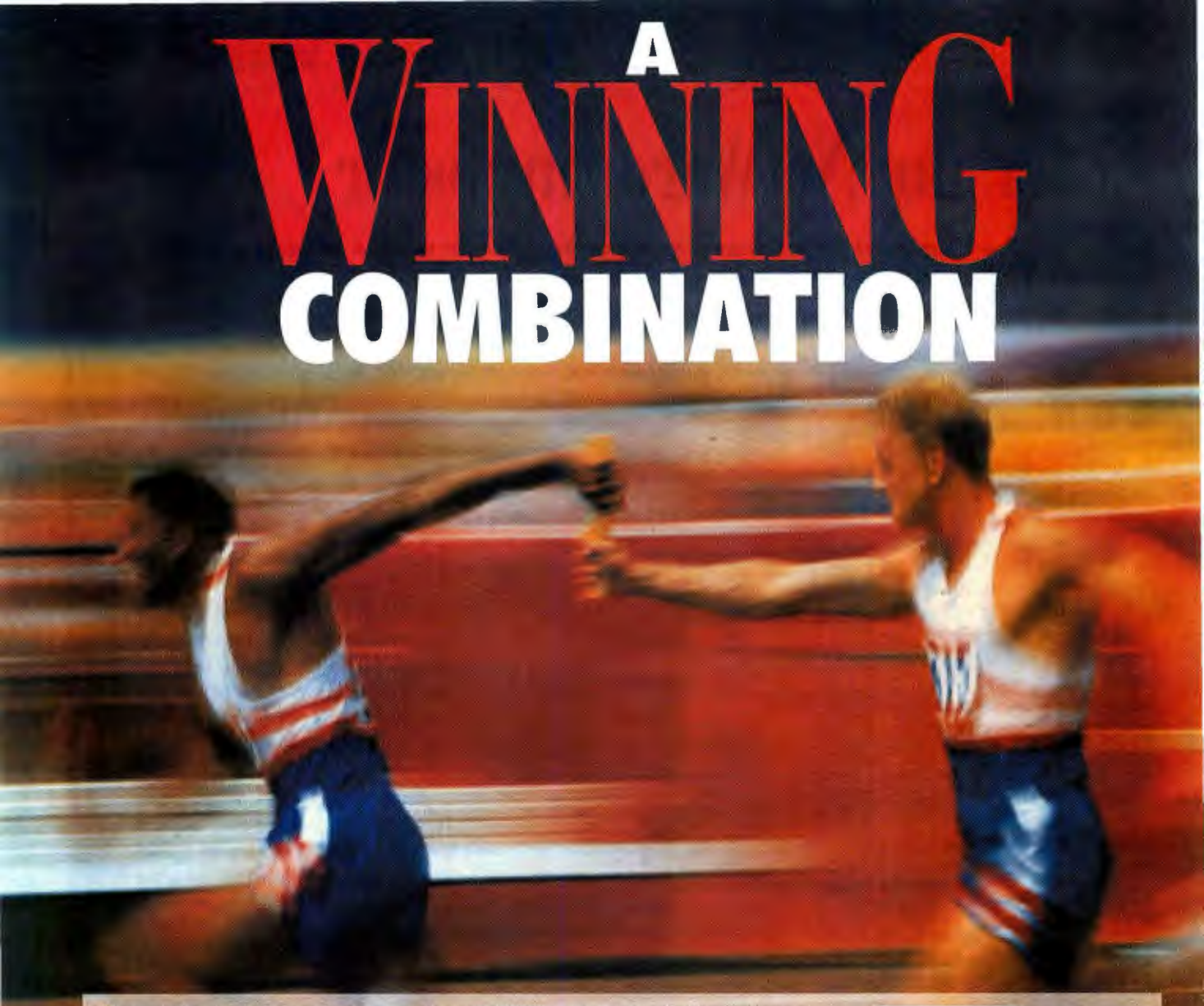

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CD-ROM Has a New MO

Plasmon's phase-change drive combines a 4X CD-ROM reader with 650 MB of rewritable data storage

ANDREW FRONING

A new modus operandi for CD-ROM readers may change the way we store and transfer large files. This emerging breed of phase-change devices combines a 4X CD-ROM reader with high-capacity optical storage. Plasmon Data Systems (along with other vendors soon to follow) recently introduced the PD2000e, a phase-change model priced below $1000 with an external case and a SCSI adapter. Panasonic has also announced its dual-function models, with prices as low as $499 for an internal unit.

A number of technologies compete in the removable-medium market. The Plasmon cartridge retails for under $60, for a cost of 9 cents per megabyte of storage. Syquest cartridges hold a maximum of 270 MB at roughly 25 cents per megabyte. Magneto-optical (MO) drives support a maximum of 230 MB of storage on 3½-inch disks and cost about 9 cents per megabyte. All these systems use proprietary storage methods. Recordable CD-ROMs store up to 650 MB of data at roughly 6 cents per megabyte.

TECHNOLOGY FOCUS

Changing Phases

Phase-change technology is just now reaching the mass market, although the process has been under development for a number of years. On the surface, phase change is simple. The recording head directs a tiny, multiple-energy-level laser across the disc. The normal state for the recording layer is amorphous, which provides one set of reflective characteristics. When heated to a precise temperature, the material transitions to a crystalline state with a different reflectiveness. The drive head reads the different states as ones and zeros.

To write over existing data, the laser heats the spot to the material's melting point. After melting, the material cools not to the crystalline state but back to the amorphous state. Controlling the head movement and laser position requires highly sensitive control mechanisms.

The Performance Stick

We used NSTL's InterMark low-level benchmark to assess the PD2000e's performance as a CD-ROM reader and as removable storage. For comparison, we also tested a Western Digital 1.26-GB hard drive and a Syquest 105-MB removable drive.

As shown in the chart, the transfer rate of the Plasmon is one-third that of the hard drive, and its random-access time is more than 10 times slower. Compared with the Syquest 105, the PD2000e achieves similar transfer rates but considerably slower random-access times. These slow speeds relegate the PD2000e to the role of a backup device or secondary storage.

The CD performance of the quad-speed drive is typical of such devices. The PD2000e and a NEC MultiSpin 4X supported almost identical transfer rates, but when running at 600 KBps, the Plasmon drive used up more CPU resources.

We installed the unit on a variety of platforms without a hitch: Windows 95, Windows NT Workstation, DOS (with ASPISYS drivers), and on the Mac.

The random-access feature of the phase-change medium makes the PD2000e much more practical than tape. The large capacity of the PD2000e exceeds that of MO drives for second-tier storage, and the cartridges also work well for moving a work environment from one machine to another (provided both systems house phase-change drives).

Plasmon Data's phase-change PD2000e. The unique cartridge can hold a standard CD-ROM disc or a 650-MB rewritable cartridge.

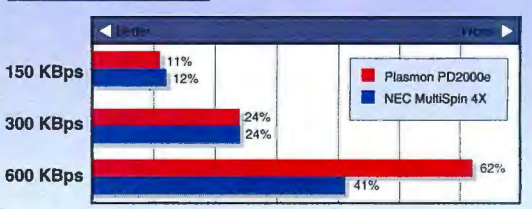
LARRY DUNN © 1996

Plasmon Performance

As removable storage	Transfer rate (KBps)	Random access (milliseconds)
Plasmon PD2000e	830	196
Western Digital AC2700	2268	19
Syquest 105	796	22

As a CD-ROM player	Sequential transfer (KBps)	Random access (milliseconds)
Plasmon PD2000e	599	325
NEC MultiSpin 4X	598	277

CPU utilization



Plasmon Data PD2000e
PC: $749; Mac: $689
Plasmon Data Systems
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fax: (408) 956-9444
http://www.plasmonca.com
Circle 1134 on Inquiry Card.

What's more, if phase-change CD-ROM drives reach critical mass on the desktop, we could end up with a universal medium for transferring large files to coworkers, clients, and prepress houses or across the sneakernet. ■

Andrew Froning serves as managing editor for NSTL Publications. He previously reviewed MO drives for NSTL's PC Digest. *You can reach him on the Internet or BIX at editors@bix.com.*

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OpenDoc: Small Is Beautiful

With Novell out of the picture, Apple is the standard-bearer for this exciting cross-application technology

RAYMOND GA CÔTÉ

Software is too large, too bulky, and too complex. Maintaining these behemoth programs has become an industry nightmare. These are not fighting words. Program complexity is a well-recognized industry problem. But acknowledging a problem neither makes it go away nor fixes it. So is a solution at hand? Component technology might be the panacea, and—finally—the OpenDoc component architecture has shipped.

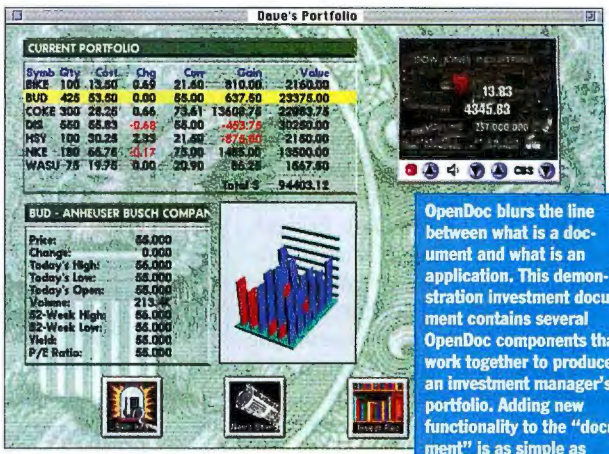
Component Technology

The idea behind component technology is to break these large, monolithic programs into their intrinsic components and then glue them back together in various ways to make applications. The components are easier to build and more robust than the same routines in a monolithic application, simply because the same component is used and tested in multiple applications. There is then no need to reinvent the functionality or the test regime. Above all, software developers can build new programs more quickly and efficiently by reusing their own or third-party components. This is the promise of component technology in general and of OpenDoc in particular.

Enter OpenDoc

OpenDoc is a new component technology that is currently available for the Macintosh and soon to be available for Windows, OS/2, and various flavors of Unix (beginning with IBM's AIX). OpenDoc offers several layers of glue for holding various components together. At its most fundamental level, OpenDoc provides a standardized, low-level framework that allows components to exchange data and messages. At a higher level, OpenDoc provides an arbitrator through which components request access to the screen.

But calling OpenDoc a framework is misleading; it's really an extension of the native OS. Although current implementations sit on top of the native OS, both Apple and IBM have committed to incorporating OpenDoc as a generic part of their OSes and modifying their OSes to take advantage of the plug-in component technology at every level. OpenDoc begins to blur the boundary between the OS and the application.



OpenDoc blurs the line between what is a document and what is an application. This demonstration investment document contains several OpenDoc components that work together to produce an investment manager's portfolio. Adding new functionality to the "document" is as simple as dragging a new component to the work area.

The User Experience

From a user's point of view, installing OpenDoc doesn't greatly change the manner in which you use your Mac. The only change that you see on the Desktop is the addition of an OpenDoc icon and a folder full of parts.

OpenDoc's name is unfortunate. Building your own documents from scratch is tedious. The real power of OpenDoc arrives as companies start supporting the plug-in technology in existing applications.

Consider what an industry standard for plug-in modules will mean. Need a special effect for Photoshop? It will also work correctly in QuarkXPress and PageMaker. Want to add a spreadsheet to that page layout? The same part will work in your word processor.

The end result is twofold. First, you can use your tools when and where you want. The application presents fewer restrictions on the operations you can perform. Second, you save both time and money. Once you learn how a part works, you can use it within different applications. In addition, you can buy a single part (e.g., a spreadsheet) and know it will work in all your OpenDoc applications.

All this is based on the premise that developers will flock to the OpenDoc standard, revise their old applications, and produce new ones that support component parts. Will this happen? Probably—at least on the Macintosh and OS/2 platforms.

continued

CI Labs: The OpenDoc Nexus

Apple Computer developed OpenDoc and is its biggest proponent. However, the intent from the beginning of the project was to create a cross-platform, industry-standard framework. It was with that intent that the three parties most committed to OpenDoc (Apple, IBM, and Novell) formed Component Integration Labs (CI Labs for short) to be the watchdog of the OpenDoc specification. Since then, other companies, including Adobe, Lotus Development, The Object Management Group, Oracle, and Taligent, have joined to foster this new standard.

Apple Computer has created OpenDoc on the Macintosh in conjunction with Novell/WordPerfect (for Windows) and IBM (for OS/2). The development cycle has typically been to produce a milestone product release on the Mac and then port it to Windows and OS/2.

As this article was being written, Novell announced it was transferring the OpenDoc development effort over to IBM. IBM has announced plans to deliver a beta version of OpenDoc for Windows 95/NT during the first quarter of 1996 and a final production release by the end of the year. The company remains committed to its delivery of the OS/2 Warp version by the end of 1995. This means that a Windows version will not be available until a full year after the delivery of the Mac and OS/2 versions.

Novell has reiterated its commitment to using OpenDoc as a development platform and supporting OpenDoc in future releases of its products, including NetWare. However, this break from the actual development of the OpenDoc framework, at a time so close to the initial OpenDoc release from Apple, raises the question of how quickly the cross-platform functionality can be delivered.

You can contact CI Labs at P.O. Box 61747, Sunnyvale, CA 94088; E-mail: info@cilabs.org; World Wide Web: http://www.cilabs.org.

Apple, in particular, has always attempted to make developers adopt the latest technologies that enhance the OS's overall integration. The result is an operating environment with a consistent look and feel.

The SDK in Practice

With all the potential advantages, how well do Apple's tools carry the OpenDoc flag? To get some perspective, we used the OpenDoc Software Development Kit (SDK) to build a bridge that let us incorporate existing Metrowerks PowerPlant code into a simulation project. (We did this for the SimCalc Project, aimed at developing interactive simulation software for education.) The SDK comes with PartMaker, a utility that produces a ready-to-compile OpenDoc part, with all source code and stubs for part-specific behavior. We could build a working part in minutes and customize it to our needs in a few days. We next built a pair of components to test the feasibility of high-speed interpart communications between a simulation and various meters, graphs, and control panels.

Overall, we're impressed. Both projects were successful, and we built the bridge and simulation parts in less than a month. Also, the QuickView on-line reference for OpenDoc is excellent. We're particularly impressed with IBM's System Object Model (SOM) technology: It seems exactly right for building simulation objects that interact with other developers' components. Right now, working with SOM is a bit slow because we need to precompile C++ bindings, but a direct-to-SOM compiler would fix that.

From a practical standpoint, OpenDoc introduces a lot of new terms and concepts, but it's a real architecture with well-conceived mechanisms for interpart communications, drag and drop, and scripting. Based on our experiences, we think OpenDoc has a promising future in education.

The Developer Experience

Remember all those rules Apple has been hounding us with for years? (Factor your applications! Support AppleScript! Implement the Object Reference Model!) It's now payback time. If you've been adopting these new standards, you'll find moving to OpenDoc fairly straightforward.

Think seriously about how to break your product into basic units of functionality. What components should you be reusing over and over again? Make them into separate OpenDoc Parts, and you're well on the way to your first OpenDoc program.

Scripting also plays a big role. OpenDoc supports the Open Scripting Architecture (OSA), the basis upon which AppleScript is built. All OpenDoc Parts are scriptable, and you can automatically record and play back your scripts, much like you can with a standard Macintosh application.

From here on, things become simpler. Language vendors, from Metrowerks and Symantec to QKS Smalltalk and Novell AppWare, are readying their OpenDoc-ready development environments. At present, all the Macintosh language vendors have stated their support for OpenDoc.

OpenDoc Timetable

Current OpenDoc announcements have centered around the availability of the final SDK for Macintosh. Although Apple expects some companies to ship applications in spring 1996, the first major wave probably won't arrive until late summer. By then, the OS/2 version will be shipping, and the Windows 95/NT version will be just a few months away.

Most users probably won't install OpenDoc on their systems until they purchase software that supports it. Since OpenDoc is free, software publishers will be distributing it with their new products. If you can't wait until then, you can download a copy from Apple's World Wide Web site at http://www.opendoc.apple.com.

OpenDoc is as important a change within the industry as the introduction of the GUI was. This is very likely the initial step toward the demise of the desktop metaphor. Taken to its logical conclusion, component technology can let us concentrate on working with information rather than manipulating specific applications. ■

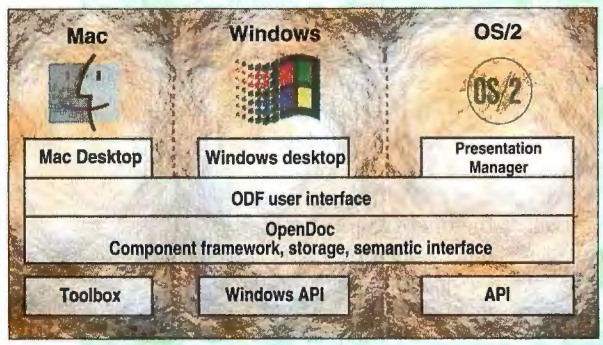
Raymond GA Côté is vice president of product development for Appropriate Solutions, Inc., in Peterborough, New Hampshire. You can reach him on the Internet at rgacote@apsol.com. Jeremy Roschelle also contributed to this review. He works on the NSF-funded SimCalc Project (http://tango.mth.umassd.edu). You can reach him on the Internet at jeremy@dewey.soe.berkeley.edu or on BIX c/o "editors."

Product Information

OpenDoc for Macintosh
free via download
(supports Motorola 68000 and PowerPC CPUs; requires System 7.1 or higher)
Apple Computer, Inc.
Cupertino, CA
(800) 776-2333
(408) 796-1010
fax: (408) 974-9994
http://www.opendoc.apple.com
Circle 1050 on Inquiry Card.

Where Does OpenDoc Fit?

OpenDoc is a cross-platform component architecture. It provides the communications framework into which developers plug components with standardized programmatic interfaces. Programming to OpenDoc standards ensures your components are both transportable to other OSes and accessible by other components in a consistent manner. OpenDoc further isolates you from machine dependencies by providing Bentos, a cross-platform object-storage format that ensures data written on one platform can be read on any other platform supporting OpenDoc.



As a multiplatform standard, OpenDoc simplifies the creation of applications.

What OpenDoc does not do is provide a complete cross-platform development solution. The OpenDoc charter does not include user interfaces. Actually presenting information to the user is still beyond OpenDoc's scope. The user interface is still platform-specific.

Don't despair, though, because there's a solution in the works. The OpenDoc Development FrameWork (ODF) is a cross-platform development environment that sits on top of OpenDoc itself. The ODF provides cross-platform user-interface components and a custom resource editor for moving your GUI controls (called Gadgets) across platforms. ODF is scheduled for shipment several months after the official release of OpenDoc.

OOP from the Guy Who Wrote the Book

TowerEiffel delivers a robust environment for multiplatform, multideveloper enterprise projects

PETER D. VARHOL

Developers who want an object-oriented language that adheres to the keystone principles of software engineering need look no further than Eiffel. Created by software researcher Bertrand Meyer, Eiffel follows design principles spelled out in his classic book, *Object-Oriented Software Construction* (Prentice-Hall, 1988). Chief among these are correctness, robustness, extensibility, and reliability.

Eiffel has become popular in academia. In addition, for three years, Tower Technology has been selling its TowerEiffel System, a multiplatform commercial version for Unix. Now the company is launching a major effort to woo mainstream developers with a combined Windows 95/NT version that has a completely redesigned, drag-and-drop interface like those available in popular C++ compilers.

We ran TowerEiffel 1.5 (the latest Unix version) on a Sun SparcStation 10 with Solaris 2.4, while we tested TowerEiffel for Windows on a homemade 486/66 with 16 MB of RAM running Windows NT 3.51. The look-and-feel improvements provided by the Windows version are striking, but more important are the design principles embodied in Eiffel itself.

Eiffel Source Code

```
class LISPLIST [Element]
  -- A singly linked Lisp-like list
  -- after Tsvi Bar-David's Simplist.

feature {ANY}

  add ( el : Element ) is
    -- add an element onto
    -- the head of the list
    local
      a_node : NODE[Element]
    do
      !!a_node.make( el, list_head );
      list_head :=a_node
    ensure
      not is_empty ;
    end -- add
```

Double dashes signify comments. A feature clause. This routine has one argument and no return value. !! denotes creation. Class LISPLIST requires a generic parameter, Element. An assignment. Assertions are always Boolean statements.

Source: Tower Technology Corp.

Unlike C++ and Object Pascal, Eiffel is a pure object-oriented language: It doesn't let you mix procedural and object approaches. Eiffel code (shown here) has relatively few symbols and pointers, making it more readable than most languages.

Constructing Programs

Tower Technology markets TowerEiffel as a program-design language (PDL), an approach also used by several Ada language vendors for their compilable packages. PDLs let you express the function of a program in a design language and then compile the design to check it for correctness. To this, Eiffel adds the means to finish the development process.

Eiffel achieves its goals primarily through extensive use and modification of object classes, coupled with a development environment that automatically creates class templates, performs dependency analyses, and permits automatic program builds. For the group method of development that often characterizes large, custom programming efforts, TowerEiffel has a form of built-in source code control. The class directories can be locked, or access can be controlled, so that the programmer can make changes to a root class only with the lock. Shared class directories can also be precompiled to save time in recompilation and relinking.

Programming with Eiffel is like using any fully object-oriented language. Rather than starting from scratch, you look for the appropriate object class from which to begin your design. You start with that root class, which forms the basis for the application, create the subclass for the application, define the inheritance properties, and write any unique functions, perhaps making use of other object classes. In Eiffel, any functions and data (methods and messages in object-oriented dialect) that are associated with an object description are known as *features*.

We first examined TowerEiffel in its Unix environment, which is based on a customized version of the `emacs` text editor that provides the indentations and syntactic styles required by Eiffel. Even though `emacs` commands are often obscure, this version comes with point-and-click editing commands in addition to the usual keystroke commands.

The Windows 95/NT version of TowerEiffel, on the other hand, has the look and feel of a Smalltalk class browser. The environment window has multiple tiled panes that let you lay out a class hierarchy sequentially, with point-and-click access to the contents of any object.

Both environments also support development in other languages, particularly C, C++, and Objective C. TowerEiffel can compile directly into an executable application, or it can produce C, C++, or Objective C code, which can then be run through a compiler for one of these languages. The Windows version lets you work with 32-bit C++ compilers from Borland, Microsoft, and Symantec.

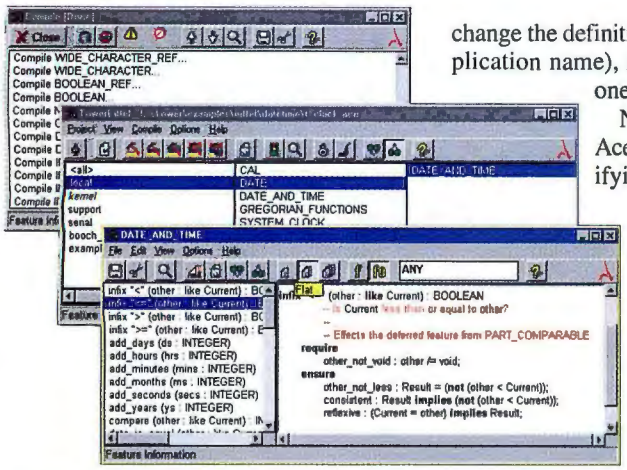
Clusters of Classes

Like any good object-oriented system, TowerEiffel provides a comprehensive and well-documented class library. In the base system, there are three general *clusters*. The kernel cluster, which is by far the largest, includes three universal classes—General, Platform, and Any—along with basic data structures, memory management, and interfaces to ANSI C libraries. These universal classes provide a wide range of functions that any special-purpose,

Product Information

TowerEiffel System $1555
(for HP-UX, Linux, NextStep, OS/2, Solaris 1 and 2, SunOS 4.1.x, and Windows NT; $249 noncommercial version also available)
Tower Technology Corp.
Austin, TX
(512) 452-9455
fax: (512) 452-1721
info@twr.com
http://www.ca.cf.cm.uk/Tower/
Circle 1041 on Inquiry Card.

OOP from the Guy Who Wrote the Book



The new Windows 95/NT version of Eiffel has a more integrated environment; shown, top to bottom, are the Monitor Panel, Project Manager (class browser), and Class Inspector (code viewer). Tower Technology plans to port the new environment to its Unix and OS/2 versions.

programmer-derived class can inherit. The support cluster is a mixture of items that's dominated by math operations and constants. The serial cluster provides mechanisms for persistent storage and serialized object streams.

To produce an executable application (known as a *system* in Eiffel terminology), you have to create a text file known as an Ace (short for Assembling Classes in Eiffel). The Ace contains the name of the root class from which you derive the application, the compilation options, and a list of directories (or clusters) where any other classes you're using are located. In some ways, it's analogous to a make file in a traditional development language. Once again, the `emacs` editor provides a template of the Ace file, and you just have to change the definition of the system (or application name), root class, and perhaps one or two other items.

Normally you define the Ace file before further specifying the application. This forces you to know your base class and other classes before modifying the class objects or adding other code.

Once this is accomplished, you can create new instances of objects and manipulate them using features that are already in the class, inherited from the class hierarchy, or that you have specifically written as features. (See the Technology Focus box below for an explanation of one type of inheritance, called *constrained genericity*, that permits strict control of the parameters that a generic class can use.)

The Eiffel development process forces you to perform a top-down, object-oriented analysis and design. This is how Eiffel supports both correctness and extensibility.

The final result of creating a program file and an Ace file and then invoking the compiler is an Eiffel system. It supports both garbage collection (i.e., automatically allocating and deallocating memory) and direct control over memory management by the program. You can also take legacy C or C++ code and encapsulate it into an Eiffel object using a class found in the kernel cluster.

A Useful Paradigm

Overall, the Eiffel development process and language remind us of Smalltalk. You don't *write* a program, at least not in its entirety; instead, you *construct* one from existing classes. As with Smalltalk, the learning curve will be steep for many programmers who are used to working with traditional languages.

Eiffel's Unix roots are mostly a detriment. We could do without the `emacs` editor and the other Unix conventions the product uses. The Unix influence also means that graphical classes are not part of the base system, even in the Windows version (but they are available as an option). In Smalltalk, these classes are closer to the core of the system. Thankfully, the Windows version is much easier to use, and Tower Technology says it will eventually move the new environment to the Unix versions.

Eiffel offers a good blend of styles and approaches. Unlike C++, it forces you to use objects immediately, yet its compatibility with C++ gives you the (perhaps false) confidence that you can always tweak the final result if it becomes necessary. The Windows version of the TowerEiffel System is definitely a worthwhile purchase for C++ programmers who want to work within a pure object-oriented architecture. ■

Peter D. Varhol is chair of the graduate computer science department at Rivier College in Nashua, New Hampshire. He can be reached on the Internet at pvarhol@mighty.riv.edu or on BIX c/o "editors."

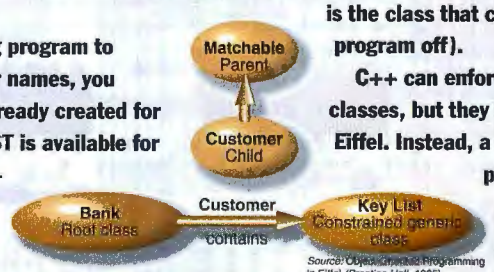
TECHNOLOGY FOCUS

Reusable Objects and Reliability

Object-oriented languages often provide generic classes (also called parameterized or template classes) that can organize or operate on other classes. A compiler must ensure that only objects that can be safely operated on are stipulated for use by these generic classes. Eiffel accomplishes this with a technique called *constrained genericity*.

For example, if you wanted a banking program to search through a list for valid customer names, you might reuse a generic class that was already created for the task. Say the generic class KEY_LIST is available for handling keyed items. To avoid parameter mismatches, you would constrain KEY_LIST to operate only on items of type MATCHABLE, stating this in the class header `class KEY_LIST[T->MATCHABLE]`.

To use this class, you'd have class CUSTOMER inherit from class MATCHABLE, which contains the code that verifies that a given class contains only members starting with, say, an integer. The list is declared this way: `customers:KEY_LIST[CUSTOMER]`. **The relationship of these classes is shown in the figure below (the root class BANK is the class that calls objects and starts the whole bank program off).**



Source: Object-Oriented Programming in Eiffel (Prentice-Hall, 1995)

CUSTOMER inherits its type-validation code from MATCHABLE and becomes the parameter used to constrain the generic class KEY_LIST. The latter is a container class whose members all begin with a key (e.g., an integer).

