Applications Development Extra
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SPECIAL REPORT: OPERATING SYSTEMS

NOVEMBER 1995

# BYTE

THE MAGAZINE OF TECHNOLOGY INTEGRATION

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P90 POWERSTATION

October 1994
P90 POWERSTATION

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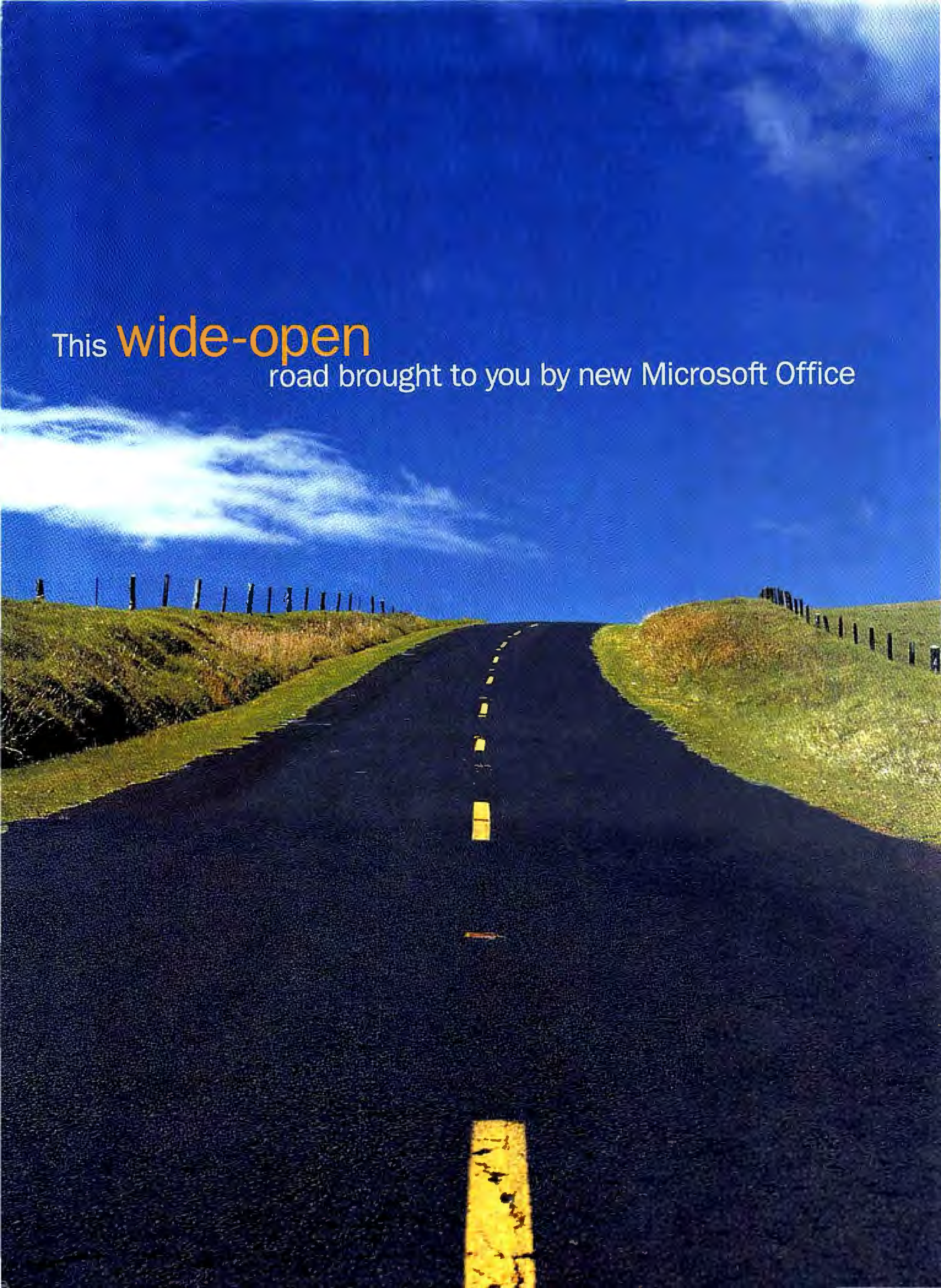
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NOVEMBER 1995 VOL. 20, NO. 11

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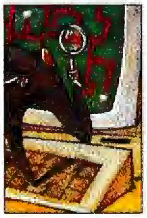
### State of the Art

# SUPER CHIPS




## Features







## SPECIAL REPORT

### OPERATING SYSTEMS

Hot new developments in the software that runs the software



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BYTE **Contents by Platform**

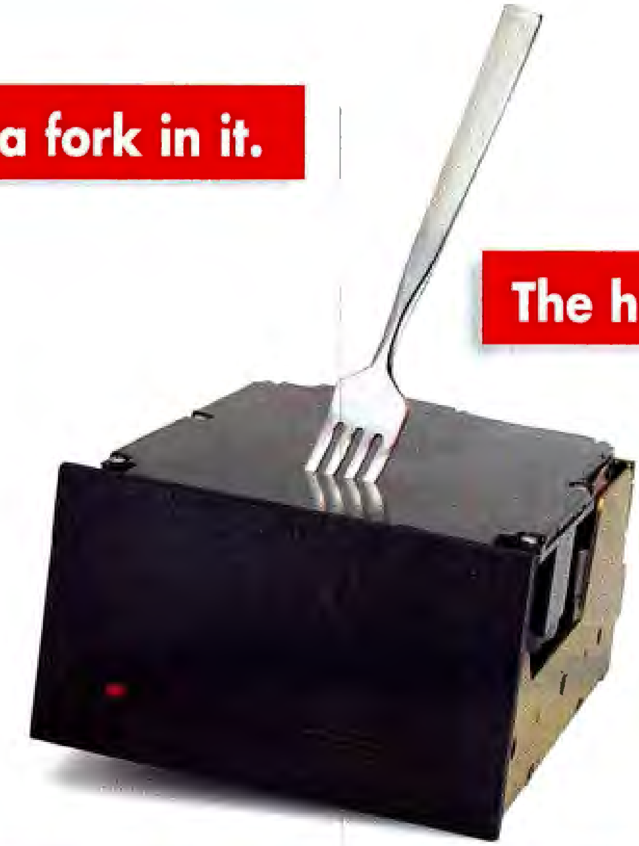
This page presents the articles in this issue according to computing platform.



# Index

Put a fork in it.

The hard drive is done.



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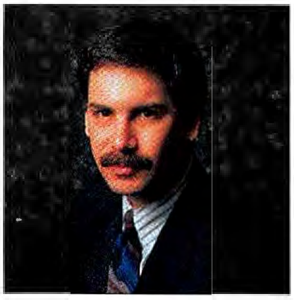
# The Ultimate Operating System?



**It takes more than a zillion-dollar marketing budget to build the perfect operating system**

I spent August 24 at the beautiful Microsoft campus in Redmond, Washington. The weather was ideal for the launch of Windows 95; the clouds did a perfect imitation of the background graphic on the Windows 95 carton. Five hundred journalists and I gave up our smug attitude for a few hours to sit in the de facto cheering section at an event that reminded many of us more of a fashion show than a computer product launch.

At one point, I had to restrain myself from leaping up in the middle of the hype and screaming, "Listen to me! It's just an OS upgrade! GET A LIFE!" Later, however, I found myself strangely caught up in the act, laughing at Jay Leno's faux-Luddite act and actually applauding when the big tent wall was dropped to reveal the bleachers full of color-coordinated Windows programmers.

It didn't take me long to come to my senses again, fortunately. All the fancy positioning and expensive marketing can't mask the more important question of the Windows 95 release: How will it really impact the way people work? Because it's the product, not the posture, that will ultimately make the difference.

Will Win 95 take the world by storm, bringing a new class of users to technology? Or will the remnants of DOS that remain in the product push people to more carefully consider the Mac, which has had, as Apple is happy to remind us, a Trashcan icon for 10 years already? Or worse, will the Win 95 hoopla and the emasculated Rolling Stones "Start Me Up" commercial (the words "You make a grown man cry" having been removed from the lyrics) backfire on Microsoft the way the nuns-with-beepers ads submarined OS/2?

I have to admit that I like Win 95. I've been using it for several months, and it's pretty good for a major upgrade. But there's a lot of stuff I miss in this OS. I wish I could take the elements I like from all the OSes available and build my own. Component technology doesn't quite offer me that flexibility yet. But if it did, here's what I'd do:

**The kernel.** Oh please, let me dump this ancient half-DOS system and build something more tight, more cross-platform, more robust. Like Windows NT.

**User interface.** People think I'm a Windows bigot, but that's just because I like to use a lot of different applications, and Windows has more than anybody else. Actually, I'd trade it in for parts of the Mac OS in a heartbeat. The Mac's user interface is better integrated into the OS itself, more consistent, and easier to teach.

**Size.** Why do I need 40 MB of hard disk space and 16 MB of RAM for a single-processor, single-user OS? I've seen faster, smaller, and equally graphical OSes that, theoretically, could do everything I need. GeoWorks and QNX come to mind.

**Networkability.** My OS should be able to easily hop onto and off the Internet, a Novell LAN, and wireless services. I like Win 95's capabilities in this arena, but the Mac and OS/2 also do well here.

**Multi-everything.** I want flexibility. That means an OS architecture that scales from the address book on my personal digital assistant (PDA) up to a big database server. I want my OS to support multiple processors (which NT and big-iron systems like VMS do). I want it to be multithreaded and multitasking (NT, OS/2, Win 95), so background processes don't bottleneck my whole system. I want it multiuser (Unix), so I can distribute some of my applications without requiring a full-power computer at each seat. Finally, it has to be multiplatform, so I'm not locked into Intel, Motorola, or any other chip architecture.

**Object-oriented.** Object-oriented OSes (OOOSes; great acronym, isn't it?) make for better data sharing among applications and, thanks to reusable components, easier applications development. This last bit is important because it makes programming less expensive, and when you spend less money on that, you can spend more on testing and reliability. The best OOOS we've seen here is NextStep, although the Newton's OS also scores well.

The ideal OS, of course, doesn't exist. But to see how close we are to OS nirvana, check out our Special Report, which begins on page 73.

And in the meantime, be thankful that there is no perfect OS. It means your job as a technologist is safe, as is mine. For now, at least. ■

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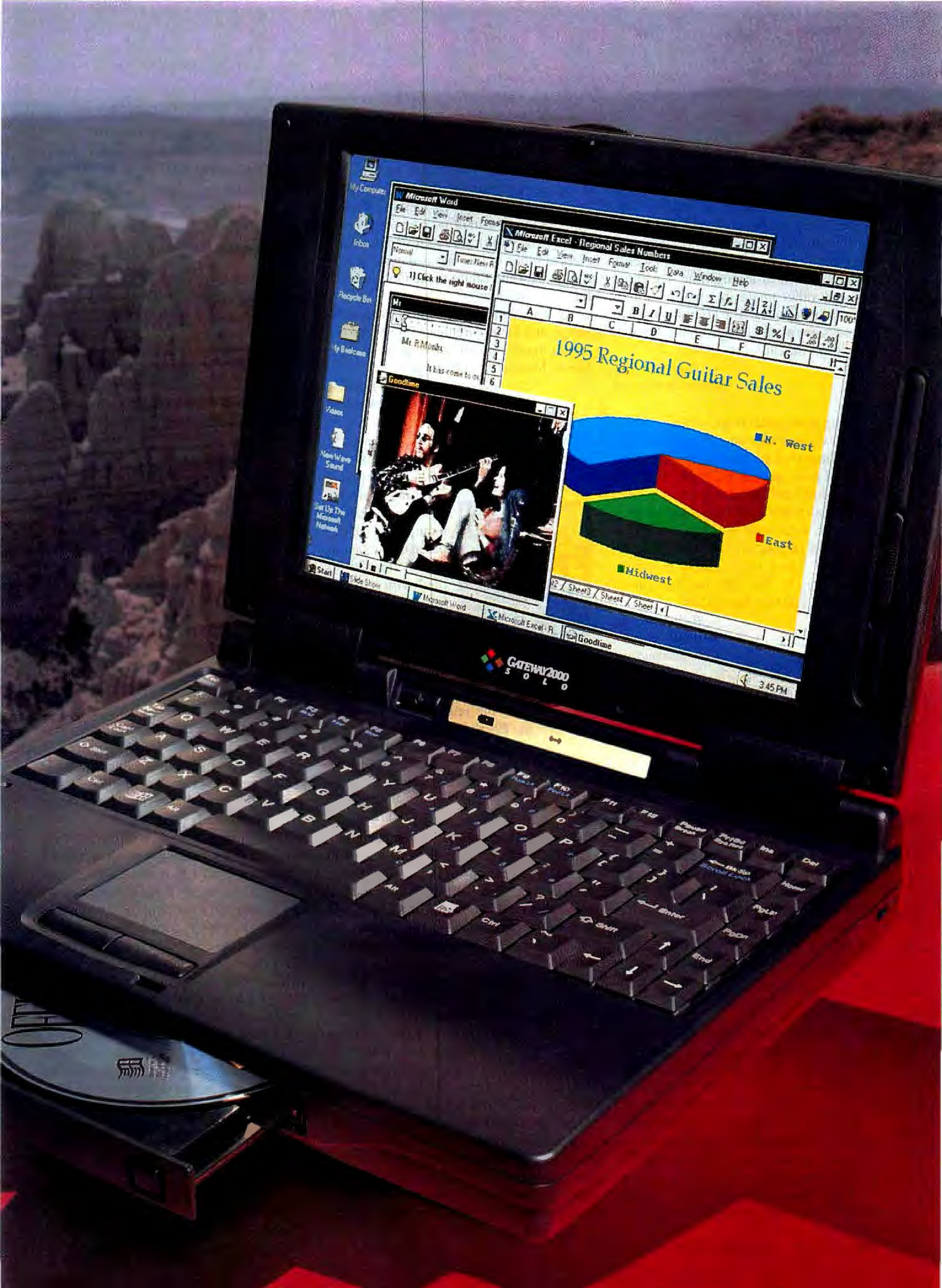
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### Happy Anniversary

Being a BYTE reader since way back 20 years ago, I had a sort of special feeling going over your anniversary edition (September)—not the least of which was noticing I'm 20 years older and still banging away on a computer keyboard. Twenty years is a heck of a long time. Far more than any other magazine, you have pioneered this industry. BYTE has a place of its own somewhere along with the Apple II and Turbo Pascal.

Gus J. Grubba
*gus@sgi.grubba.com*

Reading your anniversary articles was a trip down memory lane. I have used or owned many of the computers you mentioned. I have special praise for the Radio Shack Model 100, since it is now the heart and brain of my lawn-watering system. However, it does not use the Z80 CPU as mentioned in your article "Top 20 Small Systems." Many other Tandy machines were driven by the Z80, but the soul of the Model 100 was the 80C85.

Richard Poitras
*Missoula, Montana*
*poitras@montana.com*

*The Model 100 did indeed use an 80C85, clocked at a blazing 2.4 MHz. We regret the error.—Eds.*

The "20 Spectacular Failures" piece lacked one product worthy of inclusion—Microsoft Bob. What an oversized piece of dreck. I also expected to see somewhere in the section at least one entry regarding the Heathkit computers. A lot of us cut our eyeteeth on H-8s. You guys really seem to have a blind spot regarding the Heath company, as I pointed out the last time you did this type of historic review. Put a big pop-up reminder in your database so you don't leave them out again!

Welbrey A. Hill
*hillw@freenet.fsu.edu*

I am dismayed at the complete avoidance in your anniversary issue of any mention of OS/2, either in the "Most Important Software Products" article or in "The 10 Most Important Programs of Today" sidebar.

OS/2 2.1 was a revolutionary milestone in personal computing. The first real alternative to the MS-DOS/Windows 3.x combination, IBM's OS offered unparalleled backward compatibility. The DOS sessions were fast, protected, and individually customizable without having to reboot. OS/2 ran Windows software as well as native Windows seamlessly on the OS/2 desktop—an accomplishment Microsoft felt was impossible. Flat memory model, true preemptive multitasking (even with legacy software), unheard-of backward compatibility, object-oriented desktop, and a vision for the future make OS/2 a revolutionary product.

As Windows 95 falters from over-marketing and the usual bugs, OS/2 Warp becomes even more attractive as an alternative to Microsoft's offerings.

Tom Robeson
*drtom@infi.net*

Thanks for your stimulating list of error messages in the twentieth-anniversary issue. From 1983 to 1990, I worked as a freelance writer and used Acorn Computers (6502-based). The last of these machines died with a single intelligible phrase amongst all the garbage on the screen: "Klaatu Barada Nikto," which you may remember from the science-fiction classic *The Day the Earth Stood Still.*


Grant Nightingale
*Oxford, England.*
*100256.1361@compuserve.com*

Congratulations on the September issue. I can't, however, understand why you place three versions of the Apple Macintosh among the top 20 small systems and leave out the Commodore 64. The C-64 was a quantum leap when it appeared and was probably the best-selling computer of all time.

On another note, I have every BYTE since the January 1982 edition. Any chance these will ever come out on CD-ROM?

Eduardo Chaves
*Campinas, Sao Paolo, Brazil*
*chaves@turing.unicamp.br*

*We will add your votes for Commodore's 64 and Amiga in the growing bin of "How could you leave out such-and-such?" letters. Regarding back issues, we do have a BYTE CD-ROM that goes back five years. You can order one by calling (800) 924-6621 or faxing (609) 426-5592. You can also scan our archives on our Web page (http://www .byte.com) or our FTP site (ftp.byte.com).—Eds.*

### RADical Approach

I just finished reading "The End of Programming" (August). The main problem I've experienced in using rapid application development (RAD) is getting all the necessary design specifications from the full spectrum of clients who will use the new system. We solicited client input from the very start of our project, but as more and more clients use the actual production system, we're finding many needed refinements. And we've been getting feedback from some clients who say they have trouble adjusting to these constant refinements. In order for RAD to work, you need a client base that is willing to provide developers with feedback on the system and be flexible enough to use a continually refined system. Without this client participation, RAD isn't very effective.

Anthony W. Hanson
*ahanson@halcyon.com*

### BYTE Network Project

In his "Web Search" article (September), Jon Udell talks about freeWAIS (the NT port of it) and says that "since multiple search terms combine with OR . . . you depend on the selective power of a single term." This is only partly right: WAIS produces a ranking of result documents where the first entries fit the query better and the later entries don't fit it as well. Thus, you will find documents containing all search terms near the beginning of the ranking list, and documents containing few search terms near the end. In fact, if you access a WAIS server using a WAIS client, you will find that, in addition to the document title, you get a score indicating the match between the document and the query.

I would also like to direct your attention to freeWAIS-sf (sf = structured fields). It improves somewhat upon the standard indexing and retrieval functions of freeWAIS. A very important improvement of

**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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freeWAIS-sf is the ability to process structured fields. A document is separated into fields specified at run time (based on regular expressions), so there is no hard-wired restriction on what fields there are and how to recognize them. Here's where to find freeWAIS-sf: http://ls6-www.informatik.uni-dortmund.de/freeWAIS-sf/freeWAIS-sf.html

Kai Grossjohann
*grossjoh@dusty.informatik.uni-dortmund.de*

*The arbitrary fielded capability of freeWAIS-sf sounds particularly handy. I like the fact that the Simple Web Indexing System for Humans (SWISH) can look within HTML tags, but it only knows about certain of these kinds of "fields." I, in fact, have an application that wants more specific fielded capability, so I will give freeWAIS-sf a try. Your clarification of the behavior of freeWAIS is also very helpful.*
*—Jon Udell, executive editor*

### The BYTE Web Site

Great job on the new navigational layout for your Web site. The new style really helps, especially when a 14.4 connection is the best you can hope for. And thanks for the optional graphics. I hate having to wait on fancy graphics that don't help clarify the page's message. I've found nothing worse on the Web than waiting for graphics that mean nothing after they've finally loaded.

John Alexander
*Tuscaloosa, AL*
*76762.3310@compuserve.com*

### Letters to the Editor (in Chief)

Once again you have written so biased and inaccurate an editorial that I am compelled to write ("Why I Love/Hate Microsoft," August). You assert that Microsoft deserves credit for Word, Excel, and PowerPoint. Yet none of these products is the premier product in its respective field. You praise Microsoft for its vision of a GUI. That may be praiseworthy, but people spend most of their time working within an application, not the GUI. And Microsoft's "vision" costs untold millions in graphics accelerators just to get decent performance.

Joseph D. Moreno
*San Diego, CA*


*Microsoft's business productivity applications, especially as bundled in the Office suite, control a huge portion of the market. Like it or not, it is these applications, in conjunction with the Windows OS, that have made Microsoft a dominant force. It is not a question of technology. It is an issue of consistency, vision, and aggressive (perhaps too aggressive) exploitation of each fraction of a point of market share.*
*—Rafe Needleman, editor in chief*

I was prompted to respond to Rafe Needleman's statement that "Computers don't cost jobs" ("Old Enough to Know Better," September). As you point out, computers have indeed cost jobs in certain industries and created jobs in others. But counting jobs just doesn't tell the story. You need to look at income distribution. Computers have resulted in a widening of the income gap between the well-educated and the poorly educated. Computers have greatly benefited a well-educated minority and have tended to harm the economic well being of the rest of society. Given the current political climate, it's likely this trend will continue.

Alan Kushnir
*72500.2232@compuserve.com*

*I try to avoid political commentary in BYTE, although as computer technology pervades society, it gets more difficult.*
*—Rafe Needleman, editor in chief*

### Image Problems

David Seachrist's NSTL Software Roundup review "Document Image Managers" (May) contained inaccurate conclusions and omissions about our product, PaperClip for Windows. The review overlooked PaperClip's unique Visual Context Processor (VCP) technology, which lets the program integrate with existing applications without special programming. Somehow, Seachrist missed this feature, incorrectly relating it to OCR output and file conversion. In fact, thanks to VCP, PaperClip's folders can be pointed to from numerous other contexts and applications without DDE or OLE.

The other products are islands of technology that will exist outside users' daily application environments without a large investment in systems integration. PaperClip's unique approach obviates that need.

Sol Rosenberg
*President and Chief Technology Officer*
*PaperClip Imaging Software Inc.*
*Hackensack, NJ*

*I agree that the scope of the roundup was broad. This is endemic to any new software category. It is true that I misstated the reason for PaperClip's inability to maintain text formatting. It was the OCR engine, and not PaperClip's linking technology, that was the cause. But I continue to question the wisdom of employing VCP technology at the complete exclusion of OLE, a technology that is now well established.* ■
*—David Seachrist, NSTL*

## COMING UP IN DECEMBER

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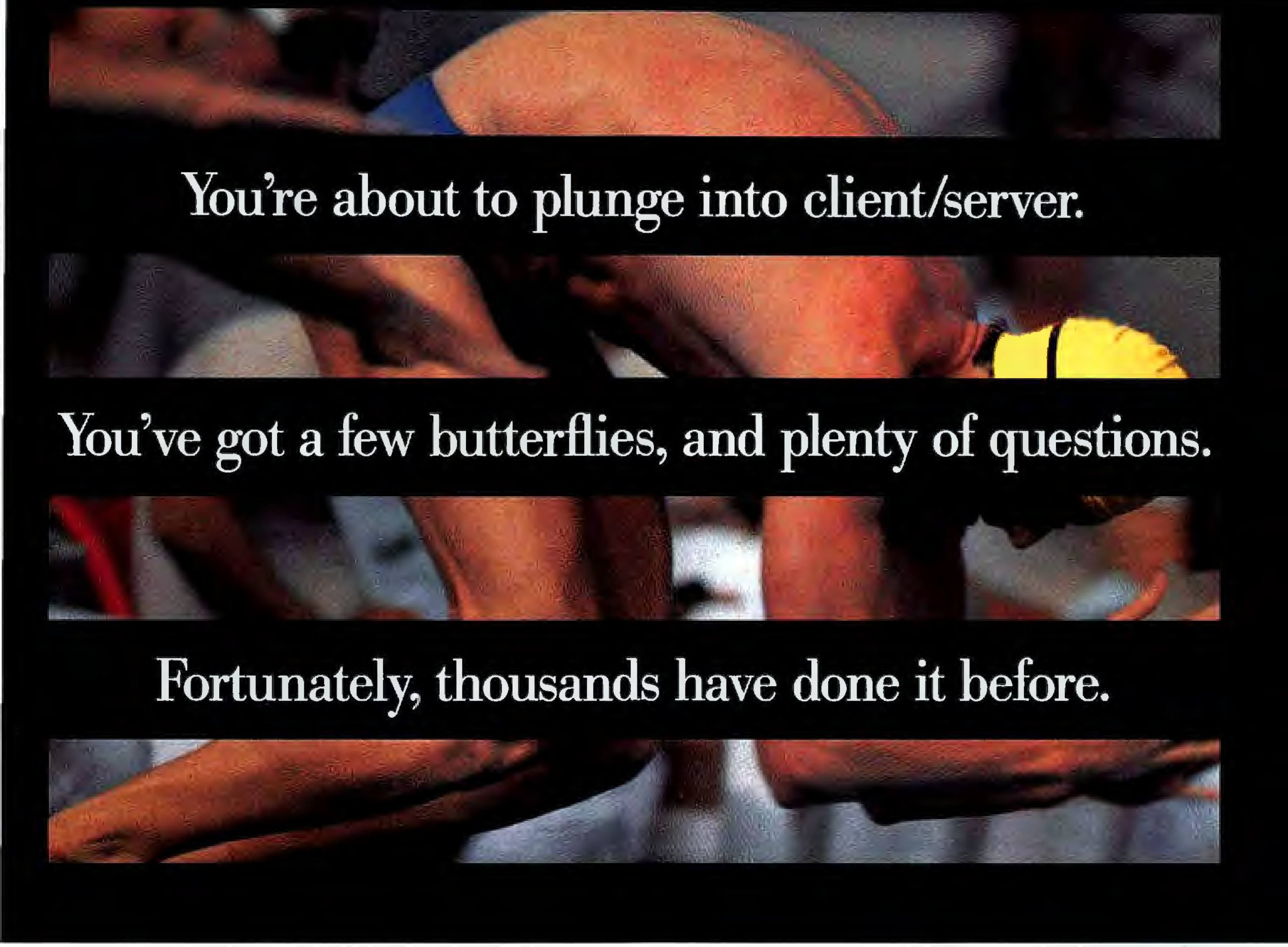
- **OFFICE 95**
  You've bought the OS—so now what do you do with it? We take a look at Microsoft Office 95.
- **HTML TO THE METAL**
  We test Hypertext Markup Language authoring and editing tools, including SoftQuad's HoTMetaL and Interleaf's Cyberleaf.
- **DOWN TO THE WIRE**
  Unplugging your computer while staying connected is becoming easier. We look at the latest wireless technologies to see where they're going and what's ready now.

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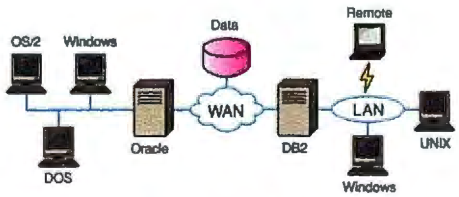


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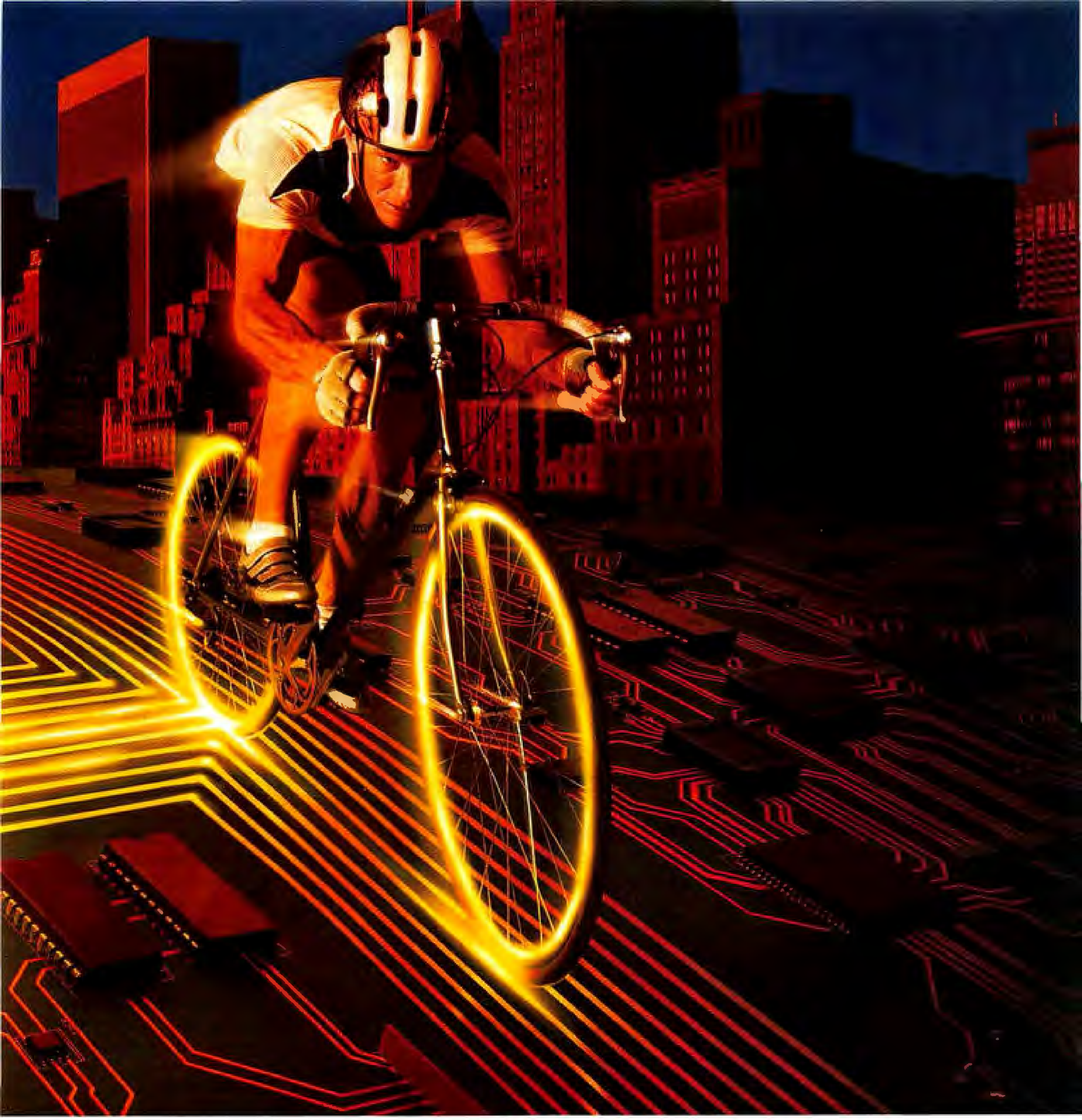

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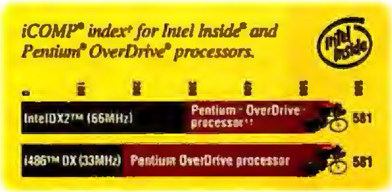


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# NEWS&VIEWS

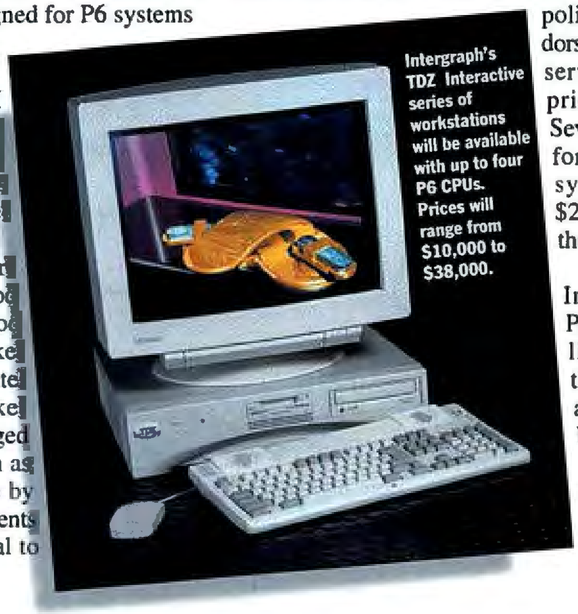
# P6 Expands PC Spectrum

**The first P6-based computers will range from affordable (under $4000) PCs to systems selling for more than $10,000**

**DAVE ANDREWS (WITH ADDITIONAL REPORTING BY MARK REYNOLDS)**

Surprise. The first PCs based on Intel's next-generation P6 processor won't be limited to big honking application servers designed to run massive database management systems. Over the next two months, vendors will release a variety of PCs ranging from moderately expandable, low-end (for P6) desktop systems selling for under $4000 to high-end servers. Vendors will also release powerful multiprocessing PC workstations suitable for 3-D modeling, CAD, and visualization.

At presstime, most companies that BYTE surveyed declined to release specific information on their P6 plans. However, sources report that many manufacturers, including Gateway, Dell, and IBM, will use—in at least some of their desktop systems—the Aurora motherboard that's manufactured by Intel. The Aurora board is reportedly designed for P6 systems that will fall into the mass market. The Aurora's intended audience explains its feature set: three open PCI slots, enhanced IDE instead of SCSI on the motherboard, no integrated sound or networking, and support for one P6 processor only. Because the motherboard lacks integrated networking and video acceleration, users will likely fill the system's first two PCI slots quickly.



Intergraph's TDZ Interactive series of workstations will be available with up to four P6 CPUs. Prices will range from $10,000 to $38,000.

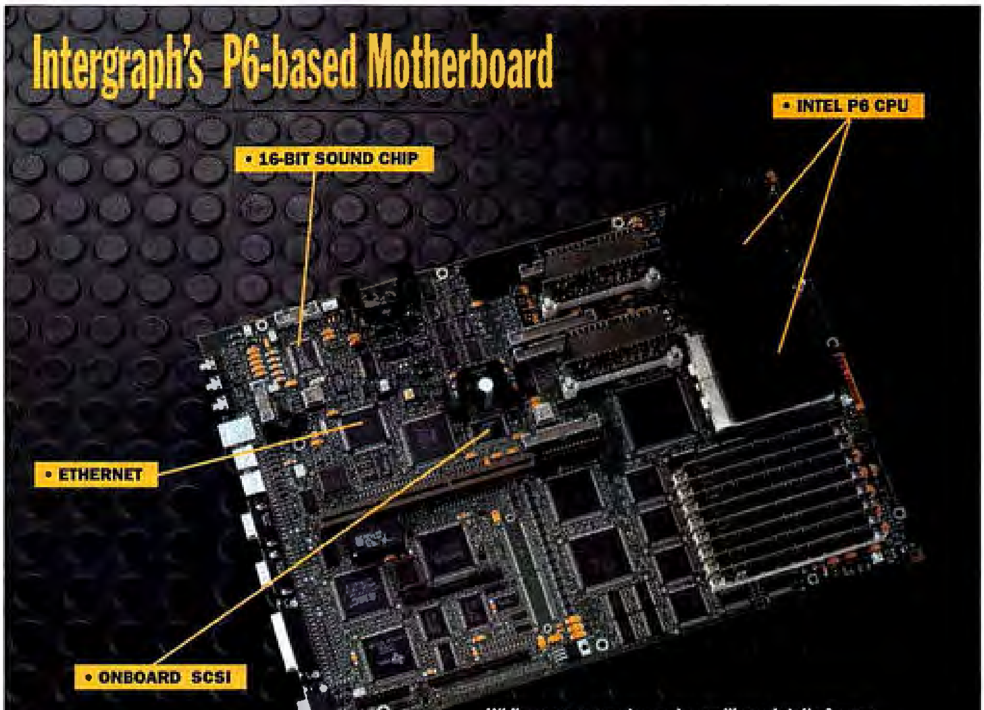
Intel's position as a supplier of P6 motherboards for desktops and servers could mean good news and bad news for PC vendors. The good news is that in today's highly competitive market with tight profit margins, a vendor using an Intel motherboard can bring a P6 system to market more quickly than if they designed and debugged the motherboard themselves. Companies such as Gateway 2000 (North Sioux City, SD) thrive by integrating readily accessible, standard components into relatively inexpensive bundles that appeal to mainstream consumers. "We were able to take the Pentium and put it in a product that appealed to the mass market," says Rus Graham, Gateway 2000's marketing communications manager for desktop products. Although Graham wouldn't comment specifically on Gateway's P6 product plans, he says that the company's PC strategy would remain the same with the P6.

The bad news, at least for vendors designing their own motherboards, is that Intel's motherboard operation could commoditize the market. Some vendors aren't satisfied with the Aurora's feature set and will provide more add-on slots and integrated components on their motherboards. But vendors have also learned that differentiation achieved through independent motherboard design is more complex with Intel's newest processor: The P6 has about 100 more pins than the Pentium, requires more control signals to handle multiprocessing, and has lower noise margins due to the P6 bus's use of modified Gunning transceiver logic running at 1.5 volts, compared to some Pentiums that run at 3.3 volts (lower voltage means lower noise margins). Some vendors feel Intel's motherboards give their competitors an unfair advantage. "Intel's motherboards allow Compaq wanna-bes," says Mike Lambert, Compaq vice president of product marketing in North America. But Intel's policy also means more vendors will make P6 desktops and servers, which should drive prices down more quickly. Several vendors predict prices for fully loaded desktop P6 systems will drop below $2000 within 24 months of the chip's initial release.

Two computer makers—Intergraph and Hewlett-Packard—have released preliminary information on their own P6 motherboards and systems. "The P6 will be excellent for Windows NT users," according to Jeff Schnabel, product manager of desktop personal computers at HP

(Santa Clara, CA). "We designed our motherboard to better serve those users." HP's high-end P6-based Vectra, which is expected to extend HP's XU line of PCs, will offer features that power users expect, such as Ultra SCSI and a 16-bit Sound Blaster chipset integrated on the motherboard. The high-end Vectra will also support ECC memory and symmetric multiprocessing (through a socket that accepts a second P6). It will also have four open PCI slots, compared to the Aurora's three, though HP says separate network and video cards will fill the first two slots.

HP's entry-level system is based on a modified version of its P6 motherboard. The low-end Vectra will be a single-CPU machine that doesn't offer ECC memory, SCSI, or integrated networking. Prices were not final at presstime, but HP says the less expensive Vectra will sell for a price that's at or slightly above current prices for a high-end 133-MHz Pentium-based Vectra XU.



While some computer makers will use Intel's Aurora motherboard, Intergraph and HP have designed their own. Intergraph says its TDZ motherboard, like the dual-P6 model shown here, will deliver performance comparable to some RISC workstations.

The P6 also lets vendors like Intergraph (Huntsville, AL) that develop high-end systems for 3-D CAD and graphics compete more readily with midrange RISC processors such as Digital Equipment's 266-MHz 21064A. Intergraph's TDZ Interactive line of 3-D workstations (dual-P6 motherboard shown above), which will range in price from $10,000 to $38,000, will be available with one to four P6s and Intergraph's GLZ OpenGL 3-D accelerator cards.

"We believe that a P6-based system will deliver performance that's equal to or better than RISC processors like Mips' 250-MHz R4400 and the 21064A," says Chandler Hall, Intergraph's product marketing manager. "But at a lower price and with binary compatibility with x86 applications and the underlying hardware drivers for networking and graphics cards."

Although BYTE tests show that the P6's performance drops to Pentium-level performance when running 16-bit operating systems such as Windows 3.1, Intergraph says that still beats the 486-level or lower performance you get from a RISC workstation running an x86 application in emulation.

Head-to-head comparisons between these first P6 systems and competing RISC workstations were not possible before we went to press, as P6 system vendors were still optimizing performance. Andrew Allison, a consultant and the editor of *Inside the New Computer Industry* (Carmel, CA), estimates that the most powerful RISC processors, such as Digital's 21164 Alpha CPU, will offer better integer and superior floating-point performance to the P6. And RISC vendors are not standing still as Intel prepares to formally announce P6 pricing in November. Digital, for example, was expected to announce in late September a line of Windows NT workstations, based on 233- and 266-MHz 21064A Alpha processors, that will sell in the $4000 to $6000 range. But Allison says the P6 puts the x86 camp within striking range of midrange RISC workstations. Says Allison, "The P6 clearly represents a threat to the [RISC] workstation and server markets."

## VENDORS READY FOR P6

**Companies were somewhat vague about their plans for new P6 systems at presstime. However, our surveys of select vendors indicate that most desktop systems will ship with at least 16 MB of RAM and a 1-GB hard drive. Look for the earliest units, such as those from Intergraph, to hit the streets in November.**

| | |
|---|---|
| AST Computer (Irvine, CA) | Manhattan series of dual-processor application/database servers |
| Compaq (Houston, TX) | Will announce servers and desktop systems when Intel officially announces the P6 chip |
| Digital Equipment (Acton, MA) | Single- and dual-processor Celebris XL desktop systems, featuring 64-bit PCI and upgrade path to Alpha processor; and the single- and dual-processor Prioris server systems, with 64-bit PCI |
| Hewlett-Packard (Santa Clara, CA) | Single-processor Vectra VT desktop system; and the single- or dual-processor Vectra high-end system, along with P6 servers |
| IBM PC Company (Somers, NY) | Single-processor PC 300 desktop system, with 16 or 32 MB of RAM, 1.2- or 2-GB hard drive, Matrox Millennium graphics accelerator, and Ultra SCSI adapter |
| Intergraph (Huntsville, AL) | Single- and dual-processor TDZ Interactive workstations (quad-processor model will come later); single-processor systems are upgradeable to dual processors, and the dual-CPU systems are upgradeable to quad processors |
| Dell (Austin, TX) | 150-MHz P6 in Dimension XPS system; P6 version of OptiPlex in spring of 96 |
| Siemens-Nixdorf (Augsburg, Germany) | P6 version of Scenic PC line |

NETWORK MANAGEMENT

# End Migration Headaches

Upgrading from NetWare 3.x to 4.1 is a time-consuming, labor-intensive task. New management tools that help speed the migration have arrived.

Network administration consumes the largest portion of a LAN staff's time (see graph). Over a three- to five-year period, administration costs can be five times more expensive than the purchase price of all networking hardware and software, says Forrester Research (Cambridge, MA).

Novell's NetWare Directory Service (NDS) helps reduce administration costs in a number of ways. NDS's single log-on to multiple servers and virtualization of network resources eliminate the need for users (or applications) to know the exact physical location of these resources. Instead of specifying a server name, volume name, and directory path, a LAN administrator using NDS assigns a unique alias to a directory for users and applications to use. This saves costs when a network resource, such as a printer or an application, gets relocated. Additionally, when using NDS, administrators can more easily handle frequently occurring, time-consuming tasks, such as adding new users and changing existing users' access rights.

To help people upgrade to NDS more easily, several companies have released migration utilities. Some of the more interesting tools include MIGRATE.EXE from Novell (Provo, UT; 801 429-7000), Double-Take from Network Specialists Inc. (Lyndhurst, NJ; 201 804-8400), DS Standard from Preferred Systems (West Haven, CT; 203 937-3000), and the REXXWare Migration Toolkit from SimWare (Ottawa, Canada; 613 727-1779). Each tool performs a different type of function, and some complement one another when used at the same time.

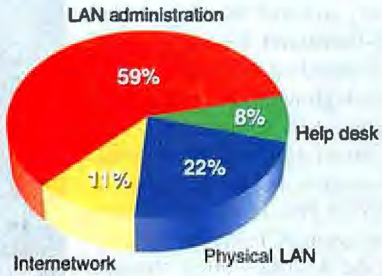
Novell's MIGRATE.EXE, a utility bundled with NetWare 4.1, lets you map all bindery objects on NetWare 2.x, 3.x, and 4.x servers into a single NDS container. The program also migrates system log-in scripts to help make the transition from 3.x to 4.x easier.

Preferred Systems' DS Standard is a Windows-based tool that helps an organization plan and administer NDS. Such tools let companies, when they move to an enterprise-wide directory service, also reexamine their corporate networking structure. This reexamination is necessary because many LANs have been thrown together haphazardly. NDS allows organizations to design a corporate LAN hierarchy that more closely matches the company's business units and their functions. DS Standard helps in this type of planning by discovering NetWare 2.x and 3.x bindery-based servers, as well as NetWare 4.x servers, and letting you merge separately created directory trees into one directory structure.

Another migration tool, which can be used as a stand-alone utility or in conjunction with DS Standard, is NSI's Double-Take. The Double-Take data-replication tool (designed for data backup) has many uses in server migration. With Double-Take, a LAN manager can migrate user and file information from NetWare 3.x servers to 4.1 servers. A manager can also use Double-Take to keep existing 3.x servers operational while moving to 4.x. In this scenario, any changes, such as adding a user to a 3.x server or modifying access rights, will be replicated to the 4.x server in real time.

SimWare's REXXWare Migration Toolkit automates many of the repetitive steps required during migration. The tool is based on REXXWare, an automation scripting tool for the NetWare environment. One of this toolkit's strengths is that it automates tasks in an intelligent way. For example, in many organizations, a user may have separate accounts on a handful of NetWare 3.x servers. Ideally, when all 3.x servers have been upgraded to 4.1, you'd want the user to have a single account. With the REXXWare Migration Toolkit, duplicate files and objects are flagged when they're being migrated so that a LAN manager can identify redundancies and decide how to handle each situation as it arises. **—Salvatore Salamone**

### Why Move to NDS?




**The bulk of the annual network-support cost per user are recurring LAN-administration costs, says Forrester Research (Cambridge, MA). NetWare Directory Service simplifies NetWare management, and NDS migration tools can make the transition to Netware 4.1 easier.**

### MICROSOFT STRENGTHENS WINDOWS DIRECTORY SERVICES

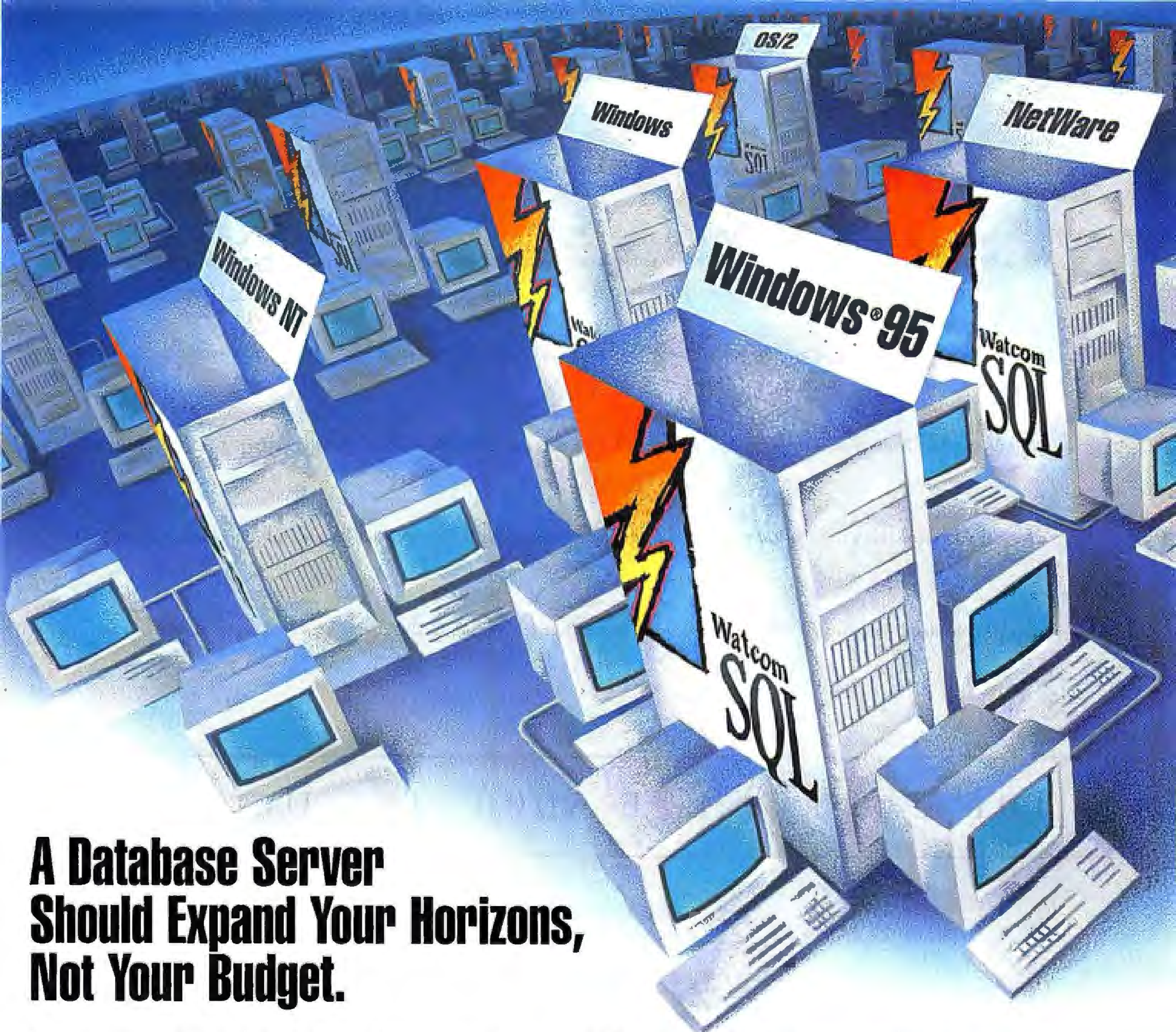
Microsoft's Windows dominates the business desktop environment, and now the company is targeting the enterprise with its Windows NT, SQL Server, and other Back Office products. However, network managers can encounter and must often manage several different directory services in an enterprise. To simplify this management, Microsoft is promoting new Open Directory Service Interfaces (ODSI), a set of APIs that will let Windows NT interoperate with the directories of other systems, including Novell's NetWare Directory Service, Banyan Systems' StreetTalk, Lotus' Notes, X.500, or any other directory for which someone writes a service provider.

With ODSI-enabled applications and operating systems, network administrators will be able to manage different directories from a single management console. Thus, a network-management program such as Microsoft's Systems Management Server could handle multiple back-end directory services.

Microsoft has already developed two ODSI interfaces. One, the Network Provider Interface, allows for a single log-in to multiple directories. The other, called WinSock Resolution and Registration, provides a way to register an application with multiple directories.

The company plans two other interfaces: An OLE Database interface that allows access to databases, and an OLE Directory Services interface that allows for the management of common directory objects. The first versions of network OSes and management applications that support ODSI will probably appear in 1996.

Jamie Lewis, president of networking consultancy The Burton Group (Salt Lake City, UT), says ODSI is a significant step forward. "It will give Windows applications access to directory services via native Windows interfaces," says Lewis. "ODSI could also help Banyan and Novell make StreetTalk and NDS more successful because more applications will use directory services." **—S.S.**

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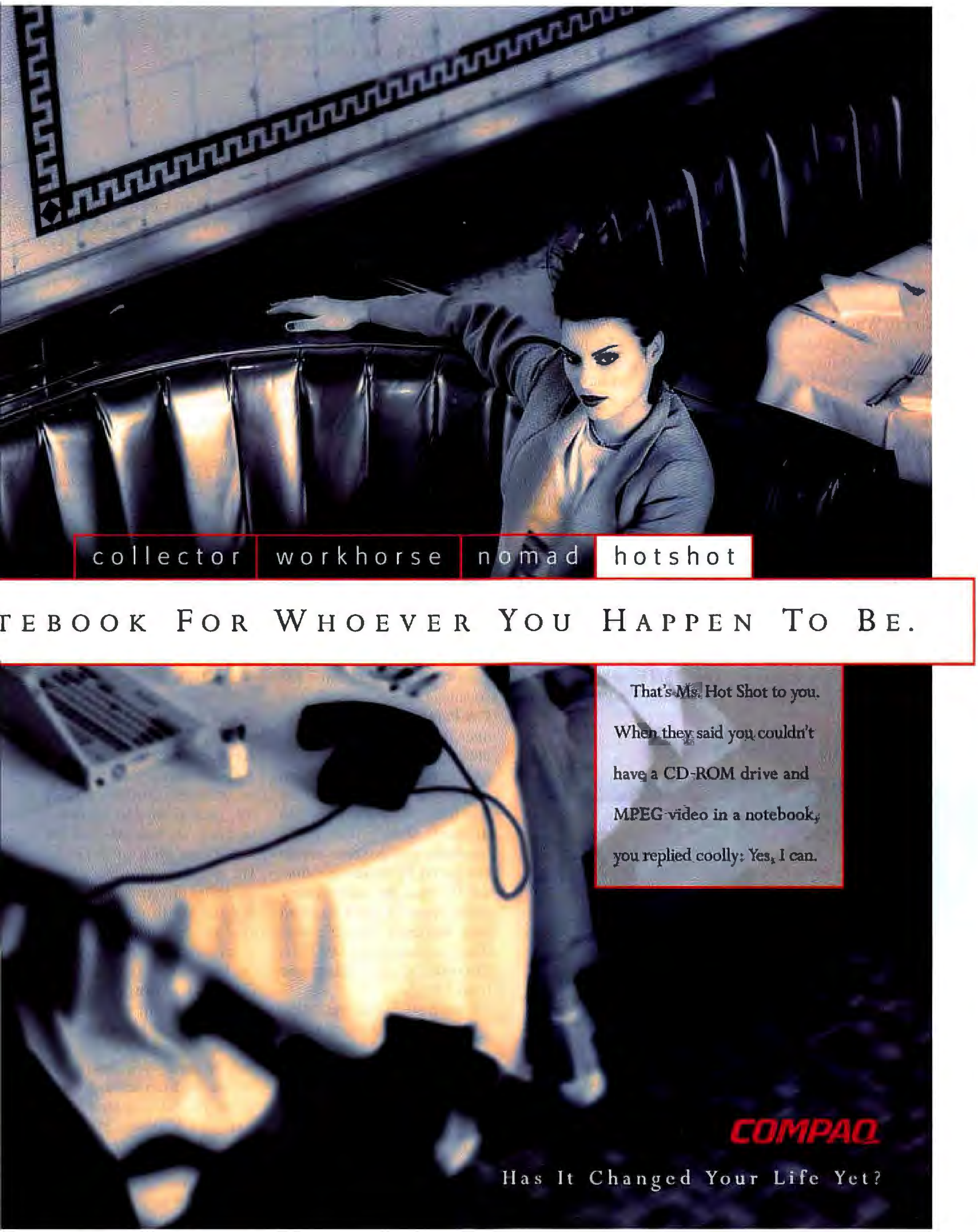
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WINDOWS 95 AND NETWORK MANAGEMENT

# Still a Work in Progress

Windows 95 has many enhancements that should improve its network manageability compared to previous versions of Windows. However, network managers moving to Win 95 will have to wait for a few important components. Other features will require an upgrade to NT.

Win 95's improved networking capabilities include built-in support for network protocols TCP/IP, NetBEUI, IPX/SPX, and PPP; easier configuration when used with Plug and Play–compliant hardware; and protected-mode, 32-bit clients for NetWare and Microsoft networks. But work progresses in other areas.

One area of Win 95 that should improve soon is its support for non-Microsoft networks and NetWare 4.x. Although Win 95 supports NetWare 3.x (and NetWare 4.x through bindery emulation), neither Microsoft nor Novell currently have Win 95 clients that support NetWare Directory Services (NDS). Microsoft and Novell are both addressing this by developing separate NetWare clients that support NDS. Network OS vendors Banyan Systems and Digital Equipment also say they will release 32-bit clients for Vines and PathWorks this fall.

Other developers are addressing programming interfaces for desktop management. Although Microsoft is a member of the Desktop Management Task Force (DMTF), the company is reportedly developing its own interfaces for collecting and reporting information about PCs on a network. The DMTF, which also includes Hewlett-Packard, Intel, Novell, Digital Equipment, and IBM, has defined standards for several groups of components, including software, PC, and network interface cards. Specifications for other types of hardware are still in progress.

Sources report that Microsoft is encouraging network management vendors to write to OLE interfaces that will pull information about PCs from the Win 95 registry.

Although this effort could compete directly with the DMI, it appears that Microsoft will support other management techniques through a foreign name space that will map the DMTF's Management Interface calls as well as those made by SNMP-based programs into OLE calls.

Programs such as Site Inventory 4.0 from McAfee Associates (Santa Clara, CA) or CA-Paradigm Problem Manager from Computer Associates (Islandia, NY) currently have to resort to a combination of querying the Win 95 registry and low-level "sleuthing" to discover what software and hardware components are on any given PC. These vendors say it would be easier if they could query PCs in a standard way. But there are many standards, including the DMTF's, Microsoft's, and another one from Compaq.

"Microsoft's not supporting DMI is not a big thing, because we've had to build the discovery service [of CA-Paradigm Problem Manager] outside of the DMI anyway," says Yogesh Gupta, CA senior vice president of product strategy. "But as DMI becomes a viable standard, we'll support it." For other companies, the lack of DMI support in Windows 95 *is* a big deal.

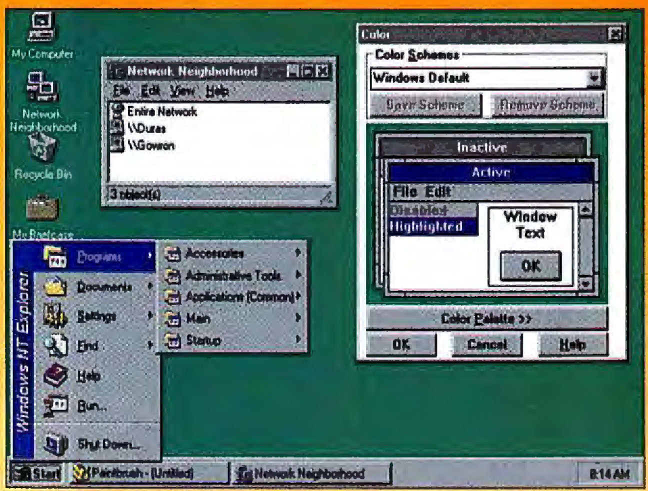
The DMI specification calls for a service layer to be present on a PC. This service layer, which DMI proponents feel should be integrated into all OSes, is a small program that resides locally on a PC and collects information about products, manages the information in the local PC's Management Information Format (MIF) database, and passes it to management applications when requested. DMI advocates had hoped Microsoft would include a DMI service layer in Windows 95, but that didn't happen. "That leaves us with a short-term problem—how to deliver those management capabilities," says Ed Arrington, chairman of the DMTF.

One solution is for PC vendors to add the service layer themselves, as Digital Equipment (Maynard, MA) did with its new line of Celebris GL PCs for Win 95. But not all PC vendors are supporting DMI.

Other more robust management features available now in NT, such as support for event logging, are not planned for Win 95, say Microsoft officials. The event log provides a way for device drivers, applications, and the OS to record useful data for administrators.

Jamie Lewis, president of the Burton Group (Salt Lake City, UT), a network consulting firm, says it would have been helpful if Microsoft had put event logging into Win 95. But, he says, "Windows 95 is an interim step toward Windows NT. NT was built to be that kind of robust environment." Lewis says event logging is just one example of how, in the long term, Microsoft will target consumers with Win 95 and businesses with NT. **—DLA**

## Windows NT Gets a Windows 95 Facelift




**Microsoft has begun testing a very early version of the Windows NT Advanced Workstation Shell Update Release (SUR) that adds the Win 95 interface to NT. Microsoft says it was going to wait until the next major upgrade of NT—code-named Cairo—to add the Win 95 interface but decided to accelerate that effort when customers said they wanted a consistent user interface between NT and Win 95. The company is not saying exactly when it will release the SUR. Support for Plug and Play is currently slated for the Cairo release of NT.**

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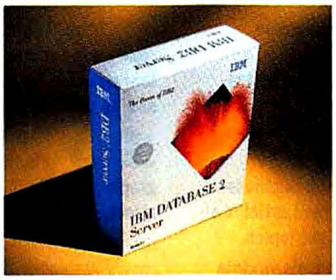


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DESKTOP DISPLAY TRENDS

# Flat Displays Squeeze Bulky CRTs

When it's time to make a computer-based presentation on a screen, most people turn to projection systems that display images in the 20- to 40-inch-diagonal range. Users who want this size of a picture at their desktop computers have to use a big and bulky CRT display. But soon, a new breed of large-area flat displays will be available, and you can have some of your desk space back.

Three major Japanese companies recently announced they will spend billions of yen to begin large-volume production of plasma-based displays by 1996. The primary market for these displays will be high-end televisions. But computer users should benefit, too, as volume production will drive prices down and let flat displays replace CRTs. Already, bulky displays of more than 20 inches are used for engineering and desktop publishing applications that require large viewing areas. Flat displays will free up desktop space, which is at a premium in Japan and in many U.S. offices.

Plasma displays are manufactured with low-cost/high-yield printing techniques instead of the expensive photolithographic methods used to make LCDs. These electrode printing techniques can be readily scaled to larger-size displays. Fujitsu (Tokyo, Japan) already sells a 21-inch display and recently announced it would soon have a 42-inch variety. NEC and Fujitsu recently announced they both plan to build new production facilities to manufacture AC-driven plasma displays.

These devices work in a way that's similar to fluorescent light bulbs; they use voltage to ignite a gas, forming a plasma. To make a plasma display, manufacturers segment gas pockets into pixels, which are individually addressed. To form a full-color display, colored phosphors are deposited at each pixel site. Says Larry Tannas, an analyst who covers the flat-panel-display industry, "Most users would be happy with the picture quality of these flat displays, and they are brighter than standard TVs."

A third major player, Sony (Tokyo, Japan), announced it will commercialize another technology: plasma-addressed liquid crystal displays (PALCDs). Sony has licensed the technology from Tektronix (Beaverton, OR) and is working with Technical Visions (Beaverton, OR). According to Tom Buzak, president of Technical Visions, PALCDs are not plasma displays but active-matrix LCDs that use a different type of transistor. "The difference is that you replace the silicon transistor with a gas, or plasma switch," Buzak says. PALCDs use the same polarizers, backlights, and color filters as active-matrix LCDs.

Today's 21-inch display from Fujitsu is still expensive: about $8000. But with high-volume production, prices should drop. Fujitsu, for example, expects its 42-inch display to initially cost about 1M yen (roughly $10,000) in 1996, then fall to half that as they reach full production.

**—Chris Chinnock**

**THIN-DISPLAY FUTURE LOOKING ROBUST**

| COMPANY | PRODUCTS/PROTOTYPE STATUS | MANUFACTURING PLANS |
|---|---|---|
| Sony | 25-inch plasma-addressed LCD in prototype<br>40-inch prototype rumored<br>Plasatron TV in Japan in late '96 | 10,000 units in first year; no mass-production plans announced |
| NEC | 20-inch AC plasma TV in '96<br>29-inch prototype<br>40-inch prototype | Investing 10 billion yen to produce 10,000 plasma displays per month<br>Plans to spend 80 billion yen to produce 150,000 units per month by 2000 |
| Fujitsu | 21-inch AC plasma monitor/TV in production<br>42-inch prototype; production expected in '96<br>55-inch display in '97 or '98 | Investing 60 billion yen in plasma-display manufacturing; expects to produce 10,000 units per month in '96 and 100,000 units per month by 2000 |
| Matsushita | 26-inch DC plasma display in prototype; production planned for Q2 '96<br>40-inch DC plasma display in prototype | No decision announced yet |
| Mitsubishi Electric | 20-inch AC plasma display in prototype<br>40-inch prototype soon | No decision announced yet |

COOL INTERNET SITES

## Top Ten Web Sites for Small Business

**1** **http://www.sbanet.uca.edu/** **The Small Business Advancement National Center provides research, training, consulting, and other information.**

**2** **http://kcilink.com** **Dozens of articles by business columnist Raj Khera and other business-related information.**

**3** **http://www.webcom.com/~seaquest/** **A "how to" information resource center for small businesses.**

**4** **http://www.yellow.com** **A World Wide Web version of the Yellow Pages.**

**5** **http://www.govcon.com** **Resource center for government contractors.**

**6** **http://www.sbaonline.sba.gov/** **The Small Business Administration's Web hangout.**

**7** **http://www.directory.net/lexis-nexis/sba** **Search here for small-business-related articles or read articles already cataloged in subtopics.**

**8** **http://ptolemy.gis.virginia.edu:1080/reis1.html** **The Regional Economic Information System database provides local economic data (1969 to 1992) for states, counties, and metropolitan areas. Good for market research.**

**9** **http://trinet.com/ucan/** **Info for a small business that wants to be the next Netscape and go public.**

**10** **http://dbisna.com/** **Financial and demographic data from Dun & Bradstreet.**

Source: The First American Group Purchasing Association (New Orleans, LA; 504 529-2030), a group that provides purchasing and information resources to small businesses. List based on member survey and comments.


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TELECOMMUNICATIONS

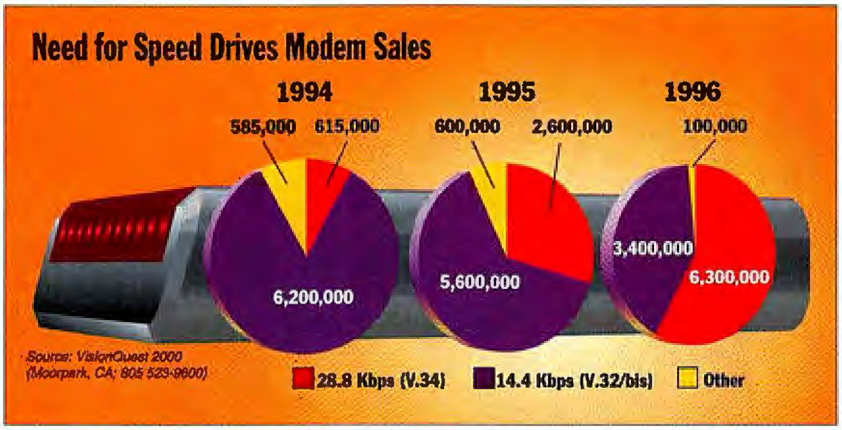
# Phone Lines Stymie V.34 Modems

Today's advanced modems push the telephone system to the limit, and users are finding to their woe that in many cases, 28.8-Kbps modems won't deliver their advertised throughput. The result: That blazingly fast 28.8 V.34 modem you bought won't deliver better than 26.8 Kbps except under prime conditions. In fact, performance could be much worse.

Even the newest modems with the amended V.34 standard, which allows for speeds up to 33,600 bits per second, won't solve your speed problem. These advanced V.34 modems, from companies such as U.S. Robotics, AT&T Paradyne, and Racal-Datacom, still have to contend with a telephone system that was never meant to handle such high-speed data communications.

Stephen Satchel, president of Satchel Evaluations (Incline Village, NV), an independent modem-testing firm, says the trouble usually isn't the quality of the copper in the phone system's local loops. He says the problems are due to trunk components and switches. "Their soakers, designed to cut down on static, artificially limit the bandwidth that V.34 needs to operate effectively," Satchell says. "Interoffice phone systems also often have artificially narrow channels that introduce distortion in the data channel." This means that even the best V.34 modem talking to the same brand of modem will often top out at 26,600 bps.

Another growing problem, Satchel says, is that the phone companies, in their changeover from analog to digital circuits, are using digital speech compression to get the most voice service from existing lines. That's fine for voice, but it's a disaster for modem users because it closes your effective bandwidth window down to a maximum of 9600 bps. "Entire neighborhoods are being changed over," Satchell says. "Modem users don't have a way out." Indeed, for many of us, the first thing you'll know about the arrival of digital voice compression on your block is when your data communication slows to a fat baby's crawl.




**The need for speed to access the Internet or a private remote network will fuel U.S. aftermarket retail sales of 28.8-Kbps V.34 modems, despite the inconsistency of data throughput.**

Many other factors determine how fast your modem can pump out data. Some of these, like the UART (universal asynchronous receiver/transmitter) chip, are under your control. But other vital elements are outside your control. For example, early-model U.S. Robotics Sportster modems—those with ROMs older than April 18, 1995—suffer from the spiraling death syndrome. The modem will blithely try to optimize the V.34 connection, but it ends up corrupting the connection so that speeds drop slowly but surely to a horrific 4800 bps. If you think you're running into this problem, you can check your ROM with the modem command ATI7. If you have one of the older ROMs, U.S. Robotics will replace it for free; call them at (703) 982-5151.

A far more common and annoying problem, since it has no solution, is that modems built around the Rockwell chip set do not show consistent speed results, even under laboratory conditions. Satchel says he's seen results ranging from 21,600 bps to 28,800 bps using Rockwell-based modems from such popular vendors as Cardinal, Global Village, Hayes, Supra, and Practical Peripherals, with absolutely no change in the testbed configuration.

A better way to get a consistently fast data connection is through ISDN. The problem with ISDN, which can push your data connection up to 128,000 bps, is twofold. First, you can't get ISDN services everywhere. Some Baby Bells, such as Bell Atlantic, are very ISDN-friendly; others, such as Nynex, are not. The second problem is that local regulators are very inconsistent in their treatment of ISDN. In some states, ISDN is so heavily taxed that it is utterly impractical for private use. In other states, ISDN may be no more expensive than an ordinary additional phone line.

If you can't get ISDN, you may want to investigate a telephone line conditioner. NAI Datacomm (Roswell, GA, 800 778-4479 or http://naidata.com on the Web) has its VFast Modem family of superchargers (about $600 or less), which can optimize modem performance. However, as company officials point out, these products address only problems at the local loop.

For now, we're stuck with less-than-perfect analog modems in an environment that will grow increasingly more hostile to high-speed performance. This should not prevent buyers from flocking to V.34 modems, however (see the graph). "Some users, especially when accessing the Internet, will take any speed improvement they can get," says Ernie Raper, market analyst for VisionQuest 2000 Associates (Moorpark, CA). "Even if the V.34 modem delivers 26 Kbps or 24 Kbps, that's a lot more data being transmitted than 14.4 Kbps." Raper predicts that prices for V.34 modems will drop steadily, which will result in a minor price difference between 14.4- and 28.8-Kbps modems.

In the long term, ISDN, clearly the optimal technical solution, will be the future of end-user data communications. For the next few years, though, take all claims of modem speed with a dose of salt.

**—Steven J. Vaughan-Nichols**

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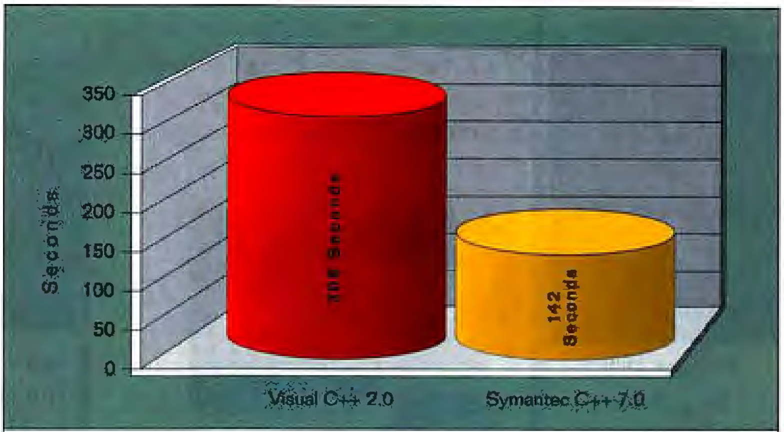
In addition, AppExpress,™ ClassExpress,™ and ProjectExpress,™ give you Wizard-like functionality to boost your productivity.

And to make your link-cycle lightning-fast, there's new 32-bit OPTLINK®




*Average of 3 builds done on Pentium Processor using the debug version of MFC 3.0 with VC++ 2.0 makefiles. Borland excluded due to lack of support for MFC.*

6.0 – the world's fastest linker.

For building great Windows resources easily, we've added ResourceStudio – the new OLE 2.0-based resource editor that supports the widest range of Windows resources including Windows 95.

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Symantec's Integrated Development and Debugging Environment (IDDE) provides the most powerful debugging features including Thread View, Inspector View, hardware watchpoints and low-level debugging.

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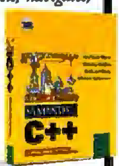



SYMANTEC.®



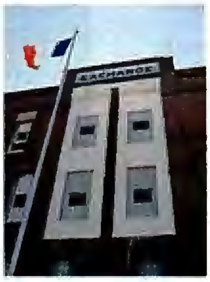
Circle 105 on Inquiry Card.

*We are Gateway 2000.*

August 1985
*"Hey, Mike ... call me crazy but I've had this craving all day to start a computer company!"*
Ted Waitt

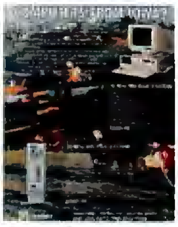
September 5, 1985
Congratulations, it's a computer company! Gateway 2000 is born at the Waitt Family Cattle Farm outside of Sioux City, Iowa.

August 1985
Ted's grandma, "Momo," takes a leap of faith and becomes Gateway's first principal investor securing a $10,000 loan.



April 2, 1986
The Livestock Exchange Building at the Sioux City Stockyards: Gateway's first home away from home.

February 1988
25 systems built and shipped in one day! All 10 phones ringing off the hook from Gateway's first major ad in *Computer Shopper*, "Computers from Iowa?"




November 1985
Ted springs for Thanksgiving dinner for entire Gateway workforce (Mike Hammond).

1986
Gateway 2000 ships its first PC.

August 3, 1986
Shipping clerk covers for Ted over lunch and becomes Gateway's first sales rep.

1987
Texas Instruments PC customers exchange TI PCs for Gateway 2000 IBM compatibles.

February 1987
Ted and Mike get sick of looking at each other. Up go the first cubicle walls!

1987
Shipping clerk/Sales Rep can't pronounce "peripherals." So we focus on systems and ship our first 286 PC for $2,295.

September 1988
Gateway sells 386-20 PC for $2,995, receives *Byte* magazine's Award of Distinction.

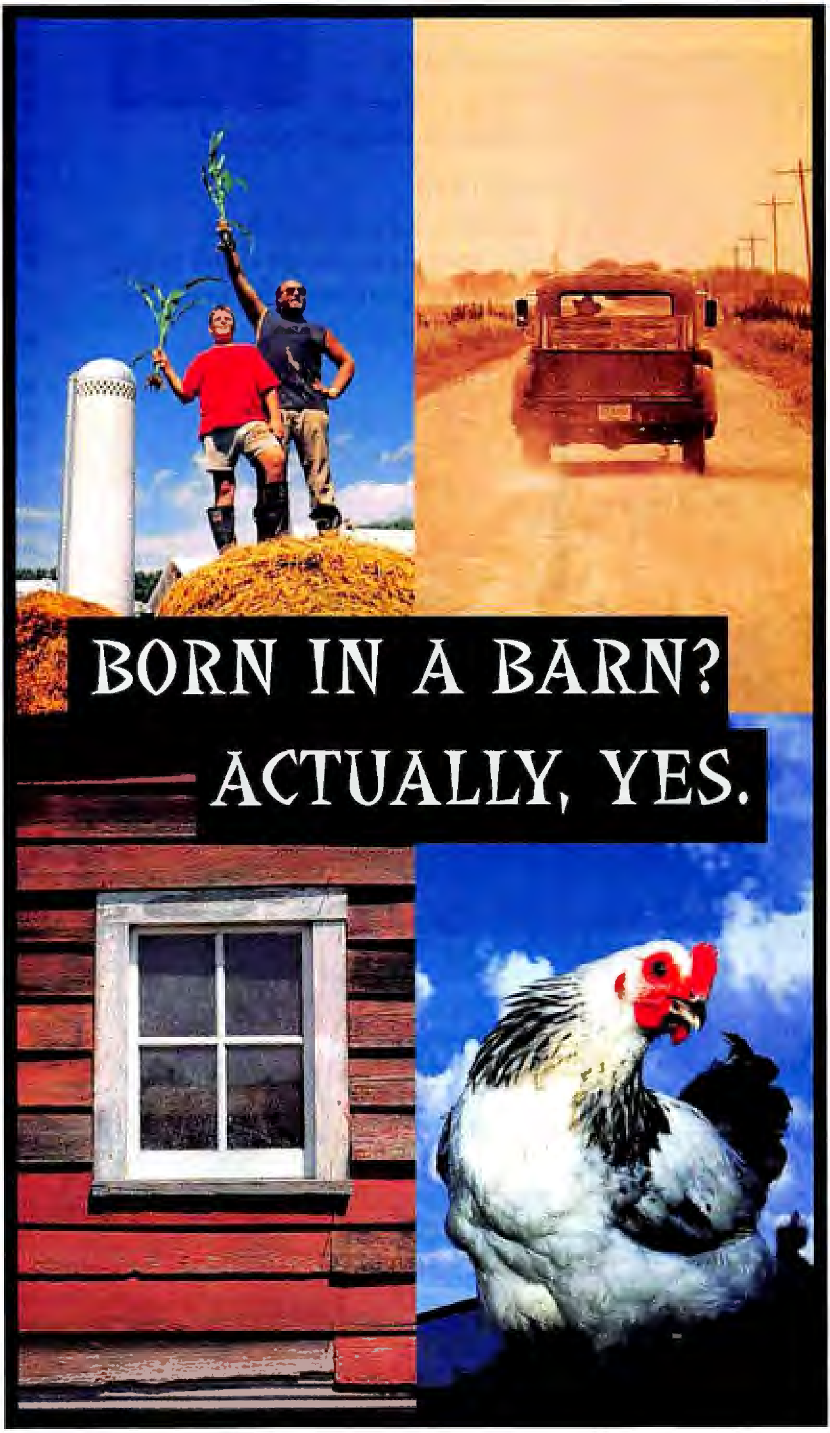
September 1988
Gateway herd finds greener pastures in Sergeant Bluff, Iowa (we moved there).

Industry First!

1988
EGA color monitors standard on all systems.

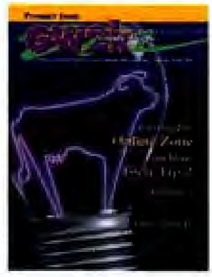
*We will always be happy, but we will never be satisfied.*

It started as a dream, born on an Iowa farm. Today, 10 years later, the same company that once clocked in by a rooster crow is recognized as the nation's PC industry leader. The Gateway 2000® secret? Give PC buyers a quality product, the latest technology, and incomparable service — all at an unparalleled value. Our hard-working employees know what it takes to get the job done right. And we're ready to outdo ourselves in the next decade and beyond.




intel inside
pentium
PROCESSOR

May 1995
Gateway's P5-120 is named the "fastest PC in the world," by *PC/Computing.*



March 1995
Premiere issue of *GW2k: Gateway Magazine.*

May 1995
Technical support completes 12,046 calls in one day! All techs treated to sparkling cider in plastic champagne glasses.

July 1995
Gateway ranks first among Intel/Windows PC manufacturers in brand loyalty.




intel inside pentium PROCESSOR

Designed for Microsoft Windows 95

November 1994
New Gateway facility opens in Kansas City.

December 1994
The Liberty small notebook makes its debut.

Industry First!

June 16, 1995
Gateway is first to offer Windows 95 as a free upgrade on all standard configurations.

July 28, 1995
Gateway goes "down under" to Australia.

August 1, 1995
Gateway Gold Service and Support program unveiled.

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International FaxBack Access 605-232-2561 • Component Add-On Sales 800-846-2080 • Sales Hours: 7am-10pm Weekdays, 9am-4pm Saturdays (CDT)

## *We share the vision of being our customers' only logical choice.*

Industry First!

1989
It doesn't get any better than this — standard VGA monitors!

June 1989
Gateway goes online with GW2k BBS.

December 1989
McGraw-Hill purchases 386-20s and achieves immortality as Gateway's first major Fortune 500 customer.

1991
Gateway becomes first company to win all four *Computer Shopper* Best Buy desktop awards.

Industry First!

February 1991
Gateway is first to introduce non-interlaced monitors on all systems.

April 1991
Gateway introduces cow-spotted boxes.

Industry First!

February 1992
Customers rejoice! Gateway begins offering choice of application software with new systems at no extra charge.

1992
Barely seven years old and already Microsoft PC Manufacturer of the Year.

1993
Gateway offers first Family PC multimed system for $1995.

August 1993
The ColorBook and HandBook 486 ente Gateway's stellar product lineup.

Inc F

May 1994
Gateway announce three-year warranty all desktop PCs and monitors.

July 1, 1994
Gateway opens a showroom in Paris, France.


1990
The population of North Sioux City reaches a whopping 2,019.

May 1990
Microsoft Windows is now standard on all Gateway systems.

Industry First!

October 1990
Gateway's first 486 system hits the market value-priced at $5,295.

April 1991
Technical support completes a record number of 2,800 calls in one day!

March 1992
Technical support holding queue is empty for the first time in company history.

May 1992
Going mobile with our first portable computers, including the HandBook, the industry's first subnotebook.

Industry First!

October 1993
Holy leprechauns! Gateway Europe se up shop in Dublin, Ireland.

In

September 1993
Gateway introduces first VESA system.

October 1993
Gateway offers our first Pentium system, the P5-60, for $359 and sweeps *Computer Shopper's* Bes Buy awards for third consecutive year.

*You've got a friend in the business.*

## CODE TALK

RICK GREHAN

### Watcom C/C++ 10.5 Gets Visual

Watcom C/C++ has many things programmers will like. But its integrated development environment is best described as spartan. Version 10.5 changes that with the addition of Blue Sky's Visual Programmer.

Watcom C/C++ 10.5 continues the compiler's tradition of multiplatform development support. Although it is still Intel-CPU-specific, Watcom C/C++ can create 16- and 32-bit applications for Windows, DOS, and OS/2. It can also create 32-bit AutoCAD applications and NetWare NLMs.

With 10.5, Watcom links the Visual Programmer into the compiler's integrated development environment. Visual Programmer provides rapid application-building capabilities, similar to those in Visual Basic, to C++. You build an application by defining windows, populating the windows with pushbuttons, scrollbars, and other elements, and attaching attributes and actions to the various objects. Visual Builder then generates MFC-based source code. As you build your application in Visual Programmer, it "back fills" the Watcom project with the appropriate files.


The major new feature in Watcom's latest C/C++ is the addition of visual programming tools.

Watcom's previous version allowed you to regulate consumption of disk space by optionally keeping the help files on the CD; all other files had to go on your hard disk. With version 10.5, you can run most everything from the CD, freeing up lots of disk space at the expense of slightly slower execution. I opted for the "run from CD" choice at installation time (freeing up more than 30 MB) and collided with one of the few bugs in the system. Apparently, the executable copy of the 32-bit C compiler is corrupted on some copies of the CD-ROM. A small batch file that I downloaded from Watcom's BBS fixed the problem. Watcom says that release 10.6 (which will be out by the time you read this) will correct that problem. It will be available to version 10.5 owners at no charge.

Watcom has also added the Watcom Infobase CD. It contains (among other things) technical tips from Watcom's support hotline, faxline, and CompuServe forum. This enormous frequently-asked-questions file is basically a core dump of Watcom's Technical Support communications. Consequently, there's lots of non-C/C++ information on the CD.

Performance of generated executables (which is among the best) appears unchanged. I recompiled the BYTEmark benchmark using version 10.5 and ran the program on our baseline 90-MHz Pentium machine. The results varied by less than 5 percent from scores I obtained using a version 10.0-generated executable on the same machine.

Watcom C/C++ 10.5 is priced at $350; owners of previous versions can upgrade for $129; a competitive upgrade is $199. Contact Watcom (Waterloo, Ontario) at (800) 265-4555 or (519) 886-3700; fax (519) 747-4971; on the Web, http://www.watcom.com.

OPERATING SYSTEMS

# Vendors Rally for 64-bit Unix

An impressive list of vendors has endorsed an initiative to develop a common 64-bit Unix API, but it may be two or three years before some vendors release compliant products. The list includes Intel, Hewlett-Packard, Silicon Graphics, Digital Equipment, Compaq, IBM, Novell, Oracle, SunSoft, and practically everyone else except Microsoft (which has Windows NT). Microsoft officials say that the NT file system is 64-bit for improved performance, but the company has not announced a 64-bit version of NT.

Unix vendors hope to define a set of interfaces and a 64-bit C programming model for data representation to reduce the variability that developers face today in writing an application for several versions of Unix. "The real benefactors will be the independent software developers," says Mark Silverberg, group manager, Unix product marketing for Digital Equipment (Maynard, MA). "If developers have a single specification they can program to, they won't have to develop or maintain different 64-bit implementations." Databases and other data-intensive applications will benefit the most from 64-bit operation.

The group says it will publish the 64-bit specification by the end of this year; it also intends to build from existing 32-bit APIs so that today's programs will run on future 64-bit operating systems. The API will also comply with existing standards such as XPG 4.2 (also known as the X/Open Spec 1170), POSIX, the System V Interface Definition (SVID), the Common Desktop Environment (CDE), and the X Window System.

The 64-bit effort follows another attempt to unify Unix around the Common Operating System Environment, an initiative that achieved mixed results. "COSE was going to unify systems management and networking, and it didn't quite succeed in that," says Scott McGregor, senior vice president of products at the Santa Cruz Operation (Santa Cruz, CA). "But COSE succeeded in getting the Unix world, including Sun, to agree on Motif as the basis for the Common Desktop Environment. That alone is a tremendous success of COSE, and it's often forgotten."

The delivery of products that comply with the spec is up to each vendor. Companies such as Silicon Graphics, Digital, and HAL Computer already have 64-bit versions of Unix, and the amount of work needed for them to comply with the specification depends on how closely it matches current products. Others, such as SCO, don't currently have a 64-bit version of Unix. "SCO plans to ship a 64-bit OS coincident with Intel shipping the P7, which will be a 64-bit processor," McGregor says. "That's probably two to three years away from happening."

—Dave Andrews

SECURITY

# Bank Robbers Go Electronic

Bank robbers are trading in their firearms for a new weapon: computers. And although companies are usually reluctant to admit embarrassing rips in security, Citibank (New York, NY), the banking division of Citicorp, has upgraded all security procedures following a breach of the bank's cash management system. In a series of break-ins, the bank's payment system was compromised (perhaps with inside help) for no less than the hack of the century: more than $10 million. (The bank says it eventually recovered most of that sum.)


**Most acts against a corporation are committed with help from the inside, including employees, vendors, and contractors. That's according to the American Society for Security's (Arlington, VA) 1995 Intellectual Property Loss Survey.**

Citibank is not the only bank to suffer from electronic burglary: Security expert Arnaud de Borchgrave estimates that in just two months this year, about $300 million dollars has disappeared, electronically, from U.S. banks.

In July 1994, Vladimir Levin, a mathematician in St. Petersburg, Russia, befriended a former St. Petersburg bus driver who had turned entrepreneur in San Francisco, according to recently unsealed court documents. Levin allegedly told his new friend he had found out how to wire-transfer money out of Citibank's computer system. Twice already, he allegedly bragged, he had squirreled substantial amounts into his own account in Finland. Court documents say Levin's colleague became a partner in what would become a multinational hacker ring.

Just a few weeks later, transfers were made to BankAmerica accounts held by Primorye (roughly translated as "Shoreland" in Russian) Corp. and Shore Corp., both of San Francisco. The companies were owned by Levin's friend Jevgenij Korolkov.

By this time, Citicorp officials had begun to suspect foul play and started questioning Korolkov. Korolkov left the country but apparently was not deterred. Instead, the two pressed on and recruited new partners around the globe, authorities say. By October 1994, 40 more transfers were made to California, Israel, Germany, Holland, and Switzerland.

Levin, who was system administrator at AO Saturn, a St. Petersburg software house, has been advised by his attorney not to speak to the press. But court documents allege he accomplished the illegal transfers by dialing into Citibank's cash management system. The system allows Citibank customers to initiate their own fund transfers to other banks; daily turnover is about $500 billion. Authorities say that to avoid causing suspicion, Levin dialed in from his house in Russia late at night. Conducting transactions during New York business hours would less likely raise alarms.

Levin apparently used valid user IDs and passwords of other banks, among them Banco del Sud in Argentina and Bank Artha Graha in Indonesia. How he got those passwords, given Citibank's extensive security, is unclear. Inside help seems likely, but Citibank claims that no employees were involved. Citibank officials declined to discuss their security procedures with BYTE, but a spokeswoman said that the bank continuously evaluates and improves its security measures.

According to Citibank, its security system flagged two August 1994 transfers, $26,800 and $304,000, as "strange." Bank officials called the FBI, who observed the electronic interlopers as they made their illegal transfers. U.S. officials were also assisted by telecommunications employees in Russia who helped track the illegal fund transfers to St. Petersburg, according to published reports.

Citibank claims it recovered most of the approximately $10 million in illegal transfers but says perpetrators were able to withdraw "less than $400,000" before other banks were notified and able to stop the transactions. Officials also say that at no time were any client funds at risk.

In March, Levin was arrested in transit at London's Heathrow airport. At presstime, he was fighting extradition to the U.S. from England. U.S. authorities want to try Levin on charges of theft, forgery, and computer fraud. Levin's attorney, Colin Reynolds, told BYTE that Levin wants to return to Russia. Five alleged accomplices in other countries, including Israel, the Netherlands, and the U.S., have been arrested.

**—Udo Flohr**

## Whatever Happened to ...?

**WEB Technologies' Amazing Compression?** (see "Instant Gigabytes," June 1992, page 45)

In an announcement that sounded too good to be true, WEB Technologies (Smyrna, GA) claimed it had developed a compression algorithm that could squeeze almost any amount of data to less than 1024 bytes. The company claimed that its DataFiles/16 program could compress files larger than 64 KB to about one-sixteenth their original size. Skeptics said what WEB claimed was impossible, yet BYTE received numerous inquiries from readers, many of whom said they felt obliged to investigate WEB's claims, however implausible.

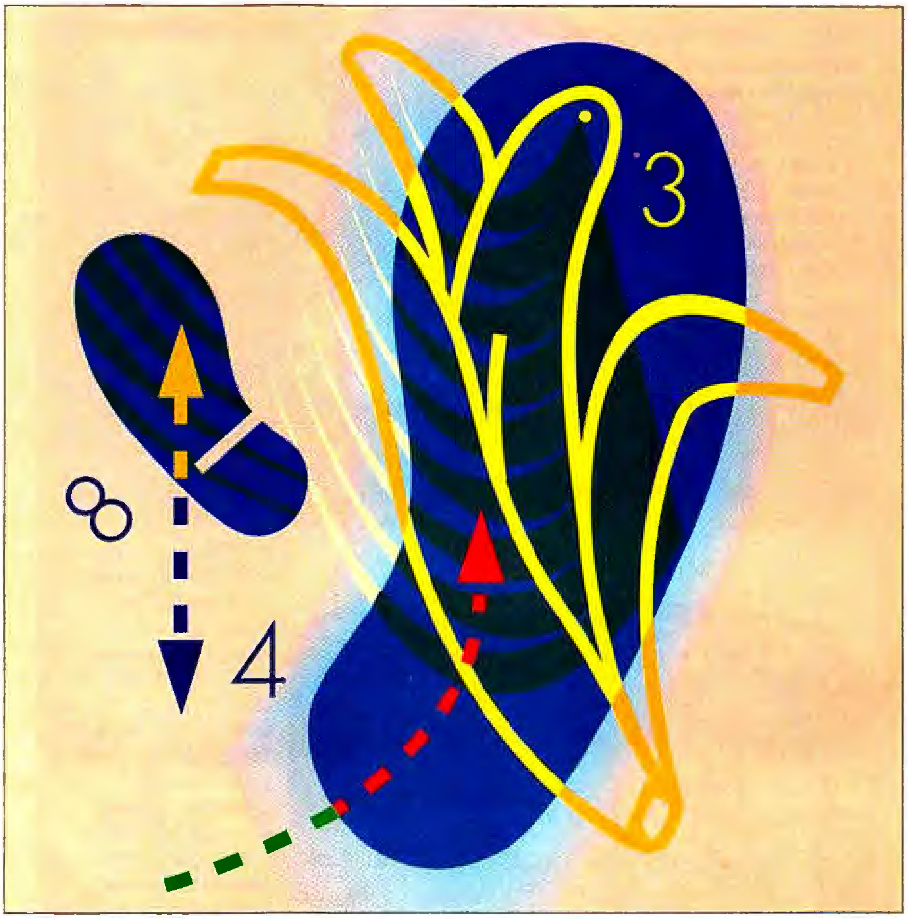
BYTE contacted WEB for a beta version of the software so that we could evaluate it. WEB at first declined to give us the beta, but we said we couldn't write a story about the product without one. WEB relented and sent us the beta version, which we tested and wrote about in the June 1992 issue.

Not surprisingly, the beta version of DataFiles/16 that reporter Russ Schnapp tested didn't work. DataFiles/16 compressed files, but when decompressed, those files bore no resemblance to their originals. WEB said it would send us a version of the program that worked, but we never received it.

When we attempted to follow up on the story about three months later, the company's phone had been disconnected. Attempts to reach company officers were also unsuccessful. WEB appears to have compressed itself right off the computing radar screen.

# Kaboom, Inc.

**CAREN D. POTTER**




BILL FRAMPTON © 1995

**When technology goes splat, Failure Analysis sends in a squad of detective engineers wielding heavy-duty computer wizardry**

So, one of your supertankers bellied-up on a reef and is now sliming Alaska? Or maybe another in a series of California earthquakes nuked your parking garage? Perhaps a network news show is dissing the trucks you make for inconveniently exploding on impact? Who ya gonna call? Failure Analysis.

Failure Analysis Associates answers nasty questions about nastier failures—by machines, buildings, and humans. Walk into their Menlo Park, California, headquarters (one of 11 facilities nationwide) and you'll be tripping over scientists and engineers brandishing Ph.Ds from MIT and Stanford. Computers are everywhere. More than 1000 personal computers (laptops, Macs, and PC clones) and Silicon Graphics workstations help slake the processing needs of the 400-plus employees. Digital Equipment minis and IBM maxis hold more than 60 databases containing such tidbits as 350 million accident and incident records, as well as handy items such as a copy of every U.S. death certificate since 1975.

The company acquires software by the "one of each" method: If there are five programs, each a little better than the others for a certain type of problem, Failure Analysis probably has them all. Perusing the typical office bookshelf turns up numerous software manuals, and not just for word processing and running spreadsheets—structural stress–analysis packages and human body–modeling programs are just as likely.

The firm's Phoenix, Arizona, desert test facility is a Disneyland of disaster that includes a two-mile road track (festooned with your basic potholes, railroad crossings, and water-filled ditches), a 1200-foot crash rail that can send a vehicle smashing into a wall (or another vehicle—your choice) at up to 90 mph, a 90-foot drop tower, and a ballistics range just right for blowing things up. What more could a catastrophe-minded techie ask for?

Failure Analysis CEO Roger McCarthy estimates that the company has invested nearly $30 million in technology, and the company spends some $3 million annually keeping it all up-to-date.

Why the tech-fest? Technology helps supply the missing (or disintegrated) pieces. "We're often called in years after an accident has happened," explains Garrison Kost, head of vehicle accident reconstruction. "By that time, the site may have changed, vehicles may not be available. We collect all the evidence we can, then use technology to fill in the gaps in our knowledge."

### Calamities of the Rich and Famous

Failure Analysis has been called in on many high-profile cases. When *Dateline NBC* showed a car plowing into the side of a GMC truck with side-saddle gas tanks, a made-for-TV collision that produced a dramatic fireball, General Motors got suspicious. GM scored a major PR body-slam when Failure Analysis showed, using computerized video enhancement (and searching dozens of junkyards to find the actual vehicles), that puffs of smoke appeared a fraction of a second *before* the collision. NBC had rigged the truck with rocket motors to ensure it exploded telegenically. The network wound up eating on-air crow to forestall the libel case of the century.

Conspiracy fans were paying avid attention when Failure Analysis reexamined some of the JFK assassination evidence for the American Bar Association's mock trial presentation, "The United States v. Lee Harvey Oswald." The company showed that an assassin on the sixth floor of the Texas School Book Depository could have committed the murder alone.

Owners (and insurers) of property damaged in the 1994 Los Angeles earthquake hired Failure Analysis to determine the extent of the damage. Following extensive and hazardous field work, and computer simulation of building behavior, the company could make useful recommendations about whether buildings should be repaired or trashed.

**Using flight data and the cockpit voice recorder, Failure Analysis recreated the approach of a 1981 World Airways flight into Boston's Logan Airport (below). The plane slid into Boston harbor (right).**

**In 1988, a series of explosions, the largest one exceeding the equivalent of 1.5 million pounds of TNT, destroyed a chemical plant in Henderson, Nevada. Two people died, and the surrounding community suffered more than $70 million in damages. Failure Analysis determined that the explosion was due to a leak in a natural-gas line under the plant.**

**On January 17, 1994, an earthquake measuring 6.6 struck the Los Angeles area, causing more property damage than any earthquake in U.S. history. This parking structure was one of the more artistic casualties Failure Analysis investigated.**


### How James Dean Died

Failure Analysis's re-creation (commissioned by the TV show *What Happened?*) of James Dean's fatal car crash 40 years ago is a good example of the puzzles the company pieces together. Without much to go on, Failure Analysis used computers to reconstruct the event as a three-dimensional animation and eventually fingered the driver at fault and showed how fast each car was going when they collided.

Dean, accompanied by his mechanic, was driving his Porsche Spyder from Bakersfield toward Monterey, where he was going to race the car. It was a clear day. At 5:45 p.m., on a straight stretch of two-lane asphalt road, where U.S. 41 and U.S. 46 intersect, Dean's westbound car collided with an eastbound Ford. Dean was killed and his passenger suffered broken bones, but the driver of the Ford had only minor injuries. What happened?

James Dean's live-fast, die-young reputation suggested an open-and-shut case: His speeding and recklessness must have been to blame. But strangely, as Failure Analysis started scrutinizing the accident, this hypothesis didn't hold together. "Damage to the vehicles didn't indicate an extremely high-speed collision," says Kost.

The steps in reconstructing this accident are typical of Failure Analysis investigations, according to Kost. (An investigation can cost anywhere from $5000 to $50,000, depending on the complexity of the accident—double that if you want computer animations. The Dean case cost an estimated $50,000, but those findings were intended for a TV audience, not a courtroom.) First, the analysts collected whatever information they could: the original California Highway Patrol report, statements from two people in a car following the Ford, a few photos of the road and vehicles after the accident, roadway "as built" drawings, and three aerial photos of the site taken the same year as the accident. Not much to puzzle out the truth.

The next step was creating computer models of the vehicles, their paths, the scene, and the surrounding terrain. Lacking the actual vehicles, Failure Analysis digitized two "exemplar" vehicles—twins of those mangled in the accident—using a theodolite, a computerized surveying tool that automatically records *x*, *y*, *z* coordi-

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## Plug and Play faxmodems for Windows 3.1 and Windows 95

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PLUG and PLAY

So you'll experience quick-and-easy installation in your system today, and again when you upgrade to Windows 95! Just plug in your modem, install the accompanying software, and you're ready to go. No more jumper hassles, device conflicts, or time-consuming diagnostics. Configuration is automatic – just Plug and Play! And there's a Supra Plug and Play modem designed especially for you. Choose from either the SupraExpress 144i PnP (14,400 bps) or the SupraFAXModem 288i PnP (28,800 bps). Call 1-800-727-8647 today for the Supra reseller nearest you.

### Installs in minutes

| | Windows 3.1 (DOS 5.0 or higher) | Windows 95 |
|---|---|---|
| 1 | "PLUG" in faxmodem | "PLUG" in faxmodem |
| 2 | Run Supra install program | Start up Windows 95 |
| 3 | Select available COMport "and PLAY" | "And PLAY" |

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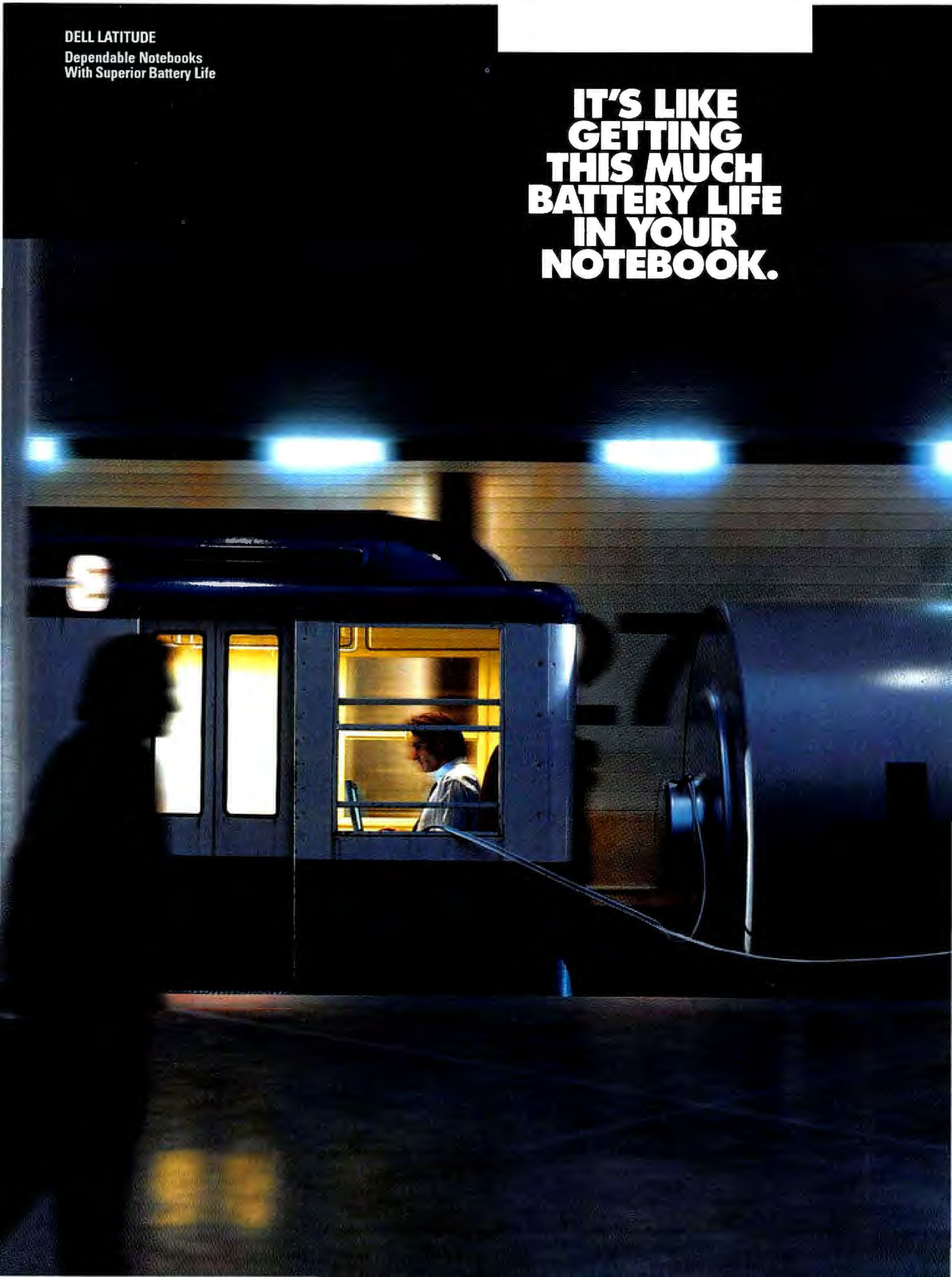

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Dependable Notebooks
With Superior Battery Life
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## INTRODUCING OUR PENTIUM PROCESSOR NOTEBOOK.

**DELL® LATITUDE™ XPi P90ST**
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- 10.4" SVGA Active Matrix Display
- 8MB RAM (40MB Max RAM)
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- 420MB Removable Hard Drive (1.2GB Max)
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- 3 Year Extended Warranty†
- ★ *Add a 1.2GB hard drive for $800 more.*

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Order Code #800035

**DELL LATITUDE XPi P90D**
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- 256KB L2 Cache
- 420MB Removable Hard Drive (1.2GB Max)
- Smart Lithium Ion Battery with Advanced Power Management
- 32-bit Local-bus Video, 1MB Video RAM
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- 128KB L2 Cache
- 420MB Upgradeable Hard Drive (810MB Max)
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- 32-bit Local-bus Video, 1MB Video RAM
- 2 Type II/1 Type III PCMCIA Slots
- 6.2 Pounds
- 1 Year Warranty
- ★ *Upgrade to an Active Matrix color display for only $300 more.*

**System Not Pictured**

**$1999**

Business Lease: $74/Mo.
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nates of an object in AutoCAD-standard DXF format. The company's theodolite gets a lot of exercise, as does the publication *Auto Trader*: It's a good way to find exemplar vehicles, which Failure Analysis buys whether they run or not.

Wavefront's Advanced Visualizer high-end visualization software, which Failure Analysis runs on Silicon Graphics workstations, imported the sketchy vehicle information in the DXF file. Applying surfaces, textures, and colors to the digitized points resulted in photo-realistic 3-D computer models of the Ford and the Porsche in the accident, right down to details such as the race numbers on Dean's car.

### Collisions by Computer

Failure Analysis pored over vehicle publications of the time, gleaning particulars such as: The Ford weighed 3000 pounds, significantly outweighing the 1400-pound Porsche. This news, along with vehicle esoterica (such as tire properties and crush stiffnesses), descriptions of the road surface, apparent point of contact, and the final resting positions of the two vehicles, was dumped into the hopper of Engineering Dynamics Corp.'s Simulation Model of Automobile Collisions program (EDSMAC). Using principles of mechanics, this PC-based package could determine the trajectories of the vehicles after the collision, as well as the damage to each vehicle. The laws of physics, after all, apply even in California, and even to James Dean.

The engineer tried out different combinations of speeds and angles, allowing the vehicles to crash on-screen many times, until the vehicles ended up in just the right positions and the simulated damage matched that of the actual cars (as preserved in photos). Guessing high speeds for Dean's car caused the simulated vehicle to overshoot its actual point of rest. (See the figure "Post-Impact Trajectory—V1 Porsche" at right.) When the simulation best duplicated the actual events, Dean's car turned out to be going only a modest 57 mph, while the Ford's speed was 55 mph. So much for the speed-demon theory.

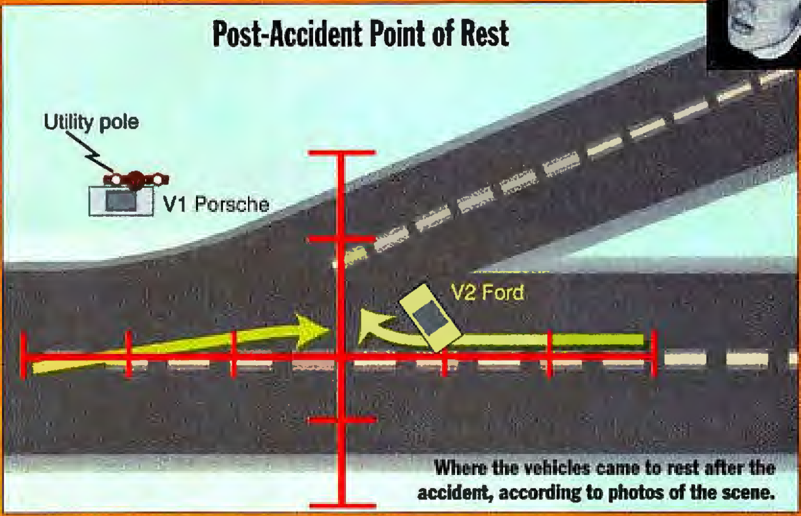
With the right vehicle speeds, EDSMAC can spit out position and velocity for each time step in the simulation: just the data Wavefront software needs to generate motion paths for an animation.

They also re-created the accident scene, using Wavefront, to make the presentation look more realistic. Theodolite measurements again marked the exact 3-D locations of the two intersecting roads, their center lines, telephone poles, and other landmarks, which were fed into AutoCAD as the basis for creating a 3-D plot of the

## Simulation of James Dean's Fatal Crash

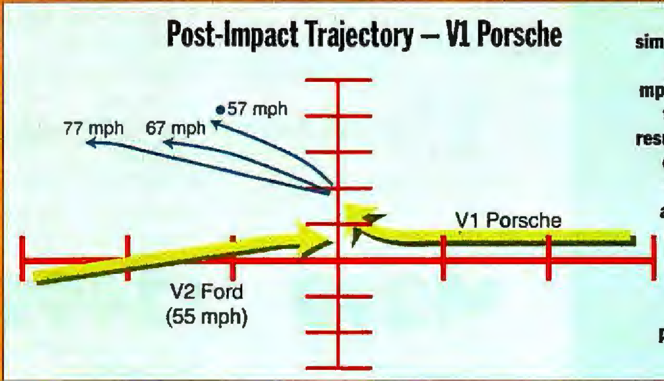
UPI / BETTMANN

### Post-Accident Point of Rest

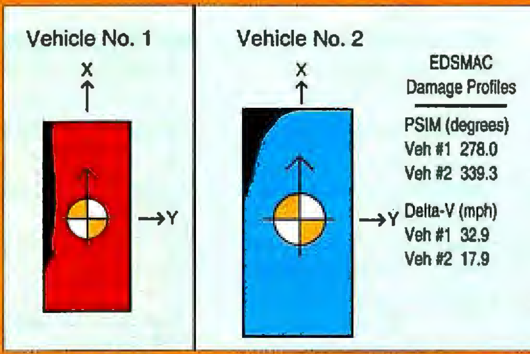



Where the vehicles came to rest after the accident, according to photos of the scene.

### Post-Impact Trajectory – V1 Porsche




EDSMAC simulations using speeds of 77 mph and 67 mph for Dean's car resulted in points of rest beyond where the car actually ended up. According to the simulation, Dean was probably going 57 mph.

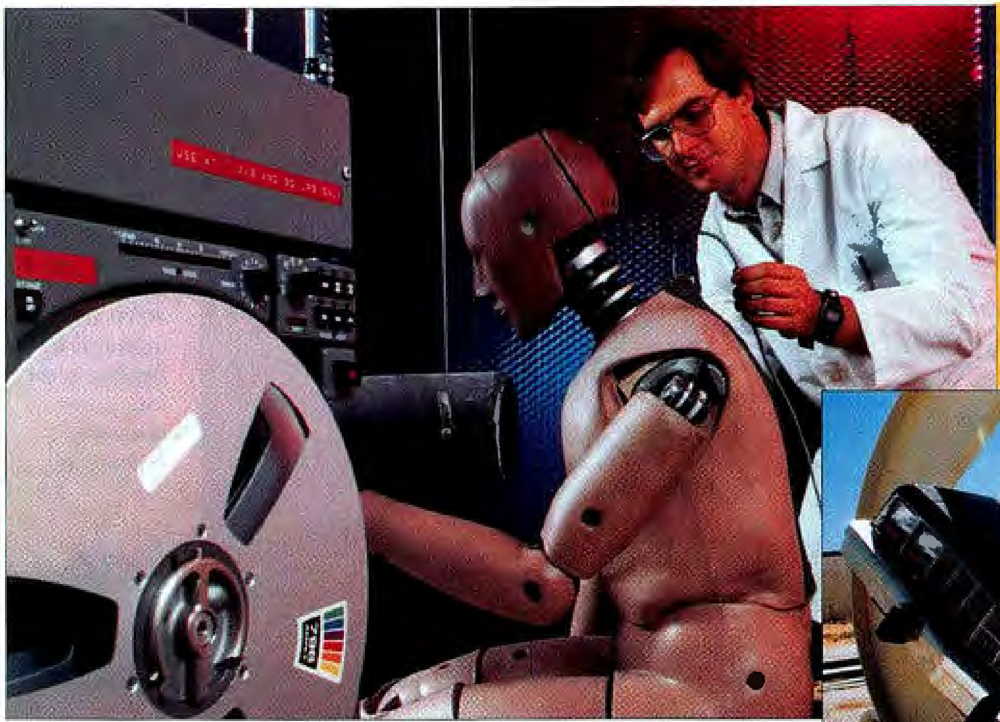



In an EDSMAC damage profile, vehicle damage is represented by darkened areas. [Dean's Porsche is Vehicle No. 1.] PSIM refers to the orientation of the midpoint of vehicle damage. Delta-V is the change in velocity at the point of impact. While EDSMAC's graphics lack flash, its calculation capabilities were critical to this investigation.

UPI / BETTMANN

Wavefront software generated this image of the two cars about to collide. Above, a photo of Dean's Porsche.

**Circle 114 on Inquiry Card.**



◀ **Data obtained from instrumented anthropometric dummies is used to assess injuries and compare different accident situations.**

▼ **Engineers at Failure Analysis's Test & Engineering Center in Phoenix use this static roll-over device to turn a car 90 degrees for evaluations of fuel-system integrity. The device can also turn a car completely over for studies of occupants during rollovers.**

scene. This plot ensured that the animation was scaled precisely. A photograph of the scene was applied as a texture map to give a near photo-realistic look.

### Better Than Film at 11

The fruit of all Failure Analysis's labor was a 45-second 3-D animation of the accident, from many points of view. (See the still image on page 48NA 6.) One of the many benefits of using computer animation, as opposed to a video re-creation, for instance, is that the "camera" can be placed anywhere: in the car following the Ford, in the Ford's driver's seat, even showing what Dean himself might have seen. While the spectacle isn't gory—no cars crumpling or glass flying into the air—it certainly does make clear what actually happened. Dean wasn't speeding excessively. Neither was the driver of the Ford. That driver made a bad judgment and turned left in front of Dean.

### The Science of Uh-Oh

Far more of Failure Analysis's work appears on the witness stand than on the TV screen. Typically, a company being sued, or its insurance carrier, hires Failure Analysis to perform its own independent investigation and testify as an expert witness. The analysts usually bring some supporting visual aids: a graph of a computer analysis, or, as in the Dean case, a full-blown computer animation.

Computer animations are so convincing that a judge might disallow them, thinking their realism could confuse the jury into thinking they portray actual events. Nonetheless, they are usually admitted as evidence since part of the job of the Failure Analysis witness is to convey the science that went into making the animation accurate. "We only use computer animation when we need to get across a sense of the time or a complicated sequence of events," says Kost. "Or, to show the point of view of the driver, to illustrate what he could or could not see."

Because accidents often tragically involve human injury or death, Failure Analysis also has biomechanical engineers who specialize in assessing injuries. These engineers use simulation software running on Silicon Graphics workstations to evaluate injury-producing forces acting on the body. Packages such as TNO's MADYMO (Mathematical Dynamic Modeling) estimate loads on the human body using vehicle motion and the geometry of a vehicle's interior. They can, for instance, calculate if the force in a collision is enough to justify claims of whiplash.

Ironically, the same sophisticated technology that helps make the world safer will almost certainly be misused by the luckless and the clueless. "Technological sophistication has the potential to make failures and accidents less likely, because the computer can second-guess you," CEO McCarthy says. "But at the same time, there will be an increasing number of people who don't understand the total system implications of what they're doing. In 20 years, Failure Analysis will be in the business of solving increasingly technological and system-related issues, such as Three Mile Island and similar control failures caused by people who didn't understand technology."

And that's why their business will probably continue booming. ■

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*Caren D. Potter is a freelance writer who lives in McKinleyville, California. You can reach her on the Internet by sending E-mail to cpotter@northcoast.com.*

**Where to Find**

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# Battle of the Sexes, Part II


**JOHN MONTGOMERY**

*The War of Desire and Technology at the Close of the Mechanical Age* by Allucquère Rosanne Stone is exactly the kind of book you'd expect to find the word *hermeneutics* in. It's also the kind of book in which you'll find the word *s***head*. Between strings of obscure words and captivating stories, you'll discover a philosophical analysis of what it is to interact with other people in our increasingly digital world.

Stone employs several writing styles, ostensibly in an attempt to echo the confusion of a digital culture. It's a little like reading an article from *Esquire* right after one from the *Journal of Sociology Nerds*: a bit startling but invigorating. But Stone is at her best when telling stories. Her recounting of the trial of a man accused of raping one of the personas of a woman with multiple personality disorder is interesting, enlightening, and dramatic.

Throughout the book, though, she resorts to academic prose. One example is in her description of how a customer of a phone-sex service will supply missing information (e.g., how a partner looks) with idealized fantasy. Her explanation goes on for nearly two pages and says nothing more than that people who listen to phone sex use their imaginations. Surprise.

The book concludes with an attempt to draw together these diverse styles: "In this brief time of upheaval and promise that always accompanies the transition between modes of experience and thought... there is a window of opportunity to transform the way academic discourse in the humanities and social sciences works." After making this point, Stone goes off on a peculiar extended metaphor—that of the vampire Lestat as anthropologist. Hmmm.

There are a few wonderful stories in *The War*, but there are too many places, particularly in the beginning, where it's just too easy to put it down and reach for your worn copy of *Neuromancer* or *Snow Crash*. These pieces of fiction relate most of what Stone is trying to convey far more effectively and memorably.

**THE WAR OF DESIRE AND TECHNOLOGY AT THE CLOSE OF THE MECHANICAL AGE**
**Allucquère Rosanne Stone**
**MIT Press**
**ISBN 0-262-19362-0**
**$22.50**

*John Montgomery, who is located in BYTE's San Mateo office, heads the features department. He can be reached on the Internet or BIX at jmontgomery@bix.com.*

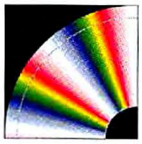
# YES, YOUR PC HAS A MIND

**ARTIFICIAL MINDS by Stan Franklin** **MIT Press, ISBN 0-262-06178-3, $35**

Will your computer ever have a mind? After reading *Artificial Minds* by Stan Franklin, I believe the answer is clearly: You're asking the wrong question. At the very beginning of Franklin's genial "tour," he sets out seven propositions he intends to illustrate. Because these include "mind is better viewed as a continuum rather than a Boolean notion" and "mind, to some degree, is implementable on machines," the outcome of the story is never in doubt. However, as a good storyteller, Franklin makes the journey both entertaining and educational.

He's prepared a hearty smorgasbord, with dishes drawn from many fields. I went light on the neurons and ganglia, merely sampled the semantics, but I took large helpings of mathematics, physics, and robotics. You'll also encounter AI, Turing machines, Schrödinger's cat, Gödel's theorem, genetic algorithms, artificial life, chaos theory, and legions of robots. Although it's written for the nonexpert, there's plenty to interest professional researchers. ■

**—Edmund X. DeJesus**



# ANIMAL BEHAVIOR

**EYEWITNESS ENCYCLOPEDIA OF NATURE**
**Dorling Kindersley Multimedia, 95 Madison Ave., New York, NY 10016, (212) 213-4800, $54.95**

**HOW ANIMALS MOVE** **Maris Multimedia/The Discovery Channel, 100 Smith Ranch Rd., Suite 301, San Rafael, CA 94903, (415) 492-2819, $49.95**

For most people, getting back to nature means cutting the lawn. These CD-ROMs offer an alternative for those of us who want a little more adventure yet are not inclined to desert safaris or underwater diving expeditions.

Eyewitness Encyclopedia of Nature requires Windows 3.1. It transports you to a virtual biological library, where you can explore everything from the savannas of Africa to the world beneath a microscope. The interface consists of books, posters, and specimen drawers that offer links to a number of organisms. By selecting a direction on a compass or coordinates on a sextant, you can explore the habitats and environments in which these animals live. The CD-ROM also includes a detailed time line, an extensive search tool, a useful help section, and a quiz that asks related questions at various difficulty levels.

How Animals Move requires Windows 3.1 or Mac System 7.0. This CD-ROM is meant for a preteen audience. It offers 11 guided tours through various methods of animal motion, including running/walking, burrowing, swimming, and gliding. Tours include short video examples of animals moving by land, air, or sea.

The simple-to-use interface also links to a game page, where you can choose from four categories: interactive graphs, experiments, simulations, and games. One interactive graph lets you control the jump of a kangaroo by adjusting air density and slope. A walking-and-running experiment calculates times and the energy used by runners over various distances. An interesting simulation lets you control the swing of a gibbon monkey.

If you're daring enough to go beyond the outdoor mowing experience, these two CD-ROM titles might provide just the thrill you're looking for.

**—Jeff MacClay**

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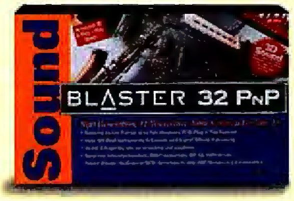


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# Needle Hunting

**PAUL KORZENIOWSKI**


RICHARD STEADHAM © 1995

**With directory services, you're supposed to be able to find anything, anywhere. Do they work?**

A network is a haystack. The printer you want to send your file to is a needle. If the haystack has two or three straws, no problem. But have you ever seen a pint-size haystack?

The key to needle hunting lies in an effective directory system that can locate and identify users, servers, files, and other resources. But it's not simple—the problems with administration and synchronization alone often appear insurmountable, and competing standards form another haystack as nightmarish as your network. The solution may lie with the ISO's X.500 specification. But until X.500 gains more acceptance, you're left with directory systems that often weren't designed to handle the load they carry.

### The Administrative Nightmare

Many users never get beyond their own network's neighborhood and don't realize there's a problem. For them, everything works fine. Not so for the network administrators, who maintain the directories that store user names and addresses in flat-file structures or DBMSes. As users join, leave, or move, each change requires a directory update.

With networks growing, the number of directories has also skyrocketed, and manually monitoring a dozen or more directories is time-consuming, impractical, and prone to error. There's also a time lag. In many organizations, technicians enter new information only weekly or monthly. Until the next update, the network is vulnerable to security breaches.

Most companies want to automate the updating process, but automation raises complex technical problems and trade-offs. "Directories are one of the most difficult issues to solve because they touch applications, networks, and users," notes Aaron Con, a product manager for Microsoft Exchange (Bellevue, WA).

### What's in a Name? Or a Directory?

Most companies want at least one global directory of all users, plus smaller directories throughout the network. How much global information should be stationed in the remote directories? As more information is stored, response times slow. For vendors, the challenge is to create a structure that's flexible but fast.

Also, vendors have to include mechanisms to ensure that each directory is aware of any change; this process is called *directory synchronization*. As networks grow, so do synchronization problems. Maintaining changes on a network with two dozen directories and 10,000 users can bring the system to its knees.

What's worse, today we rely on directories for sophisticated tasks such as network security. Consequently, they need to be flexible enough to support a wide range of uses.

"The major issue companies face with networks is cost of ownership," says David Eckert, the NetWare Directory Service (NDS) product manager at Novell. "Without robust directory services, a technician can service only 100 or so users. With robust services, he can handle 500."

The Gallup Organization (Lincoln, NE) supports 2000 users worldwide. In 1992, the company began to build a WAN. Tim

## X.500: The Once and Future Answer

In the mid-1980s, the ISO began outlining X.500, a standard that builds directories on distributed databases so that companies can divide their networks into distinct domains. Information is passed between domain servers in a hierarchical manner.

The first standard, completed in 1988, lacked needed features, such as replication. Also, X.500 was rigid, requiring addresses defined in a fixed manner: country, company, organizational unit, and locality information. By the time X.500 came into existence, many firms were reluctant to discard existing addressing schemes.

Also, the standard was designed to work with X.400, a lower-level E-mail standard, and it didn't work easily with other types of mail systems.

A 1992 version of X.500 includes replication facilities, so multiple copies of a global directory can be kept on different machines. Users now have the flexibility to customize addresses.

Problems may arise because the current specifications are broad and vendors have a lot of latitude. There are no accepted APIs that outline how to move information from one X.500 system to a second.

A directory system includes a list of such mailing addresses as well as the software needed to move it from one location to the next. X.500 has a hierarchical directory structure and global information; instructions are stored in a global Directory Information Tree (DIT). This information is then broken up and spread to different directories, dubbed Directory System Agents (DSAs), through a network via a Directory System Protocol, which lets directories exchange information.

The Directory User Agent (DUA) is client software that presents directory options to a user. A DUA then accesses the nearest DSA via a Directory Access Protocol (DAP), which connects a user to a directory system. DSAs then exchange information so the user can either transmit a message or locate a mailing address.

Gilkerson, Gallup's director of worldwide network operations, says the organization examined Banyan Systems' Vines and NetWare. "We determined that Vines was easier to maintain and required fewer technicians than NetWare."

Then, NetWare supported only simple directory services with its bindery, which stored addressing information on one stand-alone server. A technician had to relay each change to all network directories. Banyan's StreetTalk directory service automatically transmits changes to servers.

With distributed directories, a user can walk up to any machine on a network, enter a password, and begin working. With stand-alone directories, users can access information only when they are connected to a particular server. "Many employees travel, so we wanted to make it easy for them to work on the road," Gilkerson says.

Banyan is offering directory services to NetWare users, and Novell is trying to catch up. With NetWare 4.0, the company added a robust global-naming service. Novell's Eckert notes that the service lets technicians divide directories however they wish.

Microsoft has been well behind the other network OS (NOS) vendors in terms of directory services. It offers a rudimentary directory with Windows and plans to add global capabilities with the Cairo release of Windows NT, scheduled for next year.

### Directing E-Mail

E-mail suppliers have developed sophisticated directories. Gallup users work with Lotus's cc:Mail and its directory services as well as with StreetTalk. "When we installed our network, cc:Mail was the only robust mail package running on Vines," Gilkerson explains.

The Lotus product features Automatic Directory Exchange (ADE), which automatically updates all cc:Mail user addresses. Two years ago, Pathfinder (Waltham, MA) migrated from stand-alone PCs to a NetWare LAN and selected cc:Mail. "Many employees work in third-world countries, so we needed a mail system that supported a variety of transmission types," notes John Talbot, systems manager at Pathfinder. Managing updates to 15 remote directories is simple; ADE automatically transmits each new entry to all locations.

Microsoft Mail 3.0 got distributed-directory capabilities in 1992. It updates E-mail systems, gateways, and personal directories at programmable time intervals.

### Multivendor, Multiproblem

The Lotus and Microsoft products keep their own directories in sync. But many companies have multiple E-mail systems to synchronize. Unfortunately, many vendors designed incompatibilities into their directory services. One product may support addresses with three fields of eight characters each, while a second works with four 10-character fields.

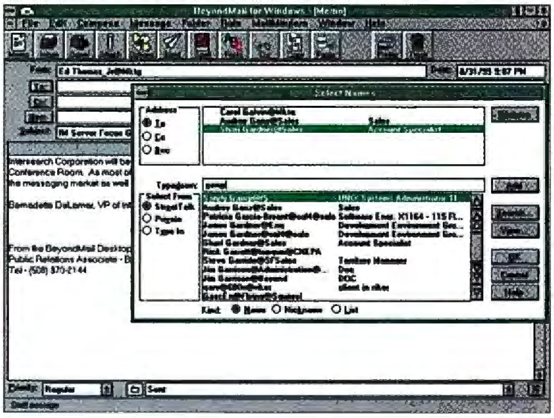
One way to solve this problem is open APIs, as with cc:Mail and Microsoft Mail. Users and third parties can then design translation programs. But few corporations are willing to take on this job. "A company we work with supports 23 different mail systems, so it's looking for ways to minimize directory management rather than take on new chores," notes Con.

These companies turn to third-party tools. For example, Soft*Switch's (a division of Lotus) Directory Synchronization Protocol (DS/P) translates directory information among Banyan, Digital Equipment, IBM, Lotus, Microsoft, Verimation, and Wang Laboratories mail systems.

Most directory-exchange programs offer only the least-common-denominator function set. For instance, one directory system may support authentication, but the synchronizing software doesn't. The result? Good-bye security.

At Prudential Insurance (Roseland, NJ), 50,000 users work with Digital's All-in-1, IBM's OfficeVision, Lotus's cc:Mail and Notes, Microsoft Mail, and Novell's MHS mail systems. Prudential had been seeking a directory-synchronization system since the early 1990s, says Randi Mather, an associate systems manager. In 1993, Prudential began testing Lotus's Enterprise Messaging Exchange (EMX). The company found it flexible enough to synchronize Prudential's many mail systems and put it into service in 1994. EMX sends between 100 and 500 administrative and address changes through the system each day. "Since EMX was introduced, Lotus has delivered add-on modules, which have made management of our mail systems simpler," Mather notes.

*continued*



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### What Kind of Directory?

EMX is geared only to E-mail systems, so users must maintain other directories. "A LAN OS houses one directory, a mail system has a second, and the phone system operates a third," says Rapport Communications' Dan Blum. "They're all growing, so management is becoming more difficult. Long term, companies want to consolidate all their directories into a single system."

Consolidation would ease software development as well as user administration. Applications developers often have to build their own directory services. "Developers would prefer to focus on applications features, not basic networking items such as directories," notes Michael Wixon, who is Banyan's director of partnerships.

In April, Banyan unveiled Universal StreetTalk, which is a directory service available free of charge to software and hardware suppliers. Cisco Systems, Collabra Software, Oracle, and SAP AG have all indicated they will incorporate it in their products.

While such work represents a step in the right direction, Universal StreetTalk is still proprietary and requires at least one Vines server. Users would prefer a standards-based solution, such as X.500 (see the text box "X.500: The Once and Future Answer" on page 52). But standards-based technology can be painfully slow. X.500 work was begun in the mid-1980s, and there's still no fully compliant product on the market.

Another directory service vying for contention is Network Information Services Plus (NIS+), from SunSoft (Mountain View, CA), which is also bundled with Unix OSes from Hewlett-Packard, IBM, Novell, and The Santa Cruz Operation (SCO). NIS+ is built on Sun's earlier NIS (also known as Yellow Pages), which was eventually licensed by all OEM Unix vendors and became the de facto standard for directory services. NIS was itself designed to attack the shortcomings of Domain Name Service (DNS), notably in the areas of database synchronization and security. NIS+ works with Sun's SolarNet and management tools for Microsoft's LAN Manager and NetWare.

Like DNS, NIS+ uses tree-structured hierarchical directories. DNS provided central control of the directory space but also allowed administrative responsibility to be distributed. NIS+ builds on this by giving every organization control over its domain namespace. NIS+ keeps directories synchronized between name servers by transmitting only changes; its predecessor had to send the entire directory map.

### Tips for Managing Multiple Directories

- **Identify how many directories there are in your organization.**
- **Determine how much addressing information is duplicated in the directories.**
- **In the short term, identify the vendor that has the most directory links with your current configuration and begin using its tools to consolidate directories.**
- **For the long term, start learning about X.500 and ask vendors their X.500 support plans.**

### The Users Revolt

Historically, vendors developed separate proprietary solutions to network directory problems and then marketed the differences as advantages. Users had to evaluate competing standards and systems, often trading one feature for another.

After a while, big users realized that vendors might not come up with the solutions they wanted. A number of organizations formed the Network Applications Consortium (NAC), which today has 26 members, including Compaq, Nike, Texaco, and the U.S. Marine Corps. During the past few years, the group has met with key suppliers, issued position papers, and tried to forge consensus early in the development cycle.

In April, NAC met with Banyan, IBM, Lotus, Microsoft, and Novell to discuss directory issues. Larry Gauthier, director of network services at the University of Michigan and current NAC chairman, says, "We don't want to end up with another situation like we had a few years ago, when Lotus was pushing Vendor-Independent Messaging (VIM) and Microsoft was backing MAPI."

The University of Michigan outlined a solution to a critical problem: X.500 is too complicated to run on PCs. The university slimmed down the X.500 client protocol, calling its new protocol Lightweight DAP (LDAP). Lotus's Greg Loux was impressed with the work and said LDAP could become the dominant way for client systems to access X.500 services. However, no vendor now offers LDAP support.

"A lot of users think X.500 will emerge as *the* solution, but I'm not sure they fully understand the problem yet," notes Novell's Eckert. "There just hasn't been enough customer experience to determine how practical it is to implement and what benefits customers receive from it."

### A Series of Compromises

Directory services are generally so entrenched that a company rarely eliminates one, even for a better solution. Instead of trying to cut administrative chores, organizations are more interested in causing the least disruption for users. Gallup's Gilkerson is interested in using Banyan's Intelligent Messaging but notes the company has a large investment in cc:Mail.

The local installed base—whatever it is—exerts a tremendous braking force on efforts to change, to simplify, to standardize. Although the benefits of centralizing directory services are quite clear, achieving and implementing the changes is profoundly difficult and moves with glacial speed. Still, we can do a number of things to deal more effectively with the directory systems we have right now (see the text box "Tips for Managing Multiple Directories" above).

And there's a new factor. Internet access and the World Wide Web are growing at incredible rates, and they don't use X.500 or LDAP. The Internet IP addressing scheme and the Web's complex but widely used uniform resource locators (URLs) are primarily addressing conventions, not directory systems. Still, they're based on the Unix world's DNS. And clearly, they'll have a big impact on the future of network addressing.

So where will we go with network directories? How will we find out how to address a message to Joe in our Podunk office? For now, the most practical solution is sometimes to call up Joe on the telephone and ask for his E-mail address. ■

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*Paul Korzeniowski is a freelance writer in Malden, Massachusetts, who specializes in networking issues. You can reach him on the Internet at 6841944@mcimail.com or on BIX c/o "editors."*

### Where to Find

**Banyan Systems, Inc.**
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# Hyper-G Organizes the Web

**UDO FLOHR**

DAVE CUTLER © 1995

**Finding what you want on the tangled Web could be much easier with this new, powerful data architecture**

Hypertext and hyperlinks sounded like magic when Ted Nelson proposed them in his 1974 book *Computer Lib*. When the World Wide Web brought real hyperlinking to the Internet in 1991, it seemed to be fulfilling that promise of near-universal access to disparate data.

But then the reality hit. An avalanche of servers, documents, and hyperlinks, compounded by the exponential growth in Web usage, has all but buried its usefulness for real work by any but the most determined. And the work needed to maintain a thriving Web site can become a nightmare, too. But that's nothing compared to the problems of organizing massive amounts of unstructured data on the Web. This calls for a new approach.

The answer may be Hyper-G, a second-generation hypermedia information system that tries to combine the advantages of the Web, WAIS (Wide Area Information Service), and Gopher while minimizing their disadvantages. Hyper-G offers a number of direct advantages: a consistent search interface over a number of servers and services; the ability to know where you are in cyberspace; the power to not only access but contribute information; and the assurance of referential integrity (no dangling hyperlinks) and reliable links. Existing Web browsers can be clients of Hyper-G servers (they just won't get all the features), and Hyper-G browsers can be full-featured clients of normal Web servers.

Hyper-G was conceived at the Graz University of Technology, in Austria, by a team headed by Hermann Maurer and Frank Kappe; most development is still being done there. Some organizations with large Web servers are switching to Hyper-G, the best-known being the European Space Agency (ESA).

### A New Way to Manage Web Documents

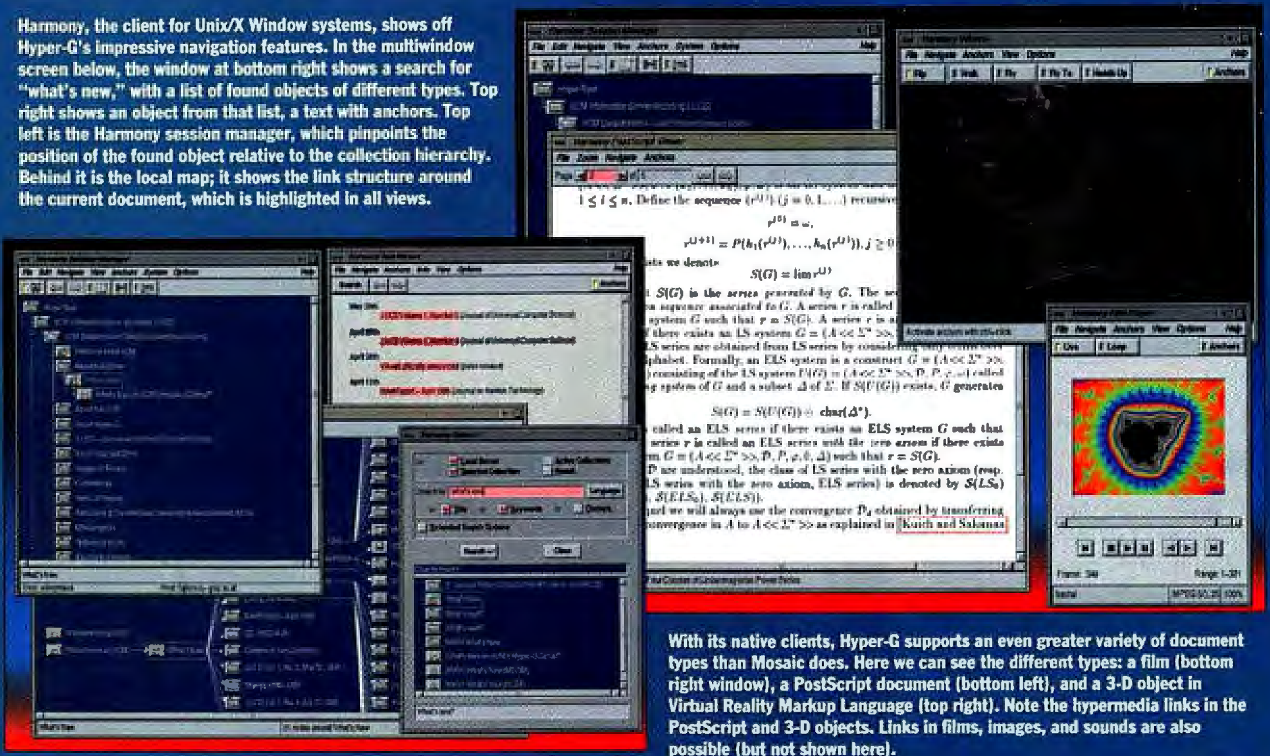
Hyper-G represents an advance over the Web as we've known it because it provides real hypermedia. It supports tools for structuring, maintaining, and serving heterogeneous multimedia data. Hyper-G guarantees automatic hyperlink consistency, and it supports hyperlinks among multimedia documents, full-text retrieval, a Unix-like security system, and client gateways to Gopher and Web browsers such as Netscape, Mosaic, and MacWeb. Similarly, it includes seamless access to popular Internet server technologies, such as WAIS and Gopher.

Hyper-G clients access Hyper-G servers across the Internet, allowing users to view and to manipulate information in multiple ways. Advanced navigation tools help keep surfers from getting lost in hyperspace.

### Links to More Data Types

In the Web, links are restricted to anchors in text and, to a lesser extent, in graphics. Hyper-G, however, supports anchors in many data types: graphics, sounds, 3-D objects, PostScript documents, or video clips. Links in Hyper-G are bidirectional. Contrary to normal Web practice, links aren't stored in documents; they're stored

**Harmony, the client for Unix/X Window systems, shows off Hyper-G's impressive navigation features. In the multiwindow screen below, the window at bottom right shows a search for "what's new," with a list of found objects of different types. Top right shows an object from that list, a text with anchors. Top left is the Harmony session manager, which pinpoints the position of the found object relative to the collection hierarchy. Behind it is the local map; it shows the link structure around the current document, which is highlighted in all views.**



**With its native clients, Hyper-G supports an even greater variety of document types than Mosaic does. Here we can see the different types: a film (bottom right window), a PostScript document (bottom left), and a 3-D object in Virtual Reality Markup Language (top right). Note the hypermedia links in the PostScript and 3-D objects. Links in films, images, and sounds are also possible (but not shown here).**

in separate databases. This means links can be attached to any type of document, such as an MPEG file, and the document format doesn't have to know about the link or how it operates. For Web links, however, you would have to change the document itself to put a link from it to another. One more advantage is that links can be attached to read-only documents—on CD-ROM, for example. Here are some other significant features:

- Support for multilanguage documents allows users to choose the language in which documents are presented.

- Information Landscape offers an interactive, 3-D representation of the database structure. Users can "fly" over the information hierarchy, represented as a virtual landscape. (See the screen on page 62.) The color and height of specific landmarks, for example, represent document type and size. Two-dimensional maps are also standard. Any changes made to documents and databases are immediately reflected in both representations.

- Documents have attributes—for example, author, keywords, and creation date—that can be used in searches.

- An underlying object-oriented database ensures data consistency and integrity.

You can appreciate some of Hyper-G's features only if you use a generic Hyper-G browser. Currently, two are available: Amadeus for Microsoft Windows and Harmony for the X Window system (see the screens above). A client application for the Macintosh will be available soon. Generic clients are not really meant to compete with Web clients; besides the advanced navigation features, the main reason for using a generic client is authoring capability, so you can modify documents.

Similar to a Web browser, a Hyper-G client contains a component that communicates with the server plus a number of internal viewers for various document types. In Harmony, these include text, image formats, video, audio, and PostScript. It can also handle highly complex 3-D scenes and models specified in a description format such as Virtual Reality Markup Language (VRML). External viewers can replace the native viewers.

A central component of Harmony's navigation aids is the session manager. It provides location feedback at all times, regardless of whether you reached an object by following a hyperlink, through a search, or by clicking on the local map.

For video, Hyper-G allows the definition of a link anchor that follows an object of interest in the video. In Harmony, these may be activated both during playback and when the video is paused.

Searches in the native clients, as well

## Why the Web Won't Work

There's only one structuring mechanism to handle all the different types of data and documents on the World Wide Web—hypertext anchors that link to other documents. Although this approach can be used to create menu-like hierarchical structures, Web databases are basically flat-file collections of documents with pointers.

The Web's limitations become apparent when you begin to maintain more than a few hundred Web pages. Here are some major weaknesses:

- No full-text search mechanism is built into the Web server, let alone the possibility to search across boundaries of Web servers.

- Because the Web currently lacks authorization features, servers are often implemented as islands, even within the same organization, to prevent access by unauthorized parties. This defeats the Web's underlying principle of tying information together, and it makes global searches even more difficult.

- The way hypertext transport protocol (HTTP) operates on the Web, an object that's located with a given URL may not be accessible at a later time. Moving an object to a different location changes the URL needed to access it. Even worse, a given URL can point to one object at one time and to a different object at another.

- You can't follow links backward. This makes it impossible to determine what other documents, even within a single server or Web site, refer to the one that you're about to move or delete. The inevitable result is dangling links.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as from a Web or Gopher client, provide a full range of query refinement. You can do Boolean or fuzzy searches, as well as searches by attribute or content, and you can specify the scope. Results are provided as a list, ranked by the server's estimate of each document's relevance.

Caution: low-flying searches. Harmony has 3-D navigation features, which the inventors of Hyper-G call Information Visualization. The Information Landscape is at bottom left. The low blocks in the front are collections; behind them are the subcollections, with their documents on top of the corresponding block. Color indicates document type; height indicates size. Above it is a 2-D overview. At top right is the selected text, while bottom right shows video with a clickable hypermedia anchor. The Information Landscape can also be enhanced with textures and patterns.

**Document Structure and Server Interaction**

When we talk about Hyper-G's architecture, we really have to consider two separate architectures: the structure of the documents, and the way in which servers interact with one another. These are related, of course, because data can be distributed across multiple servers.

Hyper-G structures data hierarchically. The basic item of a Hyper-G database is a document cluster rather than a single document. (See the figure "The Hyper-G Data Model" below.) This simplifies the implementation of such features as multiple languages or multiple graphic representations (a picture stored in different resolutions, for example).

Document clusters in Hyper-G are combined into collections. A collection can be part of one or more parent collections. This provides a big advantage: You can insert a document into a collection without having to first define the links. This is impossible in the Web, where a document with no link is inaccessible; in Hyper-G, it's simply part of the collection structure.

Collections (and document clusters) can have attributes, which are searchable. Collections can span multiple Hyper-G servers, providing a unified view of distributed resources. All servers worldwide are members of a virtual "root collection" called Hyper Root.

A Hyper-G server keeps track of object attributes, arranges collections, and connects clients with the link database. It also encompasses three separate server components: the full-text server indexes text documents, the document Server manages documents, and the link server stores hyperlinks and ensures consistent link references. (See the figure "The Client/Server Architecture of Hyper-G" on page 64.)

Hyper-G uses an efficient, connection-oriented protocol. Unlike Web or Gopher clients, which usually talk to many different servers during a session, a Hyper-G client connects to a single server. If documents from a remote server are needed, the local server fetches them and passes them along to the client. This approach has advantages: Users have to identify themselves to only one server, where accounts and access rights are maintained; the Hyper-G server, not the client, handles external protocols; and remote information can be cached in the local server. Users of commercial on-line services, such as America On-Line, get some of these benefits when they access the Web through their service, but only because the service has chosen to work that way. Hyper-G is completely decentralized and does its job regardless of which service provider the user has.

A server/server protocol ensures consistency across server boundaries in a distributed Hyper-G database, and a client/client protocol allows local Hyper-G browsers to communicate with one another via the server.

Hyper-G servers can store pointers to remote objects on Gopher and Web servers. Documents from those worlds are transformed into Hyper-G representations—Gopher menus become collections. Similar gateways to WAIS and FTP will be added soon.

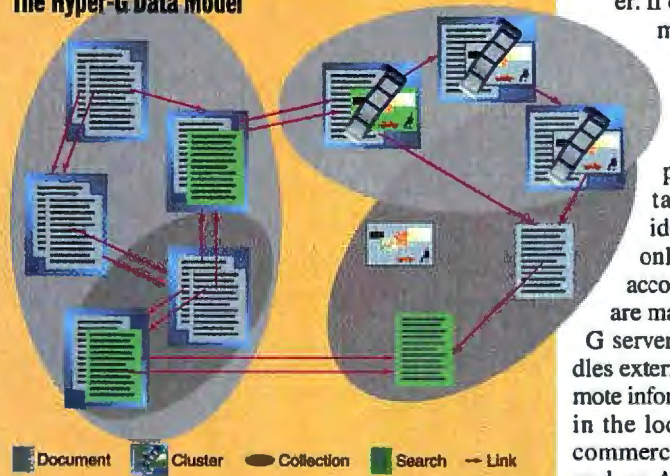
When Web clients access Hyper-G servers, specified levels of the collection hierarchy and documents are converted into Hypertext Markup Language (HTML) documents on the fly, complete with links. Most other Hyper-G functions, such as identification, language selection, and searching, are also made available to the Web user. Advanced features, such as 3-D navigation or modifying documents from within the browser, do not map to the Web; they require a Hyper-G client.

**Security Measures**

Hyper-G has a sophisticated authorization mechanism. It specifies for each user the rights to read, link, modify, and annotate documents, and it supports anonymous users ("guests"). An administrator can assign access rights on a per-document or a per-collection basis. Each user has a home collection for storing pointers to resources and personal documents.

Hyper-G uses a hierarchical access scheme. Authors may grant individuals or groups the right to read, write, link, or delete documents. Some Web browsers allow users to make annotations, but these are implemented in the browser software

**The Hyper-G Data Model**




In Hyper-G, documents can stand alone but are most often considered as document clusters, which can group different representations or versions of the same document. Clusters are themselves organized in collections managed by the server. Searches can locate and access documents in the same collection, in parent collections, and in unconnected collections.

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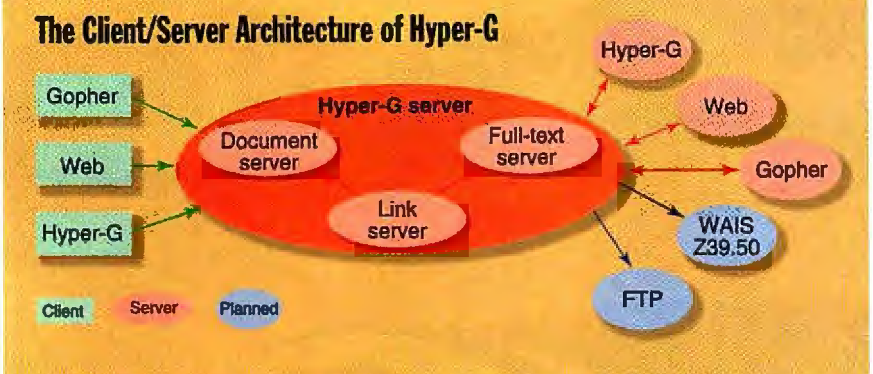


**Hyper-G's efficiency stems in part from its division of labor among servers. The Hyper-G server keeps track of object attributes, arranges collections, and connects clients with the link database. The full-text server indexes text documents, the document server manages documents, and the link server stores hyperlinks and ensures consistent link references. Clients and outside services, such as the Web and WAIS, see only the single Hyper-G server.**

and stored locally. In Hyper-G, you can set up authorization classes for annotations, permitting private, group, or public annotations to the primary document.

No secure payment mechanism—for transmitting credit card information, for example—is available within Hyper-G yet, but the European Union is about to start a project that will bring high security standards to Hyper-G. This is a prerequisite for commercial applications.

### Compatibility and Conversion

One of the really big questions about a project like Hyper-G is this: Can the Web as we know it, whatever its shortcomings, be successfully challenged by a newcomer? Compatibility is crucial, and Hyper-G's developers have gone to great lengths to ensure compatibility between Hyper-G and the Web. In fact, you might never notice that your Web browser is accessing a Hyper-G server rather than a Web site.

To convert an existing Web system with a number of servers into a Hyper-G system, the migration path is straightforward enough. For example, an organization that maintains five different Web servers, each belonging to a different department, could convert them into five Hyper-G collections, which in turn would belong to a single collection for the organization as a whole. Using Hyper-G's authorization structure, modification rights would still remain with the individual departments, but users could now search for a particular piece of information across the database as a whole. No modifications to the original HTML documents would be required. People could still use their Web browsers to access the system, but they might eventually want to switch to Hyper-G client software to take advantage of Hyper-G's additional features.

Hyper-G's developers have used their experience from the Web and other large-scale networked multimedia systems, incorporating into the basic Hyper-G all those features that have been recognized as indispensable but cannot be easily implemented on the Web. Hyper-G provides a uniform and controlled environment; while similar features might be implemented on top of the Web using external applications, this approach would eventually lead to differences between sites.

### High Performance, Low Overhead

Not much hard data on Hyper-G's performance is available yet, but experience suggests that database size is almost irrelevant to the speed of searches, since pre-indexing is used. The campus server at Graz manages about 85,000 documents and 130,000 sessions per month, with an average of 300 simultaneous users. This server is a rather ordinary SparcStation 10/40 with 64 MB of RAM. The server runs at about the same speed on a Linux PC with a 100-MHz Pentium processor and 32 MB of RAM.

Until this fall, native Hyper-G documents had to be encoded in Hyper-G Text Format (HTF). Now you can use version 3.0 of HTML, the Web's native formatting language. HTML will probably supercede HTF. Overhead for non-native clients (i.e., Web browsers) doesn't seem significant now and will become negligible as HTML 3.0 comes into use. It will also soon be possible to annotate documents from within a Web client.

The Hyper-G standard components are written in C++ and were partly developed using the Interviews toolkit library. Hyper-G runs on most flavors of Unix, and the development team plans a port to Windows NT. According to Frank Kappe, the Hyper-G code is copyrighted but freely available to all, just as Mosaic is.

It takes only a few hours to set up a Hyper-G server. The standard distribution package includes a semiautomatic installation procedure, as well as tools for inserting, modifying, and deleting objects in the database. These are most often used in scripts (e.g., using the Perl language) for mass insertion of data. One utility, called hifimport, can be used to create stand-alone versions of a Hyper-G Interchange Format (HIF) file; this could, for example, be used for CD-ROM production. Another utility, called haradmin, helps maintain the user database.

### The Future

The Gopher gateway (which makes Hyper-G accessible from Gopher clients such as GopherVR) will be enhanced to offer Gopher server administrators a migration path to Hyper-G. Also, there's a tool to import a Gopher server's data to a Hyper-G server. The University of Minnesota has embraced Hyper-G for the next generation of its Gopher information system and is working on a native Hyper-G client for the Macintosh.

Hyper-G isn't perfect. One of the problems seen so far is that clients like Harmony or Amadeus do not handle defective (or syntactically incorrect) HTML documents very well. In these cases, there can be problems getting a document up on the screen, and people would have more luck using a normal Web client.

Hyper-G is a stable, powerful, and, above all, *available* alternative to the World Wide Web that offers something no other Web-based technology does. It can organize the mass of unstructured data and unmanageable hyperlinks. Whether Hyper-G has a chance to make an impact in the decentralized and frankly anarchic environment of the Internet remains to be seen. But it's also possible that it could supersede the Web and we users won't even notice. ■

### TAKE A TEST DRIVE

**You can test-drive the Hyper-G system using a Web browser such as Netscape or MacWeb. A good starting point is the Hyper-G server at the Graz University of Technology: http://hgiicm.tu-graz.ac.at. Consult the doc directory at the Graz site, or FTP to: ftp://ftp.utdallas.edu/pub/Hyper-G. You can subscribe to a Hyper-G mailing list by sending an E-mail message with the line "subscribe hyper-g" to listproc@iicm.tu-graz.ac.at.**

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# Faking It, Then Making It

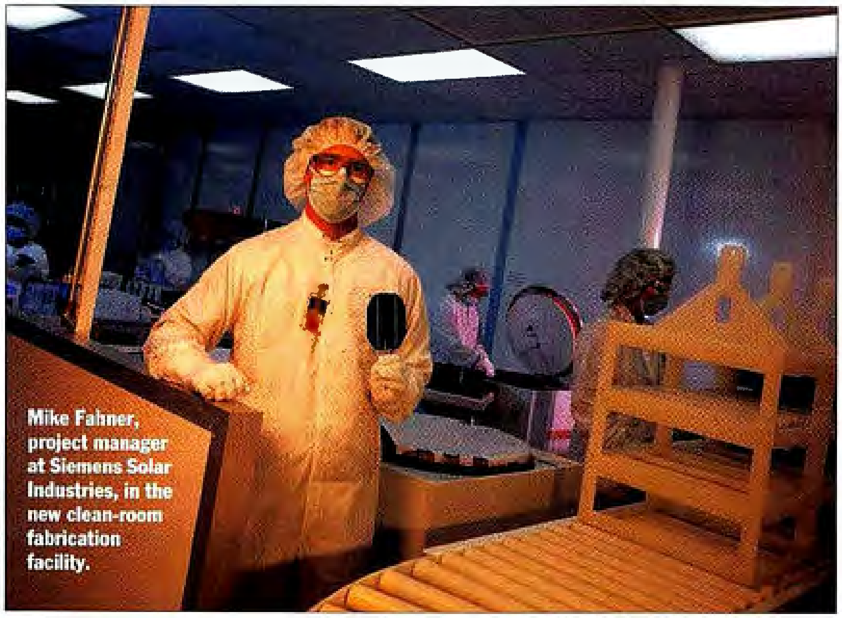
JOHN R. VACCA

If at first you don't succeed, you probably didn't run enough simulations. Take Siemens Solar Industries. It succeeded. How? Before committing its photocell production to a new-to-the-industry clean room, SSI took advantage of simulation software and a nearby university to fine-tune the processes and work-flow procedures it would use. The results were dramatic. The Camarillo, California, company saved over $10,000 in consulting fees. And because it could clear up production bottlenecks in advance, the new clean room is saving the cell-fabrication department roughly $7.5 million annually.

**It's always better to make mistakes on a model than to screw up in production. That's why the solar industry's first clean room started life as a simulation.**

The key was simulation. No longer just computer games for the intellectually curious or exercises in the computer-science curriculum, today's simulation software has come down from the world of FORTRAN subroutines and is appearing on desktop computers.

Now simulation is making its way into the world of business and industry. It was important in an earlier business-process reengineering effort at SSI, and during the past year simulation helped fine-tune the planning and operation of a new production process and fabrication facility.



Mike Fahner, project manager at Siemens Solar Industries, in the new clean-room fabrication facility.

AMY ETRA © 1995

### Making a Clean Start

SSI is the world's largest volume maker of solar electric products. Everything from power supplies for telecommunications systems to utility-scale solar electric plants uses its cells and modules. Your lawn might even be an SSI customer: The company also produces solar panels and solar-powered outdoor lighting. It's part of the worldwide Siemens Solar Group, which has locations in Germany, Japan, Singapore, and the U.S.

SSI decided to introduce clean-room contamination-control technology into its photocell fabrication. That spells money—to upgrade equipment and to create a new facility.

A *clean room* provides a controlled environment that filters incoming air and water to high standards of purity. It also controls temperature, humidity, and air pressure, but the key element is air filtration. Clean-room personnel wear special coveralls, hair covers, shoe covers, face masks, and gloves. Clean rooms are standard practice for fabricators in the semiconductor business—you couldn't make a CPU without them—but the solar industry had never used them before SSI decided to take the plunge.

There was a lot at stake. And there were high hopes. "This new facility would enable Siemens to attain higher levels of quality in the cell-fabrication process," says Mike Fahner, the SSI project manager responsible for improving information accuracy and implementing logistics systems to enhance supply-chain performance. "This was also an opportunity to improve productivity by redesigning the facility layout and material flows to increase throughput, decrease the work-in-process levels, and reduce cycle times," he adds.

### Efficiency Is the Name of the Game

World-class manufacturing organizations strive to minimize the level of what is called *work-in-process*—that is, the inventory of unfinished goods on the shop floor that are waiting for the next processing step. Work in process represents a capital asset that's tied up—money that could be better invested in things such as plant upgrades.

High inventory levels can be costly. If things move slowly enough, there can even be a cost of obsolescence. If the products are technology-driven where changes occur rapidly, then the administrative costs of managing engineering changes for partially finished goods can be cumbersome.

"At SSI, we considered that computer simulation was an ideal tool to help improve the productivity and quality of the cell-fabrication process," explains Fahner. "Computer simulation provides a virtual laboratory where an engineer can experiment with effects such as adding machines or changing their configuration without the time and expense of making the physical changes."

Computer simulation also allowed SSI to compare numerous alternatives quickly. "We believed that simulation models could predict the effects of proposed equipment investments or modifications with minimal risk," Fahner adds. "We also believed that the primary benefit of the simulation-modeling process was the knowledge and insight we would gain in understanding the interactions within the systems we were designing and studying."

According to Fahner, SSI's primary goals were to model the proposed production process, concentrating on the wafer-diffusion, oxidation, and plasma-etch processes for the new cell-fabrication room. The company also wanted to identify and remove system constraints and evaluate alternative scheduling, delivery rules, and material flow with respect to queue levels, throughput, cycle time, machine utilization, and work-in-progress levels.

### Partnering with Poly

Dr. Sema Alptekin, professor of industrial and manufacturing engineering at California Polytechnic State University in San Luis Obispo, California (generally known as Cal Poly), wanted to get her students involved in a real industrial problem using simulation techniques. She approached Fahner after a mutual contact suggested she consider SSI.

Fahner was interested in a partnership with Cal Poly because he's always looking for efficient ways to solve problems with limited resources. Siemens keeps a core group of highly skilled and focused individuals who manage projects using external resources on an ad hoc basis. This approach has allowed Siemens greater flexibility by accessing a specialized knowledge base only when needed, and without carrying costly overhead. (See the text box "Learn by Doing" on page 72.)

The project began on September 23, 1994. Alptekin visited SSI to tour the plant and discuss the project's objectives. Fahner visited Cal Poly twice during the 10-week project, defining project objectives for the students, providing data, and answering questions whenever industrial expertise was needed.

Alptekin's students were excited and willing to visit SSI to learn more about the problem. They also felt greater-than-normal pressure, since the projects weren't hypothetical exercises created by an instructor and ultimately destined for the trash can; their work would be evaluated by industry, and their recommendations might actually be implemented within a few months.

### Picking the Right Simulation Tool

Alptekin notes that simulation software has been around for a long time. "It was part of my Ph.D. dissertation in 1981 to write code in FORTRAN as a simple simulation tool to solve a simple problem. With advances in computer technology and software, solving the same problem, which took several years in the 1970s, could be accomplished in several days today," she observes.

After numerous meetings and discussions, the Cal Poly students, with Alptekin's help, selected ProModel from ProModel Corp. (Orem, UT) as the software they would use for the SSI computer simulations. "ProModel is just one of the simulation tools we use," says Alptekin. "We picked ProModel because it was the only available simulation product that was developed as a Windows application," she adds. "It offers the advantages of a true Windows-based product." (See the text box "What ProModel Can Do" on page 68.)