C++ can enforce similar restrictions for generic classes, but they are not stated explicitly, as they are in Eiffel. Instead, a C++ compiler does not verify that a parameter type is supported until a client creates an instance of a generic class. The only possible way to check for proper use of generic classes is for the programmer to closely examine the code line by line.

—David Essex

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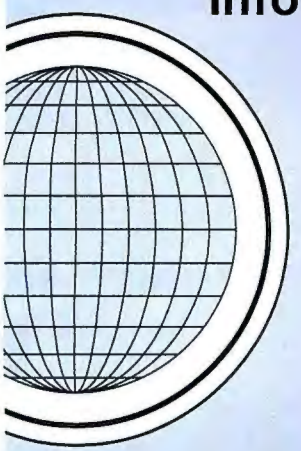

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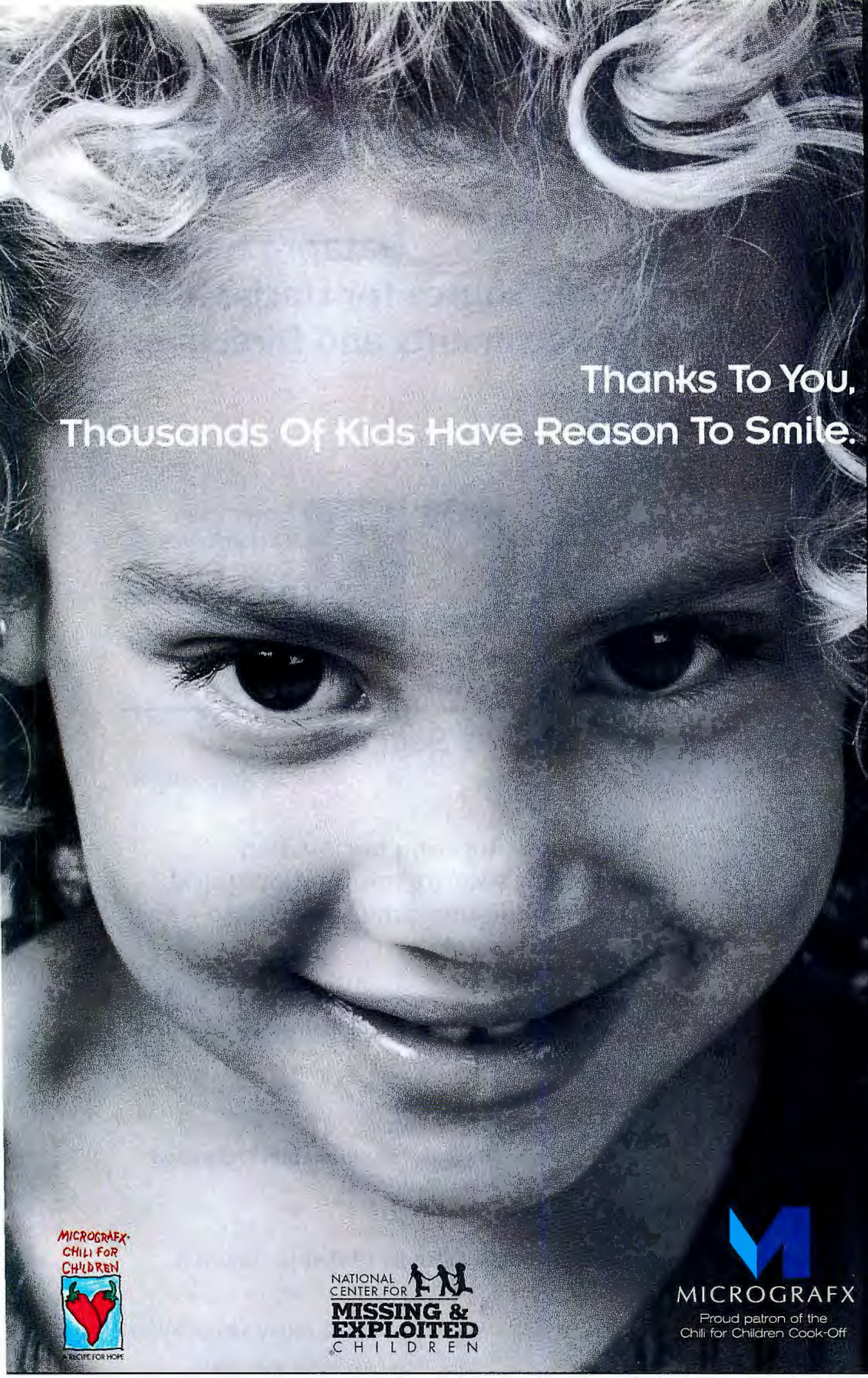

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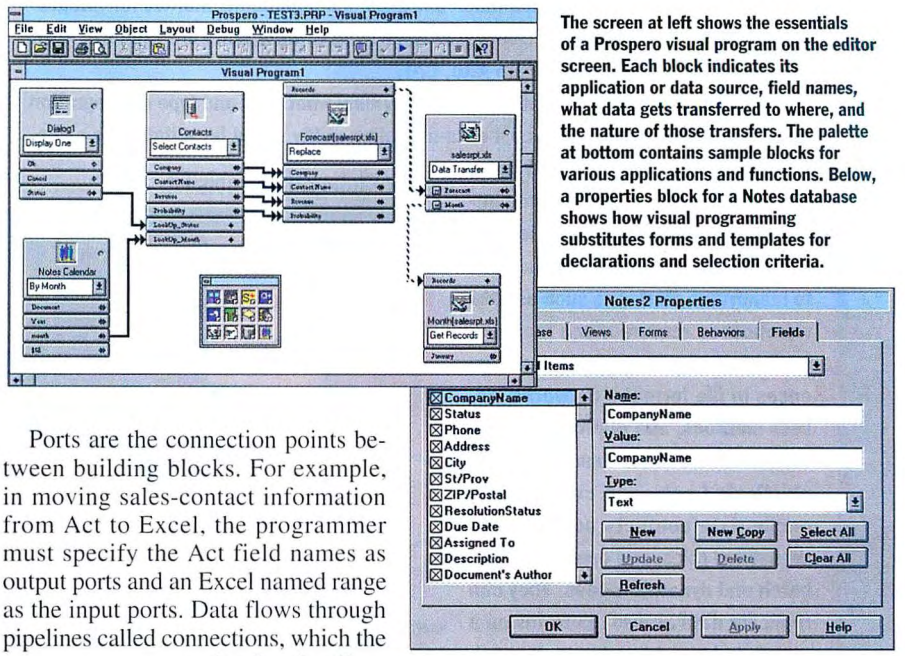
Prospero's Magic Application Integrator

A new visual programming tool helps integrate data from different Windows applications into single-click programs

KELLY TRAMMELL

Like its namesake in Shakespeare's *The Tempest*, Oberon Software's Prospero promises to work magic. With Prospero, you graphically specify the interactions between popular Windows applications and data sets and then compile the result into a stand-alone program.

Here's an example. You can draw a visual program, or map, to transfer sales data from a database, merge the data with contact information from a contact manager, consolidate and total the data in a spreadsheet, insert the data into a word processor document, then print it out. The map compiles the integration instructions with the links to the various source and target application data into a single executable file. You can then run this .EXE file without manually opening any of the applications.



The screen at left shows the essentials of a Prospero visual program on the editor screen. Each block indicates its application or data source, field names, what data gets transferred to where, and the nature of those transfers. The palette at bottom contains sample blocks for various applications and functions. Below, a properties block for a Notes database shows how visual programming substitutes forms and templates for declarations and selection criteria.

Building with Blocks

Programming in Prospero uses three basic elements: building blocks, connections, and ports. Building blocks are the components that represent tasks. Building blocks can generate, collect, or control data. Prospero uses three types of building blocks: application templates, common building blocks, and system-defined blocks.

Application template blocks are tied to specific third-party applications, such as Microsoft Excel or Lotus Notes. Prospero comes with predefined application blocks for Word and Excel, Notes, Symantec's Act contact manager, Delrina's WinFax Pro, MAPI-based electronic mail, and SQL databases. These blocks have predefined BASIC code.

Common blocks are set up to perform common chores, such as if/then/else flow, calculating formulas, and handling variables. Developers can program these blocks by filling out forms that construct BASIC code for the block. One common block is, essentially, a BASIC editor for developing custom blocks.

System-defined blocks are used for other common programming tasks, such as looping, counters, moving data to the clipboard, and printing. The only difference we could find between common and system-defined blocks is that you can't modify the latter's code.

Ports are the connection points between building blocks. For example, in moving sales-contact information from Act to Excel, the programmer must specify the Act field names as output ports and an Excel named range as the input ports. Data flows through pipelines called connections, which the programmer creates by drawing lines on-screen between ports. Connections can allow only one value to pass through (indicated with a single arrowhead) or multiple values (double arrowhead).

Making Programs with Prospero

Creating a Prospero program is quite simple. Open the visual program editor, which is similar to any vector-based drawing program. Drag-and-drop or insert a building block onto the editor screen for each task, and develop any new building blocks for BASIC subroutines you may need. Configure your building blocks as needed, specifying data, application, and file location, selection criteria, and actions to be executed. Next, you connect the ports on the building blocks, specifying the order of execution and the direction and amount of data to be moved. After testing, you can compile the visual program into an executable file.

Turn on Prospero's animation mode and, during program execution, each component on the visual editor will change color when it's active. Not only is this neat, it also serves as a kind of visual data flow debugger, since you can see the component interaction in real time.

Oberon recommends at least a 486DX2/66 processor, 8 MB of memory, 10 MB of disk space, and Windows 3.11, Windows NT 3.5, or Windows 95. Prospero is a 32-bit application, so if you're running Windows 3.11, you must install the Win32s DLLs; Oberon also recommends that you install their ODBC Win32s extensions. We installed Prospero on a Compaq Prolinea running Windows 3.11 with a 75-MHz Pentium and 16 MB of RAM. We also used Oberon's Win32s DLLs and ODBC drivers. The entire process took less than 15 minutes.

The program comes with a sample application that we tried to re-create. This puts up a dialog box to get filter information from the user, selects records from an Act database, and transfers the data to an Excel spreadsheet. Building the sample program is simple and gives you a basic understanding of how the tool works.

However, the first time we executed the program, we ran out of resources. We closed everything that was running except Prospero and the program then worked. On the third execution, the application ended abruptly with the error message "Object creation failed." Using the integrated debugger, we set breakpoints and found the program wasn't opening the Excel spreadsheet. We tried a number of alternatives without success. Finally, we

TECHNOLOGY FOCUS

Data on the Move

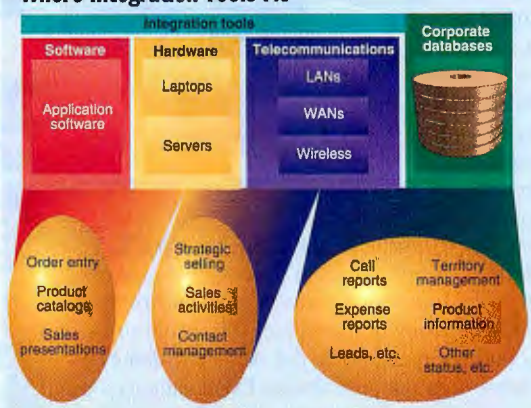
Seamless integration and interoperability across computing platforms—sounds absolutely fabulous, doesn't it? Unfortunately, implementing this kind of functionality requires tremendous computing horsepower, as well as agreement on which object-brokering technology to support (CORBA? OLE 2? Common Object Model?). Until these issues are resolved, there's a significant market for integration tools like Prospero from Oberon, Zmerge from Granite Software (Milford, MA), and InfoPump from Trinzic (Palo Alto, CA).

The key to selecting the right tool is to determine what level and type of integration you need. For example, a low-cost data-migration utility would be suitable for a one-time platform move, as would data-conversion utilities that provide import/export functions and filters.

Applications that require access to mainframe platforms such as data warehouses require much more robust tools that can resolve differences in file formats, networks, access methods, and platforms. These tools can move data based upon sophisticated selection criteria, reconcile data conflicts according to predefined rules, and operate in both batch and dynamic modes. They can replicate data across platforms on a scheduled or ad hoc basis. In addition, they can act as a workflow engine to move data bidirectionally. Other high-end features include transaction logging and audit trails, multilevel security, and reporting functions.

These multiplatform tools typically only operate at the application and presentation layers. You still have to get the data from the source to the target. For example, a number of tools can exchange data between DB/2 and Lotus Notes. However, an integrator has to resolve the conversions involved in moving that data from a VSAM data set under MVS, over an SNA network, through a token-ring adapter, to 10Base-T adapters over a TCP/IP network connected to a Windows NT server running a Notes server. These multiplatform tools specify the what, when, where (and sometimes why) of moving data. The "how" is left to the integrator.

Where Integration Tools Fit



Integration tools, such as Prospero, cut across the traditional divisions of software, hardware, and telecomm devices to create more powerful applications.

closed the program and re-created it. This time, it ran without a hitch.

Doing Real Work

Here's an example of Prospero in the real world. At KPMG Peat Marwick, an administrative person periodically collects sales information from Excel spreadsheets that have been E-mailed from various parts of the organization. This person has to consolidate and rekey the data into a Notes database for sorting, viewing, and reporting. This task normally takes 6 to 8 hours per month. We developed a Prospero application to automate the process and add a reporting function using Microsoft Word.

We initialized an Excel block for each spreadsheet using the import feature, and Prospero correctly preconfigured the blocks for name, location, and named ranges. We then added a new Excel block to consolidate these into a single spreadsheet. Specifying the ports was easy. However, when we tried to append data into the global spreadsheet, the program kept overwriting the previous contents. We finally fixed this, with a little help from Oberon's technical support staff, by changing input options.

Next we set up two Notes blocks—one to catch data from the global spreadsheet and another to transfer selected data to a report. To make this work, we created a new view in the Notes database for the status report data. We prompted the user for a date range, then fed that back into the Notes block to extract the chosen records into the report. We compiled the application and ran it several times. Performance wasn't bad: The program processed some 500 records in approximately 3 minutes.

Steep Learning Curve

Prospero is most useful for repetitive tasks or infrequent batch data conversions where the underlying data and file layouts don't change often. For dynamic data, however, it has some limitations. If you rename or move a spreadsheet, the Prospero application must be recompiled or run via the interpreter.

Like most point-and-click programming tools, once you move beyond simple data transfers, Prospero's level of complexity goes up tremendously. One factor that complicates the learning process is that each type of building block has some unique configuration options. Become an expert at configuring the Excel block, and you still have to learn the Notes block, the Word block, and so on.

This kind of difference between applications also surfaced when we tried to perform equivalent functions in Notes and in a SQL database; the options are different. Also, you can insert additional SQL code into a SQL block. Furthermore, the SQL block has buttons you can use to set the record-selection criteria.

For the next release, Oberon should try to make similar functions look and act similarly to the programmer across different building blocks. This would substantially reduce the complexity associated with learning the software.

Prospero has a ton of functionality, and its visual editor and animation features are really slick. However, to get Prospero to do complicated tasks, like multiple filters or data merges, you have to spend a lot of time learning how the tool works. ■

Product Information

Prospero $695
Oberon Software Inc.
Cambridge, MA
(617) 494-0990
fax: (617) 494-0414
Circle 1133 on Inquiry Card

Kelly Trammell is a partner with KPMG Peat Marwick's Strategic Services in Houston, Texas. You can reach him on the Internet at ktrammel@kpmg.com.

Where on Earth Am I?

The Global Positioning System used to be a huge military system. Two affordable PC Card receivers now make it a road warrior's tool.

GEORGE V. KINAL

The Internet started as an attack-resistant U.S. military network. Now look at what it's become. Similarly, the Global Positioning System (GPS) is a $10 billion collection of satellites and ground control stations developed by the U.S. Department of Defense for the positioning and navigation of military vehicles, personnel, and weapons. Yet almost overnight, civilian users and applications now greatly outnumber those of the military.

The most fascinating and useful form of a GPS receiver right now is on a PC Card. Plug one into a portable computer, and you add computational and mapping power and flexibility to the GPS picture. At least, that's the promise. We evaluate two PC Card solutions to compare the promise to reality.

A GPS receiver provides position information (i.e., latitude, longitude, and altitude) by repeatedly making comparisons on the arrival times of digitally tagged radio signals from four (out of 24) GPS satellites. Successive readings allow easy calculation of travel speed. Small hand-held receivers are useful for hikers, boaters, pilots, and forest rangers. The same electronics go into highway navigation systems. These were originally for truckers and emergency services, but they are now appearing in cars.

Trimble vs. Rockwell

Trimble Navigation's Mobile GPS PC Card 110 resembles a modem card with a tiny coaxial-cable socket. On one end of the 2-meter cable is a mating coaxial plug; on the other end is an antenna module the size of a hockey puck with a magnetic mount that clearly identifies the target market as cars.

Rockwell Semiconductor Systems' NavCard is 2 inches longer than a normal PC Card, with an antenna connector on the center of the protruding section. A small, squarish, black plastic antenna clips onto this protrusion. An optional remote kit has a coaxial plug on one end; a combination coaxial socket/magnetic mount is on the other end.

You unclip the antenna from the NavCard's protruding section and snap it onto the socket/mount. The end result is the same as with Trimble's product, but Rockwell's mounted antenna is smaller and neater.

The two cards are marketed differently. Trimble sells the Mobile GPS PC Card 110 as a consumer product, complete with its WinMobile software. Rockwell sells the NavCard primarily as an OEM product. Companies such as Liikkuva Systems International (Cameron Park, CA) place their own label on the card and sell it with value-added software as a complete package. Some dealers sell the NavCard in single-unit quantities, and applications software to use with it is available.

LARRY DUNN © 1996

At the left, attached to its round antenna, is Trimble's Mobile GPS PC Card 110. Next to it is Rockwell's NavCard, with the optional remote antenna mount below it.

Not Quite Plug-and-Play

We used each card in a Hewlett-Packard OmniBook 430, a 486SX/25 with 6 MB of RAM. We also tested the cards in a Toshiba Portégé P90 with 8 MB of RAM. We tested using Windows 3.1, though both products work with Windows 95.

One or 2 W may not seem like much power. However, it represents a significant drain on the OmniBook's battery. With either GPS card inserted and running, the OmniBook's normal 2-hour battery life drops to little more than half an hour. Similarly, the Portégé's 4-hour battery life is cut to approximately 3 hours. Extended road use requires some form of power adapter. Rockwell has a new version, called the NavCard LP, that consumes only 0.6 W.

We had serious problems swapping the Trimble card in and out of the OmniBook, which has no true on/off switch and just powers down, ready to resume work in its previous state. Removing or inserting the Trimble card would often initiate a reboot. Worse, the OmniBook would then forget it had a PC Card hard disk, and boot from its default ROM. We had to temporarily remove and reinsert the hard disk card. We didn't have this problem with the NavCard or with a PC Card modem.

Look! Up in the Sky! It's a Satellite!

The 24 GPS satellites are constantly changing their position in the sky. Thus, a GPS receiver will obtain an initial fix most quickly after power-up if it knows its approximate location and time of day, and if it has a recent almanac table stored in its memory. It then knows which of the 24 possible GPS signals to search for first. Otherwise, a cold start just runs through all the possible satellite numbers or signal codes in succession, and *it's potluck* when it will chance upon a signal. In practice, this initialization process can take up to 45 minutes.

The two GPS cards were roughly comparable in initial (i.e., warm-start) acquisition. Both use the same algorithm. In the almanac, they look up the satellite that's highest in the sky and have all receiving channels try to acquire that satellite. After some time, if that one isn't found, they try the next lower satellite (typically, there are five to eight in the should-be-available list).

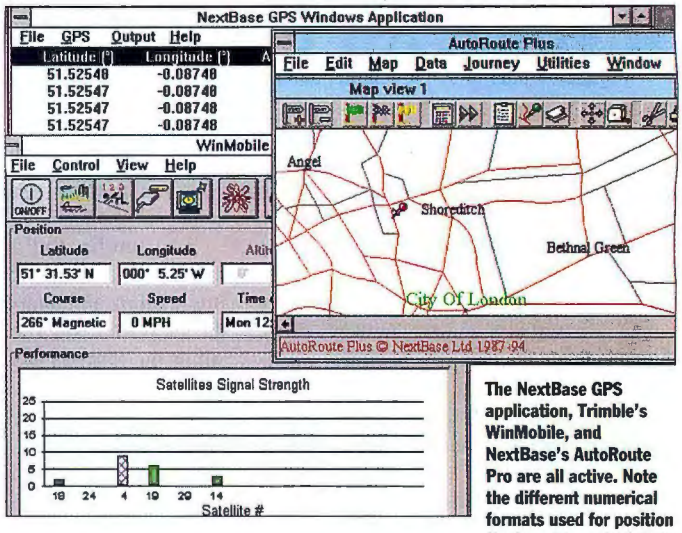
continued

Although the Rockwell card's five channels will, on average, find a signal more quickly than the Trimble card's three channels, this difference is small compared with the time lost if, for some reason, that particular signal is unavailable because it's blocked by a tree or a building. Once any channel finds a satellite signal, it locks onto it and the remaining channels hunt in parallel for other signals.

The NavCard's five channels appear to give it a slight edge in performance while on the move. When some GPS signals are temporarily blocked, it helps to be tracking as many satellites as possible and to be on the lookout for others that the almanac says should be available but aren't at the moment.

Multiplexing lets the Trimble receiver track up to eight signals in its three hardware channels, while the Rockwell receiver can track up to nine. But multiplexing involves some performance loss in both sensitivity and acquisition time. With only three channels, the Trimble receiver must always multiplex, whereas the Rockwell receiver can track four satellites and use the fifth channel in a multiplexing mode to scan for others.

In typical situations, the Rockwell receiver reported two to four GPS signals (two when heavy foliage caused brief outages), with a few short bursts of five. When turning into a residential street, we found that one or two satellites could be obscured and would drop out, but they were almost instantly replaced by others, with no net loss of vehicle tracking. In static tests with the antenna indoors and only part of the sky visible, the Rockwell NavCard would usually track four GPS satellites while the Trimble card struggled to hold onto three.



The NextBase GPS application, Trimble's WinMobile, and NextBase's AutoRoute Pro are all active. Note the different numerical formats used for position displays. The red stickpin shows the position on a map of London. Weak GPS signals are due to using the unit indoors through a coated window.

Good search and tracking algorithms can compensate for some of these factors, and Trimble's WinMobile is particularly clever in balancing different settings. For example, there are Heavy Foliage and Urban Canyon settings, as well as choices about whether the user is fixed or moving slowly or quickly. No such control seems available in the software we had for the Rockwell card. Still, we believe most users prefer not to fiddle with settings, and the Rockwell defaults work well.

37°55.382' N, 83°11.565' W: Huh?

To simplify integration, both manufacturers make their cards behave like serial interfaces to an external GPS receiver. The computer sends commands to, and receives data from, the receiver in a serial bit stream. The data includes what satellites are being received, signal quality, and position information. The computer can display this on-screen and/or log it to disk for later playback or processing.

This isn't a lot of functionality, but it lets you record property boundaries, for example, or the location of a secret treasure trove or favored fishing spot. (But see the Technology Focus on page 178.)

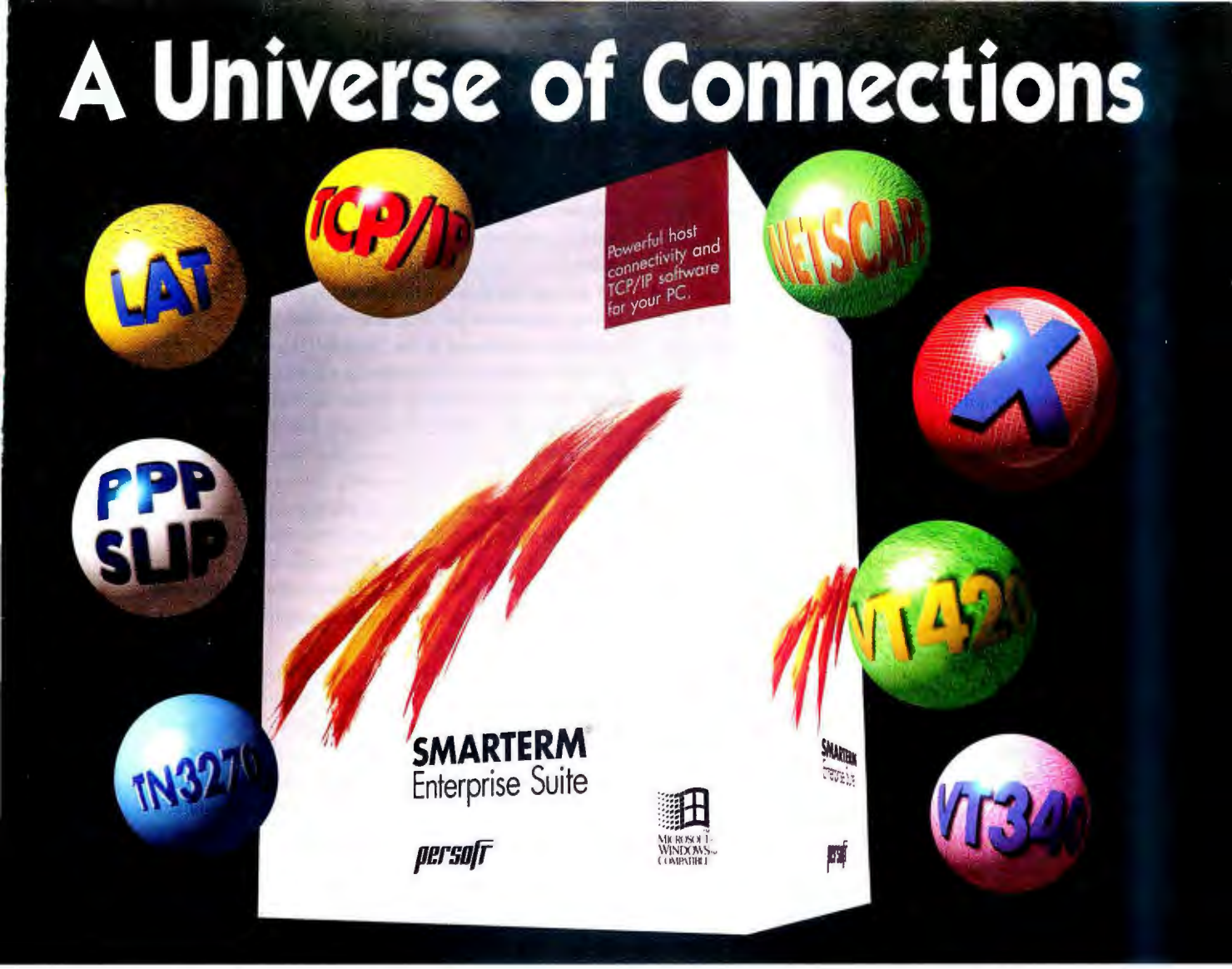
Rockwell doesn't supply user software directly, but a complete set of technical development and testing software is available from distributors and other sources. We used the DOS program Labmon and a rudimentary program written to illustrate use of the APIs. While Labmon isn't intended for nontechnical, real-life use, it's a powerful, complete program that lets you control all aspects of receiver operation. However, neither WinMobile nor Labmon is much use on the road, so most GPS users will want to develop or purchase additional software. Both Rockwell and Trimble sell software development kits.