## SIMULATING SIEMENS'S CLEAN ROOM

### The Problems

- Poor material flow.
- Unbalanced resource utilization.
- Bottlenecks in throughput.
- Schedule delays.

### The Solution

- Model alternative scenarios and select the best attributes from each.
- Study the interactions between machines to eliminate bottlenecks.
- Improve material flow and reduce work-in-process levels by implementing a "pull system" based on consumption replenishment.

### The Benefits

- Validated process capabilities prior to implementation and met budget and capacities.
- Modified scheduling rules and operating procedures to improve process performance.
- Gained a better understanding of the process, reducing the risks involved in decision-making.
- Developed an analytical tool that can be used for continuous process improvement.

The package's relatively gentle learning curve was critical, according to Alptekin. "Since this was a class project, the simulation tool had to be easy enough to learn and apply in a short time," she explains. "Anybody who's using Windows could learn to use ProModel in a short time." The user does not have to learn a simulation language. It's a point-and-click development tool through its library of tools, icons, and constructs. The package's on-line help and on-line training were also important factors.

In addition, ProModel was well suited for this project-workgroup situation because different members of the group could develop submodels and integrate them into a final model. "It allows the user to start with a small model and develop it to a larger model through the use of submodel and model-merge capabilities," Alptekin continues. "ProModel is also well suited for fast what-if analysis because of its flexibility to accommodate changes and its fast running speed."

The Windows underpinning of ProModel offered other advantages. The students found ProModel's output charts and graphs superior to those of other simulation products, and they could easily paste them into other Windows applications for reporting purposes. Finally, ProModel's animation capabilities were a definite plus. "Animation helped SSI managers validate the baseline model and provided them with a better understanding of their proposed system," says Alptekin.

### How the Students Used ProModel

The students used ProModel to develop a baseline that defined the model's scope and objectives based on real data. They also used it to make assumptions to simplify the model, as well as to create

> ### WHAT PROMODEL CAN DO
>
> **ProModel is a Windows-based simulation package that you can use to model just about any system of discrete events, such as manufacturing systems, business processes, and service systems.**
>
> **ProModel schedules simulation events based on predefined parameters. You tell ProModel how and when the entities (in this case, silicon wafers) arrive at each machine, how long each machine takes to service them, and under what conditions. When you run the simulation, the computer processes each event and keeps track of the system's vital statistics as the model changes state.**
>
> **ProModel provides several standardized reports, graphs, and animations that summarize the results of the system over time. These are valuable in comparing alternative scenarios. Important statistics include system throughput, machine utilization, and average queuing times in the machine buffers.**

a model of the network of resources in the system by defining the machines, their capacities, and the probability-distribution functions of their stochastic service times and interarrival rates of incoming parts. Some of the resources in this model included chemical-etching baths, spin-rinse dryers, wafer-transfer stations, diffusion tubes, oxidation tubes, and plasma-etch ovens.

Also, the students used ProModel to define the routines used for producing wafers. There were two product lines in the Siemens model, plus a sequence of operations, batch sizes, and logical rules that determined which machines could be used under specific conditions.

Furthermore, they used ProModel to validate the baseline model, which handled iterative simulation runs, comparison of simulation runs to real performance, and baseline-model validation when the simulation-generated statistics matched the actual performance to the given assumptions. Finally, they used ProModel to develop alternative scenarios to design enhanced systems that met the modeling objectives.

**Simulating the Processes**

The actual project modeled the wafer-diffusion, oxidation, and plasma-etch processes. The simulation involved the machines, equipment, workstations, storage-and-handling devices, operators, and material and information flows necessary to support the process. SSI and the students developed a baseline model of the proposed system and validated the baseline results from the simulation with actual process data.

Also, SSI and the students developed and evaluated alternative scenarios. Many involved the problems of producing two different models of solar cells that called for different machine setups and process times. The students considered adding extra spin-rinse dryers, diffusion and oxidation tubes, and/or plasma-etch ovens to the system; modifying machine-setup times; and using a different type of dryer that required no setup or changeover. Other potential changes included a variety of scheduling options for both production and parts arrival, modifying batch sizes according to cell model, and changing the distribution of diffusion and oxidation tubes within the facility.

*continued*



### Recommendations

The Cal Poly students delivered their final report and presentation on December 2, 1994. They proposed specific recommendations on given criteria and objectives, as well as on new operations and organizations. As a result of this project, SSI was able to make significant changes that improved the efficiency of the clean-room facility and plan for further changes that would allow even more productivity.

For example, SSI's solar-cell line includes two types of photocells, called the M-line (which accounts for 62 percent of production) and the PC-line (38 percent), that require different machine setups and production times. The facility's four spin dryers were initially set up so that three handled M-line cells and one handled PC-line cells. Simulation showed that changing the setup to two machines for each model would improve throughput and cut queuing times.

Another change that grew out of the spin-dryer study involved scheduling dedicated shifts for each model type. By running M-line product for 13 consecutive 8-hour shifts and then changing over to PC-line product for eight consecutive shifts, SSI could realize a significant increase in throughput, a reduction in waiting times, and a minimization of time devoted to equipment setup and changeover.

But SSI and the students acknowledged that a radical change in scheduling like this could significantly impact—either positively or negatively—other SSI operations that weren't studied in the simulation project. Thus, SSI needed to do further investigation before implementation.

Simulation showed that, once the spin-dryer constraints were removed, the next bottleneck in the system was diffusion. The students recommended an increase in diffusion capacity by converting a bank of four oxidation tubes to diffusion or, budget permitting, adding another bank of four tubes. They determined that converting tubes would lead to an increase in the overall system throughput and utilization as compared to the baseline model. This finding, coupled with the importance of flexibility in balancing the diffusion/oxidation mix, pointed up the need to find simple and expeditious techniques for tube conversion.

### In Production

In February, SSI's Cell Fab I clean room commenced operations. The processes of diffusion, oxidation, and plasma etching for silicon wafers are all done within the 2500-square-foot clean room. Approximately 50,000 wafers per day can be processed through the new $1 million clean-room facility.

The improved capabilities of the new facility, fine-tuned by simulation, have enabled SSI to realize significant production improvements. Also, the simulation project validated the capabilities of the proposed system, and this helped SSI meet its cost and capacity expectations. Finally, the simulations gave SSI a much better insight into the interactions among various elements within the production process, which has led directly to better-defined scheduling rules and operating procedures.

*Product yield*, which is defined as the ratio of quantity output to quantity input in the cell-fabrication process, has improved from a baseline of 83 percent to its current level of nearly 98 percent. The reduction in scrap loss is primarily the result of better material flow and contamination control in the process.

*continued*

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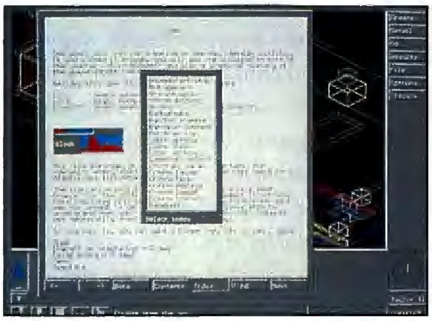

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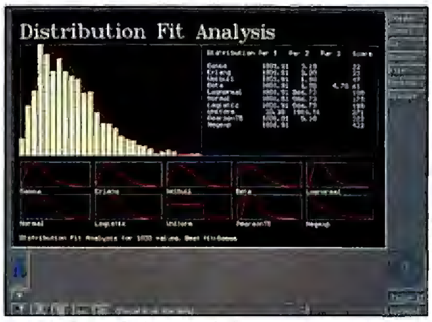


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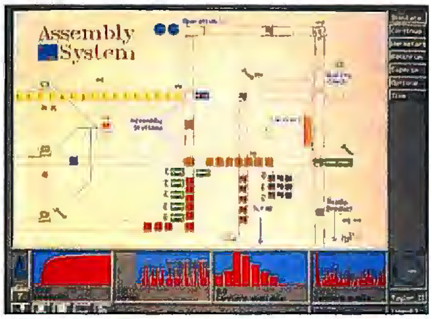


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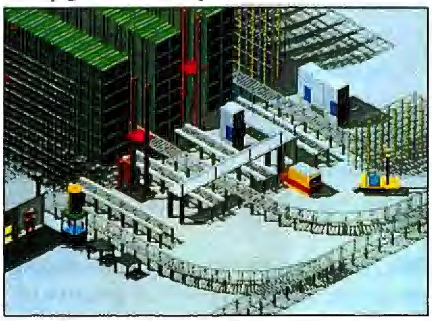

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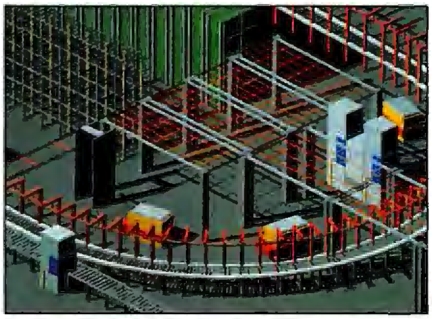

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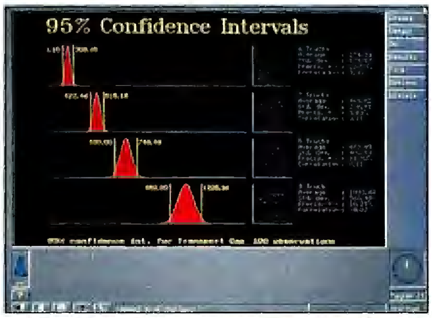


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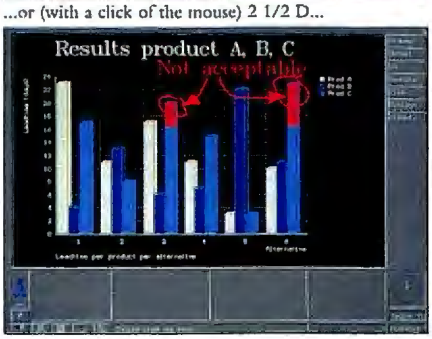


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In addition, process variability, as determined by the wafers' surface resistivity (called *sheet rho*), has been reduced. As the variation in surface resistivity decreases, the fabrication process becomes more repeatable and yields more consistent consistent electrical properties.

As a result of the clean-room implementation, the bottleneck in the process has moved from the diffusion and oxidation processes (which are done in the clean room) to downstream operations. Most of the improvement was due to the installation of additional equipment to increase capacity. However, SSI designed the facility to get more throughput with the same number of operators, and thus the cost per unit has been reduced. Also, improved material flow has resulted in lower inventory levels and reduced cycle times. This allows SSI to be more flexible in responding to customer demands.

**Lessons Learned**

While SSI's new fabrication process operates effectively, thanks in part to the simulations that went into the planning, there's still room for improvement. In particular, Fahner says that if SSI were to do the simulation project all over again, he would make some important changes.

First, he would involve manufacturing personnel to a greater degree during the what-if discussions when deciding what options and alternatives to explore. Second, he would work harder to develop a stronger in-house simulation capability. This would allow SSI to take better advantage of the model and to use it as a tool for continuing improvement. Finally, he would develop run-time models so that users not familiar with programming could still run the simulations and explore new alternatives with new data.

At the moment, primarily due to cost and time constraints, SSI has no further major simulation projects on the docket, although SSI engineers use in-house simulation tools to create simple models as the need arises. While simulation languages and software applications are improving at an accelerated rate, Fahner acknowledges that simulating a complex process still requires highly skilled engineers, a clear focus, and dedicated time for modeling.

Joint projects, like this one with Cal Poly, can be an effective way of leveraging resources, but this type of cooperative effort requires a significant amount of project management effort. It's an effort Fahner thinks was worth making.

"Overall, it went fairly well," he says. "The Cal Poly students did an excellent job in performing simulation modeling of Siemens's new cell-fabrication clean room. Their analysis was thorough and insightful. In addition to learning about Siemens's processes, they were concurrently learning how to use ProModel simulation software. It was evident that they quickly grasped the fundamentals of analyzing system constraints and applied these methods to Siemens's case study."

In sum, he says, "Their conclusions and recommendations were sound and reasonable, having direct applications to improving Siemens's processes. The presentations were very professional, and the interactive discussions were even more helpful. The real value of this project came from their fresh perspective and insight. The knowledge that they have gained can greatly improve our understanding of the cell-fabrication clean-room process." ■

*John R. Vacca is a freelance information-technology and air-and-space contract writer based in Houston, Texas. He can be reached on the Internet at 74044.164@compuserve.com or on BIX c/o "editors."*

## LEARN BY DOING

When Dr. Sema Alptekin began planning how to teach a graduate course, "Advanced Topics in Simulation," for California Polytechnic State University's industrial and manufacturing engineering program, she wanted to design the course to fit the school's "learn by doing" principle. Cal Poly claims its students take more laboratory courses than students at any other engineering school in the nation. In other words, they not only learn theory, they practice it on numerous engineering management applications. She wanted to give her students a real problem and real data.

Dr. Sema Alptekin

Because she was new both at Cal Poly and in California, Alptekin contacted an old colleague, Dr. Ali Kiran, president of Kiran & Associates (San Diego, CA), who consults with California industry on simulation and scheduling issues. Kiran pointed her to Mike Fahner at Siemens Solar Industries.

Fahner, as it turned out, was enthusiastic about collaborating with Cal Poly on this project, because its students and faculty could buy him resources and expertise that he couldn't otherwise muster. He was also eager to work with Cal Poly because of the reputation of its accredited engineering and business programs. SSI was committed to sustaining a relationship with a local university with talented faculty and students.

No money or compensation was exchanged. SSI would provide technical information and project management, while Cal Poly graduate students would contribute the systems-analysis expertise and put in the time needed to set up and perform the actual computer simulations. The relationship was a cooperative exchange of information and experiences from which both parties benefited.

The two parties decided to hold weekly teleconference meetings, and the students would have to produce periodic progress reports. The 16 students were divided into four project groups, each focusing on one specific part of the system.

The students accomplished a lot in a 10-week quarter. In fact, SSI's experience contradicts the common wisdom, widely believed in industry, that students take longer than professionals to complete projects. Everyone was happy at the end of the clean-room project. The students gained confidence in using simulation as a tool to solve real problems. Fahner and SSI obtained a number of helpful simulation results that would otherwise have taken longer to achieve. And Alptekin had succeeded in making her course more interesting and more meaningful by including industrial projects in an academic setting.

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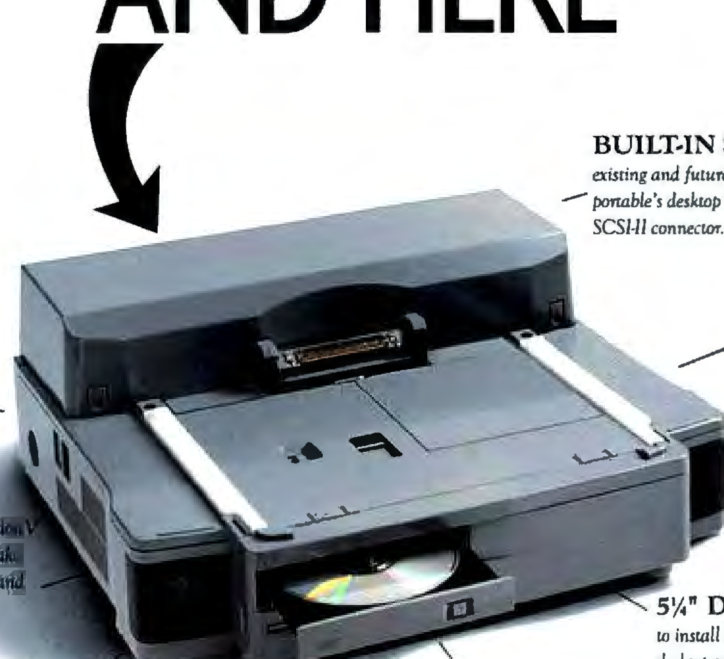

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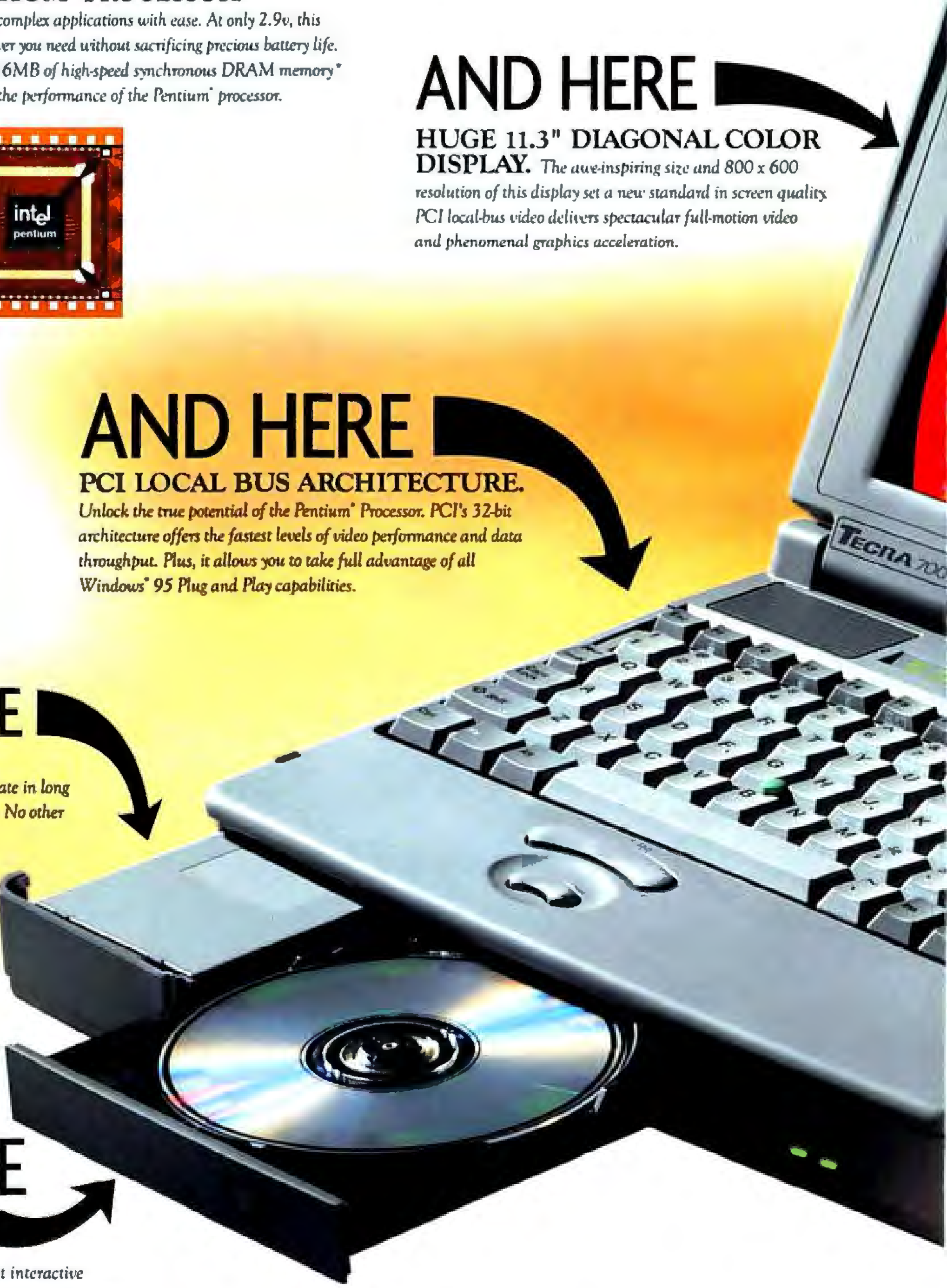


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# OPERATING SYSTEMS

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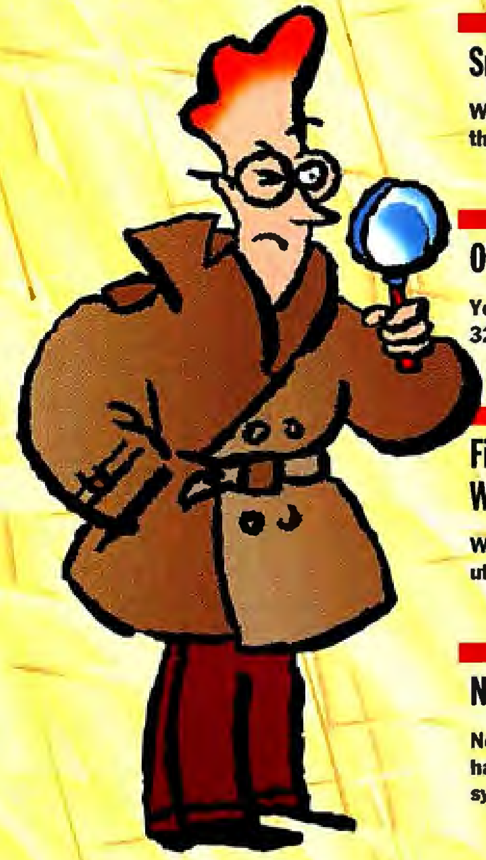



**BONUS**/Reconcilable Differences

How well has Microsoft met its own goals for backward compatibility in Windows 95? You'll find this article on the BYTE Web site—http://www.byte.com


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# Smooth Operators

## New developments with today's—and tomorrow's—OSes

No one ever bought a computer to run the operating system. And yet, OSes often inspire a "rather-fight-than-switch" loyalty among their users. Many users have been caught up in religious wars.

Expectations of OSes are constantly changing. We used to be pretty happy if it simply ran our application and let us manually configure the system with arcane and undebuggable commands. Now, we're miffed unless these software servants can automatically recognize and use all equipment (even on-the-fly modifications); wring the utmost performance out of the CPU, memory, hard drive, monitor, and all the peripherals; network effortlessly with practically any other machine; provide a stable, crash-proof platform for applications to run on; support a simple but rich applications development environment; and clothe the whole shebang in a snazzy designer interface—which users can customize to their heart's content. Not much to ask.

Our lead article ("OS Paradise" by Tom Yager) shows how OS vendors are meeting the challenge with 32-bit desktop OSes possessing some heaven-sent features. Text boxes look at Linux, a public domain superstar ("The Linux Phenomenon"); some behind-the-screens considerations of user-interface (UI) design ("What You See: What You Want?"); and two OS architects who have each gotten a second shot at designing a new OS ("Doing It Over").

BOB ROBINSON © 1995

Utility programs provide a welcome and necessary adjunct to the powers of the OS. Historically, pioneering features have appeared in utilities first and in OSes later. While Windows 95 has numerous features that were previously offered by third-party utilities, it also opens the door to new possibilities. In "Filling in Windows Blanks," Peter D. Varhol details some fresh opportunities for utilities in Windows 95, as well as some classic utilities for other OSes.

In "Not *That* DOS," Paul Korzeniowski discusses new distributed OSes, many of which exist only in university research labs—but perhaps not for long. Systems such as Plan 9 (from AT&T) and Spring (from SunSoft) have features valuable in the networked world, while Exokernel, Spin, Scout, and Flux explore the outer reaches of OSdom.

Barry Nance ("Sincere OS Flattery") shows how one OS can be made to run applications intended for another, thanks to third-party emulation software. In today's multiplatform office, that flexibility becomes essential.

Object-oriented OSes promise to simplify applications development. But where are they? Dick Pountain explores their nature—and why they don't seem to be moving off the horizon—in "OO Meets OS." The good news is that they really are getting closer.

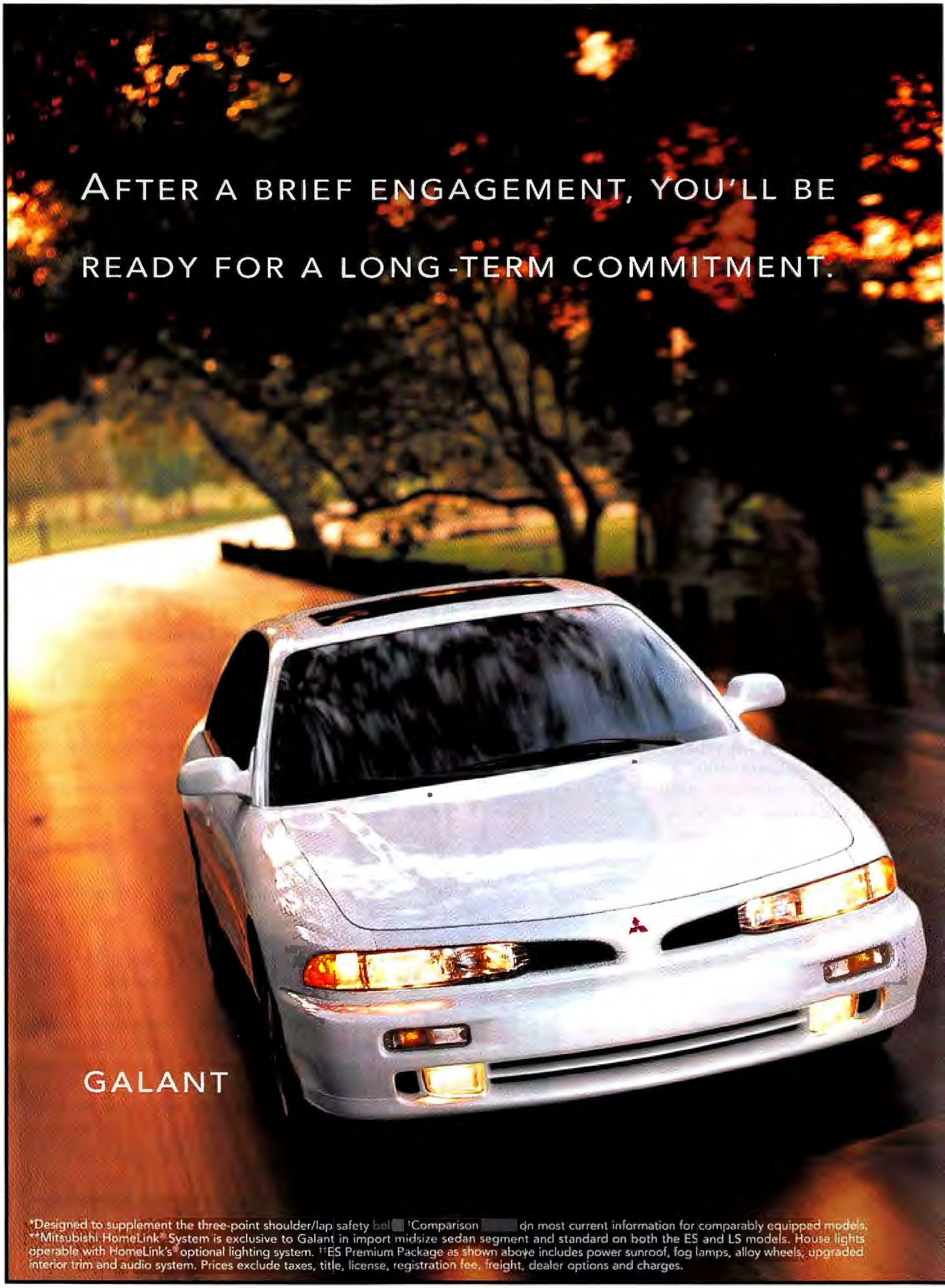
Developers writing applications today must often pay attention to more than one OS platform. David Linthicum leads a tour of development tools ("And One for All") that may simplify cross-platform development chores.

No discussion of OSes would be complete without mentioning crashes. BugNet's Bruce Brown ("Crashing the Party") examines these daily cataclysms from his unique perspective, giving helpful recipes for crashing all the major desktop OSes—and insights into what they reveal about the inner workings of each one.

Available only on BYTE's World Wide Web site (http://www.byte.com), Edmund X. DeJesus's "Reconcilable Differences" examines Microsoft's struggle to maximize Windows 95's compatibility with existing DOS and Windows applications. The programs that still won't work exactly right seem to fall into distinct categories.

Unless you're still running programs by rewiring circuit boards, you're dealing with an OS every day. Our lineup will keep you up on what's new and decidedly different in the software we love to hate. ■

**—Edmund X. DeJesus, Senior Editor**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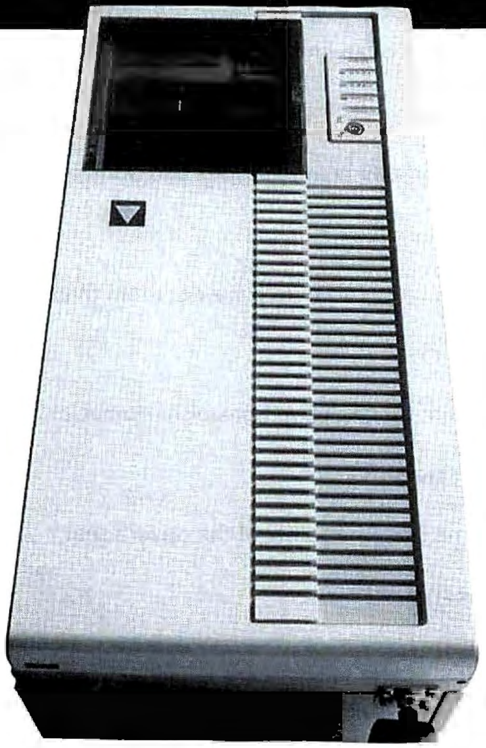

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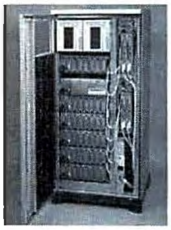

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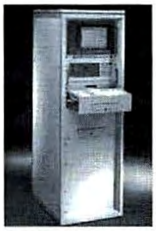

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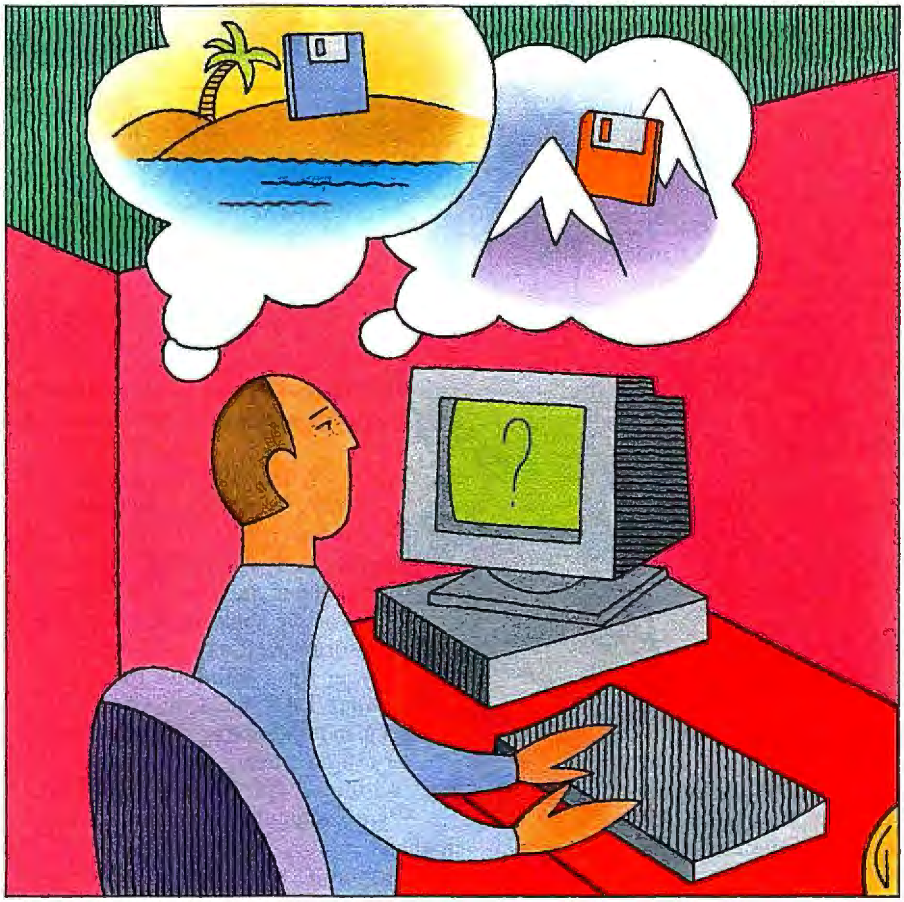
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## The lowdown on the latest 32-bit PC operating systems

Shall I take the Ferrari or the Jaguar to the restaurant? Shall I have the lobster or the linguine calimari? Shall I go to the beach house or the mountain chalet this weekend?

No doubt about it, some types of problems are more fun than others. And the problem of choosing a desktop operating system has gotten a lot more fun lately.

Today, there's so much overlap in OS capabilities—at least each vendor's *stated* capabilities—that we're cursed with an embarrassment of riches. For any problem we must solve, several OSes promise a uniquely capable solution. And with the bundling that has become commonplace, OSes sometimes *are* a self-contained solution, applications and all.

So let's look at some operating systems to see what they're good at and not so good at. For this evaluation, we chose a common base—a PC with an Intel or compatible CPU—and five commercial PC OSes: Microsoft's Windows 95 and Windows NT Server, IBM's OS/2 Warp, Novell's UnixWare, and SunSoft's Solaris.

### Using Windows 95

A user interface isn't simply a matter of drawing colored dots on a screen. Broader behavioral issues, commonly referred to as "look and feel," shape a user's feelings about his or her computer. We've seen that it can help make the difference between a productive worker and a disgruntled one.

On the benevolent-dictatorship theory alone, Windows 95 has a leg up. Microsoft is not only the sole supplier of the OS, it also sells the platform's most popular development tool (Visual C++) and the most popular suite of applications (Office).

There are passing similarities to OS/2 as well, but key features of both the layout and the behavior of Windows 95 are strikingly NextStep-like. A totem-pole stack of icons for frequently accessed applications sits glued to the desktop. Across the bottom of the screen is a list of running applications with a graphical representation for each. Both graphical and text-based applications can be launched from the command line.

Critics have taken Microsoft to task for its continued dependence on 16-bit and DOS code. These same critics would have had even more to complain about had Microsoft abandoned so-called legacy applications and devices, those programs and peripherals supported under Windows 3.x but which have no 32-bit native equivalent.

A user of Windows 3.1 should quickly feel comfortable with 95's interface. Every aspect, from installation to application launching, is easier than under old Windows. The famous Start button unravels a cascade of menus which, depending on your preference, will either catch your fancy or annoy the daylights out of you. For the latter group, Microsoft has included a version of the much-maligned (and deservedly so) Program Manager called the Explorer.

The Windows user interface has gotten more than a cursory overhaul. (Some of the interface enhancements have been split out into a product called the Plus Pack, a $55 add-on.) The entire


Windows 95 is an operating system that's pretty easy to use and fairly powerful. But don't expect it to jump through all the hoops you expect Unix to go through.

look is different, from window borders to mouse cursors. Font-smoothing drastically improves the appearance of larger text. When you resize a window, the window changes shape in real time. You can do a slow double-click on icon captions to change their names. Look-and-feel preferences now let you customize minute aspects such as the font used in title bars. Desktop Themes, including background images, colors, and font selections, can follow you around a network to make any machine feel like home. Even 16-bit Windows applications inherit Windows 95's look with regard to borders and common dialog boxes (e.g., "File Open").

TCP/IP support is standard, so if you're connected, you can use Windows 95 to run built-in apps and other Winsock (Windows sockets) software. Windows 95 also lets you connect to Windows for Workgroups and other NetBEUI LANs, as well as NetWare servers.

## Using OS/2 Warp

OS/2 Warp Connect has become a popular choice for the desktop. Before Windows 95 came along, OS/2 Warp was the best way to coax 16-bit Windows programs into multitasking more efficiently. You can run a high-speed modem session with a native Warp application (included in the Connect bundle) and support several Windows programs in the background without bogging down file transfers.

Most of these benefits pale in a field that includes Windows 95. OS/2 Warp can't run Windows NT or Windows 95 applications, and its user interface, while perfectly functional, looks industrial compared to the sleekness of Windows 95. That's sizzle, not steak, and so it may not figure into your consideration. Like Windows 95's Start button, Warp's Launchpad eases access to common functions by placing them a couple of clicks away. You may prefer the Launchpad to the Start button's incessantly cascading menu: Launchpad isn't quite as customizable, but it can save you digging through the Workplace Shell's deep hierarchies of icons for common functions.

Using OS/2 Warp to multitask Windows applications probably holds no appeal now that Windows 95 is out. It is worth running if you have even one critical native application. Warp also performs well as a nondedicated server for a Windows for Workgroups LAN; the demands of LAN print and file serving will take a lesser toll on a Warp machine than on Windows for Workgroups, and Warp's reliability is generally much higher.

The Warp Connect bundle, which includes many extra applications (a Web browser, for example), doesn't strike a decisive blow for OS/2 relative to Windows 95. Since most users have 16-bit Windows applications, they'll continue to run on whatever 32-bit OS they choose. IBM's bundling of personal productivity applications probably won't make a clear difference. IBM's anticipated shift to emphasize servers and vertical applications, areas where Big Blue has proven strength, should gain OS/2 more ground.

## Using Unix

Unix is an odd market, primarily because it means so many different things. We chose to evaluate two System V Release 4 Unix products: Novell's UnixWare and SunSoft's Solaris x86. UnixWare went through some serious changes in release 2.0, gaining considerable maturity and stability in the process. Similarly, Solaris x86 version 2.4 cast off the yoke of prior releases, which were roundly criticized as buggy.

As with OS/2, Unix suffers a lack of major-label commercial applications. That has never been Unix's strong suit. Sites looking to put themselves on the Internet should think of Unix first. Most of the tools you need are free, and there's plenty of good help available when you get in a jam. Unix is also a mature and highly functional choice for application servers. Everything from accessing remote databases to executing remote applications can be handled by commercial Unixes.

Solaris and UnixWare rely on the X Window System for a graphical user interface. SunSoft and Novell each created their own file-manager shells that implement drag-and-drop capability and otherwise approximate the behavior of other popular GUIs. You can run graphical applications remotely: The remote machine, even hundreds of miles away, runs the software, but the interface is presented to you at your desk. Any PC or Mac running a popular OS can be adapted to work as an X Window terminal. In this regard, Unix offers the widest latitude of remote access as a standard feature.

UnixWare is a strong system with a workable graphical shell and a suite of well-designed graphical administration tools. As an application platform, UnixWare is a good distance behind Solaris, but only when you compare UnixWare with Solaris' implementation

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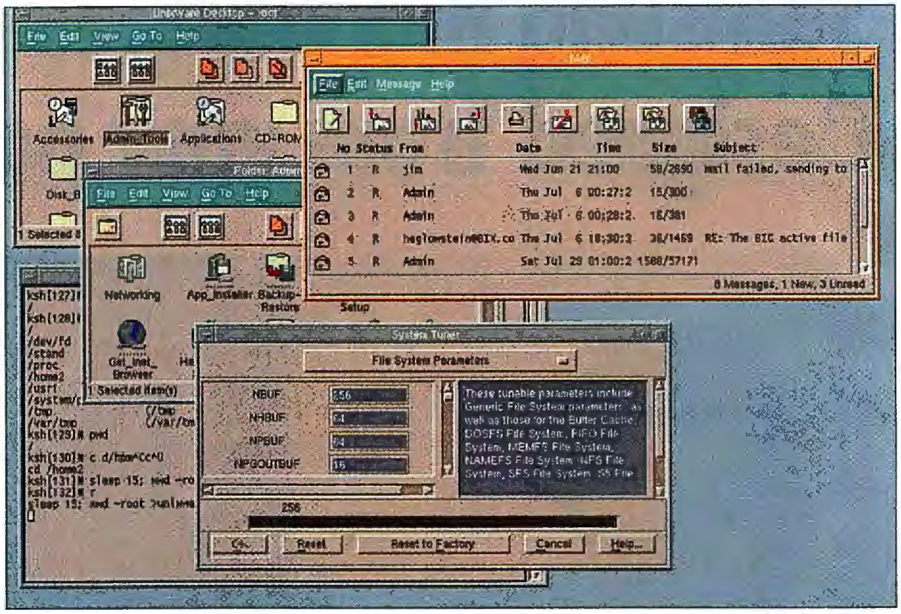



**UnixWare is Unix with a fairly attractive face. Front ends to the Unix file system, the system administration tools, and mail are built in. You will find yourself at a command line once in a while, though.**

of the Motif Common Desktop Environment (CDE). CDE's front panel (see the screen shot below) nearly matches OS/2's Launchpad, but the front panel supports multiple workspaces. Each workspace is a full virtual screen, and you can switch from one screen to the next with the mouse or the keyboard. Solaris' CDE brings the X Window System up to consumer standards with enhanced E-mail, text editor, calendar, image editor, and other tools. CDE's new help facility compares well with Windows and offers hope that Unix developers may take advantage of this powerful standard.

CDE's worth goes deeper than its glossy surface, and it isn't peculiar to Solaris. It's the product of the collaboration of Sun, Digital, IBM, Hewlett-Packard, and Novell. Solaris is the first CDE implementation we've seen.

Solaris has two unmatched features: Display PostScript (DPS) and Wabi. DPS enhances Solaris' OpenWindows X Window software with a full PostScript interpreter. You can view PostScript documents on-screen and even embed PostScript functions in your X Window programs. Solaris' documentation comes on CD-ROM in "AnswerBooks"—PostScript with embedded hypertext links. It's an effective combination, and it makes a good source for printing, too. And when it comes to running Windows applications on your Unix system, Wabi does quite well. Even enhanced-mode Windows applications run under Wabi, and SunSoft has done a good job of simplifying the work of installation. Wabi supports many popular mainstream software applications, but before adopting Wabi, first check the compatibility list to make sure that the programs you use are on there.

## Administering Windows 95

Testing is the key to deploying a fleet of machines with a new OS. You may find that devices you favor aren't supported by your new OS. In our tests, an Orchid SoundWave 32 sound card was not supported by *any* of the tested OSes. A Sound Blaster 16 ASP card proved problematic in Windows 95 (reportedly fixed now), and even Microsoft's own Windows Sound System card produced no MIDI music.

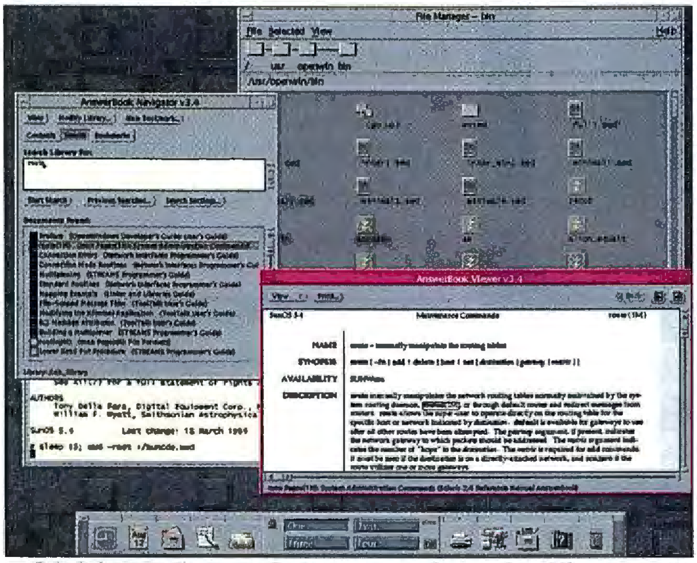
Running a 32-bit OS requires a powerful system. Vendor recommendations can be used only as an optimistic baseline. One Microsoft spokesman referred to the claimed 4-MB memory minimum for Windows 95 as sufficient "unless you want to run real applications." A more realistic minimum is 8 MB. Our testing proved that 16 MB offers enough slack to minimize swapping in a networked environment with typical applications.

Windows 95 Plus includes a 32-bit version of Microsoft's DriveSpace compression utility that can about quadruple the capacity of your hard disk. It's also flexible, letting you apply varying levels of compression to individual files or groups of files rather than to entire drives.

Windows 95 takes advantage of multitasking by introducing agents, programs that run in the background. With Plus installed, standard agents watch disk space, defragment your drives during off-hours, and implement DriveSpace's higher compression levels. The DriveSpace agent will also look for files that haven't been accessed in a specified number of days and compress them for you.

For administrators, an unpleasant aspect of Windows 95 is the VFAT file system. It gives you long filenames, but in most other ways, it's still the dumpy old FAT. Until native backup applications appear, you must resort to kludgey workarounds to reattach severed long filenames to their 8.3 DOS equivalents after a restoration from tape. VFAT also has no notion of file ownership or file-level access control, so real security is impossible to implement. If a user can get at a drive, local or remote, he or she can access every file on that drive. In our opinion, that puts Windows 95 completely out of contention as anything but a casual, completely open workgroup server.

Microsoft did itself proud, though, in redesigning the administrative side of Windows 95. You need to grab a copy of the Windows 95 Resource Kit. This chubby package explains everything the scant Windows 95 manuals don't, and the kit




**Solaris includes the AnswerBook, a very souped-up version of the `man` pages. It also features the Common Desktop Environment (CDE), which is the "new" look and feel of Unix.**

# THE LINUX PHENOMENON

Linux is an amazing work: a robust operating system designed and written by far-flung groups of engineers, working for free. Recent attempts at commercialization notwithstanding, Linux is clearly the best 32-bit OS you can get for $25. Somewhat oddly, it seems to be attracting more development than commercial PC Unix systems, at least among those developers who contribute their wares to the public. And Netscape, that mother of all Web browsers, eschews all other PC Unix versions to run on Linux.

How good is Linux (and its counterparts FreeBSD and NetBSD)? Good enough, some think, to deserve use in critical applications. For example, Internet provider FastLane Communications operates on PCs running NetBSD. Like FreeBSD, NetBSD has its roots in code developed at U.C. Berkeley—code that is commonly used in commercial Unix releases, including System V Release 4. Linux borrows its networking innards from BSD, so in that regard, at least, it earns the right to be taken seriously.

For the Unix faithful, Linux and its BSD cousins have relit the flame that commercial software giants nearly extinguished. While purveyors of pricier Unixes for Intel-based PCs have failed to deliver a binary application standard, Linux has become a standard of its own. Big-name applications (except for Netscape) are lacking, but the Internet offers an abundant selection of tantalizing free applications. You may be frustrated by the lack of precompiled public applications for UnixWare or Solaris. Linux users suffer no such frustration. Indeed, most typical Linux distributions include four CD-ROMs packed full of software. And let's not forget the always-standard complete source code, which is at least educational and, for some, a glorious road to self-sufficiency.

### Devotion Required

Defenders of Linux and FreeBSD/NetBSD reserve their most potent venom for those who suggest a noncommercial OS shouldn't be trusted for critical applications. Linux users in particular seem united in the belief that all commercial OSes are junk. Linux, they say, has gotten a raw deal in the Microsoft-cowed press. That's certainly true, but only to a limited extent. Linux and its BSD cousins still have some very rough edges. Getting the software installed isn't hard now that interactive install scripts are standard. Getting *past* that point, however, often calls for a hobbyist's devotion and love for long hours. Nearly all the Linux faithful are people who, if they couldn't rewrite the kernel in their sleep, could at least tell you where every key configuration file is squirreled away. That kind of skill takes time to acquire, and for Linux and FreeBSD and NetBSD, it is the minimum price of admission.

Perhaps that's as it should be. As one Linux aficionado put it, "If you don't understand how it works, and how to fix it when it's broken, you have no business using a computer."

includes three disks with management tools. Some tools, like the registry and policy editors, are included with Windows 95, but they're hidden away. Policies limit a user's access to resources and applications. You can restrict a user from accessing his or her Control Panel applets or modifying desktop settings. These policies can follow a user around a network, or you can create policies that keep all users of a shared machine from messing up the configuration.

Windows 95 connects, out of the box, to NetBEUI (Windows NT, Windows for Workgroups, LAN Manager, IBM OS/2 LAN Server), TCP/IP (including PPP and SLIP), and IPX/SPX (NetWare) networks. E-mail support is standard, and a unified in-box for fax, Microsoft Mail, Internet mail, and Microsoft Network mail is provided through an application called Exchange. The Plus package adds the Internet mail capability. Exchange's decision to reach into our UnixWare E-mail gateway and move (transfer and delete) all of the test user's E-mail was unexpected and unwelcome.

Windows 95 supports dial-up networking through Remote Access Server (RAS). The OS supports one dial-up client, so your users can set up their own modems to call their desktop systems for E-mail and remote networking.

Administering a network of Windows 95 systems is aided by the tools both in the OS and in the Resource Kit. It's made comparatively more difficult, however, because Windows 95 lacks both a competent shell language (for custom tools) and remote shell access. You can't easily send remote system commands through a network or dial-up connection. For that, you'll have to create your own tools, live with the limited access provided by Microsoft's standard tools, or buy Microsoft's System Management Server. Until native remote-access tools become available, managing a fleet of Windows 95 systems will be a hassle compared to OS/2 or Unix.

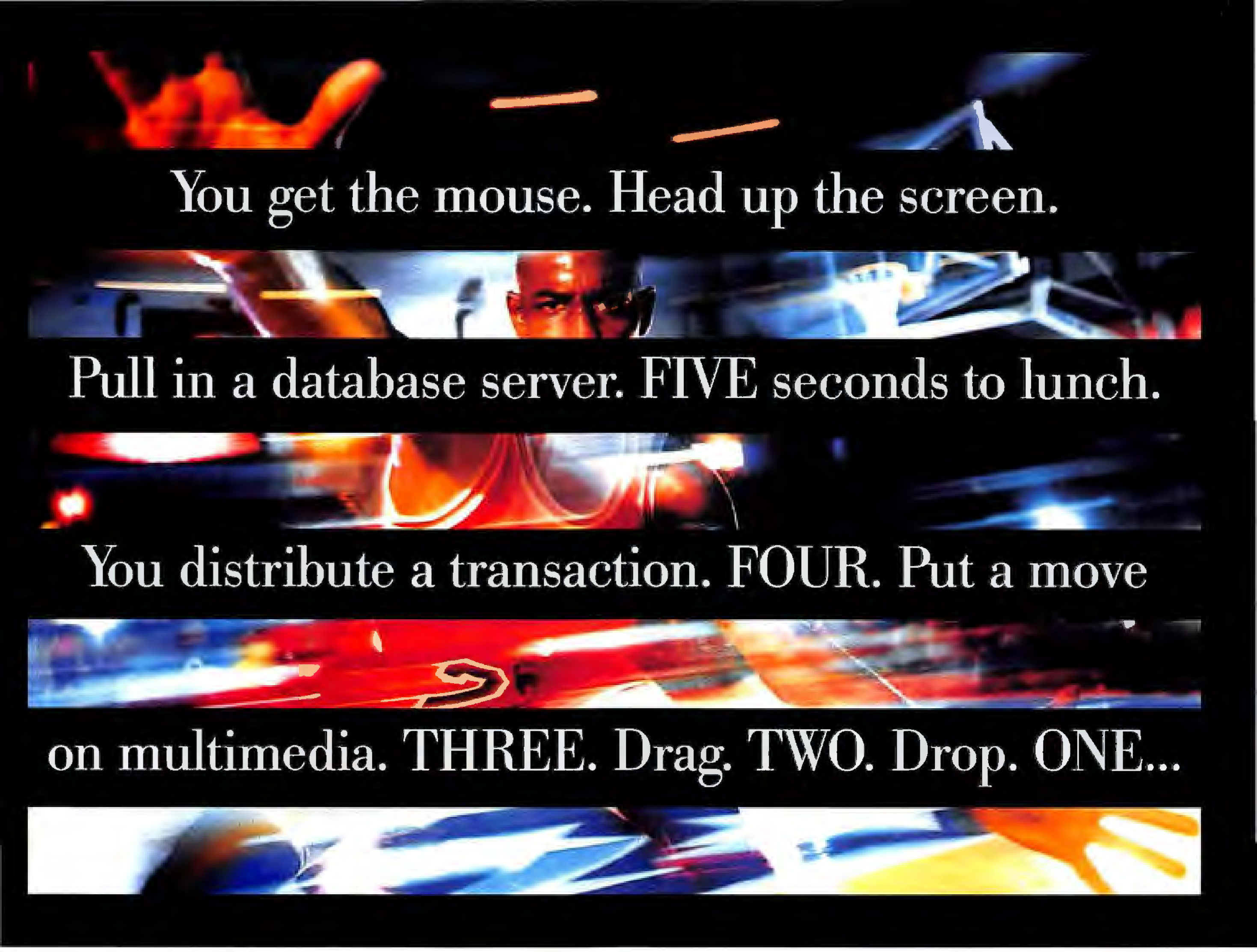
### Administering OS/2

From a feature standpoint, OS/2 has most everything Windows 95 has except the ability to run the latest 32-bit Windows applications. Warp supports NetBEUI, TCP/IP, and NetWare networks. PPP and SLIP are standard. Tools for fax, Internet E-mail, and TCP/IP are standard. Network installation is supported. To its credit, OS/2 Warp also includes both a credible shell language (REXX) and the ability to run an OS/2 shell remotely through Telnet.

Unfortunately, OS/2's administrative interface starts to unravel when you set about configuring its many options. While Windows 95 keeps all its vital controls organized under the Control Panel, OS/2 spreads its administrative tools around. You must do quite a bit of hunting to bring together all the applications you need to get the system configured.

OS/2's implementation of TCP/IP is more complete than that in Windows 95, nearly rivaling Unix. Command-line tools, including essentials such as `nslookup` (name server lookup), are standard. If you have other TCP/IP applications you'd like to run, all of OS/2's supported modes (DOS, Windows, and OS/2) have network socket support. IBM includes code that adds socket support to the REXX shell language. Also, you can use OS/2 as a router or a gateway. IP forwarding is supported (unlike in Windows 95), and the OS handles up to seven network interfaces.

*continued*

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# What You See: What You Want?

**User interfaces are in your face all day. What decisions go into—or should go into—their design?**

**DINAH MCNUTT**

To read E-mail in one Windows application, you press Alt+M G. In another application, it's Alt+U R. And, in a third, Alt+B N. All pretty intuitive, right? Who thinks up these things, anyhow?

Graphical user interface (GUI) design is one of the most controversial aspects of software development. While few people might care how the application itself is programmed or what language is used, everyone has an opinion on the UI of an application. As a software developer trying to design a product, or as a customer trying to use what developers hand us, we all have been involved in interface design. And we have the mouse-scars to prove it.

### Icons Rampant

The process of designing a UI varies depending on the size of the organization. At a small software company, it is all too common for the software engineers to design the interface themselves (usually on the fly), with predictable results. One example of this is a call-tracking system that had a call-logging option. When the user minimized the logging window, a crude bit map of a wooden log was displayed in the iconified window. One suspects an engineer quickly drew this icon to use during development, but it was never replaced with a production-quality icon in the actual product.

Other fingerprints that indicate engineers have had their fingers in the UI design are arcane technical terms used in the interface menus or commands. Often the display shows raw data instead of data in some format that might actually make sense to someone not already familiar with the information. For example, most Unix system administrators can easily recognize and parse the following data:

```
student:cOYWzzCDUrNP6:202:20:
Test Account:/users/student:
/bin/sh
```

This is a user entry from the system password file. But to the uninitiated, it makes more sense to display the information in the following way:

```
Login Name: student
Encoded Password:
cOYWzzCDUrNP6
User ID: 202
Group ID: 20
User Name: Test Account
Home Directory: /users/student
Interactive Shell: /bin/sh
```

Note that none of the information has been lost, but it is now displayed in a manner that both the seasoned system administrator and the novice user can understand.

Conversely, having someone who understands nothing about what the product does design the UI can be just as disastrous as the programmer-turned-interface-builder. Imagine a software package for accountants that does not use common accounting terms. No one with any accounting training would be able to use such a package. Novice users are probably going to have to learn the standard terminology anyway, so why invent terms no one knows just to make the product "friendlier"? Instead, the focus should be on the interaction of the user with the product.

### Feast of the Unwarranted Assumptions

Never make assumptions about how your product will be used. People will always find new ways to use—and misuse, and abuse—your product. Search for beta testers who will stress your software in new ways and find out which parts of the interface work and which parts don't. These testers can also help you find new potential markets for your software. When they say, "What if when you clicked here it did this?" you may discover a whole new niche.

Another example: One product allowed users to schedule jobs off-hours. However, the designer built in assumptions about what a "normal" work schedule is and which hours are "off-hours." There was no technical reason for this limitation, so why impose one? Who needs a user interface to dictate their work schedule?

### The Menu That Ate Cincinnati

Scalability is a prime area to focus on when evaluating an interface for usability. If a word processing package scrolls nicely for a 10-page document, how does it work for a 100-page, multidocument book? Vendors should design software that works well for both the low-end and the high-end user. A menu with 10 items is quite manageable, but what if there are 1000?

Try this, user interface designers: Multiply the number of items by 10 and then 100. Is the concept still usable? If not, see if you can come up with a different paradigm. For example, the interface of a checkbook program might work fine when the user is entering one or two transactions at a time. But some people, especially with joint accounts, write lots of checks. The software has to deal smoothly with a few checks or many checks each month. We would rather change our software than our way of life.

### Understanding the Audience

Before the design process ever begins, identify an audience for the software. Keep in mind the level of expertise of the audience—and especially their expectations of the product. If the audience is diverse, you may need to decide which subset of the audience you are going to target. Then you need to rethink your marketing strategy to see if the product is still viable. Most operating systems, of course, have a "one-size-fits-all" interface.

Many system-administration

products offer only a GUI. This type of interface is great for novice administrators but tends to hamper more experienced administrators, who are used to command-line interfaces. In this particular market, it does not make sense to satisfy the requirements of only the senior system administrator, since one of the motivating factors for buying administration software at all is the ability to delegate tasks to more junior administrators. However, by *ignoring* the senior administrators and developing only the slick GUI for the novices, you may not be able to sell your product at all.

### Wheels Reinvented Here

Many people come from backgrounds, such as Unix, where reinventing the wheel is frowned upon and reusing ideas is encouraged. But that philosophy should not apply to user interfaces. Even unimaginative implementors can appreciate good ideas. Only through innovative UIs can ubiquitous computing ever be achieved. What these interfaces will look like we perhaps cannot imagine, but we can imagine the useful things computers could do if they were more deeply integrated into our day-to-day activities.

Software and hardware design will both play factors in the role of UIs. The venerable keyboard-and-mouse combo is not always a practical way to use a computer. Both hardware technology and user demands for better interface designs should drive each other to improve the computing environment.

There was a time when it was unimaginable that anyone would need more than one window on a terminal. (When sharing a VAX 11/750 with 20 other people, this is probably true.) Now we may need several computers with many windows to do our jobs. In the same way, why should our computer interaction be limited by how fast we can type? Someday those limitations, and others we don't even recognize yet, will be removed. Now what will *that* interface look like?

In this and many other regards, OS/2 Warp combines the requirements of both desktop and server. Expect the coming Warp Server product to strengthen the server side with features such as disk mirroring and remote administration.

RAM requirements for OS/2 Warp start at 8 MB. Plan on 16 MB for a "power desktop" configuration, 32 MB if you're setting up a shared server. OS/2's device support is dated. It worked with the ET4000/W32 display card in our test machine, but only in interlaced mode with no manual override. You can override the system's modem selections, but that device list showed its age by leaving out V.34 models. Very few sound cards are supported, and the NE2000-compatible network card we used for testing required a driver from the vendor. It's essential you check the latest list of supported devices.

For supported devices, OS/2 seems smarter than Windows 95. When we changed the parameters for the network card, OS/2 queried the card and adjusted to the new parameters automatically. Windows 95 did not.

There are two more reasons to consider OS/2: its multiprocessor version and its coming support for the Power PC chip.

### Administering Unix

It may take longer to learn to administer Unix systems, but once you've achieved the skills, you'll find the tools and capabilities of Unix unrivaled for many server applications. As we've mentioned, every variety of executable—line-mode text, full-screen text, and graphical—can be executed on any LAN, WAN, or dial-up node. UnixWare includes support for TCP/IP (with SLIP and PPP) and NetWare LANs. Solaris matches this, but it makes NetWare client support optional. NetBEUI support isn't standard, but a public-domain server called Samba runs on both UnixWare and Solaris. Clients must support NetBIOS over TCP/IP; check your clients' software.

Don't be misled by all the talk about Novell merging UnixWare and NetWare: Novell currently has no NetWare server software that runs under UnixWare. Only client access is supported. Both UnixWare and Solaris do include NFS (the Network File System), and Solaris 2.4 (from Sun, which invented NFS) reportedly includes enhancements to NFS to improve performance. NFS has never been a top performer as a file-sharing system, but it is cheap to implement and easy to manage, and you can get NFS client software for all types of machines and operating systems.

UnixWare simplifies administration with a decent set of menu-driven tools. These tools are split between textual and graphical, but the most important functions are found in `sysadm`. This program's windowed textual interface makes fairly quick work of adding users, configuring dial-up lines, and other essentials. Solaris, inexplicably, discards this System V Release 4 standard in favor of its own graphical administrative tools. These tools, while prettier, don't cover the range of facilities covered by `sysadm`. Solaris administrators must navigate the jungle of command-line tools to do the work `sysadm` does for you in UnixWare.

UnixWare ships standard with a journaling file system from Veritas. Journaling limits loss of data on system failures and makes recovery after a power outage or other hard failure much quicker. You can purchase advanced file-system software for both Solaris and UnixWare to add support for striping, mirroring, spanning, and other server requirements. Unix has support for several installable file systems, all of which support ownership and detailed permissions. Most let you have long filenames and hard and symbolic links, or aliases for files and directories. Some Unix file systems support quotas, which track and limit each user's disk usage.

Machine requirements for PC Unix systems are comparatively steep, a strike against Unix as a desktop environment. We tested both Solaris and UnixWare on a Pentium 90 with 32 MB of RAM; amazingly, both suffered marked performance degradation when running a short stack of applications in a graphical environment. Solaris' performance hit was worse, but the CDE software was still in beta. If you plan to deploy PC Unix systems as servers, consider whether you really need to run the X Window interface. X eats RAM like crazy. Also, both UnixWare and Solaris automatically start NFS at boot time. You can save resources by turning NFS off if you won't use it.

Without the graphical environment, you


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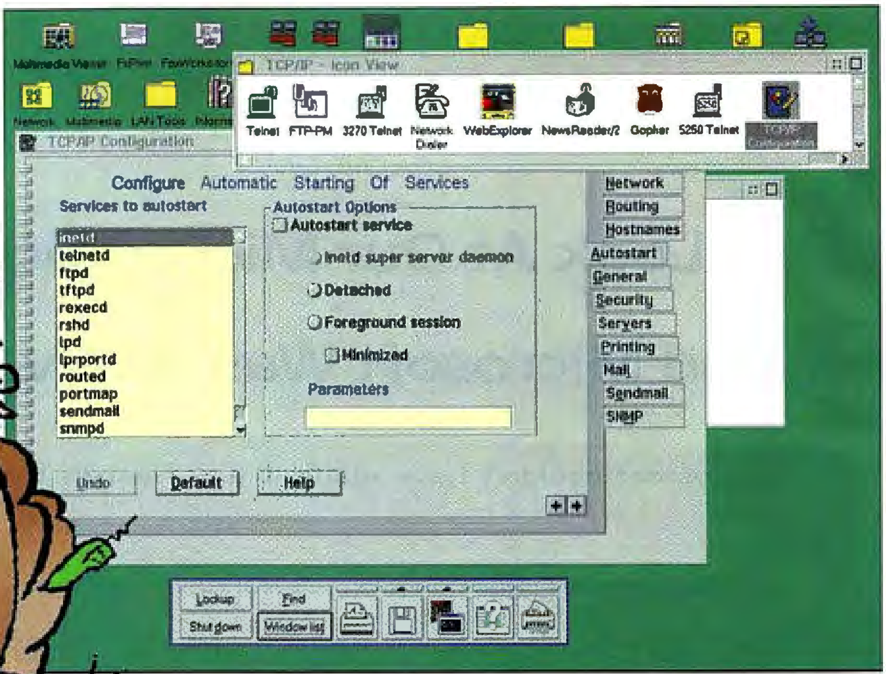


OS/2 Warp Connect comes with many useful network services—more, in fact, than rival Windows 95. But the user interface can sometimes be somewhat confusing.

should give both UnixWare and Solaris a minimum of 16 MB to 24 MB of RAM. With X Windows running, 32 MB becomes the minimum. If you don't often use the display, as with an unattended server, Unix will reclaim the memory occupied by unused graphical applications. Performance will be slower at launch, but it will improve as idle data gets swapped out of RAM.

Everything you need to put your site on the Internet, as a client or a server, is provided or freely available. Both UnixWare and Solaris work as gateways and routers if you have multiple network interfaces running. Both support demand-dialed PPP and SLIP for modem Internet connections, and both allow you to set up your modems to accept user log-ins, PPP sessions, and UUCP (Unix-to-Unix copy, a modem WAN variant). You can even pick up free fax software from several sites on the Internet. These Unixes work as DNS servers, and both support Sun's Network Information Service (NIS) for distributing user and network configuration databases among groups of systems.

Both UnixWare and Solaris have symmetric-multiprocessing support built-in.

### Administering Windows NT

Windows NT Server 3.51 seems to have everything. While we're all bored to death with NT's user interface, which Microsoft plans to update with the Windows 95 look and feel, the services provided out of the box by Windows NT Server have no equal. TCP/IP, NetBEUI, and even AppleTalk are all standard. NT will act as a gateway to NetWare files and printers, and it will link multiple NetBEUI and TCP/IP networks as well. The administrative interface is clean and centralized, and the three-volume Windows NT Resource Kit gives administrators not only the essentials but a well-rounded schooling in the OS's internal structure as well.

Microsoft's NTFS file system delivers the advantages of UnixWare's journaling Veritas file system. It provides long filenames and POSIX-compatible links, as well as ownership and extensive permissions. Mirroring and striping are standard components of NTFS, with a simple, capable volume manager easing management of even huge numbers of drives. NTFS permits mirroring at the partition level, so mirrored pairs don't have to be of equal size. NTFS still uses backward FAT drive lettering, but striping makes it possible to combine multiple drives into a single lettered volume. Microsoft thoughtfully allows several versions of each file. This clears the way for uncomplicated handling of the Macintosh file system's resource and data forks, and it also lets you use the file system for versioning and on-disk archiving. Microsoft throws in a graphical backup utility that captures all this extra data.

Windows NT Server's power comes at a price: RAM. On our 32-MB test system, running TCP/IP, NetBEUI, and AppleTalk services together left only 6 MB of RAM free. If you run additional software, 32 MB might prove insufficient. However, if your machine is operating solely as a file and print server, 32 MB should be adequate. Once you start leaning on Windows NT's Unix-like strengths as an application server, plan to raise the bar to 48 MB or higher. While you might rely on virtual memory to provide headroom on a desktop system, it's a bad substitute for real RAM on a server.

### We Live in a Political World

With all the hype and legal controversy swirling around Windows 95 at the time of its release, no one can deny that politics and marketing play as pivotal a role as technology in the OS market.

Microsoft hopes to secure more than just every desktop PC in the universe. The Redmond giant is aggressively pitching Windows NT as the premier server environment. The NetBEUI network protocol, now most often identified with Windows for Workgroups, can serve up files inside, while TCP/IP and SPX/IPX set up hooks to the outside. Meanwhile, Windows NT's user interface gets more Windows 95-like, showing Microsoft's intent to position NT for power desktop users as well.

Whether by luck or by design, Microsoft's strategy locks out other OS players. Commercial software developers must now target three systems—Windows for Workgroups, Windows 95, and Windows NT—each with its own foibles and strengths. Why write a compute-intensive application, for example, that doesn't take advantage of threads as supported by NT and 95? Meanwhile, can you afford to neglect the millions of Windows for Workgroups users who can't or won't upgrade? Developers wind up crafting specially tuned editions of the same code to run on two or more flavors of Windows. Then it all needs to be tested. Who has time for OS/2 or UnixWare?

IBM's OS/2 is, by the standards of most industries, a success. With some nine million copies sold worldwide (according to IBM), there are more machines running OS/2 than any other 32-bit OS. And IBM's OS/2 LAN Server is the second-most-used

# Database Developer Productivity Comparison

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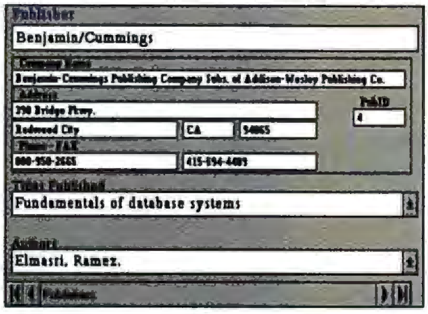


**26 LINES OF CODE.
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NO DELETES. NO QUERIES.**

```
Sub PubPubID_Change ()
Dim SavePlace As Variant
Dim SQL As String
If Loading Then Exit Sub
PubsTitles.Clear
PubsAuthors.Clear
SQL = "Select distinct Title from Titles"
SQL = SQL + " where titles.PubID = " &
         PubPubID.Text
DataCtl(PubsList).RecordSource = SQL
DataCtl(PubsList).Refresh
Do While Not DataCtl(PubsList).Recordset.EOF
  PubsTitles.AddItem
         DataCtl(PubsList).Recordset(0)
  DataCtl(PubsList).Recordset.MoveNext
Loop
If PubsTitles.ListCount > 0 Then
         PubsTitles.ListIndex = 0
SQL = "Select distinct Author from Titles,
         Authors"
SQL = SQL & " where Titles.AU_ID =
         Authors.AU_ID and "
SQL = SQL & " titles.PubID = " & PubPubID.Text
DataCtl(PubsList).RecordSource = SQL
DataCtl(PubsList).Refresh
Do While Not DataCtl(PubsList).Recordset.EOF
  PubsAuthors.AddItem
         DataCtl(PubsList).Recordset(0)
  DataCtl(PubsList).Recordset.MoveNext
Loop
If PubsAuthors.ListCount > 0 Then
         PubsAuthors.ListIndex = 0
End Sub
```

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# DOING IT OVER

## What happens when designers get a chance to build a second OS?

DINAH MCNUTT

Dave Cutler was the lead architect on Digital Equipment Corp.'s VMS, the operating system for minicomputers. Microsoft asked him to create Windows NT. Dennis Ritchie created Unix. Bell Labs put him in charge of Plan 9. Windows NT and Plan 9 are second children. Don't you wonder what it's like to get to design two major OSes? What do you learn? What do you do differently?

### A Man with Nine Plans

To most Unix users or C programmers, Dennis Ritchie requires no introduction. He was one of the key developers of the first version of Unix 26 years ago at Bell Labs. He is the "R" in K&R C. Right now, he's head of Bell Labs Computing Techniques Research in Murray Hill, New Jersey, and for more than five years, he has been working with a team of nine programmers on a new OS.

The result is Plan 9. It was originally the brainchild of Ken Thompson and Rob Pike, but Ritchie played an active role by supporting the effort and helping to get Plan 9 out the door. The first version of Plan 9 was released last June.

According to Ritchie, Plan 9 takes many of the ideas from Unix and exploits them more fully. "Everything in Plan 9 is a file," he says. "Plan 9 encourages portability and machine-independent interfaces. Applications cannot tell whether they are running in a small personal computer or a large multiprocessor computer."

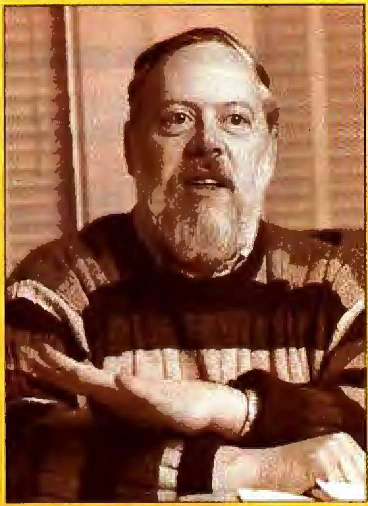
When asked about the biggest technical challenges in developing Unix versus Plan 9, Ritchie says, "On one level the technical challenge was the same—to find out how the machines really worked. That is, to get from the manufacturers a correct description of their hardware. Manufacturers really want to sell you a box with software and don't want you to write your own operating system. At a much higher level, the challenge is to create interesting abstractions and generalizations, like the notions of *file* in Unix and Plan 9."

Looking back, Ritchie notes that software development has changed a lot over the past 26 years. If he had to pick from the tools that he has now that he wished he had 26 years ago, they would be: "A windowing system. Fast communications. I won't ask for three wishes."

Besides the obvious changes in lower costs and increased computing power, Ritchie also cites the advent of networking, distributed computing, and good graphics as the biggest technical changes in software development. He also thinks the appearance of large independent software companies is the most significant nontechnical change.

Amazingly, Ritchie has few regrets about features that didn't make it into Unix and Plan 9. He says the more important release of Unix from his research group was the Seventh Edition, which strongly influenced AT&T's System III and V and BSD, but there aren't any features that they wanted to include and couldn't. His lab was doing work in networking and communications, and their research gradually influenced both flavors of Unix.

Ritchie's only regret regarding Plan 9 was that they could not include music on the Plan 9 CD-ROM. AT&T developed some proprietary algorithms for compressing digital music. Ritchie's group helped make these algorithms work on available hardware. They wanted to include the OS and several hours of music on the CD. The music would "sound like it came from an ordinary CD." Unfortunately, issues regarding the proprietary algorithms and the music itself prevented this from happening. "This had nothing to do with the Plan 9 system, but we thought it would be a lot of fun," he says.



**Plan 9 did not come from outer space. It came from Bell Labs, with help from this man, Dennis Ritchie, one of the brains behind Unix.**

Looking back, Ritchie is rightfully proud of Unix and what it's done. "The creation of a portable operating system and the consequent notion of open systems," he says, "I think this helped build an industry."

Asked what his expectations are for Plan 9, Ritchie responds, "They are modest. The ecological niche that Unix occupied is fully colonized and is now being overgrown by Windows of several varieties. The way we [in our research group] use Plan 9 is similar to the way that others use Unix or Microsoft's products, namely as a distributed development system with desktop machines and specialized servers. Whatever Plan 9's technological advantages, we don't have the resources to compete directly in this arena. On the other hand, there are plenty of more specialized areas involving embedded systems in which Plan 9's small size, portability, and technology might do well."

His expectations for Unix are just as modest: "As a product, it's certainly lost any chance to take over the mass market. As a standard, it will live for a long time."

### Cutlering Edge

Dave Cutler is the head of the NT Development team at Microsoft. Before joining Microsoft, he played key roles in the development of RSX-11 and VMS at Digital Equipment Corp. In a rare interview, Cutler and his NT team answered questions on the past, present, and future of their OS.

NT and VMS are two very different systems, but they share similar technical challenges. "Both operating systems had rigorous compatibility requirements," the Cutler team says. "In the case of VMS, it was 16-bit programs that ran on RSX-11. In the case of NT, it was 16-bit Windows programs. The number of applications, the complexity of the programming environment, and the less-rigorously defined world of PC applications made NT's compatibility work orders of magnitude more difficult."

Technological changes have helped make NT possible. Faster processors have allowed for more sophisticated systems. "The time to rebuild the system after changes has dropped dramatically, allowing us to make changes and fix problems much more quickly."

In addition to faster processors, software tools are much different than they were 20 years ago. Given a choice of tools from the '90s to take back to the '70s, the team would choose the modern compilers. "They are far better at reliably generating good, solid, optimized code."

Despite the lack of robust tools, the initial release of VMS met the goals the team set out with. Multiprocessor support was on the wish list, but it was not a "killer" feature.

Cutler and his team used the experience with VMS to help make NT a successful project. With VMS, they learned on a similar but smaller-scale project what was essential to the process of building a system. They learned the requirements for applications, and how to design systems so they can be built incrementally. They also learned "why it's important to keep the system running throughout the process, from beginning to end. And how incredibly hard you need to work to make it happen."

The first release of NT was too slow and consumed more system resources than desired. NT 3.5 demonstrated a dramatic improvement in both areas. The team's goal is for NT to be an OS for desktops as well as servers. "When people use NT, they are consistently impressed by its robustness," according to Cutler's team. "Size and performance are critical areas that we constantly strive to improve."

The aspect of VMS for which Cutler is the proudest is the quality. "Minicomputers were used, from early on, by businesses to run their business. The systems had to run all the time, the applications protected from other applications' faults."

Despite all the technical challenges, one of the team's biggest problems may be the industry press. Media hype and criticism can cause additional stress on an already overworked team.

"It's difficult to predict when a system development will be complete. To begin with, the design is complicated; the problems are problems that are often new to the developers. Add to that a competitive environment that, at times, means changing the definition of the product during the development. Then the media apparently relishes announcing that a project is 'late' while the engineers are working as hard as they can to finish. It adds pressure to an already high-pressure situation. Then come the inevitable cycles of successive praise and condemnation of the product. That can often affect the morale of the team, particularly those who have not seen the cycles before."

The NT team is not done. Nor is NT: "When [NT's] the predominant system on desktops and in networks, then we'll worry about the next project."

---

*Dinah McNutt writes and teaches about system administration. She is a founder of Zilker Internet Park Inc. You can reach her at dinah@zilker.net.*

network OS in the PC market. That's all according to IBM, but it makes sense: OS/2 was there when Windows 95 was not. Each slip in Microsoft's schedule signaled a predictable burst in sales of OS/2. Many IS managers got tired of waiting for an environment competent to drive the 100-MHz 486 and Pentium systems landing on desks.

While not conceding defeat on the desktop, IBM is busy remaking OS/2 Warp into a competitor of Windows NT. The dearth of native OS/2 applications would have eventually been OS/2's undoing in the broad commercial market. So IBM will focus on OS/2 Warp Server, a new product slated for release in the first quarter of 1996.

Commercial Unix and Unix variants have always been around to take up the slack. Failing (so far) to reach agreement on source-code compatibility, each Unix vendor still sells its special recipe. As it's impossible to write one piece of code that runs well on all Unix systems, most commercial developers choose not to bother. Interestingly, this problem doesn't exist on non-Intel Unix platforms, such as Sparc/Solaris, where the manufacturer (Sun) exercises tight control. We've seen something comparable with the Macintosh: Apple helps developers by imposing and enforcing standards on its systems. (There is such a thing as a benevolent dictatorship.) So most mainstream Unix applications, such as FrameMaker, are targeted for vendor-specific workstations (e.g., Sun) instead of PCs running Unix. That's not likely to change.

Commentators have frequently predicted the death of Unix, then marveled as it survives one seemingly fatal blow after another. A fanatical following is often credited, but other, more interesting factors are in evidence. Most of the better universities teach part, or all, of their computer curriculum with Unix as a foundation of study. It's easy to find skilled programmers and administrators among the ranks of college graduates.

Also helping Unix along is the Internet. All the information servers—FTP, Gopher, Archie, and the Web's Hypertext Transport Protocol (HTTP) among them—were born on Unix. In most cases, their most advanced implementations exist on Unix. TCP/IP, the unifying protocol that ties thousands of sites together via the Internet, started with Unix, and most TCP/IP networks have a Unix core. Being first doesn't ensure victory, but Unix made a name for itself as a server for everything from dumb terminal sessions to distributed objects. Even Bill Gates has admitted that Unix is a primary target for Windows NT development.

**Where It Leads**

Windows 95 blends a picture-postcard graphical interface with a fairly brainy OS. It provides good, but not foolproof, compatibility with 16-bit applications. Resources, while still limited, have been raised well above the limits imposed by 16-bit Windows. In short, Windows 95 is a good compromise: It fixes many of the things we hated about Windows, maintains reasonable compatibility with older applications, and, with the Plus option, adds worthwhile new functionality. It will certainly replace Windows 3.11 as the most popular PC desktop environment, and it just as certainly will maintain a solid lead in the quantity of available applications. Whether you think that lead is fairly won or not, Windows 95 is a safe bet for both users and developers. Administrators should arm themselves with the Windows 95 Resource Kit.

OS/2 Warp has grown to be the only credible competitor of Windows for Workgroups, even though IBM didn't add peer networking until the recent Connect bundle. It still has some clout, being a full 32-bit implementation and having a file system superior to Windows 95's FAT. If you're running any native OS/2 applications, or if you're developing your own code for in-house use, OS/2 Warp is worth a look. Until vendors get their Windows 95-certified applications out, Warp may still be a good way to mix 32-bit and 16-bit software. But that window is closing, and IBM is opening another one. OS/2 Warp, as it exists today, makes a great host for Lotus Notes, a BBS, or a small department server. The server edition of Warp, when it's released, should boost OS/2's file-serving power.

Windows NT Server presents administrators with a rare treat: a robust, self-contained server environment. It installs effortlessly; features central, graphical administration; and serves Mac, PC, and TCP/IP networks out of the box. NTFS is based on a marvelous file-system design, and the standard graphical volume manager simplifies management of complex array techniques, including striping and mirroring. Its weaknesses are the FAT-like drive-letter structure for disks and near-absolute dependence on graphical tools that make remote administration more challenging. Some POSIX (Unix-like) command-line tools are standard, and others are included in the Resource Kit, which, again, is a necessity for administrators. The re-made Windows 95 interface may help push Windows NT into Unix's accustomed niches.

That's assuming, of course, that Unix

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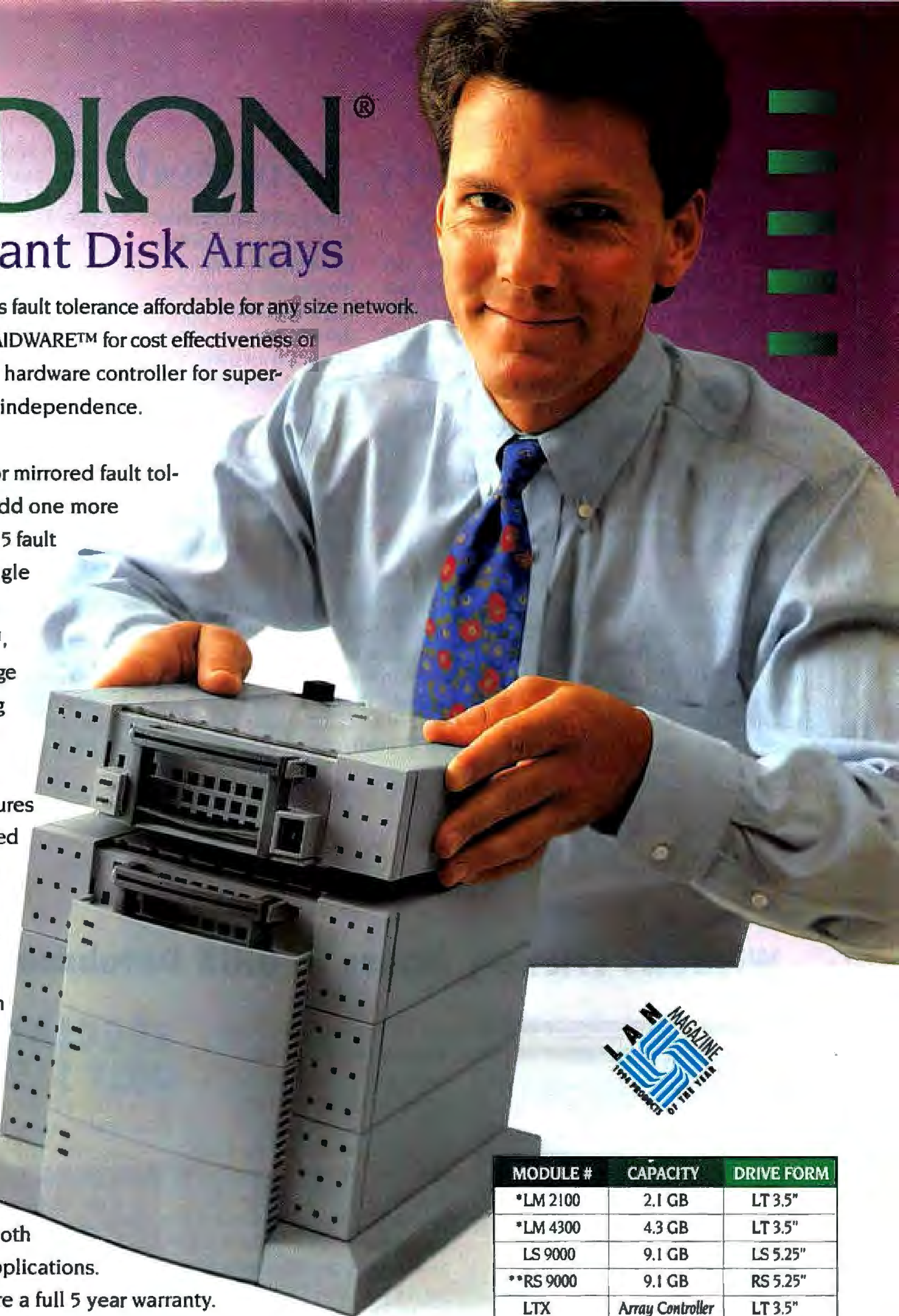

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## NextStep: Pretty, Limited

**The futuristic NextStep is a lovable mutt: a Carnegie-Mellon Mach kernel, BSD commands and libraries atop that, and a proprietary GUI that broke new ground at the time of its introduction. NextStep still has a unique look that's best summed up in one word: gorgeous. It's handily the most visually appealing OS for Intel-based PCs, thanks partly to the big, artistic icons. Unfortunately, NextStep hurts its appeal with limited device support and a decidedly proprietary approach. NextStep's fans hail mostly from those shops that can afford to create and maintain their own applications.**

**Like Solaris, NextStep has a built-in PostScript interpreter. It also includes other goodies like a lightning-quick 3-D rendering engine that you have to need to appreciate. Given a suite of custom applications, NextStep is an operating system you could sit in front of all day without going bug-eyed. X Window can't quite make that claim, but it is a standard.**

doesn't advance just as quickly.

After working with UnixWare 2.01 and Solaris x86 2.4, we find that Unix is still just as worthwhile for that which Unix has always done well: If you want to put data—terminal sessions, files, objects, you name it—on a network, Unix remains an obvious choice. But it's still not for the faint of heart. An administrator with scant knowledge of Unix will find OS/2 Warp and Windows NT easier to install and maintain. However, once learned, Unix's standard tools and quaint (but effective) ASCII configuration files ease administration in ways no other server environment can match.

The Common Desktop Environment look-and-feel you get with SunSoft's Solaris adds some sparkle to what was becoming a millstone around Unix's neck, the comparatively ugly X Window System. Ugly though it is, X Window's standard ability to run all classes of applications remotely, even through WAN links, endears X and Unix to builders of enterprise networks.

One of life's certainties is the inevitability of change. Maybe what you're running now is doing the job for you. But in time, perhaps soon, you'll find yourself forced to choose from among the field's 32-bit players. We hope we've given you a healthy head start on the homework you should do before settling on the OS you'll run for the next several years. ■

*Tom Yager used to be a BYTE technical editor covering Unix and multimedia. Now he's a freelance writer and consultant who runs his own research lab in North Texas. You can E-mail him at tyager@maxx.net.*

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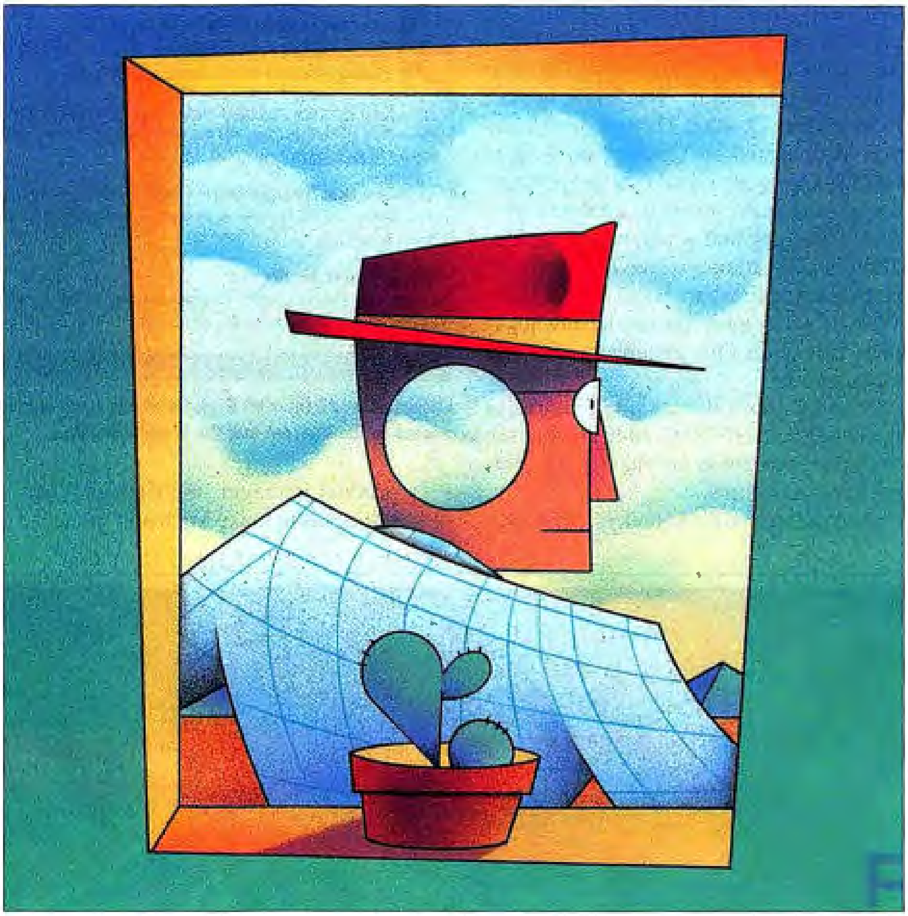
# Filling in Windows Blanks

PETER D. VARHOL




**Utility programs provide functions left out of an OS, and the best ones become part of it**

No desktop operating system is ever complete, and Windows 95 is no exception. Utilities, whether an OS vendor ships them in the operating system or an independent software vendor develops them, play a primary role in the growing and changing expectations we have of operating systems. Some make more efficient use of hardware, such as memory and storage, while others improve (or at least change) the user interface. Utilities may help the system as a whole run faster, or add features that were left out of the OS itself.

The first DOS utilities, packaged with the OS, were simple tools. Two of the most important were Format and Edlin, essential for formatting a disk and editing a (small) file. Even then, however, third-party developers were producing extensions. PC Tools let you recover damaged disks or examine and modify the contents of physical disk locations. Norton Utilities let you unerase an inadvertently deleted file. Quarterdeck Office Systems, with Desqview, added one of the first multitasking shells to DOS, taking advantage of the 386 processor. Norton Commander was for many years a popular way to navigate the directory structure of DOS.

## Why Utilities?

The obvious question about OS utilities is why they exist at all. If they are as useful as they seem, why aren't they included as part of the operating system? The answer varies depending on the utility, the OS, and their vendors.

First, utilities may fill a hole in the OS that no one knew existed until the OS got widespread use. One example is DOS 6.2's ScanDisk utility, which examines the structure of a compressed disk: Without disk compression itself, there was not much demand for ScanDisk.

Second, most users might not need the utility. If only 5 percent of all users would need a utility (such as the system-usage monitor provided by Norton Utilities' System Watch), it makes little sense to invest the development time to build it into the OS and then require the additional computer resources to run it.

Utilities are a test bed for new OS technologies. If they are popular enough, they or similar tools may appear in the next major release of the OS, or in an entirely new OS. Microsoft incorporated many third-party utilities—ones for managing memory, for example, or for undeleting files—into DOS 5.0. Qualitas, Quarterdeck, and Norton (subsequently acquired by another utility giant, Symantec) had these utilities long before Microsoft.

## Utilities for Windows 95

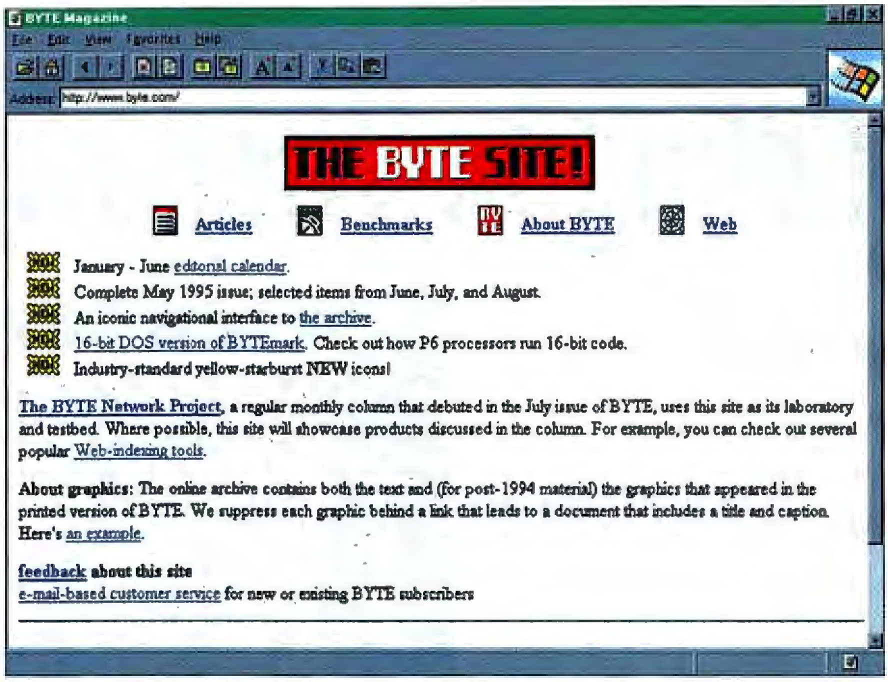
What has Microsoft included in Windows 95 that was not a part of its previous OS, and why? And an important follow-up question: What is left for utilities vendors to build?

The initial cynical response to that last question might be "not as much as there used to be." Windows 95 includes a better user interface and a better file manager/navigator, which can make interface shells such as Norton Desktop redundant. However, the increasing complexity of OSes brings out the need for more and different utilities.

Microsoft itself is shipping a companion set of utilities to Windows 95, called Microsoft Plus for Windows 95. Microsoft designed Plus to do two things: make the PC run better and make the user interface look better. In the "run better" category, the package provides utilities for system and disk maintenance, such as compression and defragmentation. The "look better" tools include Desktop Themes, which lets you load special background wallpapers and accompanying sounds, mouse pointers, colors, and other cosmetic changes, plus font smoothing and wallpaper stretching. There's also an Internet navigator, which provides graphical access to World Wide Web sites. For all-important leisure activities, Microsoft Plus includes a new 3-D pinball game.

So why aren't these same features in the base OS itself? Well, they are, but not to the same extent as provided by the Plus package of utilities.

According to Alec Saunders, Microsoft Plus product manager, the first goal of these utilities is to make Microsoft money. Fair enough. However, in differentiating these particular utilities from Win 95 it-




**Microsoft's own Internet Explorer utility, included in Microsoft Plus for Windows 95, provides GUI access to the Internet and the World Wide Web.**

# What the Other OSes Forgot

DOS, which for many years provided basic operating system services with few extras, bred hundreds of successful utilities. Norton Utilities and PC Tools offered suites combining several utilities that gave users finer control over their computers. Quarterdeck and Qualitas provided better memory management, especially once the 386 made memory more accessible.

Windows 3.0 and 3.1 opened up more possibilities for utilities. With large Windows files—and disk space at a premium—Stac Electronics' DoubleSpace utility quickly became a standard for disk compression (which almost as quickly got integrated into DOS 6.x). Windows 3 was not the best at managing memory. Quarterdeck jumped in and adapted QEMM to handle memory under Windows. Windows' adequate but uninspired Program Manager spawned an industry of Windows shells, with Norton Desktop the leading alternative.

The Macintosh OS has also been a fertile breeding ground for utilities. Many began their existence as desk accessories, enabling users to search for files (Norton File Find), defragment the disk (Norton Disk Defragment), and recover damaged disks (Central Point's Mac Tools). Norton Utilities and Mac Tools made many PC-type utilities available for the Macintosh.

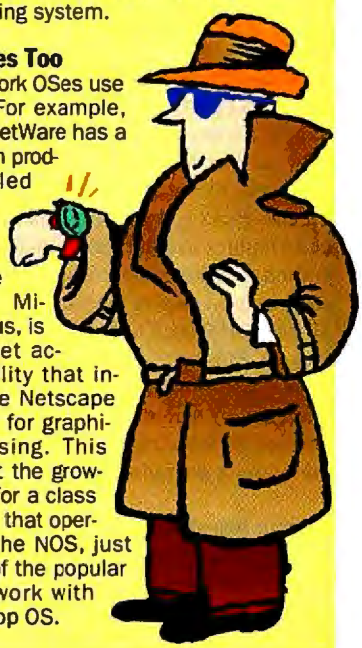
Few utilities have tampered with the look and feel of the Mac OS, however, primarily because Apple has always published and enforced user interface standards that have precluded alternative desktop managers or shells. Mac utilities have largely focused on providing the users with better access to hardware or OS internals.

## Running Multiple OSes

For those who run multiple operating systems from the same PC, V Communications' System Commander is an indispensable utility. System Commander lets you load and boot from any of several OSes, such as DOS, Windows 3.1, Windows NT, Windows 95, and OS/2—on different disk partitions or on the same partition. It will even work with an OS, such as Win 95, that requires installation on the boot sector of the disk. Boot-management utilities such as this are, in effect, OS-independent, giving the user ready access to any PC operating system.

## And NOSes Too

Even network OSes use utilities. For example, Novell's NetWare has a companion product called LAN WorkPlace. LAN WorkPlace, like part of Microsoft Plus, is an Internet access facility that includes the Netscape Navigator for graphical browsing. This points out the growing need for a class of utilities that operate with the NOS, just as most of the popular utilities work with the desktop OS.

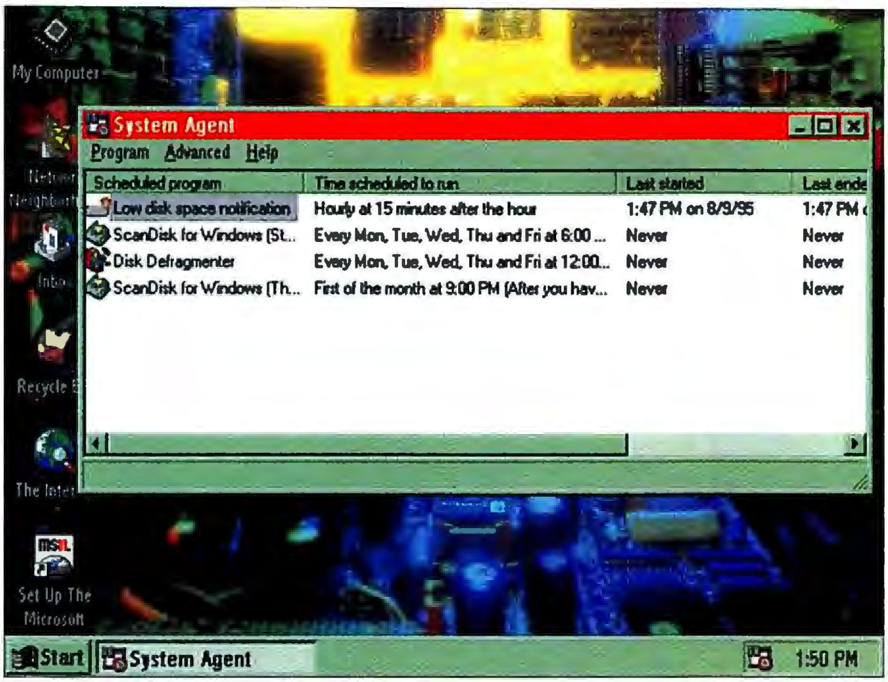


self, Microsoft used performance and system resources as the deciding factor. For instance, the base Windows 95 is advertised to run on a 386 PC with 4 MB of memory, thus fulfilling a Microsoft promise to make the new OS work on many older systems. For more powerful systems, Plus enhances both operation and appearance. As an example, Saunders cites the Plus disk compression algorithm; it's optimized to run on the Pentium processor. Likewise, the wallpaper used in Desktop Themes looks and performs best with high-end graphics adapters and graphics acceleration. All these utilities *will* run reasonably well on slower systems (such as the 33-MHz 486 used to test Win 95 and Microsoft Plus for this article). However, power users running a Pentium PC with a graphics accelerator will find that the Plus utilities improve many aspects of system use without degrading performance.


**Norton's System Information tells you all about your PC, including BIOS, memory, and video.**

## System Agent, Man

An important feature of Microsoft Plus is the System Agent, along with other affiliated agents. According to Saunders, Microsoft developed the System Agent to improve disk compression. The agent uses a "lazy compression" algorithm, meaning that it waits for idle system time and then compresses files. To do this, Microsoft needed a way of determining when the system is idle, and the System Agent was




**Windows 95's System Agent allows you to schedule actions, alerts, and program launches by time and other conditions. System Agent may represent a whole new area of smart Windows utilities.**

born. It uses preprogrammed rules to detect when the system is not doing anything and cues the disk-compression utility to start squeezing uncompressed files.

The System Agent uses the same criteria to schedule defragmentation, backup, and scan-disk activities. Agents can also control the launching and running of applications. If an application requires little or no user interaction, the System Agent can schedule the application launch and make sure it completes properly. Applications have to be "System Agent-aware" to receive this kind of service, and Microsoft includes an API that applications can call to do just that.

### Third-Party Survival Tactics

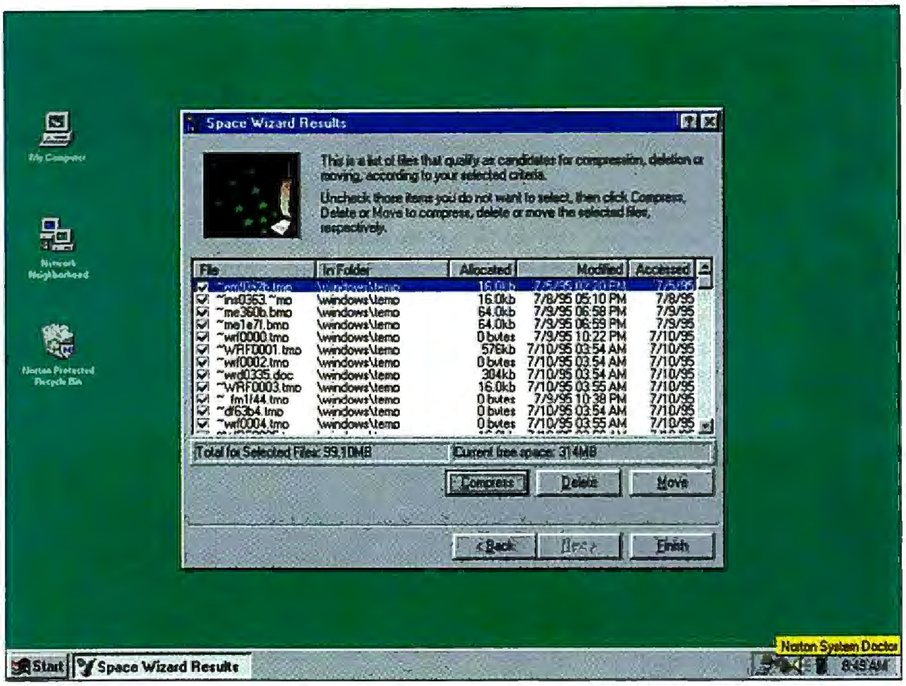
Microsoft has a business group for working with third-party developers—including utilities developers—for Windows 95. According to Deborah Epstein-Celis, a product manager with Microsoft's third-party software group, Microsoft attempts to build a base level of features into the OS and then counts on utilities to round out the less basic needs of diverse groups of users. Many of these utilities are pioneered and marketed by other vendors, some in direct competition with Microsoft.

Symantec's Norton division released Norton Utilities for Windows 95 concurrently with Microsoft's release of the OS. Norton Utilities includes tools, such as Disk Doctor and Disk Edit, that have become standard fare for power users trying to get the most from their PCs. The Norton Utilities for Windows 95 contains many of the same utilities found in previous versions, including a "safe" format and a system information reader. These are supplemented by Space Wizard, a system diagnostics utility, and the System Doctor. The System Doctor monitors system resources, including CPU, virtual memory, and unfragmented disk space.

Norton Navigator, a companion product for Norton Utilities, is an enhancement of the Windows 95 Explorer. Navigator lets you set up "multiple virtual desktops," different looks and configurations that you can quickly load and switch between. Navigator also incorporates tools for preparing files to move to other systems, such as a way to create self-extracting archives and a uuencode/uudecode utility for sending binary files across the Internet.

Quarterdeck's QEMM memory manager, in the old days of DOS, made parts of the upper memory area available to store drivers. Today, it enables Windows 95 to compress data in memory and make it appear as though the system has more memory available.

For diagnostics, Cybermedia's First Aid 2.0 will examine error messages and other system problems and recommend solutions. Mastersoft's Viewer95 supplements Win 95's existing image viewer by supporting Hypertext Markup Language (HTML) images.




**Norton's nifty Space Wizard helps free up room on your hard disk and clear up clutter in the process.**

### Evolving with the OS

While new versions of utilities may often do the same tasks as their older versions, the new ones don't always work the same. Like the OS itself, they change, offering new capabilities and finding better ways of doing old things. For example, Norton SysInfo originally obtained much of its system-configuration data by reading the CMOS memory that maintained the information used to boot the PC and recognize devices such as hard disks. However, CMOS memory is static. Under most circumstances, it cannot automatically recognize and adapt to changes in the system hardware. It's possible that information in CMOS, and therefore the information reported by Norton SysInfo (and other similar utilities), could be incorrect.

But an industry consortium led by Intel is in the process of developing the Desktop Management Interface (DMI), part of whose role is to dynamically determine the system configuration and status, prepare and execute queries of system resources, and perform fault diagnosis. The PC updates the DMI data whenever the configuration changes, so the information provided to network administrators is always up to date.

Future iterations of utility software will make use of the DMI, and other new capabilities of the PC architecture, to read system information. This will ensure that system information is accurate and up to date: accomplishing the same task as before, but in a different and better way.

### Agents of the Future

Microsoft's introduction of the System Agent—and its OS hook—portends a new way of thinking about utilities. Developers can adapt an agent to many tasks besides detecting system idle time and launching other utilities. The system agent of the future might be able to detect unstable conditions and warn the user before a failure occurs, or perform housekeeping chores such as backing up files.

A preview of what you can use a system agent for comes from Charles River Analytics (Cambridge, Massachusetts), the developer of Open Sesame. Open Sesame uses system agents, along with a neural network, to "learn" your normal pattern of actions and then assist in performing common activities. For example, if you routinely open a word processor and resize and reposition the document window in the same way every time, Open Sesame will "observe" this behavior and ask if you want it done automatically. Open Sesame has been so useful as a Macintosh utility that Apple is incorporating some of its functions into its next-generation Copland operating system.

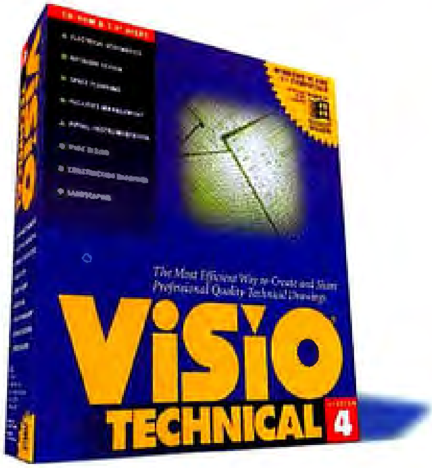
An agent itself may be an OS utility. Agents can be used to perform many tasks behind the scenes, either by themselves or in conjunction with other utilities. An agent can change the scheduling algorithm to allocate CPU time between running processes or change the priority of the processes. These types of agents need artificial intelligence, such as the neural network used by Open Sesame, to detect complex patterns of operation and behavior and then use that information to tune the OS.

### A Future for Utilities?

The relationship between an OS and a utility is symbiotic. The OS provides the "host," without which the utility cannot survive. The utility, on the other hand, can actually help the OS perform better or behave more reliably. If a utility is incorporated into the OS, it can improve its overall capability, just like beneficial microorganisms in the human body.

A smart developer will make sure a utility evolves into something completely different, yet just as useful, as its predecessor, and begin the symbiotic process all over again. ■

*Peter D. Varhol is chair of the graduate computer science department at Rivier College in New Hampshire. He can be reached at pvarhol@mighty.riv.edu.*

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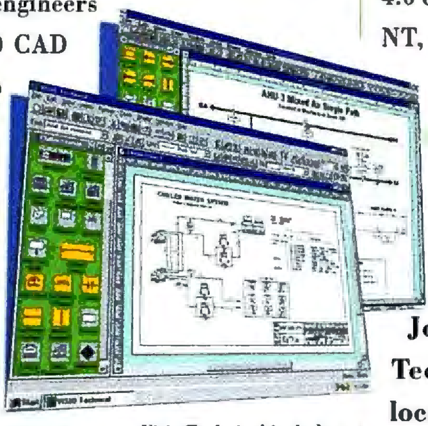

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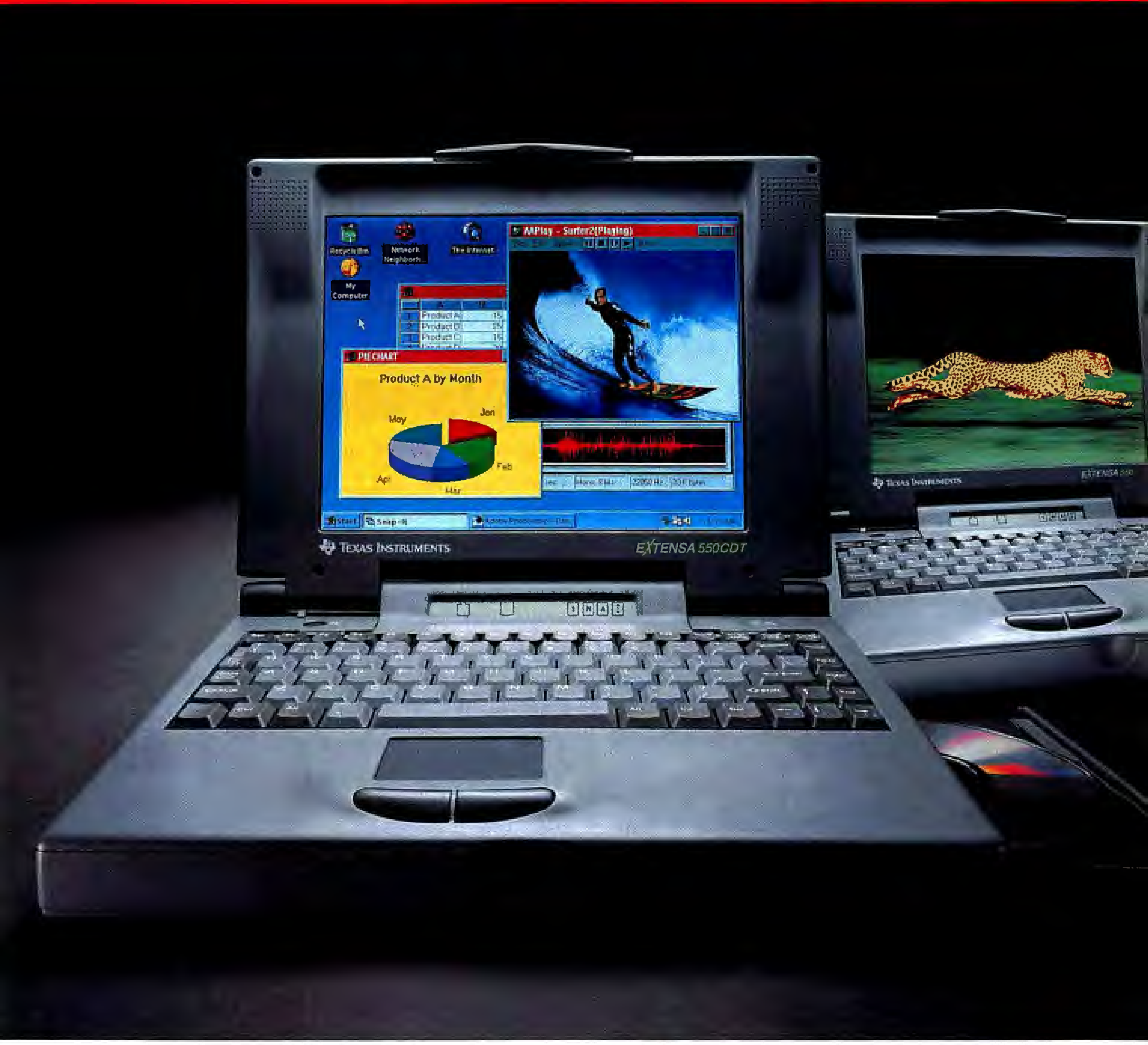


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# Not *That* DOS


MARK FISHER © 1995

## Distributed OSes, slowly emerging from research, cure a multitude of ills

**PAUL KORZENIOWSKI**

The OS market, being the cutthroat and competitive beast it is, gives vendors few opportunities to experiment with new approaches to distributed computing. However, a few vendors—AT&T and Sun Microsystems, for example—and some research universities are taking a shot at developing distributed OSes. They claim these OSes will do a better job of exploiting today's ubiquitous networking infrastructures and the processing power distributed throughout organizations.

Until recently, most of the work in this area centered around OSes that required large amounts of memory and suffered from kludgy network connections. (In other words, they were variations of Unix.) Additionally, many distributed OSes (especially those for embedded systems) were proprietary and lacked ways for third-party developers to easily access the services of the OS.

Now, however, a handful of researchers are tinkering with ways to overcome some of the difficulties involved in making OSes work in distributed environments. Companies and universities are attacking the present problems in several ways. For example, some are focusing on improving network connections, others are developing OSes capable of supporting add-on modules, and still others are looking at ways to shrink the OS microkernel.

### Plan 9 = Unix++

One effort to develop a distributed OS is being carried out by the Computing Science Research Center of AT&T Bell Laboratories (Murray Hill, NJ). The group is trying to build on a previously successful project—Unix, which it developed a quarter of a century ago.

At that time, Unix was at the forefront of several emerging ideas: applications portability, desktop processing, and multiprocessor design. As Unix weaved its way onto corporate desktops during the 1980s, researchers asked the question: "If we could develop Unix now, what would we do differently?"

While Unix possessed many strengths, one weak area was its networking capabilities. "Connecting different Unix computers on a network requires a great deal of administrative overhead," notes Robert Pike, a member of the technical staff at AT&T Bell Laboratories.

Thus, in 1987, the Computing Science Research Center began work on a new OS dubbed Plan 9. The name is in honor of Ed Wood's campy science fiction thriller *Plan 9 from Outer Space*, which is considered by many to be the worst movie of all time.

Plan 9 is a distributed OS comprised of three components. They are a client part that runs on terminals residing on a user's desk, file servers that store data, and other servers (sometimes called applications servers) that provide faster CPUs (which are on the user's desktop), user authentication, and network gateways.

The components can be connected over a wide variety of LANs and WANs—including Ethernet, custom-built fiber networks, and dial-up modem connections—as well as over ISDN. Typically, a user interacts with applications running on either a terminal or a CPU server, and the applications pull their data from the file servers (see the figure "Plan 9's Down-to-Earth Architecture" on page 118).

Plan 9 exploits three general technical concepts. First, all system objects present themselves as named files that are manipulated by read/write operations. Second, all such files may reside either locally or on another device. Third, the file system namespace (i.e., the set of objects visible to a program) is dynamically adjustable for each program running on a particular machine.

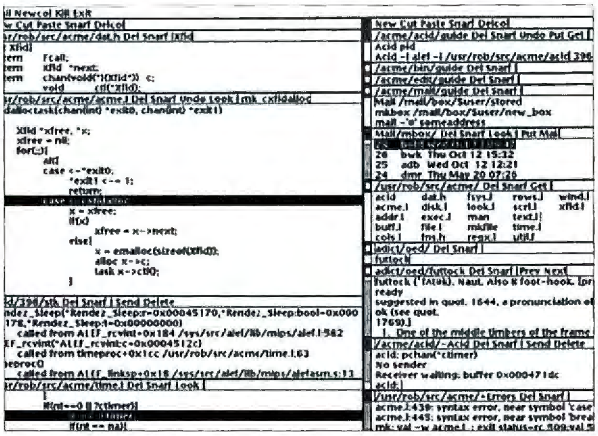
The first two concepts, in the opinion of Plan 9's developers, were ideas foreshadowed in Unix. The third concept, however, allows a new approach to distributed computing. The construction of an application is not dependent on where the application will run or on what machine it will run on. Thus, Plan 9 allows for a modular design of applications.

Because applications and data may reside in many locations, security is a key component of Plan 9. It uses an authentication scheme similar to Kerberos, where passwords are never sent over networks. Instead, it uses encrypted tickets issued from an authentication server. Plan 9 has additional security features. For instance, applications never run on the file servers (the place data is stored under Plan 9). This makes data stored on those servers safe from security threats such as computer viruses.

Another strength of Plan 9 is that its flexibility eases administration. "Plan 9 users can access information stored on computers with different microprocessors as if the data were stored on their own system," says Pike.

AT&T Bell Laboratories has ported Plan 9 to several types of CPUs, including Intel's x86 (including the Pentium), Motorola's 680x0, Sun's SPARC, and Mips Technologies' microprocessors. In addition, the Computing Science Research Center has developed compilers and debuggers for the new OS.

In July, AT&T announced that Plan 9 was available for educational and research use. The product with source code sells for $350; a kit with only the manuals is available for $125. The company said 200 universities are working with Plan 9, and Pike expects them to develop new applications and programming tools.



Part of a Plan 9 screen using the Acme user interface (UI). The left column holds a few source files, and a debugger window displaying a stack trace and a third source file. The right column contains some guide files, a mailbox presented by Acme's mail program, the columnar display of files in Acme's own source directory, a few windows from the OED browser, a debugger window, and an error window showing diagnostics from a compilation.

## The Plan 9 Network at York

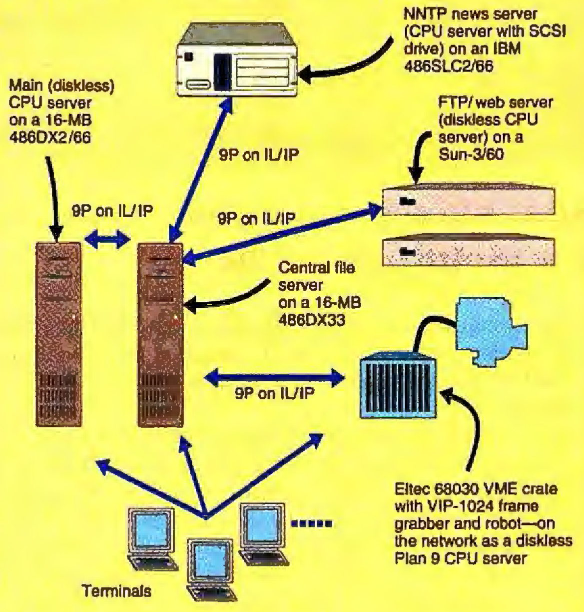



Diagram of the Plan 9 (9P) network at the University of York (York, U.K.). Plan 9 terminals include diskless 486s, 68020s and SparcStations, all with bit-map graphics displays. All run the same software from the shared file server and use the faster CPU server for compilations.

### Spring Is in the Air

Also focusing on Unix's limitations, SunSoft (Mountain View, CA) began to work on Spring, its next-generation object-oriented OS, in the early part of 1989 (see "Springtime at Sun," September BYTE). Jim Mitchell, a Sun fellow and leader of the Spring R&D team, said the project team established three goals for the OS. First, it had to be easy to evolve and extend. Second, it had to work well on networks. Third, it had to include strong security features.

The company assigned a team of its top 15 programmers to reach those goals. In 1991, the team delivered a prototype of Spring that featured a distributed-directory service, fast interprocessor communication, security services, and a new interface definition language (IDL). The IDL bound its objects at run time, outside the microkernel. This improves the OS's performance by 50 percent, according to SunSoft.

The company has taken a multifaceted approach for spreading the Spring doctrine. SunSoft convinced the Object Management Group (OMG), a Framingham, Massachusetts, consortium, to incorporate Spring's directory service, IDL, and security features in the Common Object Request Broker Architecture (CORBA) 2.0 specifications.

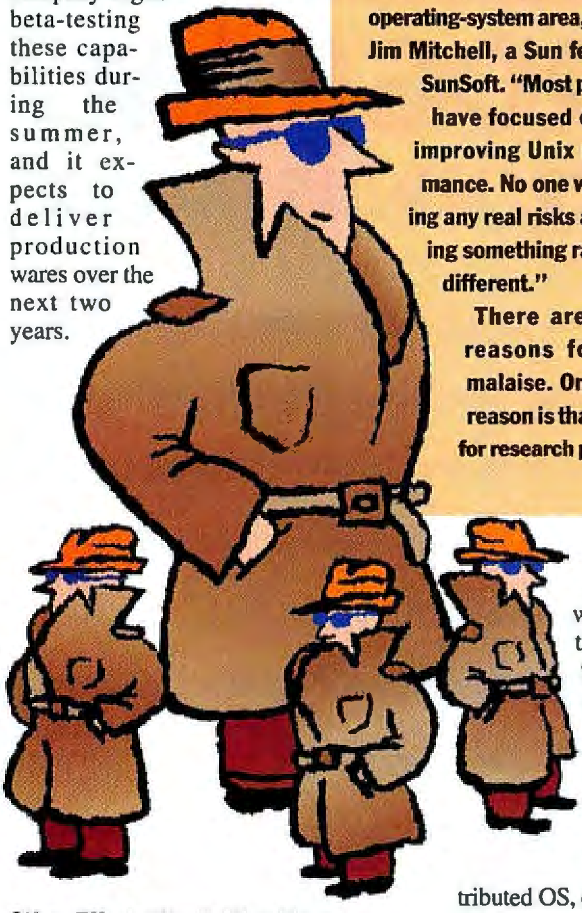
**KEY FEATURES OF SPRING**

- **Object-oriented to the core.**
- **System designed with security, symmetrical multiprocessing, and distributed-directory services in mind.**
- **One key component, the interface definition language, has already been adopted by and incorporated into the Object Management Group's object-broker standard.**

In March, SunSoft offered Spring to universities and commercial research institutions. It sells the Spring Research Distribution technology on a CD, which

includes software, documentation, and instructional materials. Universities can purchase the package for $75; corporate research groups pay $750.

In addition, SunSoft plans to incorporate Spring into its commercial products. Mitchell says Spring will be the foundation for the company's Distributed Objects Everywhere (DOE) architecture. SunSoft is also incorporating Spring components into Solaris. The company began beta-testing these capabilities during the summer, and it expects to deliver production wares over the next two years.



### Other Efforts Worth Watching

In addition to AT&T and SunSoft, QNX Software has developed an OS called QNX. It overcomes some of the problems with distributed OSes. QNX, which was developed for process-control and embedded-OS applications, is a 32-bit, Posix-compliant, real-time, message-passing microkernel OS for Intel x86 machines. Its core is only 8 KB in size. It supports four functions: process scheduling, interrupt dispatch, interprocessor communication, and network communication.

Outside the commercial world, several notable distributed-OS efforts are now taking place in the academic community. For instance, projects to develop distributed OSes are under way at four universities: MIT, the University of Washington, the University of Arizona, and the University of Utah. The projects are all trying to improve OS performance. All four groups are focusing on different ways to reach that goal.

MIT began work on its distributed OS, called Exokernel, in the fall of 1993. Frans Kaashoek, a professor of computer science, said the project is trying to push OS functions into the user space.

The base OS does not include page-table management, a file system, interprocessor communication, or process management. Instead, it offers only a set of bare-bone features. As a result, it should operate faster than systems now available. Initial tests indicate that Exokernel works 10 to 100 times faster than Digital Equipment's Ultrix.

In addition to faster processing speeds, the new design offers programmers more flexibility, according to Kaashoek. Currently, OSes offer all applications one set of services. Yet, there are different requirements for different functions in a distributed operating environment. For example, a file system needs different buffering and disk management features than a database management system.

*continued*

## OPERATING-SYSTEM RESEARCH: DIM OR BRIGHT FUTURE?

**Operating-system research became passé during the early 1990s, and there is fear it will remain that way. "Recently, there has been little research of interest in the operating-system area," notes Jim Mitchell, a Sun fellow at SunSoft. "Most projects have focused only on improving Unix performance. No one was taking any real risks and trying something radically different."**

**There are many reasons for this malaise. One main reason is that funds for research projects are limited. The two main suppliers, ARPA and the National Science Foundation, have seen their budgets cut as elected officials tighten government spending.**

**The cuts come just when the competition for R&D dollars has greatly increased. New technologies, GUIs, multimedia applications, networking, and videoconferencing are all vying for limited funding with operating-system projects.**

**Despite the problem, there is hope. Frans Kaashoek, a professor of computer science at MIT, said researchers focused on filling holes in microkernel technology for several years because the technology was new and limited. A few years ago, researchers realized that they had pushed that technology as far as they could.**

**Therefore, a handful of projects focusing on new technology have sprouted during the past two years. "Several projects represent the beginning of the next wave of operating-system research," Kaashoek said. "I am confident they will result in design breakthroughs and there will be plenty of areas of interesting research in a couple of years."**

### KEY FEATURES OF PLAN 9

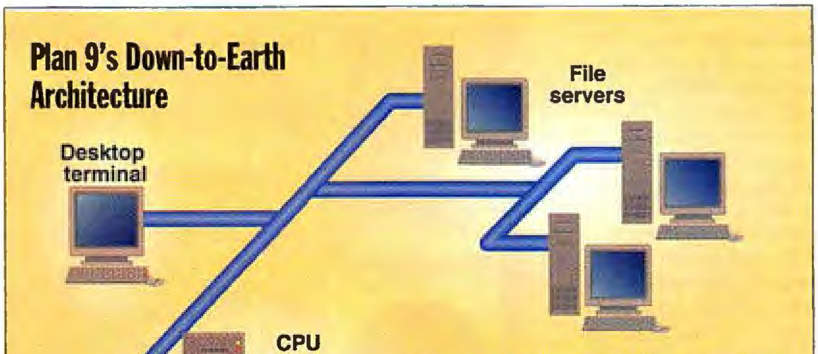
- **Small size (a single self-booting disk can hold the kernel, a window system, an editor, and a basic Ethernet/Internet interface).**
- **Modular approach that includes a client, CPU server, and file-server components.**
- **Runs on many CPUs, including Intel's x86 (including Pentiums), Motorola's 680x0, Sun Microsystems' SPARC, and Mips Technologies' Mips microprocessors.**
- **Strong security features, including an authentication scheme that's similar to Kerberos.**

Kaashoek says Exokernel enables programmers to address these differences by letting them build subsystems for different types of applications.

The University of Washington is taking a similar approach with its Spin project, which began in early 1994. Brian Bershad, an assistant professor of computer science, said current OSes have to be trimmed. "Just to load Windows NT requires at least 16 MB of storage," he explains. "And various OS functions take up processing power even if they are not used." For instance, 30 percent of current OS overhead comes from memory management and networking functions.

Spin replaces functions now found in the user address space with downloadable OS extensions. This modification lets programmers extend the microkernel and control OS functions.

The new design could produce an interesting side effect. Currently, OS designers determine all system functions. "We need to loosen the grasp OS vendors have on determining their systems' APIs," Bershad said. With Spin's approach, the OS becomes a foundation that third parties can build on.



AT&T Bell Laboratories' distributed OS called Plan 9 is comprised of three software components: a client piece that runs on a user's desktop terminal, a piece that runs on applications servers (called CPU servers), and a piece that runs on file servers, which store data.

### PORTS

**Plan 9 has been ported to these compilers:**

| | |
|---|---|
| Motorola | SGI Power Series |
| MC68020 | SGI Indigo |
| Mips | SGI Challenge M |
| SPARC | SparcStation |
| Intel 386 | IBM PC |
| Intel 960 | **...and file servers:** |
| AT&T 3210 | SGI |
| **...OSes:** | Mips 6280 |
| Gnot | Mips Magnum |
| Nextstation | SparcStation |
| Mips Magnum | IBM PC |

The University of Arizona has tinkered with OSes since the late 1980s. "New networking techniques that promised to support speeds of 500 Mbps were emerging, so new OSes were needed to keep pace," notes Larry Petersen, a fellow in the computer science department.

The university has been working on the Scout project. "With client/server applications, a process could be completed in one of many different locations," Petersen says. "Current OSes do not easily enable this to take place."

Thus, the university's new OS relies on something called paths (i.e., considered roads that show how functions are completed) rather than processes, which focus on what an OS does. The university is developing a version of Scout for Digital's Alpha computers.

Rounding out the academic efforts is the University of Utah's project, dubbed Flux, to enhance the Mach OS. One result of Flux was the development of a new IDL called Flexible Interface Definition (FLICK) and a series of shared libraries. "Our goal was to address inefficiencies that stemmed from Mach's underlying language," explains Jay LePreau, who is a professor in the university's computer science department.

The new OS is designed to run on Intel and Hewlett-Packard PA-RISC microprocessors. In addition, the OS's distributed shared-memory system is available on five architectures—Digital's Alpha, HP's PA-RISC, Mips, Motorola 68000, and Sun's SPARC—and five OSes, including Digital's OSF/1, HP's HP-UX, Silicon Graphic's IRIX, Sun's SunOS, and Unix 4.3 BSD.

### SuperNOS = NetWare + UnixWare

The university research projects may compete with corporate development that's under way at Novell (Provo, UT). After purchasing Unix Systems Laboratories (USL) at the end of 1992, Novell found itself with two OSes: NetWare and UnixWare. The company's long-term goal has been to consolidate them into a single system, which has been dubbed SuperNOS.

Toby Corey, vice president of marketing for Novell's Operating Systems Division, says the company plans to meld the strengths of each OS. It will blend NetWare's fast file and print services with UnixWare's support for symmetrical multiprocessing, its ability to scale well, and its support for large, complex servers.

Novell has been talking about the SuperNOS concept for a while. However, a real OS that combines the strengths of NetWare and UnixWare is still a long way from delivery. Corey says the system is being designed for machines that support Intel's P7 64-bit microprocessors, which should arrive in late 1997 or early 1998.

### Time Will Tell

Such long lead times are typical with these projects. The R&D work for distributed OSes is in a nascent stage, and, for the most part, there is no clear path from the laboratories to the desktop.

Researchers are not sure if their work will make its way into the mainstream. For instance, AT&T has downplayed comparisons between Plan 9 and Unix. It does not view the new OS as a Unix replacement. "Plan 9 was designed to solve specific problems experienced by users working with large, complex, multiprocessor systems," Pike says. "Consequently, there has been a great deal of interest in it among members of the university community. We are not sure if it will evolve into anything but a niche solution for a specific type of user."

To gauge the impact of today's projects, one might need to take a look back. "Research work on microkernel technology began in the early 1980s, winners emerged in the middle of the decade, and users began to realize the benefits of this work as the decade closed," notes Bershad at the University of Washington. "I see no reason why work from current projects should emerge any differently." ■

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# Sincere OS Flattery

BARRY NANCE


## Emulators help you run existing applications on a wider variety of OSes

You do your engineering under Unix, you do graphics on a Mac, and you use a Windows-based word processor. Do you need three computers? Maybe not. Maybe you just need a good emulator.

Emulating an OS goes beyond recognizing one CPU's instructions and translating them to another CPU's architecture. Emulators need to provide an environment in which specific hardware devices (e.g., video adapters and parallel ports) appear to be present. They also need to compensate for the differences between the native file system and the emulated file system, as well as provide networking support, file sharing, and record locking.

Despite these challenges, several companies offer OS-emulation products, including Insignia Solutions (SoftPC and SoftWindows), Locus Computing (DOS Merge), and SunSelect (Wabi). In Windows NT, Microsoft's emulation of 16-bit Windows is a version of SoftWindows. IBM is the hands-down winner, though. Over the years, IBM has emulated many CPUs and OSes, ranging from second-generation 1401 and 7074 I/O Control Systems (IOCSes) hosted on mainframes (i.e., 370 architecture) to IBM PC-DOS hosted on an RS/6000.

Some of these emulators, such as the DOS-on-RS/6000 product (called PC Simulator), are no longer on the market. IBM's two most popular emulators run DOS and Windows programs in the OS/2 environment. The programs run directly on the Intel CPU in virtual-8086 mode, yet they can access files on a High Performance File System (HPFS) drive and perform port-level I/O through OS/2's serial, parallel, DMA, and other virtual device drivers (VDDs).

### Differences Exist

Emulators take different approaches. The one chosen depends on whether the target CPU can execute the emulated OS's instructions and whether the emulator developers have access to the OS's source code.

Insignia Solutions' SoftWindows can run x86-based Windows programs on RISC or 680x0 CPUs, hosted by either Unix or Macintosh System 7. Insignia Solutions licenses Windows source code from Microsoft. DOS Merge, from Locus, runs DOS and Windows programs on Unix-based Intel CPUs (e.g., running SCO Unix). Like Insignia Solutions, Locus has licensed Windows source code from Microsoft. SunSelect's Windows Application Binary Interface (Wabi) can run some but not all Windows programs on Unix-based non-Intel machines. Instead of licensing Windows source code, SunSelect chose to use the published Windows API to engineer its emulator.

PC video hardware presents special problems for the emulator. To run Windows programs, most emulators provide Windows video drivers that act as a liaison between the host (native) video system and Windows. Often, the emulator offers both a full-screen and a windowed (seamless) video driver.

Under Unix, for example, a Windows application can appear in its own X Window System window. Similarly, OS/2 can show a Windows program running on the OS/2 desktop. On Macs, SoftWindows contains a Windows video driver that translates screen updates into QuickDraw calls. So complete is the video support that emulators on Unix, OS/2, and Mac System 7 can properly process an application's changes to the Windows color palette as well as changes to the mouse-cursor shape. In the latter case, the emulator changes the mouse cursor to the appropriate shape depending on whether it's in the emulated Windows screen region.

The emulator might allocate a portion of the host OS's file system for use by the emulated OS, or it might go a step further to translate the emulated OS's file information into host file information. Translated file information lets both the host OS and the emulated OS share the same files and directories (or Mac folders). Because products such as Microsoft Word and WordPerfect use the same file layout on the Mac and the PC (depending on the version of the product), the result is transparent file sharing between different operating environments.

Emulators usually allow cut, copy, and paste operations between the host OS and the emulated OS. In the Win-OS/2 environment, IBM uses a technique called *deferred rendering* to speed up Clipboard access. Win-OS/2 renders the Clipboard in an application's desired format (e.g., CF_TEXT) when the application asks for the data. OS/2 thus avoids having to render the data in all possible formats at the time the data is placed on the Clipboard.

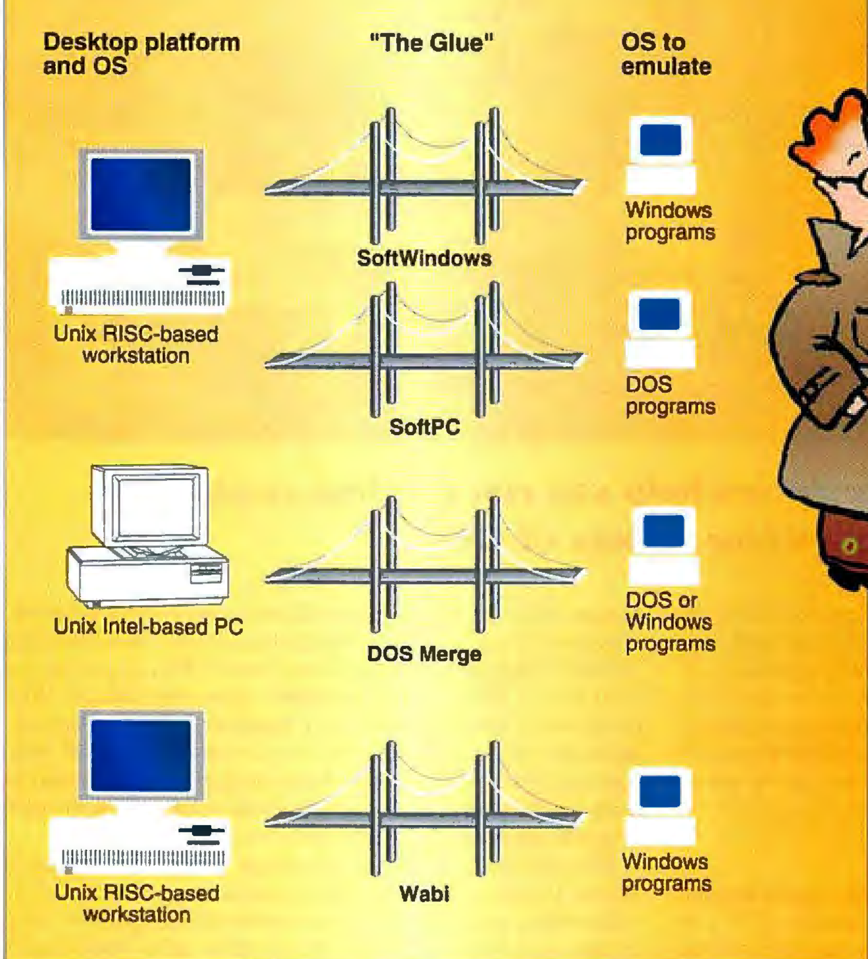
The Insignia Solutions products interleave Clipboard translations with window redrawing. When you switch from one window to another, SoftWindows uses a small amount of time to process the Clipboard data. SoftWindows implements Clipboard sharing with a pair of programs called Smart Copy, one a Windows application and one a native-OS application.

## Elements of Emulation

- VGA or SVGA video adapter
- serial (COM) ports
- parallel ports
- Ethernet or Token Ring network adapter
- file system (directories, filenames, and file contents)
- floppy drive
- extended, expanded, and conventional memory
- ROM BIOS
- CMOS configuration data

An OS-emulation product must not only translate CPU instructions but also establish an environment in which these hardware elements appear to be present and functioning.

## Bridging the Gap




Emulation programs let DOS and Windows programs run on many platforms and OSes.

You can configure printer emulation in a variety of ways. In Win-OS/2, you can print to a printer port named LPTx.OS2, a serial COM port, or a file. In SoftWindows running in a Unix environment, you can choose to send LPTx data to a Unix file, to `/dev/lp`, or through a pipe to the Unix `lpr` utility. On the Mac, SoftWindows simply sends print data to the System 7 print manager.

### Speed It Up!

When you leave the world of x86, things get really complicated. RISC and 680x0 CPUs don't understand x86 instructions, of course. The emulator parses each x86 instruction, decodes it to determine its intended effect, and executes RISC or 680x0 instructions to produce the same result an Intel CPU would have produced. Along the way, the emulator faithfully imitates the registers, flags, internal arithmetic, and logic states of the Intel CPU.

A GUI application, especially one that's highly interactive, spends much of its time inside OS service routines. Emulators take advantage of the application's loitering inside the OS to make the application run faster. For example, SoftWindows contains precompiled ("static") functions that

implement often-used Windows API and DOS functions. The emulator can quickly execute some native code that achieves the same result as if it had examined and translated each system instruction in the API library. Also, SoftWindows contains an optimizing compiler that dynamically evaluates the code it's emulating, looking for ways to speed up program execution.

Wabi uses the workstation's native X display protocols to manage the appearance of Windows applications on Unix workstations. Wabi translates DOS I/O into Unix I/O, and it similarly manages memory allocations and other resources.

Using technology from Praxsys Technologies, Wabi decodes and imitates individual x86 instructions that are not inside a Windows API or DOS function call. Within such a system call, Wabi switches to native mode to perform the DOS or Windows function in terms of equivalent X or Unix system calls.

SunSelect engineered Wabi not by acquiring a Windows source code license, but rather by establishing an environment in which each published, well-known Windows API call or DOS function call is available as a Wabi library routine. SunSelect publishes a list of 24 applications that it guarantees Wabi will run. Wabi can't run all Windows programs, especially those that have intimate knowledge of the Windows environment.

Windows applications running under Wabi have the look and feel of an X-based Unix GUI such as Motif or OpenLook, rather than that of Windows. And instead of running the entire Windows desktop environment within a single window, as SoftWindows does, Wabi opens a new window on the Unix desktop for each Windows-based application.

Wabi runs Windows programs fairly quickly because it contains precompiled equivalents for each Windows API function. Wabi doesn't have to translate instructions in Windows system files (e.g., USER.EXE and GDI.EXE).

### The Same CPU Issues

Just as OS/2 gives DOS and Windows programs partial control of the CPU yet retains sufficient ownership to virtualize I/O ports and the file system, SCO Unix uses DOS Merge to run DOS and Windows programs directly on the Intel CPU. DOS Merge runs DOS and Windows programs full-screen or within an X Window System 11 window at VGA or higher resolution. DOS Merge consists of three levels of emulation: DOS, ROM BIOS, and direct-to-hardware screen memory. Besides offering a bridge between DOS and Unix resources, DOS Merge also supports direct exclusive access to hardware devices (e.g., scanners) with no equivalent Unix device driver.

The Mac 6100 can run DOS programs on a 486 coprocessor, without the need to emulate Intel instructions on the RISC CPU. Apple placed a 25-MHz 486SX processor, a Chips & Technologies BIOS, a VGA chip set, and some of its custom ASICs on a 68040 Processor Direct Slot plug-in board. The DOS card can have up to 32 MB of RAM on it, or it can share memory on the Mac's main logic board. At boot-up time, the Mac scans the board for RAM. If none is found, the emulator dedicates a user-configurable amount of RAM on the main logic board to the DOS environment.

Hardware transceivers in a custom ASIC on the DOS card do the byte swapping required by the different processor architectures (Intel CPUs store integers low byte first). Memory-controller hardware keeps the address spaces of the two environments separate. The DOS-emulation environment maps the Mac's floppy drive as DOS drive A. Apple even provides an MSCDEX extension; on a Mac with a built-in CD-ROM drive, DOS programs can access CD-ROMs.

The DOS coprocessor board operates independently of the Mac's CPU, which means that DOS/Windows applications can run concurrently with the Mac OS. You hot-key between the two environments. And selecting a printer via the Mac Chooser selects the same printer for the DOS environment. The emulation software routes DOS print streams to the selected printer. The coprocessor approach has a huge edge over CPU instruction translation—DOS programs run full-speed on the 486 and actually multitask with programs running on the Mac's CPU.

## Required Support

- **Windows 95**
- **Windows 3.1 and 3.11, and Windows for Workgroups**
- **various versions of DOS**
- **486 and Pentium instruction sets**
- **file compressors, disk defragmenters, and other file system utilities**

The developers of an OS emulator must provide support for a wide range of software, including different versions of the OS itself.

### Taking Care of Windows 95

The biggest challenge for emulators isn't running an oddly written device driver or virtualizing an unusual adapter. It's Windows 95. Emulator developers are hard at work exploring the instructions that make up the new version of Windows. Insignia Solutions and Locus are arranging to acquire Windows 95 source code from Microsoft, which will make the job much easier. But even with source code at hand, emulating Windows 95 is a formidable task. A Windows 95 emulator has to manage Win32 API functions, frequent switches between protected and real mode, virtual device driver (VxD)—ring 0—CPU operation, and a minefield of combined 32- and 16-bit memory accesses.

Locus and Insignia Solutions have announced they'll support Windows 95 in future versions of their products. To date, IBM has said only that it will supply an OS/2 library of Win32 functions that OS/2 programs can use (thus easing the chore of porting Win32 programs to OS/2). Rumors abound, however, that IBM may eventually provide a full Windows 95 emulator in OS/2 Warp.

Emulation for Windows 95 will be an important issue for the field of OS emulation. However, Windows 95 is just one of many OSes that users will want supported.

The range of CPUs and OSes that must be supported is growing all the time. Users will increasingly demand that they be able to run existing applications on whatever platform and OS they choose. And, as time goes by, that will only serve to elevate the role of OS emulators in organizations. ■

### Product Information

**DOS Merge**.....bundled with many OSes
Locus Computing Corp.
Inglewood, CA
(800) 955-6287
(310) 670-6500
fax: (310) 670-2980
**Circle 1228 on Inquiry Card.**

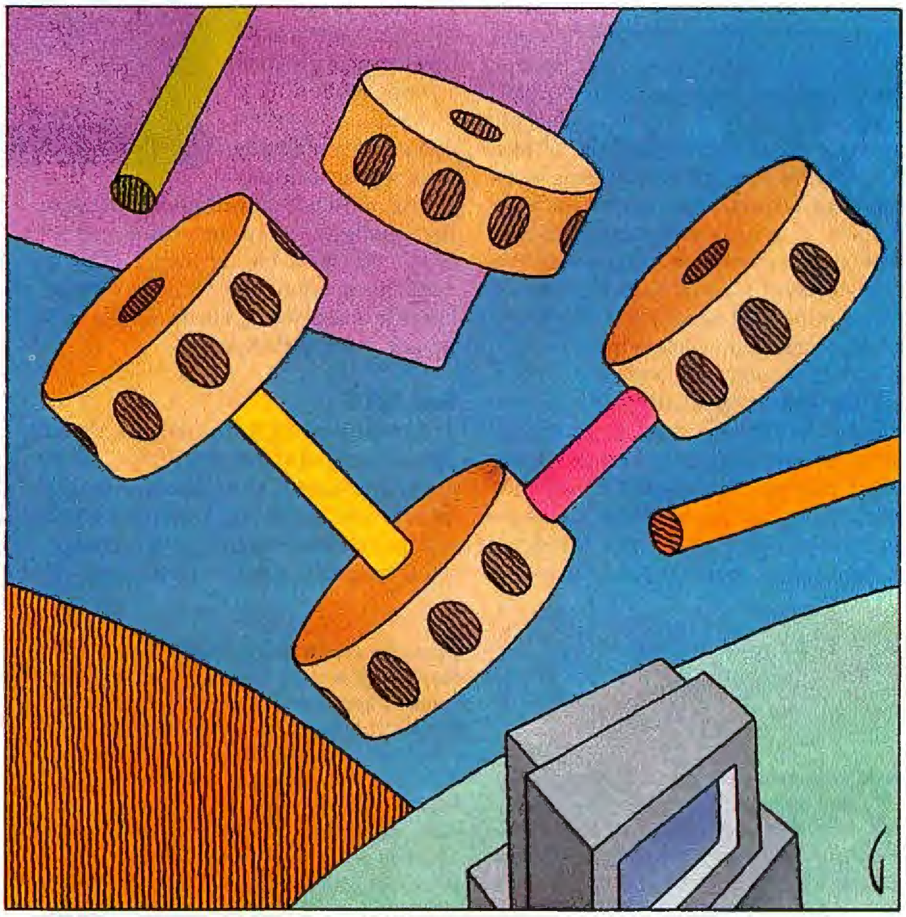
**SoftPC**.......$249
**SoftWindows**......$499
Insignia Solutions, Inc.
Mountain View, CA
(800) 848-7677
(415) 335-7100
fax: (415) 335-7105
**Circle 1229 on Inquiry Card.**

**Wabi**......$225
SunSoft, Inc.
Mountain View, CA
(800) 786-7638
(415) 960-3200
fax: (415) 336-2473
**Circle 1230 on Inquiry Card.**

*Barry Nance is a BYTE consulting editor. He is the author of* Using OS/2 Warp *(Que, 1994) and* Introduction to Networking *(Que, 1994). You can reach him on the Internet or BIX at barryn@bix.com.*

# OO Meets OS

DICK POUNTAIN



JOSEF GAST © 1995

## Object-oriented OSes are almost here—as always

How hard do you laugh when you hear that "there is an object-oriented OS in your future"? It's not that the words are *necessarily* untrue. Unfortunately, however, OOOSes remain stubbornly stuck in your future, not your present.

Why should you care? How about better integration. Microsoft Office users already take for granted the ability to drag an Excel graph into a Word document. Now picture this: You need a widget diagram for your monthly report. Click on the search button and ask for widgets. Soon the search returns an icon for the report "Widgets in the 1990s" by Fred Smith in the Manchester office. You open it, drag his diagram into your document window, and attach an electronic Post-It note to his report, thanking him for the loan. Computer users now only dream of this seamless, content-addressable data access, but an OOOS is the way there.

Which OOOS aspects are in this fantasy? Well, the reason you could locate that widget diagram is that Fred's report is a compound document—a collection of objects whose multiple attributes are made visible to the search software—rather than a file that is just a named bag of bits and makes sense only to the application that created it.

Your search could reach Manchester because Fred's compound document is stored in a distributed object store encompassing not just his own hard disk, nor even just his office LAN, but the whole company's WAN. It doesn't matter whether he's running the same hardware (or even OS) as you because a Common Object Request Broker Architecture–compliant (CORBA) ORB broadcast your search in a platform-neutral format. You didn't need to explicitly log on to any network or run a communications program because in this *persistent object store*, you access objects by specifying their names or attributes, neither knowing nor caring where they are physically stored.

Finally, you could drag the diagram from his document into yours because both documents conform to the same object-embedding interface. This might be OpenDoc or Microsoft's OLE (see the text box "Signs to Cairo" on page 126). By the time this scenario is realized, maybe they'll have stopped squabbling and be compatible with one another.

### Portrait of an OOOS

The purest form of an OOOS could hardly be simpler in concept: A small microkernel talks to the computer hardware, and the rest of the OS consists of replaceable modules, or objects. Outside the kernel code, there's no distinction between the OS, utilities, and applications. Everything is an object. A generic architecture for such an OOOS might look like the figure on page 124.

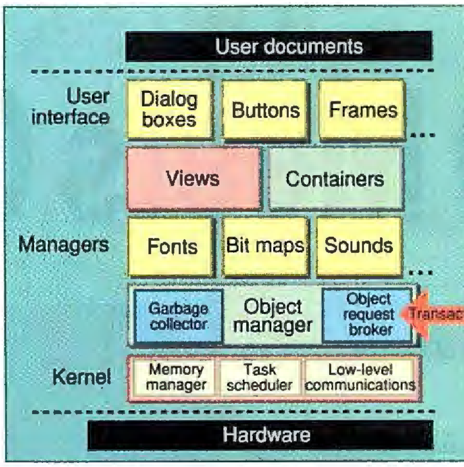
Objects are bundles of data with associated code that can act on the data. Anything from a business letter to the word processor that edits it can be structured like this. Program execution occurs when objects exchange messages, causing the kernel to execute their code. The kernel provides such low-level hardware-dependent services as memory allocation and protection, task scheduling, and communication (both process-to-process and remote). The kernel of an OOOS should be multitasking so that many objects can execute simultaneously. It should support automatic garbage collection of dead objects to avoid memory leaks.

An object manager uses kernel services to dynamically create and destroy transient objects and to preserve objects that will be needed in the future (e.g., user documents) in the persistent object store, a repository of objects available to all applications. When a program invokes an object's unique object identifier (OID), the object manager fetches it from the store into RAM.

In a fully distributed OOOS, an ORB translates requests for OIDs into network messages that find objects and transparently relocates them onto the local system. ORBs maintain indexes of various object attributes, so they're closer to a database manager than a conventional file system. An OOOS will update objects using transaction-based semantics, with commit and rollback so that any action can be undone. Remote communication will operate on a fault-tolerant store-and-forward basis, transmitting data when a link can be established and hiding delays from the user.

OOOS support for inheritance—creating new objects by modifying old ones—can save programmers from reinventing the wheel and users from wasting storage space. For the designers of OOOSes, however, inheritance is a headache. Child objects frequently execute code belonging to their parent, but that parent may live elsewhere on the network.

The most difficult technical challenge for an OOOS is to avoid massive and unpredictable network overload due to tangled inheritance webs. The solution may lie in message-optimization schemes that group interdependent objects close to one another, dynamically migrating them where necessary.




**In a pure object-oriented OS (OOOS), everything above the kernel is a replaceable object, and files are abandoned in favor of persistent objects that are transparently moved between memory and mass storage.**

Program objects under an OOOS will be finer-grained. A word processor would not be a single object, but a spelling checker or a search engine might be. The same spelling-checker object would check reports, presentations, or spreadsheets.

### Real OOOS

The most pure OOOSes thus far are on personal digital assistants (PDAs), where engineers started from scratch with little legacy code. RAM-based persistent object storage (eliminating battery-powered rotating magnetic storage media—and the conventional file system) is a feature of Apple's Newton and General Magic's Magic Cap. The code reuse under a properly designed inheritance hierarchy reduces the size of software—a major consideration for PDA vendors when everything has to fit into 4 MB of ROM.

On the desktop, going to a full OOOS means making compromises to preserve legacy code and data, especially over the file system. Because all our existing data is in conventional files on conventional magnetic media, it has made commercial sense to continue supporting these rather than

## Object Babel

**The biggest obstacle to the wider adoption of object-based systems is their lack of interoperability: You can't transport objects from one OS to another without some conversion process. The only way to demolish this Tower of Babel is to adopt standards for object interoperation at three levels: for object creators, object users, and interobject communication.**

**For object creators (i.e., vendors), we need a standard object model that specifies the binary formats for storing object data and sending messages. This model should also dictate the means of inheritance. The two contenders on the desktop are Microsoft's Common Object Model (COM) and IBM's System Object Model (SOM). Naturally, they're incompatible. In the wider computing world, several competing object models further muddy the water, including SQL3, the next major version of the query-language standard.**

**At the second level, object users need a standard way to embed objects into compound documents. The two competitors are Microsoft's OLE 2.0 and OpenDoc (supported by a consortium including Apple, IBM, Novell/WordPerfect, and Sun). A compound document that is stored using either technology is more like a whole mountable volume than a single file, with its own internal "directories" to store the pieces.**

**OLE 2.0 implements structured storage via a file format called a *docfile* (common to Word, PowerPoint, and Excel), which organizes objects into internal *streams*. One application can drive another through an automation interface by calling object methods that all OLE 2.0–compliant applications must make visible.**

**OpenDoc, too, defines a compound-document format (Bento) in which document components (parts) are stored in directory-like streams (storage units). OpenDoc goes beyond OLE 2.0 by offering built-in version management. You can reconstruct any earlier version at will using stored changes. Also, while OLE 2.0 is proprietary and confined to Windows and NT, OpenDoc will work on Mac, OS/2, and Unix platforms.**

**OLE 2.0 appears to have the edge over OpenDoc in the reusable software component market. OLE 2.0 enhances Visual Basic's very successful Visual Basic custom control (VBX) file standard into the more fully object-oriented OLE custom control (OCX) format (which supports inheritance), for which success is also assured. OpenDoc supports end-user programming only via Apple's rather old-fashioned HyperCard and AppleScript, and it badly needs some answer to Visual Basic.**

**The final standard needed would let heterogeneous object systems cooperate across a network. The cross-industry Object Management Group (OMG) has produced a standard for a Common Object Request Broker Architecture (CORBA)—the software layer that mediates requests between one object world and another. IBM's Distributed System Object Model (DSOM), which underlies OpenDoc, is CORBA-compliant. While the first version of CORBA was severely limited in that it allowed communication only between systems using the same object model, CORBA 2 supports cooperation between any CORBA-compliant systems. However, Microsoft has indicated that Cairo's OLE 2.0 will not be CORBA-compliant, dealing a heavy blow to the standard.**

# Where Does Your Passport Take You?

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**Jennifer Lane** is a 17 year old high school student from southern California. She has placed fourth in the prestigious nationwide Composer's Guild Composition Contest, as well as winning three separate awards from the Disneyland Creativity Challenge™ Contests.

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# Signs to Cairo

Cairo, Microsoft's object-oriented successor to Windows NT, will begin beta testing in early 1996 for release in 1997. Although Microsoft is not revealing the full details of Cairo yet, there are enough clues within current Microsoft OSes to yield a good idea of how it might work.

The OLE 2.0 embedding model that integrates the components of Microsoft Office already contains the seeds of a future object-oriented file store in its structured-storage technology. Word DOC files, Excel XLS files, and PowerPoint MPP files share a common internal *docfile* format. The screen below shows the internal structure of a Word document that's embedded in a PowerPoint presentation. The internal stream structure of the combined file has taken on a tree structure, just like a disk directory, reflecting the embedding of its components.

If you open the document in PowerPoint and double-click on the embedded Word document, PowerPoint finds out what application owns it from the Windows Registry. The OLE engine then negotiates between PowerPoint and Word, and PowerPoint's toolbar morphs into Word's formatting toolbar so you can edit the Word document.

Now peek into the future. The top level will no longer be a separate application such as PowerPoint, but the Cairo desktop itself. The streams comprising the compound document will no longer be inside a DOS file allocation table (FAT) file system. Cairo's Object File System (OFS) makes the whole hard disk a single huge docfile that exposes its internal objects to the user.

The groundwork for a distributed object store is present, too, in the shape of Microsoft Exchange Server (MXS) and the OLE-automatable Jet 3 database engine. If you drop any structured-storage object (e.g., a Word file) into an Exchange folder, any custom properties you've defined become available as values to sort on or filter by. MSX is based on the ISO X.400 message transport and X.500 directory services, which, combined with Cairo's OFS, should be able to locate remote objects across a network. By the time Cairo is released, MXS might be absorbed into the OS.

In short, the migration from Windows to Cairo could be less drastic than expected, given that all your Office data files are already in a structured format that Cairo will understand. The much greater challenge for Microsoft is how to decompose monolithic applications such as Excel into collections of discrete lightweight objects. The OLE automation interface already requires that applications make some of their internal organs visible as objects, but that is not at all the same as delivering them as separate pieces. It could turn out that Microsoft will encounter stiff competition from Visual Basic custom control/OLE custom control (VBX/OCX) vendors such as Sheridan and MicroHelp, who have a head start because their products are already in bits.

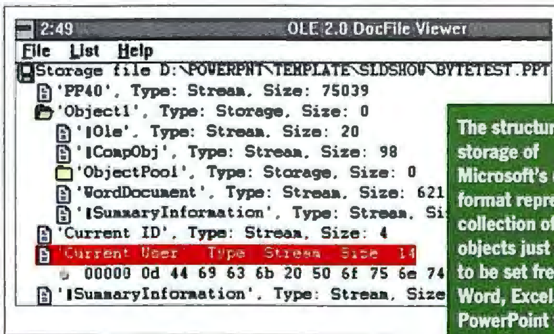
taking the radical step to a persistent object store.

For example, NextStep, the nearest thing to an OOOS in widespread use, is built on the Mach microkernel and employs a conventional Unix file system. However, the rest of the superstructure of NextStep is a hierarchy of Objective-C objects, fully available to the applications programmer.

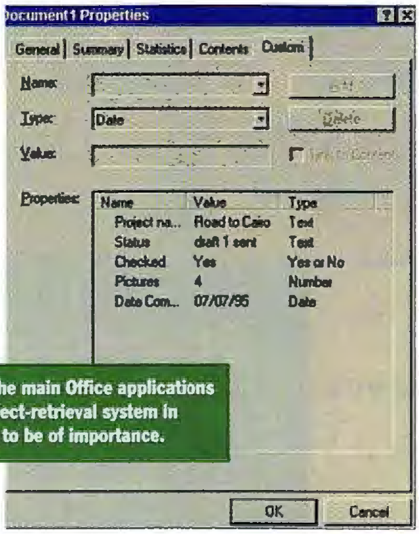
IBM's OS/2 Warp is object-oriented to a much shallower degree. The Workplace Shell user interface (UI) is a programmer-accessible object hierarchy, but the lower levels of the OS are quite conventional.

In 1992, IBM, Apple, and Hewlett-Packard set up Taligent to develop a new OOOS from the four years of research Apple had put into Pink. Last May, Taligent announced it had abandoned producing a whole OS and would instead release a cross-platform object-oriented *framework* (containing prefabricated application parts) called CommonPoint. In July, Taligent shipped CommonPoint source code to its sponsors to start porting to their own OSes (IBM's AIX and OS/2, Apple's Copland, and HP's HP-UX; versions for Windows 95 and NT will follow).

CommonPoint contains 100 such frameworks (including complete working and extensible text and graphics editors and presentation and communications programs), built from thousands of object classes. Taligent also has an interactive, drag-and-drop GUI building tool called cpConstructor and plans for a highly sophisticated development environment.




The structured storage of Microsoft's docfile format represents a collection of objects just waiting to be set free. Word, Excel, and PowerPoint files all have the same internal structure, so embedding one in the other is easy.




Custom properties in the main Office applications point the way to an object-retrieval system in which filenames cease to be of importance.