Microsoft owns NextBase, a U.K. company that produces Automap (called AutoRoute in the U.K. and Europe) software. We used the CD-ROM version of AutoRoute Pro, which can be linked to a variety of GPS receivers. Curiously, the U.K. version has options for both Trimble and Rockwell cards, while the U.S. versions (downloadable from Microsoft's World Wide Web or FTP sites) have drivers for Sony, Rockwell, and some other units, but not for the Trimble card. You'll also need the manufacturer's proprietary Windows

POSITIONING THE POSITIONERS

Product	Mobile GPS PC Card 110	NavCard
Manufacturer	Trimble Navigation Sunnyvale, CA (800) 827-8000 (408) 481-7808 fax (408) 481-7781	Rockwell Semiconductor Systems Newport Beach, CA (800) 854-8099 (714) 833-4600 fax (714) 833-4078 http://www.nb.rockwell.com/
Price	$595, with software for Microsoft map systems; $649, with software for Road Scholar's City Streets	$495–$595, hardware only; $795, Liikkuva unit with software
Number of receiver channels	3	5
Number of satellites tracked	8	9
Card size	Type II; 86x54x5 mm	Type II extended; 137x54x5 mm
Power consumption	0.75–1 W	< 2 W; <0.75 W average
Antenna	Hockey puck size and shape, 65 mm diagonal by 23 mm; 2-meter cable, magnetic mount	48x57x22 mm, attaches directly to card; optional 6-foot cable and magnetic mount
Included software	WinMobile (Windows 3.x); Mobile.exe (DOS)	None
Other software available	Developer's kit	Developer's kit; Labmon; downloads from CompuServe's sailing forum
Automap/AutoRoute link capability	Yes	Yes
Acquisition times (initialized/cold start)	<30 seconds/15–45 minutes	20–30 seconds/10–30 minutes
Inquiry number	1056	1057

A Universe of Connections



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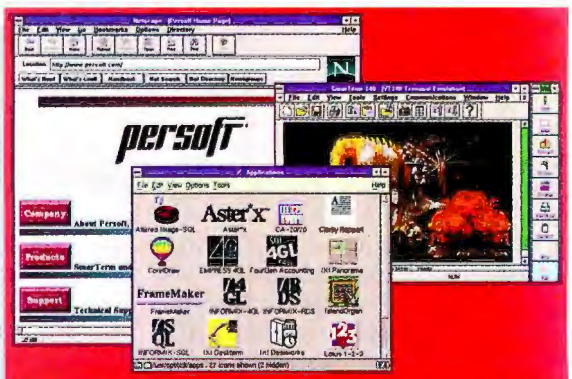

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How Accurate Is GPS?

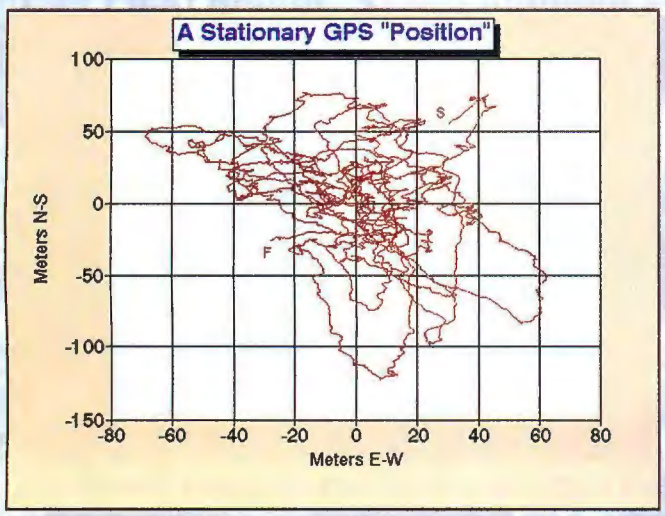
Even the simplest civilian Global Positioning System (GPS) receivers are capable of ranging precision under 10 meters, which translates into a horizontal-positioning precision of 15 or 20 meters. But these are average values, and we need to remember that precision (the fineness of the ruler's scale) and accuracy (how true each marking is) aren't the same.

GPS accuracy is affected by two external factors. First, physical or environmental influences can alter the paths of GPS signals. The receiver assumes that the radio signal has traveled at the speed of light, and it converts a time measurement to distance (like estimating the distance to a lightning bolt from the speed-of-sound delay on the thunderclap). If this propagation speed is changed by the atmosphere, an error is introduced. Civilian (i.e., nonmilitary) receivers use only a crude model to account for ionospheric variations.

A second, more severe inaccuracy is caused deliberately by the operators of the GPS, who introduce intentional fluctuations on the timing of the "civilian" signals. Without these fluctuations, euphemistically called selective availability (SA), state-of-the-art civilian receivers could be almost as precise as military receivers, which use different, encrypted signals from the same satellites. The Department of Defense considers this possibility dangerous to national security and imposes SA to limit positioning accuracy to 100 meters or better, 95 percent of the time, averaged worldwide. (See "A Stationary GPS Position" for a graphic depiction of SA's effect.) Part of the variation may be due to signal-propagation variations, but most of it comes from SA.

Both SA and ionospheric errors can largely be compensated for with differential corrections, where a fixed monitoring station makes GPS measurements and transmits them to the user over some form of radio link. Differential corrections basically calibrate each GPS signal path against a known reference location. It's like telling the user that when his or her tape measure reads 900 meters, it's really 898. The user can then infer that the 902-meter mark really means 900.

An interesting sidelight on SA is rumored to have occurred during the 1991 Gulf War, when U.S. military forces had only a limited number of military-grade GPS receivers that could use the more accurate position information. Their solution was to turn off the SA scrambling, so that troops could use readily available civilian-grade receivers.



The effects of selective availability on positioning accuracy are shown here. A stationary GPS receiver took 6720 measurements at 1-second intervals. While the unit didn't move, the indicated position certainly did. The receiver was located in North London, U.K., at 51°36.8496' N, 0°11.149' W. Note that the majority of positions are within 50 meters of the origin.

DLL. Trimble's TGPSDLL.DLL ships with the PC Card bundle, while Rockwell's NAVCORE.DLL is available on CompuServe.

The two cards work somewhat differently with the three applications. Both Automap (or AutoRoute) and the NextBase GPS Windows application program must be opened. With a Trimble card, the application program automatically opens WinMobile, with all the latter's controls available. The screen that's found on page 176 shows all three of the applications open. For the NavCard, an invisible binary-mode reader communicates with the GPS card, so only two windows appear. In our tests, the OmniBook didn't have enough memory to run AutoRoute and either of the GPS card interface programs simultaneously.

Other mapping and position-display programs are available for use with these two GPS receivers. City Streets, from Road Scholar Software (Houston, TX), and MapExpert, from DeLorme Mapping (Freeport, ME), are two well-known products. These mapping programs are quite resource-intensive, and running them simultaneously with a GPS tracking program probably requires at least 8 MB of RAM and a 486DX processor.

Take Your Pick

The bottom line? If you're going to use commercial mapping software and can find the needed software drivers, and if the way the card sticks out from the PC Card socket won't be a problem for you, the NavCard's superior performance and lower cost make it a good choice. (Alternatively, Liikkuva's bundled package offers a complete, ready-to-run solution.) In principle, combining Automap Pro and the Trimble bundle should offer the same functionality, but Microsoft doesn't seem to offer the necessary Trimble driver. However, the Mobile GPS PC Card 110 is available with other software from a variety of sources.

In the end, both of these units offer roughly equivalent results. If you want to know where in the world you are, there's nothing like a GPS receiver. ■

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Desktop Publishing Photo Finish

FrameMaker, PageMaker, QuarkXPress, and Ventura Publisher are all contending for the lead, but PageMaker wins by a nose

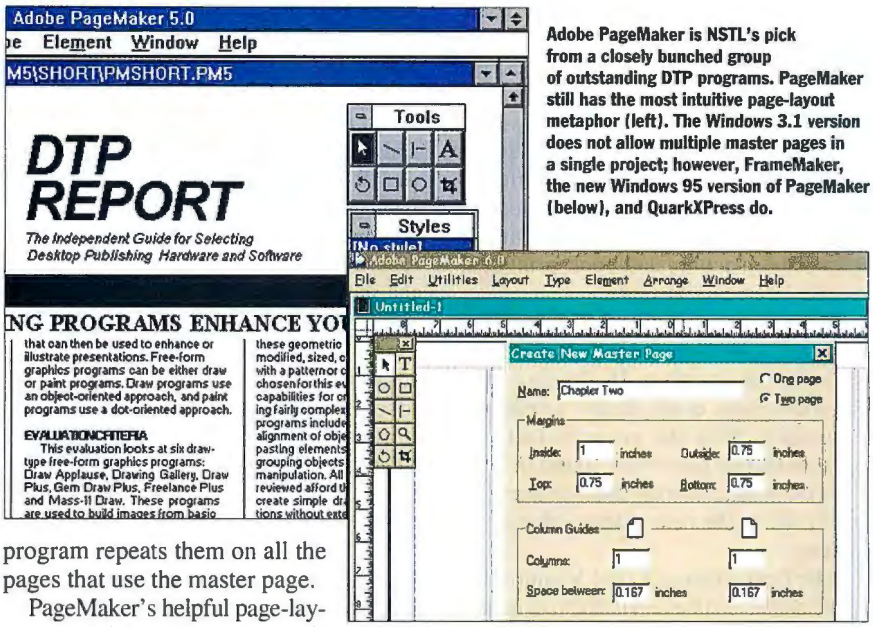
DAVID SEACHRIST

It's hard to tell the leading desktop publishing (DTP) programs apart. All provide page-layout, word processing, typography, and I/O tools galore, and they tend to copy each other's features. The differences are mostly in the details.

NSTL evaluated Windows DTP packages characterized by broad feature sets and midrange prices. We did not include more costly and specialized publishing software, such as Interleaf Publisher. Excluded as well were entry-level products, such as Microsoft Publisher.

The programs retain vestiges of their original incarnations. The Windows-based version of Adobe PageMaker, for example, is a drag-and-drop beauty like its groundbreaking Macintosh ancestor. QuarkXPress and Corel Ventura Publisher are strongest in the text-processing and graphics-handling features required for professional publishing. (Quark tilts toward magazines, while Ventura excels at book-length projects.) And Frame Technology's FrameMaker has the best tools and specialized typography for technical publishing.

At press time, Adobe Systems had completed its acquisition of Frame Technology. However, "specific product-name changes are yet to be determined and will be announced when they are introduced to the marketplace," according to Adobe.



Adobe PageMaker is NSTL's pick from a closely bunched group of outstanding DTP programs. PageMaker still has the most intuitive page-layout metaphor (left). The Windows 3.1 version does not allow multiple master pages in a single project; however, FrameMaker, the new Windows 95 version of PageMaker (below), and QuarkXPress do.

Adobe PageMaker

PageMaker delivers the best balance of usability, feature-richness, and overall quality, and it's NSTL's top choice. Much of its appeal to casual business users stems from its intuitive page-composition metaphor and screen interface. PageMaker's master-page method of repeating text and graphics acts like a set of left- and right-page overlays on an overhead projector. Once you place text or graphics on the master page, the program repeats them on all the pages that use the master page.

PageMaker's helpful page-layout extensions automate repetitive procedures. Adobe distributes PageMaker with Extensis's PageTools, which adds such functions as a move-page command and a floating tool palette for quick screen-button access to PageMaker commands. Other bundled additions include a scripting language, a graphical archive management system, TWAIN scanner support, and tools for diagnosing various layout problems.

Like QuarkXPress, PageMaker offers superior *tracking* (a method of adjusting the spacing between resized characters that's similar to kerning). With tracking, the spacing is relative to the typeface size and style rather than absolute, as is the case with kerning.

PageMaker also has the best selection of file filters, but all four programs were strong in this area. The features tables on pages 184 and 186 list many of the import file formats supported.

PageMaker's picture isn't all rosy, though. The program lacks vertical justification, so it won't automatically add or remove space to make columns align with the bottoms of pages. The running header/footer addition, which automates the creation of headers and footers, does not offer chapter-head variables. So, when adding or deleting pages, you have to rerun the header/footer addition—a time-consuming process. PageMaker also lacks an automated backup-file feature, although

DESKTOP PUBLISHERS: HOW THEY STACK UP

NSTL RATING		VERSION	PERFORMANCE	QUALITY	VERSATILITY	EASE OF LEARNING	EASE OF USE	PRICE
★★★★	Adobe PageMaker	5.0a	▲	▲	▲	▲	▲	$895
★★★★	Corel Ventura Publisher	5	■	▲	▲	▲	▲	$595*
★★★★	FrameMaker	5.0	▲	▲	▲	▲	▲	$895
★★★	QuarkXPress	3.31	■	▲	▲	▲	▲	$895

KEY

★★★★★ Outstanding
★★★★ Excellent
★★★ Average
★★ Below average
★ Poor

▲ Good
■ Fair
▼ Unacceptable

* For floppy disk version; CD-ROM version, $495.

it partially compensates by saving a file automatically each time a page is "turned."

Corel Ventura Publisher

Corel Ventura Publisher bundles more extensions than the other programs. The CD-ROM includes extensions for scientific-equation processing, database publishing tools, a paint/photo-enhancement program, additional foreign-language hyphenation dictionaries, 17,000 clip-art images, and a graphics management application.

Ventura Publisher's print quality in the newsletter test was the best in a strong group. Its ability to render both of the imported graphics in the newsletter test file set it apart from the other programs. Its solid display quality and book-print quality also bolstered its score.

With version 5.0, Corel Ventura Publisher has gone a long way toward improving its screen interface. Its floating "roll-up" tools allow quick access to program commands. Still, the program lacks the editable facing-page view found in every other program, although this was supposed to change in the next release, due out in January.

Like FrameMaker, Corel Ventura Publisher comes with everything you need to handle column formatting. In addition to the standard column-formatting features found in the other programs, FrameMaker and Corel Ventura Publisher offer a full array of column-balancing and vertical-justification controls. Unfortunately, the two programs both apply tracking as an absolute value via a named style (in contrast to PageMaker's more intelligent method). Thus, when you apply an absolute value at the paragraph level and a larger font size at the character level, you must adjust the tracking value to maintain the same relative spacing held by the original, smaller font.

Corel Ventura Publisher is also the only program that doesn't fully support graphics rotation (it does so for imported, but not drawn, graphics). Nor does it allow the flipping of graphics, although the next version will. In addition, Corel Ventura Publisher does not allow you to save graphics or text files within its chapter files. We generally found its file management more difficult to learn and use than that of the other three programs.

On the plus side, Corel Ventura Publisher (along with FrameMaker and QuarkXPress) supports automatic file save and file backup. And its ability to render Windows Metafiles gives it a slight edge over both FrameMaker and PageMaker in newsletter print quality.

FrameMaker

As the only program that employs Win32, Microsoft's 32-bit OS extension, FrameMaker excelled in our speed tests. Its unparalleled speed, solid print quality, and breadth of features make it one of the most versatile programs (the other being Corel Ventura Publisher). It also has the most drawing tools, although its competitors are strong in this area, too.

Technical documentation has long been one of FrameMaker's target markets. The CD-ROM ver-

Windows 95 Begets DTP 96

At press time, three of the four programs we tested were being upgraded for Windows 95 compatibility. Here are the highlights.

QUARKXPRESS 4.0, expected sometime this year, will be fully Windows 95 compatible. (A maintenance release that came out in November, QuarkXPress 3.32, runs under—but is not optimized for—Windows 95.) Among the new features in version 4.0 are

- **File compression.**
- **The ability to create indexes and tables of contents.**
- **Chapter-number variables.**
- **A chapter management utility.**

COREL VENTURA PUBLISHER 6.0, due out in January, was to include

- **Multiple master pages.**
- **SGML and HTML support.**
- **Version control for tracking edits.**
- **An enhanced table interface.**
- **A scripting language.**
- **Customizable toolbars.**

ADOBE PAGEMAKER 6.0, released in November, contains more than 50 new features, including

- **Multiple master pages.**
- **Table-editing enhancements, such as floating text and palettes.**
- **An HTML filter for creating World Wide Web documents.**
- **A polygon tool.**
- **Support for Kodak's Precision Color Management System and the Pantone Hexachrome libraries.**

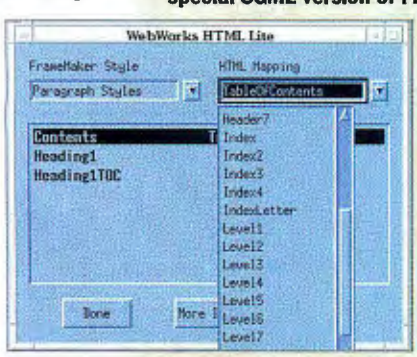
Desktop Publishing for Electronic Distribution

The growth of specialized programs for creating on-line documents has put pressure on traditional desktop publishing programs to support such electronic publishing standards as Hypertext Markup Language (HTML) and its parent, Standard Generalized Markup Language (SGML).

SGML is an ASCII-based tagging system that lets you define the parts of a document (e.g., abstracts, subsections, and captions) so that they can be managed like a database and shared electronically. SGML has taken hold in the U.S. federal government and in large, technology-based corporations, while HTML is the de facto standard for World Wide Web publishing. But SGML has recently made inroads to the Internet as publishers strive to improve the appearance of on-line documents.

Of the reviewed products, only FrameMaker comes with an HTML filter; a special SGML version of FrameMaker is also available for $1495. Adobe, which bought Frame Technology last fall, will continue SGML and HTML support in the package. And it will add an HTML filter to the next PageMaker upgrade, although the current version comes with HTML-compliant style sheets. Corel plans to add SGML and HTML features to the next version of Ventura Publisher. QuarkXPress supports both in third-party XTension products.

All but QuarkXPress let you print to Acrobat format, an Adobe standard for creating portable documents that retain their original design when viewed with an Acrobat reader.



FrameMaker's HTML filtering utility (Unix version).

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DOCUMENT HANDLING AND EDITING FEATURES

	ADOBE PAGEMAKER	VENTURA PUBLISHER	FRAMEMAKER	QUARKXPRESS
STYLE SHEETS				
SGML-compliant	○	○	○	○
HTML-compliant	○	○	●	○
Supports named paragraph styles	●	●	●	●
Supports named character styles	○	○	●	○
Create named paragraph style by example	●	●	●	●
Character-formatting controls	●	●	●	●
Line-spacing and alignment controls	●	●	●	●
Paragraph-formatting controls	●	●	●	●
Page-break controls	❶	●	❶	○
Column-break controls	❶	●	❶	○
PAGE COMPOSITION				
Provides layout-error diagnosis	●	○	○	○
Precision placement and sizing of page elements via numeric values	●	●	●	●
Supports text-block links (i.e., flowing text between separate blocks)	●	●	●	●
Multiple master pages per document	○	○	●	●
Define page layout by sections	○	●	●	●
PAGE MANIPULATION				
Move page	●	○	○	●
Insert/delete pages	●	●	●	●
Drag and drop pages in thumbnail view	●	○	○	●
Insert and duplicate page contents	●	○	○	○
BASIC TEXT EDITING				
Cut/paste using drag and drop	○	○	○	●
Undo command	●	●	●	●
Global and conditional search and replace	●	●	●	●
Text-formatting attributes can be search/replace criteria	●	●	●	●
Search and replace named styles	●	●	●	○
Spelling checker	●	●	●	●
Table editor	●	●	●	○
Thesaurus	○	●	●	○
DOCUMENT FORMATTING				
Chapter management utility	●	●	●	○
Allows leading adjustment	●	●	●	●
Widow/orphan control	●	●	●	●
Multiple-page text flow (creates linked frames)	●	●	●	●
Insert pages as text is imported	●	●	●	●
Automatic hyphenation	●	●	●	●
Specify left/center/right justification of header/footer lines	●	●	●	●
Headers/footers on even or odd pages only	●	●	●	●
Line numbering	○	○	○	○
Automatic numbered lists	○	●	●	○
Automatic chapter-number restart	○	●	●	○
Automatic page-number restart	○	●	●	●
Table of contents	●	●	●	○
Generate contents from named paragraph styles	●	●	●	○
Index from external file	○	○	●	○
WORD PROCESSING FILE FORMATS				
Reads/writes ASCII files	●	●	●	●
Reads/writes DCA/RFT files	●	○	●	○
Reads/writes RTF files	●	●	●	●
Reads/writes WordPerfect files	●	●	●	●
Reads/writes Microsoft Word files	●	●	●	●
Reads/writes WordStar files	❷	●	○	○
Reads/writes Word Pro files	❷	●	○	●
Imports word processor style sheets	●	●	●	●
SPREADSHEET/DATABASE FILE FORMATS				
Delimited ASCII	●	●	●	●
dBase II/III/IV	❷	○	○	○
Lotus 1-2-3 WKS, WK1	●	●	○	○
Excel worksheet files	●	●	○	○

❶ Can set break before but not after paragraph. ❷ Imports only.
●=yes; ○=no; features not included with package are marked ○.

sion of the reviewed upgrade includes 17 hyphenation dictionaries, 600 clip-art images, and a powerful scientific-equation and math-processing module. Frame Technology sells a separate Standard Generalized Markup Language (SGML) version of FrameMaker but also distributes a Hypertext Markup Language (HTML) filter with the standard version. (See the Technology Focus box on page 182 for more on electronic-publishing standards.)

During our usability testing, we found every program's style sheets except FrameMaker's to be easy to learn. FrameMaker's style sheets, called Properties, contain more formatting options than any other program does, and its dialog boxes aren't as intuitive as those of the other packages.

FrameMaker's screen environment has a number of drawbacks. Despite the program's use of a quick-access tool palette, some common tools are less accessible than they are in the other programs. For example, you must search through a cascading menu to find the command to establish text links (a feature called *text flow*). Some of the program's dialog boxes were overloaded with information. These criticisms aside, FrameMaker remains a solid tool, especially for creating long documents quickly.

QuarkXPress

Popular in the magazine industry, QuarkXPress offers tools that are easy to learn

Product Information

Adobe PageMaker 5.0a $895
Adobe Systems, Inc.
Seattle, WA
(206) 622-5500
fax: (206) 343-4240
http://www.adobe.com
Circle 1135 on Inquiry Card.

Corel Ventura Publisher 5.0
CD-ROM version $495
Floppy disk version $595
Corel Corp.
Ottawa, Ontario, Canada
(800) 772-6735
fax: (613) 761-8056
http://www.corel.com
Circle 1136 on Inquiry Card.

FrameMaker 5.0 . . . . . $895
Frame Technology
San Jose, CA
(800) 843-7263
fax: (408) 975-6799
http://www.frame.com
Circle 1137 on Inquiry Card.

QuarkXPress 3.31 . . . . . $895
Quark, Inc.
Denver, CO
(303) 894-8888
fax: (303) 343-2086
http://www.quark.com
Circle 1138 on Inquiry Card.

- **The BYTE Archive**
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GRAPHICS FEATURES

	ADOBE PAGEMAKER	VENTURA PUBLISHER	FRAMEMAKER	QUARKXPRESS
COLOR				
Control image brightness	●	●	●	●
Control image contrast	●	●	○	●
Select screen pattern and angle	○	●	●	●
Adjust gray-scale information	●	●	●	●
DRAWING				
Polygons	○	●	●	●
Arcs	○	●	●	○
Color fills	●	●	●	●
Shading/dithering	●	●	●	●
Free-form lines	○	●	●	○
Bézier curves	○	○	●	○
GRAPHICS MANIPULATION				
Group/ungroup objects	○	○	●	●
Flow text around graphics	●	●	●	●
Text over graphics	●	●	●	●
Proportionally and nonproportionally scale graphics	●	●	●	●
Rotate graphics	●	❶	●	●
Anchor graphics to text	●	●	●	●
GRAPHICS FORMATS IMPORTED (PARTIAL LIST)				
Encapsulated PostScript (EPS)	❷	●	●	❷
TIFF	●	●	●	●
Gray-scale/color TIFF	●	●	●	●
GEM	●	●	●	○
Scitex CT bit map	○	●	○	●
Windows Metafile	●	●	●	●
Windows BMP	●	●	●	●
GIF	●	●	●	●
CGM	●	●	●	●
Micrografx Charisma, Designer (DRW)	●	○	●	●
CorelDraw	○	●	●	○
PC Paintbrush	●	●	●	●
AutoCAD DXF	○	●	●	○
Lotus 1-2-3 PIC	●	●	○	○
JPEG	○	●	○	●

❶ Rotates imported but not drawn graphics. ❷ Also exports EPS files.
● =yes; ○ =no; features not included with package are marked ○.

and use for creating newsletters and other design-intensive documents. However, it falls short in features for creating long documents, especially automatic indexing and table-of-contents creation.

QuarkXPress has long offered sophisticated typographic control. Graphic-design professionals find its power in kerning, tracking, point-size control, automatic ligature conversion, and incremental text rotation useful. Such features may be of little interest to the average business user, however.

Quark markets its product heavily to professional DTP service bureaus and therefore does not include templates with QuarkXPress, although it bundles a few page-layout extensions and a graphical archive management system. Third-party vendors produce most of the many XTension products, including some for SGML, HTML, and the sorely missed indexing/table-of-contents functions.

Like PageMaker, QuarkXPress maintains scalable tracking information at the font level, a superior method for preserving good spacing when type fonts are resized. It does not, however, allow parallel column formatting, which is used in formatting screenplays. Also, it's the only program that doesn't support printing to Adobe Acrobat format, an aspiring portable-document standard. Nevertheless, QuarkXPress's user interface is good, its file management is easy to comprehend, and its text-editing functions are easy to learn.

Ultimately, all four programs are robust, feature-rich, and mature. Only a few quibbles separate the "worst" from the best. But still on top is Adobe PageMaker, the program that started it all on the first Macintosh a decade ago. ■

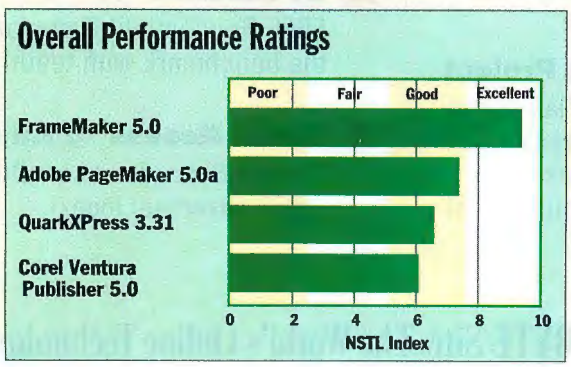
David Seachrist has tested software for NSTL for nine years. His specialties are DTP and graphics.

FrameMaker Is Fastest

NSTL measured the speed of common desktop publishing operations using a three-page newsletter (containing text and imported graphics), and a 69-page, text-only book. Although the overall performance score shows FrameMaker easily beating its competitors (see the bar graph), all four programs showed snappy performance in absolute terms. Testing was done on a Gateway 2000 4DX-2 66V with 8 MB of RAM and a 400-MB hard drive. Print output was directed to a Hewlett-Packard LaserJet 4MP.

In the Go to Page test, which measures the time it takes to go from page 1 to page 3 of the newsletter (page 1 to page 63 in the book) and back, all four programs did each job in less than 1 second. Similarly close results occurred in six cut-and-paste tests and two file-save tests.

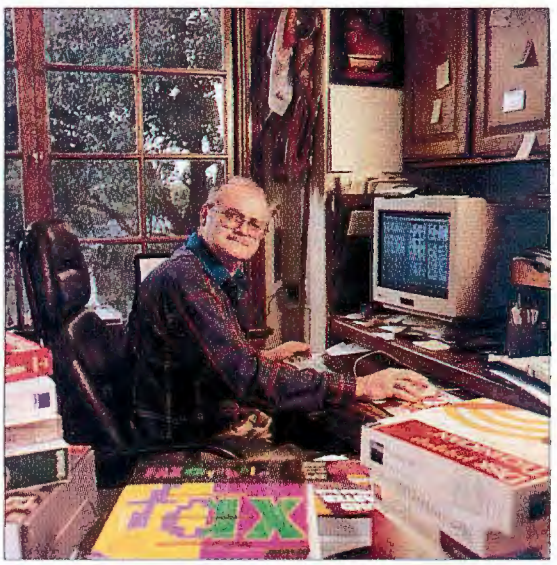
FrameMaker is far and away the fastest at printing, especially in returning control after you issue the print command. FrameMaker was roughly three to 16 times faster at printing the newsletter, which accounts for most of its lead in the overall score. PageMaker nearly matched FrameMaker's return-of-control time in the book test, because no graphics were involved.



This report contains the partial results of a recent issue of Software Digest, *a monthly publication of NSTL, Inc. To purchase a complete copy of the 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.*

JERRY POURNELLE

SuperCow on the Beach



AMY ETRA © 1996

Carrying monitors is an odd way to get exercise, but Jerry does get a gorgeous display

Once a month, I go to the beach house to write fiction. Chaos Manor is a comfortable place, but there are distractions. The telephone is the worst, but there are also piles of review stuff that I really want to look at. You'd think I'd get over feeling guilty about unreviewed items, but I haven't, especially if I asked for it in the first place. If people go to the trouble and expense of sending me things, the least I can do is look at them. Realistically, I know that most items are "yet another," with little to recommend them over what I'm using, but that's not always true.

Incidentally, when I began writing about the computer revolution, I really could keep track of everything and still have time to write science fiction. I knew all the significant players, too. I still get flashes of the old evangelistic spirit: I want to look at everything so I can recommend the best and point out why it's still not good enough.

Because of our treks to the beach house, I've had to learn about portability and environments. The simplest solution would be to do what my son Richard does: don't have a desktop. He has an IBM ThinkPad 755CX Pentium running Windows 95 (W95) and uses it for everything from sending and receiving E-mail and faxes to Excel business models.

Richard grew up in Chaos Manor, but unlike Alex, he never had much interest in computers except as tools. When he got out of UCLA, he was in the right time and place and became in effect the MIS person for the majority in the House of Representatives. Now he's the director of marketing for an Internet service company.

Richard is on the road a lot and also works out of his house much of the time. The top-of-the-line ThinkPad 755CX wasn't much more expensive than a desktop and portable would have been, and he can use his Internet connection for backup capability and additional disk storage.

The ThinkPad came with OS/2, but after trying it for a few days, he changed to W95. He likes the built-in W95 TCP/IP dialer, which is troublesome to set up but works for him much better than most competing Winsock software. He also uses the built-in W95 fax software. I prefer Delrina WinFax, but Microsoft Windows Fax is good enough.

For E-mail, he likes Eudora. I agree. Exchange is huge and clunkier to set up, and when you fire it up, the lights dim. We all wish Eudora could be integrated with software like Excel and Word, which is Exchange's main virtue.

Richard also uses Visioneer's PaperPort VX scanner, which I like a lot. This small 400-dot-per-inch unit connects to a serial port and sits there until you need it. It's easy to install, and like the Citizen PN60 printer, you can carry it in a briefcase or, more likely, throw it into checked luggage. The reader is free—download it from http://www.visioneer.com—and you can send fax documents by E-mail to anyone who has the reader (or send the reader by E-mail, for that matter). This little gadget makes life easier without adding complications. Recommended.

Getting rid of the desktop machines wouldn't work at Chaos Manor, although it's not easy to say why. First there's screen size, but most laptops have a port for an external monitor; I could keep one monitor at the beach and one here. It's the

ILLUSTRATIONS: VICKI YIANNIAS © 1996

same with keyboards. Given how much writing I do, I want a better one than I've found on any laptop—but most laptops provide for an external keyboard, and some have a mouse port.

Laptops have ways to attach CD-ROM drives, and the best laptops come with PC Card slots for modem and Ethernet connections. It is getting harder to think of things you can do with desktops that you can't do with a good laptop. One of these days, I may change over and be done with it. Meanwhile, I have the transportation problem.

Chuck Peddle at Tandon once had a line of hard disk cartridges; the notion was to take your desktop environment with you—but not many people had systems to accept the Tandon cartridge. Then came Ergo's Brick, which was no larger than a disk cartridge and contained your whole computer. Plug in a keyboard and monitor, or plug the Brick into a docking station, and you were set.

That worked well, and I used to carry it to the beach; but the Brick I had contained a built-in VGA video board. When VGA came out it was great, but like everyone else, I've gotten used to better. In particular, for editing text in Word, you want 1024- by 768-pixel resolution for the text to look decent on-screen; and Larry Niven and I do a good bit of editing at the beach.

It's surprising how many people don't know that documents look a lot better when you install higher screen resolutions. I find systems with good video boards (e.g., those from ATI Technologies and Diamond Multimedia Systems) still running off the original Windows VGA driver. Friends are amazed at how much their systems improve with a change to better video drivers and higher resolutions.

Anyway, I've been carrying SuperCow, the Gateway 2000 486DX2/66. Actually, SuperCow isn't all that heavy. What's tough to get down the stairs is the NEC MultiSync 5FGp monitor or the ViewSonic 17GA with built-in speakers. Carrying monitors is an odd way to get exercise, but I do get a gorgeous display.

Last time I was at the beach, the mouse died. It was an old mouse, one of the first of the Microsoft "Dove soap bar" Home Mouse models, and it just quit working.

Fortunately, I had brought Logitech's MouseMan Cordless: a small box you plug into the mouse port and a cunningly shaped feeley that's a delight to hold, with a small trackball and three mouse buttons. Installation was simple: turn off the computer, plug in the Logitech device, and start up, still using the software that came with the old Microsoft mouse.

It not only worked, it was a pleasure to use for all point-and-click operations. There's only one problem: the buttons aren't placed properly for drag-and-drop operations. You can *do* it by holding down the button with the side of your finger while using your thumb on the trackball, but it's pretty awkward. If you mostly use a mouse to control presentations, or just to point and click, the MouseMan Cordless is wonderful and highly recommended. But because a lot of my mouse activity is to mark and drag text, despite the great feel of the MouseMan Cordless, it just wouldn't do.

Thus, next morning I went off to Staples and bought a Microsoft "Big Teardrop" Mouse 2.0. It too installed with no change of software, and it's what I use at home on my main machine, where I have lots of table room. On the OS/2 machine, where space is at a premium, we're using a Logitech TrackMan, which is the only upside-down mouse I know that you can use for drag and drop over long periods of time without wrist exhaustion.

That afternoon I picked Niven up at the train station so we could work on *The Burning City*, our new novel. Niven and I have very different tastes in keyboards. I like my old Northgate OmniKey Plus, with the function keys on the left side and the oversize Backspace key just to the right of the *P* key and above the quotes key. He, on the other hand, is used to having the function keys across the top and the Backspace key next to the numbers row. I always keep a "Niven" keyboard at the beach, and we swap when it's his turn to work.

Of course, no sooner did he get there than his keyboard died—it was about five years old—so we were off to Staples again, this time to buy a Microsoft Ergonomic (née Natural) Keyboard. That's the hump-shaped thing that won't fit in a keyboard drawer. I don't like it much, but Niven bought one the day he saw the evaluation copy at Chaos Manor. The new mouse and keyboard stay at the beach, and with luck, I won't have to worry about them for another five years. Keyboards and mice are very personal things, and if you spend much time at a computer, it's well worth it to buy just what you like.

I like Delrina's WinFax Pro 4.0, but I had a job installing it in W95. It would sort of install, but it didn't automatically attach itself to Word for Windows as it had in Windows 3.11. Whenever I ran the macro script to attach WinFax to Word, I got the message that it couldn't find the file NORMAL.DOT. There was no opportunity to tell WinFax where to find that file, nor any indication of where it expected to see it.

In desperation, I tried copying NORMAL.DOT into every subdirectory I could possibly think of, including the root, Windows, Winword, and Winword\Templates subdirectories. None of this helped, so I

therefore got on-line and fired off some bitter complaints.

The next day I hadn't heard from Delrina, but someone at Microsoft explained the situation. Have you noticed that Microsoft technical support is much better for products like Word, where they have competition?

They told me that WinFax expects to find NORMAL.DOT in the Winword\Templates subdirectory and no other, *and* you must go into Word's Tools menu, Options item, choose the File Locations tab, and tell Word to look for User Templates in \Templates. Since Word created the \Templates subdirectory in the first place, you'd think it would default to looking there for NORMAL.DOT—especially since I'm using the exact same copy of Word 6 that worked with WinFax under Windows 3.11 and got broken only when I installed W95.

Getting WinFax Pro 4.0 installed with W95 is largely a matter of persistence. You will get a lot of warning messages. Ignore them, bull through, and you'll win. Once you get WinFax Pro 4.0 and Word set up properly, WinFax works like a charm. Recommended.

That's not the only default problem I've had with Word 6. Long ago, when Niven and I would work independently on a novel, we'd each pick chapters that would belong to one or the other exclusively until we got together again. That was awkward.

Now we each work on anything we like, and when we get together, I use Word's document-comparison feature to build a merged document that has each change marked. We can see where our two versions differ, admire each other's work, and decide which version to keep or agree on something else. Obviously, this technique would work anywhere people collaborate on documents, and it's one of the most powerful and important features of Word.

Alas, this time it didn't work: Word wouldn't compare our two versions. Eventually, I figured out what to do.

First, while the Options item in Tools has many tabs, the one it doesn't have is Language. That's a separate menu item, and the default is No Proofing. If you want to compare documents, or just check your spelling, both versions have to be set to the same language, which in our case is, unsurprisingly, U.S. English.

The second problem was more serious: I kept getting "out of memory" errors, along with the suggestion that I close down some windows. Since the only window open was Word 6, this wasn't useful advice. SuperCow has 16 MB of memory, surely enough. Now what was wrong?

Eventually I figured out what was happening. Larry was working on SuperCow, while I was working on the same story with SpaceCalf, which is a Gateway 2000 Liberty laptop. SpaceCalf (the name comes from the wallpaper: a space-suited cow standing on the moon) does a great job with 640- by 480-pixel VGA, but that's the best it can do. SuperCow with the NEC MultiSync 5FGp is set to 1024 by 768 pixels.

When I took Niven's copy over to SpaceCalf, I had to reset the document margins to get the whole line on the screen. The result was that Word thought that each changed line was a revision, and when it tried to compare the documents, it really did run out of memory. If this ever happens to you, the remedy is simple: make sure that each version of the document is formatted in exactly the same way. After that, Word for Windows performed fine.

I just came back from the annual Hackers' Conference. This is an invitational event featuring hackers in the old sense: creators of clever things to do with computers. Attendees included Allan Alcorn (who designed the original Pong), Nancy Blackmun, Stewart Brand, Lee Felsenstein, Richard Garfield (who created the game known as Magic: The Gathering), Mike Godwin of the Electronic Frontier Foundation (EFF), and Donald Knuth.

Also there were Amory Lovins, Matthew McClure (who founded The Well), Chuck McManis (who used to be an intern here at Chaos Manor), Ted Nelson, Don Norman (now a VP at Apple), Clifford Stoll, Vernor Vinge, Bruce Webster, and 180 others of that ilk. These are many of the people who invented the computer revolution, and others who now think about how we can improve it. Sessions

tend to be serious, but the main value of going is to get together and compare notes.

It does have its lighter moments. After lunch on Saturday, I noticed that everyone was out on the patio. Picture over 150 people, the least experienced of whom could command a consulting fee of $75 an hour, all working on a problem, to wit: Edward Haas had built a scale-model trebuchet, a medieval device that uses gravity power and a long lever to fling objects, and the problem at hand was to make it launch a potato as far as possible. We did pretty well, too.

Years ago, Poul Anderson had a trebuchet in his wonderful science fiction book *The High Crusade*, but I questioned the range he gave it and tried to do a mathematical model. Those things are complicated! If you can do a good computer simulation of a trebuchet, please send me E-mail. I'll think of a suitable reward for the most elegant simulation.

When I was getting ready to go to the Hackers' Conference, I found to my great horror that SpaceCalf wouldn't run Windows. It booted up into DOS all right, but when I invoked Windows, it gave the error message that the required file PAGEFILE was corrupt. A quick search with Norton FileFind confirmed what I suspected: there is no such file.

Since DOS was working all right, the next thing was to take a look in SYSTEM.INI, where, sure enough, it was loading *PAGEFILE on start-up. That initial * means this is not a real file but a virtual file created when Windows starts up; and there's no real way to know what elements go into that file's creation.

The first thing to do was to use BOOTCON to make a copy of my system files: AUTOEXEC.BAT, CONFIG.SYS, WIN.INI, and SYSTEM.INI. BOOTCON lets you keep many combinations of those files, so you can work on the copy and still get back to where you started. BOOTCON doesn't work with W95 yet; but if you still use DOS/Windows, you definitely need BOOTCON.

I tried commenting out the line that brought in *PAGEFILE. That merely locked the system more thoroughly. There was nothing for it: I'd need to reinstall Windows, and since SpaceCalf has some special routines for power and PC Card slot management, I'd need the floppy disks that came with it. This was the first real problem I've had with the Liberty in a year, and I hadn't a notion of where I had put the documents and floppy disks.

Finding them took longer than solving the problem. Once I found them, I connected the floppy drive. On the Liberty it's external, attaching to the parallel port.

I ran Windows Setup from the floppy disk, and at disk two was dropped back to DOS. I should have known why, but in fact I called Gateway technical support. I realized what the problem was as I was describing it. Before you can reinstall Windows over an older version, you *must* run Windows Setup and change the screen resolution to standard VGA. That done, the reinstallation went just fine, and when I invoked Windows, that worked, too. Of course, SpaceCalf was in VGA mode, which isn't all that pretty, and I had forgotten what video mode I usually used.

Experimenting isn't hard, just tedious; but for luck I told BOOTCON to select my original WIN.INI and SYSTEM.INI rather than the copies I had been working on. It worked, and SpaceCalf is his old self.

I have no idea what happened, and neither does Gateway. Every now and then, Windows does something odd. Lest OS/2 people get too complacent, we recently

had a similar experience with the OS/2 machine. In fairness, I have to say I have not had to reinstall W95 since the "termination with extreme prejudice" I reported on in December.

One important discussion at the Hackers' Conference was about intellectual property rights and the Church of Scientology. The church claims both copyright and trade-secret protection for certain documents. Former members have been broadcasting those "confidential" documents on the Internet. To make matters even worse, someone then hacked the Scientology BBS so that the confidential documents were available from the open area of the church's BBS. This allowed third parties to innocently obtain copies of material the Scientologists don't want anyone but their officials to see.

From there it gets even more complex. There have been raids on private BBSes and personal systems, with confiscations of equipment that may or may not contain copies of the allegedly protected documents. This is done under federal copyright laws intended to protect business.

Consider, for example, a case in which science fiction novels were printed by a pirate firm in Israel. The books were smuggled into the U.S. and sold to discount stores with no royalty payment to the copyright holders. When the Science Fiction Writers of America—I was president at the time—found those books, we had them seized by U.S. marshals since they were clearly in violation of copyright. If they had been allowed to get into the commerce stream, it would have been impossible to undo the damage. The action is intended to prevent further damage.

The Scientologists are claiming that the same laws allow seizure of *electronic* copies, which means hard and floppy disks. The problem with that theory is that the seizure is not precisely preventative—a document that has been put out on the Internet exists in multiple copies—but in effect *punitive*, and this without trial or defense, or any real determination that the documents exist on the seized equipment.

We have a conflict of values. Clearly, I favor the protection of intellectual property. I also favor the free exchange of ideas. I am enormously uncomfortable about federal officers raiding private houses to seize computer equipment, just as I am very much opposed to the President's draft legislation that makes it easy and convenient for federal officers to tap telephones by the hundreds of thousands.

I'll be continuing this discussion in the future. There will also be a session about this at the annual meeting of the American Association for the Advancement of Science late this month in Baltimore. The problem isn't going away.

We have an embarrassment of riches in removable storage media. Looking around Chaos Manor, I see magneto-optical (MO) disks—the Fujitsu DynaMo 230 I wrote about in October continues to work well—several formats of optical drives, digital audiotape (DAT) controlled by Palindrome's Network Archivist, a huge 8-mm Exabyte Mammoth tape drive, and the newest additions, two HP Colorado Memory Systems drives that use Travan 400-MB cartridges.

Travan is *much* cheaper per megabyte than the old 40-, 80-, 120-, and 250-MB Jumbo tape drives. It's also quieter and a lot cooler. The old 40-MB tapes could get too hot to touch after a full backup. The Travan cartridges are smaller physically than DAT or 8-mm but have more storage, which is why they're cheaper; larger tapes mean looser tolerances.

The drive we have is the HP T1000, a make-over of the Colorado Memory Systems 1000. The software that comes with it will back up an entire Windows network. Like Network Archivist, Colorado Backup for Windows and Colorado Backup for Windows 95 will copy any drive they can see, and you can set them to do an incremental backup (i.e., copy only files that have changed) at night if you like.

We have both the external and internal versions. The HP T1000e external drive is a 9- by 7-inch box—it's 12 by 7 inches with the cables attached—and 1½ inches thick. It can lie on its side or stand on edge; either way, it gets plenty of ventilation. Installation couldn't be simpler: plug the power cable into the wall (in my case, into the little Clary OnGuard uninterruptible power supply [UPS] that runs SuperCow) and connect the parallel cable. Install the software, insert a tape cartridge, and let fly.

Be warned: while 6 MB a minute sounds pretty fast, it takes over an hour to back up a 225-MB hard drive, thanks to things like verification. Incremental backups are faster, but still slower than you might think due to the time required to write tape headers.

The HP T1000 internal version runs off the floppy cable string. Because the limiting factor in both cases is tape drive speeds, there's no particular speed advantage to the internal drive, and you can use the external drive for file transfer.

The HP T1000 is solid, easy to use, and reliable. The external version will work with any computer with a parallel port, including laptops, and is smaller than many laptops. The medium is rugged, isn't expensive, and holds between 400 and 800 MB a tape depending on the kind of file.

The disadvantage is speed, and if you do backups at night of a lot of data, you may need to be present to change tapes. Withal, it's a lot better than no backup at all, and anyone can afford it.

If you have kids, employees, or students, look into World's Easiest Certificates. This is a kit that makes great-looking certificates, ranging from suitable for framing with gold seals down to a coupon exchangeable for a hug or a big favor. World's Easiest is a branch of T/Maker, and they also make kits for invitations, résumés, stationery, and announcements. It's solid, well thought out, and lives up to the name "World's Easiest." There's nothing here you couldn't manage to put together on your own with Word, Microsoft Publisher, and stuff from a stationery supply house, but you'll likely use this kit.

The game of the month is Mission Code: Millennium, from Virtual Entertainment. Try to see a demonstration: it's a bit like Broderbund's Carmen Sandiego games, in that it's educational and oddly fascinating. It kept my interest for hours longer than I'd ever intended to put into it. It's a fascinating exhibition of what you are able to

program nowadays with Macromedia and QuickTime.

The Hot Flash of the month is that MicroProse Software is releasing Sid Meier's Civ Net, a multiplayer version of Civilization, with provision for playing by modem or over the Internet. I expect this to take off.

The book of the month is Ivars Peterson's *Fatal Defect* (Times Books, 1995, ISBN 0-8129-2023-6), which is about computer bugs that have been fatal in more than one sense. Well written and a bit frightening.

The CD-ROM of the month is the 1996 Grolier Multimedia Encyclopedia. It includes linkages through CompuServe if you have a modem, but it's plenty good stand-alone.

We're putting together a hot dual-Pentium system; lots about it and cutting-edge stuff like six-speed CD-ROM drives and Micropolis 9-GB drives next month. ■

Product Information

BOOTCON 2.5 ($49) lets you keep many combinations of your system files, so you can work on the copy and still get back to where you started. Contact **Modular Software Systems,** Kent, WA, (800) 438-3930 or (360) 886-8882; fax (360) 886-8883; on CompuServe, go modsoft. **Circle 1058 on Inquiry Card.**

The **HP T1000** ($218) and **HP T1000e** ($255) are solid, easy to use, and reliable. Contact **HP Colorado Memory Systems,** Loveland, CO, (800) 845-7905 or (303) 669-8000; fax (303) 667-0997; colorado_support@hp-loveland-om10.om.hp.com. **Circle 1059 on Inquiry Card.**

Mission Code: Millennium ($49.95) kept my interest for hours longer than I'd intended to put into it. **Contact Virtual Entertainment, Inc.,** Needham, MA, (800) 301-9545 or (617) 449-7567; fax (617) 449-4887; http://www.virtent.com. **Circle 1060 on Inquiry Card.**

The **MouseMan Cordless** ($79.95) not only worked, it was a pleasure to use for all point-and-click operations. Contact **Logitech, Inc.,** Fremont, CA, (800) 231-7717 or (510) 795-8500; fax (800) 245-0000; on CompuServe, go logitech. **Circle 1061 on Inquiry Card.**

The CD-ROM of the month is the **1996 Grolier Multimedia Encyclopedia** (Mac and Windows, $49.95 each), which includes linkages through CompuServe. Contact **Grolier Electronic Publishing, Inc.,** Danbury, CT, (800) 285-4534 or (203) 797-3530; fax (203) 797-3835; http://www.grolier.com. **Circle 1062 on Inquiry Card.**

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Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, he cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.

Extending OS/2's User Interface

The Workplace Shell API is a wondrous object-oriented UI. You can extend it without adding a single executable.

KURT WESTERFELD

IBM's OS/2 Warp gives you hooks to customize its Workplace Shell user interface in ways that Windows 95 has still not caught up with. That capability has been exploited in a number of commercial shell-enhancement products, including Lotus' cc:Mail, Wordperfect's Integration Tools for WP 6.1, and IBM's own Warp Bonus Pak, VisualAge developer tools, Search Manager/2, and multimedia tools. But despite the fact that Workplace Shell has had a stable and robust object technology since 1992, many developers have not become familiar enough with Workplace Shell's underlying System Object Model (SOM) to take full advantage of this power. You can take several routes to a new UI for OS/2, ranging from simply registering new DLLs, through adding object types, to replacing whole classes in the object hierarchy.

For starters, you don't necessarily need to master SOM to change Workplace Shell. Last year, the company I work for, Stardock Systems, introduced a software product based on OS/2 Workplace Shell objects called Object Desktop for OS/2 Warp and OS/2 2.11. Object Desktop blends the use of system objects, object class replacement, system hooks, and other means to create an evolutionary upgrade to the OS/2 Workplace Shell.

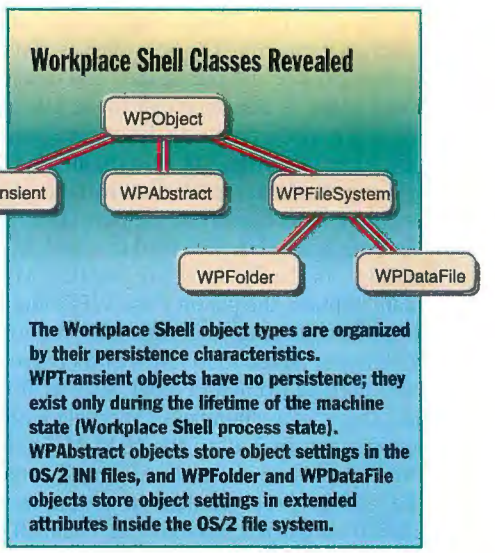
Most of Object Desktop is written to the Workplace Shell API. It exploits a number of unique specializations of this API, as well as a few obscure system hooks rarely seen in OS/2 programs. One interesting result of the Object Desktop implementation is that there are no executables! Object Desktop is made up entirely of dynamic link libraries, which are registered either directly or indirectly via the Workplace Shell object-class registration mechanism (WinRegisterObjectClass). Registering a Workplace Shell object class results in an entry being placed in the OS/2 system INI database. The OS/2 Workplace Shell interrogates this database on system start-up and demand loads the corresponding object classes via dynamic linking. Hence, the only executable that runs is the installation program, and thereafter the operating system directly invokes the object code when necessary.

Changing the OS/2 Shell

The most common way to enhance the OS/2 Workplace Shell is by adding new object types to the system class hierarchy. Programming in this environment necessitates using IBM's SOM and Workplace Shell APIs. SOM programming fully supports object-oriented capabilities such as inheritance, polymorphism, and encapsulation, as well as binary replacement of base classes.

To create a new class, you generate a SOM interface definition language (IDL) file and run it through the SOM precompiler. The precompiler emits C or C++ bindings with empty functions for each object method, private and public header files, and other optional project components. The parent class for the newly generated object class is specified in the SOM IDL file, which, in the case of Workplace Shell objects, is one of the preexisting classes defined by the default OS/2 Workplace Shell. Each overridden method is also specified in the IDL file, along with public and private methods and data.

After the components of the SOM/Workplace Shell project have been generated, OS/2 API or Workplace Shell method code is inserted in each of the overridden methods. The structure of the Workplace Shell methods provides the necessary entry points for creating new windows as necessary, and for creating new threads and initializing resources. For example, a wpInitData method is provided; it's analogous to a C++ object constructor. The Workplace Shell process calls this method whenever a new object is awakened or created. In other cases where new object views may be desired, a programmer can override the base method *wpOpen*, which is called by the shell whenever a new view is generated for the user to interact with.

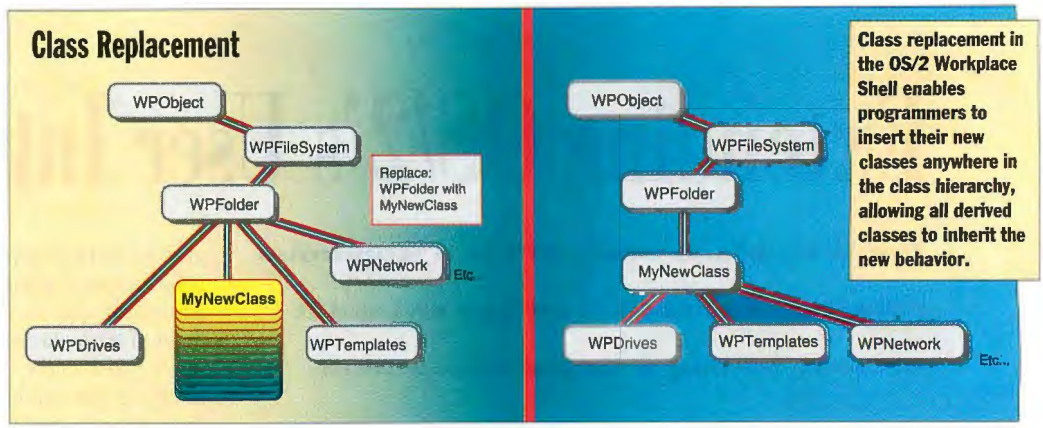


The Workplace Shell object types are organized by their persistence characteristics. WPTransient objects have no persistence; they exist only during the lifetime of the machine state (Workplace Shell process state). WPAbstract objects store object settings in the OS/2 INI files, and WPFolder and WPDataFile objects store object settings in extended attributes inside the OS/2 file system.

Although there are several object types in the Workplace Shell (see the figure above), there are several reasons for using the WPFolder class as a parent class. Contained objects are saved and restored in a safe and portable manner. File system back-notification of object changes is provided via wpAddToContent and wpDeleteFromContent methods. WPFolder supports background bit maps to customize appearance, custom colors and fonts are saved with no extra effort, and drag-and-drop operations such as copy and delete are supported. And the context

menus of contained objects are invoked and dispatched.

WPTransient objects are used within Object Desktop to display temporary objects that do not correspond to any object normally on the OS/2 Desktop. This includes displaying the contents of an Object Archive (i.e., a ZIP file), which is really just a view of a database. In fact, the use of WPTransient objects as temporary placeholders to database query entries is fairly common.



Class Replacement

Probably the most powerful capability exposed by the Workplace Shell API is replacing classes in the SOM/Workplace Shell class hierarchy. Class replacement enables programmers to add behavior to all classes derived from a particular class. The Workplace Shell group originally developed this capability by creating a customized SOM class manager object. (SOM version 2.x has this capability in the somSubstituteClass class manager method).

Class replacement is difficult to describe since there is no analog in other object models to pull examples from, and since "replacement" isn't really what happens. The mechanism is actually more like an "insertion" into the object class hierarchy.

A new class is derived from a parent class in the Workplace Shell class hierarchy. The new class is given specialized behavior—new private and public data and methods may be added to the new class. A one-time call to the OS/2 WinReplaceObjectClass API is made, replacing the original parent class with the new class. After restarting the system, all classes derived from the original parent class, including instance objects of that parent class, gain the behaviors of the new class.

This mechanism may be hard to visualize, but the results are astounding. As the figure above implies, MyNewClass does not actually replace the parent class WPFolder as much as it sneaks into the class pecking order right after WPFolder. The result is that any behavior added to MyNewClass is propagated down to the classes derived from WPFolder, such as WPDrives and WPNetwork. This is how a number of Workplace Shell enhancements are implemented, including the IBM Multimedia Viewer, Lotus cc:Mail, and some object-level security add-ons.

To see class replacement in action, install the Multimedia Viewer from the Warp BonusPak. Then, all objects derived from WPDataFile (which includes any file on your system) will gain the menu choice Create LTReference, which can be used to create a reference for the data object (an image or other multimedia data type) in a new type of folder called a "light table."