CommonPoint may score over OLE 2.0/Visual Basic in its persistent object store (built on the native OS file system), so that applications objects remain alive at run time rather than being frozen at compile time: Programmers maintaining a delivered application can extend it using inheritance. On the downside, CommonPoint is very expensive and very, very large.

It's the long wait for Taligent that has caused a widespread feeling that object technology has failed to catch on. The fact is, OOOSes are just around the corner.

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*Dick Pountain is a BYTE contributing editor based in London. You can reach him on the Internet or BIX at dickp@bix.com.*

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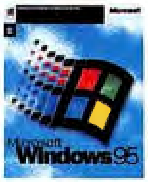


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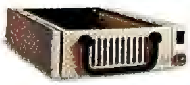

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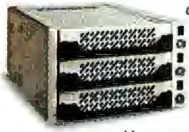

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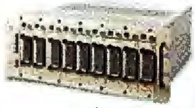

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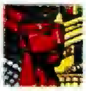

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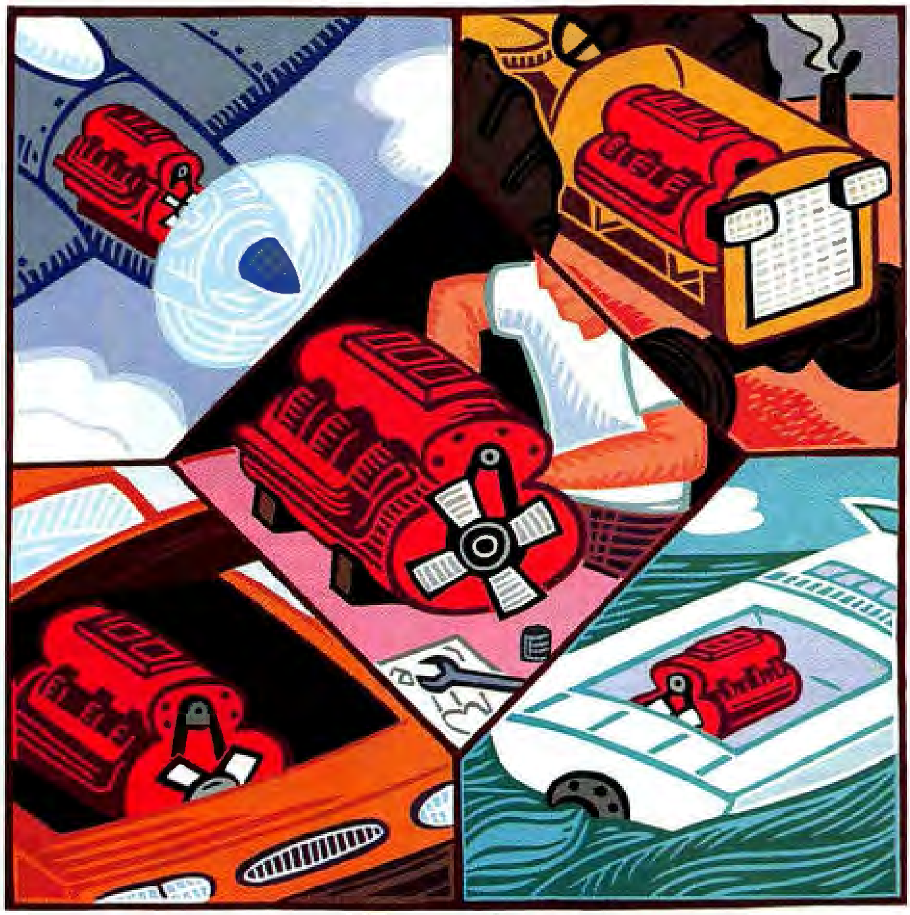
# And One for All



SCOTT BALDWIN © 1995

**Using one source code base to target multiple platforms is possible, but not ideal**

DAVID S. LINTHICUM

The four programmers draw their épées and simultaneously raise them to the sky. "All for one," they exclaim, "and one for all!" Such is the way of multiplatform development.

The ability to move an application from OS to OS, from GUI to GUI, and from processor to processor is a desirable, if elusive, goal. But the various environments in which we deploy applications have little in common, and environment-neutral development tools must create an additional layer to accommodate their differences. With this kind of architecture, it's difficult to expect excellence from a multiplatform application in all environments. Multiplatform applications are never a native, always a tourist.

"The problem with portable tools is that they never look native in any environment," says Robert Holmes, computer technology research analyst with the Southern California Gas Company (Los Angeles, CA). "They [tools vendors] simply can't be all things to all environments." Simply put, you pay your money and you make your choice: separate development for each platform, or multiplatform development only once.

As the cost of applications development rises, it makes sense to develop applications that run on a multitude of platforms. This allows companies to leverage their investment in code and more easily adjust to the inevitable technological changes. In addition, if you're marketing your applications, the more platforms they run on, the merrier your accountants will be.

Many tools vendors, including Compuware, Intersolv, Neuron Data, Unify, and Zinc Software, provide facilities for multiplatform development. When using these tools, developers can write an application once and then deploy it into many environments without modifying the programming code.

The trick for the developer is to find a tool that makes the application look at home no matter where it is. Some of the issues surrounding multiplatform development include approaches to portability, business justifications, pitfalls, tools, and how to win the portability game.

### Desperately Seeking Portability

The idea of portability is conceptually simple: Keep the environment-specific code in its own layer. Then, when you move an application from platform to platform, simply swap out the old environment layer and swap in a new one.

For example, when developing a C++ application for portability, the developer places all the native GUI- and OS-specific code in its own object or group of objects. Then, when moving the application from platform to platform, the developer must replace just the native-object layer to redeploy the application in a new environment.

Most developers find that achieving true portability using traditional programming techniques is an arduous task. But a number of portable class libraries (e.g., C++ Views from Intersolv, zApp from Inmark Development, and Zinc from Zinc Software) and fourth-generation-language (4GL) tools (e.g., C/S Elements from Neuron Data, Uniface from Compuware, Unify Vision from Unify, and VisualWorks from Digitalk/ParcPlace) are available to make the job much easier.

These tools provide a layered API framework. At some layer of this framework, the tools maintain the environment-specific code. Developers then build applications on top of the environment-specific layer.

By using proprietary API calls from third-generation-language (3GL) code, developers don't have to deal with the differences between native environments. The API provides a consistent set of available functions from compiler to compiler and from platform to platform to enable normal applications operations. It's the job of the tool, not the programmer, to handle the presentation of the application in the various environments supported by the portable development tool.

Although the basic concepts remain the same, there are many ways in which portable development tools approach the portability problem. These include lowest common denominator (LCD) and emulation. LCD tools (e.g., XVT from XVT Software) support those features found within all environments.

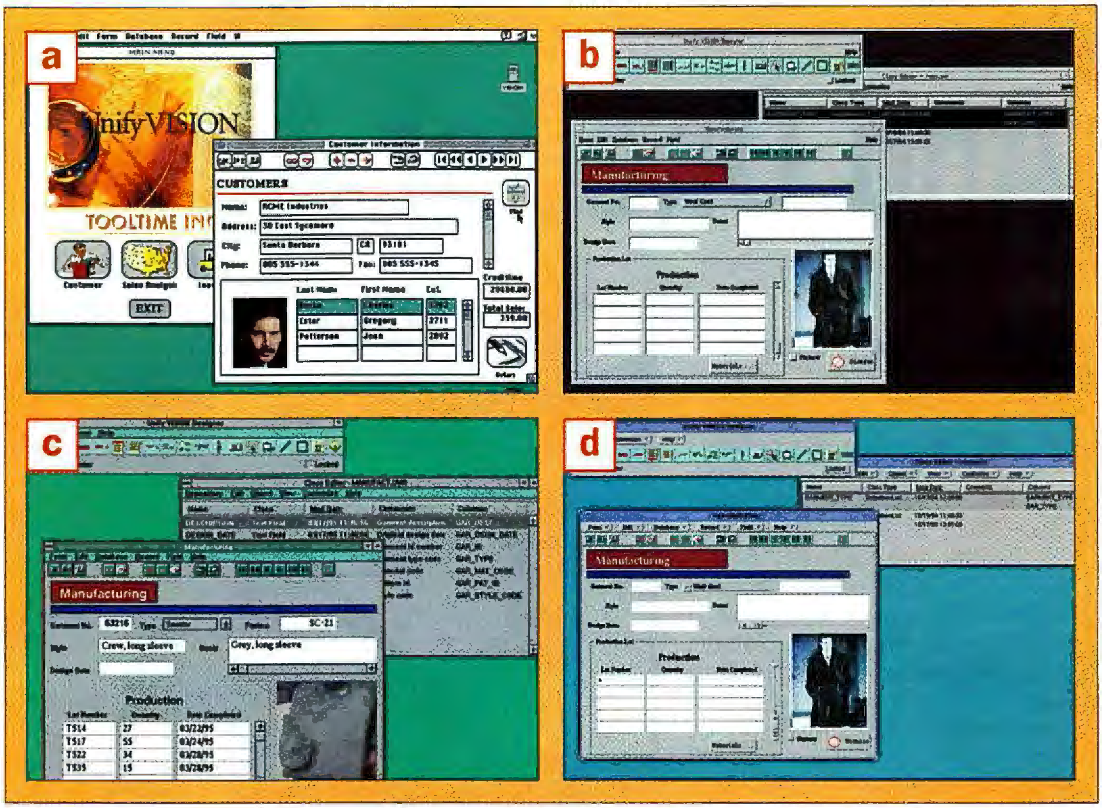
Yet to maintain portability, you have to give up some native application features. For example, LCD does not support nonportable features, such as Multiple Document Interface (MDI) for Windows applications or the geometry management found in Motif applications.

And while LCD provides the same look and feel across platforms, it doesn't consistently provide their *native* look and feel. For example, a Windows application built with an LCD tool looks out of place. But this can be an advantage. For instance, system administrators who manage many different types of systems may appreciate system-administration applications that look the same across all platforms.

In contrast, portable development tools that use emulation (e.g., C/S Elements) draw their own GUI controls for each environment. These tools go directly to the graphics subsystems of each specific environment, avoiding the native APIs. Again, these applications never really look at home, and bypassing the native API can cause other problems.

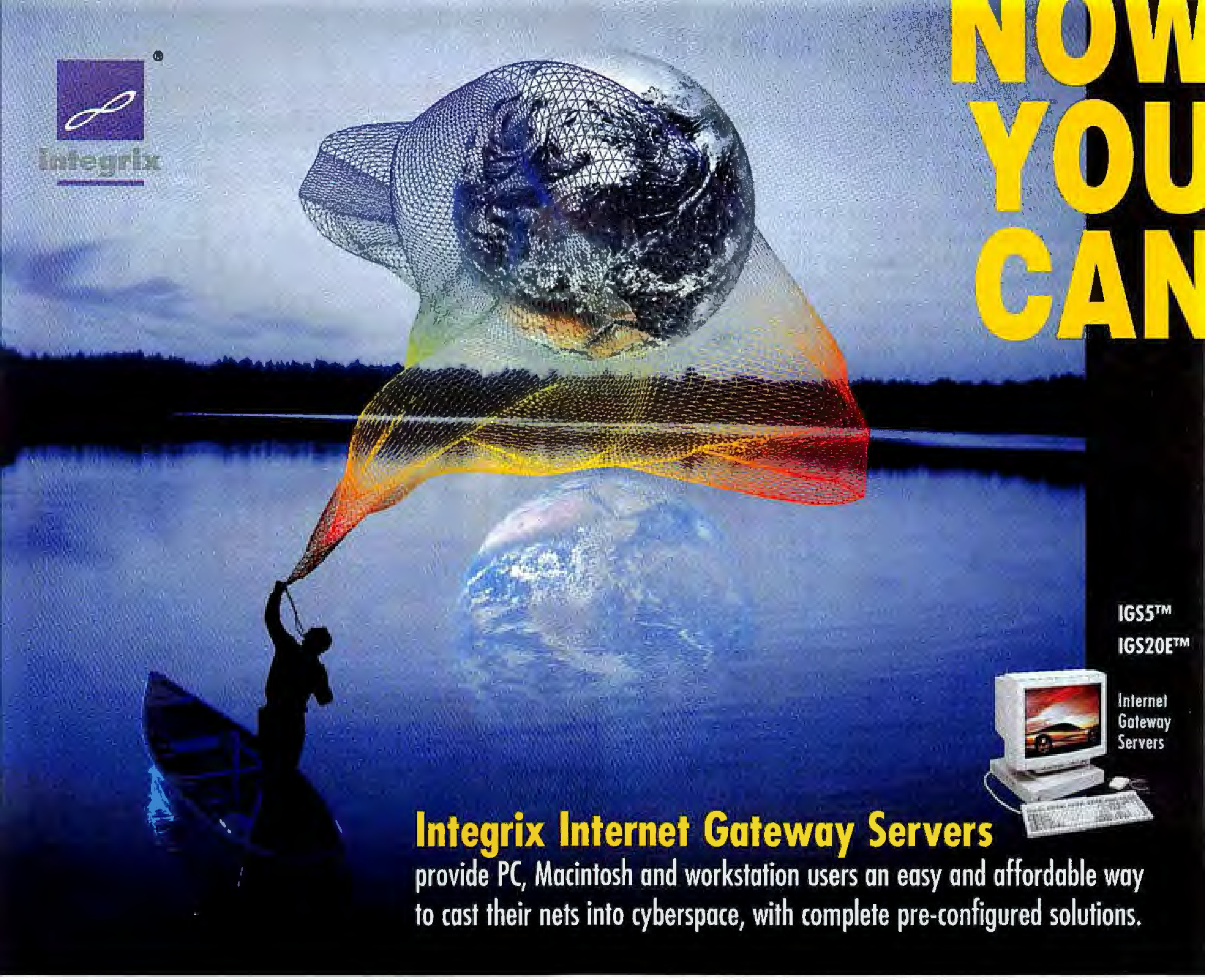
For example, by the time this article sees print, many people will have already upgraded to Windows 95. But portable applications built with emulation-based tools in the Windows 3.1 environment probably won't find a happy home with Windows 95: These applications rudely bypass its Win16 and Win32 native APIs. Or, even if the application does run, it will have a Windows 3.1 look and feel in the Windows 95 environment.

To correct this problem, the developer




**Unify's Vision provides multiplatform rapid application development for the Macintosh (a), Windows NT (b), Windows (c), and Unix (d). Vision's automated application-partitioning feature allows developers to partition applications across various applications servers.**


**In one style of access (left), the development tool translates 4GL references into native calls. In another style, the tool supplies a proprietary API to which developers write code.**

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**Circle 152 on Inquiry Card.**

must rebuild the portable application using a new Windows 95 version of the portable development tool. The same is true for other platforms as well.

So, what's the best approach? It's no big surprise that the situation is not simply black and white. There are no clear differences between the LCD and emulation approaches to portable applications development when you consider the purchase of a portable development tool. In fact, most tools fall somewhere between the two approaches (e.g., XVT is more LCD, while C/S Elements is more emulation), and the only way to determine the efficiency of a portable tool's approach is to test it in the environments where you wish to deploy it.

But don't abandon all hope. There could be good news on the horizon for portable applications developers. As portable-tools vendors, such as Intersolv, work to improve their products, there seems to be a movement toward using more of the native APIs when deploying portable applications. This will eliminate many of the drawbacks of using portable development tools by making portable applications indistinguishable from native applications.

Thus, many tools, such as Intersolv's C++/Views, are moving to a *superset* approach to portability. Using this approach, portable tools build as many native functions as they can into portable applications. If any native functions are missing, the tools emulate the missing features. The resulting applications should provide all the native features you need while remaining completely portable. But using the native API makes a portable-tool vendor's job much more complicated, and it's going to take time before most tools move in the native direction.

## Tools That Rule

Developers can divide portable tools into 3GLs and 4GLs. If you decide to go the 3GL route, you'll find a number of portable C++ libraries, including zApp, Zinc, and C++/Views. The basic idea behind these tools is that C++ developers will use these frameworks, which leverage the object-oriented aspects of C++, and place environment-specific code in their own libraries. Thus, when you switch platforms, you switch libraries as well.

Using portable C++ libraries, an application can access all OS and GUI services using the proprietary API of the tool, which in turn implements the proprietary API call using environment-specific calls. Since the tool API never changes from platform to platform, the applications are portable. You can, as an option, put environment-specific calls in your application using these portable frameworks. However, you'll have to either remove or work around those calls to make your application portable to other platforms.

As with any 3GL, developing portable applications using C++ takes a great deal of time and patience. To build portable applications in less time, you should consider portable 4GL development environments. Instead of using a proprietary API, 4GL tools provide a high-level language across platforms.

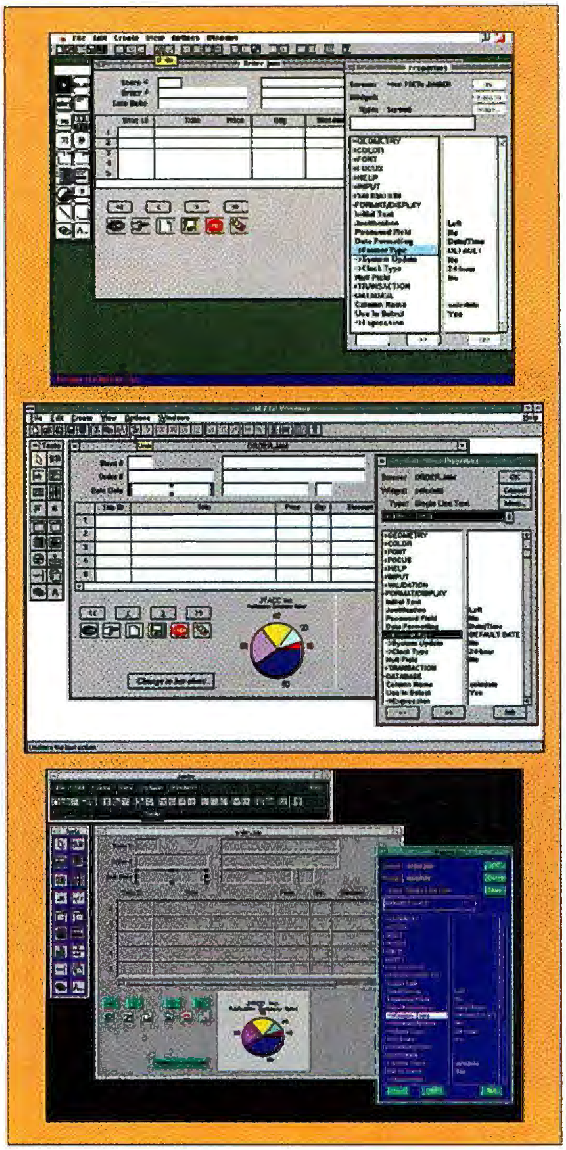
Examples of portable 4GL tools include C/S Elements, Uniface, and Unify. These tools use proprietary 4GL languages that sit on top of the environment-specific features of the tool. Uniface, for example, can deploy its 4GL applications on Windows, OS/2, Windows NT, Unix, and the Mac.

When selecting a portable 4GL tool, you should consider its ability to handle other application services, such as database-server connections, and its ability to assist in the development of a database schema. Many of these tools, such as Uniface and Unify, make good rapid-application-development (RAD) tools as well.

One drawback of portable 4GL tools is that they almost always use an interpreter, and therefore their performance is usually lackluster. With 3GL and 4GL tools, you need to check with the applications vendor to see if they support all the environments you plan to deploy applications on. Many tools support only a select few, or they support only one or two very well, while supporting others poorly.

## Portable Traps

Despite the drawbacks, the allure of portability is just too strong for many organizations to resist. Most companies run a wide range of processors, OSes, and GUIs, and having to write an application just once for all those environments solves many problems. However, portability creates other problems. Failed portable applications development projects outnumber successful implementations, and it's clear that the honeymoon with portable applications development tools is over.



**JYACC's Jam 7 is a multiplatform client/server applications development tool. Jam 7 applications are portable to (from top to bottom) the Mac, Windows, and Unix, plus other OSes.**

The problem with building portable applications is traceable to the differences among platforms. Like "one-size-fits-none" gloves, portable development tools can't be all things to all platforms; therefore, they don't work exceptionally well on any of them. Most users can instantly discern a portable application from a native one and reject it as seemingly out of place.

For example, zApp, a useful portable C++ library that allows developers to deploy applications on Windows, Unix, Windows NT, OS/2, and Macintosh environments, looks a lot like a native Windows application no matter what platform you deploy it on. A developer may get away with this with Windows users, but not with anyone else.

Look and feel aside, when you use

portable tools you have to give up other native goodies as well. Portable development tools that support Windows, for instance, might not have the mechanisms to use OLE 2.0 objects, Visual Basic custom controls (VBXes), or MDI. Moreover, they might make it difficult—or impossible—to use other third-party development tools and libraries.

Other issues are cost and performance. Most portable applications don't run as fast as native applications do, because of the overhead of using a native layer. In addition, portable development tools add significant cost to development projects, usually doubling the tool cost. You also need to consider staffing costs as well. Portable applications, especially in the 3GL world, take more time to develop, and their learning curve is steep.

### Unarrested Development

Before jumping into portable applications development, take a deep breath and consider whether you really need to do so. Although vendors' sales pitches are compelling, if you don't have an immediate need to deploy applications on multiple environments, just say no. Multiplatform development adds both cost and trouble to the development life cycle. It's much easier to build native applications, and users are happier with them.

What if you decide to go native and get an unexpected demand to run your application on a different platform? The good news is that you can rebuild your application around a portable tool that handles the new platform. The bad news is that it requires a lot of additional work.

If portable applications development makes sense for your application, you need to consider the type of tools to use. While multiplatform development frameworks for C++ are flexible, they're difficult to learn and use. Moreover, it takes more time to build an application using a 3GL, such as C++, than it does with a 4GL.

Portable tools that use 4GLs offer an easier development environment, but—in support of the you-can't-have-everything theory—you might run into performance problems. For each type of tool, you always need to consider the OSes and GUIs that each works on. You probably want to set up pilot applications on all the platforms you're supporting as well. Never assume that your portable application will work the same across all platforms. Developers are often unpleasantly surprised at how widely tools-vendor support varies from platform to platform.

If you want to put advanced GUI features in your portable application, such as MDI, OLE, DDE, and Motif geometry, then make sure the tools support them. If you plan to use graphics, make sure the tools can display and print the graphics for your application on each platform.

You need to look at other details as well. For example, some portable applications development tools don't use the native help systems or the native help file; others don't use native fonts or bit maps. As always, it's caveat emptor.

Finally, when considering getting into the portable applications development game, use common sense. Determine your application requirements and platform requirements up front. Next, research the different portable development tools and select the ones that meet your requirements. From there, test each tool to determine its viability. Don't be afraid to dump a tool if it doesn't meet your expectations.

While portable applications development has many advantages in today's heterogeneous world, there are many tradeoffs to consider when selecting a portable development environment. As tools vendors become better at building portable development environments, someday maybe all development tools will provide portability, settling all the problems once and for all. ■

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# Crashing the Party

**BRUCE BROWN**


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**How to crash the major desktop OSes, and what it says about their architectures**

Although their fans speak of them in almost transcendental terms, the major desktop OSes sometimes exhibit all the rigor of a tube of toothpaste: You squeeze here, it bulges there; you squeeze there, it breaks. It's almost axiomatic in computer technology, of course, that every strength is simultaneously a weakness, and nowhere is this more apparent than in the crash performance of the major desktop OSes.

Under stress, Windows 3.1, Windows NT 3.5, OS/2 Warp, and Mac OS 7.5 (the PowerPC and Motorola 68000 versions) are all vulnerable to their own particular brands of system failure. They are often called General Protection Faults (GPFs) in the Windows world and system bombs on the Mac side. These flashes of woe (or whoa) typically render the active software application unusable and can freeze the whole system solid, requiring rebooting. As a bonus, you probably lose whatever you were working on, too.

Sometimes seemingly random system failures can at other times be replicated by following specific procedures, with near-scientific reproducibility. The following tour of the shores of computer hell is offered not for the sake of mayhem (or, at least, not for mayhem alone), but for what it reveals about the workings of various desktop OSes and the state of OS development. Forewarned is forearmed.

### Breaking Windows

To crash Windows 3.1: Simply open and close Windows applications. Repeat a few dozen times, or until the Black Screen of Death appears.

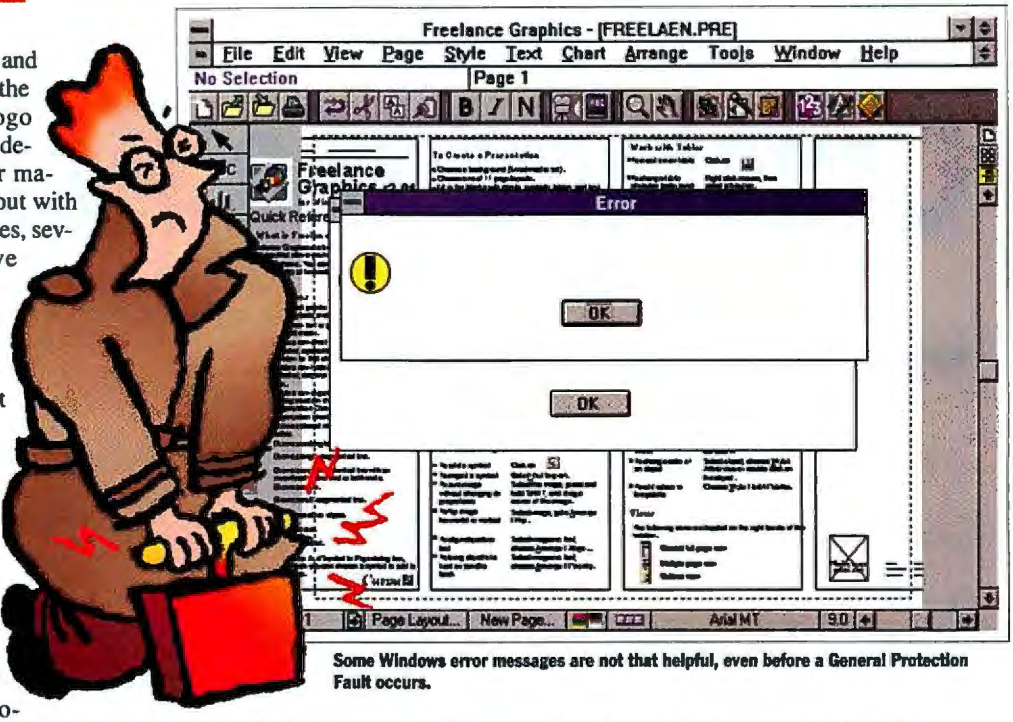
The most popular OS is also the one that's most prone to total system meltdown. In fact, one of the dark facts about Windows is that you can cause Windows 3.1 and Windows for Workgroups 3.11 to crash simply by using them enough.

Windows 3.x is notoriously susceptible to potentially fatal memory leaks in two crucial 64-KB resource heaps used for system operation: USER.EXE and GDI.EXE. It's common for Windows applications to consume, or *leak*, memory (i.e., releasing less memory back to the system when closing than they took when opening).

Microsoft estimates that Word for Windows 6.0 and Excel for Windows 5.0 both leak about 6 percent of system resources whenever applications are opened and closed. Keep this up long enough, and the OS will choke—asphyxiated by lack of memory—and the system will crash. Thus, simply opening and closing enough Windows programs can eventually exhaust system memory and produce a GPF—even if you've got 100 MB of RAM installed.

There's an almost-infinite number of ways to bring on system-resource crashes in Windows 3.x. It's particularly (and ironically) easy with many Microsoft applications. For instance, if you insert a series of Microsoft Graph 5.0 objects into a Microsoft Word for Windows 6.0 document, you lose system resources every time you do so, until you eventually crash.

*continued*




Some Windows error messages are not that helpful, even before a General Protection Fault occurs.

Many Windows users exit from and restart Windows all day, not for the cool breeze of the Microsoft logo blowing by, but to replenish the depleted system resources on their machines. Although they may start out with 80 percent or more of free resources, several hours of hard use can leave them on the wrong side of the perilous 50 percent line, even with no applications open. One of the great attractions of Windows 95 is that it reduces—but does not eliminate—this problem.

Windows NT, a true 32-bit multithreaded OS, promises much greater stability than Windows 3.1, but it has still singed a few eyebrows along the way. Here's a recipe for a quick Windows NT disaster: With either Word for Windows 6.0 or Excel for Windows 5.0 running under Windows NT 3.1, close the program, reopen it, minimize it, and then quit again. Then listen for the splat. Microsoft acknowledges that this particular GPF is the result of a bug—not a feature—in the Windows-on-Windows subsystem memory manager in KRNL386.EXE.

In both Windows NT 3.1 and 3.5, available memory can also become exhausted if more than 100 threads or processes are launched simultaneously. The reason? The great insulation of applications from each other, which is one of NT's virtues, requires system overhead that can overwhelm the system. So, to protect against the sort of bumper-car GPFs that plague Windows 3.x, Windows NT introduces at least the slim possibility of another sort of calamity. "Quis custodiet ipsos custodes?" (translation: "Who shall guard the guards themselves?") is what you're probably saying to yourself at this point.

### Protection...for a Price

OS/2 Warp, Windows NT's main high-end 32-bit competitor in the OS wars, has trimmed its sails in a somewhat different fashion. One of OS/2's virtues is that it's more sentient about hardware than Windows is. It can actually tell if your system has a bad memory chip, a floppy drive controller heading south, or even a loose add-in card.

But OS/2's hardware intelligence has a downside. Here's a way to quickly produce the "trap 0002" or "trap e" meltdown in OS/2 Warp—and probably burn up thousands of dollars in consultant fees, too. Open up the case on the system and slightly loosen one of the add-in cards (a network interface card [NIC] or modem will do nicely). Don't take the card out; just loosen it a little.

You now have the makings of an exquisite little bit of misfortune. If you do it right, on a dual-boot machine you will then be able to run DOS just fine, but when you try to run OS/2, you'll get a black screen rudely slammed in your face.

Consultant Chris White, who's based in West Sacramento, California, remembers running into this exact problem. "DOS ran fine, but I kept getting these bomb-outs all the time in OS/2," she recalls. It turned out that this was the beginning of a hardware failure that ultimately cost a great deal of lost data. "OS/2 was trying to warn me, but I didn't understand until it was too late," she explains. "At the time, I was just furious that the system would not work."

Also, while shielding applications from each other, as Windows NT does, OS/2 does not shield the OS from errant code as fully as NT does. A good deal of Warp code and data reside in portions of memory that are distressingly writable by all applications, which opens another door to memory conflicts and system crashes.

### Sys! Boom! Bah!

Meanwhile, the Mac, like Windows, has its own heaps of memory trouble. Some Mac users report encountering strange names and arcane text on their screens during particularly showy system failures. These include the following:

```
_Jackson
+0000 408314A *Debugger
+0002 408314C _NewHandle, Immed
+0004 408314E BNE.S
    _DisposeCIcon+0032
```

These are vestiges of the original Mac development process. The name *Jackson*, for instance, is an abbreviated label for _JacksonPollock, the development code name for Color QuickDraw.

When Mac OS 7.5 users see the name *Jackson* amid the digital debris, they are probably in the grip of System Error 25, which can also generate out-of-memory errors and the bomb dialog box if MacBug is not installed. Mac System Error 25 occurs when memory stacks and heaps collide. This is commonly caused by an improper calling sequence by an application, prompting the stack to grow until it overruns the heap. (Boom!)

Another type of memory issue causes

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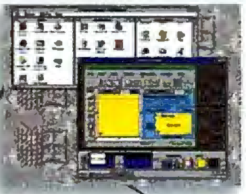

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system bombs on classic Motorola-powered Macs. It results from the code-swapping model that's used by Mac OS 7.5 when virtual memory or RAM Doubler is turned on.

Unlike the PowerPC version of Mac OS 7.5, the 68000 chip version-segments code so that it doesn't have to be loaded into memory all at once. This is an advantage in some respects (especially on machines with limited memory and disk space), but it can lead to situations where there isn't enough memory left to load a particular program's code into RAM when the time comes. (Bawoomba!)

PowerPC machines running Mac OS 7.5 are designed to overcome this problem, but in the process they introduce a new type of crash. The PowerPC version of Mac OS 7.5 *doesn't* segment and swap code, and therefore it requires that enough memory—virtual or otherwise—be available to load a program's code into memory all at once.

To crash Mac OS 7.5 on the PowerPC: To crash a PowerPC system with less than 16 MB of RAM, all you have to do is turn off virtual memory and RAM Doubler, and then reboot the machine and try to run Adobe Photoshop. (MacSplat!)

## Crash-Test Dummies?

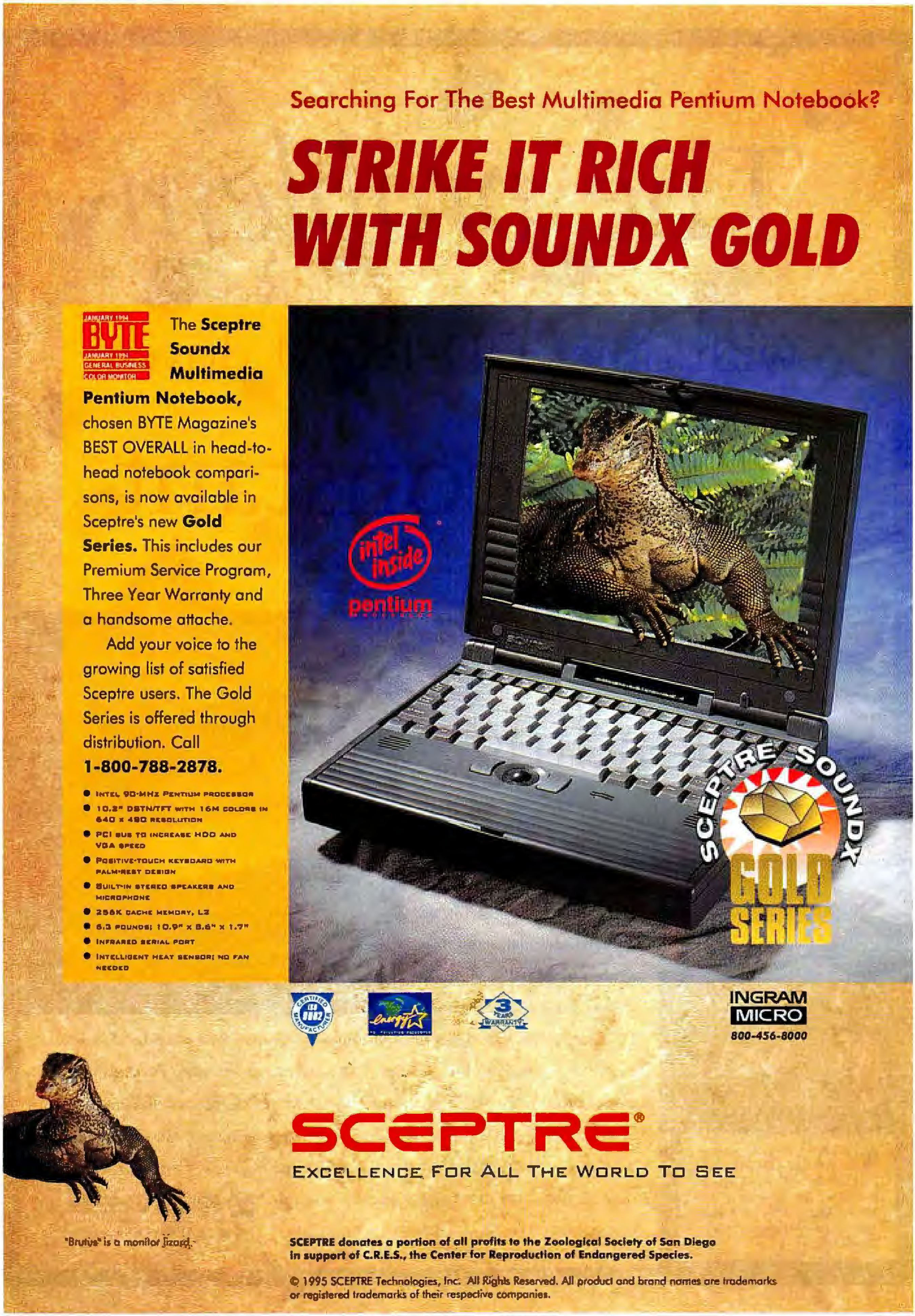
So, what's the moral of all this sorrow? It's not necessarily that every desktop OS is a disaster waiting to happen, nor that everyone's data is doomed. The problems discussed here do not plague every desktop user every day. In fact, they are rare enough that many users may never see them at all.

Yet in a general sense, the crash characteristics of the major desktop OSes reveal some fundamental OS verities. One is that, like military generals, OS designers often seem to be fighting the previous war (e.g., Mac OS 7.5 for PowerPC versus Motorola 68000, or Windows NT versus Windows 3.1). Another is that the major OSes are all essentially involved in the same trade-offs (or deals with the devil) when it comes to protection against showstoppers. Each has gleaming strengths, and each has potentially mortal weaknesses.

Users should remember that each OS represents a real-world compromise. And you know what the real world is like. ■

*Bruce Brown is the editor of the BugNet electronic newsletter and is based in Sumas, Washington. He can be reached on the Internet at bugnet@bugnet.com, on the World Wide Web at http://www.bugnet.com/~bugnet, or on BIX c/o "editors."*

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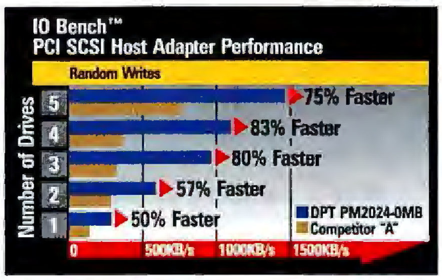


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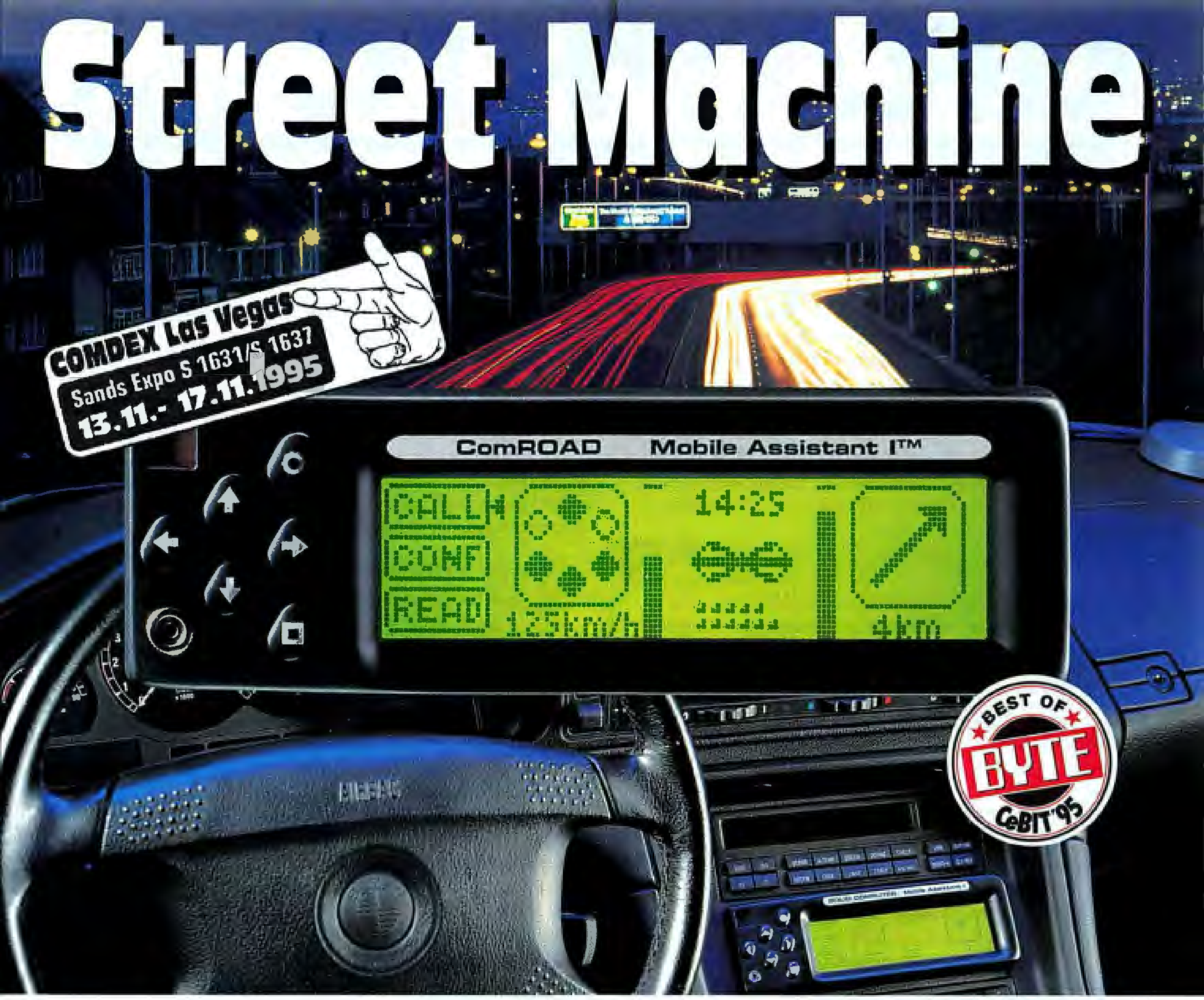


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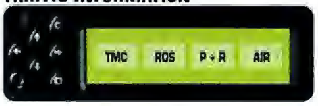


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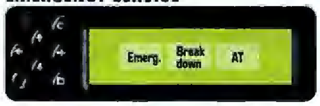


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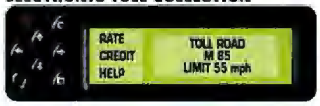


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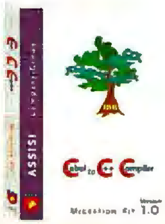
# The First Migration Toolkit From COBOL to C++




For more informations
www.freinet.de/CCC/

## 1. Independent of platform:

All COBOL language elements are contained in a COBOL-API, such that all dialogues are handled by means of a SYSTEM-API. This gives you a high level of portability. DOS, Windows, Windows NT, OS/2, UNIX - all are reduced to a few run-time libraries.

## 2. Faster and easier change:

Transfer from COBOL to C++ takes place automatically and therefore rapidly. A COBOL-like syntax is retained. Programs are recognisable to a high degree, since the sources remain comprehensible. In addition, the previous program structure (program sequence) is retained, because of which the unfamiliarity experienced by the customer in the application is less extensive than with a new development.

## 3. Competitive advantage:

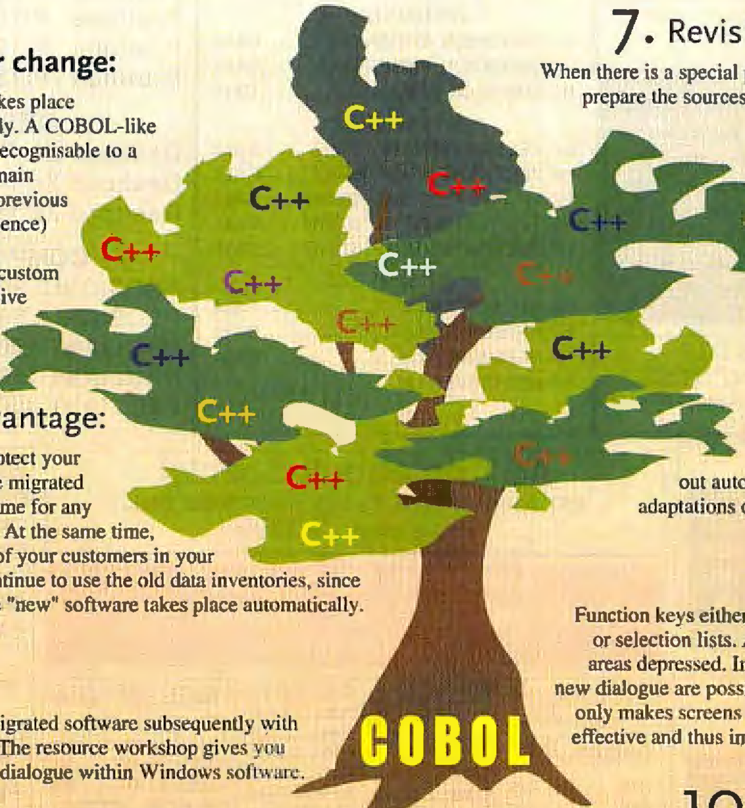
By migration of software, you protect your investment. Since you can use the migrated software immediately, you gain time for any new developments that you have. At the same time, you also protect the investments of your customers in your software. Your customers can continue to use the old data inventories, since data transfer from the "old" to the "new" software takes place automatically.

## 4. Flexibility:

In addition, you can extend the migrated software subsequently with additional dialogue and features. The resource workshop gives you all the facilities insert continuing dialogue within Windows software.

## 5. Multitasking/ergonomics:

With migration, you can utilise all the advantages of modern Windows software. Apart from the possibility of multitasking, the ergonomics, i.e. the usability of your programs is substantially enhanced.




## 6. Analysis of the program structure forming the basis:

Examines how the problem encapsulation is reflected in the individual COBOL modules. Usually the individual program functions are started from a central shell, which at the same time contains the menu management. Often, however, additional functions, such as initialisation and management of a global data area are integrated into this shell.

## 7. Revision of COBOL sources:

When there is a special program structure, it can be sensible to prepare the sources for migration. Possible steps here are:

- Consistent modularisation
- Separation from old menu systems
- Sub-division of the menu shell into individual components (menu system, management of global area)
- Make main modules capable of being separately run from the test environment

## 8. Migration:

After careful preparation of the sources, conversion of the COBOL sources into C++ sources is carried out automatically. Depending on the compiler, adaptations of the run-time libraries can still result.

## 9. Visual layout:

Function keys either become standard buttons in a tool bar or selection lists. ASCII graphics appear raised, inverted areas depressed. Integration of message boxes and use of new dialogue are possible, using the resource editor. You not only makes screens visually more attractive, but also more effective and thus improve the ergonomics of the software.

## 10. Use of class libraries:

The migrated programs are programs with run-times identical to the programs of the original software, on one hand, and on the other hand are pure message-driven programs, e.g. Windows. Therefore, newly-developped program code can be installed at any point in the C++ program code without restriction, using other class libraries.

● Advantages of migration ● Procedure for migration projects

---

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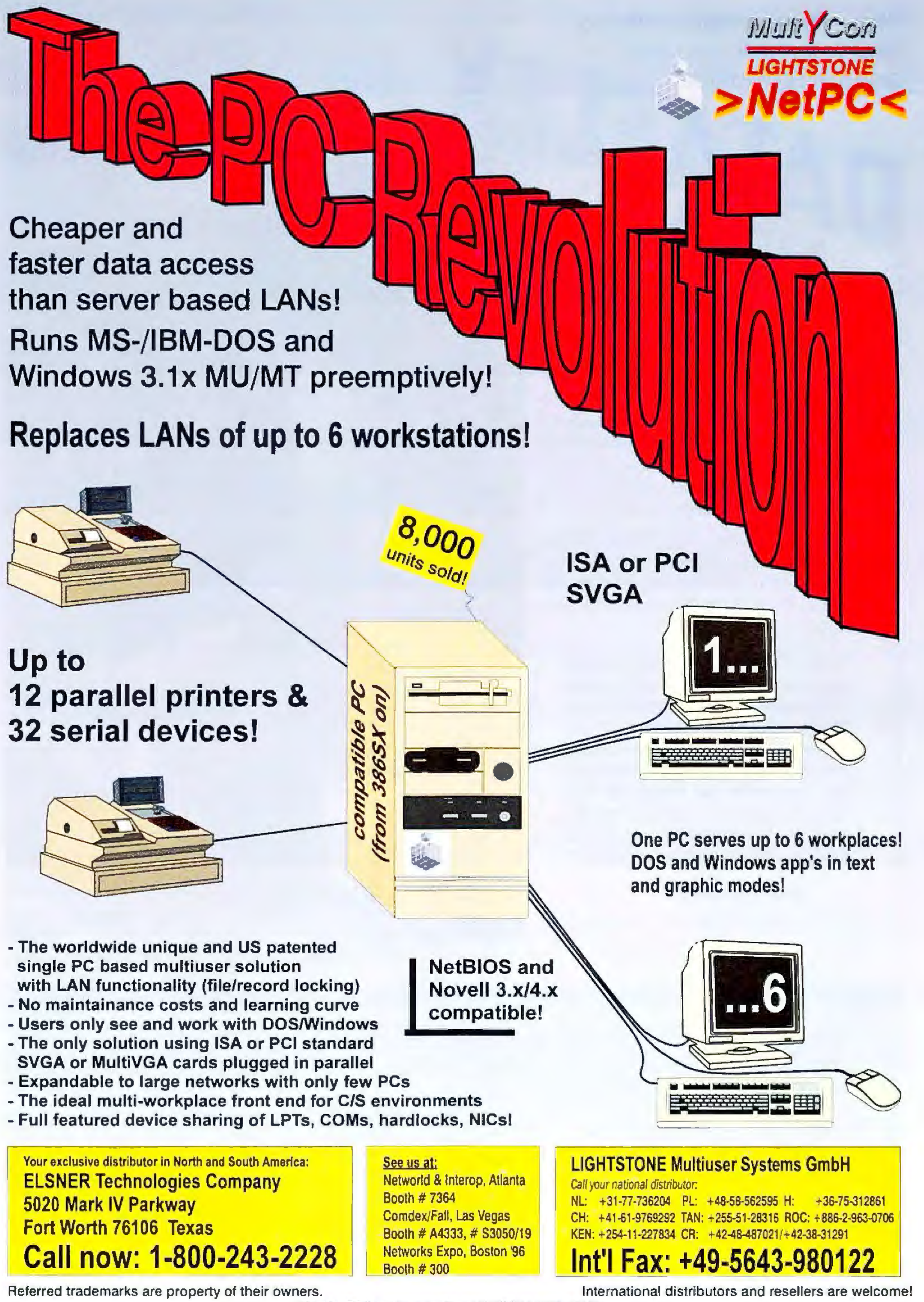


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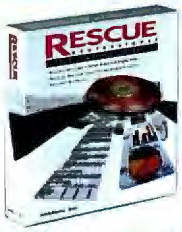


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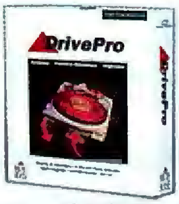


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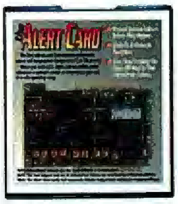


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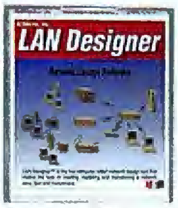


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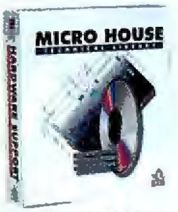


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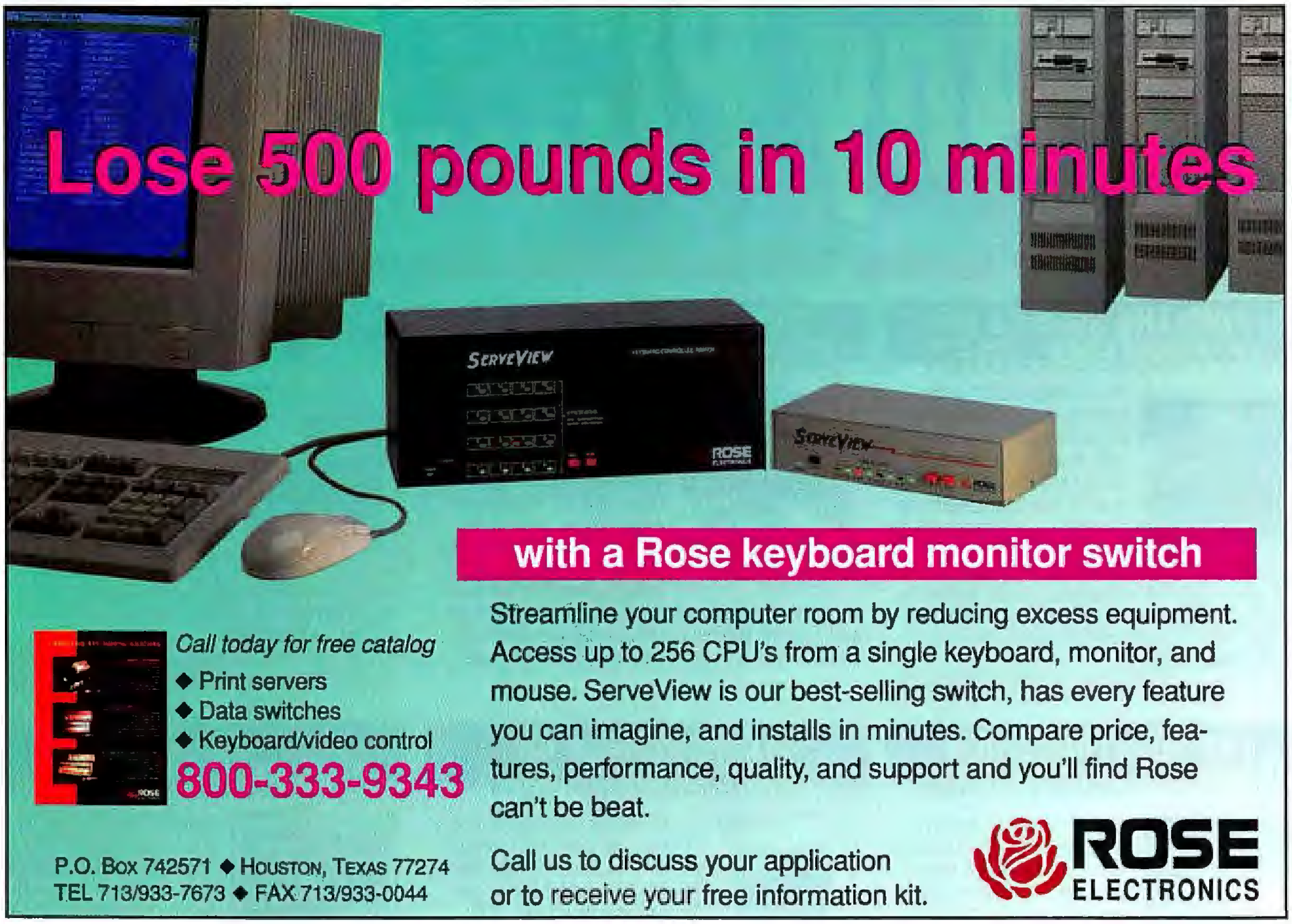


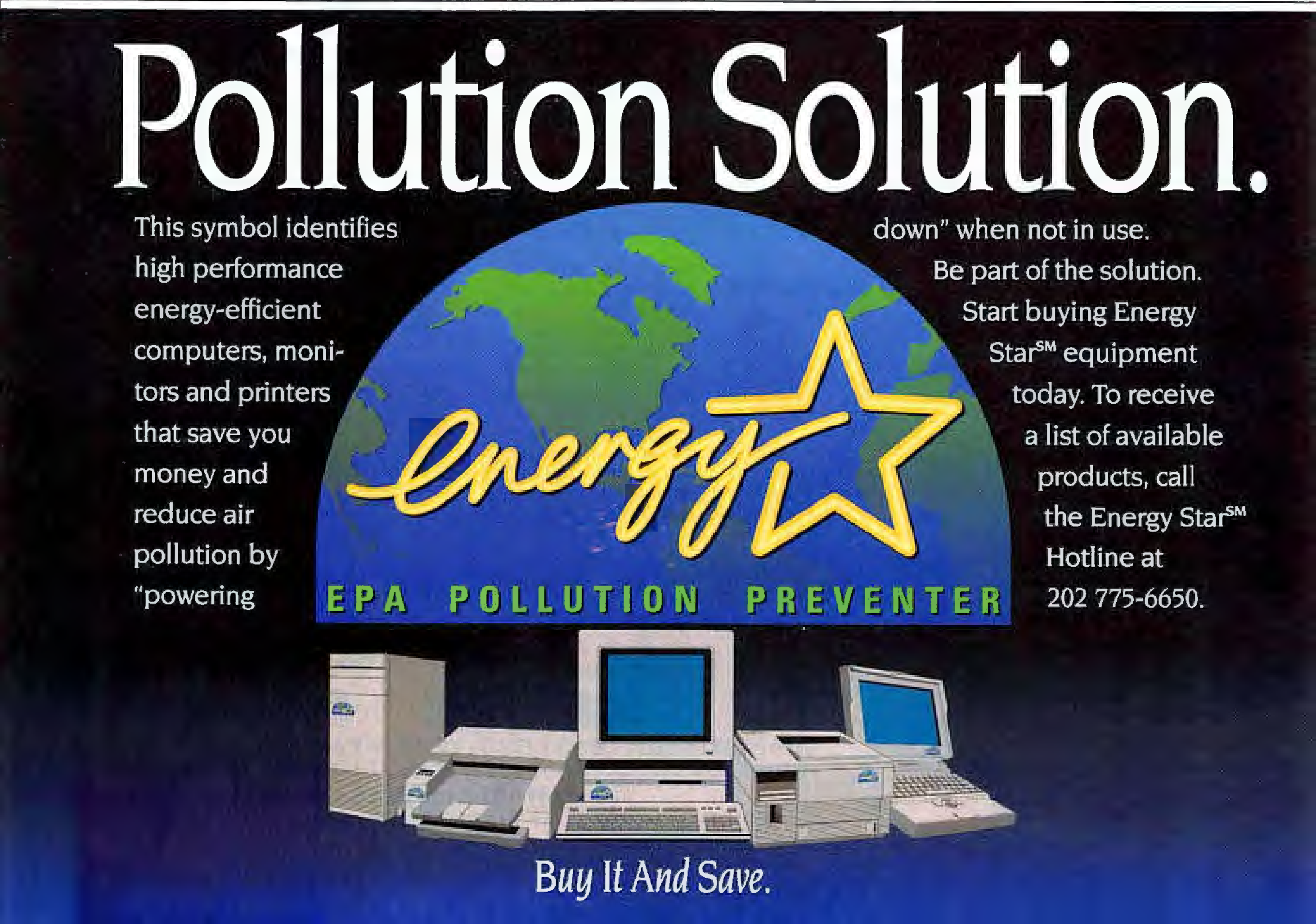

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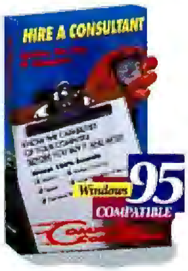


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So many factors go into making a great computer. You need to consider I/O, storage, memory, and the display. Oh, and don't forget ergonomics; human factors are very important. But what *really* gets your heart pumping is what lies at the heart of today's best systems: the newest, most screaming, most radically designed CPUs.

We have become addicted to speed. Gordon Moore is our pusher. Moore's law, which states that processing power will double every year and a half, has thus far held true. CPU designers, always in search of a better fix, drain every possible ounce of fat from processor cores, squeeze clock cycles, and cram components into smaller and smaller dies.

# HEART THROBS

**CPU designers beg, borrow, and steal for every ounce of performance they can get**

They also steal ideas from each other. As "CPU Scorecards" shows, the line between CISC and RISC is getting blurrier every day, and the next-generation offerings from the major chip families continue this trend. The upside for us is that a SPECint95 score of 300 will soon be the high-performance midrange, and we'll be eyeing scores of over 500 by this time next year.

However, processors aren't just getting faster; they are becoming more specialized as well. Consider the handful of new multimedia chips that we describe in detail in "Chip Fashion."

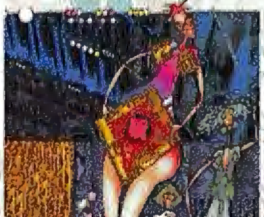
Perhaps nothing epitomizes the merging of CISC and RISC and the rise of specialization more than IBM's stealth processor, the PowerPC 615. This single-chip marriage of PowerPC and x86 promises to run native applications from both platforms with little performance hit. Insiders say that IBM has been working on it for years and has found the design mind-numbingly difficult to build.

The latest round of rumors puts the chip's introduction sometime in 1996. IBM, which barely admits that the project even exists, won't talk technical details. So, we asked a leading expert on chip design, the *Microprocessor Report*'s Linley Gwennap, to design the 615 for us. As far as we know, this design, outlined in "Why the 615 Matters," isn't necessarily what IBM is working on, but the efficiencies of Gwennap's shared-memory model may be fodder for Big Blue's engineers.

Whether you admire CPUs inherently or just appreciate them as one of the many important system components, the technologies described in the following pages should raise your pulse. ■

**—Alan Joch, Senior Editor**



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| | SPECint 92 | SPECfp 92 |
|---|---|---|
| hyperSPARC 125 MHz | 133 | 154 |
| MIPS 175 MHz | 130 | 100 |
| Alpha 166 MHz | 108 | 135 |
| superSPARC 75 MHz | 126 | 121 |
| microSPARC-II 110 MHz | 75 | 65 |

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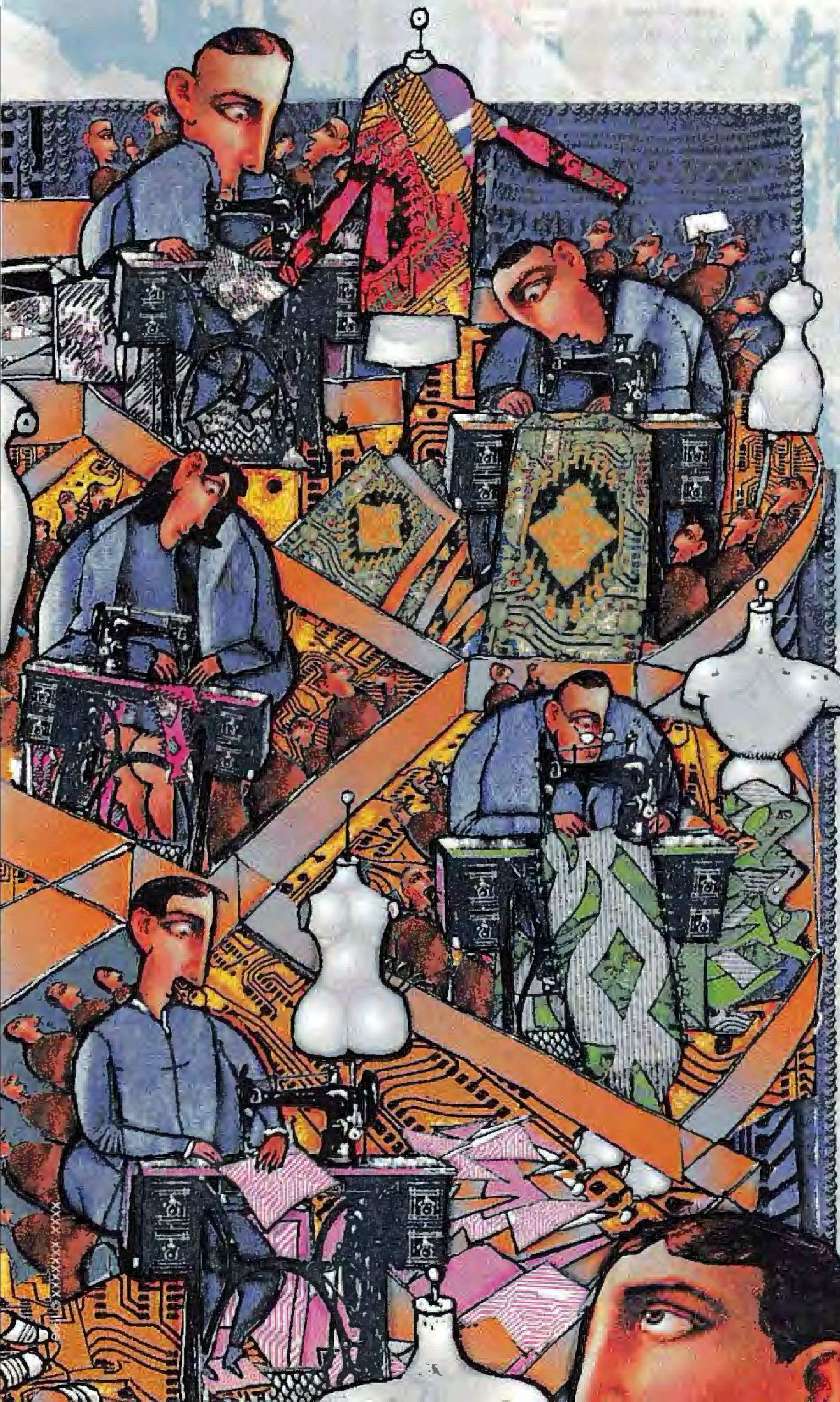
# CHIP FASHION

**Multimedia chips will dominate the technical talk at this year's Microprocessor Forum**



VICTOR GAD © 1995

**TOM R. HALFHILL AND JOHN MONTGOMERY**

In 1996, skirts will be longer, suits will be double-breasted, and chips will go multimedia. The latter is the big news at this year's Microprocessor Forum. This is the high-tech equivalent of the annual Paris fashion shows. At last year's forum, all the excitement surrounded next-generation CPUs. But at this year's forum in San Jose, California, the focus is moving to a wave of specialized microprocessors optimized for multimedia.

Some will replace general-purpose CPUs in vertical applications, such as TV set-top boxes. Others will work as coprocessors alongside conventional CPUs in mainstream PCs. They all share a departure from the generalized computational architecture that typifies today's microprocessors. To deal more efficiently with real-time digitized streams of analog audio and video, these innovative microprocessors are adopting some techniques used by digital signal processors (DSPs). Indeed, they often resemble hybrid CPU/DSPs that blend CISC, RISC, and DSP architectures in fascinating ways.

The four multimedia chips expected to heat up this year's forum are the MicroUnity Mediaprocessor, the Philips Trimedia, the Chromatic Mpact Media Engine, and the Nvidia NV1. They're all scheduled to appear in products in 1996.

General-purpose CPUs are also adapting to the demands of multimedia, and the forum will highlight those chips as well. Sun Microsystems is announcing the UltraSPARC-II, an enhanced version of its CPU, with special multimedia instructions, that was unveiled at last year's forum. Cyrix is expected to release some details about its Multimedia 586, which is apparently an M1 variant. Intel is known to be working on a multimedia version of the Pentium (code-named P55C), though it probably won't be presented this year.

Clearly, a new trend in chip design is under way. As PCs move beyond simple numbers and words to richer, more complex data types, the old approach to number crunching is no longer adequate. Over the next decade, we'll see a new generation of PCs that are as adept at handling audio and video as today's computers are at running word processors and spreadsheets.

**MicroUnity Mediaprocessor**

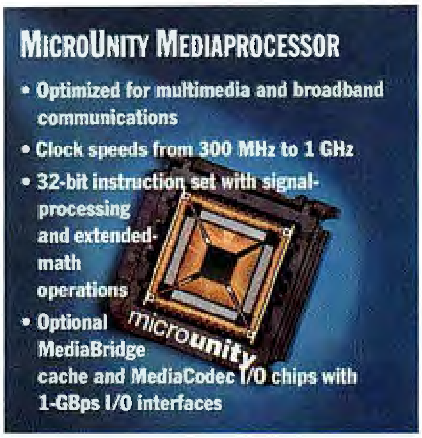
MicroUnity has been working in great secrecy on a new chip set that is supposed to revolutionize multimedia and broadband communications. What hath MicroUnity wrought? Only time will tell if it's a breakthrough, but its technical underpinnings are fascinating. MicroUnity has created a three-part chip set that streamlines the links among broadband interactive networks (e.g., coaxial cable, fiber optics, and wireless) and client devices.

The client device could be a next-generation set-top box, where MicroUnity's chip set might replace a general-purpose CPU and half a dozen ASICs. Or it could be a communications device, such as a cable modem or an asynchronous transfer mode (ATM) switch, where the chip set might replace an embedded processor, a DSP, and various support chips. The MicroUnity chip set could also be integrated onto the motherboard of a multimedia PC, if it can weather the economics of today's low-margin clone market.

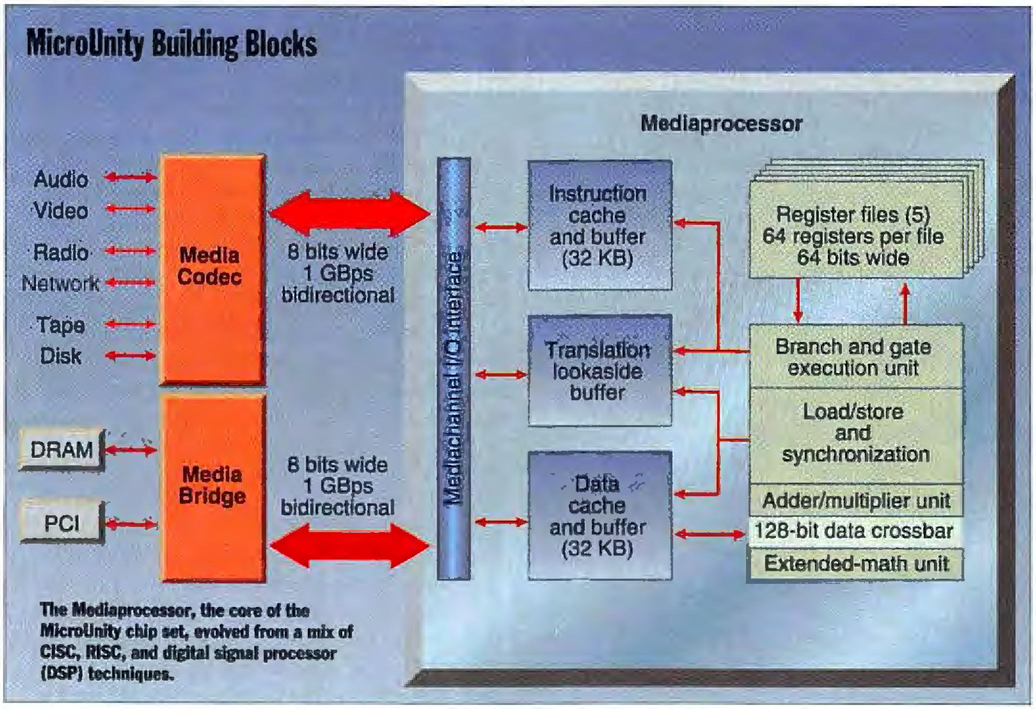
Central to the MicroUnity chip set is the Mediaprocessor, which is a programmable microprocessor that combines CISC, RISC, and DSP techniques with a high-bandwidth architecture. The actual interface to the broadband network is provided by the MediaCodec, an A/D converter (ADC) that boasts an impressive set of communications functions. Rounding out the trio is the MediaBridge, an external cache that can interface to a Peripheral Component Interconnect (PCI) bus and main-memory DRAM. The MediaCodec and MediaBridge are optional.

By far the most interesting chip is the Mediaprocessor, which is capable of prodigious throughput. MicroUnity is fabricating a "slow" 300-MHz version of the chip on a 0.6-micron CMOS process. The fast version, built on 0.5-micron BiCMOS, runs at 1 GHz (i.e., 1000 MHz). Thanks to a proprietary process technology invented by MicroUnity (which has built a chip foundry), the 1-GHz version squeezes about 10 million transistors onto a die only 10 millimeters square. It achieves these tiny dimensions by using four interconnected layers of ultraplanar metal, which is also part of the secret behind the Mediaprocessor's blazing speed. The critical paths are extremely short.

The other reason for the Mediaprocessor's high performance is a unique architecture. It's a five-cylinder multithreaded microprocessor. It can handle five tasks at once, devoting 200 MHz of processing bandwidth to each task. To do this, it maintains five files of 64-bit registers, with 64 registers per file. It also has 64 KB of onboard cache memory, equally divided between instructions and data. A dedicated I/O bus that's only 8 bits wide but can transfer 1 GB of data per second connects the Mediaprocessor to the MediaCodec and MediaBridge.




The Mediaprocessor has a dense instruction set that includes special operations for signal processing and extended math. For example, one of the instructions is called group fixed-point multiply and add. In a single cycle, this lone instruction can multiply four 32-bit operands by four other 32-bit operands, add the results to four more 32-bit operands, and return four 32-bit final results. That's 512 bits of bandwidth per clock cycle: 384 bits of input and 128 bits of output.




**The Mediaprocessor, the core of the MicroUnity chip set, evolved from a mix of CISC, RISC, and digital signal processor (DSP) techniques.**

The Mediaprocessor is fully programmable and can run its own real-time OS or other low-level real-time OSes. It can even run a higher-level OS such as Unix. Thus, it doesn't need a regular CPU for vertical solutions (e.g., set-top boxes). MicroUnity expected to announce products that will use its chip set in October.

**Philips Trimedia**

If you think of small talking heads in postage-stamp-size windows when you think of PC video, Philips may have a surprise for you. The Trimedia microprocessor is capable of taking over for your video and sound cards and generating multiple, independently scaled live video windows that overlap in any way you want.

The Trimedia is a general-purpose microprocessor that

has been enhanced to boost multimedia performance. It's a cross between a CPU and a DSP. When the Trimedia is placed in a typical PC, it will act as a multimedia coprocessor. Its role as a general-purpose microprocessor will be realized only when it's used in such devices as set-top boxes.

At the center of it is a 400-MBps bus that connects autonomous modules, including video in, video out, audio in, audio out, an MPEG variable-length decoder (VLD), an image coprocessor, a communications block, and a very long instruction word (VLIW) processor.

The VLIW processor includes a rich instruction set, with many extensions for handling multimedia. It is capable of sustaining five RISC operations per clock cycle at 100 MHz. Philips gets this performance by incorporating 27 functional units in the VLIW engine and feeding them with five instruction-issue registers. The functional units include multiple-integer ALUs, a multiple floating-point ALU, several integer and floating-point multipliers, and DSP attachment units. The functional units are pipelined, ranging from one deep (the integer ALU) to three deep (the floating-point ALU). Pipelines are also redundant (e.g., there is more than one add unit). With this design, the only functional unit that can't be fed on every clock cycle is the floating-point square root/divide.

The VLIW engine also includes 48 KB of cache memory: 32 KB for instructions and 16 KB for data. To save bandwidth and storage space, the VLIW instructions are compressed until the VLIW core needs them—even the instruction cache stores them compressed.

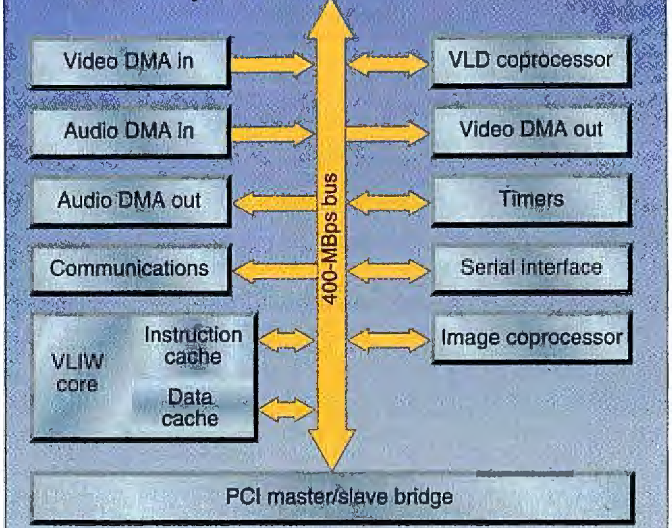
The other modules are processors that are each responsible for handling data-specific functions. These are generally functions that prepare data for the VLIW core.

The Trimedia is tuned to enable multiple modules to prepare their data simultaneously. The key to this is DMA. The VLIW core can issue a single instruction that opens a DMA path between main memory (stored off the chip) and any of the modules. With two instructions, video and audio could start streaming into the Trimedia. The video in and audio in modules would then asynchronously prepare the data for whatever future it may have.

The Trimedia uses "glueless" interfaces to the PCI bus, a digital camera, a video encoder, a stereo audio ADC/DAC, and a V.34 modem analog front end or ISDN terminal interface. The glueless interfaces decrease the cost of installing the Trimedia in a system—by up to one-third—by eliminating the need for separate adapters. The chip will cost below $50 in quantity.

With its low price and high performance (Philips estimates it will be able to perform 2 to 4 billion operations per second [BOPS] at 100 MHz), the Trimedia has the potential to become a standard part of PCs and consumer electronics devices. Philips, however, was reluctant to disclose its partners at press time.

### Inside the Philips Trimedia




**The Trimedia looks a lot like a CPU and a lot like a digital signal processor (DSP). The chip is designed so that the very long instruction word (VLIW) core has to do few extraneous calculations, leaving those to dedicated coprocessors.**

### PHILIPS TRIMEDIA

- DMA mastering-video and audio-I/O units
- MPEG-2 VLD that also supports MPEG-1
- Interfaces to PCI bus, digital cameras, and stereo audio
- Low cost (under $50)


### Mpact Media Engine

The Mpact Media Engine, which is from Chromatic Research, is architecturally similar to a general-purpose DSP. However, it's actually a highly specialized microprocessor that's designed to bring a wealth of multimedia features to mass-market x86-compatible PCs. When integrated on a PC motherboard, the Mpact can do the jobs of a Windows graphics accelerator, a 3-D graphics coprocessor, an MPEG video encoder/decoder, a sound card, a fax modem, and a telephony card. It should cost system vendors less than $150 and should be in PCs by mid-1996.

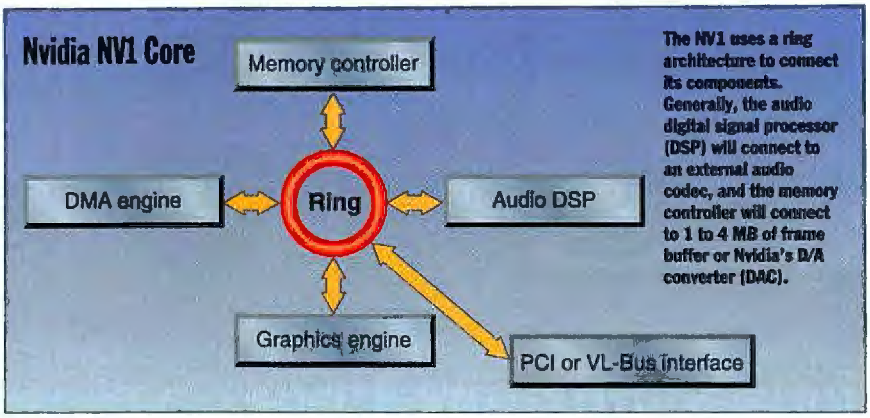
Internally, the Mpact is a 1.4-million-transistor specific-purpose processor, not just a gate array or a standard-cell amalgam of other chips. It has five ALUs, including one dedicated to motion estimation—a critical function for video encoding and videoconferencing. The parallel ALUs tie into an enormous 792-bit-wide crossbar bus that can move up to 8 billion integers per second between the ALUs and the chip's primary cache. The cache has eight ports and 4 KB of static RAM (SRAM), and it's connected over a 500-MBps bus to an off-chip secondary cache that has 2 to 4 MB of Rambus DRAM (RDRAM).

According to Chromatic, this architecture (which is reminiscent of the Texas Instruments MVP DSP) can sustain 1 to 2 BOPS for most multimedia functions. Its peak rate when performing motion-estimation functions is an incredible 20 BOPS.

Much of this speed is made possible by the Mpact's dense instruction stream and DSP-like optimizations. The Mpact processor has its own machine language that packs two op codes into every word by

### MPACT MEDIA ENGINE

- MPEG-1 real-time video and audio encoding/decoding
- MPEG-2 video and audio decoding
- Wave-table and wave-guide sound synthesis
- H.320 (ISDN) and H.324 (analog phone line) videoconferencing




The NV1 uses a ring architecture to connect its components. Generally, the audio digital signal processor (DSP) will connect to an external audio codec, and the memory controller will connect to 1 to 4 MB of frame buffer or Nvidia's D/A converter (DAC).

using a long instruction word (LIW) format. The op codes are single-instruction multiple-data operations that can perform vector functions on arrays of operands without time-consuming program loops.

This programmability is crucial to the Mpact's versatility. Multimedia algorithms written in the Mpact's machine language will run atop the chip's own real-time OS. Device drivers running under the system OS—such as virtual device drivers (VxDs) in Windows 95—map high-level API calls to these low-level programs, which are called *mediaware modules*. Thus, users can adapt their PCs to new industry standards and improved algorithms merely by upgrading the Mpact's device drivers and mediaware modules.

### Nvidia NV1

Nvidia wants your games. The NV1 is a highly integrated multimedia accelerator that includes a 3-D video accelerator (which can do 2-D graphics, too), a 350-MIPS audio engine (with Sound Blaster emulation), and an I/O processor (for joysticks and the like). This chip is designed to improve the game experience significantly. If early demonstrations are any indicator, it will.

The 3-D video accelerator is the most interesting part of the chip. What's intriguing is a graphics primitive called QTM (Quadratic Texture Map), a derivative of an algorithm named nonuniform rational B-splines (NURBS).

Here's why. Computers are good at generating straight lines, but curves present a problem. Most 3-D accelerators represent curves by interlocking polygons—polygons that consist of three or more vertices connected by straight lines. To make a curve smooth, a 3-D accelerator must use lots of small polygons, and that's compute-intensive.

The NV1 is more clever than that. Put simply, it curves the sides of its polygons, so it doesn't need as many to make curves smooth. Fewer polygons mean fewer calculations and faster 3-D acceleration. The NV1 picks up extra speed by decreasing the number of control points required by the host CPU to move through 3-D space. Its resolution is something more like plus or minus 1 pixel. In short, it's great for games with fast 3-D motion.

The audio subsystem is similarly game-oriented. It can generate 32 concurrent audio channels of CD-quality (i.e., 16-bit) audio with phase shifting (for 3-D sound). Perfect for monsters breathing, guns firing, and a great sound track. The secret of the audio subsystem is its DMA engine. The NV1 can push and pull data from main memory incredibly quickly over its preferred PCI or VL-Bus interface. Thus, it


doesn't need on-board memory to hold wave sounds—it can store them in main memory. The one potential problem with the NV1's DSP is that its algorithms are hard-wired into its silicon, so upgrades could be difficult. It's a gamble that reduces the cost and size of the NV1 overall.

Everything's connected with a 32-bit unidirectional ring bus. The bus's controller accepts transaction requests and sends instructions to every component.

The main problem we see with the NV1 is its lack of MPEG-1 decoding. MPEG-1 is popular with games. A secondary problem has to do with the new game APIs in Windows 95: They aren't optimized to the

NV1's 3-D texture map, so games written to these APIs won't exploit the NV1. With a volume price of $70, we'll probably see many multimedia boards built on this chip, so maybe the API problem will work itself out. Already, Sega has worked out a deal to port many of its games to the NV1, and Diamond has developed a board that uses the NV1.

### Lights, Camera, Action

These aren't the only multimedia chips around—they're not even the only ones at the Microprocessor Forum this year. Hewlett-Packard's PA7300LC has multimedia instructions, for example, and Motorola and IBM are announcing new versions of their venerable DSPs.

**Product Information**

**Mediaprocessor** . . . . .not announced
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fax: (408) 734-8141
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**NV1** . . . . . . . . . . . . . . . . . . . . .$70
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**Circle 1245 on Inquiry Card.**

But these chips do show that microprocessor developers are reconsidering what a microprocessor is and how it should function. More important, they show a trend toward consumerization: These multimedia processors are inexpensive and small, and they consume little power. You'll be seeing them not only in your PC, but in your set-top box, your TV, and probably devices we haven't even thought of yet. ■

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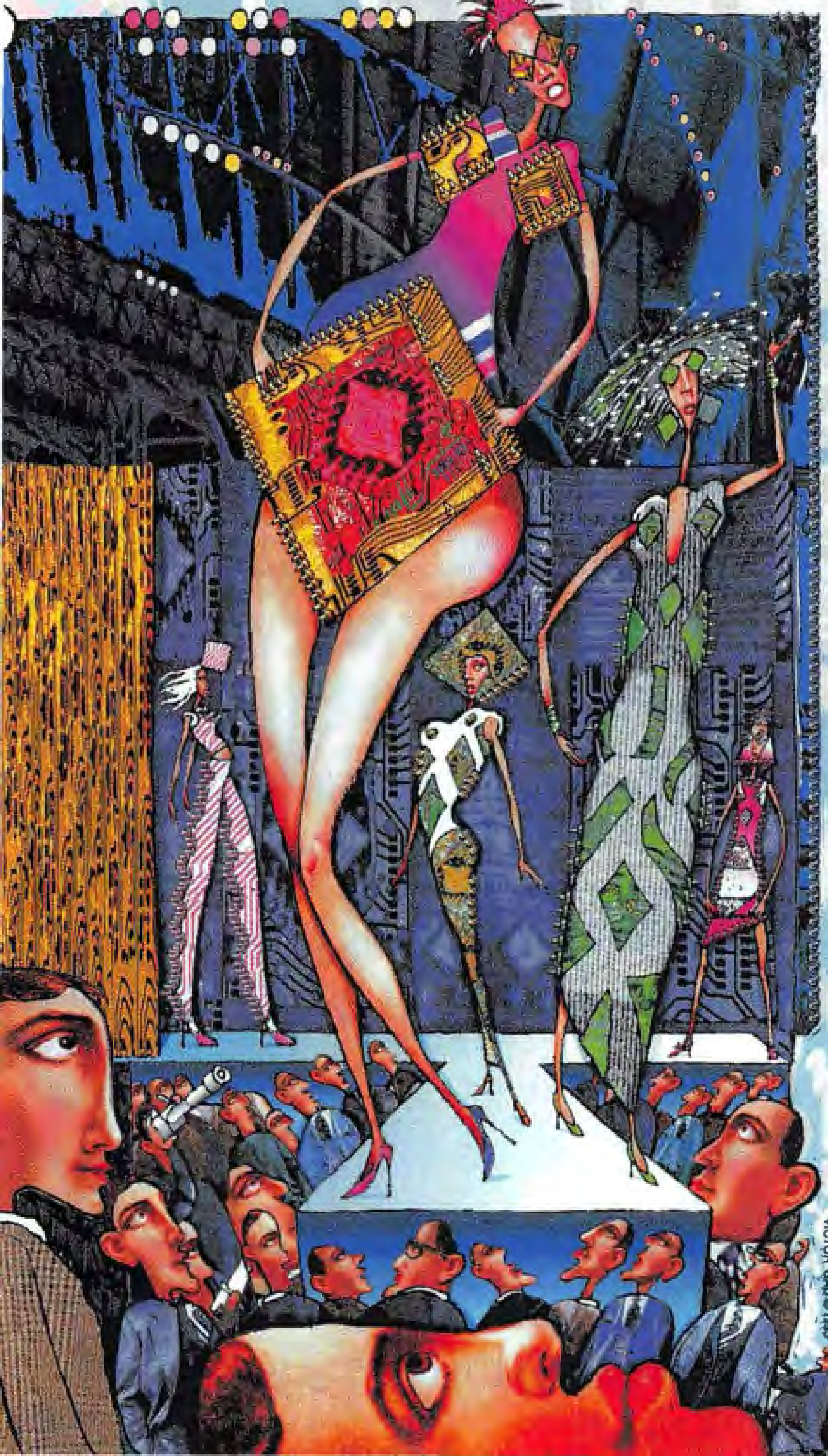
*The guardians of BYTE's San Mateo office, Tom R. Halfhill is a senior editor, and John Montgomery is the features editor. They can be reached on the Internet or BIX at thalfhill@bix.com and jmontgomery@bix.com.*

# CPU SCORECARDS




**A look at how tomorrow's next-generation chips stack up**

DICK POUNTAIN AND TOM R. HALFHILL

CPU choices used to be clean when the great rivals, CISC and RISC, were in two distinct camps. But with the CPU introductions set to begin late this year, each camp steals the other's best ideas, and blurs replace distinctions.

For example, Intel's P6 translates long x86 CISC instructions into simple, fixed-length micro-operations executed by what is essentially a RISC processor core. Sun Microsystems' UltraSparc-II will boast special graphics instructions to speed up the MPEG decoding that would require up to 48 instructions on other processors. These are CISC instructions in all but name.

The scorecards on the following pages show that next-generation CISC and RISC CPUs will fight performance battles on four fronts: executing more instructions per cycle, executing instructions out of order to sidestep dependencies, renaming registers to avoid register famine, and contributing to faster overall system performance, not just CPU speed.

All these chips issue more than one instruction per cycle; the five RISC CPUs here are all four-issue superscalar designs. But they vary in the number of function units they provide, ranging from nine in the UltraSparc to four in the Alpha 21164.

Processes are shrinking, too. Intel, Digital, and Mips will all deliver 0.35-micron chips by early 1996. By 1997, expect to see CPUs built in 0.25-micron CMOS, clocked at 400 MHz, and delivering 1000 SPECfp95. It's also reasonable to expect that by then software designers will have found a way to soak up all that power and redraw the battle lines.

*Dick Pountain is a BYTE contributing editor based in London. Tom R. Halfhill is a BYTE senior editor based in San Mateo, California. You can reach them on the Internet or BIX at dickp@bix.com and thalfhill@bix.com, respectively.*


**CURRENT STATUS:** Entering production

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Good

**TARGET CLOCK SPEED:** 150 MHz

**ESTIMATED PERFORMANCE:** 220 SPECint92; 215 SPECfp92

**FABRICATION PROCESS/FEATURE SIZE:** BiCMOS/0.6-micron

**TECHNOLOGICAL ADVANTAGES:** A multichip package with a 256-KB secondary cache coupled to the CPU at full core speed; out-of-order superscalar microarchitecture; chip is superpipelined for high clock speeds.

**TECHNOLOGICAL DISADVANTAGES:** The multichip package is costly to manufacture; the microarchitecture is tuned for 32-bit software, yielding poor performance with 16-bit code; power consumption and heat dissipation are currently unsuitable for notebook computers.

**PRIMARY MARKET:** Servers and high-end PCs.

**WHERE TO FIND:** Intel, Santa Clara, CA, (800) 628-8686 ext. 134 or (408) 765-8080; fax (800) 628-2283 (documents 7162 through 7165); http://www.intel.com/.

# INTEL

## Next generation: **P6**

**DOSSIER:** The first PCs containing Intel's sixth-generation P6 processor should appear late this year. Intel originally planned to introduce the P6 at 133 MHz, but thanks to better-than-expected performance from the initial silicon, Intel now hopes to debut the chip at 150 MHz. Some speed-sorted parts may reach 166 MHz.

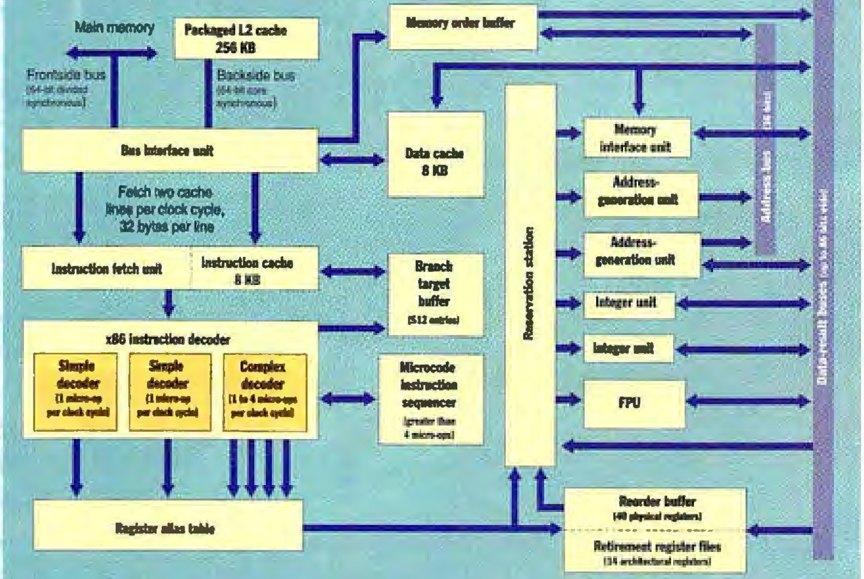
Even faster clock speeds are coming soon, and Intel designed the superpipelined P6 to handle them. In 1996, the P6 will begin migrating from Intel's 0.6-micron BiCMOS process to a smaller, faster, 0.35-micron BiCMOS process technology. (High-end Pentiums are already fabricated on this process.) The optical shrink could allow Intel's flagship processor to hit 231 MHz by the end of next year.

The P6 has a dark side, however. It runs 16-bit software slower than a Pentium does. Intel optimized the P6 for 32-bit code, making compromises that severely impair its performance with older, 16-bit code. As a result, even a Pentium that runs at a slower clock speed than a P6 will do a better job with most of today's mainstream software. (See News & Views, September and October BYTE.)

Competitors are ecstatic about this, but Intel is keeping a stiff upper lip. By around 1997, the P6's price should drop low enough to make it a mainstream processor, and 32-bit OSes and applications should be commonplace.

Meanwhile, the Pentium will continue to dominate the market for x86 CPUs. Late this year, Intel will introduce a 150-MHz Pentium, to be followed by faster versions in 1996. The 0.35-micron process technology should allow future Pentiums to run at 167 to 180 MHz, and perhaps 200 MHz. These advances at the high end will pull the entire market forward. Today, standard Pentiums run at 75 to 100 MHz; by this time next year, the midpoint will probably be 120 MHz.

### P6 Plumbing




The P6 is superpipelined for fast clock speeds, starting at 150 MHz.

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**Circle 120 on Inquiry Card (RESELLERS: 121).**


**CURRENT STATUS:** Taped out (i.e., design completed)

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Fair

**TARGET CLOCK SPEED:** 120 MHz

**ESTIMATED PERFORMANCE:** 176 to 203 SPECint92

**FABRICATION PROCESS/FEATURE SIZE:** CMOS five-layer metal/0.6-micron

**TECHNOLOGICAL ADVANTAGES:** Performance is estimated to be equal to or better than that of the Pentium-150, with a 50 percent smaller die than the original 6x86-100.

**TECHNOLOGICAL DISADVANTAGES:** Die size is still relatively large compared to that of the latest Pentiums.

**PRIMARY MARKET:** Mainstream PCs.

**WHERE TO FIND:** Cyrix, Richardson, TX, (214) 968-8388; fax (214) 699-9857; http://www.cyrix.com.

# CYRIX

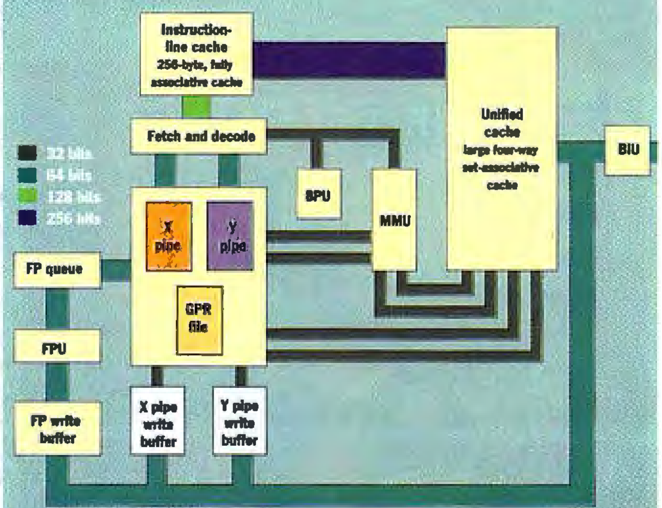
## Next generation: **M1rx**

**DOSSIER:** Cyrix's first M1 chip, the 6x86-100, is crippled by a monstrously large die that's difficult and expensive to manufacture. The M1rx (a code name) addresses that problem by using five layers of metal instead of three on the same 0.6-micron process, which reduces the die from 394 square millimeters to approximately 225 $mm^2$. This also allows Cyrix to boost the internal clock speed to 120 MHz.

Cyrix is ramping up production of both the 6x86-100 and the M1rx-120 late this year, but don't expect to see high volumes of either chip until 1996. In fact, nobody will be surprised if the large-die 6x86-100 *never* attains high volumes; it's so costly it will probably be discontinued after a relatively short product life.

In the first quarter of 1996, Cyrix plans to optically shrink the 6x86 to a 0.5-micron, five-layer-metal process that will reduce production costs still further and increase the clock speed to 133 MHz. That version should match or exceed the performance of a 167-MHz Pentium. In the third or fourth quarter of 1996, Cyrix promises that the 6x86 will reach 150 MHz. The estimated performance would exceed that of a 180-MHz Pentium.

**The M1rx Foundation**




**The M1rx will shrink Cyrix's 6x86 design down to a more manageable die size.**

If Cyrix is able to meet these goals, the company will likely sell all the CPUs it can make. Clock for clock, the 6x86 beats the Pentium and is competitive with Intel's P6. Indeed, the 6x86 should easily outperform the P6 when running the 16-bit and mixed 16-/32-bit code that dominates the PC market today.

Meanwhile, Cyrix isn't ignoring entry-level PCs. Although the company is phasing out 486 production late this year, it's filling the gap with the 5x86, a hybrid design that adopts some of the 6x86's features in a chip that's initially pin-compatible with 32-bit 486 sockets (see "New 486 Chips Deliver Inexpensive Power," September BYTE). The low-power 5x86 is also ideal for notebook computers.

Although Cyrix has had trouble getting the 6x86 into production, the company now appears well-positioned to take advantage of the explosive growth in the PC market. The P6's poor performance with 16-bit code is a lucky break for Cyrix, because the 6x86 will be a better choice for the millions of people using Windows 3.1 and Windows 95.


**CURRENT STATUS:** Sampling

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Good

**TARGET CLOCK SPEED:** 75 MHz

**ESTIMATED PERFORMANCE:** 109 to 115 SPECint92

**FABRICATION PROCESS/FEATURE SIZE:** CMOS three-layer metal/0.35-micron

**TECHNOLOGICAL ADVANTAGES:** Four-way superscalar microarchitecture; decoupled RISC-like core; speculative, out-of-order execution.

**TECHNOLOGICAL DISADVANTAGES:** Clock speeds are falling short of initial targets; lengthy compatibility testing has delayed introduction.

**PRIMARY MARKET:** Mainstream desktop PCs.

**WHERE TO FIND:** AMD, Austin, TX, (800) 222-9323 or (408) 749-5703; http://www.amd.com.

# AMD

## Next generation: K5

**DOSSIER:** AMD's reputation is riding heavily on the K5, the company's first x86 processor to break free of Intel's designs. The birth of the K5, however, has not been without labor pains.

Originally, AMD planned to ship the K5 in volume this year at clock speeds ranging from 100 to 120 MHz. Instead, only a few thousand K5 chips will trickle out of AMD's foundries in the fourth quarter, and they will be clocked at a conservative 75 MHz.

What happened? AMD apparently underestimated how long it would take to verify the K5 (especially after the public furor over the Pentium bug), and the company was overoptimistic about the K5's initial silicon. Missed deadlines and slower clock speeds resulted.

But AMD is working hard to catch up. Few, if any, of the K5 chips manufactured this year on AMD's 0.5-micron process will show up in commercially available systems. In the first quarter of 1996, AMD plans to move the K5 onto its new 0.35-micron process technology, which was developed in partnership with HP and is centered in AMD's brand-new Fab 25 in Austin, Texas. That will shrink the K5's 4.2-million-transistor die to about 167 $mm^2$ and allow significantly higher yields. It will also permit faster clock speeds.

AMD says its production will ramp up rapidly in 1996, enough for it to ship more than 5 million K5s by the end of next year. According to AMD, clock speeds will rise to 90 or 100 MHz in the first quarter and go beyond 100 MHz after that. AMD hasn't released official SPEC numbers or allowed independent benchmarking, but based on the claim that the K5 is 30 percent faster than a Pentium at the same clock speed, we estimate the performance of a 75-MHz K5 at 109 to 115 SPECint92. That should scale to about 150 SPECint92 at 100 MHz.

Even if AMD succeeds in meeting these goals, the K5 will trail high-end Pentiums in raw performance—and then there's the P6. AMD's answer to Intel's sixth-generation CPU is supposed to be the K6, but that's highly unlikely to happen before 1997. Nevertheless, AMD should have no trouble selling all the chips that it can make next year. In addition, the company is putting itself into a better position for the future; it recently purchased a second Quickturn simulator to accelerate its compatibility testing.

**A look at the AMD K5's superscalar architecture.**

Meanwhile, AMD will keep its foundries busy by cranking out 486 chips for a declining but worthwhile market. Worldwide 486 shipments are expected to drop from 35 million this year to 20 million in 1996, and AMD hopes to ship most of those. AMD's souped-up 486 chips, clocked at 120 and 133 MHz, will compete with low-end Pentiums in entry-level PCs (see "New 486 Chips Deliver Inexpensive Power," September BYTE). However, the pressure is on AMD to ramp up the K5, because the 486 is quickly dropping off the map.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fat, lazy dream
off the ground.


**CURRENT STATUS:** Design stage

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Fair

**TARGET CLOCK SPEED:** Unknown

**ESTIMATED PERFORMANCE:** Unknown; probably comparable to that of the Intel P6.

**FABRICATION PROCESS/FEATURE SIZE:** CMOS/0.35- or 0.25-micron

**TECHNOLOGICAL ADVANTAGES:** The Nx686 will enhance the decoupled RISC-like microarchitecture first introduced in the Nx586 while retaining the Nx586's high-speed dedicated cache interface.

**TECHNOLOGICAL DISADVANTAGES:** The Nx686 could reveal the future limits of increased parallelism in a decoupled core.

**PRIMARY MARKET:** Mainstream desktop PCs.

**WHERE TO FIND:** NexGen, Inc., Milpitas, CA, (800) 863-9436 or (408) 435-0202; http://www.nexgen.com.

# NEXGEN

## Next generation: **Nx686**

**DOSSIER:** Little is known about the Nx686, because the chip hasn't been announced yet and NexGen doesn't want to tip its hand to rivals AMD, Cyrix, and Intel. However, NexGen has stated that the Nx686 will match the performance of Intel's P6 and build on the microarchitecture introduced by the Nx586 in 1994.

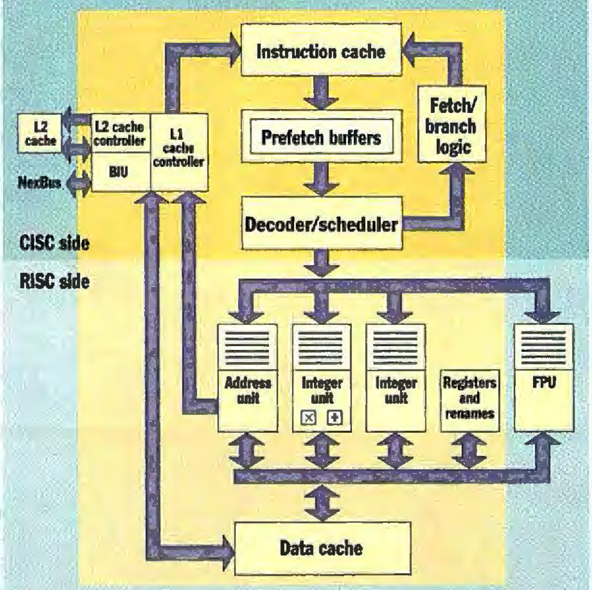
That microarchitecture, dubbed RISC86 by NexGen, was the first of its kind to appear in an x86 processor. Similar microarchitectures have since been adopted by Intel's P6 and AMD's K5. The basic idea is to convert the troublesome CISC instructions of x86 software into RISC-like operations that execute in parallel within a RISC-like processor core. This approach, known as a *decoupled microarchitecture*, allows a CISC processor to take advantage of RISC's architectural innovations and be backward-compatibile with existing x86 software.

The Nx686 will advance this philosophy to the next logical level. Currently, the Nx586 has three execution units, a three-way superscalar core, and the ability to decode only one x86 instruction per clock. That opens up several opportunities for improvement. The Nx686 will probably have at least five execution units, four execution pipelines, and multiple decoders capable of handling two or more x86 instructions per clock. To cope with the increased complexity of this design, the Nx686 will likely add more rename registers and instruction queues.

One thing that won't change is the integrated cache controller and high-speed cache interface. The Nx686, like its predecessor, will talk to its secondary cache over a dedicated I/O bus that runs at the full speed of the processor core. Intel adopted this feature in the P6 and went even further by including a 256-KB static RAM (SRAM) cache in a multichip package. NexGen says it's considering this option because its foundry partner, IBM Microelectronics, is good at making SRAM and multichip modules (MCMs).

An example of IBM's MCM technology can be seen in a new version of the Nx586 that's scheduled to ship this quarter and includes both a CPU and an FPU die in an MCM. At the same time, a relayout and a process shrink to 0.35 micron have made it possible for NexGen to dramatically reduce the size of the CPU die to less than 118 $mm^2$—the smallest in its class.

**A Hint of Things to Come?**




BIU = branch interface unit

**The earlier-generation Nx586 architecture, shown here, will probably be extended in the Nx686.**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**CURRENT STATUS:** Sampling in first quarter of 1996

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Unknown

**TARGET CLOCK SPEED:** Over 300 MHz

**ESTIMATED PERFORMANCE:** 500 SPECint92; 700 SPECfp92

**FABRICATION PROCESS/FEATURE SIZE:** CMOS/0.35-micron

**TECHNOLOGICAL ADVANTAGES:** The Alpha 21164A retains the microarchitecture of the 21164, a four-way superscalar design with extremely simple, stripped-down data paths that allow it to be clocked faster than other vendors' chips.

**TECHNOLOGICAL DISADVANTAGES:** At around $3000, the Alpha 21164 is the most expensive RISC chip on the market, and the 21164A is likely to retain this distinction. The latest version depends more on compiler quality to achieve maximum throughput than some competitors. For optimum throughput, the chip must cluster instructions into groups of four that execute together, and this task is left entirely to the compiler.

**PRIMARY MARKET:** Scientific and engineering workstations and high-end Windows NT and Unix servers.

**WHERE TO FIND:** Digital Equipment, Hudson, MA, (800) 332-2717 or (508) 568-6868; semiconductor@digital.com.

# DIGITAL EQUIPMENT

## Next generation: **Alpha 21164A**

**DOSSIER:** The Alpha adheres more closely to the RISC philosophy than its competitors by stripping away every ounce of fat from the hardware and instruction set in favor of the fastest possible data path. Alpha designers believe that a faster clock will buy you what other chips achieve through fancy hardware. The principle appears to work: The 21164 was the fastest single-chip microprocessor in the world when it was launched in 1995, with three times the integer performance of a Pentium/100 and faster FPU performance than Mips' R8000 supercomputer chip set. The next-generation 21164A's layout has not changed, but the chip will apply a process shrink and compiler enhancements to deliver even more SPECmarks.

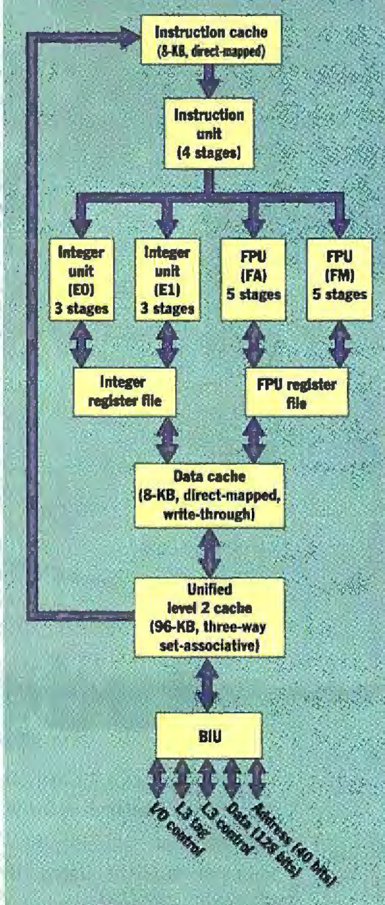
The 21164 family eschews out-of-order execution, relying instead on smart compilers that can sequence code to minimize pipeline stalls. At 9.3 million transistors, these chips have the largest transistor budget of any CPUs made so far, but most of them are used for cache-memory cells. The 21164 design has relatively small (8-KB) direct-mapped primary caches, but it's the first CPU to place a large (96-KB) secondary cache actually on-chip for minimum latency. Intel's P6 has its secondary cache in the same package, but not on the same silicon slice.

The 21164 family has four execution units (two integer and two floating-point) and can issue two instructions of each kind per cycle. It has a four-stage instruction pipeline that feeds into separate integer, floating-point, and memory-execution pipelines. Compared to other next-generation RISC chips, the 21164 has pipelines that are relatively deep and simple, for high clock speeds.

The instruction pipeline doesn't do any complex checking for data dependencies or issue any instructions out of order. If the current four instructions cannot all be issued into different execution units, the instruction pipeline stalls until they can. Unlike its competitors, the 21164 doesn't use register renaming; instead, it updates architectural registers directly once a result has reached the final writeback stage of the pipeline. To avoid delaying any dependent instructions, the chip has extensive register-bypass routes so that shared operands are available well before the write-back stage.

Digital intends to push the Alpha for NT servers rather than for the more traditional Unix. Coupled with keener pricing, this could become a winning strategy.

### Inside the World's Fastest RISC CPU




**The 21164A improves upon the existing Alpha design with a process shrink and a better compiler.**


**CURRENT STATUS:** Sampling

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Good

**TARGET CLOCK SPEED:** 200 MHz

**ESTIMATED PERFORMANCE:** 300 SPECint92; 600 SPECfp92

**FABRICATION PROCESS/FEATURE SIZE:** CMOS/0.35-micron

**TECHNOLOGICAL ADVANTAGES:** The 64-bit R10000 has five functional pipelines, so it can potentially execute up to five instructions in any given cycle. With two double-precision FPUs, the R10000 is optimized for high floating-point performance.

**TECHNOLOGICAL DISADVANTAGES:** For best performance, the off-chip secondary cache needs to be built from expensive SRAM.

**PRIMARY MARKET:** Graphics workstations, symmetric multiprocessing (SMP) servers, and supercomputers.

**WHERE TO FIND:** Mips, Mountain View, CA, (415) 933-6477; fax (800) 446-6477; http://www.mips.com.

# MIPS

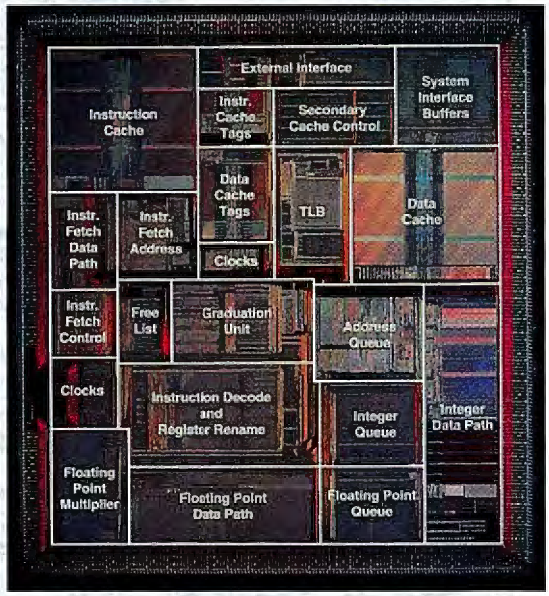
## Next generation: **R10000**

**DOSSIER:** The R10000 inherits its superscalar design from the R8000, which was created for the scientific supercomputing market. But the R10000 is intended for more mainstream applications. The R10000's adoption of dynamic instruction scheduling, which reduces the need to recompile software that's written for older-generation processors, is of particular benefit to Mips partner Silicon Graphics, which has a back-catalog of large and complex graphics applications.

The R10000 is the first single-chip superscalar processor from Mips. It features dynamic branch prediction to minimize pipeline stalls, with up to four levels of speculative execution, using register renaming to ensure that no results are committed to the real registers until the branch is resolved. The chip maintains a "shadow map" of its rename register mappings. In the event of a mispredicted branch, it just restores this map rather than having to clear registers and flush buffers, which reduces the penalty to one cycle.

The R10000 also features a radical out-of-order execution scheme. Instructions remain in program order through the first three pipeline stages, but following that they divert into one of three queues (which wait on the integer ALUs, the FPUs, or the load/store unit). These queues get served in whatever order that their resources become free.

Program order is eventually restored by always "graduating" (which is Mips jargon for retiring) the oldest instruction first. This also ensures precise exception reporting. This hardware-assisted instruction reordering offers a great advantage to end users, because code that's written for Mips's older, scalar CPUs (e.g., the R4000) will gain almost the entire speed benefit without needing to be recompiled.




**Twin FPUs in the R10000 processor mean exceptional SPECfp92 speeds.**

Although it has the potential to issue five execution instructions per cycle, the Mips R10000 can fetch and retire only four; a fifth cannot complete on the same cycle. Nevertheless, this excess of dispatch bandwidth offers more flexible opportunities for instruction scheduling, which means that the R10000 can complete four instructions per cycle for more of the time.

One of the twin double-precision FPUs handles addition; the other processes multiply/divide and square-root functions. The latter is further split into two subunits that can execute a division operation and a square-root operation in parallel. An on-chip processor-bus interface permits up to four R10000s to be clustered in a multiprocessor configuration without requiring any glue logic.

PCMCIA


**CURRENT STATUS:** Design

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Excellent

**TARGET CLOCK SPEED:** 250 to 300 MHz

**ESTIMATED PERFORMANCE:**
350 to 420 SPECint92; 550 to 660 SPECfp92

**FABRICATION PROCESS/FEATURE SIZE:**
Five-layer-metal CMOS/0.3-micron

**TECHNOLOGICAL ADVANTAGES:**
The UltraSparc-II is a 64-bit, four-way superscalar CPU that Sun optimized for multimedia and networking applications rather than for outright CPU performance.

**TECHNOLOGICAL DISADVANTAGES:**
The lack of hardware assistance for instruction reordering places a premium on compiler quality and requires companies to recompile older software to reap the benefits of the UltraSparc's enhancements.

**PRIMARY MARKET:**
Multimedia workstations.

**WHERE TO FIND:** Sun Microsystems, Sunnyvale, CA, (800) 681-8845 or (408) 774-8119; http://www.sun.com/sparc/Net.Engine.

# SUN MICROSYSTEMS

## Next generation: **UltraSparc-II**

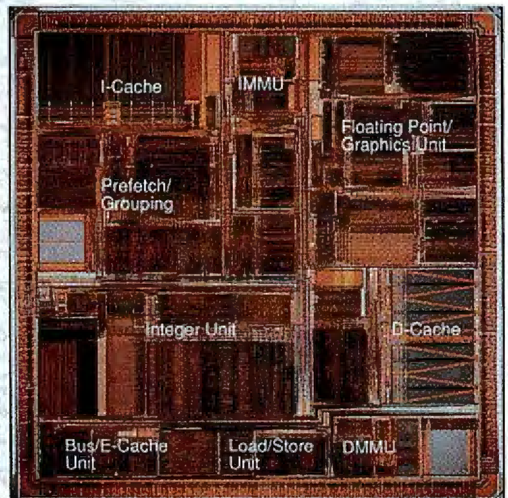
**DOSSIER:** An early adopter of RISC technology, Sun specified SPARC in 1988 as a scalable, "future-proof" architecture. However, by 1993, the SuperSparc implementation had begun to lag badly behind its competitors.

The UltraSparc, the fourth SPARC generation, will make up much of that lost ground. It contains no less than nine execution units: two integer ALUs, five FPUs (two for floating-point addition, two for floating-point multiplication, and one for floating-point division/square roots), a branch-processing unit, and a load/store unit. The UltraSparc has dynamic branch prediction integrated into its primary instruction cache and speculatively executes predicted branches, but it cannot issue instructions out of order. It relies on optimizing compilers to order them well.

The SPARC architecture has always offered register *windows*, eight overlapping banks of 24 duplicate registers that can preserve the processor state during context switches instead of doing an expensive write to memory. Compiler writers have often found these windows insufficient, so the UltraSparc adds an extra mechanism whereby a fresh window of eight registers becomes available every time an interrupt, memory management unit (MMU), or other trap occurs. This should greatly speed up the handling of multithreaded code.

To get high sustained system bandwidth, the UltraSparc uses a hierarchy of decoupled buses. The memory bus is 128 bits wide and runs at full processor speed. This connects via buffer chips to a 128-bit system bus that runs at half, one-third, or one-fourth the core speed. At the slowest level, the SBus is used for I/O to low-cost peripherals.

Sun implements this scheme at the hardware level by a crossbar switch chip, which is part of the support chip set. This chip can isolate the memory bus from the I/O bus so that instead of stalling during memory reads, the CPU continues writing to graphics or other I/O devices. The effect of this scheme is high overall bus utilization and sustainable 1.3-GBps throughput.




**Sun Microsystems' UltraSparc offers nine execution units.**

The UltraSparc-II uses the Visual Instruction Set (VIS), which includes 30 instructions for handling multimedia, graphics, imaging, and other integer-oriented algorithms. VIS instructions include addition, subtraction, and multiplication operations, which allow up to eight integer byte-wise or halfword-wise operations to be performed in parallel with a load or store operation and a branch in a single clock cycle.

This approach can be used to improve video performance. For example, for alpha blending (i.e., superimposing one image on top of another with a translucent top image), VIS includes instructions specifically designed to multiply the alpha value by the pixel values, a process that can take many floating-point operations.

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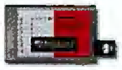

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**CURRENT STATUS:** Sampling

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Good

**TARGET CLOCK SPEED:** 200 MHz

**ESTIMATED PERFORMANCE:** Greater than 360 SPECint92; greater than 550 SPECfp92

**FABRICATION PROCESS/FEATURE SIZE:** CMOS/0.5-micron

**TECHNOLOGICAL ADVANTAGES:** HP is the only RISC vendor to leave its primary instruction and data caches off-chip, where they can be made to be several megabytes in size. (RISC cores designed solely for maximum processing speed often perform badly on data sets that are too big to fit in the cache.)

**TECHNOLOGICAL DISADVANTAGES:** The off-chip caches run at full CPU speed and so need to be created with ultrafast SRAM, which makes them expensive to build.

**PRIMARY MARKET:** Commercial data processing; engineering and scientific workstations.

**WHERE TO FIND:** Hewlett-Packard, Cupertino, CA, (408) 447-4747; fax (408) 447-7983.

# HEWLETT-PACKARD

## Next generation: **PA-8000**

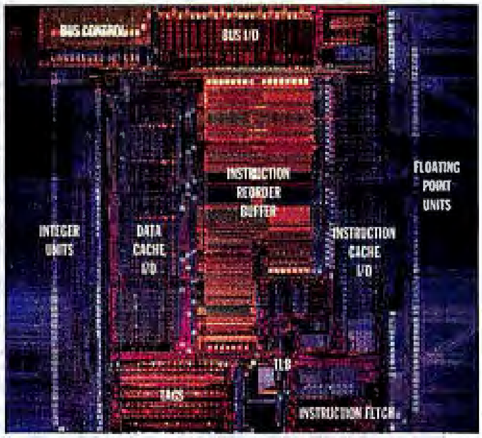
**DOSSIER:** Hewlett-Packard was an early entrant into the RISC market, launching its first 32-bit PA-RISC processor in 1986. Practically all PA-RISC chips go into HP's 9000 series workstations. HP shipped enough of these machines from 1991 to 1993 (prior to the introduction of PowerPC systems) to make PA-RISCs the biggest-selling RISC chips in dollar volume.

HP set up the Precision RISC Organization (PRO) to promote the use of its chips by other manufacturers. Then, in 1994, HP dropped the bombshell that it was teaming up with Intel to create a new architecture. This throws doubt on the future of the PRO.

The PA-8000 is a 64-bit, four-way superscalar design with a radical out-of-order execution scheme. The chip has 10 function units: two integer ALUs, two integer shift/merge units, two floating-point multiply/accumulate (MAC) units, two floating-point divide/square-root units, and two load/store units. The MAC units have a three-cycle latency and are fully pipelined for single-precision processing to deliver up to 4 FLOPS per cycle. The divide units have 17-cycle latency and are not pipelined, but they can be run concurrently with the MACs.

The PA-8000 uses a 56-instruction-deep instruction reorder buffer (IRB), which looks ahead to the next 56 instructions in the stream to find four that can execute in parallel. The IRB actually consists of two 28-slot buffers: The ALU buffer holds instructions for the integer unit and FPU, and the memory buffer holds load/store instructions.

Once an instruction has been stored into an IRB slot, the hardware watches all instructions being dispatched to the function units to see whether any of them supplies one of the operands for the instruction in the slot. The instruction in the slot runs only after the last instruction for which it is waiting has been dispatched. Each of the IRB's two buffers can dispatch two instructions per cycle, and in all cases it's the oldest instruction in the buffer that gets issued. Since the PA-8000 uses register renaming and retires instructions from the IRB in program order, it maintains a precise exception model.



**Off-chip instruction and data caches make HP's design unique.**

HP designed the PA-8000 especially for commercial data processing and complex computational applications, such as genetic engineering, where data sets tend to be too big to fit into any conceivable on-chip cache. Thus, the PA-8000 employs external primary data and instruction caches. The slots in a third 28-slot buffer, called the address-reorder buffer (ARB), are associated one-to-one with the slots of the IRB's memory buffer. The ARB keeps the virtual and physical addresses of all dispatched load/store instructions. In addition, the ARB permits loads and stores to execute out of order while maintaining coherency, and it effectively hides the long latency associated with the addressing of off-chip caches.

Finding a single source for all your mass storage needs, from WORM to multifunction, is definitely a big advantage. With this in mind, one name continues to rise to the top: Panasonic. Panasonic offers both the security of true WORM and the flexibility of multi-function in its wide range of optical drives and jukeboxes. Here's a quick look at just a few of Panasonic's offerings:

| DEVICE DRIVER SUPPORT | OPERATING SYSTEM |
|---|---|
| Panasonic | DOS, Windows, Mac, Novell, OS/2, SUN |
| Corel | DOS, Windows, Mac, Novell, OS/2 |
| Optisys | DOS, Windows, Banyon, 3COM, Novell |
| Ten X Technology | AIX, NFS, TCP/IP, IPX, Network Envir. |
| Software Architects | Macintosh |
| OTG | Windows NT |
| **IMAGING & BACKUP SOFTWARE SUPPORT** | **OPERATING SYSTEM** |
| FileMagic! | Windows, Novell |
| Optika | Windows, Novell |
| Paperclip | Windows, Novell |
| Cheyenne | Novell |
| Palindrome | Novell |

**WORM.** The Panasonic LF-5300A 5 1/4" WORM Optical Disk Drive. Ideal for backup/archival, CAD/CAM and image storage. It's large capacity (1.4 GB) and small size makes it an excellent choice if you're starved for space. Phase Change media makes it highly reliable and secure.

**Multi-function.** Panasonic LF-7300A/LF-7304. The best of both WORM and re-writable capability in a single drive. High capacity (1.5 GB) and fast read and write times, aided by Panasonic's Phase Change technology, provides low cost storage for many data, imaging and CAD/CAM applications.

**Multi-function Autochangers.** Panasonic offers a full range of jukebox solutions for near on-line data storage and retrieval. A 28 platter 42 GB single drive, 24 platter 36 GB dual drive, 50 platter 75 GB dual drive and a 300 platter 450 GB multi-drive jukebox.

All four models offer major advantages. (1) Increased storage capacity and quick and easy access to data. (2) Compact size. (3) Their ability to utilize either Rewritable or Write Once (WORM) media for increased flexibility.

**PowerDrive**

Keep your eye open for PowerDrive, Panasonic's new "2-in-1" drive. PD combines optical disk storage technology with the added convenience of a 4X speed CD-ROM player.

In the high capacity storage arena, Panasonic has definitely come out swinging. And with their huge selection of optical disk drives and jukeboxes in every imaginable capacity, they are definitely a contender to be reckoned with.

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Panasonic has drives and jukeboxes in every capacity to fit all your storage needs. And at only **12 cents per megabyte** you won't find storage that's more competitively priced.

In addition, Panasonic is the only company that offers the flexibility and security of both ***true* WORM and multi-function 5 1/4" drives.**

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OP2-BY

Circle 314 on Inquiry Card.


**CURRENT STATUS:** Sampling

**LIKELIHOOD INTRODUCTION DATE WILL BE MET:** Good

**TARGET CLOCK SPEED:** 133 MHz

**ESTIMATED PERFORMANCE:** 225 SPECint92; 300 SPECfp92

**FABRICATION PROCESS/FEATURE SIZE:** CMOS/0.5-micron

**TECHNOLOGICAL ADVANTAGES:** The 620 can software-switch between 64- and 32-bit modes. It can also switch between big-endian and little-endian modes; this will be useful for running mixed OSes, as is envisioned in IBM's future plans.

**TECHNOLOGICAL DISADVANTAGES:** The performance of the 620 lags behind that of other next-generation RISCs.

**PRIMARY MARKET:** Graphics workstations, SMP servers, parallel supercomputers, and Macintoshes.

**WHERE TO FIND:** For Motorola information: (800) 845-6686 or (512) 434-1502; http://www.mot.com .PowerPC/ or Motorola@Selectnet .BGA.com. For IBM information: (800) 769-3772.

# POWERPC ALLIANCE

## Next generation: **PowerPC620**

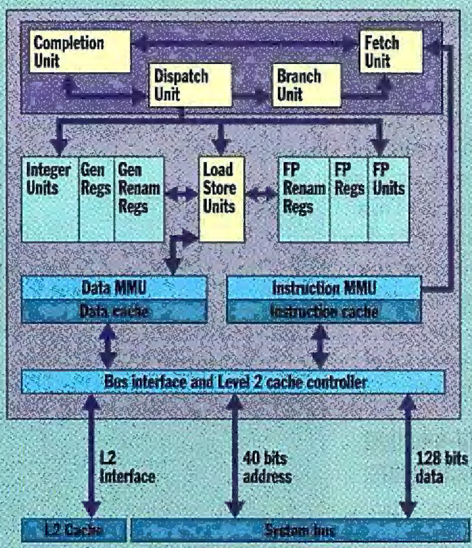
**DOSSIER:** The PowerPC620 is the first 64-bit implementation of the PowerPC architecture. With 64-bit registers and internal data paths, and 7 million transistors, the 620 uses a larger die than—and is almost twice as complex as—the PowerPC 604. The 620 is a four-way superscalar design with six execution units: three integer ALUs, an FPU, a load/store unit, and a branch unit. The latter performs four-level branch prediction and speculative execution using a register-renaming scheme.

The microarchitecture of the 620's RISC core is similar to that of the 604. It differs mainly in its wider registers and data paths, and it has more reservation stations for speculative execution. Most of the overall performance enhancements come from a much-improved bus interface. There is now a 128-bit-wide memory interface that can fetch two 64-bit longwords per bus access and a 40-bit address bus that can address 1 TB of physical memory.

The bus interface offers integral support for a second-level cache of up to 128 MB, which can run at 100, 50, or 25 percent of the CPU's clock speed. This allows flexibility for the price of the memory parts used. The bus interface uses pipelined snoop responses, which reduce the latency due to bus snooping in SMP systems and improve throughput.

The 620 has the same 16-entry reorder buffer as the 604, which tracks instructions from dispatch to completion to facilitate out-of-order execution. However, the 620 releases up to four rename buffers per cycle (compared to the 604's two), making them more available to other instructions in the pipeline. As a result, the 620 needs only 16 rename buffers, compared to the 604's 20.

**620 Building Blocks**




**The 620 is the PowerPC Alliance's first 64-bit processor. It software-switches between 64- and 32-bit modes.**

Nevertheless, the PowerPC's challenge to Intel seems to have lost some of its momentum. The alliance's declared intention was to offer twice the price/performance value of a comparable Intel CPU. The 601 processor achieved this against the Pentium. Since then, however, Intel has been progressively narrowing the gap in terms of maximum integer performance. A 200-MHz 620 processor may appear in mid-1996, but a 200-MHz P6 will also arrive around then. While Motorola continues work on a fast 604+ chip, other RISC vendors, including Mips and HP, seem to be overtaking the PowerPC alliance in the absolute-performance stakes.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# WHY THE 615 MATTERS

**Even though it's not in the British Museum's collection, emulation is RISC's Rosetta stone**

**LINLEY GWENNAP**

Software is like water for a computer: Even the best hardware can't thrive without it. Intel-compatible PCs are awash in applications software, more than the platform can really use. Most RISC machines, however, can only sip slowly from the software spring.

One of the most intriguing answers for expanding the RISC software base is IBM's secretive PowerPC 615 project. IBM only grudgingly admits the project even exists. Although technical details are unavailable, reliable sources tell us this hybrid chip will natively run both PowerPC and x86 code. It is scheduled to ship in the second half of 1996. But the 615 has encountered many delays due to the complexity involved, so its shipping date could slip further. (See the text box "We Build a 615" for details on how a first-generation 615 might be built. Also see the text box "Alternate Views of the 615" on page 200 for details on a Pentium-pin-out design.)

Several roadblocks stand in the way of completing the 615. IBM has designed its own Blue Lightning 486, but certain restrictions in the Intel license would force IBM to design a clean-room x86 core for the 615. To properly execute x86 code, the PowerPC's memory management unit (MMU) and caches must be modified to correctly handle x86 quirks, such as unaligned accesses, segmentation, and self-modifying code. Finally, the entire design must be tested and verified to properly execute two distinct instruction sets, a task that has never been achieved.

If IBM executes this strategy well, it will have a chip that outruns the fastest Pentium chips when executing native-PowerPC code, while delivering strong Pentium-class performance on x86 applications. The price premium to end users could be only $30 to $40 over the price of a traditional PowerPC system. Such a system could convince users of x86-based PCs to switch to the PowerPC because they could keep their old software and gradually ease over to new RISC applications.

### Better Software Could Win Out

But not everyone is convinced that the 615 is the best approach. Software emulation is the most common tactic RISC vendors use for building a software base. The best example is the 68000 emulator that Power Macs use to execute software written for older Macs. The emulator examines each 68000 instruction, decodes it, and faithfully—if considerably more slowly—replicates the actions that would have occurred in a real 68000 CPU.

Another option is the two-headed beast Apple sells: a system that has 486 and PowerPC chips in the same box. The cost of

## We Build a 615

**Our hypothetical design combines an x86 and a PowerPC 604 processor on one chip. By using the same package, the processors can share all external memory, support logic, the FPU, and even the on-chip cache to reduce costs.**

**We chose a 486 core because it is less than one-third the size of the Pentium core. Even so, the 486 with necessary modifications would make the die size of this 615 about 20 percent larger than a standard 604 chip. The 486 should be able to keep up with the clock speed of the 604; both could reach 133 MHz in current IC processes. At this speed, the combined chip would deliver roughly 75-MHz Pentium performance for x86 software and 150-MHz Pentium performance on native-PowerPC software. By the second half of 1996 (when IBM's 615 may debut), process advancements should allow both the 486 and 604 cores to reach as high as 180 MHz, giving a proportional increase in performance.**

**The Pentium's FPU is significantly faster than the 486's. But our design leverages the fast PowerPC FPU to achieve results competitive with a Pentium's, even with some 486-related overhead in the shared design.**

**The 486 core natively executes x86 instructions. This approach is faster and simpler from a design standpoint than alternatives that involve decoding and converting x86 instructions into RISC instructions. For a first-generation device, we think it makes sense to use a simple x86 core rather than adding a bulky translation unit. Translating x86 code into the PowerPC's RISC instruction set is difficult and may require modifications to the PowerPC core to handle x86 condition codes and other features.**

**Finally, a native-PowerPC OS would handle such things as the PC BIOS and core logic. DOS applications that directly access the hardware would have to be emulated, as in SoftWindows today. Performance would be mediocre for these types of programs.**

**As we have designed it here, the 615 would cost about 30 percent more to build than a standard PowerPC 604. At current margins, this would be an additional $30 to $40. However, business considerations would probably encourage a vendor such as IBM to sell the chip without charging a premium.**

including two processors, along with their associated memory and support chips, makes this an expensive option that's unappealing to PC buyers.

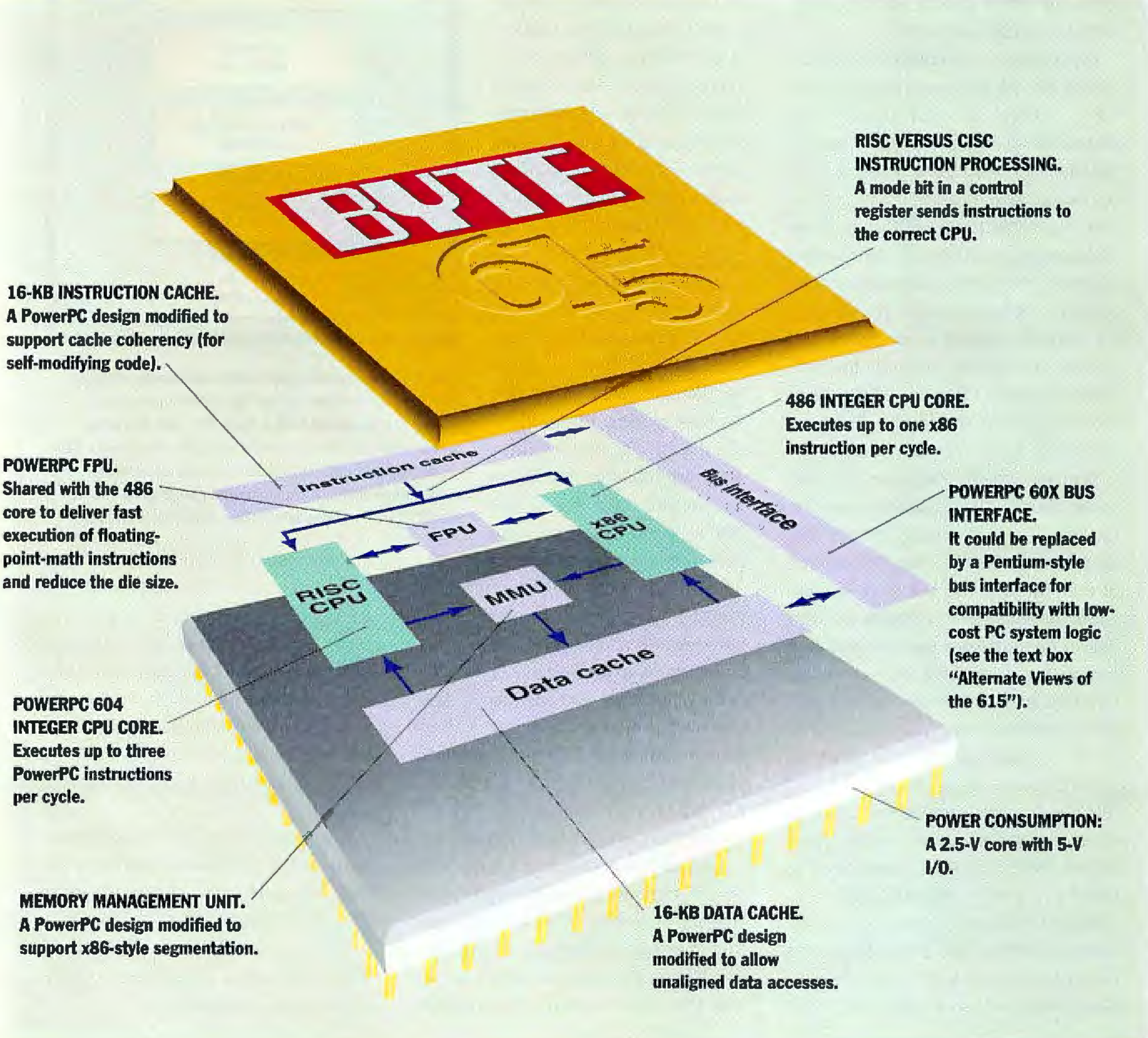
A third alternative is to improve the performance of software emulation with hardware "assist" functions that speed up the emulator. For example, a new RISC instruction called decode x86 could quickly translate an x86 instruction into an integer offset; current emulators must extract fields and do table lookups to decode instructions. Another assist would implement in hardware the x86 condition flags, which are difficult to emulate.

These and other assist functions could be added to a standard RISC chip at little cost. Such changes could cut by half the number of RISC instructions needed to emulate a CISC instruction. Even this strategy, however, leaves the x86 programs running at no better than a third of the speed of native code, and even that performance achievement requires specially modified RISC chips.

A more promising approach is to convert the x86 code into RISC instructions using a technique called binary translation. A special program converts each x86 instruction into one or more RISC instructions, creating a new version of the program that can execute natively on the RISC processor. Many x86 instructions can be replaced by a single RISC instruction, and most of the rest require only two or three. The translated program could run at 50 percent to 80 percent of the speed of a program that has been ported directly to the RISC platform.

The advantages of translation are good performance, no added hardware cost, and the ability to run on existing RISC chips. But the translation technology is tricky. No vendor has produced an x86-to-RISC translator that is reliable and delivers adequate performance. Digital Equipment has deployed a VAX-to-RISC translator for its Alpha processors and may be the closest to delivering a viable x86 translator.

If a vendor makes binary translation work, it could make obsolete hardware



solutions such as the 615. In any case, watch for RISC PCs with fast x86 emulation coming to a store near you by the end of next year. These systems could begin to break the software stranglehold the x86 has on the PC industry. ■

*Linley Gwennap is the editor of the* Microprocessor Report, *an industry newsletter from MicroDesign Resources (Sebastopol, CA). You can contact him on the Internet or BIX at editors@bix.com.*

# Alternate Views of the 615

**TOM R. HALFHILL**

What if almost everything that has been written about the PowerPC 615 is backward? What if IBM's goal is not to bring x86 compatibility to PowerPC systems, but rather to bring PowerPC compatibility to x86 systems?

The difference is subtle but crucial. It means IBM would have to design a PowerPC chip that works on standard PC motherboards and performs as well as the latest x86 processors. Yet, the same chip would also make its native instruction set visible to PowerPC-compatible OSes and applications. In other words, you'd get the same multiplatform compatibility that has been rumored all along for the 615, but within an ordinary PC instead of a system based on the PowerPC Reference Platform (PReP), Common Hardware Reference Platform (CHRP), or Power Mac architectures.

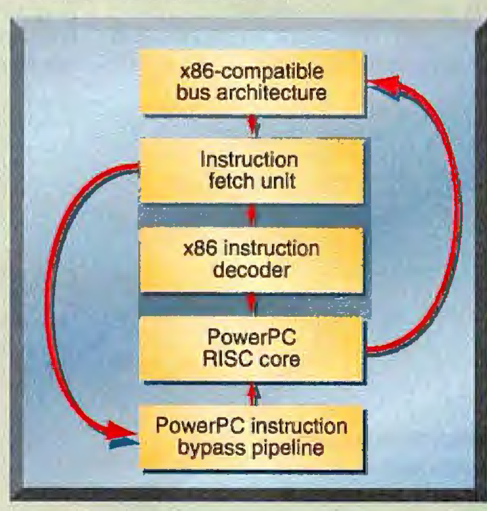
Sources close to the project, but who spoke to us on the condition of anonymity, say IBM is developing exactly that kind of chip. Sources say this version of the PowerPC 615 will fit a Pentium socket on existing PC motherboards and deliver Pentium-level performance at a comparable price. It will also run native-PowerPC software at speeds competitive with other PowerPC processors.

This scenario raises a host of technical and marketing questions that only IBM can answer, and IBM isn't talking. However, by interviewing sources close to IBM, BYTE has pieced together an intriguing view of the PowerPC 615.

First of all, such a chip is technically feasible; similar x86 processors exist today. Intel's P6, AMD's K5, and NexGen's Nx586 all use a hybrid CISC/RISC design known as a decoupled microarchitecture. This design combines a RISC-like execution core with a sophisticated x86 instruction decoder. The decoder translates x86 CISC instructions into simpler RISC-like operations that execute more efficiently in a superscalar RISC core. It's a way of adopting the advantages of RISC while maintaining compatibility with x86 software.

Sources say that IBM is developing a similar chip that uses PowerPC as the RISC core. The chip also has an x86-style bus architecture and a Pentium pin-out, so it fits into Pentium sockets. However, unlike the P6, K5, and Nx586—which use RISC-like instructions for internal purposes only—IBM's hybrid CPU can make both instruction sets visible to an OS.

### Pentium-Pin-out PowerPC




**Based on information obtained from sources close to IBM, this speculative design for a Pentium-pin-out PowerPC chip shows how a PowerPC core could be united with an x86-compatible bus. The dual-mode CPU would support both instruction sets, routing x86 instructions through a special decoder that converted the CISC instructions into native-RISC instructions.**

One catch, according to sources, is that the hybrid chip can't easily switch between x86 and PowerPC modes. You have to boot up the system in one mode or the other to get full performance. Also, one source said the chip has a "fairly big die," which would make it relatively expensive to manufacture. But he said it's still cheaper than putting x86 and PowerPC processors in a system.

Another drawback is that a hybrid CPU on a PC motherboard would need special versions of Windows NT and OS/2, apart from the existing PReP/CHRP versions. And it almost certainly wouldn't run the Mac OS, which supports the largest installed base of PowerPC software.

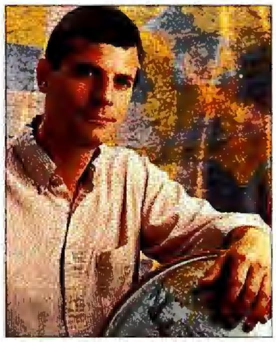
Nevertheless, if this variation of the 615 goes into production, it could be IBM's way of hedging its bets. The hybrid CPU could compete directly with the Pentium for sockets on PC motherboards, ensuring some kind of future for PowerPC chips in case PReP and CHRP fail. It would also let the PowerPC infiltrate the mainstream PC market.

IBM is believed to have several variations of the 615 in development. The first announcements are expected in the first half of 1996.

*Tom R. Halfhill is a senior editor for BYTE in San Mateo, California.*

# GLOBAL GROUPWARE

JON UDELL


AL KARVEY ©1995

**How we built two Web applications that showcase both private and public networking**

If you work for a company that employs more than a hundred people, it's probably set up a lot like BYTE: one headquarters and a bunch of satellite offices. Linking far-flung intracorporate LANs is a problem that many companies solve poorly, if at all. Linking those intracorporate sites to extracorporate ones is a problem that most companies don't even *try* to solve.

World Wide Web technology can tackle both. I'll show how this month with a pair of applications, one private and one public.

The private application, `demos`, converts reports filed by BYTE staff members into a password-protected Web archive that only fellow BYTE staff members can view and search. The public application, `vpr` (which stands for virtual press room), empowers vendors to submit product and technology announcements directly to BYTE's Web server; it builds a Web archive that BYTE's staff or any other Web user can navigate and search.

### Web vs. Notes

Nearly every day of the week, vendors demonstrate their products and technologies to BYTE editors in Peterborough; San Mateo, California; and New York. We file reports on these demos in our private conference on BIX, where we also hold an ongoing debate about which emerging technologies matter most and how best to cover them.

BIX is a fine discussion forum, but a lousy text database. Once a report scrolls by, it's hard to find it again. The deluxe tool for distributing, managing, and discussing this kind of semistructured data is clearly Lotus Notes. Pervasively deployed throughout a company, Notes enables even ordinary users to build `demos`-like applications—a stunning simplification of client/server software development. The problem is *getting* Notes deployed as pervasively as the Web technology that's becoming the kudzu of the corporate LANscape.

You wouldn't toss out your Notes server and put in a Web server to run the likes of `demos` and `vpr`. But if you don't already have a Notes infrastructure in place, these applications might make you stop and think. They're easy to build, they work within and across corporate networks, and they run on nearly every kind of client.

### Destination Host Unreachable

The Internet's pervasive, but is it a reliable transport for mission-critical applications? Not by a long shot. Start with a network that's anarchically managed, dismantle and privatize its backbone (NFSnet), and dump in a few million new users (from America Online, CompuServe, MSN, and Prodigy). You'll end up with a mess.

Folks in the Internet business assume—not unreasonably—that it'll get cleaned up sooner or later. But right now, slowdowns and partial outages are common. I access the Internet primarily from four points: two local providers and two national providers. More often than I like to admit, a `ping` command from any one of these access points returns the infuriating reply "Destination host unreachable."

Experiments with `traceroute` reveal no single culprit; congestion seems to afflict a variety of intermediate networks in a variety of ways. Those on the East Coast of the U.S. know that afternoons, when both Route 128 and Silicon Valley are in full swing, can be especially sluggish. At an Internet seminar I recently attended in New York, not a single afternoon presenter could fetch a complete home page.

Still, a global network that works most of the time is far more powerful than a local one that always works. You wouldn't build a real-time trading system on today's Internet, because such applications require guaranteed low latency and high availability. But applications like `demos`

### RFC 1597 REVISITED

In "Live Wire" (August BYTE), I discussed the pros and cons of using non-unique IP addresses to form private corporate networks. Use of the 192.1.1 Class C network for this purpose is an Internet folk tradition, I said. RFC 1597 proposes instead to reserve one Class A network, 16 Class B networks, and 256 Class C networks for non-unique addressing.

Why isn't 192.1.1 one of the Class C networks that RFC 1597 proposes to reserve? Well, you can't always trust folk traditions. As it turns out, 192.1.1 is a registered network. Walter "Doc" Urbaniak, a network engineer with BBN Corporate Telecommunications, contacted me to set the record straight.

For years, 192.1.1 has been registered to Bolt, Beranek, and Newman. Urbaniak says that because 192.1.1 is widely but wrongly believed to be available for testing, BBN doesn't even try to use it anymore. "We even found some instances in which vendors were shipping hardware preconfigured for the 192.1.1 network," he adds.

He agrees that private IP networking can be a useful thing, endorses RFC 1597, and configures his own routers not to accept those networks as sources from the Internet. "However," he says, "I wish people wouldn't just assume that 192.1.1—and also 192.1.2 and 192.1.3 [also registered to BBN]—are test city."

and vpr can deliver useful benefits even on an imperfect substrate.

### The Power of Plain ASCII

Some months ago, I posted a form (see the figure "A Simple Tagged ASCII form") to our staff conference on BIX and asked editors to use it to structure their demo reports. This simple but surprisingly powerful technique is all you need to make an E-mail or conferencing system work as the data-input front end to a database.

Because the demos database that these forms go into is really just a collection of Hypertext Markup Language documents, the form we use could make everyone tag entries in HTML, but that would be overkill. A simpler format, like the one shown in the figure, is easier for users and works just fine.

It matters not at all *which* tags you use; it matters only *that* you use them and do so consistently. With Perl or any other text-processing language that supports regular expressions, it's trivial to convert any well-formed ASCII tags into HTML. (Why plain ASCII? All word processors can produce it, Internet mailers can reliably exchange it, and text-processing tools can easily parse it.)

### A Simple Tagged ASCII Form

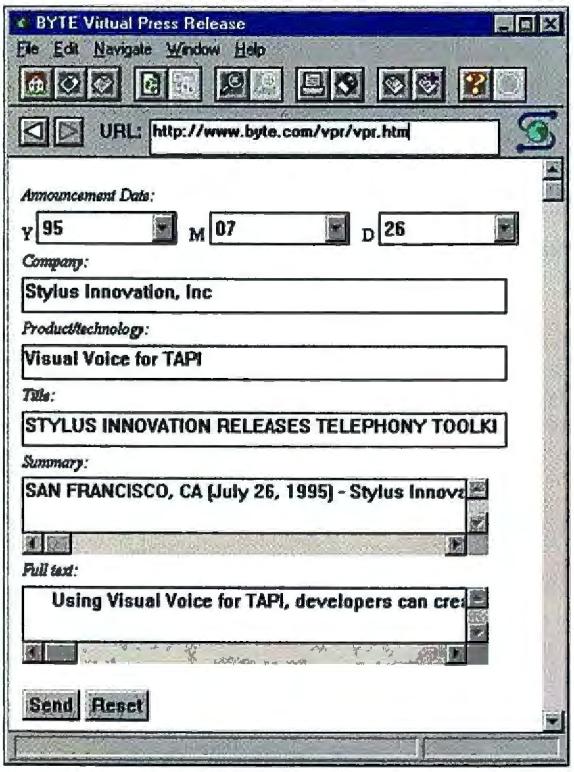
<visitdate>
95-05-24
<company>
XYZ, Inc.
<product>
XYZ Internet router
<attendees>
DaveA, DaveE, DaveR
<summary>
The XYZ router....
<report>
This RISC based router.....
<recommendations>
Candidate for upcoming roundup?

**You can use any old tags for the front end of a database of HTML documents; just use them consistently. Perl makes conversion to HTML a snap.**

### Structure of a vpr Record

<html><head>
<title>VENDOR INFO: 95-08-11 / XYZ Company / XYZ Internet Router</title>
<meta name=date content=95-08-11>
<meta name=comp content=XYZ Company>
<meta name=prod content=XYZ Internet Router>
</head><body>
<h1>BYTE Virtual Press Release</h1>
...

**The HTML <meta> tag is a convenient place to tuck arbitrary name/value pairs. You can use the values stored here to create ordered views of an HTML document archive.**




**Use this form to submit a press release or product announcement to BYTE. Copy text into each of the fields from your GUI word processor. If you supply HTML, we'll use it. If not, we'll automatically convert URLs into links.**

For demos, I wrote a little Epsilon Extension Language (EEL) program to do the HTML conversion and built a simple table of contents that lists the reports in reverse chronological order. When a bunch of demo reports had accumulated in the BIX conference, I downloaded them, ran the converter, indexed the resulting HTML files with freeWAIS (see "Web Search," September BYTE), moved the archive to the Web server, and secured it with a password.

### Securing Private Data

The demos application is an example of a private application that uses the public Internet as its transport. (Another flavor of private application runs only *within* private IP networks hidden from the public Internet; see the text box "RFC 1597 Revisited.") Because demos runs on the Internet, it's accessible from anywhere—offices, homes, hotel rooms, and phone booths around the world. But since the Internet's one big party line, how can you publish documents intended for only limited distribution on a Web server that the whole world can see?

The first line of defense is to disallow browsing of the directory tree that the Web server controls. If nobody can see the DEMOS directory on the server, and no readily accessible pages contain links to it, then nobody's likely to find and explore it. Many Web archives and applications begin life this way: as prototypes that are public but are advertised only to a small audience.

If you need more than the most casual form of privacy, though, you'll want to guard against unauthorized use of your private archive's hidden uniform resource locators (URLs). Most servers, following the style of the National Center for Supercomputing Applications (NCSA) and European Laboratory for Particle Physics (CERN) servers, support two forms of authorization: by user name/password and by IP address.

User name/password methods rely on a directory of Web users that's distinct from the underlying network OS's (NOS's) user directory. This duplication is something that I normally abhor because I've spent too many hours synchronizing E-mail, fax-server, and other user directories with NetWare binderies. I want LAN-based services to synchronize with NOS user databases, and I'm often disappointed when they don't.

But Web applications are a different breed. They're inherently global. And unless your corporate LAN is in the minority that's running NetWare 4.x or Vines, you probably don't have a global directory to tap into, so it makes sense to create one for this purpose.

Don't be scared off by the grand unified theory of directory services, however. In practice, securing a Web archive is quite simple. If your private application doesn't need to track individual users, you can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even have everyone share a single, common account, as we do with `demos`.

With the other approach—restriction by IP address—you can, in principle, form a virtual private network on the Internet. If our Peterborough, San Mateo, and New York subnetworks were 199.125.99, 199.125.100, and 199.125.101, respectively, our Web server could be configured to allow only the nodes on those subnetworks into the DEMOS directory.

In practice, however, this doesn't work so well. Allowing only these subnetworks defeats the worldwide access that makes this kind of application so compelling. But if you also allow access for IP addresses from the likes of BIX, CompuServe, and MSN so that traveling staff can reach the Internet through these services, you can't distinguish between staff and nonstaff users: Both will present the same IP addresses.

### User/Password Authentication: Unix and NT

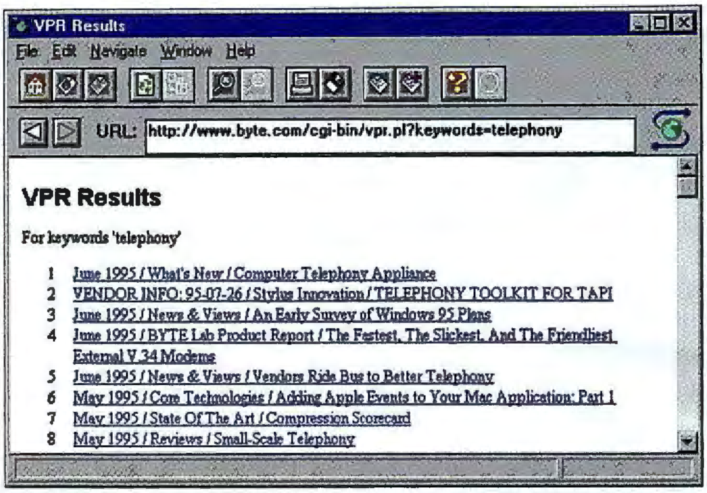
To secure a DEMOS directory on the BYTE Network Project's BSDI 2.0 machine, which was running the NCSA Web server, I first created a password file with this command:

```
htpasswd -c /pwdir/.passwd
DEMOS_USER
```

This prompts for and confirms a password, creates in `/pwdir` the password file `.passwd`, creates in `.passwd` the user name `DEMOS_USER`, and prompts for a password. Then, in the DEMOS directory that I wanted to protect, I put a file called `.htaccess`, which contains these lines:

```
AuthUserFile
  /pwdir/.passwd
AuthGroupFile /dev/null
AuthName ByPassword
AuthType Basic

<Limit GET>
require user DEMOS_USER
</Limit>
```




**The hit list includes BYTE articles and vendor-supplied info.**

This setup limits HTTP `GET` requests (the kind that fetch documents) to user `DEMOS_USER`, specifies password authentication, and then refers the server to `/pwdir/.passwd` for `DEMOS_USER`'s password.

On the pair of NT Web servers I've been using—O'Reilly and Associates' WebSite and Process Software's Purveyor—there's none of this Unix-style, text-file-oriented administration. Both offer GUI tools that you use to create users and groups, specify passwords, and authorize access to resources. WebSite provides tabbed dialog boxes that you use to define users, groups, and *realms*, which contain both users and groups. Purveyor installs a File Manager extension that you use to define and interactively test access controls.

These graphical tools are great when you're sitting at the server's console. But they're no help at all when you need to modify access restrictions on a distant server. NT's lack of support for both telnet- and X Window System–style remote access is its most serious drawback as a platform for Web service. The Unix way is more primitive, but for remote administration it's far more effective.

### Searching the Archive

For this project, I used the Simple Web Indexing System for Humans (SWISH) 1.1 (ftp://ftp.eit.com), which compiled easily and ran smoothly under BSDI 2.0. SWISH is just an indexing and search tool. To use it in a Web application, you need to wrap it in a front-end form that sends in search keywords and a back-end filter that formats the SWISH output as HTML—more trivial chores for Perl scripts.

Once the `vpr` archive was searchable, I realized it could merge with the BYTE on-line archive. That way, a user of the archive who enters the search keyword *telephony* sees a list of hits that includes BYTE articles mentioning telephony, as well as vendor-supplied press releases and white papers on telephony (see the screen above). Therefore, users get more information, vendors get more exposure, and BYTE gets better control over vital—but hitherto intractable—sources of information.

I'm excited about `vpr` because I'm swamped with paper press releases. Vendors: I hate to say it, but if you send me paper, I might as well burn it for all the good it does either you or me. So drop on by http://www.byte.com and try `vpr`. It will ensure that BYTE staff members worldwide can find your information when they need it.

How long will it take to move the stuff from a private editors-only archive to the public BYTE archive? The gating factor is administrative, not technical: We just need someone to verify what we republish to the world. Nothing else prevents this internal corporate application from becoming a global one. That's why the Internet, if it can get past the era of brownouts, just might live up to its hype. ■

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

**TOOLWATCH**

**Weblint**
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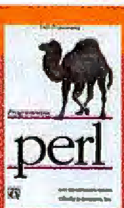
**HTML Validation Service**
(http://www.halsoft.com/html-val-svc/)

BYTE reader Adrian John Howard recommended these on-line HTML checkers to me, and I recommend them to you. Point either one of them at one of your own URLs to find out which HTML sins Netscape has been allowing you to commit.

**BOOKNOTE**




**Programming Perl,** $29.95
by Larry Wall and Randal Schwartz
O'Reilly and Associates, 1995
ISBN 0-937175-64-1

O'Reilly and Associates says that an update to the Perl bible is forthcoming. Until then, this is it: the complete guide to the programming glue that holds the Web together.

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# BYTE EXTRA



# Applications Development Edition


## Databases Get Objective

Database architects, anxious to support objects, have shoehorned object orientation into existing models. New models are emerging, however, that should require less exertion. PAGE 208DM 13

## Whither ODBC?

ODBC is not simply evolving, it's spreading. Upcoming versions will add object support as well as move ODBC into the realm of three-tier systems. PAGE 208DM 5

ILLUSTRATION: DIANE FENSTER © 1995

# NEWS & VIEWS

# Application Partitioning

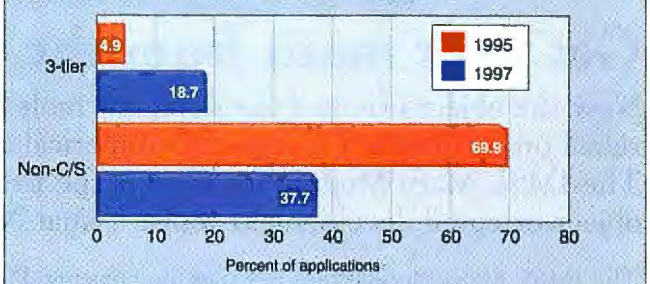
DAVID S. LINTHICUM

Although aplication-partitioning tools may not be on your client/server radar screen now, they will become more common as companies move to implement three-tier and other client/server applications. Application-partitioning tools let you break down an application into components that execute on separate machines. Strategic Focus (Milpitas, CA), a consulting firm that specializes in client/server and component-based software market studies, expects three-tier applications to quadruple in the next two years. This will certainly spur growth in application-partitioning tools (see the chart).

Ed Horst of Forté Software (Oakland, CA), whose company produces an application-partitioning tool (also called Forté), agrees. Horst is nevertheless quick to point out that application partitioning is not new. "People were building three-tier applications long before Forté came along. They were just doing it the hard way: Buy a GUI builder from one company, write the middle tier with a bunch of C code, write the database application with stored procedures, and then buy a messaging system to tie it all together." Forté bundles all these pieces in a single package, along with debugging and performance-monitoring tools.

Other companies are also on the scene with partitioning tools. Dynasty Technologies' (Naperville, IL), Dynasty, is considered a contender in the same industrial-strength arena that Forté plays in (a typical installation can run $50,000 or more). Existing application-building tools with lower price tags—Oracle's (Redwood Shores, CA) Developer/2000 and Unify's (Sacramento, CA) Vision, for example—are being modified to offer application-partitioning features that will allow easy distribution of objects between client and server.

**Growth In Three-Tier Applications Will Spur Growth in Partitioning Tools**




**The percentage of applications that use a three-tier architecture will grow from 4.9 percent to 18.7 percent in two years, according to a survey of corporate sites in the U.S. conducted by Strategic Focus. The percentage of applications that are nonclient/server will shrink from 69.9 percent to 37.7 percent. This trend toward client/server applications—particularly the increase in three-tier development—is likely to generate a demand for application-partitioning tools.**

# Are Distributed Objects Safe?

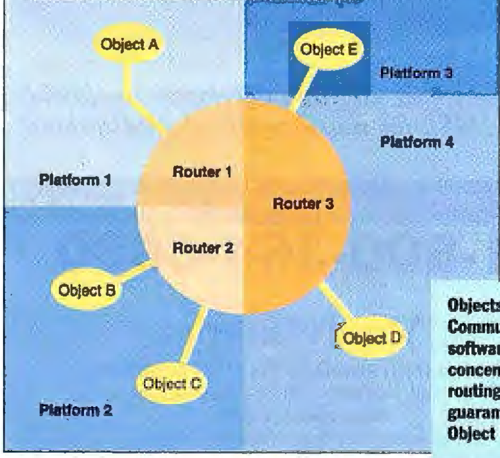
Distributed objects are the threshold technology of a new era in computing. They will allow the construction of sophisticated applications with widely dispersed software components. Before promise becomes reality, however, developers need well-defined standards for object characteristics, including an architecture for secure distribution and object collaboration.