Advice for Enhancing the UI

Developing an object that enhances the UI implies that the code is always active, which is a challenge to minimizing system impact. Products intended to be add-ons must work with the same performance features and stability as the system they are installed on. System requirements should not be greatly affected.

The best way to ensure system stability is to use OS exception handlers in all object methods. The OS/2 and Win32 APIs allow for structured exception handlers to be added to programs or objects, giving programs the ability to self-diagnose memory violations, to recover gracefully from stray pointers, and so on. If your objects or objects you interact with use semaphores—a universal trait in a multithreaded environment—exception handlers are a necessity to ensure that resources acquired are freed even when a memory violation occurs.

When implementing a system add-on, use the least common denominator of API features for maximum compatibility. While it is tempting to use features that may appear only on one particular flavor of an operating system, don't succumb. Use the set of APIs that maximize your potential market.

In terms of forward and backward compatibility, an interesting option surfaces when using a flexible object model like IBM's SOM or another CORBA-compliant object model. With these types of systems, it is easier to write objects that adapt to the environment they encounter. For example, in OS/2 2.11 there is no provision for folder objects to have animated icons. Users of Stardock's Object Desktop, however, would like to have support for this new feature in the OS/2 Warp user interface. By taking advantage of SOM, Object Desktop objects are able to discover that a particular interface is implemented by base functionality when running under OS/2 Warp, and then dynamically overriding the corresponding methods on the fly.

After investigating the various ways you can enhance the OS/2 Warp user interface, and the care you must take to write applications that seamlessly blend with the operating environment, you have to answer a fundamental question: Is it worth it?

There are obvious advantages to developing applications in this manner. Complete forward and backward compatibility is guaranteed by the IBM System Object Model, which allows for changes to base class code without recompiling. Because of this capability, Workplace Shell developers enjoy receiving new features for free as versions of the OS are released with changes to base classes. Another advantage to SOM/Workplace Shell programming is a more elaborate and flexible architecture for developing adaptable code.

Workplace Shell objects also present a more powerful set of capabilities to end users. Most OS/2 applications are written to the Presentation Manager API alone. These programs miss out on exposing links to shell objects altogether. To gain similar features to shell objects, developers have to laboriously code drag and drop, settings notebook, and other UI nuances instead of inheriting them. What's more, as IBM adds the intended OpenDoc and Taligent code bases to the Workplace Shell, Presentation Manager applications will have to be revised to keep up. Workplace Shell objects will inherit these features for free. ■

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An Alpha in PC Clothing

Digital Equipment's new x86 emulator technology makes an Alpha system a fast x86 clone

TOM THOMPSON

In the day-to-day skirmishes between the RISC and CISC camps over performance issues, few dispute that Digital Equipment's Alpha RISC processor holds the crown for raw speed. However, speed alone doesn't determine the practicality of a desktop system these days. Instead, software that provides solutions is a major part of the decision process. A port of Windows NT 3.51—and over 1200 mainstream Windows applications—to the Alpha helps sweeten its appeal by allowing it to run familiar programs at RISC speeds.

But while the prospect of running CAD and imaging programs at breakneck speeds is tempting, losing the rest of the software that handles your day-to-day activities—that World Wide Web browser, the word processor, a terminal emulator, and the E-mail program—in the bargain is still too high a price to pay. Simply put, although there's a lot of useful x86-based software out there, cost, development efforts, and other issues mean that these programs aren't going to be ported to the Alpha soon, if at all.

To improve the Alpha's usability as a desktop alternative to Intel processors, Digital decided to provide x86 code support. The company determined that an on-chip solution was too costly in terms of die space and implementation difficulty, as witnessed by AMD with its K5 processor.

With its extensive experience in porting and translating Mips, SPARC, and VAX code to the Alpha, Digital instead opted to write an x86 software emulator. Another reason to employ a software emulator rather than porting code is that the technology can be quickly modified to support changes in Windows NT.

However, Digital added an interesting twist to its emulator technology, called FX!32. Since emulation is always slower than native code, FX!32 quietly performs a binary translation of portions of an x86 program to Alpha code and saves these translations to the hard disk. The end result is that over time, your favorite x86 programs become composed mostly of Alpha code and run much faster. Because of the Alpha's high throughput, these translated programs should run faster than any existing Intel-based system, making an Alpha-based computer an ideal PC clone.

It's in the Launch

To perform its sleight of hand, FX!32 consists of several modules, as shown in the figure "FX!32 Components." The FX Server invokes the Background Optimizer component as necessary. When the system first starts, a Transparency Enabler patches NT's `CreateProcess()` routine. Since `CreateProcess()` handles the generation of all child processes in the system, the Enabler thus provides a mechanism by which FX!32 detects the launch of an application process. When one occurs, the patch code examines the file's header to check the processor type. Bits in this header indicate whether the application code runs on an Alpha, Intel, Mips, or PowerPC processor.

Normally, Windows NT gives you a warning message if there's a mismatch between an application's processor type and that of the host. If the type bit indicates the file is an x86 application, a Runtime component (described below) handles the creation of the application process. First, it consults a database file to see if a translated version of the x86 program exists. If so, it starts this translated code.

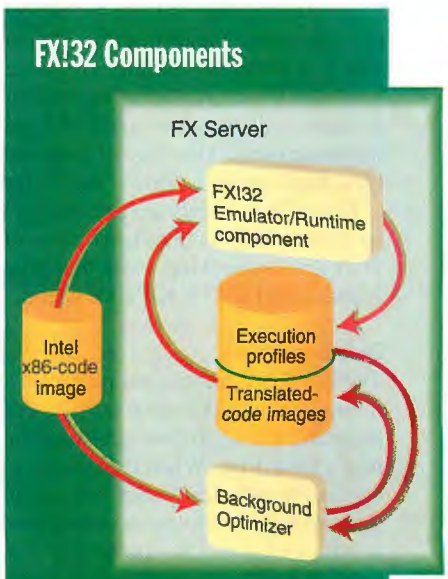
The first time you launch the x86 program, the patch code hands off the job to the FX!32 Emulator/Runtime component. This component is so named because it not only interprets x86 instructions but also intercepts x86-based NT API calls and routes them to corresponding Alpha-based NT calls.

Code Wrapping

The Runtime portion of the component implements its own NT loader. As it loads the x86 code into memory, the Runtime portion inserts "jackets" that provide an interface to the system's Alpha-based NT calls. It does this by first examining the application file's import section, which lists all the DLLs it requires to operate and all references to API functions in these libraries.

The Runtime modifies these import-table entries to reference jacket code. This code starts with an illegal x86 op code, which invokes the Runtime's exception handler. When the x86 program accesses an NT service, it first pushes the function's parameters onto the stack and calls the function.

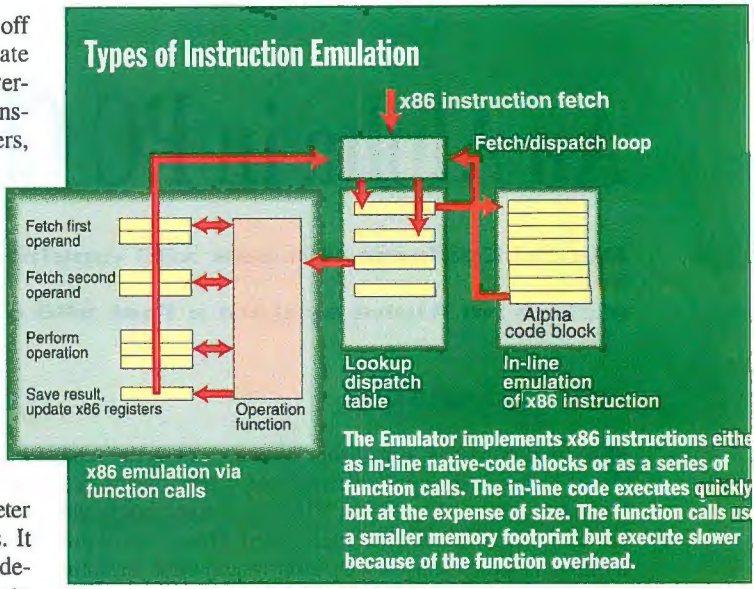
continued



The various FX!32 components. The Emulator/Runtime component handles the launch and operation of an x86 application. The FX Server starts the Optimizer component as a background process when system activity is low, and it maintains a database of execution profiles and translated-code images for each x86 application.

This triggers the exception handler, which pops the parameters off the emulated x86 stack and then places them in the appropriate registers on the Alpha. Finally, the jacket code calls the native version of the NT function. Function results undergo a similar transformation so that they wind up in the appropriate x86 registers, where the x86 program expects them.

The loader also examines the database to see if translated portions of the program or DLLs exist. If so, it loads these into memory as well and sets up a table that consists of address pairs. The first entry is the x86 program's address in memory, and the second is the corresponding memory address for the Alpha code. If no translated code exists, the second entry is empty. As the Emulator component runs, it continuously monitors this table. If it finds a pair of addresses, it uses the second address to jump into native code.



Emulation Strategies

The Emulator component is basically an x86 instruction interpreter with support for code jacketing and translated-code jumps. It has a pipelined dispatch loop that fetches an x86 instruction, decodes it, and, via a lookup table, routes the thread of execution to a native-code block that carries out the requested operation. The pipelined design enables the loop to start the table lookup for the next x86 instruction (recall that x86 instructions are variable-length) as it dispatches the current instruction.

Native-code blocks take two forms, as shown in the figure "Types of Instruction Emulation." The first type executes only the x86 instruction, such as an add to a memory location, that performs the necessary memory accesses and operations and adjusts the state of the x86-condition registers. This type of block executes quickly because it's all in-line code. It's also large, because this code must handle the operation in every detail.

The second type of code block consists of function calls. The first call parses the instruction. This function calls another function that performs the memory accesses. Next it calls an add function, which performs the addition operation, and another function call stores the result. A final call updates the x86-condition registers. This type of code block is smaller than the first type, but it executes slower due to function-call overhead.

Digital's engineers are fine-tuning the emulator design so that specific x86 instructions invoke one or the other code-block type. They are also seeking a mix that minimizes cache misses in the Alpha 21064A's 16-KB code cache.

Code Conversion

The Emulator component performs another important task. As it runs, it stores execution profiles that document the flow of the program. These profiles get stored in a database file on the system's hard drive. When the system's activity level falls below a certain point (typically after you stop using an application), the FX Server starts the Optimizer component. This acts like a compiler with a front end that parses x86 instructions instead of source code. It builds an intermediate representation of the program, working on those sections for which it has execution profiles. It also performs some code optimizations, instruction scheduling, register allocation, and dead code removal.

Finally, the Optimizer creates an accurate representation of the program section as Alpha code and saves this image on disk. The next time you start the program, the FX Runtime picks up the translated code. Digital's goal is for such translated programs to run at 70 percent of the speed of native programs.

The Emulator produces profiles only for those portions of the program that actually run, and the Optimizer translates only those parts of the program for which it has a profile. On subsequent application launches, portions of the program that aren't translated wind up in the Emulator, which begins generating profiles on them. Over time, most of the x86 program gets translated, typically in about two or three uses. Because FX!32 adds code to the application files, you can expect an application's disk footprint to at least double in size.

The FX!32 Server maintains a database of the translated code sections for each program. Ordinarily, the Server discards old translated code when a new translation is started and the hard disk quota is about to be exceeded. The FX!32 user interface lets a user manage this process. For example, the user can raise or lower the disk-quota size and mark x86 programs whose translated code should not be purged.

The initial implementation of FX!32 runs entirely in user mode on Windows 3.51. Some FX!32 code, such as the loader, duplicates functions that are part of NT but are not available to user programs. This isn't desirable, because FX!32 must track changes in the parts of NT that it duplicates. Microsoft is making changes to the Win32 API, which will support emulators like FX!32. As part of Digital's alliance with Microsoft, the two companies are working to ensure that FX!32 works with this new interface.

It's important to note that FX!32 is designed to work with 32-bit Windows programs. Sixteen-bit DOS and Windows programs are handled by the x86 emulator technology in NT provided by Insignia Solutions.

The implications for FX!32 on the computer industry are interesting. Unless a new platform offers a large performance difference, it's not worth the effort and software costs to switch from an existing platform. Since FX!32 is bundled with every Alpha system, you now have a compelling reason to switch: a huge performance difference (even compared to the Pentium Pro) and the ability to host that huge investment in x86 software your business has made. Better still, through FX!32, 32-bit applications can run at near-native speeds. ■

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What's the Future of Dylan?

It's an expressive object-oriented language, but Dylan might have spent too much time out on Highway 61

DICK POUNTAIN

The saga of Apple's Dylan language begins in the mid-'80s, when object-orientation was only just moving into the mainstream and C++ did not have the mindshare it does today. Advanced thinkers at Apple decided that the new Macintosh interface deserved a truly high-level programming-language environment. None of the available languages they inspected (such as Smalltalk, Common Lisp, Eiffel, and Self) quite fitted their bill, so the team created Dylan. It may be named after Dylan Thomas or Bob Dylan, depending on who you talk to. So far, only experimental implementations of language subsets—like Marlais and Mindy—have emerged. But at the time of this writing, Apple is finally about to issue a near-commercial-quality "technology release" of Dylan for the Macintosh.

How Does It Feel?

Dylan is intended to be a general-purpose high-level language as suitable for systems programming as it is for commercial application programming. The target audience is developers who have become disillusioned with the complexities and insecurities of C++.

Dylan differs from C++ in several major ways. It's a pure object-oriented language in which everything is an object, like Smalltalk but unlike C++. It is a dynamic language that retains information about the types of objects at run time rather than compiling it out. Dylan also features automatic memory management and garbage collection. It's incrementally compiled and hence facilitates a rapid development cycle. And it's a modular language, with type-checked module interfaces, to help in building large, extensible applications.

Dylan uses an object model closer to that of Common Lisp Object System (CLOS) than to that of Smalltalk, so rather than sending messages to objects, Dylan implements polymorphism via generic functions with many alternative implementations called *methods*. The type of the arguments passed at run time determines which method to execute. Though Dylan is inspired by CLOS, it doesn't use a Lisp-like syntax, is a smaller and simpler language than CLOS, and can run on much smaller computers. Dylan is fully compiled, and it provides that clean distinction between the development environment and the run-time deliverable that's expected of commercial applications.

Dylan programs contain just two basic entities: objects and functions. Objects are bundles of data contained in named *slots*, while functions are code that performs action on objects. Objects are related in a class hierarchy with multiple inheritance.

The listing below shows a typical Dylan declaration, of a class called `<employee>`. The angle brackets are a Dylan naming convention that indicates a class or type name. The class `<employee>` inherits from class `<object>`, the parent of all objects. The `<employee>` class contains two slots (like data members in C++) called `name` and `salary`, which hold data of type `<string>` and `<number>`, respectively. The Dylan language supports automatic initialization, so the salary slot of an employee will get initialized to 50000 if no other value is supplied during instance creation.

Dylan also supports *keywords*, similar to those in Smalltalk, that label function parameters and make the code much more readable. At the end of the "Dylan Class Declaration" listing, I create an instance of `<employee>`, called `Jim`, using the `make()` function. I can initialize these slots by name, using the keywords `name:` and `salary:` in any order, but the `name:` initialization is compulsory (`required-init-keyword`) and will raise a compiler error if omitted. Omitting a slot from the `make` call altogether causes it to take its default value. This mechanism hugely improves the readability and writeability of Dylan code when functions have many arguments.

Dylan is a strongly typed language, but type declarations for variables are optional since the system knows the type of every object. A variable is just a way of attaching a name to an object, and it's the object rather than the variable that possesses a type. Omitting a type definition will force Dylan to perform run-time checks, and so supplying a type (as in slot `name :: <string>`) will usually enable the compiler to generate faster code.

It is impossible to change the data in a Dylan slot by direct assignment; you must use functions to change or read slots. However, Dylan helps you by creating such access functions automatically; in the case of my `salary` slot, these will by default be called `salary-setter` and

Dylan Class Declaration

```
define class <employee> (<object>)
 slot name :: <string>,
  required-init-keyword: name: ;
 slot salary :: <number>,
  init-value: 50000,
  init-keyword: salary: ;
end class <employee>;

define variable Jim = make(<employee>, name:
"Jim Smith", salary: "54000");
```

salary-getter. I could change Jim's salary by salary-setter(56000, Jim) or using the familiar dot syntax Jim.salary := 56000, or I could use a hybrid: salary(Jim) := 56000.

Generic Functions

```
define method double(x)      // match any object
 pair(x, x);              // return two references
end method double;

define method double(x :: <number>) // match any number
 2 * x;                   // multiply it by two
end method double;

define method double(x :: <string>) // match any string
 concatenate(x, x);           // return 'stringstring'
end method double;

define method double(x == nickel:) // match only the symbol nickel:
 dime:;                   // return symbol dime:
end method double;
```

Methods and Polymorphism

Dylan functions are of two kinds: methods and generic functions. A method is the smallest executable unit of code, and a collection of methods with the same name but with differently typed argument lists constitutes a generic function (see generic function double in the listing at right). The argument list of a method is called its *specializer*, and when a generic function is called, the method whose specializer most nearly matches the type of the actual supplied arguments is the one that gets dispatched for execution. So, in double(12) the second method would fire. If several specializers related by inheritance would all match an argument, then the most specialized subclass is chosen. In fact, Dylan is multiply polymorphic (unlike Smalltalk or C++) since functions can have arbitrarily many required parameters, each of which can be specialized independently.

Unlike Smalltalk or C++, Dylan's methods are not encapsulated in a class definition, and you can call them directly like ordinary functions. This looser association of methods with classes confers an important advantage. In Dylan, you never need to create artificial glue classes just to inherit virtual methods from, as you so often do in C++. This makes for shallower class hierarchies in Dylan programs and so reduces the overhead of method dispatch.

All Dylan functions return a value, which is the value of the last statement executed in their code body; no return statement is needed. The first version of double has no specialization at all and simply returns two pointers to its argument, of whatever type. The last specialization of double illustrates two more features: *singletons* and *symbols*. The == operator constrains that argument to be equal to just a single object rather than belonging to a class of objects. In this case, that singleton object is the symbol nickel:, an immutable string that behaves like an enumerated type in Pascal.

Modules and Libraries

Dylan provides large-scale program structuring by modules and libraries, which control the visibility of variable names. Since all Dylan classes and functions are stored in variables, modules can effectively import and export them, as in this example:

```
define module company
 use dylan, ;
 export <employee>, workgroup;
end module;
```

Company is a module that imports dylan (the system module containing language primitives) and exports just the class employee and the function workgroup to any other module that uses it. Libraries are even larger structuring units that contain, import, and export a number of modules. Dylan libraries will also be responsible for maintaining links between source-code and executable-code modules, in an implementation-dependent way that is intimately linked to a particular development environment.

Modules are enormously helpful in the building of large programs. They prevent name clashes (since each module constitutes a separate namespace); but in object-oriented programming, they have a special, even more important role to play as the unit of application extension. Thanks to late binding (e.g., virtual methods in C++), you should be able to extend an object-oriented application by adding new compiled code without needing to recompile the application itself or even needing its source code. To make this work effectively requires a compilation unit that's larger than a single class, and that supports well- defined and type-checked interfaces. Surprisingly, many OOP languages lack such a facility, but Dylan's libraries fit the bill.

Once Upon a Time You Dressed So Fine . . .

Dylan collects together many of the best ideas in modern programming-language design, combining highly expressive primitives with a clean attractive syntax. However, several question marks hang over its future. Dylan's very late, having taken almost a decade to realize. In that time, C++ has achieved an almost unshakeable grip on the programming world. Performance remains in question, too, and since the experimental Dylans have all been interpreters, they offer little guidance as to how fast a commercial compiler would be.

A team at Carnegie Mellon University continues work on a Unix Dylan. The software firm Harlequin is close to releasing commercial Windows and Unix implementations, including a prototype producer for the Architecture Neutral Distribution Format system, which produces portable binaries.

Apple recently closed the lab where all Dylan work took place and disbanded the team. The company issued E-mail to developers indicating that the prototype "technology release" of Dylan will be distributed but will be the last to be funded or supported by Apple. The latest verdict from Apple says: "The investment required to deliver a Dylan product that satisfies the customer needs in a timely manner and create the infrastructure to ensure Dylan's success in the market at this time is prohibitive." ■

Where to Find

Dylan home page:
http://www.cambridge.apple.com/dylan/dylan.html

Harlequin Dylan page:
http://www.harlequin.com/full/dylan.html

Usenet: comp.lang.dylan

CompuServe: GO APPLE

Applelink: DYLAN

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IP-Address Management on LANs

Convenience, control, and security are important issues when adding IP to a LAN

BOB SCHOETTLE

As more applications move to Unix hosts and demand for Internet access grows, there is an increasing need for IP on LANs. On the surface, adding it to a LAN is not a major technical challenge. However, it can be an administrative nightmare. One of the issues for which LAN administrators are often least prepared is the allocation and administration of IP addresses.

In a traditional IP network, each device on the network has a permanent IP address. It's a 32-bit binary number broken up into four 8-bit segments called *octets*. While each IP address can be changed in software, in practice, each IP address has typically been associated with a fixed hardware address (e.g., an Ethernet address).

This stable association has been used as the basis for IP-based security and network management and configuration schemes. IP addresses are also the usual way of finding network resources, such as servers on TCP/IP networks.

If the server's IP address changes, the Domain Naming System (DNS) must be reconfigured, or applications won't be able to connect with the server. In an environment with many changes, this maintenance can be time-consuming.

A Lack of Stability

Many network functions, including security, finding resources, and routing, assume stable addresses. Unfortunately, many of today's LAN environments tend to thwart such stability. Machines move from one network to another as departments grow or shrink, workgroups move from one set of machines to another, and networks are segmented to improve performance.

For every machine moved, the administrator has to change the IP address, default routers, DNS information, and all IP-address-dependent security. Thus, from the LAN administrator's point of view, the requirement to assign an IP address to each device on the LAN can create real management problems.

The simplest ways around such problems are often not practical. For example, having an IP address hard-wired to an Ethernet card, and then having that IP address determine security, configuration, and routing, makes sense only with stable usage patterns and nonmobile users.

Similarly, having one IP address per workstation makes sense if there are plenty of addresses to go around. However, because of the way IP addresses are allocated to companies, organizations frequently do not have enough addresses to assign a separate one to each device that's on a LAN.

Given these circumstances, there are two approaches to dealing with IP address management. The first is centralized management and storage for workstation-based TCP/IP stacks. The other is an IP gateway, providing a combination of centralized, automatic allocation of addresses; dynamic address pooling; and address sharing.

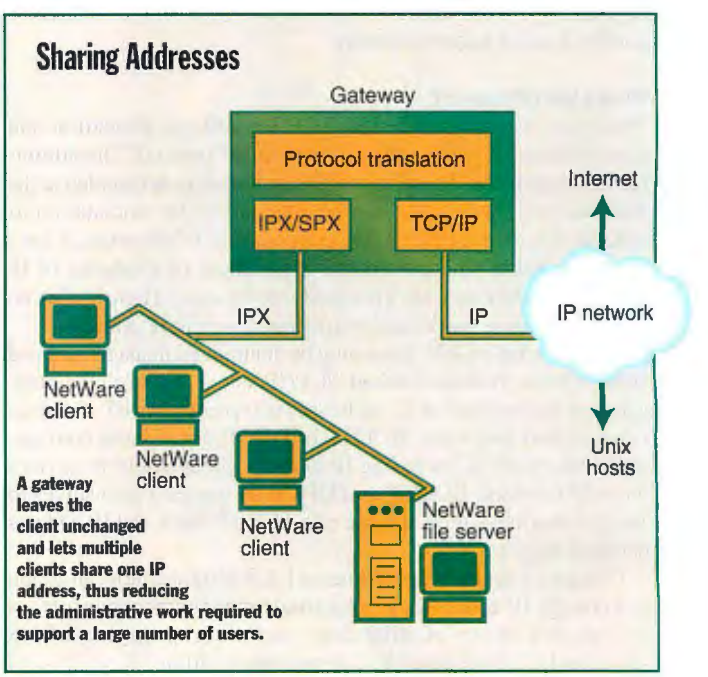
A Matter of Choice

The workstation-based stack and gateway approaches differ primarily in the extent to which address allocation is centralized and automated, and whether it's possible for multiple workstations to share a single IP address. Before discussing these differences, it's important to have a common definition of the terms.

With dynamic allocation, software allocates and deallocates a pool of addresses on the fly, in response to user needs. An example of dynamic allocation is sharing 10 IP addresses among 25 sporadic users. Such an approach might be used to give 25 users access to 10 shared Internet-access accounts. Each time a user requests an address, he or she may get a different one.

Automated allocation does not imply on-the-fly responses to user requests for IP addresses. It simply means that a whole block of IP addresses can be allocated to hardware addresses in a single operation, instead of having to be allocated one at a time.

It's important to differentiate sharing addresses from pooling addresses. When one address is shared among multiple workstations, all the workstations can access the



IP network simultaneously using that address. (This is typically possible only with gateways.) Software running on the gateway machine separates multiple IP data streams and routes them to the correct workstations based on the port number, a standard TCP/IP identifier for a software process or application (see the figure "Sharing Addresses").

This type of sharing is like mail coming to a company and being delivered to individual boxes through company mail. Each workstation needs its own port number—just as each employee needs a unique internal address. But as with the public mail system, the routers and gateways outside the LAN must pay attention only to the corporate address.

With address pooling, each workstation has a unique IP address while that workstation is on the IP network. Centralized IP management software allocates a given IP address to a workstation when the workstation requests access to the IP network, and deallocates the address and returns it to the pool when the workstation is through using the IP network. Each time the workstation needs IP access, it may use a different address.

Address sharing is possible when workstations need to act only as clients and therefore no one needs to find them through the DNS. For instance, multiple FTP and telnet clients on the same network, or even the same machine, can share a single address. This is also true for clients for NFS, Mosaic, gopher, mail, and news. Clients need unique IP port numbers for these applications, but they can share a single address.

In contrast, servers require a unique IP address. If they are to be located through the DNS, they must have fixed addresses. FTP and NFS servers fall into this category. Some servers (e.g., X servers) are not typically registered with the DNS. They need a unique address, but not necessarily a fixed address, and are therefore suited to address pooling but not address sharing.

MANAGING IP ADDRESSES

- **Address sharing—A single address is shared among multiple workstations, and all the workstations can access the IP network simultaneously using that address.**
- **Address pooling—Each workstation has a unique IP address while that workstation is on the IP network. The address is deallocated after the session is complete. Each time the workstation needs IP access, it may use a different address.**
- **Automatic allocation—Blocks of IP addresses can be allocated in a single operation rather than being allocated one at a time.**
- **Dynamic allocation—Software allocates and deallocates a pool of addresses in response to user needs.**

What's the Difference?

With pure workstation-based TCP/IP, address allocation and management are decentralized, static, and manual. The administrator assigns the IP address when the software is installed at the workstation. The address can be changed at the workstation as needed. Typically, though, once an address is allocated, it isn't changed. There's no automated assignment or changing of IP addresses; addresses are allocated one-by-one. There's also no way for multiple workstations to share a single IP address.

However, on a LAN, there may be centralized management and storage for workstation-based TCP/IP stacks. Centralized management and storage of IP addresses is typically based on one of two standard protocols, BOOTP or DHCP, for passing configuration information (including IP-address information) to devices on an IP network. BOOTP and DHCP do not lend themselves to address sharing—they assume one TCP/IP stack and IP address per workstation.

Using such centralized facilities, a LAN administrator can assign and change IP addresses from a single management console, as well as do a variety of other tasks, including specifying a DNS server and a default gateway for each workstation.

The central management utility can also automate the process of assigning IP addresses. For instance, the administrator can manually type in a list of IP addresses, which the management utility automatically allocates to hardware addresses. An IP address can be reserved for a particular user or simply assigned from a pool. However, a single address cannot be shared.

Gateways, on the other hand, are much more flexible. They provide any combination of centralized, automatic allocation of addresses; dynamic address pooling; and address sharing. A gateway can be configured to share a single address among all the workstations on the LAN.

The advantage to the gateway approach is that pooling addresses or sharing a single address can greatly simplify the task of IP-address administration on LANs. Not only do these techniques reduce the number of addresses, they also make it possible to adapt automatically and transparently to moves and changes. Such an approach also lends itself to handling mobile users. If a machine moves from one LAN to another, there's no need to change the machine's IP address or default router, because it doesn't have an IP address of its own.