Recognizing these problems, Microsoft unveiled the broad outlines of its distributed object strategy as part of its OLE 96 announcement. Distributed OLE objects will be secured with a Kerberos-based validation scheme that ensures not only that objects interact appropriately, but that data they acquire in privileged transactions is not passed to unauthorized objects.

OLE 96 is still on the drawing board, but Neuron Data's (Mountain View, CA) Distributed Communications Environment is already in action. It is designed to *slide in* under existing object technologies, providing a robust, secure transport layer. Distributed Communications Environment models a hardware network router in software, eliminating the need to maintain point-to-point connections for communicating objects. The routing agent intelligently analyzes messages and delivers them only to objects that should get them. It builds four levels of security into its transport layer abstraction: permitted host and object class lists, Kerberos-style authentication, packet-level protection (which prevents the unauthorized insertion or deletion of packets from the stream), and packet-level encryption. Neuron Data has published the API and its object standard. It currently supports a wide variety of platforms, including OS/2, Unix, Macintosh, and Windows.

**—Nancy Nicolaisen**

**Neuron Data's Distributed Communications**




**Objects running in Neuron Data's Distributed Communications Environment communicate through software routers. Security features can be concentrated in the routing agents. For example, the routing agents can—using packet-level protection—guarantee that communications between Object A and Object D have not been tampered with.**

# WHITHER ODBC?

KEN NORTH

Multidatabase products have become increasingly important as developers target applications for more than one DBMS. In the world of Windows applications, Microsoft's Open Database Connectivity (ODBC) API has become the de facto standard for multidatabase access. ODBC will continue to play a major role in Windows' future, particularly since Microsoft has identified ODBC as an integral part of OLE DB.

But Windows does not circumscribe ODBC's arena: It is available for a variety of OSes (ODBC drivers can be had for the Macintosh, OS/2, and various flavors of Unix), and it's soon to be aligned with a new international standard SQL call level interface (CLI). Additionally, Visigenic Software (San Mateo, CA) has ported the ODBC Software Development Kit (SDK) to OS/2, Macintosh, SCO Unix, Solaris, SunOS, HP-UX, AIX, Irix, and the Power Mac.

ODBC is a technology in motion. Though there are alternatives—Oracle Glue and the Integrated Database API (IDAPI), for example—most don't provide access to as many different databases as ODBC. (Some actually extend their database coverage by reverting to ODBC sockets or adapters.) Consequently, serious database developers would do well to study ODBC's trajectory and ask the question: What are its current and planned capabilities?

**New Standards, new servers, and OLE DB**

## ODBC Today

The ODBC API includes core, level 1, and level 2 functions to connect to data sources, as well as functions to specify connection and statement options. Because ODBC uses SQL to operate on data, it also includes functions to execute or compile SQL statements. Prepared queries permit a DBMS to optimize a query, store its access plan, and reuse the plan without the overhead of optimizing the query again and again. Some drivers emulate prepared queries when they are not available in the DBMS by creating temporary stored procedures.

ODBC includes a variety of metadata functions that return information about tables, columns, procedures, owners, and indexes. The sequence of ODBC operations is similar whether an application requests data or metadata from the DBMS (see the figure "Typical ODBC Data or Metadata Request" on page 208DM 6). ODBC supports escape clauses and parameter markers in SQL statements, and its `SQLBindParameter` function binds the data to substitute for parameter markers. Escape clauses are constructs that are used to delineate SQL extensions such as outer joins, date-and-time-stamp expressions, procedure calls, scalar functions, and LIKE predicates. Because the driver translates the ODBC syntax into the native SQL, the escape clauses let programmers express SQL statements in an interoperable fashion.

Both ODBC and OLE have mechanisms to use run-time binding and adaptive programming techniques. Developers who write OLE programs write late binding code by calling `GetTypeInfo`

FRANK MILLER PHOTOILLUSTRATION © 1995

of an object's `IDispatch` interface to determine object characteristics. To write interoperable ODBC applications, developers can use similar logic to identify database characteristics at run time. (This isn't necessary when using a native API with known data types and features.) To support multiple database platforms, ODBC includes functions that provide run-time information about DBMS features and data types. This allows a developer to build adaptive code. `SQLFunctions` enumerates the ODBC API functions supported by a driver, while `SQLGetTypeInfo` and `SQLProcedures` enumerate data types and stored procedures. `SQLGetInfo` returns a host of information about features such as default isolation levels, cursor commit behavior, and so on.

**ODBC 2.5 and 3.0**

Microsoft rolled out ODBC 2.5 while awaiting approval of the new SQL CLI. It will release version 3.0 to align with the new CLI standard and SQL-92, although ODBC will remain a superset of the standard CLI. ODBC defines three levels of conformance to its SQL grammar and its ODBC API. The core-level API functions were specified in the original 1992 SQL Access Group (SAG) CLI, while level 1 and 2 are extensions to that specification. Because driver capabilities vary, ODBC provides a function (`SQLGetInfo`) that returns information about the API and SQL that a given driver implements.

ODBC 2.5 is a 32-bit update for Windows 95 that uses Windows 95 3-D controls. It adds an uninstall API and system data source names that are accessible to all users and system services on a machine.

ODBC 3.0, the version that will align ODBC with the ANSI/ISO CLI, will include:

- enhanced metadata capabilities
- more efficient handling of binary objects
- new handle allocation capabilities
- attribute information for database connections and SQL statements
- extensible diagnostics data structures for error handling

Other major new features include SQL-92 descriptors and SQL-3 locators. (SQL-3 is the SQL specification that eventually will succeed SQL-92.)

Locators support the retrieval of binary large objects (BLObs) and *memos*, which are character objects. A locator is a handle or a pointer that is used to retrieve data for a specific binary or character object. The use of locators is likely to replace current ODBC programming practices such as binding to a variable-length binary column and retrieving all instances of the data for that column.

While ODBC 2.0 programmers can call `SQLColAttributes` and `SQLDescribeCol` for data about columns, ODBC 3.0 and SQL 92 programmers will be able to use descriptors to provide information about columns and statement parameters. A developer can allocate a descriptor handle and use a data structure that contains metadata about SQL statement parameters or query results.

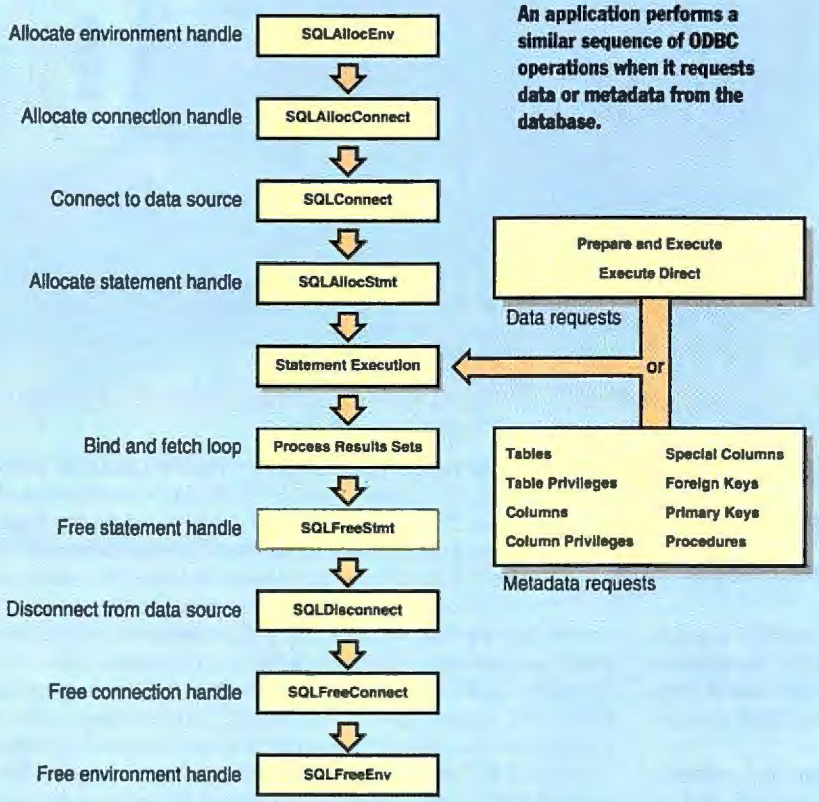
Parameter descriptors can provide two views of the parameter's metadata: one as seen by the application and the other as seen by the driver (i.e., the application parameter after data conversion). Row descriptors provide information about query results. Application row descriptors and driver row descriptors provide information about result set data before and after data conversion by the driver. Descriptors use a fixed header and a variable number of detail records that include fields such as type, length, precision, scale, pointer to a null indicator, and so on.

ODBC uses handles to track resources associated with the application environment, each connection to a database, and each SQL statement. ODBC 2.0 includes `SQLAllocEnv`, `SQLAllocConnect`, and `SQLAllocStmt` to allocate environment, connection, and statement handles, respectively. Version 3.0 adds a generic `SQLAllocHandle` function that accepts a handle type code that includes the new descriptor handles. Version 3.0 also adds functions to get attributes for the environment, connections, and statements.

To retrieve error information after issuing ODBC calls, developers currently use a loop that calls `SQLError`. For version 3.0, Microsoft is adding two functions, `SQLGetDiagRec` and `SQLGetDiagField`, which work with an extensible diagnostics data structure, in contrast to the fixed argument list `SQLError` uses.

ODBC developers expect the version 3.0 Driver Manager to maintain the kind of backward compatibility shown, for example, when version 2.0's `SQLBindParameter` replaced version 1.0's `SQLSetParam`. The Driver Manager will support existing applications that use drivers that conform to the new SQL CLI. However, it will not

**Typical ODBC Data or Metadata Request**




**An application performs a similar sequence of ODBC operations when it requests data or metadata from the database.**

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support the use of existing drivers by applications that write to the new CLI.

### Object Interfaces

Though ODBC and the ANSI/ISO CLI represent well-entrenched standards, there is a newer class of developer tools that provide object interfaces to databases. These include Microsoft Data Access Objects (DAO), Oracle Objects for OLE, and Sylvain Faust's (Hull, Quebec, Canada) SQL Sombrero (an OLE interface to SQL Server). Though Microsoft currently supports different versions of DAO in Access, Visual Basic, and Visual C++, it will release a version with OLE DB underpinnings. OLE DB and Network OLE will extend DAO to include remote and cross-application data objects.

The emergence of object interfaces caused some confusion among industry observers, who tended to view component technology and APIs as mutually exclusive. One way to clarify Microsoft's positioning of ODBC and OLE is to look at Visual Basic 4.0, one of the company's key products. Microsoft offers an Enterprise Edition for developers who want to create three-tier client/server applications using Visual Basic, OLE, and ODBC. It uses ODBC to implement remote data objects and emphasizes OLE as a tool for encapsulating business rules.

### Three-Tier Architecture

The three-tier architecture for client/server database applications separates presentation logic, business rules, and data access into different processes, generally on different computers. The typical ODBC installation found today (see the figure "Typical ODBC Installation" on page 208DM 10) produces a two-tier, fat-client architecture in which machines have multiple network and client libraries, multiple drivers, the ODBC Driver Manager, and other ODBC components.

The Enterprise Edition of Visual Basic offers one route to three-tier applications development, but the developer traffic moving toward three-tier architecture is heavy enough that other routes are appearing. Intersolv (Rockville, MD) and Visigenic are working on ODBC server technology that moves much of the infrastructure (network, client libraries, and ODBC) onto an ODBC server, yielding a client with only a single network transport and ODBC driver (see the figure "Application Topology Using an ODBC Server" on page 208DM 12). All ODBC client applications use a single driver and network library to talk to an ODBC server that has

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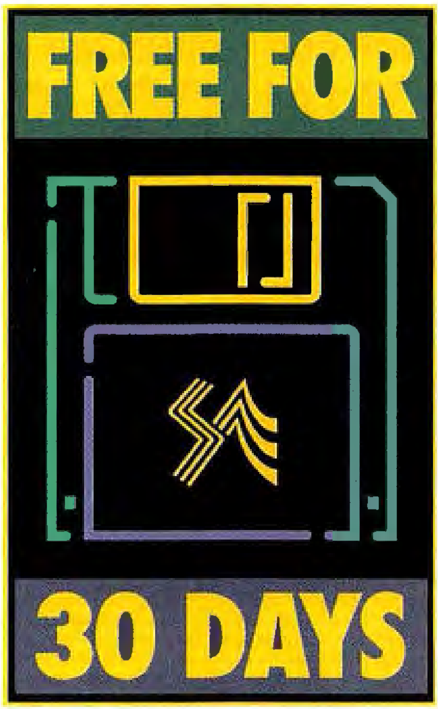


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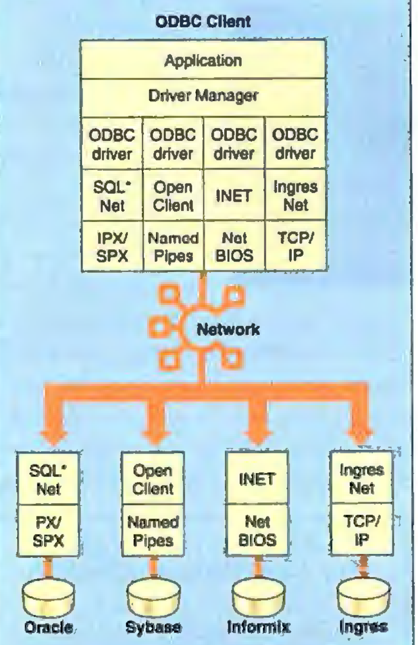
the drivers, proprietary libraries, and protocol stacks necessary to connect to ODBC data sources. In addition to simplifying installation and administration, the new architecture opens the door for development of server-side heterogeneous joins and three-tier client/server applications. Several companies are working on ODBC drivers for the Internet. Open Horizon (Belmont, CA) is developing a product to support three-tier applications by using Distributed Computing Environment (DCE) remote procedure calls (RPCs).

### Performance

When discussing ODBC's maturation, industry observers often note that driver performance is now comparable to native-API performance. I recently benchmarked

**Typical ODBC Installation**




**Today's ODBC installation is usually a two-tier, fat-client architecture.**

Intersolv DataDirect drivers, using client/server benchmarks for Oracle, Ingres, Sybase, and Informix servers that tested ODBC against a mix of embedded SQL and native CLIs. My tests showed that ODBC had better performance about half the time; the difference between ODBC and native performance was negligible for most tests.

[Editor's note: *The author's benchmark is a Windows application, written in C, that uses DLLs to implement tests for each of the SQL APIs. The benchmark kit—called APIBENCH—is available in the*

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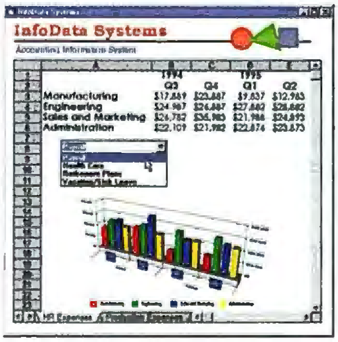



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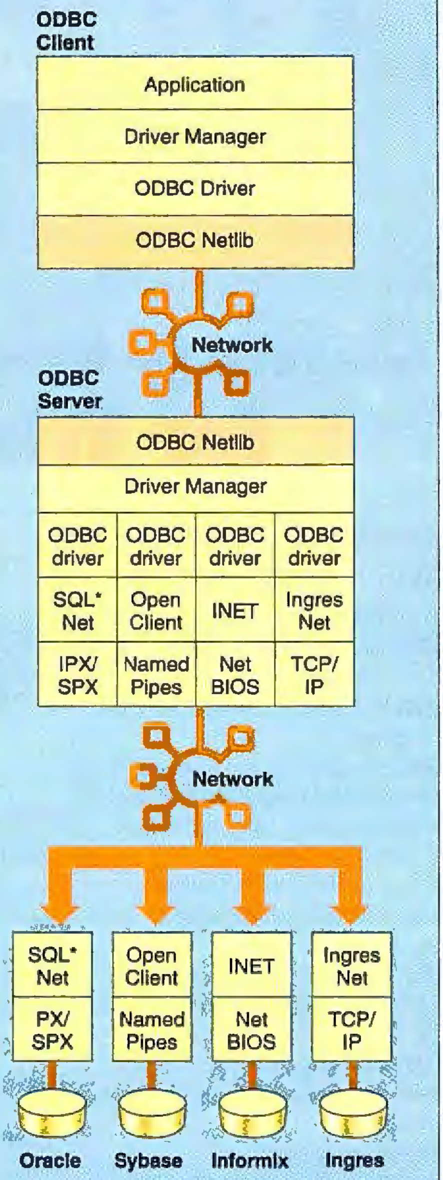
*ODBC library of the WINEXT forum on CompuServe.*]

There is not an obvious way to directly compare ODBC to desktop databases such as Paradox, dBase, or FoxPro. Desktop drivers have a single-tier configuration in which the driver includes a SQL engine that sits over an indexed sequential-access method (ISAM) layer. ODBC uses SQL for all data-access operations. Relative performance would be difficult to assess; it would involve comparing SQL to ISAM operations.

**Application Topology Using an ODBC Server**




**An application built on an ODBC server technology would result in a "thin client" with a single network transport for communication with the ODBC server.**

### Developer Reaction

Ronald Laeremans, who is a consultant with expertise in ODBC development using C++ and the MFC application framework, sees MFC as having much improved performance: "The ODBC database classes in MFC started out as a VB/Access look-alike layer for ODBC with very little thought given to performance. Performance has improved quite a bit with subsequent MFC releases." Laeremans adds that he expects 16-bit ODBC development to "die an incredibly speedy death" because 32-bit development tools will quickly eclipse the feature set and robustness of their 16-bit counterparts.

Lee Fesperman of FFE Software (El Cerrito, CA), who developed FirstSQL and its ODBC driver, commenting on the effort required to develop an RDBMS architecture that exposes OLE interfaces, suggests that the basic nature of an RDBMS will remain unchanged. However, he sees replacement of the parser, treatment of the execution plan as an object, and support for objects and methods embedded in the database as parts of the move toward a cooperating component architecture. Transactions, security, replication, and archiving are operations that will likely shared, according to Fesperman, but he sees "basic access to and organization of tables remaining under the full control of the RDBMS. That is what they do best."

Dean Guida of ProtoView Development (Cranbury, NJ), an independent software vendor (ISV) of Windows prototypers and client/server tools, says that porting applications to 32-bit ODBC was easy. However, migrating to OLE Custom Controls (OCXes) is "time-consuming and requires a port to MFC." Regarding Microsoft's direction with ODBC and OLE, he observes, "New technology is a double-edged sword for an ISV. You either understand it, how you can add value to what Microsoft is doing, how to quickly improve on their solutions and tell the world about it, or you find your market share and revenue being eaten up and shifted to Microsoft and other players that can understand and execute a plan quickly." ■

---

*Ken North is a software consultant and the author of* Windows Multi-DBMS Programming *(John Wiley & Sons, 1995). You can contact him on the Internet at 71301.1306 @compuserve.com or on BIX c/o "editors."*

# DATABASES GET OBJECTIVE

**OLIVER SHARP**


FRANK MILLER PHOTOILLUSTRATION © 1995

New kinds of database systems have emerged over the last several years to challenge the well-entrenched relational DBMS (RDBMS). Their developers tout them as object-oriented or object-relational. They are designed to handle the new and more complex types of information that we are already generating in a world heading relentlessly toward object orientation.

These object-aware databases differ widely, so it can be difficult to see what advantage one offers over another. Relational-database products may be distinguished by unique sets of features, but they generally share the same fundamental model. Databases that are designed to handle objects are at a much earlier stage in their evolution and benefit from no such consensus. They use different programming models, terminology, and implementation strategies. Some efforts are under way to develop standards, but there isn't yet a broad agreement on what an object-oriented database should be or how it should be programmed.

**As the database world embraces object orientation, what will it end up hugging?**

#### Relational Databases

Relational databases, which represent on the order of $4 billion in annual sales, are a well-understood and relatively mature technology. Most readers are probably familiar with the underlying programming model. Data is stored in tables; each row is an item, and each column has a particular type that is known to the database system. Application programs written in a language such as C do not directly access the database; interactions are mediated by SQL. Usually, the database is completely segregated from the application, and the two talk via interprocess communication.

Relational databases have become so popular because they offer a number of nice features. They use a standardized notation, SQL, that works with many different languages. They support multiple users well, offer flexible optimized queries, and allow good control over who is allowed to access information in the database. Over the years, relational-database implementations have become robust, efficient, and standardized. Utility programs that ease administration tasks are available for the major database engines.

All is not perfect, however. For one thing, SQL is alien to standard programming languages. Programmers must insert SQL statements into their code, and the result is not very pretty. As Michael Stonebraker (well-known database expert, University of California at Berkeley professor, and the mind behind Illustra) says, it is like making an apple pancake by "gluing the apple onto the pancake."

#### The Motivation for Change: Objects

The pros and cons of the relational model have been argued since the first relational databases were developed. However, there is a new reason to look for a more flexible model: the emergence of objects. There is widespread interest in using an object-oriented programming style to take advantage of encapsulation, complex types, and inheritance. Current relational databases, however, are inherently poor at dealing with objects. *continued*

A standard relational database knows how to deal with only a fixed set of types, such as numbers and text. There are three ways to put an object of a new and unsupported type into the database:

- store it in a file
- store it as a binary large object (BLOb)
- disassemble the object

The easiest thing to do is to insist that all unknown object types be stored in a file and that the database have only a pointer to the filename. But this is not a very satisfactory solution; after all, the whole point of the database is to store data. Objects in files are not protected via locking and access controls and cannot be restored to a previous state if a transaction is aborted.

The next option is to keep the objects in the database as an opaque collection of bits, known as a BLOb. Then, at least the database access controls apply to the object. However, meaningful queries are impossible, and you can lock only the entire object or none of it.

The last approach is the only one that allows the database to manage the object in any real sense. The idea is to add the object to the database by taking it apart and storing its various fields in tables (see the figure "Storing Objects in a Relational Database" on page 208DM 16). Of course, the object must be reassembled when it is extracted from the database. This poses two problems. First, writing the conversion code is a major nuisance; second, not every object is composed of primitives that can be handled well by the database. The first issue can be addressed by providing tools to automatically do the conversion, but the second is more difficult to work around.

Some types of objects (e.g., sound clips and images) don't decompose well. Even when an object can be disassembled appropriately, the result may not support the kinds of queries that users would like to make. For example, a document could be treated as one enormous text field, a collection of smaller ones (paragraphs or sentences, perhaps), or a collection of words. None of those representations allow you to make comparisons between documents in any reasonable way.

Performance can also be poor, thanks in part to the B-tree indexing mechanism typically used by relational databases. Although it usually works well with the standard types, it runs into trouble when new kinds of objects are being managed.

**Object-Oriented Model**

In the past 10 years, several companies have begun implementing databases in a totally different way. Instead of adhering to a rigid separation between the application code and the database, they integrated them. They got rid of the query language and made the database "more invisible" by treating it as a seamless extension of an object-oriented language (usually C++ or Smalltalk). A program picks an object out of the database, operates on it like any other object in the language, and then puts it back before terminating. Rick Cattell, chairman of the Object Database Management Group's ODMG-93 standards committee, describes the database as containing "pickled objects."

The simplest way to think about an object-oriented database is that a data type can have a new property that's called *persistence*. If you have a persistent data type, you can retrieve instances from the database and store them there. A run-time library handles the details for you, usually interacting with a remote object server.

*continued*

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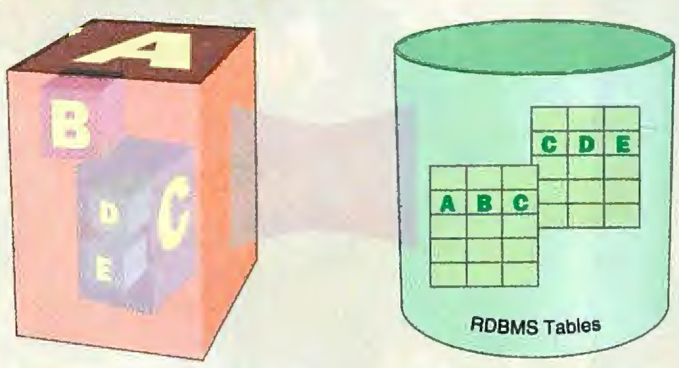
**Storing Objects in a Relational Database**




**One means of storing an object in a relational database: The object is carved up, and its various fields are placed in rows.**

Once you have incorporated an object into your environment, you can work with it directly.

This integration eliminates the awkwardness of using a separate interface like SQL. There is also no need to decompose the object when you store it; the system understands your type declarations. To use database terminology, the type structure defines the database schema implicitly.

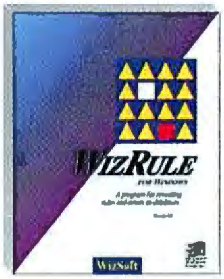
The close integration of language and database is a mixed blessing, however. The database tries to be seamless by obeying the data model of the programming language, but a language like C++ was not designed to work with a database. It doesn't have any support for locking objects, limiting access to them, sharing objects between processes, querying, or transactions. There is a fundamental conflict between remaining faithful to the programming language and efficiently implementing database services.

Consider the relationship between persistent objects that are stored in the database and normal (transient) ones that are not (see the figure "Problems with Object-Oriented Databases" on page 208DM 18). To achieve seamless integration, the programmer should be able to treat them alike. Shouldn't a query apply to every object of the appropriate type regardless of whether it is persistent? The transient objects, however, reside only in the application, not in the database, so it becomes much more difficult to optimize and execute such a universal query.

Transaction semantics are also an issue; if a transaction is aborted, the persistent objects will be restored to their original state. It would be difficult to do the same thing for transient objects as well. For both querying and transactions, the most obvious solution would be to draw a rigid distinction between the two kinds of objects and provide database support only for those that are persistent. But that forces the programmer to make the same distinction and to treat persistent and transient objects differently.

Access control presents a more serious



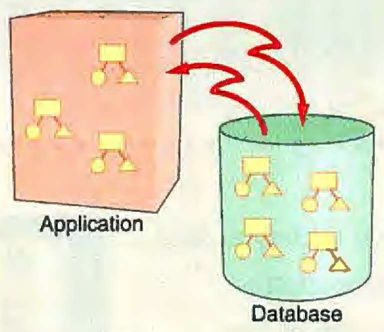




problem. Traditional databases allow administrators to control what user applications are allowed to do to a database object. Because the database is in a separate process and is manipulated through SQL, it can enforce almost any access policy. In an object-oriented database, however, once an object is loaded from the database into an application, it is difficult to have any further control over what happens to it.

**Problems with Object-Oriented Databases**




**A mix of transient objects (located in the application) and persistent objects (located in the database) makes queries difficult to optimize and execute.**

### Object-Relational Model

During the past few years, a third model has emerged as an alternative to both relational and object-oriented databases. This object-relational model tries to preserve the fundamental principles of relational theory while still addressing the needs of an object-oriented world.

Object-relational databases are similar in philosophy to relational databases—interactions with the database are handled through an enhanced SQL. There is no attempt to match the close level of programming language integration of an object-oriented DBMS. The difference is that the object-relational database engine can store and manipulate objects based on a flexible type system.

An RDBMS supports a limited set of simple types—numbers, text, and so forth. Query optimization is tuned to understand the built-in types, the organization of storage is optimized for them, and SQL can manipulate them directly. Object-relational systems let you define new types using object-oriented structuring techniques like inheritance. It is possible to provide new access methods in situations where the standard B-tree indexing is not appropriate.

Rather than forcing a document to fit preexisting types, in an object-relational system, you can define a new type called "document" and list the methods that can be applied to it. You might want to look for documents that discuss the same topic. In that case, you could define a method called "relevance" that compares two documents and grades their similarity. The programmer could use a SQL query to apply relevance to a table full of documents, just as a traditional query can add numbers or test for equality. You can put an object in the database without disassembling it and still take advantage of traditional database features like transactions, query support, and query optimization.

### The Future

The relationship of databases and objects is in rapid flux. The relational-database companies are trying to make their engines more flexible so they can move closer to the object-relational approach. The object-oriented database companies are trying to standardize, notably through the ODMG. They are also adding more sophisticated database management features and improving performance. The object-relational systems vendors are improving their implementations and building tuned packages that support new data types.

In the meantime, everyone is eyeing the evolving object standards: Common Object Request Broker Architecture (CORBA), Common Object Model (COM), and System Object Model/Distributed System Object Model (SOM/DSOM) (see the text box "The Proliferating Object Standards" to the left for details). These interfaces will have tremendous impact on software system design during the next several years.

The databases of the future will need to manage objects, store methods, and interact with object frameworks. Not all applications deal with complex data, and some that do can manage by disassembling objects so they fit into relational tables. However, there are a number of data management problems for which the basic relational systems are just not good enough. As complex objects become pervasive and databases try to manage them, applications programmers will have to migrate toward a more flexible model. ■

*Oliver Sharp is the director of strategic marketing at Colusa Software (Berkeley, CA). You can reach him on the Internet at sharp@colusa.com or on BIX c/o "editors."*

## The Proliferating Object Standards

There is a large pile of emerging standards for dealing with objects. It is easy to get lost in all the acronyms, but the basic intent behind them is worth understanding.

One way to think about these standards is to treat applications design as a spectrum. The traditional monolithic application that is compiled into a static executable file that runs on a single isolated machine constitutes one end of the spectrum. At the other end is a distributed system that is divided into pieces that can be retrieved from remote databases and executed on a range of hardware architectures.

The whole alphabet soup of standards is designed to support your progress toward the complicated end of the spectrum. The steps usually proceed as follows:

**Separating Code and Data:** The first step is to pry objects away from the applications that built them. In a traditional application, an object, once it is built, cannot be extracted and sent elsewhere. The object definition is intimately bound up with the compiled form of the program. The object models (like IBM's System Object Model [SOM] and Microsoft's Common Object Model [COM]) define ways to describe an object so that it can be used by another application.

**Sharing an Object Between Applications:** Once you achieve some separation between applications and objects, the next step is to allow applications to share an object. That is the job of standards like OpenDoc from Apple and OLE 2.0 from Microsoft.

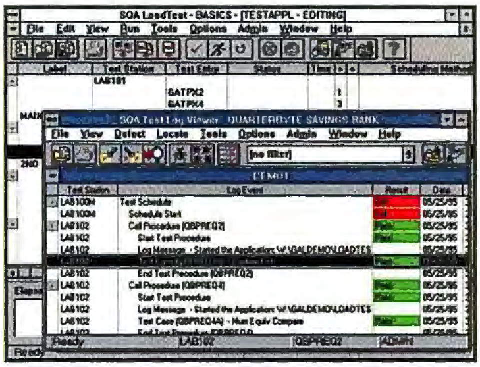
**Using Distributed Objects:** The next level of sophistication would let programs and objects come together across a network. In particular, a program would like to be able to search for an appropriate remote object, call its methods, and generally interact with it. Ideally, the application and the object could reside on different machines. That is the promise of Common Object Request Broker Architecture (CORBA). It defines a whole framework of services to support the use of objects in a distributed environment.

**Using Mobile Objects:** To completely support distributed systems, objects should be able to execute on any machine. You might have a centralized database of objects that includes methods and data. A query might yield a set of objects, with methods that could be executed locally regardless of the architecture. This kind of strategy requires objects to be expressed in a form that can be executed anywhere. Currently, there are interpreted languages that can provide this functionality, including Java from Sun and Telescript from General Magic. There is also Omniware, from Colusa, which is a compiled solution that supports C/C++.

# WHAT'S NEW

## STRESS YOUR APPLICATION

SQA has released SQA LoadTest, an automated tool for load, stress, and multiuser testing of Windows client/server applications. SQA LoadTest can exercise both the client and server sides of an application and can easily handle Unix, Windows NT, or OS/2 servers connected to Windows clients. It also supports all the popular network protocols: TCP/IP, NetBIOS, and IPX/SPX. LoadTest is offered as an add-on product for users of SQA TeamTest or is bundled as part of SQA Suite. Pricing is based on how many machines run the client software.



*Contact: SQA, Inc. Woburn, MA, (800) 228-9922 or (617) 939-3000; fax: (617) 932-3280; info@sqa.com*

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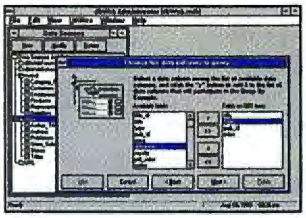

## THE WEB-WIRED DATABASE ▲

Aspect Software Engineering has released dbWeb 1.0, which is a software tool that provides database connectivity for HTTP Web servers running on Microsoft Windows NT. Essentially, dbWeb is a gateway between ODBC data sources and Web servers such as Purveyor, WebSite, and EMWAC HTTPS. dbWeb offers full insert, update, and delete capabilities, as well as query-by-example record selection. dbWeb uses 32-bit ODBC, providing access to databases such as Microsoft's SQL Server, Microsoft Access, Sybase, and Oracle. dbWeb comes with administrative tools and application wizards that simplify the process of publishing database information. A schema wizard, for example, lets you rapidly create and test a schema without writing a single line of HTML. dbWeb requires a minimum of a 386 processor, 16 MB of RAM, and 10 MB of hard disk space. dbWeb's suggested retail price is $695.

*Contact: Aspect Software Engineering, Honolulu, HI, (808) 539-3782; fax: (808) 539-3785; http://www.aspectse.com*

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## POWERBROKER

Expersoft has released the PowerBroker 4.0 suite of ORB and object management tools. PowerBroker 4.0 lets CORBA 2.0, OLE 2.0, Visual Basic, Smalltalk, and C++ interoperate, and it includes CORBA Services 1.0 as well. The PowerBroker technology supports an extensive range of platforms, including SunSoft's Solaris 1 and 2, Hewlett-Packard's HP-UX, IBM's AIX, SGI's Irix, Digital Equipment's Unix for Alpha, Microsoft Windows (client only), and Windows NT. PowerBroker offers three programming models: a "C++-centric" model, a CORBA-compliant Smalltalk model, and a CORBA-compliant environment that has C++ mappings. PowerBroker OLE automates interaction between PowerBroker objects and OLE automation clients. Finally, PowerBroker lets programmers express CORBA object references in the World Wide Web's URL format, making it easy to build Internet-accessible applications and services. Price varies according to platform and language.

*Contact: Expersoft Corp., San Diego, CA, (619) 546-4100; fax: (619) 546-4110; http://www.expersoft.com*

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## WEB SERVER FOR WINDOWS 95

O'Reilly & Associates makes the job of building a World Wide Web server easier with WebSite.

Now available for Windows 95, WebSite can take advantage of many of the new OS's user-interface features, such as tabbed dialog boxes, tree displays, and Visual Basic support. WebSite lets you incorporate data from spreadsheets and databases into Web documents via a Windows Common Gateway Interface. It can even accommodate ODBC and OLE automation within your Web documents. WebSite is priced at $499. It requires a 386 or better processor, at least 12 MB of RAM (16 MB is better), 5 MB of disk space, TCP/IP connectivity, and Windows 95.

*Contact: O'Reilly & Associates, Inc., Sebastopol, CA, (800) 998-9938 or (707) 829-0515; fax: (707) 829-0104; http://website.ora.com*

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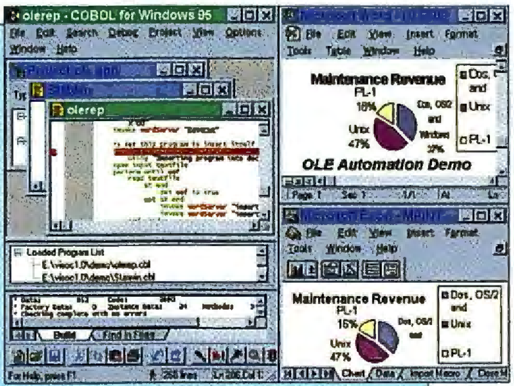
## COBOL FOREVER




**Not only is it COBOL, object-oriented, and ready for Windows 95: It's *visual*. A longtime provider of products for The Language That Will Not Die, Micro Focus now makes available Visual Object COBOL for Windows 95 ($499). Visual Object COBOL presents a new development environment that boasts tools such as a Project Wizard and a Resource Editor. Shaking off any suggestions of senility, Visual Object COBOL supports OLE automation (including the ability to create OLE service providers), features a 32-bit architecture, and can even create multithreaded applications. To supplement the system's object-oriented nature, Micro Focus also includes a class library and browser.**

*Contact: Micro Focus, Inc., Palo Alto, CA, (415) 856-4161; fax: (415) 856-6134; http://www.mfltd.co.uk*

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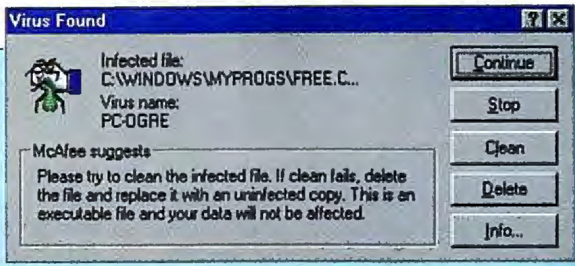


## ONE LESS THING TO WORRY ABOUT

**Windows 95 users can breathe easier. McAfee has released VirusScan for Windows 95, which, the company says, accurately detects over 5100 viruses. VirusScan can optionally scan for viruses at system start-up, on demand, or on access. (On-access scanning permits VirusScan to detect viruses during the launch of an executable file.) VirusScan also offers extensive configuration options. For example, it can be set either to clean the infection or delete the offending file. For a limited time, VirusScan for Windows 95 will also include protection for Windows 3.1, to assist users who are migrating from that OS to Windows 95. VirusScan is available for $65, though Internet users can download a free evaluation version from McAfee's FTP site (ftp.mcafee.com).**

*Contact: McAfee, Santa Clara, CA, (408) 988-3832; fax: (408) 970-9727; http://www.mcafee.com*

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## THE YEAR 2000 APPROACHETH

Many of today's applications base date calculations on the last two digits of the year. When the millennium rolls around, such calculations are liable to be in error—it's possible that an application will report the difference between two dates as a negative number. Consequently, Micro Focus is offering Challenge 2000, an extensive package of tools that will allow programmers to identify potentially "date-confused" applications and make the necessary changes. Challenge 2000 also includes a consulting service package that provides access to experienced consultants who can help users appraise the potential for damage and recommend action. Prices start at $3000.

*Contact: Micro Focus, Inc., Palo Alto, CA, (415) 856-4161; fax: (415) 856-6134; http://www.mfltd.co.uk*

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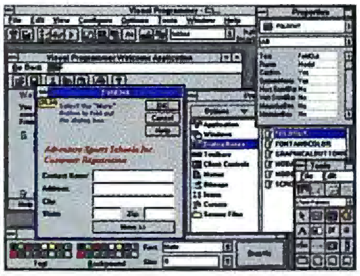
## WATCOM C/C++ 10.5 AVAILABLE

The Watcom Products Division of Powersoft is shipping version 10.5 of the respected Watcom C/C++ multiplatform compiler. The new release adds Windows 95 to the compiler's list of target OSes and incorporates Blue Sky Software's Visual Programmer applications-development tool, which generates MFC code for both 16- and 32-bit Windows environments. The retail price is $350. A version upgrade is available for $129; a competitive upgrade is $199.



*Contact: Powersoft Corp., Watcom Products Division, Waterloo, Ontario, Canada, (800) 265-4555 or (519) 886-3700; http://www.watcom.on.ca*

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## SIMPLER SQL MANAGEMENT

Sheridan Software Systems' sp_Assist ($595) makes life easier for anyone who has to deal with SQL Server databases. sp_Assist can generate both SQL and Visual Basic code, making it critical for building Visual Basic front ends to SQL Server back ends. It also helps developers generate and maintain a wide variety of SQL objects, including stored procedures, tables, triggers, and more.

sp_Assist, which is available for Windows 3.1 or Windows 95, includes database administration tools for user and group management, ISQL script creation, and SQL GRANT RIGHTS functions. sp_Assist maintains its own database, which it uses as a kind of repository for SQL code. Consequently, it works well in team development environments, where code tracking is important.

*Contact: Sheridan Software Systems, Inc., Melville, NY, (516) 753-0985; fax: (516) 753-3661; On CompuServe, GO SHERIDAN*

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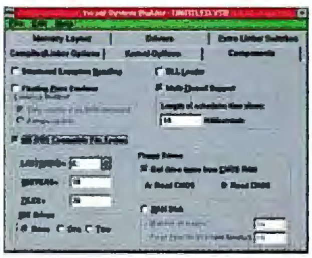
## EMBEDDED WIN32

Designers of 32-bit embedded systems will welcome Phar Lap Software's new TNT Embedded ToolSuite 8.0. Programmers familiar with the Win32 API and popular 32-bit C/C++ compilers (Borland, Watcom, Microsoft, and MetaWare) can now exercise that familiarity in the embedded world. Embedded applications built with the ToolSuite will run on any Intel 386, 486, or Pentium processor, and offer developers a ROMable real-time kernel that supports threads, priority scheduling, and advanced



interthread communication. In addition, the kernel includes an MS-DOS-compatible file system and a floating-point emulation library. The ToolSuite's Visual System Builder provides rapid kernel configuration. The base price is $4995. Developers who do not need real-time capabilities may purchase the Standard Edition—which lacks the real-time kernel, MS-DOS file system, floating-point emulator, DLL loader, and real-time manual—for $2995.

*Contact: Phar Lap Software, Inc., Cambridge, MA, (617) 661-1510; fax: (617) 876-2972; info@pharlap.com*

**Circle 1265 on Inquiry Card.**

## REMOTELY POSSIBLE

Avalan Technology's Remotely Possible/32 is a 32-bit remote-control communications package that supports Windows 95 and Windows NT. In its simplest form, Remotely Possible/32 lets you control your office PC from a distant location or over the LAN. (Remotely Possible/32 works equally well over networks and modems.) One advanced feature, multitakeover, lets a single host PC simultaneously control multiple viewer

PCs. Remotely Possible/32 also supports file transfer and chat; even while controlling other machines, the host can perform background file downloads and carry on a chat session. The base price of $169 includes a license for one host and one viewer PC. Packages for additional PCs are discounted.

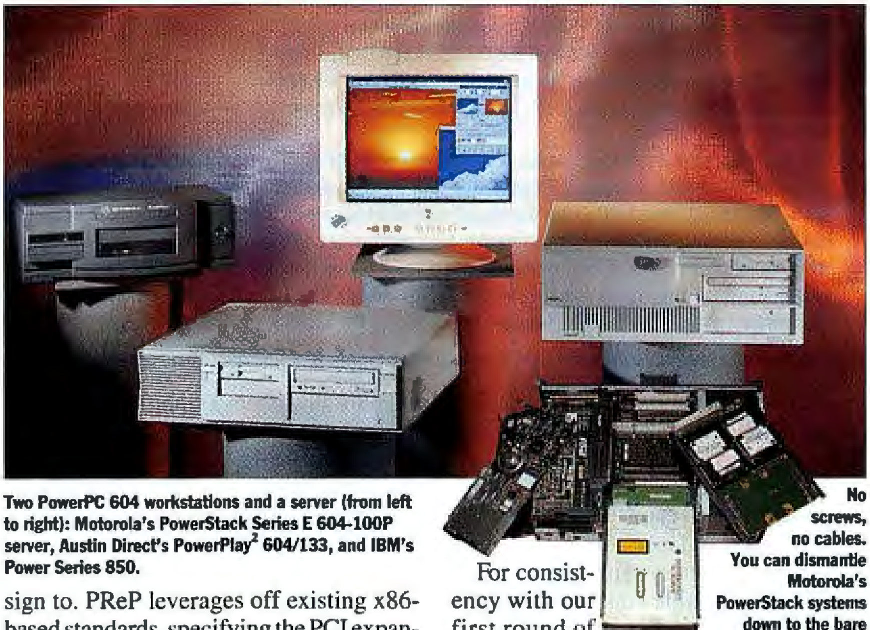
*Contact: Avalan Technology, Holliston, MA, (508) 429-6482; fax: (508) 429-3179; http://www.avalan.com/~avalan*

**Circle 1268 on Inquiry Card.**

# NT Roars on the 604

**Faster than P6 and Mips, slower than Alpha, the PowerPC 604 makes a mean NT workstation**

**DAVE ROWELL**



Two PowerPC 604 workstations and a server (from left to right): Motorola's PowerStack Series E 604-100P server, Austin Direct's PowerPlay² 604/133, and IBM's Power Series 850.

No screws, no cables. You can dismantle Motorola's PowerStack systems down to the bare chassis without tools.

DENNIS WARNESKY © 1995

Systems running Windows NT on the PowerPC 604 RISC processor are finally here. Our cross-platform BYTEmark tests show these machines have processor performance nearly twice that of Pentium PCs at the same clock speed. The 604 also compares favorably to other RISC chips, although the latest 21164 Alpha chip is still 30 percent to 50 percent faster (see "Alpha Stays Ahead" on page 210).

We tested three of the first available systems: Motorola's 100-MHz PowerStack Series E 604-100P server, IBM's 133-MHz Personal Computer Power Series 850, and a beta PowerPlay² 604/133 from Austin Direct that provides symmetrical multiprocessing (SMP) with two 133-MHz 604 chips. Performance testing with BYTEmark and several native PowerPC NT applications shows that the 604 makes a mean NT workstation.

All three systems we tested comply with the PowerPC Reference Platform (PReP), a hardware standard that hardware-component and operating-system vendors can design to. PReP leverages off existing x86-based standards, specifying the PCI expansion bus, for example. As a result, the three systems we review share many similarities besides the 604 processor. All have expansion card risers, for example, and two use similar PCI SCSI-2 or Ethernet controllers. PReP systems run Windows NT 3.51 and AIX 4.1 now, and they should be running OS/2 by year end and Solaris next year.

For consistency with our first round of NT workstation testing (see "Fastest NT Workstations," March BYTE), we requested high-end system configurations. The tested machines have 64 MB of memory, 1 GB of hard drive capacity, a CD-ROM drive, accelerated graphics (PCI-based SVGA), and an Ethernet adapter. We ran as many of the same benchmarks as were available for PowerPC, but under Windows NT Workstation 3.51 instead of 3.5.

Along with the BYTEmark benchmarks (formerly the BYTE Native Mode benchmarks), we tested application performance with North Coast Software's PhotoMorph 2.01 (beta SMP version), a multimedia image-processing program, and with an alpha version of Bentley Systems' MicroStation 95, a CAD package (the equivalent of version 5.5). NSTL's InterMark test for NT wasn't ready for PowerPC.

The PhotoMorph Swirl test creates a 2.5-MB AVI file using a swirl distortion; the test basically measures floating-point performance. The MicroStation tests were driven by a script developed by NSTL. We ran the tests in both 8- and 24-bit color depths, because the IBM Power Series 850's built-in graphics doesn't support 24-bit color. PhotoMorph and, to some degree MicroStation 95, take advantage of NT's SMP capabilities, giving added performance when a system has multiple

TECHNOLOGY FOCUS

### 601 to 604

**Microsoft didn't release Windows NT 3.51 for the PowerPC until June, not long after IBM and Motorola fixed problems with the bug-delayed PowerPC 604 chip. Since we first tested the PowerPC systems, performance has improved dramatically. While the speed increase comes partly from refinements in Motorola's compiler technology, it's mostly due to the switch from first-generation 601 chips to the second-generation 604.**

**From BYTEmark results at the same clock speed, the 604 comes out roughly 30 percent faster than the 601. While both chips are 32-bit implementations of the 64-bit PowerPC architecture, the 604 is more superscalar than the 601. It can do more work per clock cycle. Here are some major differences between the two chips:**

| PowerPC 601 | PowerPC 604 |
|---|---|
| 2.8 million transistors | 3.6 million transistors |
| Three independent execution units | Six independent execution units |
| Dispatches up to three instructions per clock | Dispatches up to four instructions per clock |
| Completes up to three instructions per clock | Completes up to five instructions per clock |
| Static branch prediction | Dynamic branch prediction |
| 32-KB unified cache | Separate 16-KB instruction and data caches |
| Eight-way set associative cache | Four-way set associative cache |

## Alpha Stays Ahead

**The last time we tested NT workstations, Alpha 21064A-based systems were the clear performance winners. Today's 133-MHz PowerPC 604 systems provide the same BYTEmark performance as those Alpha boxes did at 275 MHz. Since then, however, Digital Equipment Corp. has come out with the faster 21164 CPU, a chip that includes among its enhancements both a 16-KB primary cache and a built-in 96-KB L2 cache (see "Alpha Rides High," October 1994 BYTE).**

**Eager to test the 21164, we got our hands on one of the first systems to use it: DeskStation's Raptor 3 (DeskStation Technology, Lenexa KS; (913) 599-1900). DeskStation has developed an architecture called UniFlex that allows the same system board to take processor cards carrying either Mips or Alpha CPUs, with Windows NT as the operating system. Our test machine came with a 266-MHz 21164 module (the 300-MHz version wasn't yet available) loaded with 2 MB of write-back L3 cache. Other performance features include a claimed 900-MBps bus to external cache and a 128-bit 150-MBps bus to external memory.**

**The $15,000 price includes 64 MB of system memory, a 1-GB Seagate ST31230 SCSI drive, a 2x CD-ROM drive, a 4-MB Diamond Stealth 64 PCI graphics card, built-in Ethernet, and a 17-inch ViewSonic 17E monitor. Performance testing with BYTEmark put the Raptor 3 far ahead of the crowd. Its CPU performance was 40 percent to 60 percent faster than 275-MHz 21064A systems and single-processor 133-MHz PowerPC systems (see the BYTEmark test results below). The 300-MHz version should be another 13 percent faster.**

processors (as in the case of Austin's PowerPlay$^2$). MicroStation didn't support SMP in our previous testing.

### Austin Direct PowerPlay$^2$

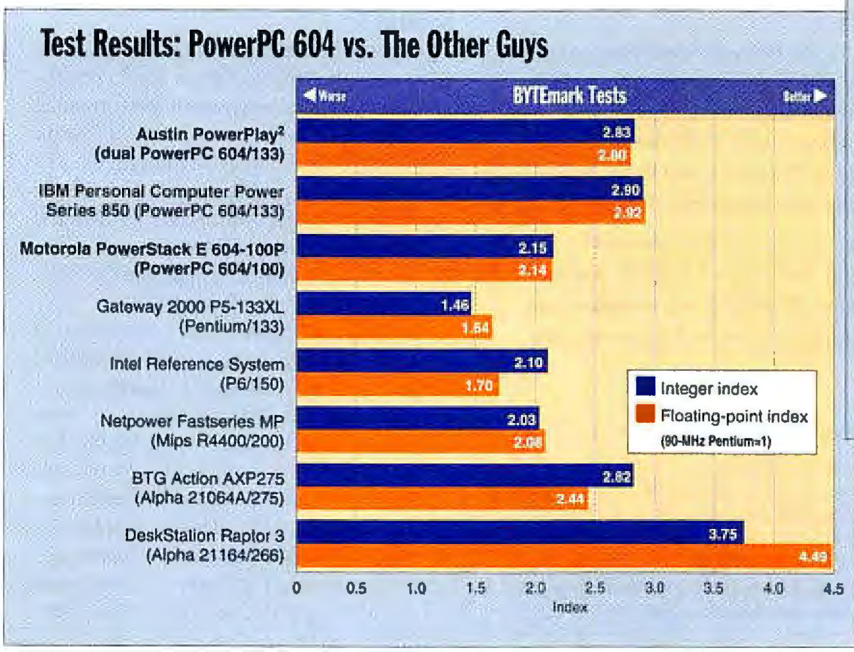
We examined a dual-processor PowerPlay$^2$ 604/133 beta system that should be available by the time you read this. (List price with 64 MB will be $9995.) Several jumper wires crisscrossed the motherboard, and a flash BIOS upgrade arrived later to enable the 512-KB L2 cache, but we ran into few problems. (FirePower, which designs and manufactures this system for Austin Direct, makes a similar system for Canon, but it wasn't ready for review.)

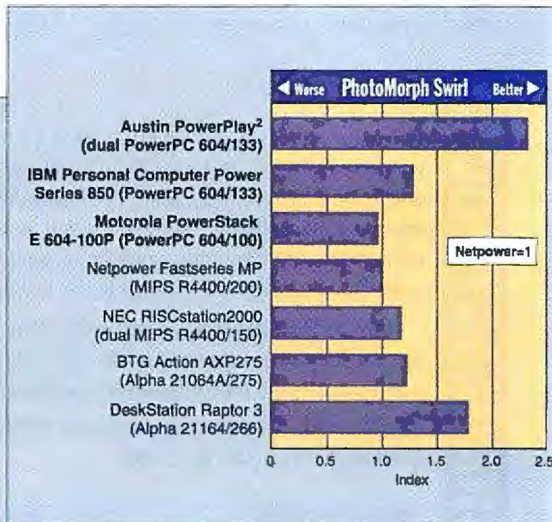
Notable features include the two 133-MHz 604 processors, ECC memory, and a memory-bus-direct graphics system controlled by FirePower's Powerized Graphics L1A9403 chip, which moves graphics data from the CPU to the 4-MB VRAM frame buffer over the system's 128-bit-wide memory bus. The CPU does the graphics work. A Philips SAA7196 video decoder/scaler chip has its own 2-MB VRAM frame store buffer. The FirePower motherboard provides asynchronous I/O, which decouples I/O from the memory bus so that activities like disk I/O don't hold up CPU/memory operations.

The BYTEmark CPU test exercises only one processor at a time. With both CPUs enabled, the Austin trailed the 133-MHz IBM Power Series 850 just slightly, due to the overhead of managing two CPUs. But in the PhotoMorph test, two CPUs gave the PowerPlay$^2$ a great advantage; it performed better on this test than any machine we've seen yet. Display of graphics isn't amenable to SMP under NT, but MicroStation uses SMP when it can. However, with no independent graphics processor, the PowerPlay$^2$ fell 19 percent behind the IBM system in the 8-bit MicroStation CAD test.

### IBM Power Series 850

IBM's Power Series 850 is also aimed at the desktop. It has IDE drives, but no built-




**The BYTE cross-platform BYTEmark CPU test shows the PowerPC 604 favorably compared to other CPUs. The Austin PowerPlay$^2$ 604/133 trailed the 133-MHz IBM Power Series 850 just slightly, due to the overhead of managing two CPUs. Two processors gave the PowerPlay$^2$ a strong advantage in the PhotoMorph Swirl test, but not in the MicroStation CAD test (results not shown), where graphics controllers are a big factor.**

**POWERPC SYSTEM FEATURES**

| | AUSTIN DIRECT POWERPLAY² 133 | IBM PERSONAL COMPUTER POWER SERIES 850 | MOTOROLA POWERSTACK SERIES E 604-100P |
|---|---|---|---|
| **Processor(s)/Memory** | | | |
| CPU(s)/speed (MHz) | Two PowerPC 604s/133 | PowerPC 604/133 | PowerPC 604/100 |
| Secondary cache (all direct mapped, write-back) | 512 KB split (will be shared in final version) | 512 KB, synchronous | 256 KB |
| Memory bus width/speed | 128 bits/66 MHz | 64 bits/66 MHz | 64 bits/66 MHz |
| RAM (standard/as tested/maximum, in MB) | 32/64/256, ECC | 16/32/192, parity | 32/64/256, parity (ECC optional) |
| **Storage** | | | |
| Hard drive | One 1-GB Fujitsu M1606 SAU 3.5-inch SCSI-2 | One 1-GB IBM DPEA-31080 3.5-inch EIDE | Two 525-MB Toshiba MK2428FB 2½-inch SCSI-2 |
| CD-ROM drive | Hitachi IDE (4x) | IBM CRMC-FX400C3 IDE (4x) | Toshiba XM-4101B (2x) |
| Drive bays | Two accessible 5¼-inch, two accessible 3½-inch | Two accessible 5¼- by 1-inch, one 3½-inch floppy, two internal 3½-inch drives | Three 5¼- by 1-inch drive bays (two accessible), one floppy |
| **Graphics** | | | |
| Graphics card | Built-in | Built-in | Number Nine GXE64 Pro PCI graphics card |
| Graphics processor | Powerized Graphics 128-bit L1A9403, Philips SAA7196 video decoder/scaler | S3 64-bit Vision864 | S3 64-bit Vision964 |
| Video memory (as tested/maximum, in MB) | 6/6 VRAM (includes 2-MB video frame store) | 2/2 DRAM | 4/4 VRAM |
| Pixel clock maximum | 135 MHz | 135 MHz | 220 MHz |
| Max. 24-bit resolution (refresh rate) | 1024 by 768 (75-Hz) | No 24-bit driver support | 1280 by 1024, 76-Hz. |
| Max. resolution (color depth, refresh rate) | 1280 by 1024 (16-bit, 75-Hz) | 1280 by 1024 (8-bit, 72-Hz) | 1600 by 1200 (16-bit, 76-Hz) |
| Monitor | 17-inch Austin | 17-inch IBM 17S/S Sight and Sound | none |
| Optimal resolution (refresh rate) | 1280 by 1024 (70-Hz) | 1280 by 1024 (77-Hz) | not applicaple |
| Dot pitch (mm) | 0.26 | 0.27 | not applicaple |
| **Expansion interfaces/ports** | | | |
| Total slots | Two 33-MHz PCI, two ISA (none shared) | Two shared 33-MHz PCI/ISA, three ISA (one half-length) | Three 33-MHz PCI |
| SCSI | Built-in PCI, 8-bit Fast SCSI-2, internal and external connectors | none | Built-in PCI, 16-bit (Wide) Fast SCSI-2, internal (8-bit) and external (16-bit) connectors |
| Serial | Two 9-pin 57.6-Kbps | Two 9-pin 115.2-Kbps | Two 9-pin 19.2-Kbps asynchronous; two 26-pin mini-D 1-Mbps synchronous |
| Parallel | One IEEE 1284 25-pin | One IEEE 1284 25-pin | One IEEE 1284 36-pin high-density |
| **Networking** | | | |
| Interface | Built-in PCI Ethernet (10Base-T) | Built-in PCI Ethernet (10Base-T) | Built-in PCI Ethernet (10Base-T (tested), thin-net, or AUI) |
| **Pricing** | | | |
| Price (as tested) | $8295 (32 MB RAM)/$9995 (64 MB RAM) | $5607 (32 MB RAM)/ $7303 (64 MB), monitor $1410 extra | $6869 (32 MB RAM)/$9279 (64 MB), no monitor |
| Price includes | CD-quality audio with speaker and mic, videoconferencing camera | Built-in 16-bit "business" audio with speaker and mic | Optional "business" audio (on floppy-drive card) |
| **Warranty** | Three years, parts and labor; first year on-site; lifetime 24-hour, 7-day tech support | Three years, parts and labor; first year on-site | Five years, parts and labor, depot; or three years on-site (2-day response); or one year on-site (best-effort response) with 7-day, 24-hour phone support |
| **FCC Rating** | Class B pending | Class A | Class A |

in SCSI, and an 8-bit graphics system—an S3 Vision864 accelerator chip with only 2 MB of frame buffer. Graphics options include IBM's H10 PCI card with 4 MB of VRAM and a video coprocessor. "Business" audio and 10Base-T networking are also built in.

Security starts with a locking front cover. Once it's unlocked, you can open the mostly metal case without turning any screws. There is a ZIF socket that can take an upgrade CPU, though IBM has no firm plans for this socket.

Like the Motorola system, the Power Series 850 uses the Motorola MPC105 PCI Bridge/Memory Controller chip and therefore has a 64-bit memory data bus and a 32-bit address bus. The 850 Series comes in 100- and 120-MHz versions, which have a 256-KB asynchronous cache instead of a 512-KB synchronous cache. As noted, the 133-MHz system performed slightly better with non-SMP benchmarks than the Austin Direct PowerPlay² did.

The $7017 test system came with IBM's 17-inch 17S/S Sight and Sound monitor, which provides speakers, microphone, and an empty enclosure for an optional video camera. The unit also comes with IBM software that can take advantage of the 604's floating-point capabilities, including an MPEG decoder.

**Motorola PowerStack Series E**

Motorola Computer Group sells its systems only through reseller channels and offers a limited selection of peripherals, expecting resellers to add their own. The PowerStack Series E is designed as a desktop server. It lacks ISA slots and an internal IDE connector but provides four serial ports (two synchronous), built-in Fast and Wide SCSI-2, and Ethernet. You can stack a SCSI expansion module on top of the Series E. The system provides over-temperature detection for the CPU and also for the external SCSI module.

The 100-MHz PowerStack Series E 604-100P is a solid, cleverly built unit. You can quickly take the whole system apart (including removal of the motherboard and power supply) without touching a screw or a cable; there are none.

The system we tested (list price $9279) came with a Number Nine GXE64 Pro PCI graphics card (loaded with 4 MB of VRAM) but no monitor. It also included two Toshiba 525-MB SCSI hard drives and a CD-ROM drive. The floppy-drive card plugs into its own proprietary slot on the expansion card riser and also holds the business-audio option.

In fact, all the drives are on cards so that they can plug in without using cables. The hard-drive cards can hold up to three 2½-inch SCSI drives. By plugging in two of these cards, you can pack this server with six hard drives (plus the CD-ROM drive). You will need a second PCI SCSI controller if you want to add the stacking SCSI expansion module, which holds four 5¼-inch drives. Normally, it can run off the built-in SCSI controller.

In terms of performance, the 100-MHz Series E suffered in comparison with the 133-MHz IBM and Austin systems, but it performed proportionately to its lower clock speed.

**Company Information**

**Austin Direct PowerPlay²**
IPC Technologies
Austin, TX
(800) 752-1577
(512) 339-3500
fax: (512) 454-1357
http://www.ipctechinc.com
**Circle 1147 on the Inquiry Card.**

**Personal Computer Power Series 850**
IBM Personal Computer Co.
Somers, NY
(800) 772-2227
fax: (800) 426-4329
**Circle 1148 on the Inquiry Card.**

**PowerStack Series E 604-100P**
Motorola Computer Group
Tempe, AZ
(800) 759-1107, ext. PR
(512) 434-1526, ext. PR
http://www.mot.com/computer/
**Circle 1149 on the Inquiry Card.**

### Are You Running NT Software?

PowerPC NT systems are priced very competitively with equivalently configured x86-based systems, particularly when you consider that they perform faster than the initial 150-MHz Intel P6 systems we've tested. While NT allows running of 286-level 16-bit software under emulation, that feature becomes increasingly less appealing as more 32-bit Windows 95 software arrives. To justify buying a RISC-based NT system, you must not only require top performance with a major processor-intensive application, but you must also be able to satisfy most of your software needs with NT applications. ■

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# Enterprise Database Managers

**You can run a whole business on DB2/2, Oracle, or SQL Server. But there are important differences in scalability, support, and reliability.**

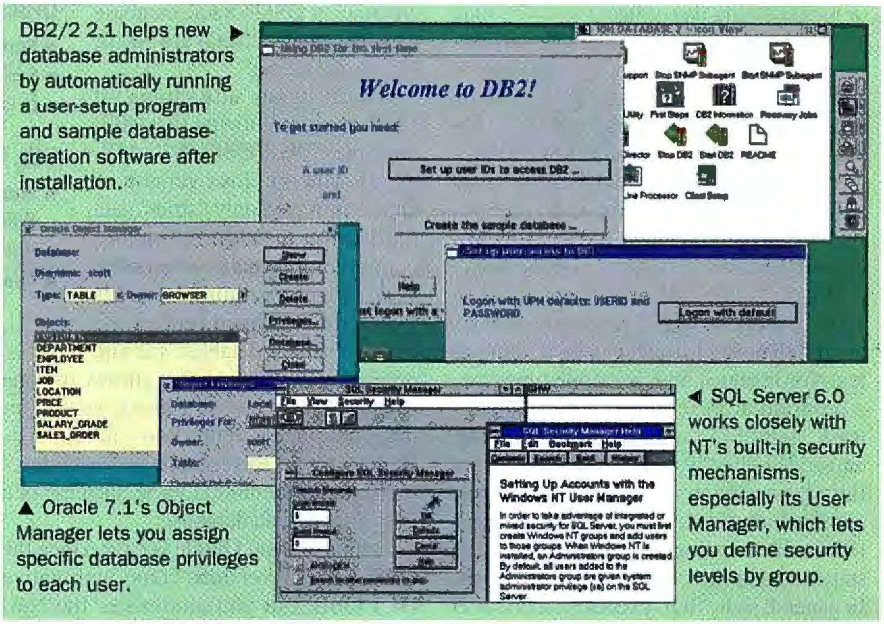
**BARRY NANCE**

If you work with important business information such as customer names, orders, billings, and payments, a relational database management system (RDBMS) is essential. Running an RDBMS on a networked desktop PC puts the data close to the people who use it.

For this review, we looked at the latest versions of three PC-based RDBMSs that have the power and the capabilities needed to run an enterprise: IBM's DB2/2 2.1, Oracle's Oracle 7.1, and Microsoft's SQL Server 6.0.

All three systems offer stored procedures, triggers, and constraints. A stored procedure is a set of processing steps that executes on the database server PC rather than on the client. A trigger is a stored procedure that fires when a specified event (row insertion, deletion, or updating) occurs. A constraint is a business rule in the database that specifies acceptable values or relationships among data fields. Constraints let you enforce referential integrity relationships among your database tables; you can ensure, for example, that no one can delete a customer's account in one table if billing records for that customer still exist in another table.

These are big-league features that, along with higher capacity and performance, help distinguish these database managers from such products as Microsoft Access, Lotus Approach, and Borland Paradox.




DB2/2 2.1 helps new database administrators by automatically running a user-setup program and sample database-creation software after installation. ▶

▲ Oracle 7.1's Object Manager lets you assign specific database privileges to each user.

◀ SQL Server 6.0 works closely with NT's built-in security mechanisms, especially its User Manager, which lets you define security levels by group.

### Stress Test

Overall, we found Oracle to be the best of the three. It scales the most consistently across PCs, minicomputers, and mainframes (see the chart "Comparing Relational Database Features" on page 216), and it offers more platform choices than DB2 or SQL Server. We recommend Oracle for enterprises with many remote sites of diverse sizes. It is also mature, a market leader, and rich in features.

DB2/2, though it scales almost as well as Oracle, doesn't offer you as big a range of choices; for example, the next higher gradation of DB2, which runs on IBM's RS/6000 RISC workstation, has relatively little third-party support. Still, for companies downsizing to client/server and that already have DB2 on a mainframe, DB2/2 is an excellent desktop solution. It's also a good choice for organizations that need the utmost in reliability.

SQL Server runs only on Microsoft Windows NT, which limits its scalability to 486-based PCs through DEC Alpha-based systems and, eventually, PowerPCs. But it offers excellent integration with Visual Basic and with Microsoft and third-party applications.

To gauge reliability, we wrote an "RDBMS killer" program to find out how each product behaves at its saturation point. The multithreaded program, emitting SQL operations to each RDBMS at an ever-increasing rate, ran directly on the database server rather than across the LAN. All three products died during the stress test, as we expected. We wanted to study the failure itself, not measure how long each RDBMS lasted (long before your own database software died, you would have gotten more hardware and scaled your systems upward).

DB2/2 failed gracefully, shutting down and leaving the database undamaged. But when SQL Server and Oracle died, we had to run repair utilities before we could resume using the database.

### DB2/2 2.1

IBM continues to make DB2 more consistent across PCs (running OS/2), RS/6000s (AIX), AS/400s (OS/400), and mainframes. IBM has targeted other platforms for DB2 as well, including HP-UX, Solaris, Sinix (Siemens Nixdorf Unix), and Windows NT. But DB2 is not yet one database product with a single code base. Slight differences exist among versions, most notably in the Data Definition Language (DDL) statements you use to allocate and initialize a new database. The bottom line: You sacrifice some portability with DB2.

We tested DB2/2, the OS/2 version that supports symmetric multiprocessing (SMP). DB2/2 supplies programming interfaces for a wide variety of computer languages, including C, C++, COBOL, and FORTRAN. IBM's own VisualAge and many third-party products (such as Watcom's VX-REXX) are excellent add-on tools you can use with DB2/2.

You can configure DB2/2 to replicate data among a set of database servers. DB2/2 can also work through Distributed Database Connection Services (DDCS) or other middleware products to interface with mainframe DB2 databases. Administration is easy, either locally or remotely, through GUI administration software. For remote sites that don't have their own database administrator, DB2/2 offers remote administration tools. A separate product, Visualizer, lets you build, update, or query your database.

DB2/2 2.1 subjects SQL statements to one of nine levels of optimization just prior to processing those statements. The nine levels, which can be configured by a database administrator or set by application software, allow precise tuning of database response times. You'd use level 0 or 1 for SQL that's already optimized by the programmer. Higher levels let DB2/2 examine and reformat SQL submitted by, for instance, a front-end query tool such as Microsoft Access.

Programs can emit either "dynamic" or "static" SQL to DB2. Dynamic SQL is compiled at run time; it can be a string of text, for instance, that someone types into a program at the command line. In contrast, static SQL consists of statements, embedded directly in the program, that are fully known at compile time. Precompile and postcompile steps, part of a process IBM calls "binding," store the static SQL statements in files with a .BND extension. In general, static SQL executes much faster than dynamic SQL.

### Oracle 7.1

Oracle runs on more than 90 platforms (about 60 of which are Unix environments). Because the database software is essentially the same code for each platform, Oracle is amazingly consistent on different platforms. Moving an Oracle database from one platform to another is a simple matter of using the export and import utilities supplied with the package. Database administration and design are also consistent among platforms. The same DDL for creating an OS/2 Oracle database can also create a NetWare NLM, NT, or Unix one.

Oracle takes advantage of SMP in environments that offer multiple CPUs (OS/2, NT, AIX, SCO). The previous version of Oracle provided only "strict" data replication through two-phase commit or unsynchronized table snapshots. Version 7.1 adds loose, time-delayed replication from a primary database site and optimistic replication that allows any one database site to update without waiting for other sites to catch up. You can also configure Oracle to replicate table updates onto another (remote) Oracle database or a DB2 mainframe database.

Administering Oracle is easy, since the OS/2 and NT versions come with native GUI tools, but you administer the NetWare NLM version through an over-the-wire Windows interface. Oracle, through a separate product, offers remote administration tools for distant sites that don't have their own database administrators.

Oracle supports the use of triggers, stored procedures, and database constraints through its PL/SQL database server programming environment. It also supports dynamic SQL and, for embedded SQL, a form of static SQL. However, unlike in DB2/2, there is no separate "bind" step the programmer performs during development. And, to improve processing of SQL statements, Oracle uses an optimizer to predigest SQL. (See the Technology Focus box below for an explanation of SQL processing in all three products.)

Oracle isn't quite as easy to program as DB2/2, and it doesn't have tight, thread-oriented integration with the host operating system. On the other hand, Oracle enjoys a great deal of support from third-party software vendors, and SQL*NET is an excellent, multiplatform-oriented SQL de-

## TOP THREE REASONS TO BUY...

**DB2/2**

- **Supports faster-executing static SQL**
- **Works on SNA networks**
- **Is easy to program**

**Oracle**

- **Supports row locking**
- **Scales in fine gradations from PCs to mainframes**
- **Is consistent across platforms**

**SQL Server**

- **Works well with Visual Basic and shrink-wrapped Windows programs**
- **Has good Windows NT-based security features**
- **Replication is easy to set up and administer**

TECHNOLOGY FOCUS

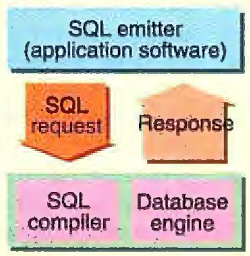
## SQL Compilers: The Performance Nexus

**The database engine's SQL compiler is arguably the most important part of an RDBMS. It must recognize and understand natural language (SQL), then turn the SQL statements into "instructions" it gives to the database engine's retrieval and update processes. The job is compounded by speed requirements.**

**SQL compilers process SQL statements in five basic steps. The first step parses the SQL, examines it for syntax errors, then converts the SQL parse tree into an internal representation. The second step examines the reformatted SQL to ensure that executing the statement won't violate referential integrity. This step also notes whether the database engine should process a constraint or trigger for the SQL.**

**Next, the SQL compiler rewrites the SQL statement, replacing view references with actual column names and transforming the SQL for processing by the optimizer. The transformation eliminates redundant joins, adds implied predicates, and converts INTERSECT clauses to EXISTS subqueries.**

**In the fourth step, the optimizer uses cost-based algorithms to determine the most efficient execution method for the SQL statement. It finds the best join order, for example, and it decides whether the execution of the SQL statement will be CPU- or I/O-bound. The optimizer chooses an execution path for the SQL statement that will result in the quickest response from the database engine.**



An RDBMS's SQL compiler has a central role in making efficient queries.

**The fifth step "remembers" the essence of the SQL statement for later comparison with other SQL statements; the SQL compiler keeps a history of how well it optimizes statements so it can "learn" the fastest ways to access the database. After this fifth step, the SQL compiler delivers the compiled, optimized SQL statement to the retrieval and update processes in the database engine.**

# THE 1995 MICROGRAFX CHILI FOR CHILDREN COOK-OFF

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livery mechanism.

### SQL Server 6.0

Microsoft originally licensed an OS/2 version of SQL Server from Sybase. But when Microsoft ditched OS/2 for Windows NT, it terminated that business relationship. The latest version of SQL Server continues to look much like the Sybase database management products (which run on Unix platforms), but Microsoft says that it has changed about 60 percent of SQL Server. We found that the underlying architecture has changed considerably from prior versions. The programming interface and configuration process, on the other hand, are similar to earlier versions of both Microsoft SQL Server and the Sybase product.

SQL Server, which now runs only under NT, has a new GUI administration tool called SQL Enterprise Manager (SEM). While previous versions of the RDBMS used a text-mode Interactive SQL (ISQL) interface, this one has GUI database-administration tools. New features include scrollable cursors, distributed management objects, and extended stored procedures. Before, you coded your SQL Server stored procedures in Microsoft's (Sybase's) Transact-SQL language, and you were limited both in performance and in function to the design of Transact-SQL. Extended stored procedures allow SQL Server to use external programs to handle database events. And, like Oracle, the program uses a cost-based optimizer to examine and reformat SQL statements.

Microsoft has tightly integrated SQL Server into the NT environment. It is consistently the same database manager, from both architectural and user interface viewpoints, on Intel, Mips, or DEC Alpha systems. NT schedules individual SQL Server threads on different CPUs if your database server is an SMP machine.

SQL Server, like DB2/2 and Oracle, can automatically replicate changes onto remote databases, but its replication uses a publish-and-subscribe metaphor. A distribution server hosts a distribution database, which holds rows from published tables until SQL Server can copy the rows to the databases that subscribe to the published tables. A publication database can define publication tables, and a subscription database can subscribe to those published items. Through SQL Server's SEM interface, replication is particularly easy to set up. However, changes made on a remote SQL Server by means of a remote procedure cannot be rolled back (undone).

SQL Server's tight integration with NT helps make it a secure database, and SEM gives it point-and-click ease of use. But SQL Server isn't yet ready for the enterprise. If you use OS/2 or Macs, you'll have to buy an ODBC connectivity solution from a company other than Microsoft. And because of the rift between Microsoft and Sybase, SQL Server customers who want to mix the Sybase and Microsoft versions of the program will have trouble. ■

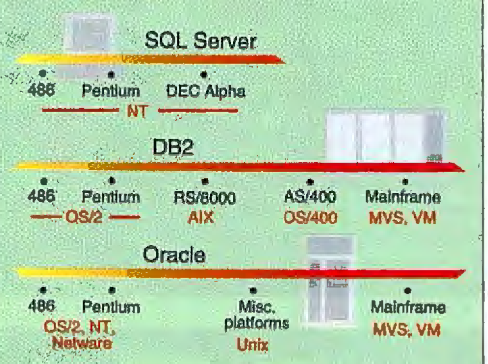
*Contributing editor Barry Nance is the author of several books, including* Using OS/2 Warp *and* Client/Server LAN Programming *(Que, 1994). You can reach him via the Internet at barryn@bix.com.*

**COMPARING RELATIONAL DATABASE FEATURES**

| | DB2/2 | ORACLE | SQL SERVER |
|---|---|---|---|
| Price per user (50 users) [1] | $123 | $101 | $25 |
| Server platforms (with OS) | PC (OS/2), RS/6000 (AIX), AS/400 (OS/400), mainframe (MVS, VM) | PC (OS/2, NT, NetWare), assorted Unix, mainframe (MVS, VM) | NT |
| Client platforms | DOS, Windows, OS/2, Macintosh | DOS, Windows, OS/2, Macintosh | DOS, Windows [2] |
| RAM (replication enabled) | 16 MB | 16 MB | 32 MB |
| Symmetric multiprocessing support | ● | ● | ● |
| Maximum columns per table | 256 | 256 | 250 |
| Row locking | — [3] | ● | — [3] |
| Replication | ● | ● | ● |
| Centralized management | ● | — [4] | ● |
| Referential integrity | ● | ● | ● |
| Stored procedures, triggers, and constraints | ● | ● | ● |
| Programming languages | C, C++,COBOL, REXX, FORTRAN | C, C++, COBOL, FORTRAN | C, C++, COBOL, Visual Basic |
| Transport protocols | IPX, NetBIOS, SNA (APPC), TCP/IP | IPX, NetBIOS, TCP/IP | IPX, NetBIOS, TCP/IP |
| Static SQL | ● | ○ | ○ |
| SNMP alerts | ● | ○ | ○ |

● = yes; ○ = no
[1] Includes base product plus 49 client licenses
[2] Microsoft does not support OS/2 and Mac clients, but third-party support is available.
[3] Page-level only
[4] Oracle offers separate remote-monitoring utilities.

**Moving On Up**




**While SQL Server runs only on Windows NT, DB2 scales from PCs up through mainframes. Oracle, which runs on more than 90 platforms, scales especially well.**

**Product Information**

**DB2/2 Client/Server 2.1** . . . .$1495
(includes five client licenses; $85 per additional client)
IBM
Armonk, NY
(800) 342-6672
(914) 765-1900
fax: (313) 225-4020
**Circle 1144 on Inquiry Card.**

**Oracle 7.1** . . . . . . . . .$199 per server
($99 per client)
Oracle
Redwood Shores, CA
(415) 506-7000
fax: (415) 506-7200
**Circle 1145 on Inquiry Card.**

**SQL Server 6.0** . . . . . . . . . . .$999
(plus $119 for 20 client licenses)
Microsoft
Redmond, WA
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
**Circle 1146 on Inquiry Card.**

# Organization Made Loud and Clear

**NetManage's ECCO Pro is both a sophisticated PIM and an alternative Windows desktop**

**JOHN MONTGOMERY**

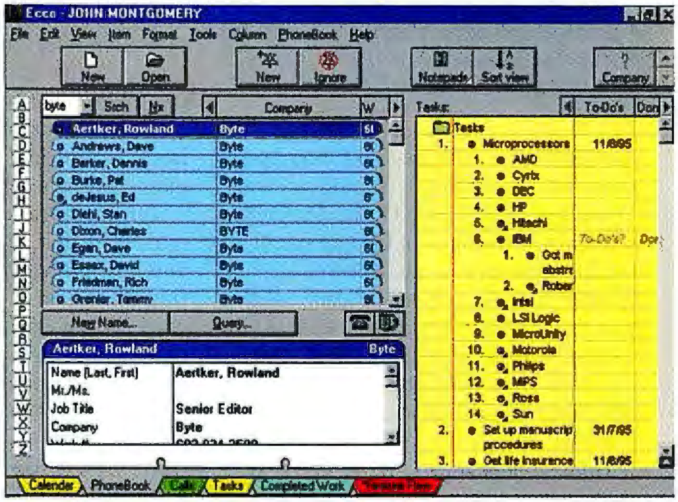
There *is* a method in your madness, you continue to insist, despite working in an office that seems to have been decorated by the guy who invented the Post-It, where the papers on your corkboard should be carbon-dated, and where any horizontal surface is a filing cabinet. This is entropy in action.