Similarly, a user can move to a new machine without creating any problems. User workstations require no configuration. All configuration information resides centrally on the file server and can be associated with the user ID, group name, or Ethernet address.

With address pooling or sharing, it's not always possible to tie security or configuration to IP addresses, which may not be associated with any particular machine or user. Instead, the gateway management software may support security and configuration tied to the user ID, group membership, or Ethernet address.

Using such characteristics may offer a degree of flexibility not normally available when configuration and security are associated with IP addresses, which are in turn associated with the Ethernet address. For instance, a user will always have the same user ID, no matter which workstation he or she is using. Thus, transplanted workgroups and mobile users can have the same security and configuration wherever they go.

There are fault-tolerance implications to using gateways, too. If a user's machine fails, he or she can easily use another machine. The ability to configure by group achieves the same level of flexibility without having to define security and configuration for each individual. On the other hand, if it's desirable to associate security and configuration information with a particular machine, that can be accomplished via the Ethernet address.

Given these choices, many managers are opting for the gateway approach to providing IP connectivity for LAN users. It offers less administrative work to manage user moves, adds, and changes. Also, there's less work handling changes in the rapidly changing networking environment found in many corporations. ■

Bob Schoettle is vice president of Firefox Communications, Inc. (San Jose, CA). Firefox supplies server-based TCP/IP communications software for NetWare LANs. You can reach him on the Internet or BIX at editors@bix.com.

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KWGYB03

WHAT'S NEW Hardware

PREVIEW INPUT DEVICES

Kantek Fingers a Better Mouse

If you're concerned about repetitive stress injuries, or you have a messy desk that hampers mouse movements, you might be interested in Kantek's Spectrum RingMouse 1.5 ($99). The RingMouse is a wireless input device that fits on your finger and operates like a two-button mouse. You can use RingMouse as you would any mouse in DOS, Windows 3.x, and Windows 95 environments.

Spectrum RingMouse 1.5 $99
Kantek, Inc.
East Rockaway, NY
(516) 593-3212
fax: (516) 593-3295
http://www.business1.com/kantek/
Circle 1023 on Inquiry Card.

The RingMouse package includes driver software and a device that sits on top of your monitor. The monitor device has sensors that triangulate the mouse's position and detect its movement. Waving your hand above your keyboard moves the cursor. While this may look a little peculiar, it really works. And it works very well for common tasks, such as opening applications and accessing files. The only trouble I had with an older version of the product was highlighting text in a Word document (as I'm a big coffee drinker, my hand was very unsteady). However, the new RingMouse 1.5 has a selectable sensitivity level that makes even this task easier.

RingMouse also supports 3-D cursor movement, something that's becoming desirable in CAD programs and games. (RingMouse comes with a couple of 3-D games so you can see how this works.) The 3-D movement makes RingMouse more versatile than a trackball or a traditional mouse. It can also emulate a joystick.

The device requires an IBM-compatible 386 or higher, a serial port, a VGA display adapter, 1 MB of RAM, and MS-DOS 3.3 or higher.

I especially like the RingMouse's dual operating feature, which lets you work with RingMouse and a traditional mouse without having to edit system files or add and delete mouse drivers. You access the dual operating feature through a configuration icon and simply choose whether to install or uninstall the RingMouse driver.

Kantek's Spectrum RingMouse 1.5 may be the answer for mouse users affected by repetitive stress injuries and wrist strain.

—Salvatore Salamone

SPARC-BASED RAID SUBSYSTEM

To prevent data loss due to a power failure, the Integrix RD-10 features a battery-backed write cache. The cache safeguards data that has been written to the RAID but not yet fully written to the disk. The RD10 supports RAID levels 0, 1, 3, 5, and 6, with automatic data rebuilding to a spare drive in RAID levels 1 through 6. A base subsystem includes a 33-MHz R3000 CPU; a 16- by 16- by 3-inch pizza-box-style enclosure, which holds up to six 3.5-inch disks; 6 GB of drive space; 8 MB of cache memory (expandable to 32 MB); a Solaris-based GUI; and two Fast and Wide SCSI host adapters. Prices start at $12,595; with 12-GB of drive space, $19,995; with 24 GB, $29,995. You can add up to seven RD-10s to a single SCSI host adapter.

Contact: Integrix, Inc., Newbury Park, CA, (800) 300-8288 or (805) 375-1055; http://www.integrix.com.

Circle 1028 on Inquiry Card.

MULTIMEDIA FOR PORTABLES

Now you can add multimedia capabilities to your portable computer. The KXL-D721 ($599) bundle includes the KXL-D720 PC Card-based portable CD-ROM drive; a battery-powered speaker system; a 16-bit, 44-kHz stereo digital sound controller; a 24-voice Yamaha OPL3-compatible FM music synthesizer; and ESS Audio Sound Suite software. The double-speed CD-ROM drive has a transfer rate of 300 KBps, an access speed of 250 ms, and a memory buffer of 128 KB. If you already have a KXL-D720 PC Card CD-ROM drive, the KXL-D20 upgrade kit ($349) provides the same speakers, sound/SCSI card, and software.

Contact: Panasonic Communications & Systems Co., Secaucus, NJ, (800) 742-8086 or (201) 348-7000.

Circle 1030 on Inquiry Card.

SHARED PRINTING WITHOUT WIRES

Now PC users can share up to eight printers without wires or a network. AirPrint (set of adapters, $450) is a plug-and-print device that sends data to a printer at a rate of 1 Mbps and has a range of 3000 feet unobstructed or approximately 500 feet if obstructed.

Contact: ConnectWare, Inc., Richardson, TX, (800) 449-0192 or (214) 235-9060; http://www.connectware.com.

Circle 1034 on Inquiry Card.

HIGH-CAPACITY PC CARD HARD DRIVE

Now mobile professionals traveling with a notebook computer can carry along high-capacity storage. Data you store on the $599 Callunacard (up to 260 MB uncompressed) is made instantly accessible by slipping the product into your notebook's PC Card Type III slot, or you can use it on your desktop with an IDE or PC Card interface. With data transfer rates of up to 11 MBps and an average seek time of 16 ms, Callunacard lets you easily transport files and data from notebooks to desktop PCs. You can also organize files and data by project or application on separate Callunacards. A two-level password utility protects data from viruses and unauthorized reads and writes.

Contact: Calluna Technology, Inc., San Jose, CA, (408) 453-4753.

Circle 1046 on Inquiry Card.

CYRIX 5X86 COLOR NOTEBOOKS

The EzBook 500T, with a 100-MHz Cyrix 5x86 processor, and the EzBook 520T, with a 120-MHz Cyrix 5x86 processor, come with 8 MB of RAM (expandable to 32 MB); an 810-MB slide-out hard drive; a 10.4-inch TFT active-matrix color display, which supports resolutions of 640 by 480 and displays 262,000 colors; a Sound Blaster Pro-compatible 16-bit stereo sound card; speakers; a microphone; a 3.5-inch 1.44-MB floppy drive; two PC Card slots (one Type II and one Type III); and an EzGlide touchpad pointing device. Prices start at $2699.

Contact: CTX International, Walnut, CA, (800) 888-9052 or (909) 595-6146.

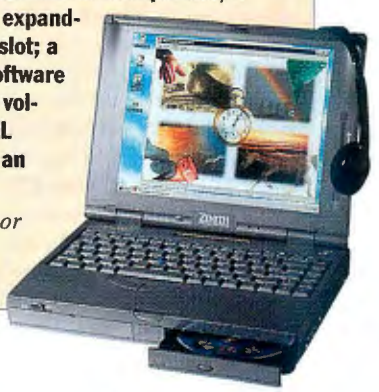
Circle 1027 on Inquiry Card.

PENTIUM NOTEBOOK OPTIMIZED FOR MULTIMEDIA

Zenith's new Z-Note GT (from $3999) is powered by a 64-bit Mobile Pentium 75- or 90-MHz processor. The notebook comes with an 11.3-inch SVGA TFT or DSTN display (or you can buy one with a 12.1-inch screen); broadcast-quality, full-motion, full-screen video; Sound Blaster Pro-compatible audio; an upgradable, modular CD-ROM drive; Labtec stereo headphones; a microphone; an 810-MB or 1.3-GB EIDE hard drive; 8 MB of RAM, expandable to 40 MB; 1 MB of VRAM; 256K secondary cache; a PC Card slot; a graphics accelerator; a serial infrared port; and Puma's TranXit software for transferring files via infrared beam. An audio in/out jack and a volume control facilitate audio recording and playback, and NTSC/PAL video-out lets you project images onto most TVs. An MPEG card is an option.

Contact: Zenith Data Systems, Buffalo Grove, IL, (800) 533-0331 or (708) 808-5000; http://www.zds.com.

Circle 1024 on Inquiry Card.



ETHERNET WIRELESS LAN SYSTEM

The VIPSLAN-10 combines infrared technology, 10-Mbps Ethernet-speed throughput, and the mobility of a wireless LAN system. The package consists of a ceiling-mounted transmitter for 360-degree connection, a power hub and node, and hardware for point-to-point connection ($800 to $1000). You can also buy a Type II PC Card and a 10Base-T device for laptop-to-Ethernet connection (from $250 to $350).

Contact: JVC Information Products Company of America, Irvine, CA, (714) 261-1292.

Circle 1031 on Inquiry Card.

SECURITY ON YOUR KEY CHAIN

So only authorized users can access a network, the SecurID Key Fob (from $34) provides two-factor identity authentication. You log in by entering a secret PIN and the current access code displayed on the SecurID token. The randomly generated access code changes every 60 seconds.

Contact: Security Dynamics Technologies, Inc., Cambridge, MA, (800) 732-8743 or (617) 547-7820; http://www.securid.com.

Circle 1037 on Inquiry Card.

EXTERNAL MODEMS WITH VOICE

The LX voice/data/fax series consists of a 28.8-Kbps modem, the Smart One 2834VLX ($319), and a 14.4-Kbps modem, the Smart One 1442VLX ($189). Voice-mail features let you record messages with a telephone handset and access them at any time using a Touch-Tone phone. The modems can accommodate up to 999 voice-mail boxes and activate a remote pager when they receive new messages. Modem features include hardware-based V.42bis data compression, V.42 and MNP 2-4 error correction, and MNP 10 for better performance in areas with poor phone-line conditions. Fax features range from scheduling, remote retrieval, personalized cover sheets, phone books, faxback, and fax on demand. The LX series also includes two data/fax modems, the 28.8-Kbps Smart One 2834FLX ($299) and the 14.4-Kbps Smart One 1441FLX ($159). There are also four models for Mac users.

Contact: Best Data Products, Inc., Chatsworth, CA, (800) 632-2378 or (818) 773-9600; http://www.bestdata.com.

Circle 1040 on Inquiry Card.

STATIONARY MOUSE ▼

DeskStick ($59.95) is a stationary Microsoft-compatible pointing device that lets you guide the cursor using only your fingertip. It is compatible with Microsoft Mouse, DOS, Windows, and Windows 95 mouse drivers and comes with its own VersaPoint software.

Contact: Interlink Electronics, Camarillo, CA, (800) 340-1331 or (805) 484-1331; support@interlinkelec.com.

Circle 1036 on Inquiry Card.

HEADSET TELEPHONE

If you spend much of your working time on the telephone and accessing computer files and information, Compudial may be of interest to you. Available in single- and two-line versions (call the company for prices), the lightweight headset connects between your PC's keyboard and CPU. You can control all telephone features from your PC's keyboard and set Compudial to ring on incoming calls at the control box or in the headset.

Contact: International Products Management, Houston, TX, (800) 969-8655 or (713) 465-0086.

Circle 1035 on Inquiry Card.

INTERNATIONAL DATA/FAX MODEM FOR POWERBOOKS

The V.34 DF2814APB Global Class Data/Fax Modem PC Card ($529) for the PowerBook 190 and 5300 supports V.34 28.8-Kbps data, 14.4-Kbps send and receive fax, data compression, and error correction. The card's programmable DAA phone-line interface is configurable for phone systems in Australia, Belgium, Canada, Denmark, Finland, Germany, Great Britain, Hong Kong, Ireland, Italy, Luxembourg, the Netherlands, New Zealand, Norway, Sweden, Switzerland, and the United States. You can originate calls from various places around the world by simply pointing and clicking on the country name in a pull-down menu.

Contact: TDK Systems, Nevada City, CA, (800) 999-4835 or (916) 478-8421; tdkpr@tsd.ssi1.com.

Circle 1044 on Inquiry Card.

SPARCSTATION 20-COMPATIBLE WORKSTATIONS

The SuperCompstation 20S/81 (from $16,315) comes with one 85-MHz SuperSparc II processor (upgradable to two CPUs) and 1 MB of external cache. The SuperCompstation 20S/812MP (from $21,365) features two 85-MHz processors and 1 MB of external cache per CPU. Entry-level configurations include a 20-inch color monitor; two MBus slots; four 32-/64-bit SBus slots; 32 MB of RAM (upgradable to 512 MB); a 1-GB hard drive (upgradable to 4 GB); a Turbo GX graphics card (upgradable to a Turbo GX+2 (2 MB) or Turbo GX+4 (4 MB) graphics card; 16-bit, CD-quality audio; and support for 24-bit color SX graphics.

Contact: Tatung Science & Technology, Inc., Milpitas, CA, (800) 659-5902 or (408) 383-0988; http://www.tatung.com/tsti.

Circle 1026 on Inquiry Card.

WHAT'S NEW Hardware

INTERNAL QUAD-SPEED CD-ROM CHANGER

The MultiSpin 4x4 CD-ROM Changer (about $279) offers 250-ms access times and 600-KBps data transfer rates. Housed in a 5¼-inch form-factor, the changer can run audio CDs and complies with formats such as Enhanced Music CD, CD-I, XA, VideoCD playback, Kodak multisession and single-session PhotoCD, and QuickTime. The package includes a utility program that allows the MultiSpin 4x4 to operate as a single-drive-letter or as a four-drive-letter device.

Contact: NEC Technologies, Inc., Wood Dale, IL, (800) 366-0476 or (708) 860-9500; http://www.nec.com.

Circle 1039 on Inquiry Card.

WIN 95 MULTIMEDIA KIT

The TeleMedia Windows 95 Companion Upgrade Kit (about $399) bundles a wavetable-upgradable 16-bit plug-and-play sound card, a quad-speed internal CD-ROM drive, and amplified 10-W stereo speakers. The package also comes with Syncronys Software's SoftRAM, a memory-doubling program that lets you expand your 4-MB system to 8 MB or your 8-MB system to 16 MB. The kit also includes Microsoft Works 95, Microsoft Money, Explorapedia World of Nature, and World of Flight.

Contact: TeleVideo Systems, Inc., San Jose, CA, (800) 835-3228 or (408) 954-8333.

Circle 1032 on Inquiry Card.

MULTIMEDIA KEYBOARD WITH 3-D SRS SOUND

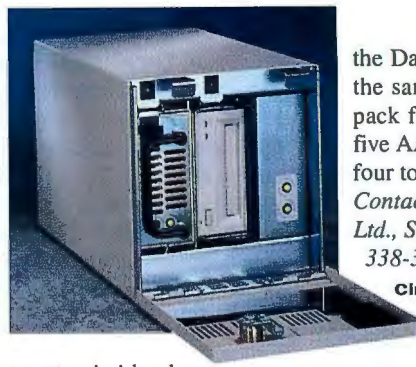
The ConcertMaster multimedia keyboard ($189.95) puts sound and audio controls at your fingertips, including volume, mute, and SRS stereo on/off. The model RT-9100WIN has jacks for headphone, microphone, and subwoofer; a shielded speaker system with 2+2-W amplifier; and three keys for quick access to Windows 95 software. A switch lets you turn on the speakers or internal microphone without affecting the keyboard's functionality.

Contact: NMB Technologies, Inc., Chatsworth, CA, (800) 662-8321 or (818) 341-3355; http://www.nmbtech.com.

Circle 1029 on Inquiry Card.

MODULAR DISK AND TAPE STORAGE

A two-bay storage system, MiniFlex supports 16-bit Fast/Wide SCSI for PCI or EISA machines; 3½-inch 2- or 4-GB disk drives for up to 8 GB capacity per enclosure; and 8-GB DDS-2 DAT tape drives for up to 16 GB of unattended backup per enclosure. The system supports multiple operating environments, such as NetWare, Windows NT, OS/2, and Unix. Enclosure, about $725; preconfigured with two 2-GB drives, about $3300; and with two 4-GB drives, $4900.



Contact: Storage Dimensions, Milpitas, CA, (800) 765-7895 or (408) 954-0710.

Circle 1033 on Inquiry Card.

INSTANT TEXT AND DATA INPUT

If you're looking for a way to selectively scan text and data directly into your applications, DataPen for the Macintosh ($299) may be for you. The 2.7-ounce DataPen can read up to 100 8- to 22-point characters per second with an accuracy rating of over 99 percent, the manufacturer claims. The device supports 12 languages and recognizes most fonts. A pass-through serial switch/connector lets you plug the DataPen and a printer into the same serial port. A power pack for mobile users runs on five AA batteries and lasts from four to eight hours.

Contact: Primax Electronics Ltd., Sunnyvale, CA, (800) 338-3693 or (408) 522-1200.

Circle 1041 on Inquiry Card.

LOW-COST CD RECORDER

A double-speed recorder/player, the RCD 5020 comes with a 1-MB cache buffer; an Adaptec AHA 1540 Bus Master SCSI host adapter; and Corel's CD Creator 2 software, which supports data and audio recording, audio editing, READ digital audio, disk at once, track at once, and Photo CD viewing and recording. The package also includes Pinnacle's RCD Archive software, which can double a CD's capacity to 1.3 GB and lets you copy or move files from a hard disk to the RCD 5020 automatically or manually. The internal PC version is $995; Mac and PC external versions, $1295.

Contact: Pinnacle Micro, Irvine, CA, (800) 553-7070 or (714) 789-3000.

Circle 1038 on Inquiry Card.

PCI MULTIMEDIA ACCELERATORS

Two PCI-based boards are built around new multimedia accelerator chips from SGS Thomson and Nvidia. Both boards combine GUI acceleration, 3-D rendering, video acceleration, audio processing, and resolution rates from 640 by 480 with 16.7 million colors to 1600 by 1200 with 256 colors. The Proview GD400 ($299), based on the Thomson chip, comes with 1 MB of EDO RAM. The Proview GD500 ($439), based on the Nvidia chip, comes with 2 MB of VRAM, upgradable to 4 MB.

Contact: Leadtek Research, Inc., Fremont, CA, (510) 490-8076.

Circle 1042 on Inquiry Card.

INTERNET-BASED MULTIPLATFORM NETWORK PC

A Windows NT-ready device, Explora provides simultaneous access to Windows, Unix, and legacy applications. The system ($995) includes a 32-bit PowerPC 403 processor; a 15-inch 1024-by 768-pixel color monitor, which can display 256 simultaneous colors from a palette of more than 16 million; a keyboard; and a three-button mouse. Options include a 3½-inch floppy drive, an audio card, and a 17- or 20-inch monitor. NCD's WinCenter Pro software, which includes NFS, lets users share files in mixed computing environments, cut and paste graphics, auto-launch Microsoft applications from anywhere over the network, and copy files to and from the NT-based WinCenter server.

Contact: NCD Systems Corp., Mountain View, CA, (415) 694-0650; http://www.ncd.com.

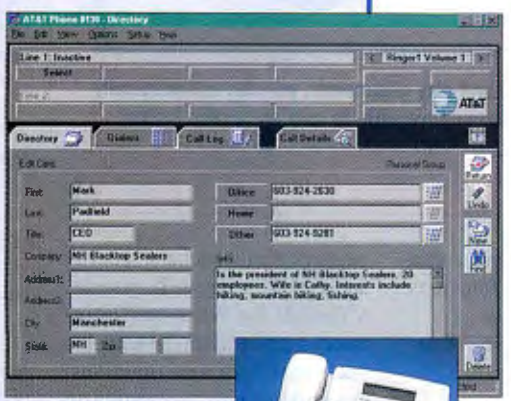
Circle 1025 on Inquiry Card.

WHAT'S NEW Software

PREVIEW WINDOWS 95 TELEPHONY

PC Phone: Telephony Cards Are Smarter

The Windows 95 version of the AT&T Computer Telephone 8130 hints at the benefits of PC telephony, but it lacks capabilities you get with add-in telephony cards. The hardware/software combination ($199) includes a two-line speakerphone, which connects to your PC's serial port and works over regular phone lines but will not integrate with a PBX; and Windows 95 software, which provides functions such as contact management, logging of incoming and outgoing calls, and Caller ID.



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dspecht@attmail.com
Circle 989 on Inquiry Card.

Three advantages of the system are immediately apparent: It's easier to program the phone (e.g., time/date) using the Windows software rather than the phone's buttons, the logging feature helps keep track of the time I spend with individual contacts, and the software's Caller ID feature automatically displays information on an incoming call. A more subtle advantage the AT&T 8130 has over add-in telephony cards is that you can use the phone even when your PC is not running, although most of the telephone features are disabled in stand-alone mode.

However, I wish the software provided features such as the ability to set up password-protected voice-mail boxes, which cards like Boca Research's SoundExpression 28.8 offer. The AT&T Computer Telephone requires you to buy a separate answering machine. Since the phone is, for many businesses, the primary interface to customers, you may prefer to project a more professional image by presenting your customers with several options for leaving messages.

The 8130 phone works with Symantec's Act for Windows, which is also available for Hewlett-Packard hand-held computers and, soon, for the Psion Series 3A. The combination of a telephony-enabled Act with the ability to fit those same contacts onto a hand-held computer could be quite intriguing to those folks who make a lot of sales calls from their home/office and from the road.

—Dave Andrews

A BETTER WIN 95 EXPLORER

Turbo Browser for Windows 95 ($49.95) looks and feels like—ut replaces—Windows 95 Explorer, with features such as properties, drag and drop, cut, copy, rename, and even support for third-party "right-click" utilities. The Autoview feature lets you view multimedia and sound files, graphic images, documents, and spreadsheets in popular formats without the program that created them. With Qbar, you can drag and drop files from different folders, drives, and computers into Qbar buttons. Then, simply click the Qbar button to power-process all its files—autoview, print, convert format, sequentially send to the clipboard, zip/unzip, or export to a backup drive. The program will also let you find files with exact or closest match and extract single frames from multimedia files and save them as graphics files.
Contact: Pacific Gold Coast Corp., Glen Cove, NY, (516) 759-3011; gobrowser@aol.com.
Circle 1003 on Inquiry Card.

UNIX CHANGE-REQUEST MANAGEMENT

With ClearTrack, software engineering teams can record change requests, track their evolving status, and obtain metrics through the program's query and reporting facilities. ClearTrack integrates with ClearCase, Atria's software configuration-management system (licenses from $795; bundled with ClearCase, licenses from $4595).
Contact: Atria Software, Inc., Lexington, MA, (617) 676-2400; http://www.atria.com/.
Circle 992 on Inquiry Card.

ACCOUNTING FOR WIN 95, NT

Visual AccountMate consists of seven customizable modules: system manager, general ledger, accounts payable, accounts receivable, sales order, purchase order, and inventory control. You can access key micro information in each field without interrupting your current process, send and receive E-mail without leaving the system, and store full-color photographs of products or employees. Visual AccountMate (compiled version, from $995; source-code version, from $1295; developer version, from $1795) also includes direct links to Excel and Lotus 1-2-3 spreadsheets, a report designer, multiple levels of password security, and full document viewing.
Contact: SourceMate Information Systems, Inc., Mill Valley, CA, (800) 877-8896 or (415) 381-1011; 72357.1436@compuserve.com.
Circle 1005 on Inquiry Card.

SIGNAL PROCESSING TOOLS

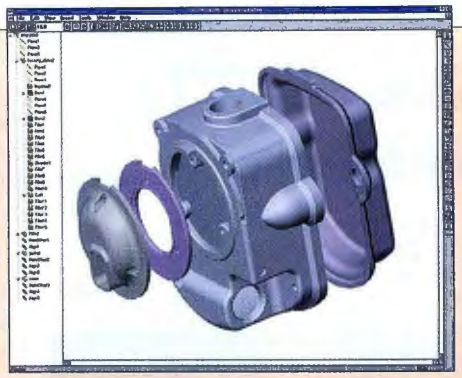
Based on the Mathematica computing engine, Wolfram's Signals and Systems Pack integrates numeric and graphics capabilities with symbolic functions for expressing signals of infinite extent. The software also lets you perform operations on nonseparable multidimensional signals. The Signals and Systems Pack ($295), which includes source code, runs on Windows, Mac, Solaris, Silicon Graphics, Hewlett-Packard 700 Series, DEC MIPS, OSF/1 AXP, IBM RISC System 6000, Linux, and NextStep.
Contact: Wolfram Research, Inc., Champaign, IL, (800) 441-6284 or (217) 398-0700; http://www.gammalink.com.
Circle 1007 on Inquiry Card.

ADD VOICE RECOGNITION TO WINDOWS APPS

ProNotes Voice Tools ($179) are 16-bit Visual Basic custom controls and 16- and 32-bit OLE custom controls that Windows developers can incorporate into their applications to make them voice-capable for IBM's VoiceType Dictation System. Controls include a voice-playback and voice-record panel, a voice-command button, a list box, a dictation window, and a voice navigator. The application user can dictate notes and letters, enter data by voice (such as form filling), navigate around the application by voice, and voice-activate programmable computer events.
Contact: ProNotes, Inc., Philadelphia, PA, (800) 706-6837 or (215) 533-8569; http://www.pronotes.com.
Circle 994 on Inquiry Card.

WHAT'S NEW Software

SOLID MODELING IN WINDOWS



With the SolidWorks 95 modeling program, you can drag and drop a model's features to different locations; reshape parts in real time with dynamic visual feedback; and create overlapping and variable radius fillets, draft angles, multisection blends and lofts, multiface shells, extrusions ending at complex surfaces, sweeps along complex paths, chamfers, revolves, and patterns. SolidWorks 95 ($3995) lets you embed OLE 2-compliant documents, such as spreadsheets and text files, into SolidWorks 95 files and vice versa. With record and play commands, you can automatically re-create successive modeling steps, associating each procedure with its own on-screen button.

Contact: SolidWorks Corp., Concord, MA, (508) 371-2910.

Circle 990 on Inquiry Card.

BUSINESS PROFILES ON CD

For access to company data on more than 210,000 firms, the Gale Business Resources CD (annual subscription with three updates, $7995) contains an overview and analysis of each American industry that has a four-digit SIC code. The database also provides industry statistics, leading companies (addresses, officers, employment, and financial data), full-text SEC reports of the top 1000, company histories, financial ratios, market-share reports, rankings, and industry associations. You can search by company, brand, product, and industry or create targeted searches with up to 28 criteria.

Contact: Gale Research, Inc., Detroit, MI, (800) 347-4253 or (313) 961-2242; http://www.thomson.com.

Circle 995 on Inquiry Card.

MATH AND SCIENCE CENTER

Scientific Center for Windows gives you instant access to more than 1600 mathematical formulas; a scientific calculator; a conversion program for length, area, volume, and energy; illustrations; a personal page, which you can edit and print; an on-screen user manual; and a chemical Periodic Table. The program ($39.95) covers algebra, trig, analytic geometry, probability, statistics, process control, integrals, differentiation, series, constants, vector analysis, differential equations, and hyperbolic functions.

Contact: InfiniText, Inc., Irvine, CA, (800) 255-6216 or (714) 651-0640.

Circle 997 on Inquiry Card.

PATIENT MANAGEMENT AND SCHEDULING

The Windows-based MedSched (from $275) system offers medical practices with multiple offices and multiple providers the ability to schedule patient appointments by day, week, or month and to view patient status, the type of appointment, and the patient's preferred location. Available in single-user and network versions, MedSched's reports and statistics functions can generate information such as insurance carriers and charges, appointment histories, provider productivity, and procedures and diagnoses profiles.

Contact: Principal Decision Systems International, Irvine, CA, (800) 850-7374 or (714) 474-7374.

Circle 996 on Inquiry Card.

DEVELOP VXDS IN C, C++

Hardware developers can use VToolsD for Windows 95 ($495) to build optimized drivers for high-speed devices, build Plug and Play-compatible drivers, and prototype new drivers. Software developers can use it to build debuggers, virus checkers, security applications, and new file systems. VToolsD for Windows 95 includes support and documentation for hundreds of new functions; support for new dynamically loaded and pageable device drivers; communication between Win32 applications and device drivers; and a revised QuickVxD utility, which automatically generates source code for Windows 95 VxDs.

Contact: Vireo Software, Inc., Bolton, MA, (508) 779-8352; http://www.world.std.com/~vireo.

Circle 1008 on Inquiry Card.

WINDOWS VIDEO-EDITING SOFTWARE

A PCI-based 32-bit video editor, Real Impact ($2995) helps you prepare digital video for multimedia presentations, CD-ROM titles, information kiosks, interactive training, Internet distribution, and videotapes. The Dial-a-Quality feature lets you select image quality to balance distribution needs, system performance, storage availability, and media complexity. You can import and export standard video, audio, animation, and graphics files and integrate logos, charts, and animations.

Contact: Avid Technology, Inc., Tewksbury, MA, (800) 949-2843 or (508) 640-6789; ri_support@avid.com.

Circle 998 on Inquiry Card.

Software Update

You can combine **A2B 3.2's** remote-connectivity automation functionality with remote-access servers. A2B automatically detects preexisting client software and gives users the option of replacing it with A2B or using the two programs cooperatively. A2B supports popular LAN access security products like SecurID, Traqnet, and CryptoCard. $495; A2B Remote LAN Access Client, $79.

Contact: Simware, Inc., Ottawa, Ontario, Canada, (800) 267-9991 or (613) 727-1779; http://www.simware.com.

Circle 1018 on Inquiry Card.

Technical graphics and data-analysis software for Windows, **Origin 4.0** includes new analysis and graphics tools, such as baseline and peak analysis for spectroscopy and improved fast Fourier transform for digital signal processing; a nonlinear curve fitter with 200 functions; and a toolbar-based user interface. $495; with 3D & Contour Module, $545; international version with 3D & Contour Module, $600.

Contact: Microcal Software, Inc., Northampton, MA, (800) 969-7720 or (413) 586-2013; http://www.microcal.com.

Circle 1016 on Inquiry Card.

Silverrun 2.4 provides database administrators with greater functionality and synchronization between models and databases in an Oracle-based or heterogeneous database environment. Version 2.4 offers integrated management of physical model characteristics; automatic, incremental synchronization of changes between models and RDBMSes; and on-line reverse engineering and support for multiple physical models (or views). $3500.

Contact: Computer Systems Advisers, Inc., Woodcliff Lake, NJ, (800) 537-4262, (201) 391-6500; http://www.silverrun.com.

Circle 1015 on Inquiry Card.

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8MB 501565-001 ... $269 16MB 501566-001 ... $599
32MB 501567-001 ... $1,089 64MB 501568001 ... $2,199

Premmia MX (all models)
8MB 500987-003 ... $269 16MB 501340-002 $599
32MB 500987-005 ... $1,089 64MB 501569-001 ... $2,359

COMPAQ

Presario 720, 724, 744, 774, 920, 924, 860, 992, 982, 972, 978, 954, 526, 524, 528, 520, 510
4MB 147522-001 $144 8MB 147523-001 $269
16MB 147524-001 $559 32MB 147525-001 $1,089

Presario 650, 660, 663, 433, 425, 866, 850, 833, 866
4MB 141684-001 ... $161 8MB 141685-001 ... $307
16MB 149320-001 $599 32MB 149147-001 $1,089

ProLinea 575MX, 590MX, 5133, 5100, 575, 590, 4100, 466, 450
4MB 172712-001 ... $144 8MB 172713-001 ... $269
16MB 172714-001 ... $559 32MB 172715-001 $1,089

ProLinea Enhanced (all models), 466, 433, 450, CDS, 4255, 4335
4MB 141864-001 ... $161
8MB 141685-001 ... $307
16MB 149320-001 ... $599

DeskPro 590MX, 575MX, 575, 590, 5100
4MB 172712-001 ... $162 8MB 172713-001 $299
16MB 172714-001 ... $599 32MB 172715-001 $1,089

DeskPro XL (all models)
4MB 148187-001 ... $161 8MB 148188-001 $339
16MB 148189-001 $669 32MB 148190-001 ... $1,298

DELL

Dimension P75, P90
4MB n/a ... $144 8MB n/a $269
16MB n/a ... $559 32MB n/a $1,089

Dimension P100+, P75+
4MB (EDO) n/a ... $169 8MB (EDO) n/a $307
16MB (EDO) n/a ... $799 32MB (EDO) n/a $1,299

Dimension XPS (all models)
4MB n/a ... $144 4MB (EDO) n/a ... $161
8MB n/a ... $269 8MB (EDO) n/a ... $307
16MB n/a ... $559 16MB (EDO) n/a ... $699
32MB n/a ... $1,089 32MB (EDO) n/a ... $1,299

GATEWAY 2000

P5-75, P5-90/90XI, P5-100XL, P5-120, P5-133/133XL
4MB n/a ... $144 8MB n/a $269
16MB n/a ... $559 32MB n/a ... $1,089

PC 300 Series (all models) Aptiva (all models)
4MB n/a ... $144 8MB n/a ... $269
16MB n/a ... $559 32MB n/a ... $1,089

Aptiva 300, 500 and 700 series
4MB n/a ... $144 16MB n/a ... $559

Eduquest 55
4MB 74G1299 ... $174

HEWLETT-PACKARD

Vectra VE, VL3, VL2 66/100, XM3, XM2, M2
4MB D2690A ... $144 8MB D2691A ... $269
16MB n/a ... $559 32MB n/a ... $1,089

IBM

PC 700 Series (all models) & Valuepoint Performance Series (all models)
4MB n/a ... $144 8MB n/a $269
16MB n/a $559 32MB n/a ... $1,089

IBM, continued

Eduquest 30, 40 and 50 models
4MB 60G0896 ... $174 16MB 60G0898 ... $549

PS/1 286, 386SX
2MB 92F9935 ... $83 4MB 92F9694 ... $163

Valuepoint Performance models
4MB 92G9201 or 73G3131 ... $161
8MB 92G7520 or 73G3132 ... $307

PS/1 Consultant, Essential, Expert models x43, x44,
PS/Valuepoint all models except Cxx models
4MB 96F9290 ... $177 16MB 96F9291 ... $599

PS/1 Consultant, Essential, Expert models
16MB 96F9291 ... $599

PS/2 25/286, 30/286
2MB 30F5360 ... $79

PS/2 35SX LS, 40SX, 50Z, 55SX; L5, 65SX; L5, 70, XStation
2MB 64S0604 ... $87

PS/2 70-A21; A61; 921; B61, P5/Valuepoint Cxx models
PS/1 Consultant, Essential, Expert models
2MB 64S0608 ... $95

PS/2 35SX, L5, 40SX, 55SX; L5, 65SX, L5, XStation, P5/Valuepoint Cxx models
4MB 34F2933 or 87F9977 ... $179

IBM, continued

PS/2 35SX, L5, 40SX, P5/Valuepoint
8MB 64S0129 ... $307

PS/2 90 XP, 95 XP, P75 (pairs) 56, 57 (all) P5/1 Pro M2123
2MB 64S0902 ... $85

PS/2 90 XP, 95 XP, P75 (pairs) 56, 57 (all models)
PS/1 Consultant, Essential), Expert models, P5/1 Pro M2123
4MB 64S0128 ... $161 8MB 64S0130 ... $307

PS/2 80-111; 311; 121; 321; 081; 161
2MB 64S0379 ... $88

PS/2 80-A21; A31; A16
4MB 64S1060 ... $193

Expansion boards for PS/2 80286 based models
4-16MB w/4MB 64S0609 (use 72-pin) ... $299

Expansion boards for PS/2 80386 based models
2-14MB w/2MB 34F3077 (use 72-pin) ... $205
4-16MB w/4MB 34F3011 (use 72-pin) ... $299

MICRON

486 and Pentiums
4MB n/a ... $144 8MB n/a ... $269
16MB n/a ... $559 32MB n/a ... $1,089

NEC

PowerMate Express II (all models) & Image Series (all models)
4MB OP-410-30001 ... $161 8MB OP-410-30002 ... $307
16MB OP-410-30002 $613 32MB OP-410-30002 ... $1,199

PowerMate Value Series (all models) & Ready Series (all models)
4MB OP-410-14003 $144 8MB OP-410-14004 ... $269
16MB OP-410-14005 $559 32MB OP-410-14006 $1,089

Image 425, 433, 466
4MB 410-12002 ... $144 16MB 410-12003 ... $559

Ready 425, 433
4MB n/a ... $144 16MB n/a ... $559

PowerMate 386/33i, Express Te, e models
4MB OP-410-6205 ... $161 16MB OP-410-6206 ... $613

PowerMate 286/12; SX/16, SX/20
2MB OP-410-8103 ... $89

PowerMate 386SX/20i; vi, 16i; 25i, 486/50i, 33i
8MB OP-4102101 ... $304

PowerMate SX Plus
2MB Board n/a ... $163
4MB Board n/a ... $278

PowerMate SX/20
2MB CPU Upgrade OP-410-8101 ... $151
2MB Board OP-410-8102 ... $171

NEC, continued

PowerMate 386/20, 25
2MB APC-H655 ... $219 8MB APC-H656 ... $559

PowerMate 386/33E, 486/25E
2MB OP-410-5101 ... $171

PACKARD BELL

Force Series (all models) & Executive Series (all models)
4MB n/a ... $144 8MB n/a ... $269
16MB n/a ... $559 32MB n/a ... $1,089

ZENITH

Z-400+, Z-Station SEh, SEn, Sh, Sn, DEh, Dh and Xen
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4MB ME-100 ... $161
16MB ME-90 ... $599

Z-Station models
1MB ME-70 ... $49
4MB ME-100 ... $179

Z-Select 100 models
4MB AME-0070 ... $179 8MB AME-0073 ... $354

Zenith Z-386/20, 25, 33, 33E
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4MB ZA3800MK ... $179

Zenith Z-386SX/16 and Z-386SX/20
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Z-Server EX and LT models
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HP LaserJet 4L
1MB C2024A ... $48

HP LaserJet 5L
1MB C3939A ... $88 2MB C3147A ... $137
4MB C3148A ... $225 8MB n/a ... $390

HP LaserJet IIP, III, IIIP, IID
2MB 33475B ... $95 4MB 33477B ... $169

HP LaserJet II, IID
2MB 33444B ... $95 4MB 33445B ... $169

HP LaserJet IIIsi, 4, 4M, 4Si, 4Si-MX, XL300, DeskJet 1200c
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4MB C2065A ... $169 8MB C2066A ... $339

HP LaserJet 4P, 4MP, Color LaserJet
2MB C3131A ... $95 4MB C3132A ... $170

HP DeskJet 500, 500C, 520, 520C, 550C, 560, 560C
256K 22707B ... $40

HP DesignJet 5P, 5MP
4MB C3132A ... $170 8MB C3133A ... $329

IBM/Lexmark Laser 4019 (all models)
2MB 1039137 ... $107 3.5MB 1038675 ... $167

IBM/Lexmark Laser 4029 (all models)
2MB 1183334 ... $87 4MB 1183335 ... $157

IBM/Lexmark Laser 4039, 4079 (all models)
4MB 1328363 ... $157 8MB 1328365 ... $319

Okilaser 400
1MB 70014701 $69 2MB n/a ... $97

Okilaser 400e, 410e
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Okilaser 830, 830 Plus, 840
2MB n/a ... $124 4MB n/a ... $209

Panasonic LaserPartner 4400, 5400
2MB KX-PEM1 ... $110 4MB KX-PEM2 ... $204

Panasonic LaserPartner 4410, 4430
2MB KX-P444 ... $115 4MB n/a ... $196

Panasonic LaserPartner 4450i, 4420
2MB KX-P441 ... $116 4MB n/a ... $187

Texas Instruments MicroLaser, XL
1MB 2555739-0001 ... $49

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16MB ... $659

Contura Aero
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16MB ... $659

Compaq LTE 5000
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64MB ... $2,629

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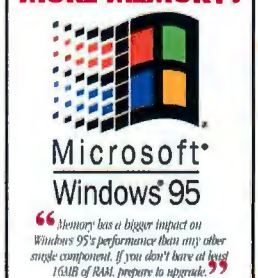

"Memory has a bigger impact on Windows 95's performance than any other single component. If you don't have at least 16MB of RAM, prepare to upgrade."
Windows Sources Magazine, April 1995

EPSON

Action Note 866c, 880c, 880cx
4MB ... $189
8MB ... $369
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32MB ... $1,399

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16MB ... $599

ThinkPad 755
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8MB ... $339
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8MB ... $359
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Extensa 550
8MB ... Call
16MB ... Call
32MB ... Call

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16MB ... $799

TravelMate 5000
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16MB ... $993
32MB ... $1,896

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T2155, T2105
4MB ... $172
8MB ... $335
16MB ... $679
24MB ... $999

T1900, T4500, T4600, T4700, T4800, T4850, T4900
4MB (3.3 V) ... $189
8MB (3.3 V) ... $359
16MB (3.3 V) ... $599
32MB ... $1,200

T3400, T3600
4MB ... $189
8MB ... $349
16MB ... $679

T610 Portage T400, T410
8MB PRO ... $399
16MB DC ... $790
32MB DC ... $1,529

T4400, T6400 (all models)
4MB ... $179
8MB ... $339
16MB ... $675

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MB ... Call

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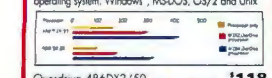

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TOSHIBA

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TEAC 4X, Int. EIDE Kit	$211
TEAC 6X, Int. EIDE Kit	$258
Toshiba 4X, Int EIDE Kit	$206
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Scanmaker IIHR flbd 1200dpi 24bit-clr SCSI w/sw	$565
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Viewsonic 17PS 17" 25mm 1600x1280ni 60hz flat	$902

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T2130CT, 486DX4/75, 8MB, 10.4"Active, 520MB	$2,421
T610CT, Pentium/90, 8MBEDO, 9.5"Active, 720MB	$3,874
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Extensa 450T, 486DX4/75, 4MB, 9.5"Active, 340MB	$2,052
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Extensa 550CD, Pentium/75, 8MB, 10.4" DS, 524MB	$2,931
Extensa 550CDT, Pentium/75, 8MB, 10.4"Active, 524MB	$3,518
TM5000, Pentium/75, 8MB, 10.5" DS, 500MB	$2,734
TM5000, Pentium/75, 8MB, 10.4"Active, 772MB	$3,459
TM5100, Pentium/90, 8MB, 10.4"Active, 1.2GB	$4,211
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Versa 4000C, Pentium/75, 8MB, 10.1"Active, 540MB	$3,720
Versa 4050C, Pentium/90, 8MB, 10.1"Active, 810MB	$4,427
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ThinkPad 760C, Pentium/90, 8MB, 10.4" Active, 810MB	$5,092

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Ascentia 950N, Pentium/75, 8MB, 10.4" DS, 500MB	$2,604
Ascentia 950N, Pentium/75, 8MB, 10.4"Active, 800MB	$3,767
Ascentia 950N, Pentium/90, 8MB, 10.4" DS, 800MB	$3,209
Ascentia 950N, Pentium/90, 8MB, 10.4"Active, 800MB	$4,140

ZENITH

Z-Note MX, Pentium/75, 8MB, 10.4" DS, 420MB	$2,579
Z-Note MX, Pentium/75, 8MB, 10.4"Active, 810MB	$3,408
Z-Note GT, Pentium/75, 8MB, 11.3" DS, 810MB	$3,648
Z-Note GT, Pentium/90, 8MB, 11 3"Active, 1.3GB	$5,250

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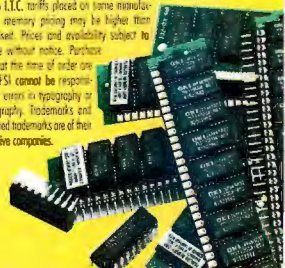

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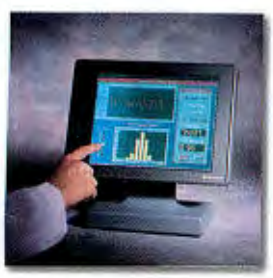

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DATALUX is in its 4th year of LCD monitor manufacture and is an industry leader. Its new LCD Monitors use brighter 10.4" diagonal Dual-Scan or TFT Color panel in a rugged, sealed, yet attractive housing with a selection of 8 wall or base mounting options. Resolution is 640 x 480. The monitors can be driven directly from a Databrick or through an ISA bus controller. No external power is required. An integrated resistive **Touch Screen** is optional with input through one of the Com Ports. Monitors may be extended to 50' from the CPU.

Keyboards
The Space-Saver keyboard is the smallest full function 100 key keyboard available. With standard left right spacing touch typing is easy yet the overall size is only 6" x 10.75".
It is available in a flat, panel mount or desktop model. The Glidepoint® pointing device is available as an option.

FAX BACK DATA SHEETS (540) 662-1675

Databrick Vertical Systems
The new DATALUX Databrick Vertical System (DVS) combines the Databrick, LCD Monitor and the Space-Saver Keyboard in a unique enclosure for Wall, Swing Arm, or Pedestal Mounting. The all aluminum housing provides compactness and security. The monitor screen tilts to accommodate the height of the user. A variety of options include bar code and mag stripe readers, speakers, or a small printer. The DVS measures 13.5" x 19.6" x 3.2".

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The Databrick is the heart of the DATALUX system. In performance and features it is more like a desktop unit, in size comparable a notebook (10.25" x 4.8" x 2"), yet more rugged and more easily mounted than either.

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DVS shown here on Rolling Stand

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- 11.3", 800x600 high resolution displays
- Optional 4X CD-ROM Drive (swap floppy & CD-ROM)
- Multimedia docking station with PCI bus (optional accessory, priced separately)
- Built-in 16-bit sound, microphone, **2 speakers** & MIDI
- **HUGE**, 1.13GB hard drives

WIN95 INSTALLED

Processor	Screen	HD	Price
Pentium 120	11.3" Dual Scan	1.13GB	$4679
Pentium 120	11.3" Active	1.13GB	5949

Tecra 700

90MHz Pentium

Portégé 610CT

WIN95 INSTALLED

Portégé 610CT

- Pentium 90MHz processor
- 9.5" True Color display for optimum color
- Built-in 16-bit sound (SoundBlaster Pro compatible), microphone & speaker
- Lithium Ion battery technology
- Accupoint stick for easy control

Processor	Screen	HD	Price
Pentium 90MHz	9.5" True Color	720MB	$3939

Satellite 2110/2130

Satellite 2110/2130

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	330MB	$1679
486DX4/75	10.4" Dual Scan	500MB	1969
4B6DX4/75	10.4" Active	500MB	2499

Satellite Pro 410

WIN95 INSTALLED

Satellite Pro 400 & Satellite Pro 410

- Built-in 4X CD-ROM Drive (Swap floppy & CD-ROM) (Active models only - optional on Dual Scan)
- Built-in 16-bit sound, microphone, speaker & MIDI
- EDO RAM memory, exp. to 40MB (Sat. Pro 410 only)
- Built-in AC adapter - small, sleek design & reduced weight
- Integrated Accupoint - small, accurate & easy to use
- Lithium Ion battery technology
- Built-in infrared for wireless communications

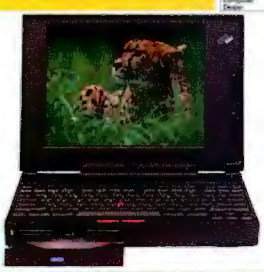
Satellite Pro 400

Processor	Screen	HD	Price
Pentium 75	10.4" Dual Scan	772MB	$2899
Pentium 75	10.4" Active	772MB	3999

Satellite Pro 410

Processor	Screen	HD	Price
Pentium 90	11.3" Dual Scan	772MB	$3499
Pentium 90	11.3" Active	772MB	4679

IBM®



ThinkPad® 365CD

ThinkPad® 365

- 10.4" Active & 10.4" Dual Scan
- Built-in infrared for no-hassle printer connections
- Multimedia models include built-in 2X CD-ROM, SoundBlaster compatible audio, speaker, microphone & MIDI/joystick port
- MS Windows 95 or Selecta System models available

Processor	Screen	HD	Price
486DX4/75	10.4" Dual Scan	540MB	$1999
486DX4/75	10.4" Active	540MB	2599
486DX4/75	10.4" Dual Scan	540MB	2499*
4B6DX4/75	10.4" Active	540MB	3099*

*Multimedia Models

ThinkPad® 760

- Pentium 90 & 120Mhz with 32-bit local bus
- 12.1" Active displays with 800x600 resolution (selected models)
- 4X CD-ROM Drive, MPEG-2 support, & full motion video (ThinkPad760CD only *)
- Built-in 28.8 fax/modem
- SoundBlaster-compatible audio & telephony
- Lithium Ion battery technology

Processor	Screen	HD	Price
Pentium 90	10.4" Active	720MB	$5349
Pentium 90	12.1" Active	720MB	6049
Pentium 120	12.1" Active	720MB	6599
Pentium 90	12.1" Active	1.2GB	7449*

*Features built-in CD-ROM drive
WIN 95 models available. Call for details.

ThinkPad® 760

NEC

Versa 2000

Processor	Screen	HD	Price
486DX4/75	9.5" Active	350MB	$2099*
486DX4/75	9.5" Active	350MB	2399
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*16MB RAM standard

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Contura 420C	486DX4/100	10.4" Color Dual Scan	8/32	720MB	2/II or 1/III	Bit-in TrackBall	1MB	11.9x9x2.2	6.25	2369
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Ascentia 950N	Pentium 75	10.4" Color Dual Scan	8/40	800MB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	2879
Ascentia 950N	Pentium 75	10.4" Color Dual Scan	8/40	1.2GB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	3249
Ascentia 950N	Pentium 75	10.4" Color Active	8/40	800MB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	3799
Ascentia 950N	Pentium 75	10.4" Color Active	8/40	1.2GB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	4199
Ascentia 950N	Pentium 90	10.4" Color Dual Scan	8/40	800MB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	3259
Ascentia 950N	Pentium 90	10.4" Color Dual Scan	8/40	1.2GB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	3639
Ascentia 950N	Pentium 90	10.4" Color Active	8/40	800MB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	4199
Ascentia 950N	Pentium 90	10.4" Color Active	8/40	1.2GB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	4579
Ascentia 950N	Pentium 120	11.8" Color Active	8/40	800MB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	4919
Ascentia 950N	Pentium 120	11.8" Color Active	8/40	1.2GB	2/II or 1/III	TrackPoint Stick	1MB	11.5x8.5x1.8	6.4	5199
TOSHIBA										
Satelite T2110CS	486DX4/75	10.4" Color Dual Scan	4/28	320MB	2/II or 1/III	AccuPoint Stick	1MB	11.8x7.9x2.1	6.8	$1679
Satelite T2130CS	486DX4/75	10.4" Color Dual Scan	8/32	500MB	2/II or 1/III	AccuPoint Stick	1MB	11.8x7.9x2.1	6.8	1969
Satelite T2130CT	486DX4/75	10.4" Color Active	8/32	500MB	2/II or 1/III	AccuPoint Stick	1MB	11.8x7.9x2.1	6.8	2499
Satelite Pro 400CS	Pentium 75	10.4" Color Dual Scan	8/40	772MB	2/II or 1/III	AccuPoint Stick	1MB	11.7x8.8x2.2	6.8	2999
Satelite Pro 400CDT	Pentium 75	10.4" Color Active	8/40	772MB	2/II or 1/III	AccuPoint Stick	1MB	11.7x8.8x2.2	7.3	3999
Satelite Pro 410CS	Pentium 90	11.3" Color Dual Scan	8/40EDO	772MB	2/II or 1/III	AccuPoint Stick	1MB	11.7x8.8x2.2	6.8	3499
Satelite Pro 410CDT	Pentium 90	11.3" Color Active	8/40EDO	772MB	2/II or 1/III	AccuPoint Stick	1MB	11.7x8.8x2.2	7.3	4679
Portege 610CT	Pentium 90	9.5" True Color	8/32	720MB	1/III or 2/II	AccuPoint Stick	1MB	9.9X7.9X2.0	4.8	3939
TECRA 700CS	Pentium 120	11.3" Color Dual Scan	8/40	1.13GB	1/III or 2/II	AccuPoint Stick	1MB	11.8x9.1X2.3	7.3	4679
TECRA 700CT	Pentium 120	11.3" Color Active	16/48	1.13GB	1/III or 2/II	AccuPoint Stick	1MB	11.8x9.1X2.3	7.3	5949
DIGITAL										
HiNote	486DX2/50	9.5" Color Active	4/20	240MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.6	5.5	$2239
HiNote	486DX4/75	9.5" Color Dual Scan	4/20	510MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.6	5.5	2239
HiNote	486DX4/75	9.5" Color Active	4/20	340MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.6	5.5	2239
HiNote	486DX4/75	9.5" Color Active	4/20	510MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.6	5.5	2239
HiNote Ultra	486DX2/50	9.5" Color Dual Scan	4/20	340MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.2	4	2549
HiNote Ultra	486DX2/50	9.5" Color Active	8/24	340MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.2	4	3079
HiNote Ultra	486DX4/75	9.5" Color Dual Scan	8/24	528MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.2	4	3079
HiNote Ultra	486DX4/75	9.5" Color Active	8/24	340MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.2	4	3319
HiNote Ultra	486DX4/75	9.5" Color Active	8/24	528MB	2/II or 1/III	Bit-in TrackBall	1MB	8.5x11x1.2	4	3639

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SCSI $103
•Daisy-chain up to 7 SCSI devices •Low power, high speed

PCMCIA Type III Hardrives
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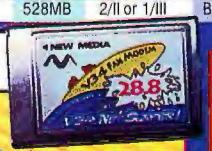

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Combo 10Base-T & Base-2 XJ10BC . 159

Hayes

Optima 144 + Fax with EZjack 02252 $165
Optima 28.8 + Fax 14.4 with EZjack $289
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IBM

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AUTHORITY

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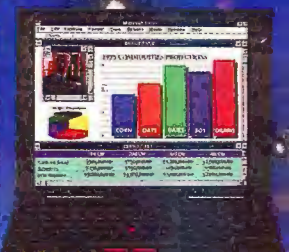
NOTEBOOK MODEL	PROCESSOR Type/Speed	SCREEN SIZE	RAM Std/Max	HARD DRIVE	PC CARD Qty/Type	POINTING DEVICE	VIDEO RAM	SIZE WxDxH	WEIGHT LBS.	PRICE
IBM										
ThinkPad 365CS	486DX4/75	10.4" Color Dual Scan	8/24	540MB	1/III or 2/II	TrackPoint III	1MB	4.7x8.3x2.0	5.8	$1999
ThinkPad 365C	486DX4/75	10.4" Color Active	8/24	540MB	1/III or 2/II	TrackPoint III	1MB	4.7x8.3x2.0	5.8	2599
ThinkPad 365CSD	486DX4/75	10.4" Color Dual Scan	8/24	540MB	1/III or 2/II	TrackPoint III	1MB	4.7x8.3x2.0	6.3	2499
ThinkPad 365CD	486DX4/75	10.4" Color Active	8/24	540MB	1/III or 2/II	TrackPoint III	1MB	4.7x8.3x2.0	6.3	3099
ThinkPad 701C	486DX4/75	10.4" Color Dual Scan	8/24	360MB	1/III or 2/II	TrackPoint III	1MB	9.6x7.8x1.6	4.5	2469
ThinkPad 701C	486DX4/75	10.4" Color Dual Scan	8/24	540MB	1/III or 2/II	TrackPoint III	1MB	9.6x7.8x1.6	4.5	2849
ThinkPad 701C	486DX4/75	10.4" Color Active	8/24	360MB	1/III or 2/II	TrackPoint III	1MB	9.6x7.8x1.6	4.5	2999
ThinkPad 701C	486DX4/75	10.4" Color Active	8/24	540MB	1/III or 2/II	TrackPoint III	1MB	9.6x7.8x1.6	4.5	3299
ThinkPad 701C	486DX4/75	10.4" Color Dual Scan	8/24	720MB	1/III or 2/II	TrackPoint III	1MB	9.6x7.8x1.6	4.5	3099
ThinkPad 701C	486DX4/75	10.4" Color Active	8/24	720MB	1/III or 2/II	TrackPoint III	1MB	9.6x7.8x1.6	4.5	3659
ThinkPad 755CD	Pentium 75	10.4" Color Active	8/40	810MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	7.3	4949
ThinkPad 755CD	Pentium 75	10.4" Color Active	8/40	1.2GB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	7.3	5399
ThinkPad 755CX(Value)	Pentium 75	10.4" CA(no audio-modem-phone)	8/40	540MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	6.1	3749
ThinkPad 755CX(Value)	Pentium 75	10.4" CA(no audio-modem-phone)	8/40	810MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	6.1	4149
ThinkPad 755CX	Pentium 75	10.4" Color Active	8/40	540MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	6.1	4849
ThinkPad 755CX	Pentium 75	10.4" Color Active	8/40	810MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	6.1	5249
ThinkPad 755CX	Pentium 75	10.4" Color Active	8/40	1.2GB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.2	6.1	5699
ThinkPad 755CV	Pentium 75	10.4" Color Active	8/40	810MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	6.5	5949
ThinkPad 755CV	Pentium 75	10.4" Color Active	8/40	1.2GB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	6.5	5899
ThinkPad 755CDV	Pentium 75	10.4" Color Active	8/40	810MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	6.5	5999
ThinkPad 755CDV	Pentium 75	10.4" Color Active	8/40	1.2GB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	6.5	6449
ThinkPad 760C	Pentium 90	10.4" Color Active	8/40	720MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	6.1	5349
ThinkPad 760C	Pentium 90	12.1" Color Active	8/40	720MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	7.3	6049
ThinkPad 760C	Pentium 120	12.1" Color Active	8/40	720MB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	7.3	6599
ThinkPad 760CD(4X)	Pentium 90	12.1" Color Active	8/40	1.2GB	1/III or 2/II	TrackPoint III	1MB	11.7x8.3x2.0	7.3	7449
HEWLETT PACKARD										
Omnibook 600C	486DX4/75	8.5" Color Dual Scan	8/16	340MB	2/II or 1/III	Pop-Up Mouse	1MB	11.1x7.3x1.6	3.8	2539
OmniBook 600CT	486DX4/75	9.5" Color Active	8/32	340MB	2/II or 1/III	Pop-Up Mouse	1MB	11.1x7.3x1.6	4.6	2999
OmniBook 5000C VL75	Pentium 75	10.4" Color Dual Scan	8/64	540MB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	3279
OmniBook 5000CT VL75	Pentium 75	10.4" Color Active	8/64	1.2GB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	3589
OmniBook 5000C VL90	Pentium 90	10.4" Color Dual Scan	8/64	810MB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	3859
OmniBook 5000CT VL90	Pentium 90	10.4" Color Active	8/64	1.2GB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	4889
OmniBook 5000CT	Pentium 90	10.4" Color Active	8/64	1.2GB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	5329
OmniBook 5000CTS	Pentium 90	10.4" Color Active (800X600)	16/64	1.2GB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	5889
OmniBook 5000CTS	Pentium 120	10.4" Color Active (800X600)	16/64	1.2GB	2/II or 1/III	Bit-in TrackBall	1MB	11.6x8.9x1.9	6.8	6539
TEXAS INTRUMENTS										
EXTENSA 450	486DX4/75	10.4" Color Dual Scan	4/32	340MB	1/II	Touch Pad	1MB	11.7x8.2x1.7	5.0	$1649
EXTENSA 450	486DX4/75	9.5" Color Active	4/32	340MB	1/II	Touch Pad	1MB	11.7x8.2x1.7	5.0	2039
EXTENSA 550	Pentium 75	10.4" Color Dual Scan	8/40	524MB	2/II or 1/III	Touch Pad	1MB	11x6X9x2.2	6.2	2449
EXTENSA 550CD	Pentium 75	10.4" Color Dual Scan	8/40	524MB	2/II or 1/III	Touch Pad	1MB	11x6X9x2.2	6.2	2939
EXTENSA 550CDT	Pentium 75	10.4" Color Active	8/40	524MB	2/II or 1/III	Touch Pad	1MB	11x6X9x2.2	6.4	3519
TM5000	Pentium 75	10.5" Color Dual Scan	8/32	500MB	2/II or 1/III	Point Stick	2MB	11x8.7x2.2	6.7	2769
TM5000	Pentium 75	10.4" Color Active	8/32	772MB	2/II or 1/III	Point Stick	2MB	11x8.7x2.2	6.7	3469
TM5100	Pentium 90	10.4" Color Active	8/32	1.2GB	2/II or 1/III	Point Stick	2MB	11x8.7x2.2	6.7	4199
TM5200	Pentium 120	10.4" Color Active	8/32	1.2GB	2/II or 1/III	Point Stick	2MB	11x8.7x2.2	6.7	5099
ZENITH										
Z-Star	486DX4/100	10.4" Color Dual Scan	4/20	420MB	2/II or 1/III	Bit-in TrackBall	1MB	11x8.7x1.8	5.2	2329
Z-Note MX	486DX4/100	9.5" Color Dual Scan	8/32	420MB	2/II or 1/III	Pressure Pad	1MB	11.1x8.7x1.9	5.9	2499
Z-Note MX	486DX4/100	9.5" Color Dual Scan	8/32	540MB	2/II or 1/III	Pressure Pad	1MB	11.1x8.7x1.9	5.9	2599
Z-Note MX	486DX4/100	9.5" Color Dual Scan	8/32	810MB	2/II or 1/III	Pressure Pad	1MB	11.1x8.7x1.9	5.9	2799
Z-Note MX	486DX4/100	10.4" Active Color	8/32	810MB	2/II or 1/III	Pressure Pad	1MB	11.1x8.7x1.9	6.1	3499
SAMSUNG										
SENS 700	486DX4/75	10.4" Color Dual Scan	8/32	520MB	2/II or 1/III	Bit-in TrackBall	1MB	11.3x8.9x2.2	6.2	$1999
SENS 700	486DX4/100	10.4" Active Color	8/32	810MB	2/II or 1/III	Bit-in TrackBall	1MB	11.3x8.9x2.2	6.5	2499
SENS 800	Pentium 75	10.4" Color Dual Scan	8/32	520MB	2/II or 1/III	Bit-in TrackBall	1MB	11.3x8x2.1	6.2	2399
SENS 800	Pentium 75	10.4" Active Color	8/32	810MB	2/II or 1/III	Bit-in TrackBall	1MB	11.3x8x2.1	6.5	2999
SENS 800	Pentium 90	10.4" Active Color	8/32	1.3GB	2/II or 1/III	Bit-in TrackBall	1MB	11.3x8x2.1	6.5	3499



IBM ThinkPad 760CDV/CD
PENTIUM 90
12.1" Color Active
1.2GB 8/40RAM
$7449

COMPAQ LTE 5200
PENTIUM 120
10.4" Color Active
1.35GB 8/72RAM
$6379

TEXAS INTRUMENTS TravelMate 5200
PENTIUM 120
10.4" Color Active
1.2GB 8/32RAM
$5099

NOTEBOOK MEMORY

SIZE PRICE

AST RESEARCH MEMORY

Ascentia 900N 4/50, 4/75, 910N	4MB	$189
Ascentia 900N 4/50, 4/75, 910N	8MB	389
Ascentia 900N 4/50, 4/75, 910N	16MB	649

COMPAQ MEMORY

LTE Lite/20, Lite/25, Lite/25C, Lite/25E	4MB	189
LTE Lite/20, Lite/25, Lite/25C, Lite/25E	8MB	389
LTE Lite/20, Lite/25, Lite/25C, Lite/25E	16MB	689
LTE Lite 4/25C, /33C, /25E, /25SL Mono Notebk	4MB	189
LTE Lite 4/25C, /33C, /25E, /25SL Mono Notebk	8MB	389
LTE Lite 4/25C, /33C, /25E, /25SL Mono Notebk	16MB	649
LTE Lite 4/40C, /50E, /40CX, /50CX, /75CX	4MB	189
LTE Lite 8/40C, /50E, /40CX, /50CX, /75CX	8MB	389
LTE Lite 4/40C, /50E, /40CX, /50CX, /75CX	16MB	789
Contura 4/25, 4/25C, 4/25CX	4MB	189
Contura 4/25, 4/25C, 4/25CX	8MB	389
Contura 4/25, 4/25C, 4/25CX	16MB	649
Contura 3/20, 3/25, 3/25C	4MB	189
Contura 3/20, 3/25, 3/25C	8MB	349
Contura 400C, 400CX, 410, 410C, 410CX	4MB	189
Contura 420 DX4/75, 430 DX4/100		
Contura 400C, 400CX, 410, 410C, 410CX	8MB	349
Contura 420 DX4/75, 430 DX4/100		
Contura 400C, 400CX, 410, 410C, 410CX	16MB	649
Contura 420 DX4/75, 430 DX4/100		

NEWLETT-PACKARD MEMORY

OmniBook 600C	4MB	$189
OmniBook 600C	8MB	389
OmniBook 4000	4MB	189
OmniBook 4000	8MB	349
OmniBook 4000	16MB	649

IBM MEMORY

ThinkPad 701	4MB	$189
ThinkPad 701	8MB	349
ThinkPad 701	16MB	649
PS/2 CL57SX, ThinkPad 700, 700C, 720C; ThinkPad 750, 755, 355, 340 (All Models)	4MB	189
PS/2 CL57SX, ThinkPad 700, 700C, 720C; ThinkPad 750, 755, 355, 340 (All Models)	8MB	389
ThinkPad 750, 755, 355, (All Models)	16MB	699
ThinkPad 750, 750CS, 750C, 750P, 755	32MB	1449
ThinkPad 730T, 750, 755, 360, (All Models)	4MB	189
ThinkPad 355, 355CS, 355C		
ThinkPad 730T, 750, 755, 360, (All Models)	8MB	349
ThinkPad 355, 355CS, 355C		
ThinkPad 730T, 750, 755, 360, (All Models)	16MB	699
ThinkPad 355, 355CS, 355C		
ThinkPad 755 Series	8MB	449

NEC MEMORY

UltraLite Versa, Versa E, M, P, V, 4000	4MB	$189
UltraLite Versa, Versa E, M, P, V, 4000	8MB	349
UltraLite Versa, Versa E, M, P, V, 4000	16MB	649
Versa E, M, P, V, 4000 P75	32MB	1509
Versa S, 2000	4MB	189
Versa S, 2000	8MB	349
Versa S, 2000	16MB	649

TEXAS INSTRUMENTS MEMORY

TravelMate 4000, 4000E, 4000M	16MB	$849
TravelMate 5000	8MB	389
TravelMate 5000	16MB	749
Extensa 450, 450T, 455, 455T	4MB	189
Extensa 450, 450T, 455, 455T	8MB	349
Extensa 450, 450T, 455, 455T	16MB	649

TOSHIBA MEMORY

Portege 610CT, Satellite Pro 400CS, 400CDT	8MB	$389
Portege 610CT, Satellite Pro 400CS, 400CDT	16MB	749
Portege 610CT, Satellite Pro 400CS, 400CDT	32MB	1499
T2100, /CS, /CT, T2105, /CS, /CT T2150CDT, T2150CDS, T2155CDT, T2155CDS	4MB	189
T2110, T2115, T2130, T2135		
T2100, /CS, /CT, T2105, /CS, /CT T2150CDT, T2150CDS, T2155CDT, T2155CDS	8MB	389
T2110, T2115, T2130, T2135		
T2100, /CS, /CT, T2105, /CS, /CT T2150CDT, T2150CDS, T2155CDT, T2155CDS	16MB	699
T2110, T2115, T2130, T2135		
T2100, /CS, /CT, T2105, /CS, /CT T2150CDT, T2150CDS, T2155CDT, T2155CDS	24MB	1279
T2110, T2115, T2130, T2135		

ZENITH DATA MEMORY

Z-Star EX	4MB	$189
Z-Star EX	16MB	649
Z-NoteFlex	4MB	189
Z-NoteFlex	8MB	389
Z-NoteFlex	16MB	689

NOTEBOOK DRIVES

IBM
MODELS 755-355-360-750
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710MB-$995 1.2GB-$1695
MODELS 700-700C-780-720C
340MB-$995 720MB-$1495
524MB-$1295
MODELS 701C-701CS
540MB-$795 720MB-$895

NEC
VERSA E,M,V, P
340MB-$595 720MB-$1095
524MB-$895 1.2GB-$1695

TOSHIBA

MK2526FC	524MB	15MS	IDE	$399
MK2428FC	520MB	15MS	SCSI	449
MK2628FC	810MB	13MS	IDE	499
MK2720FC	1.3GB	13MS	IDE	575

SEAGATE

ST9150AG	131MB	16MS	$169
ST9000AG	210MB	16MS	199
ST9420AG	420MB	16MS	299
ST9655AG	524MB	16MS	399
ST9816AG	810MB	16MS	549

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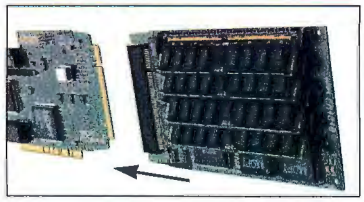

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Presario 433, CDS520, CDJV520 CDL524, CDS529, CDTV528 660, CDS660, CDS720, CDS724, CDS744, CDD660 CDS920, CDTV920, 924, CDS924, CDS954	4/8/16/32Meg	139/279/549/1048
Presario 400 Series, 600 Series	2/4/8/16/32Meg	89/154/319/649/1189
Presario CDS774, CDS972, CDS982, CDTV978, CDS974 (xi pairs) CDS992, 7152, 7170 7180, 9546, 9548, 9564	4/8/16/32Meg	139/279/549/1099
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Prolinea 450, 466, 4100, 575, 590, 5120, 575, 590, 5120 575 mini, 5100 mini, 5133 mini	4/8/16/32Meg	154/319/649/1189
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T4400SX, SXC T6400, T6600	4Meg	PC-PA2004U	169.00
T4400SX, SXC T6400, T6600	8Meg	PC-PA2008U	379.00
T4400SX, SXC T6400, T6600	16Meg	PC-PA2016U	689.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	4Meg	PC-PA2012U	189.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	349.00
T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	16Meg	PC-PA2014U	652.00
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T3100SX	4Meg	PC15-PA8310U	189.00
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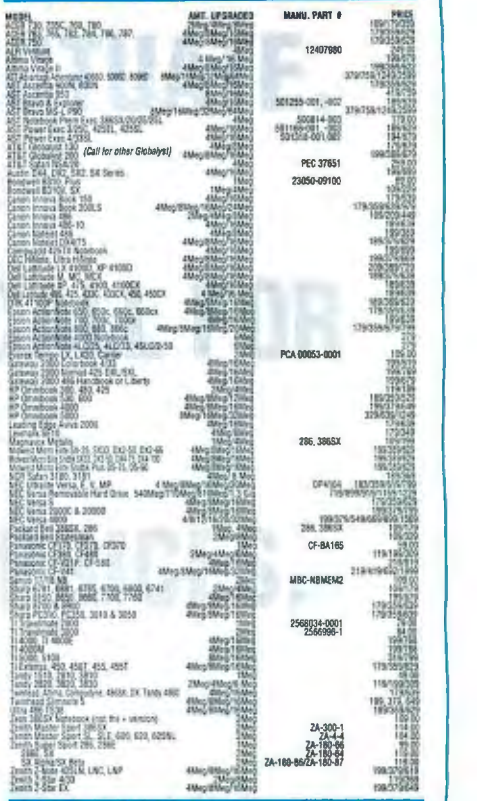

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Canon LBP 860	–	–	–	99	–	–	179	–	–	349	699	1249
Canon LBP4, 4Lite, 4plus	–	–	129	179	–	–	–	–	–	–	–	–
Epson 6000, Action Laser	–	–	–	129	–	–	229	–	–	–	–	–
Epson Action Laser 1100, 1600	–	–	69	99	–	–	169	–	–	379	599	–
Epson Action Laser II	–	–	89	–	208	–	–	327	–	–	–	–
Epson 8000, 8000, 4000, 4300	–	–	89	–	208	–	–	327	–	Call	Call	Call
Epson 1000, 1500, 5000, 5200	–	–	–	*169*	–	–	*218*	–	–	–	–	–
HP 2, 2D-	–	–	–	89	–	–	179	–	–	–	–	–
HP 3, 3D, 3P, 2P 2P+	–	–	–	89	–	–	149	–	–	–	–	–
HP 4, 4M, 4Si, 4SiMX	–	–	–	89	–	–	149	–	–	349	–	–
HP 4P, 4PLUS, 4MPm 1600, 1600CM	–	–	–	–	–	–	145	–	–	289	–	–
HP 4Si	–	–	89	–	–	–	–	–	–	–	–	–
HP 3Si	–	–	69	–	–	–	169	–	–	299	–	–
HP 4Si	–	–	–	89	–	–	155	–	–	299	–	–
HP 4Si	–	–	89	129	–	–	–	–	–	399	–	–
HP 5P	–	–	–	69	–	–	155	–	–	305	539	–
HP Design Jet 600, 650, 200	–	–	–	89	–	–	167	–	–	349	–	–
HP Design Jet 500, 510, 550/560	49	–	–	–	–	–	–	–	–	–	–	–
HP Deskjet 1200C, 1200CP	–	–	–	89	–	–	187	–	–	349	–	–
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HP Palmjet XL300	69	–	–	–	–	–	249	–	–	429	837	–
IBM Laser 4019, 4019E	–	–	–	–	–	169	–	–	–	–	–	–
IBM Laser 4029, 4037	–	–	–	–	–	–	169	–	–	–	–	–
IBM Laser 4039, 4079	–	–	–	99	–	–	169	–	–	359	–	–
Konica LP-3110	–	–	119	189	239	–	–	–	–	–	–	–
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Lexmark Valuewriter 300,600	–	–	59	89	–	–	169	–	–	–	–	–
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NEC 90, 290	–	–	119	–	–	–	–	–	–	–	–	–
NEC 95, 97	–	–	99	–	–	–	249	–	–	–	–	–
Oki 400	–	–	–	104	199	–	219	–	–	–	–	–
Oki 400E, 460EX, 410E, 410EX	–	–	89	129	–	–	–	–	–	–	–	–
Oki 830, 840	–	–	–	199	–	–	–	–	–	–	–	–
Packard Bell PB 9500	–	–	–	139	–	–	227	–	–	–	–	–
Packard Bell 9813	–	–	–	139	–	–	229	–	–	–	–	–
Panasonic 4420/4450i	–	–	–	129	–	–	229	–	–	–	–	–
Panasonic 4410/4430	–	–	–	125	–	–	195	–	–	–	–	–
Panasonic 4450	–	99	–	–	–	–	–	–	–	–	–	–
Panasonic 4400/5400	–	89	129	–	–	–	229	–	–	–	–	–
Panasonic 4440, 5410	–	89	129	–	–	–	229	–	–	–	–	–
Sharp 9400, 9460, 9600, 9700E	–	89	129	–	–	–	229	–	–	–	–	–
Sharp 9500 E, N, 9700, N	–	79	–	–	–	–	259	–	–	–	–	–
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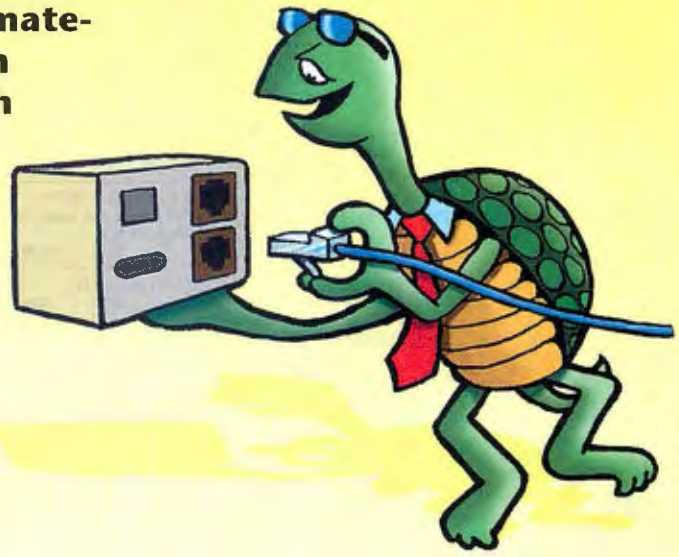

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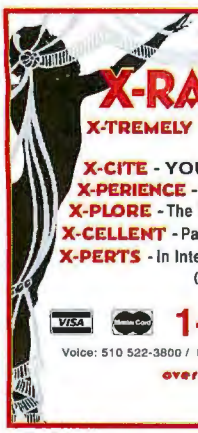

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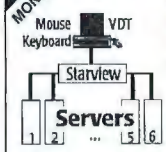

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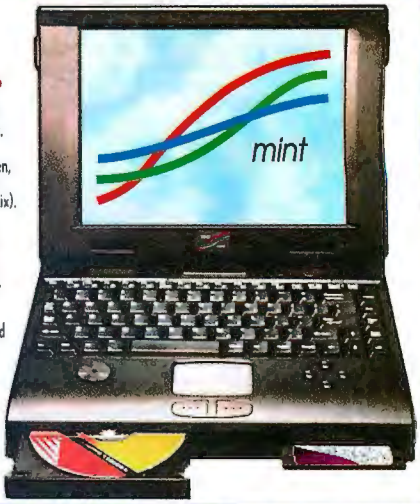

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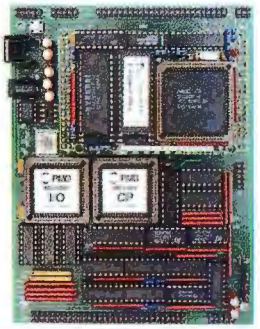

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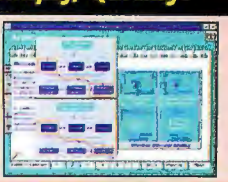

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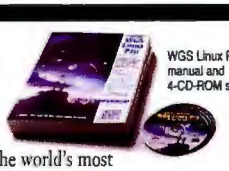

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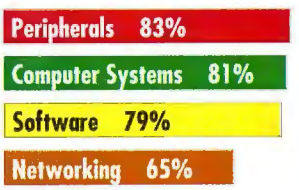

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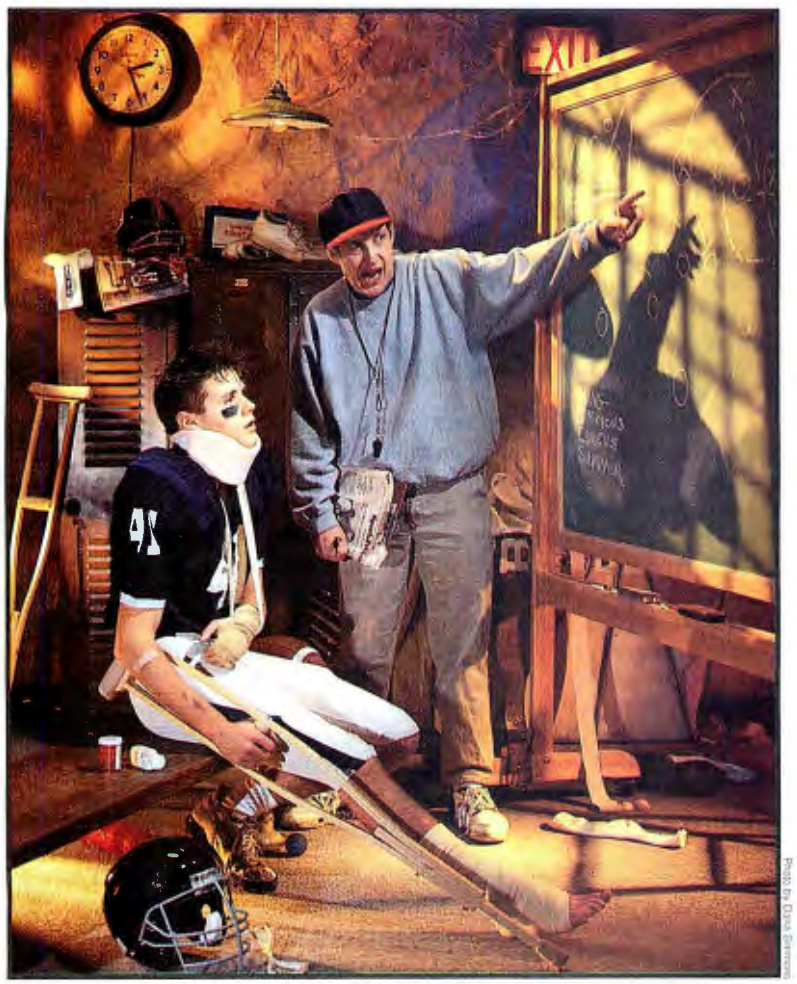

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From Copyrights to Telerights

A modest proposal for protecting copyrights in this digital society

KEVIN VANDIVIER © 1996

I'd like to propose a simple solution to the problem of copyrights in the digital era. It's a hot issue because the ease with which digital information can be duplicated runs against the best interests of society as a protector of intellectual property.

We can actually give in to this devilish aspect of the digital era *and* improve the lot of writers, publishers, and anyone else producing copyrightable material. My solution doesn't require new technology; we just have to adapt current technology to valid social goals already established in the law. Copying may be easy, but decryption is not.

I call the solution *telerights*. It involves cryptography, telephony, objects, and software meters—things that are individually in vogue but have not yet congealed in a way that can protect intellectual property.

In the age of distributed intelligence, where everyone can be a publisher, the responsibility for copyright enforcement should also be distributed and automated. No one has approached it this way because we're trained to see computer memory as divided into applications and passive data, a distinction exacerbated by object orientation. Each bit of memory is really an instruction to the computer; every instance of an object is a method. These sentences, stored somewhere in RAM, tell my monitor what to draw. They are instructions. But until now, digital documents have been passively interpreted and not designed as objects that can talk back.

A telerighted document would be a miniature application capable of informing its publisher about its use. Each would be encrypted with a unique key and would stay encrypted whenever stored on fixed media. The document would fetch the key from the publisher when someone wanted to view it and decrypt itself into a tamper-resistant part of RAM. Sending a key would be less expensive than resending the whole document, which is the Ted Nelson/pay-per-view solution. When the person was finished with the document, the document would notify its publisher and erase itself.

This sort of strict copyright enforcement doesn't necessarily mean people would pay more for viewing copyrighted material. A professor could "lend" a copy of one of his or her infrequently used books to a student. Only one copy of that book could be decrypted at any given time. Students wanting a personal copy could buy a version with its own key.

Ownership would be portable. I could resell or even rent my copy of *Terminator 5*, and the publisher wouldn't have to worry about piracy because it could block multiple users. Libraries wouldn't have to pay for unused copies, and even small publishers would have a cheap but strong method of guarding their intellectual property.

If I republished part of a compound document in my own work, I wouldn't have to pay for using all of it. The document would be able to tell its publisher exactly what part I used. If I grabbed a still from *Terminator 5*, I would not have to pay for the soundtrack. Fair-use quotations would also be easier to handle. Telerights would create an audit trail in case the courts had to judge the fairness of the use.

Parts of the telerights puzzle are being assembled. The Copyright Clearance Center has set up a Web site where people can negotiate licenses. It's also designing a network system for metering information used on CD-ROMs, which is great for big corporations that have the proper hardware. But this approach won't work well for everyone else because information won't stay on a central CD-ROM or server. Folks want to have their own copy to pass around.

Xerox Palo Alto Research Center (PARC) has come closest, with a centralized client/server solution that appears to rely on a private network. It's proprietary technology, and information about it is limited. But from what I've heard, PARC's thinking is similar to mine. Whatever the final details are, telerights should be a public standard for open, peer-to-peer networks. While none of this technology is new, the necessary networking infrastructure is not in place, and getting it there will require tremendous cooperation among some very powerful companies, such as cable and phone providers. Computers and their OSes will have to be modified.

While companies should be able to maintain telerights, the government will have to regulate them, just as it does the money supply. Information, after all, is money. ■

Wade Riddick is a graduate student and a former National Science Foundation Fellow in the government department at the University of Texas at Austin. You can contact him at riddick@jeeves.la.utexas.edu.

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