NetManage's ECCO Pro is a personal information manager (PIM) that fights entropy. By using linked outlines, ECCO not only can round up your to-do list, your list of people to call, and your phone book, it can help restructure the way you work. With ECCO, you'll start to think in hierarchical terms, categorizing what needs to be done and even doing simple project management.

But that's ECCO's downside, too. As with any PIM, *you* have to adjust to the way *it* works. Despite this one possible shortcoming, ECCO is powerful enough to handle most PIM tasks. Actually, ECCO is a little scary. It's so all-inclusive that you may find you can't function without it. You won't feel comfortable jotting a name down on a piece of paper. You'll have to enter it directly into ECCO's phone book.

### Not Just a PIM

About three years ago, ECCO reintroduced PIM users to the concept of outlines. The new version (3.0) calls them notepads, but they're basically still outlines, with some user interface (UI) improvements, such as easy ways to join and split lines.




Unlike standard Windows applications that are compliant with the Multiple Document Interface (MDI), ECCO Pro actually merges different views into one seamless window, so it's easy to move data from one notepad to another.

ECCO is capable of far more complex presentation and organization, though. You can add columns, as you can in a spreadsheet. For a project outline with a month-project-tasks hierarchy, you could add a start date and an end date, a pop-up list of people available to work on the project, and a check box to mark when you finish a stage of the project. If you wanted to get really fancy, you could even add Gantt charts and columns based on information in your phone book or to-do list. In fact, you can cross-reference the information in any of the outlines you create.

This type of cross-referencing is handy. You can drag information from one outline into another, and it will be referenced in both places. For example, drag a name from your phone book to your calls list. ECCO not only adds it there but adds a check mark by that name in the phone book to remind you to call the person. During the phone call, you can take notes under the person's name in either the calls list or the phone book. The name and note will appear in both places. When you mark the call as done, it's added to your completed tasks list, so you can keep a record for your nosy boss.

### Learning How to Think

ECCO includes six templates, each targeted at a type of information: general, legal, manager, project, research, and sales. Common to each template are, not surprisingly, a calendar and a phone book—standard in any PIM. Common across most are a tasks list and a calls list.

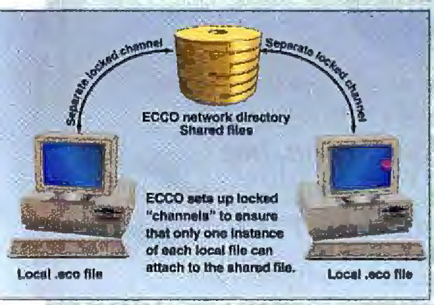
Outlines and templates aside, what makes ECCO special is its integration with other applications. It supports OLE 2.0, so you can embed documents into ECCO outlines with no problem (though in these days of widespread OLE 2.0 availability, that goes without saying). Beyond that,

TECHNOLOGY FOCUS

### ECCO's Unique File-Locking System

**When you share files on a network, you need some way to ensure that two people can't modify the same data at the same time. That's easy if you're not expecting two people to try to access one file at once. But with shared files, such as those ECCO uses, you need sophisticated file locking.**

**ECCO isn't record-oriented, so it can't use the type of locking found in most commercial databases. Instead, it usually (depending on the type of file) locks a file for as long as a client needs it and then unlocks it. This basic protocol is called OF_SHARE_DENY_NONE, which specifies that if the file is already open in another mode, a second open command should fail, but multiple clients can open it in this mode. When the file is open, ECCO sets the first 16 bytes of the file as locked using the DOS FLOCK function (a DOS INT 21H function). Once all this is set up, only the locking process can read or write to the file.**




**File locking varies a little depending on the type of file you're opening. The most common scenario would run like this. You open a shared file. ECCO opens the shared file itself, loads it into memory on your machine, and then closes it. ECCO then opens a pair of shared status files and holds them open until you close the original file.**

# Organization Made Loud and Clear

## What's New in Version 3.0

- Group scheduling via direct network access, TCP/IP, and E-mail
- Real-world templates (e.g., Rolodex and three-ring binder)
- Expanded drag-and-drop functions
- Time and expense tracking
- Simplified dialog boxes

ECCO also includes a clever tool called the Shooter—a sophisticated cut-and-paste tool that far surpasses Windows' own. When you install ECCO, the Shooter (a small arrow) appears in the title bar of all the applications you run. You left-click on it, and a drop-down menu appears, offering you the option of "shooting" selected information to another application. Generally, you'll probably be shooting names and addresses from your ECCO phone book into word processing documents.

Here's the best part: When you update the information in your ECCO phone book, it will be updated in your word processing document, too. We noticed a minor problem with the Shooter, however. On slow machines, it drags down the responsiveness of your running applications. But on any machine faster than a 486/50, you shouldn't notice a problem.

The main drawback to ECCO is that the database around which it's centered isn't fully relational, and the filtering engine can't compensate for this. So, to take different views of a project, you must create a new outline and drag the folders from the folder manager into the new outline. You can't click on a column in your existing outline and say, "view by this column." You can sort by columns, however.

Once you have mastered ECCO, you will probably find that your coworkers are envious of your newfound efficiency. That's when to install it on your network. ECCO uses three tools for sharing information. With the first tool, ECCO stores its shared files on a file server but keeps the executable file on your local disk. You then use the second tool—an E-mail transport such as Vendor-Independent Messaging (VIM) or MAPI—to request meetings. The third tool is replication. You can replicate local information from a desktop computer to a notebook and back.

**Product Information**

**ECCO Pro 3.0** .............. $175
NetManage, Inc.
ECCO Division
(206) 885-4272
fax: (206) 885-0127
eccoservice@netmanage.com
http://www.netmanage.com
**Circle 1231 on Inquiry Card.**

### Enforced Organization

For people who are already organized, ECCO is a natural way to work. If you're not organized, ECCO can help you get there by making you think of projects and information hierarchically. But if your style is more free-form, maneuvering to the correct outline, finding the right place to enter data, and learning how to use the information in the various columns could be more trouble than it's worth. With that caveat, we recommend ECCO Pro for anyone who is striving to reach the apex of organization. ■

*John Montgomery is BYTE's features editor. You can reach him on the Internet or BIX at jmontgomery@bix.com.*

# Storming the Enterprise

**OLE Automation servers make Visual Basic 4.0 a tool for three-tier client/server applications**

STEVE GILLMOR

With release 4.0, Visual Basic developers can create their own OLE components, deploy them via Remote Automation technology, and programmatically control the development environment. Microsoft's new version offers other significant improvements to the existing Standard and Professional Editions, as well as adding an Enterprise Edition for team-based client/server projects. It's a big leap forward.

As Microsoft moves millions of computer users to the 32-bit world of Windows 95 and NT, Visual Basic has been endowed with both 16- and 32-bit versions. Now users can not only create NT and Windows 95 logo-ready applications, but they can use the same Visual Basic for Applications programming language that was first introduced in Microsoft Excel.

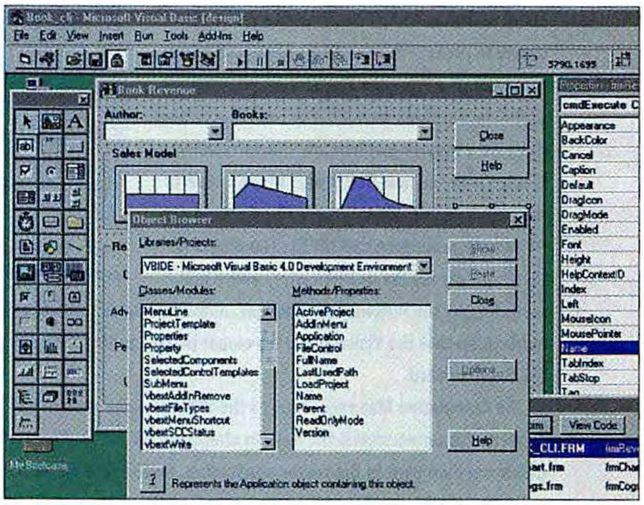
### From 16-bit VBXes to 32-bit OCXes

Since version 1.0, Visual Basic has prospered by providing an intuitive development toolkit augmented with third-party Visual Basic custom controls (VBXes). Version 4.0 delivers a migration path from 16-bit VBXes to 16- and 32-bit OLE Controls (OCXes).

The conversion is automatic. Visual Basic checks to see if OCX updates exist when your project is loaded, and it then prompts you with a dialog box to confirm the changes. You can still use VBXes if you like, but only with the 16-bit versions of Visual Basic 4.0 provided in the Professional and Enterprise Editions. The Standard Edition is available only in the 32-bit version. All three editions ship with 10 Windows 95 custom controls.

Integration of the Data Control and the data-aware controls, which began with version 3.0, continues with the new product. The OLE Container Control now is data-bound, as are the grid, list, and combo boxes. A new 32-bit version of the Jet database engine, which Visual Basic shares with Microsoft Access, adds referential integrity, cascading updates and deletes, programmatic security control for users and groups, multiple workspaces for multiple simultaneous connections, and Rushmore technology for accelerated queries.

Version 3.0 of the Jet engine also marks Microsoft's first steps toward database replication; developers can now convert databases into replicable forms that can be copied and subsequently synchronized. If you have Access for Windows 95, you can synchronize (or merge) one replica with another via the Windows 95 Briefcase.



Visual Basic 4.0's Object Browser displays objects you create, as well as objects from other applications. Here objects are being selected from Visual Basic's own integrated development environment (IDE) library.

We were particularly pleased with Visual Basic's leveraging of the Windows 95 environment. For example, you need Windows 95's expanded Resources to load multiple instances of the program, a requirement for developing remote OLE servers on a local machine. Drag-and-drop and right-mouse quick-menu support (both Windows 95 features) quickly become old friends during forms development.

### The Look and Feel of OLE

Like its predecessor, Visual Basic 4.0 lets you control other applications' objects via OLE Automation. You can use the enhanced OLE Container Control to display stored OLE documents, including audio and video clips. Commercial applications, such as Excel, Word, and Visio for Windows, can provide ToolBox icons to represent their OLE document objects.

The Visual Basic editor reflects the expanded integration of OLE Automation. You use the new Object Browser (see the screen) to explore the object libraries supplied by OLE-enabled applications. When an OLE server is installed on your system, you can select its object library from a drop-down list that also includes your current project. You then choose a class from the Classes/Module box, which displays the associated methods and properties in the companion window.

You can show or paste syntax templates into your code, jump to context-sensitive help, or simply use the Browser as a quick way to navigate from one spot to another in your project's code. You can also set an option to view either one procedure at a time or all in a scrollable listing.

### OLE Automation and Other Developments

Microsoft is midway through the process of migrating the Visual Basic for Applications language across its Office suite; Office 95 now has it in Excel and Project, with Access to receive it soon, and Word and PowerPoint to follow by year's end. VBA has finally arrived, bringing with it optimized OLE tools such as the `With` and `For Each` statements and the `Collection` data type. These constructs make code simpler, faster, and more readable, plus you can use code generated by the Excel macro recorder without modification.

VBA allows conditional compilation both in code and from the command line, making it simple to create common code that can be recompiled for either 16- or 32-bit versions of projects. You can use the new Compile on Demand and Background Compile switches to determine whether a project is to be fully compiled before it starts, compiled as needed to speed application start-up, or compiled in the background during idle time. Support has been added for automatic incremen-

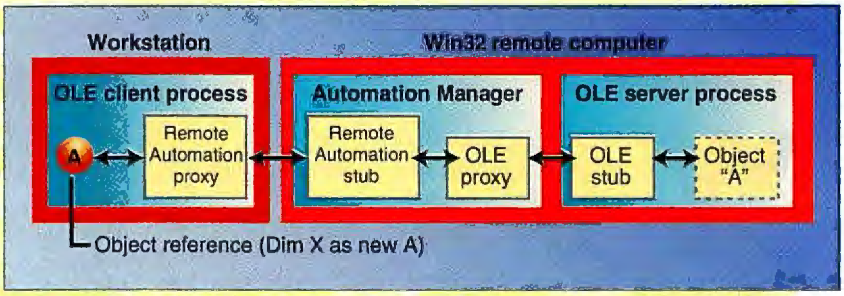
TECHNOLOGY FOCUS

### Executing Remote Objects

Visual Basic 4.0's technology for distributing and executing remote objects offers a glimpse of future Windows technology. Microsoft says these remote-execution features will be included as part of Cairo, the next major upgrade of Windows NT.

When you install the Enterprise Edition on a client machine, Visual Basic adds a new OLE Automation proxy. When an OLE client asks to use an object, the Windows Registry knows whether that object resides on a local or remote machine. If it's on a remote machine, the Registry communicates with the new OLE proxy, which converts the standard OLE Automation call to a Windows NT remote procedure call (RPC). The object is then sent across the network wire, where it's picked up by the Automation Manager, a multithreaded, redistributable application that the Visual Basic developer places on the server by using the Setup Wizard.

The Automation Manager receives the RPC message stream and reconverts (or *unmarshalls*) the data to standard OLE Automation calls, which are then sent to the server application. Neither the client nor the server deals with anything other than standard OLE Automation. In addition, the programmer doesn't need to know anything about RPC coding.




Remote Automation works by replacing the original proxy and stub with modules that use the remote procedure call (RPC) protocol to communicate over the network.

Because OLE servers created in Visual Basic are single-threaded, programmers tend to run several instances of the same object within a server to achieve multitasking. But since each object takes up roughly 500 KB of RAM, running multiple remote servers simultaneously can drag down performance. To get around this problem, Visual Basic provides a Pool Manager, which maintains pools of objects that can be handed to clients as needed. The pools can be on separate computers.

The Remote Automation technology works only with out-of-process servers. You cannot access a remote in-process DLL directly from a client machine, but the remote server can access those DLLs on its own machine.





tal versioning, and you can now edit and store Windows EXE header-file information (e.g., comments and trademarks).

The Professional Edition takes a giant step by offering the ability to create your own OLE Automation servers. Two types are possible: in-process and out-of-process. Both expose methods and properties that can be browsed by any OLE client application. An in-process server is implemented as a DLL and runs in the same process as the client that accesses it.

Out-of-process servers run in their own address space; they require OLE's proxy/stub mechanism to receive parameters from the client and then return them. The Enterprise Edition adds the capability of executing these out-of-process servers remotely over a network (see the Technology Focus box). You can move frequently changing code from front-end client machines to a centralized OLE Automation server for easier maintenance, while processor-intensive tasks are executed by powerful remote servers at the back end.

Visual Basic 4.0 is itself an OLE server, exposing its integrated development environment (IDE) to interaction with OLE-compatible applications, including OLE servers that you can now create. This technology opens Visual Basic to a variety of integrated add-ins, including Wizards, template libraries, forms generators, CASE, and team development tools.

**A Promising Future**

Visual Basic 4.0 continues to expand the horizons for custom applications. Wholesale adoption of OLE Automation throughout the programming system goes hand in hand with Microsoft's Office 95 strategy. Gone are the synchronization issues with Microsoft Access that required reduced-functionality compatibility layers.

The ability to create OLE Automation servers is not matched in OCXes; that task still falls to Microsoft Visual C++ or comparable tools. Visual Basic continues to generate code that requires a run-time interpreter for execution, with a resulting trade-off in performance versus a compiled product. On the other hand, Visual Basic executables remain smaller, because they don't have to add run-time code for each module in a distributed application.

Furthermore, the Remote Automation technology does not constitute true, distributed-component computing. Rather, it supports a new approach to rapid applications development for client/server tools. Because business rules are separated from the front and back ends, the resulting code can be revised, maintained, and reused more easily. And the new OLE-server capability can make users providers—not just consumers—of Visual Basic applications and add-ins. ■

*Steve Gillmor is director of Southern Digital, Inc., a consulting firm in Charleston, South Carolina. He is coauthor of* Using Visual Basic 3 *(Que/Prentice-Hall, 1993). He can be reached on the Internet at sgillmor@aol.com or on BIX c/o "editors."*

**Product Information**

**Visual Basic 4.0**
**Enterprise Edition** ........ $995
(Standard Edition, $99; Professional Edition, $499)
Microsoft Corp.
Redmond, WA
(206) 882-8080
(800) 426-9400
fax: (206) 936-7329
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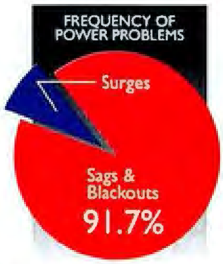
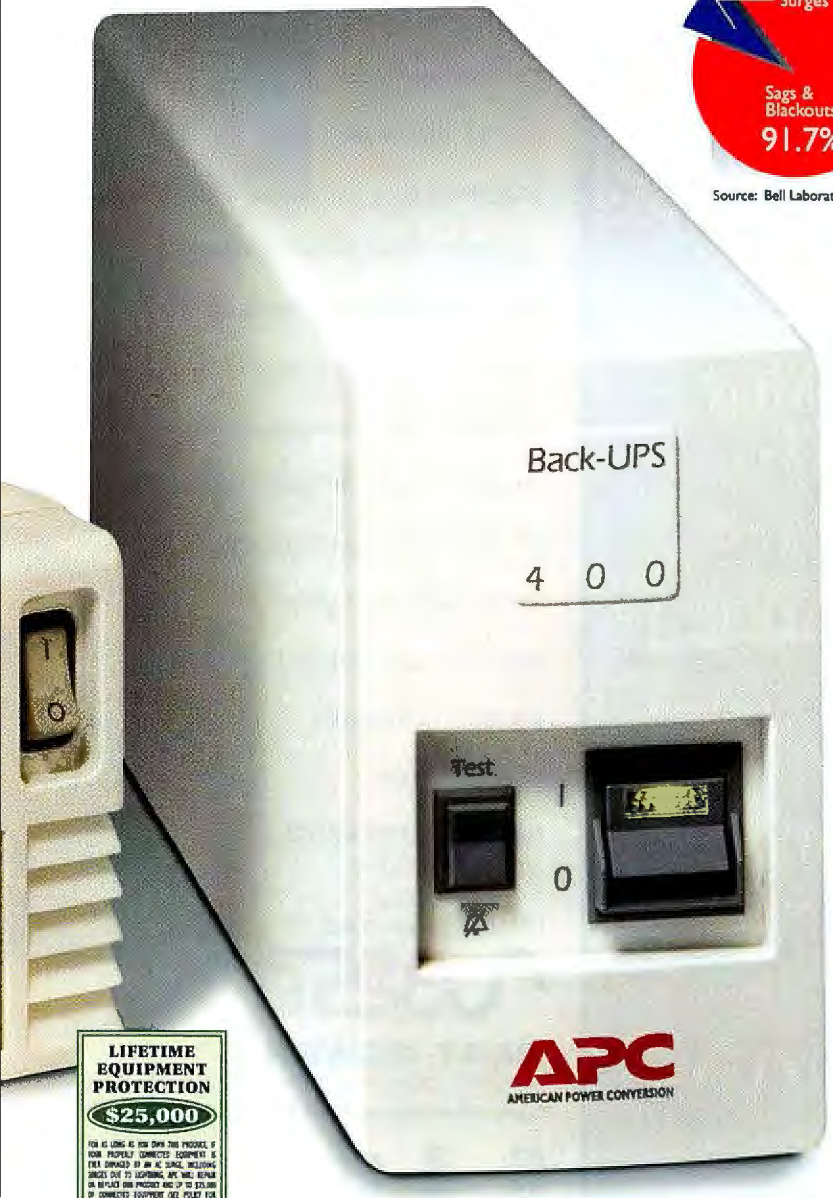


Source: Bell Laboratories

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Who needs power protection? If you use a computer, you do. A study in a recent *PCWeek* showed that the largest single cause of data loss is bad power, accounting for almost as much data loss as all other causes combined. Every PC plugged into an outlet is vulnerable. In fact, you have better odds of winning the lottery than of escaping the sting of power problems. One study found a typical PC is hit over 100 times a month, causing keyboard lockups, hard drive damage, and worse.

Simply put, if power problems are the least of your troubles, you've got one chance to keep it that way. You insure your car and home with the best policy you can afford. It just doesn't make sense to leave your PC (which is at far greater statistical risk) vulnerable to loss or damage.

## Why a $119 APC UPS costs less than a $9.99 "surge protector"...

Contrary to most people's belief, a PC alone already has more protection built into it than a low-end "surge suppressor," which is usually nothing more than a well-packaged extension cord. In other words, going without any protection is just as good as underspending on one of the most important PC decisions you'll make.

For extended brownout protection for advanced PC workstations call about APC's New Back-UPS Pro!

And since sags and blackouts represent more than 90% of power problems likely to hit your computer, even quality, high-performance surge suppressors are literally powerless to protect you from data loss.

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PC World Top 20 Upgrade

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| MODEL | OPTI-UPS 280E | APC BK280 | APC BP280 | TRIPP LITE BC280 | TRIPP LITE OMNIPRO280 | TRIPP LITE SMART280 |
|---|---|---|---|---|---|---|
| Price* | $139 | $139 | $199 | $137 | $194 | $295 |
| VA | 280 | 280 | 280 | 280 | 280 | 280 |
| Type | Line Interactive | Standby | Line Interactive | Standby | Line Interactive | Line Interactive |
| Voltage Regulation | Buck & Boost | None | Buck & Boost | None | Buck & Boost | Buck & Boost |
| Intelligent Comm. Port | Yes | No Port | No Port | No Port | No Port | Yes |
| Data Line Protection | Yes | No | Yes | No | No | No |
| User Replaceable Battery | Yes | Yes | Yes | No | No | No |
| Auto Self Test | Yes | No | Yes | No | Yes | Yes |

The OPTI-280E is part of our power-packed E-Series, which also includes the 420E, 650E, 1000E and 1400E. It offers the high-end features you need like buck and boost line conditioning, a smart communications port and compatibility with our OPTI-SAFE+ UPS Communication Software. The bottom line is that the OPTI-UPS E-Series offers more than basic protection and still costs over $60 less than the comparable APC or Tripp Lite unit!

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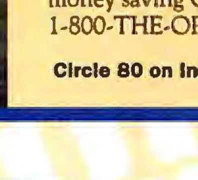
LIFE INSURANCE FOR COMPUTERS



It's never been easier to get the most protection less money can buy. For more information on the money saving OPTI-UPS E-Series simply call 1-800-THE-OPTI; Product Code 519.

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Computer Reseller News TEST CENTER RECOMMENDED • 1995

# Sudden Darkness

**BYTE tests 31 network-capable UPSes and picks the best**

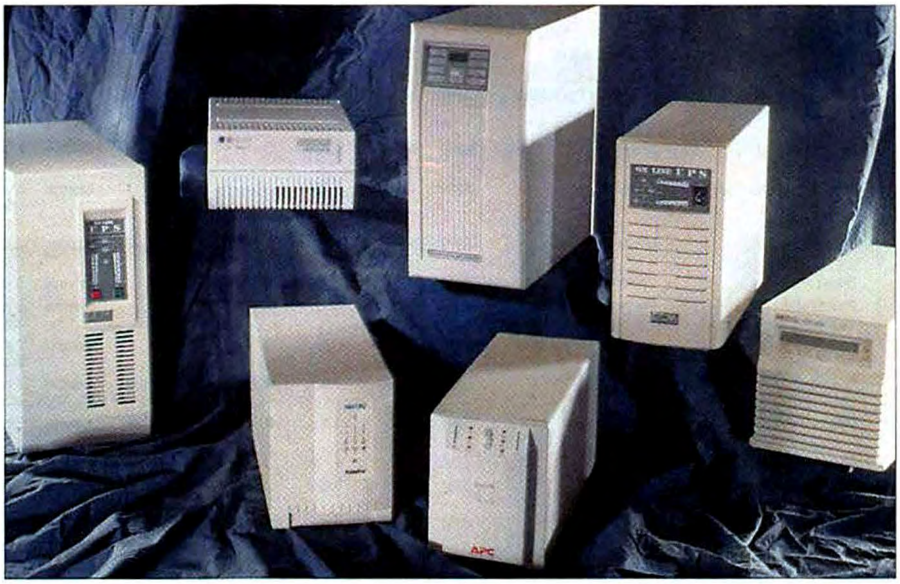
**REX BALDAZO, RICK GREHAN, AND DAVE ROWELL**

Deciding that your network servers need power protection is easy. Choosing an uninterruptible power supply (UPS) to protect them is not.

At the very least, you'll want a UPS that can automatically and gracefully shut down servers without data loss during a power outage. The ability to run through brownouts is important in some locations, and any UPS should filter out voltage transients (e.g., spikes, surges, and noise) that can damage data or equipment.

Before you buy, however, you should consider many other factors, such as local power conditions, equipment load, network topology, business dependency, budget, and even your style of system administration. To help simplify your decision, we tested 31 such network-capable UPSes with capacities between 750 and 1250 volt-amperes—enough to comfortably support two to three file servers. Prices ranged from $600 to $2050.

We evaluated hardware performance and network software features. In most cases, all 31 units can do the job, but some better than others. Weighing output quality, software functionality, battery life, and price, we wholeheartedly recommend seven of these units (see the photo at right). To help you decide which is best for your needs, see our feature-comparison table that begins on page 228.

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**The network UPSes we'd recommend most. For on-line units (back row, left to right): Powercom's ONL-1250, Exide Electronics' Powerware Prestige 1000P-1, Controlled Power's LT-1200, Powercom's ONH-1000, and Hewlett-Packard's PowerWise 1000 VA UPS. For line-interactive units (paired in front): Deltec's PowerRite Pro 1000VA and American Power Conversion's Smart-UPS 1000.**

### Line Interactive or On-line

UPSes suitable for backup of small server installations come in two classes: line-interactive units and on-line units (the latter tend to cost more).

The main distinction between line-interactive UPSes and on-line UPSes, practically speaking, is what happens to output voltage at the moment of a power loss. A line-interactive unit lets through a small and usually inconsequential power gap (measured in milliseconds as a *transfer time*) when it switches to battery power during an outage.

Line-interactive units are basically high-class standby UPSes that have microprocessors, some voltage regulation, better performance characteristics, and a greater ability to communicate with software on a server, usually through a serial connection. (We didn't test standby UPSes with lesser capabilities.)

A typical on-line UPS constantly converts AC to DC and then back to AC again, and a power outage (or just about any other power abnormality) has little or no effect on output. Most PC power supplies, especially server-quality units, can easily withstand voltage dropouts of 20 milliseconds, and sometimes longer, without consequence. The longest transfer time we measured from a line-interactive UPS was 15 ms (see the comparison table). Some electronic equipment may not tolerate any transfer time, and touchy power supplies in some older PCs might reboot with transfer times as short as 5 ms, but these are not typical situations on most networks.

Quality of voltage regulation is perhaps a more important difference between the two classes. On-line UPSes produce a nearly constant, purely sinusoidal voltage between 115 VAC and 120 VAC regardless of input voltage. Line-interactive units pass utility power directly through to their output receptacles, although with noise filtering and surge suppression. As a result, output voltage rises as input voltage does. At a lower-threshold voltage, and usually at an upper-threshold voltage, the UPS switches to battery power.

To extend its operational voltage range and reduce variations in output voltage, a line-interactive design uses a transformer that boosts low voltages and often trims (or bucks) high voltages (see the text box "Boost and Buck" on page 231). One result is that a line-interactive UPS can power through extended periods of low utility voltage (i.e., brownouts). The line-interactive units from American Power Conversion (APC), Deltec, Superior Electric, and Tripp Lite can also tolerate overvoltage as high as 140 VAC because they trim input voltages around 125 VAC or above (see "Boost/buck trigger levels" in the feature-comparison table).

The power supplies in most computers can operate over a wide range of AC voltages, generally 102 V to 132 V, but running long-term near either end of the range shortens operating life. If power in your area is consistently high or low, an on-line unit makes sense.

## COMPARISON OF UPS MODELS TESTED

BLUE = HIGHLY RECOMMENDED
RED = HONORABLE MENTION

| | MODEL | PRICE | CAPACITY (VOLT AMPS) | PRICE PER VOLT AMP | TAKES EXTERNAL BATTERIES | REMOTE TURN-ON OPTION | SNMP HARDWARE OPTION | WARRANTY [1] | WEIGHT (LBS.) | SOFTWARE TESTED (NETWARE/WINDOWS NT) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Line-Interactive Systems** | | | | | | | | | | |
| Acme Electric | SM 800 | $799 | 800 | 1.00 | ○ | ● | ○ | 2 years, incl. batteries; 5 years transformers | 45 | PowerMon II/PowerMon II |
| American Power Conversion | Smart-UPS 1000 | $769 | 1000 | 0.77 | ○ | ● | internal | 2 years; $25,000 load protection | 42 | PowerChute Plus/PowerChute Plus |
| Best Power | Fortress LI 1020B | $799 | 1020 | 0.78 | ● | ● | external | 2 years, $25,000 load protection | 45 | CheckUPS/Windows NT |
| Clary | OnGuard LI-1000 | $849 | 1000 | 0.85 | ○ | ● | external | 2 years | 49 | Data Save Plus 7.0/Data Save Plus 3.5 |
| Deltec Electronics | PowerRite Pro 1000VA | $699 | 1000 | 0.70 | ● | software only | external | 60-day money-back, 10 years, prorated after 2 years, $25,000 load protection | 54 | LanSafe III/LanSafe III |
| Hewlett-Packard | PowerWise UPS L900VA | $649 | 900 | 0.72 | ○ | ○ | ○ | 2 years, next-day exchange | 48 | PowerWise Assistant/PowerWise Assistant |
| International Power Technologies | I-UPS 1250 | $899 | 1250 | 0.72 | ○ | ● | external | 5 years, battery pro-rated after 3 years, unlimited load protection | 55 | IPT-Vision/IPT-Vision |
| Liebert | UPStation D | $972 | 900 | 1.08 | ○ | ● | internal | 2 years, $25,000 load protection | 45 | SiteNet 2/SiteNet 1 |
| Oneac | ON900A | $949 | 900 | 1.05 | ○ | ● | external | 5 years; 2 years battery | 64 | MopUPS-RM/Windows NT |
| Para Systems | Minuteman Alliance A1250 | $689 | 1250 | 0.55 | ○ | ○ | external | 2 years, $25,000 load protection | 50 | Network Manager II/Windows NT |
| Para Systems | Minuteman Powermind PML1250 | $879 | 1250 | 0.70 | ○ | ● | external | 2 years, $25,000 load protection | 49 | LanMaster/Windows NT |
| Powercom America | UPS 1200-A | $599 | 1200 | 0.50 | ● | software only | external | 2 years, parts; 1 year labor and battery | 59 | Power Mon II/Power Mon II |
| Square D-EPE | Topaz SV 1200 | $999 | 1250 | 0.80 | ● | software only | external | 2 years | 51 | Merlin-Gerin UPS Manager/Windows NT |
| Superior Electric | Stabiline SL 1000 | $695 | 1000 | 0.70 | ○ | ○ | external | 2 years | 50 | Power Mon II/Power Mon II |
| Tripp Lite Manufacturing | Smart 1050 | $664 | 1050 | 0.63 | ○ | ● | external | 2 years, $50,000 load protection | 32 | PowerAlert Plus/PowerAlert Plus |
| Upsonic | LAN 100 | $699 | 1000 | 0.70 | ● | ● | external | 4 years; 2 years battery; $25,000 load protection | 64 | UPSaver/Windows NT |
| **On-Line Systems** | | | | | | | | | | |
| Alpha Technologies | CFR 1000 | $1649 | 1000 | 1.65 | ● | ○ | external | 2 years, in-the-field warranty adds labor costs | 93 | AlphaNet C/Windows NT |
| Best Power | Ferrups 1.15 | $1789 | 1150 | 1.56 | ● | ● | external | 2 years, $25,000 load protection | 126 | CheckUPS/Windows NT |
| C-Power Products | Guardian CPG-750 | $1255 | 750 | 1.67 | ● | ● | external | 5 years electronics; 3 years batteries | 57 | PowerEdge/Windows NT |
| Controlled Power Company | LT-1200 | $1165 | 1200 | 0.97 | ● | ● | external | 1 year | 108 | PowerMon II/PowerMon II |
| Exide Electronics | Powerware Prestige 1000P-1 | $889 | 1000 | 0.89 | ● | ● | external | 2 years | 28 | OnliNet/OnliNet |
| Hewlett-Packard | PowerWise 1000 VA UPS | $1099 | 1000 | 1.10 | ● | through software | internal | 2 years; next-day exchange | 48 | PowerWise Assistant/PowerWise Assistant |
| IntelliPower | Bright-UPS IQ 1100 | $1099 | 1100 | 1.00 | ● | ● | external | 1 year | 38 | PowerEdge 1.1/PowerMon II |
| Liebert | UPStation GX | $1485 | 1000 | 1.49 | ● | ● | internal | 2 years, $25,000 load protection | 71 | SiteNet 2/SiteNet 1 |
| Para Systems | Continuous Power CP1K | $1399 | 1000 | 1.40 | ● | ● | external | 2 years, $25,000 load protection | 50 | LanMaster/Windows NT |
| Powercom America | ONH-1000 | $969 | 1000 | 0.97 | ● | software only | external | 2 years, parts; 1 year labor and battery | 55 | Power Mon II/Power Mon II |
| Powercom America | ONL-1250 | $1095 | 1250 | 0.88 | ● | software only | external | 2 years, parts; 1 year labor and battery | 114 | Power Mon II/Power Mon II |
| Square D-EPE | Topaz SX 900 | $1390 | 900 | 1.54 | ● | ● | external | 2 years | 60 | Merlin-Gerin UPS Manager/Windows NT |
| Toshiba International | 1400S Series 1000VA | $2049 | 1000 | 2.05 | ● | ● | external | 3 years on-site (includes battery), 4-hour response | 70 | PowerMon II/Windows NT |
| Tripp Lite Manufacturing | Unison MPS 1200 | $1399 | 1200 | 1.17 | ○ | ● | external | 2 years, $100,000 load protection | 58 | PowerAlert/Windows NT |
| Upsonic | System 100 | $999 | 1000 | 1.00 | ● | ● | external | 10 years, 1 year on-site with 2-day response, 2 years for battery | 51 | UPSaver/Windows NT |

● = yes ○ = no
[1] Load protection pays for surge and lightning damage to load equipment; days are business days.
[2] All software for the UPSes we tested can shut down the server, alert workstations on the network, and log blackouts.

Some line-interactive UPSes, while running on battery power, produce output that is nicely sinusoidal (it costs more to do), but many units create just a rough approximation (a stepped square wave) that is tough to digest for some equipment. Fortunately, your servers need use it only during a controlled shutdown.

An on-line UPS can offer power factor correction—circuitry that reduces the "spiking" effects of the switching power supplies used in computers so that they draw less current from the wall (and you can run more equipment). An on-line UPS also has a higher crest factor (i.e., the ability to take a short surge of current much higher than it's rated for, typically 3 to 1) than that of line-interactive units (often just 2 to 1); thus, they can better handle the surge that occurs when computers are first turned on.

The typical on-line UPS's disadvantages are equipment cost, lower power efficiency (its rectifier and inverter constantly run), and heat production, which requires a fan. A line-interactive UPS costs less because of its simpler design, so it's less expensive to manufacture. A line-interactive UPS runs more efficiently because power is usually just passing through. And a line-interactive unit generates little heat because no real circuitry is active.

For mission-critical applications, you will probably want the reassurance of

| | SOFTWARE FEATURES[2] | | | | | | HARDWARE TESTING RESULTS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOFTWARE RATING (1-5) | SHOWS BATTERY CHARGE OR RUN TIME | SHOWS UPS TEMPERATURE | SHOWS WEAK BATTERY | PERFORMS UPS DIAGNOSTIC TEST | DOES SOFTWARE UPS SHUTDOWN | SUPPORTS MULTIPLE SERVERS[3] | BATTERY RUNDOWN TIME (MINUTES), 70% LOAD | BATTERY SWITCH POINTS (VAC): LOW/HIGH[5] | BOOST/BUCK TRIGGER LEVELS (VAC) | TOTAL HARMONIC DISTORTION (PERCENT); NORMAL/ON BATTERY | TRANSFER TIME/ AVERAGE WORST CASE |
| 2.5 / 2.5 | ○/○ | ○/○ | ●/● | ○/○ | ○/○ | ●/● | 4.0 | 90/132 | 102/none | 3.4 / 14.5 | 4.3 / 5.0 |
| 5.0 / 5.0 | ●/● | ●/● | ●/● | ●/● | ●/● | ●/● | 6.0 | 99/146 | 102/130 | 1.7 / 6.8 | 3.2 / 5.6 |
| 3.0 / 2.5 | ●/○ | ●/○ | ○/○ | ○/○ | ●/● | ●/● | 5.5 | 94/135 | 108/none | 2.7 / 8.8 | —[7] / 7.2 |
| 3.0 / 3.0 | ●/● | ○/○ | ●/● | ●/● | ●/● | ●/○ | 6.0 | 95/137 | 105/none | 2.2 / 14.0 | 5.5 / 5.8 |
| 4.0 / 4.0 | ●/● | ○/○ | ●/● | ●/● | ●/● | ●/● | | 97/144 | 108/127 | 1.5 / 9.0 | 3.0 / 3.4 |
| 5.0 / 5.0 | ●/● | ●/● | ●/● | ●/● | ●/● | ●/● | 10.5 | 93/131 | 102/none | 1.7 / 3.4 | 9.3 / 12.0 |
| 3.0 / 3.0 | ●/● | ○/○ | ●/● | ●/● | ●/● | ●/● | 6.0 | 92/134 | 113/none | 2.3 / 8.7 | 5.5 / 5.8 |
| 5.0 / 2.5 | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/● | 5.5 | 88/131 | 102/none | 3.6 / 11.3 | 4.7 / 6.5 |
| 2.5 / 2.5 | ○/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/● | 6.0 | 87/140 | 103/none | 4.8 / 52.2 | 10.8 / 5.0 |
| 3.0 / 2.5 | ○/○ | ○/○ | ●/○ | ●/○ | ●/○ | ●/● | 4.5 | 93/131 | 103/none | 1.9 / 34.0 | 3.3 / 5.6 |
| 3.0 / 2.5 | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/● | 7.0 | 98/138 | 104/none | 2.1 / 3.5 | 8.7 / 12.4 |
| 2.5 / 2.5 | ○/○ | ○/○ | ○/○ | ○/○ | ●/● | ●/● | 7.5 | 90/135 | 105/none | 4.4 / —[6] | 2.6 / 5.6 |
| 3.5 / 2.5 | ●/● | ○/○ | ●/○ | ●/○ | ●/○ | ●/○ | 7.5 | 93/130 | 101/none | 2.2 / 3.7 | 9.3 / 12.3 |
| 2.5 / 2.5 | ●/● | ○/○ | ●/● | ●/● | ●/● | ●/● | 14.0 | 97/142 | 108/128 | 3.2 / 7.0 | 3.8 / 5.4 |
| 4.0 / 4.0 | ●/● | ●/● | ●/● | ●/● | ●/● | ●/● | 10.0 | 86/139 | 110 and 101/126 | 1.7 / 30.2 | 4.7 / 5.8 |
| 3.5 / 2.5 | ○/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | 4.0 | 85/133 | 117/118 | 2.1 / 2.5 | 5.8 / 6.2 |
| 2.5 / 2.5 | ○/○ | ○/○ | ●/○ | ○/○ | ●/○ | ●/● | 8.0 | 92/139 | N/A | 12.9 / 12.6 | N/A |
| 3.0 / 2.5 | ●/○ | ●/○ | ○/○ | ○/○ | ●/● | ●/● | 8.0 | 87/>140 | N/A | 7.2 / 7.5 | N/A |
| 2.5 / 2.5 | ●/○ | ○/○ | ●/○ | ●/○ | ●/○ | ●/○ | 10.0 | 86/>140 | N/A | 5.6 / 5.9 | N/A |
| 2.5 / 2.5 | ○/○ | ○/○ | ●/● | ●/● | ●/● | ●/● | 18.0 | 84/138 | N/A | 7.3 / 8.1 | N/A |
| 3.0 / 3.0 | ●/● | ●/● | ●/● | ●/● | ●/● | ●/● | 9.0 | 94/>140 | N/A | 2.9 / 2.9 | N/A |
| 5.0 / 5.0 | ●/● | ●/● | ●/● | ●/● | ●/● | ●/● | 7.0 | 88/>140 | N/A | 3.7 / 3.6 | N/A |
| 2.5 / 2.5 | ○/○ | ○/○ | ○/○ | ○/○ | ○/○ | ●/●[4] | 6.0 | 91/>140 | N/A | 5.1 / 5.9 | N/A |
| 5.0 / 2.5 | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/● | 8.0 | 90/>140 | N/A | 3.6 / 3.7 | N/A |
| 3.0 / 2.5 | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/● | 6.5 | 90/>140 | N/A | 4.9 / 4.8 | N/A |
| 2.5 / 2.5 | ○/○ | ○/○ | ○/○ | ○/○ | ●/● | ●/● | 12.0 | 78/>140 | N/A | 3.8 / 3.8 | N/A |
| 2.5 / 2.5 | ○/○ | ○/○ | ○/○ | ○/○ | ●/● | ●/● | 14.0 | 80/>140 | N/A | 3.9 / 4.9 | N/A |
| 3.5 / 2.5 | ●/● | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | 10.0 | 80/>140 | N/A | 1.5 / 1.4 | N/A |
| 2.5 / 2.5 | ○/○ | ○/○ | ○/○ | ○/○ | ○/○ | ●/● | 9.5 | <75/>140 | N/A | 3.3 / 3.4 | N/A |
| 2.5 / 2.5 | ○/○ | ○/○ | ○/○ | ●/○ | ○/○ | ●/○ | 8.0 | 91/>140 | N/A | 2.7 / 2.7 | N/A |
| 3.5 / 2.5 | ○/○ | ●/○ | ●/○ | ●/○ | ●/○ | ●/○ | 9.5 | 89/138 | N/A | 4.6 / 6.1 | N/A |

N/A = not applicable.
[3] Under Windows NT, UPS requires cabling option.
[4] Up to two servers

[5] With most on-line units, we did not test above 140 VAC.
[6] THD difficult to measure; modified square wave.
[7] Transition times too variable to measure; sometimes none, sometimes up to 7.2 ms.

cleaner, more regular power, which you get from an on-line UPS. For most ordinary networks, line-interactive units are adequate.

### Applying the Volts

Our hardware testing yielded few surprises from any of the UPSes; results were generally in agreement with vendor specifications. We used a California Instruments AC power source to drive varying voltages into each UPS and to test how well each handled low- and high-voltage conditions. With a BMI 3060 PowerProfiler, we accurately measured voltages going into and coming out of the UPS under test. The BMI also measured total harmonic distortion (THD) of output, a gauge of how far the output waveform diverges from sinusoidal (a low percentage is good; 25 percent is getting squared off). We judged the THD that a UPS produces on battery power as a significant measurement of quality.

To simulate power failures, we shorted the power source's output with a switch. That operation triggered a Tektronix TD5410A digital-storage oscilloscope with which we observed UPS output waveforms and, for line-interactive units, measured transfer times. We ran 10 trials for each UPS, more if the waveform was noisy, which nonsinusoidal output tended to be in the cycles just after transfer to battery.

After charging a UPS overnight, we

## FOR MORE INFORMATION ON UPS MODELS TESTED

| BLUE = HIGHLY RECOMMENDED<br>RED = HONORABLE MENTION | MODEL | LOCATION | PHONE | INQUIRY NUMBER |
|---|---|---|---|---|
| **Line-Interactive Systems** | | | | |
| Acme Electric | SM 8001 | Cuba, NY | (800) 325-5848; (716) 928-2400 | 1150 |
| American Power Conversion | Smart-UPS 1000 | West Kingston, RI | (800) 800-4272; (401) 789-5735 | 1151 |
| Best Power | Fortress LI 1020B | Necedah, WI | (800) 356-5794; (608) 565-7200 | 1152 |
| Clary | OnGuard LI-1000 | Monrovia, CA | (800) 442-5279; (818) 359-4486 | 1153 |
| Deltec Electronics | PowerRite Pro 1000VA | San Diego, CA | (800) 854-2658; (619) 291-4211 | 1154 |
| Hewlett-Packard | PowerWise UPS L900VA | Rockaway, NJ | (800) 533-1333; (201) 627-6400 | 1155 |
| International Power Technologies | I-UPS 1250 | Orem, UT | (800) 944-0356; (801) 224-4828 | 1156 |
| Liebert | UPStation D | Columbus, OH | (800) 877-9222; (614) 888-0246 | 1157 |
| Oneac | ON900A | Libertyville, IL | (800) 327-8801; (708) 816-6000 | 1158 |
| Para Systems | Minuteman Alliance | Carrollton, TX | (800) 238-7272; (214) 446-7363 | 1159 |
| Para Systems | Minuteman Powermind PML1250 | Carrollton, TX | (800) 238-7272; (214) 446-7363 | 1159 |
| Powercom America | UPS 1200-A | Placentia, CA | (800) 666-8931; (714) 632-8889 | 1160 |
| Square D-EPE | Topaz SV 1200 | Costa Mesa, CA | (800) 344-0570; (714) 557-1636 | 1161 |
| Superior Electric | Stabiline SL 1000 | Bristol, CT | (800) 787-3532; (203) 585-4500 | 1162 |
| Tripp Lite Manufacturing | Smart 1050 | Chicago, IL | (312) 755-5400 | 1163 |
| Upsonic | LAN 100 | Viejo, CA | (800) 877-6642; (714) 448-9500 | 1164 |
| **On-Line Systems** | | | | |
| Alpha Technologies | CFR 1000 | Bellingham, WA | (360) 647-2360 | 1165 |
| Best Power | Ferrups 1.15 | Necedah, WI | (800) 356-5794; (608) 565-7200 | 1152 |
| C-Power Products | Guardian CPG-750 | Rockwall, TX | (214) 771-4303 | 1166 |
| Controlled Power Company | LT-1200 | Troy, MI | (800) 521-4792; (810) 528-3700 | 1167 |
| Exide Electronics | Powerware Prestige 1000P-1 | Raleigh, NC | (800) 554-3448; (919) 872-3020 | 1168 |
| Hewlett-Packard | PowerWise 1000 VA UPS | Rockaway, NJ | (800) 533-1333; (201) 627-6400 | 1155 |
| IntelliPower | Bright-UPS IQ 1100 | Irvine, CA | (714) 587-0155 | 1169 |
| Liebert | UPStation GX | Columbus, OH | (800) 877-9222; (614) 888-0246 | 1157 |
| Para Systems | Continuous Power CP1K | Carrollton, TX | (800) 238-7272; (214) 446-7363 | 1159 |
| Powercom America | ONH-1000 | Placentia, CA | (800) 666-8931; (714) 632-8889 | 1160 |
| Powercom America | ONL-1250 | Placentia, CA | (800) 666-8931; (714) 632-8889 | 1160 |
| Square D-EPE | Topaz SX 900 | Costa Mesa, CA | (800) 344-0570; (714) 557-1636 | 1161 |
| Toshiba International | 1400S Series 1000VA | Houston, TX | (800) 231-1412; (713) 466-0277 | 1170 |
| Tripp Lite Manufacturing | Unison MPS 1200 | Chicago, IL | (312) 755-5400 | 1163 |
| Upsonic | System 100 | Aliso Viejo, CA | (800)-877-6642; (714) 448-9500 | 1164 |

connected it to enough computer equipment to create a load that was around 75 percent of its rated capacity. Starting with a 115-VAC input, we lowered the voltage into the UPS in 5-V increments, observing output voltages at each step. We noted where taps changed on line-interactive units and where battery power kicked in on all units. We repeated the same procedure in the other direction, going from 115 VAC to 140 VAC and sometimes further.

All the UPSes showed a built-in hysteresis when returning from battery power. If a UPS kicked on to battery power at 85 VAC, for example, it would stay on battery power even as input voltage climbed back up to 90 VAC, 95 VAC, and sometimes even 100 VAC. Hysteresis prevents a UPS from oscillating off and on battery when power hovers near the threshold. The APC SmartUPS 1000 has a sensitivity switch that lets you control the hysteresis (e.g., you can increase hysteresis when voltage is variable).

Some regulation was more complex. When we first tested the line-interactive Upsonic LAN 100, it produced 124-VAC output with 115 VAC going in. After low-voltage testing, it produced 113-VAC output with 115-VAC input. The Upsonic's output at 115 VAC was dependent on how the input had gotten to 115 VAC—whether it had risen, or fallen, to 115 VAC. The Controlled Power LT-1200 is unusual because it uses fuzzy logic to adjust its lower threshold to match load (the lesser the load, the lower the shutdown voltage).

For some UPSes, we tracked output voltage for 5 minutes after going on battery. While on-line units held their output constant, some line-interactive UPSes let output voltage drop over time. Some of the "smarter" line-interactive UPSes—the Superior Electric Stabiline SL 1000, for example—used its transformer to boost the battery and keep the voltage up.

Several of the on-line UPSes regulate overvoltages but don't cut to battery as voltage climbs beyond their specified operating range. This is the case with units from IntelliPower, Toshiba, and Tripp Lite, though the first two have that capability as an option. When we pushed one unit up to 160 VAC, it burned out. You're not likely to run into utility power over 140 VAC, but it does occur in some areas of the world and in miswired buildings.

We tested battery run-down (i.e., hold-up) time under a load that was 70 percent of rated UPS capacity. (Most UPSes were not very accurate in their own load-measuring capabilities, erring conservatively on the high side.) With half load, you should get more than twice as much run-down time as we did.

Although run-down time is related to actual battery capacity, it's a pretty loose relationship. Some UPSes shut down while reporting 70 percent charge remaining. Not only does the UPS prevent you from discharging batteries to destructive levels, in some cases, there's enough charge to go through several consecutive blackouts without battery charging in between. In other words, if programmed differently, some of these units could give you more hold-up time, but at the expense of a safety margin.

In general, all you need is enough time to comfortably shut down whatever server OS you're using. Usually, 5 minutes is okay, but 10 is better. The Controlled Power unit provided an exceptionally long battery life, but it's also a big guy (108 lbs.), as are other on-line units that use a ferroresonant transformer (e.g., the Alpha CFR 1000 and the Best Ferrups).

### The Soft Side

The software that makes a UPS suitable for a network server comes in three basic levels of functionality: unattended shutdown, status monitoring, and SNMP monitoring. We judged software functionality at all three levels, giving weight to ease of use (see "Software Rating" in the comparison table). You may not care about some of the more sophisticated UPS software features because you're close enough to eyeball the UPS setup, or because you know you don't have time to learn and configure the software. However, for large networks, the ability to remotely monitor power problems is a labor- and money-saving feature. Also, the best software isn't expensive and often comes with the most cost-competitive hardware.

Most UPS vendors can supply software for most OSes, usually as an option (American Power Conversion includes the software in the UPS price). We tested each UPS's server software under NetWare 3.11 and Windows NT 3.51 (x86 flavor).

Many UPS units come with third-party software, such as System Enhancements' PowerMon II or CompuSci's PowerEdge (often disguised with customized screens). These aren't as good as the best stuff we saw during our testing, although Liebert's UPStation comes with System Enhancements' SiteNet II, an excellent package. Windows NT comes with a built-in UPS program that shuts down a server and logs power outages. Some vendors therefore supply just a communications cable as their NT option. Used with the Windows-based monitoring software some vendors offer, it makes a fairly complete package. Current Windows UPS software can't shut down an NT server, but the Windows 95–compliant programs that can should be available by now.

For this review, all units needed a communications-cable connection and software for shutdown of one or more servers. Desirable software features here are the ability to send alarms to all network workstations (natural to NetWare) and close down all the servers connected to the UPS. Under NT, the latter requires add-on multiplexing hardware so that each server gets a communications cable. Some units offer remote turn-on hardware options that let you control startup or shutdown over phone lines. Pager notification, as found in Tripp Lite's Power Alert Plus, can also be a very useful feature; if power goes out over the weekend, for example, the UPS software will beep your facilities manager.

From the front panel of most UPSes, you can configure the unit, do diagnostics, and check for a weak battery (which requires briefly using battery power). A battery that can't hold much charge doesn't help in an outage.

We rated a UPS and its software on how much diagnostic data the UPS could communicate to the software, and how accessible the software made the data to the systems administrator. Thus, the UPS should have true RS-232 serial communications (rather than just a contact closure connection that signals the power's out and the battery's low). The software should also let you initiate or schedule UPS battery tests. Hewlett-Packard's PowerWise 1000 VA UPS constantly monitors battery health, and Deltec's PowerRite Pro automatically tests its battery every 30 days.

Ideally, you should be able to access your UPS across the network, either with the unit's network software or with optional SNMP hardware and software. Most vendors offer hardware options (internal or external) that provide a direct UPS/network connection, as well as software that makes the UPS management information base (MIB) available to your SNMP platform software. (We tested with HP's OpenVue). There is basically a standard MIB, but many UPSes come with extended MIBs. Agent software makes the data available to the MIB browser of different SNMP platforms. American Power Conversion and Tripp Lite also sell SNMP manager software that provides organized graphics displays of data from multiple UPSes, much like their LAN software.

### Other Factors

A clean, well-regulated output signal is a manifestation of quality, and good software makes management easier, but they're not the only factors to consider. Check out service and warranty policies, too. For example, we think the Toshiba 1400S is one of the best on-line UPSes, but it's expensive. However, the company offers a three-year onsite warranty with a 4-hour response time. That may be worth the price to some people.

Weighing price, software, and performance, we highly recommend seven models: five on-line and two line-interactive units. Among on-line models, HP's PowerWise 1000 VA had the best software and a low price; Powercom's ONH-1000 and ONL-1250 both provide good output quality at a low price, as does Exide's Powerware Prestige 1000P-1; and Controlled Power's LT-1200 has the longest battery holdup time, and fuzzy logic, too. For line-interactive UPSes, we recommend APC's Smart-UPS 1000 and Deltec's PowerRite Pro 1000VA, both for great software and clean output.

We give honorable mentions to Tripp Lite's on-line Unison MPS 1200—by the time you read this, it will come with the excellent Power Alert Plus software; Toshiba's on-line 1400S Series 1000VA for its great quality and warranty; Superior Electric's line-interactive Stabiline 1000 for its clean signal and low transfer time; Best's line-interactive Fortress LI 1020B for the same reasons; and Square D-EPE's on-line Topaz SX 900 for the cleanest output. ■

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TECHNOLOGY FOCUS

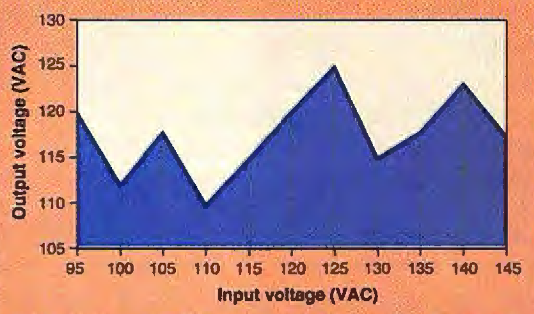
### Boost and Buck

**Output from a line-interactive UPS varies with the input voltage, but regulation extends the voltage range of input power the UPS can use without going to battery. Typically, the regulator is a transformer with multiple taps that can be switched in or out, depending on line conditions. Like changing gears, the tap switching boosts voltage up when it gets low (brown-out protection) or trims it down when it gets high.**

**If you plot input against output voltage, you get a sawtooth pattern, as represented by our test results with Deltec's PowerRite Pro 1000VA (see the figure). Lowering input voltage from 115 VAC (to the left), output voltage declines. At 110 VAC on input, the UPS switches to another transformer tap, and output jumps to 118 VAC. (The "less than abrupt" output change that takes place during a tap switch isn't evident here because we took readings at 5-V intervals.) The sawtooth just below 100 VAC is where the unit switched to battery.**

**Proceeding up from 115 VAC, the output voltage climbs until about 125 VAC, where a tap switch bucks it down to about 115 VAC. Again, as the input voltage continues rising, output rises until just around 140 VAC, when the battery kicks in and output drops to 117 VAC. Some units provide just a single tap point for low voltage. Others provide more than two—as does Tripp Lite's Smart 1050—to provide finer regulation and another tooth in the plot. —Rick Grehan**

**The Line-Interactive Sawtooth Curve**




**With a line-interactive UPS, such as Deltec's PowerRite Pro, output voltage varies with input voltage. Regulation by the UPS's transformer keeps output within a tolerable range, but not at a constant level.**

# Beauty Isn't Only Skin Deep. Neither Is Quality.

**The quality of the Toshiba 1400 Plus Series UPS extends much deeper than the surface.** Inside you will discover the beauty of our technology, including IGBT high-powered transistors, surface-mount technology circuit boards and a high speed microprocessor in a totally modular design. However, the real beauty lies in the performance of these units. Toshiba's 1400 Plus Series UPS offers a wide input voltage/frequency window and an intelligent charger for increased battery life, high crest factor and overload capabilities, ensuring the UPS will run at its rated value without oversizing. Input power factor correction eliminates overheating of circuits and an RS232 communication feature provides SNMP compatibility and "smart" UPS power monitoring.

Indeed, the beauty of the Toshiba 1400 Plus Series UPS is more than just skin deep. Every unit is built with superior quality and commitment in our ISO 9001 certified U.S. manufacturing facility. Each and every unit (not just random sampling) is inspected and electrically tested to meet stringent quality control standards before it is packaged and shipped to you. We take our protection one step further with Toshiba's "Security Plus" On-Site Warranty, ensuring trouble-free operation and peace of mind for three full years-parts, labor, travel and batteries included. A staff of experienced service technicians is available 24 hours a day-7 days a week for any assistance you may need. No other company can match this protection package offered by Toshiba.

***Superior quality, unmatched reliability and true on-line protection are all in one enclosure. This is the true beauty of Toshiba's 1400 Plus Series UPS.***

In Touch with Tomorrow

**TOSHIBA**

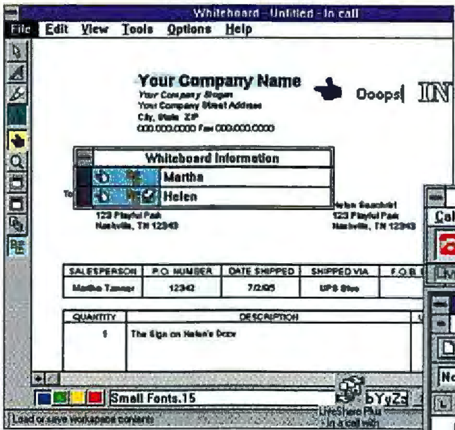
13131 WEST LITTLE YORK • HOUSTON, TEXAS 77041 • 1-800-231-1412 • CANADA-DIAL 1-800-872-2192

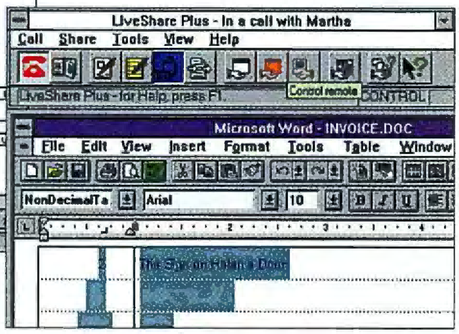
**Circle 122 on Inquiry Card (RESELLERS: 123).**

# Virtual Whiteboards

**We look at seven desktop-conferencing programs that bring coworkers together over shared, editable documents**

DAVID SEACHRIST






**Superior performance, richness of features, and ease of use make PictureTel's LiveShare Plus the best of seven document-conferencing programs reviewed by NSTL. Shown here are LiveShare Plus's whiteboard (left) and applications-sharing module, standard components in any good conferencing program.**

Sharing and discussing ideas with colleagues, regardless of their location, is what makes videoconferencing so attractive. But for some collaborative work, you don't have to see and hear each other. Document-conferencing software—a set of tools for sharing "live" documents across remote or networked computers—is often an easier and more cost-effective alternative.

NSTL evaluates seven Windows-based, NetWare-compatible programs that provide some level of collaborative editing of bit-mapped images (a technique known as whiteboarding). All seven also offer varying degrees of file transfer. Most of them let you share and annotate Windows applications. Recognizing the appeal of videoconferencing to many companies, we limited our review to document-conferencing programs that have upgrade paths to videoconferencing.

PictureTel's LiveShare Plus is the clear winner for its ease of use, feature versatility, and performance. Our second and third choices, Intel's ProShare Premier Edition and Future Labs' TalkShow, top LiveShare Plus in supporting conferencing between more than two workstations.

### Conferencing Basics

Document-conferencing programs offer four main ways to collaborate: whiteboarding, applications and data sharing, file transfer, and real-time text messaging (i.e., chatting). Whiteboard modules are named after their real-world counterparts, but in practice they more resemble paint programs. Because the whiteboard is a graphical environment, documents imported into it can't be edited as they could in a word processor. Instead, editing marks are superimposed on the "page." Thus, a program's ability to get graphics into and out of the whiteboard module, and its selection of markup tools, strongly determine its usefulness.

To get images into whiteboards, the most convenient way is print capture, in which you convert word processing files to print files using a special Windows driver. You can also use import filters to pull in files saved in Windows' BMP format. (All but one of the programs do some type of importing, but they vary widely in the number of file types supported.) A third approach uses the Windows Clipboard to import screens captured from other Windows programs.

Three image-manipulation tools are important in making whiteboarding a comfortable medium. Magnification allows closer scrutiny of the screen. Synchronization refreshes all participants' screens to make sure they are working with the same information at the same time. Page sorters allow browsing and moving document pages by viewing thumbnails. The features comparison table on page 234 shows which products have these tools. (All seven support synchronization.)

Applications-sharing capabilities vary, with some programs offering a remote-control environment that lets users edit files simultaneously. Others periodically send bit-mapped images that can be edited by only one attendee, though seen by all. The reviewed programs do not support this feature as well as they do whiteboarding. In judging them, look for full remote control (where two people can take turns editing the same file) and the ability to share data in the Windows Clipboard. *continued*

### OVERVIEW

| NSTL RATING | | VERSION | PERFORMANCE | VERSATILITY | EASE OF LEARNING | EASE OF USE | PRICE |
|---|---|---|---|---|---|---|---|
| ★★★★ | LiveShare Plus | 2.0 | ▲ | ▲ | ▲ | ▲ | $249 |
| ★★★ | ProShare Premier Edition | 1.6 | ▼ | ■ | ▲ | ▲ | $299 |
| ★★★ | TalkShow | 3.02 | ■ | ■ | ▲ | ▲ | $249 |
| ★★★ | AT&T Vistium Share | 1.0 | ■ | ▼ | ▲ | ▲ | $99 |
| ★★ | InVision | 3.1.23 | ■ | ■ | ▲ | ■ | $595 |
| ★★ | Person to Person | 1.0.3 | ▼ | ■ | ▲ | ▲ | $280 |
| ★ | Face to Face | 2.0.1 | ▼ | ▼ | ▲ | ■ | $59 |

**KEY**

| | |
|---|---|
| ★★★★★ | Outstanding |
| ★★★★ | Excellent |
| ★★★ | Average |
| ★★ | Below average |
| ★ | Poor |
| ▲ | Good |
| ■ | Fair |
| ▼ | Unacceptable |

**CONFERENCING FEATURES**

| | AT&T VISTIUM SHARE | FACE TO FACE | INVISION | LIVESHARE PLUS | PERSON TO PERSON | PROSHARE PREMIER | TALKSHOW |
|---|---|---|---|---|---|---|---|
| **Videoconferencing** | | | | | | | |
| Capture video to movie file | ○ | ○ | ○ | ○ | ○ | ○ | ●[1] |
| Capture still to Clipboard | ●[1] | ○ | ● | ●[1] | ●[1] | ●[1] | ●[1] |
| Capture still to file | ●[1] | ○ | ● | ●[1] | ●[1] | ●[1] | ●[1] |
| Freeze frame | ●[1] | ○ | ● | ●[1] | ●[1] | ●[1] | ●[1] |
| Adjust color | ●[1] | ○ | ● | ○ | ●[1] | ●[1] | ●[1] |
| **Whiteboarding** | | | | | | | |
| Selection or screen-capture tool | ● | ○ | ● | ● | ● | ● | ● |
| Copy/cut/paste and clear | ● | ○ | ● | ● | ● | ● | ● |
| Page sorter/organizer | ○ | ○ | ● | ● | ○ | ● | ● |
| Highlighter tool | ● | ○ | ● | ● | ○ | ● | ● |
| Magnification (zoom) tool | ○ | ○ | ● | ● | ○ | ● | ● |
| Import graphics files | ● | ○ | ● | ● | ● | ● | ● |
| Import text files | ● | ○ | ● | ○ | ● | ● | ● |
| Import spreadsheet files | ○ | ○ | ● | ○ | ○ | ● | ● |
| Import via Windows Clipboard | ● | ○ | ○ | ● | ● | ● | ● |
| Export graphics files | ● | ○ | ● | ● | ● | ● | ● |
| **Applications and data sharing** | | | | | | | |
| Share Windows Clipboard | ● | ○ | ○ | ● | ● | ● | ○ |
| Number of applications-sharing participants | 2 | 0 | 0 | 2 | 0 | 2 | Unlimited |
| Users can request/relinquish control of shared applications | ● | ○ | ○ | ● | ○ | ● | ○ |
| Share DOS applications | ○ | ○ | ○ | ● | ● | ● | ● |
| Share Windows applications | ● | ○ | ○ | ● | ● | ● | ● |
| OLE and DDE support | ● | ○ | ● | ○ | DDE only | ● | ● |
| **File transfer** | | | | | | | |
| Attach file to message | ○ | ○ | ○ | ○ | ● | ○ | ○ |
| View transfer status | ● | ○ | ○ | ● | ● | ● | ○ |
| Option to compress/decompress files during send/receive | ○ | ○ | ● | ○ | ● | ● | ● |
| **Chat** | | | | | | | |
| Number of chat participants | 2 | 0 | 2 | 2 | 8 | 0 | Unlimited |
| Chat window lists participants | ○ | ○ | ● | ● | ● | ○ | ● |

[1] Requires additional package sold by same vendor or third-party vendors.

●=yes; ○=no. Features not integral to the package are marked ○ but are sometimes available as options or in future versions.

## Conferencing with the World

**Will today's document-conferencing products stand the test of time? Unless one of these systems becomes dominant enough to establish a de facto standard, industry standards committees will be needed to fill the void.**

**T.120 is the standard proposed by the International Telecommunications Union (ITU) to facilitate interoperability of different vendors' document-conferencing products. It's an evolving specification offering guidelines on key aspects of document-conferencing technology, including domains in which conferences can occur, document-conferencing protocols, conference management protocols, and network interfaces. T.120 primarily addresses whiteboarding and file transfer considerations. Applications sharing is not currently a part of the specification.**

**Though none of the programs in this evaluation comply with T.120, many of the vendors plan to support it in the near future. AT&T plans to add T.120 to Vistium Share eventually. Intel (ProShare Premier Edition) and Future Labs (TalkShow) plan to do so by early next year.**

File transfer lets you send files (e.g., a spreadsheet) between conference attendees to allow the sharing of data for off-line and on-line editing. All seven programs do this. Their interfaces vary somewhat, but they all center on the Windows File Open dialog box, where you select files from a scrolling file list and issue a command to send.

Chatting allows the exchanging of text messages in real time. If you're used to the amenities of on-line services such as Prodigy and America Online, you will not be impressed with the relatively simple tools available in these programs.

**AT&T Vistium Share**

Based on AT&T's TeleMedia Personal Video System, AT&T Vistium Share is a

low-cost, easy-to-use solution that sacrifices versatility to gain simplicity, though its performance is generally among the best. It lags behind the other programs in its whiteboard and applications- and data-sharing features. (It can't import spreadsheets, for example, and it lacks a page sorter.) Chat support is minimal, and password protection is nonexistent.

Vistium Share is speedy in five of the six performance tests, slowing down only in network file transfer tests. It's also the only program to support the telephony API (TAPI), making it easier to customize with other telephony applications.

## GATHER 'ROUND THE POWER MAC

**At MacWorld Expo in August, Apple unveiled what it claims are the first personal computers with built-in conferencing features. Apple Media Conference, a QuickTime conferencing application, will be bundled with the new Power Mac 7500 and 8500.**

**Though the software works with the PlainTalk microphone supplied with the computer, you must add an NTSC analog-output camera for videoconferencing. Plain document conferencing works right out of the box. Apple claims the product has whiteboarding features, but we weren't able to see how the quality compares with that of the Windows-based products we tested.**

**The new Power Macs start at $1699. Apple says it will offer an upgrade kit for current Power Mac owners in the first quarter of 1996.**

**Two new Power Macs make desktop conferencing standard equipment.**

### Face to Face

Priced at only $59, Crosswise's Face to Face is meant to be a simpler, less-feature-rich solution than the other products. Thus, it lacks applications- and data-sharing features, and it has mediocre speed and versatility.

Face to Face can't import Windows BMP files, which is an important requirement for routine whiteboard use. Instead, you must use the program's print-capture utility to bring documents into the whiteboard.

Face to Face is the only cross-platform product, however, with Macintosh and Windows versions.

### InVision

InVision, from InVision Systems, is the only reviewed program that has bundled videoconferencing software. It employs an older—and less feature-rich—version of a competitor, Future Labs' TalkShow, for many of its conferencing features. It is unique, however, in employing OLE,

**GENERAL PROGRAM FEATURES**

| | AT&T VISTIUM SHARE | FACE TO FACE | INVISION | LIVESHARE PLUS | PERSON TO PERSON | PROSHARE PREMIER | TALKSHOW |
|---|---|---|---|---|---|---|---|
| **Communications/Networking** | | | | | | | |
| Number of attendees per document conference (LAN) | 2 | 2 | [1] | 2 | 8 | 2 | 17 (TCP) |
| Number of attendees per document conference (modem) | 2 | 2 | 17 (TCP) | 2 | 8 | 2 | 17 (TCP) |
| Number of video-capture boards supported | 2 | 0 | 11 | 0 | 1 | 1 | 0 |
| Document conferencing via plain old telephone system (POTS) | ● | ● | ● | ● | ● | ● | ● |
| Document conferencing via ISDN | ○ | ● | ● | ○ | ● | ● | ● |
| Document conferencing via LAN | ● | ● | ● | ● | ● | ● | ● |
| Document conferencing via TCP/IP | ○ | ● | ● | ○ | ● | ● | ● |
| Simultaneous LAN and modem connections in document conference | ○ | ○ | ● | ○ | ● | ○ | ● |
| Videoconferencing via POTS[2] | ○ | ○ | ● | ○ | ○ | ○ | ● |
| Videoconferencing via ISDN[2] | ● | ○ | ● | ● | ○ | ● | ● |
| Videoconferencing via LAN[2] | ○ | ○ | ● | ● | ● | ● | ● |
| Videoconferencing via TCP/IP[2] | ○ | ○ | ● | ○ | ○ | ● | ● |
| Simultaneous LAN and modem connections in videoconference[2] | ○ | ○ | ○ | ○ | ○ | ● | ○ |
| Supports telephony API (TAPI) | ● | ○ | ○ | ○ | ○ | ○ | ○ |
| **Address Book** | | | | | | | |
| Allows multiple-address databases | ● | ○ | ● | ● | ● | ● | ● |
| Maintains LAN and modem addresses | ● | ● | ● | ● | ● | ● | ● |
| Attach graphics files (photos) to address | ● | ○ | ● | ○ | ○ | ● | ● |
| Attach movie files to address | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| **Miscellaneous** | | | | | | | |
| Number of modem setups included | 190 | 193 | 43 | 160 | 20 | 183 | 234 |
| Add custom modem setup | ● | ● | ● | ● | ● | ● | ● |
| Supports Voice over Data (VOD) modems | ○ | ● | ● | ● | ● | ● | ● |
| Utility to print third-party files to document image files | ● | ● | ○ | ● | ○ | ● | ● |

[1] 13 using IPX/SPX, seven using NetBIOS. [2] Requires additional videoconferencing hardware. ●=yes; ○=no

Features not integral to the package are marked ○ but are sometimes available as options or in future versions.

rather than standard remote control, for applications sharing. This approach makes it harder to use, however.

Along with TalkShow and IBM Direct's Person to Person, InVision allows more than two people to mark up a document per conference. It is among the top two in network file transfer speed, but it's a bit below average in whiteboard speed.

### LiveShare Plus

PictureTel's LiveShare Plus clearly offers the best balance of usability, features, and performance. This program is the hands-down winner in two-site conferencing, but it also has numerous other advantages, including the best chat environment and friendly installation.

LiveShare Plus's tool set and work environment are more complete than those of the other programs. Its overall performance score puts it head and shoulders above the rest due to fast file transfer and efficient whiteboard transfers. However, it can't do data sharing over ISDN or TCP/IP lines, and its interoperability support is poor (though the others aren't much better at supporting international standards and non-Windows environments such as the Mac or OS/2).

### Person to Person

IBM Direct's offering has the best file transfer features of the group. Besides letting you view the status of incoming and outgoing files and saving the results to a log file, the program allows the attaching of files to text messages, as in E-mail. Its chat windows, like those in LiveShare Plus, are the best of the lot, showing participants' names and date/time stamps of when messages were sent.

Performance is Person to Person's downfall. Surprisingly, its two-level compression scheme somehow results in *more* bytes flying across the network during file transfers.

Person to Person's whiteboard lacks a highlighter tool, a page sorter, and a zoom option—all helpful during the often awkward process of coordinating shared document editing.

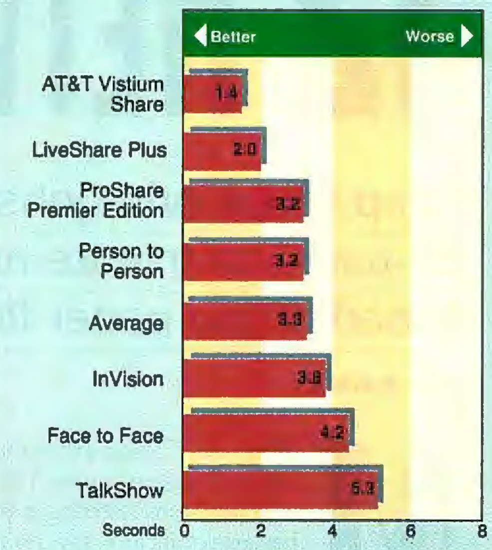
### ProShare Premier Edition

Intel's document-conferencing program offers usability and features comparable to LiveShare Plus. It is our second choice, winning high praise for ease of use. It has excellent applications-sharing and file transfer features, and an especially user-friendly whiteboard.

As is the case with Face to Face, InVision, and TalkShow, ProShare Premier Edition comes with a receive-only version that you can send to conference participants. This purposely limited version of the program does not let recipients initiate their own conferences.

But for disappointing performance, ProShare Premier Edition might have been our top pick. However, the product also is hurt by lack of a whiteboard eraser, chat module, and password protection.

### Graphing Whiteboards




**AT&T Vistium Share was the fastest program at updating a graph displayed on the whiteboard. This test used uncompressed files to measure network performance only (factoring out file loading, format conversion, establishing the network link, and so forth).**

### TalkShow

TalkShow's multipoint conferencing and strong support of transfer protocols merit praise. The program lets LAN and modem participants join a single conference (InVision and Person to Person also do it), and it's the only one that lets you scan documents directly into the whiteboard.

Ranking near the top in ease of use, TalkShow is only middling in performance and feature versatility. Raw file transfer speed is among the fastest, but network efficiency in whiteboard transfers (which adds file size to the equation) is among the worst. The program's applications-sharing module lets only one participant make changes, and its chat windows are not as informative as those in Person to Person and LiveShare Plus. However, its whiteboard is among the easiest to use. It employs a slide-tray metaphor that functions as a page sorter. ■

### Product Information

**AT&T Vistium Share 1.0.......$99**
AT&T Global Information Solutions
Dayton, OH
(800) 447-1124
**Circle 1232 on Inquiry Card.**

**Face to Face 2.0.1................$59**
Crosswise Corp.
Santa Cruz, CA
(800) 747-9060
(408) 459-9060
fax: (408) 426-3859
**Circle 1233 on Inquiry Card.**

**InVision 3.1.23...........$595**
InVision Systems Corp.
Tulsa, OK
(800) 847-1662
fax: (918) 584-7775
**Circle 1234 on Inquiry Card.**

**LiveShare Plus 2.0.............$249**
PictureTel Corp.
Danvers, MA
(800) 716-6000
(508) 762-5000
fax: (508) 762-5245
**Circle 1235 on Inquiry Card.**

**Person to Person 1.0.3...........$280**
IBM Direct
(800) 342-6672
fax: (512) 823-1864
**Circle 1236 on Inquiry Card.**

**ProShare Premier Edition 1.6..........$299**
Intel Corp.
Hillsboro, OR
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# 12 Network Printers

## Keep those print jobs rolling with these fast, 16- to 32-page-per-minute networked laser printers and stay ahead of the paper flow

**JIM KANE**

Maybe your 12-page-per-minute networked laser printer just doesn't cut it anymore, with print jobs festering in the print queue because of its too-slow print engine. Perhaps you need some duplexing capabilities, or maybe you just want to be able to know if the printer is off-line, out of paper, or tied up. Your old printer was OK when you just had a handful of employees sending print jobs, but now your company has grown, and you need a faster, networkable, more manageable unit.

We evaluated 12 network laser printers with print speeds ranging from 16 to 32 ppm—fast enough to satisfy the needs of larger workgroups. These faster devices also have built-in Ethernet capabilities, so you don't have to use a PC as a baby-sitter to provide network functionality.

With third-party equipment, any printer can be considered a network printer, so we focused on network integration and tested only those printers with internal network interfaces (either standard or optional). Network management software helps differentiate between dedicated network printers and those with third-party add-ons. Network-printer-management software delivers configuration tools to the workstation and also reports the remote printer's status to your PC, keeping you informed.

To get real-world network performance numbers, we tested only monochrome printers in network configurations. Most of these units—which range in price from $3549 for the desktop Hewlett-Packard LaserJet 4MV to $29,616 for the copy-machine-size Dataproducts Typhoon 30—have at least two paper-input trays that are switchable on demand via the driver or the printer management software.

These 300- to 1200-dot-per-inch-resolution printers allow documents with typical graphics to print relatively fast, along with the normal flow of letters and other text documents. The 1200-dpi devices, however, slow down when you send print jobs that have complex graphics.

We categorized these network printers into two groups: 16- to 20-ppm units and 30- to 32-ppm units. The 16- to 20-ppm printers are more common in smaller offices than their high-speed counterparts and offer higher-quality output. You can buy three or four of the 16- to 20-ppm printers for the cost of the least expensive 30- to 32-ppm printer that we put through the paces. Only two of the devices in the lower-speed group exceed $5000 as configured for testing.

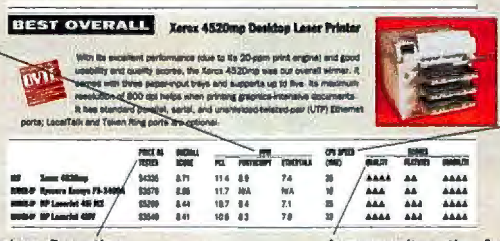
The major differences between desktop lasers (some of which are featured here as printers for smaller networks) and the console-type, high-volume/high-speed lasers is that the high-end units provide larger paper capacities, faster engine speeds, better longevity, and security features.

Of course, there are also price/performance issues to consider when choosing a network printer. Do you really need a 30-ppm printer/fax machine when three

### How to use this guide

We used our suite of PC- and Macintosh-based printer tests to choose the fastest network printers with the best-quality output. We summarize test details about the winners and runners-up in each of the two categories (16- to 20-ppm and 30- to 32-ppm printers) using charts like the one shown here.

The vendor's rating for engine or printhead speed, measured in pages per minute; it does not include printer-processing time.




The printer's processor speed, measured in MHz.

The price of the as-tested configuration, which may include optional memory (see the Roll Call on page 246).

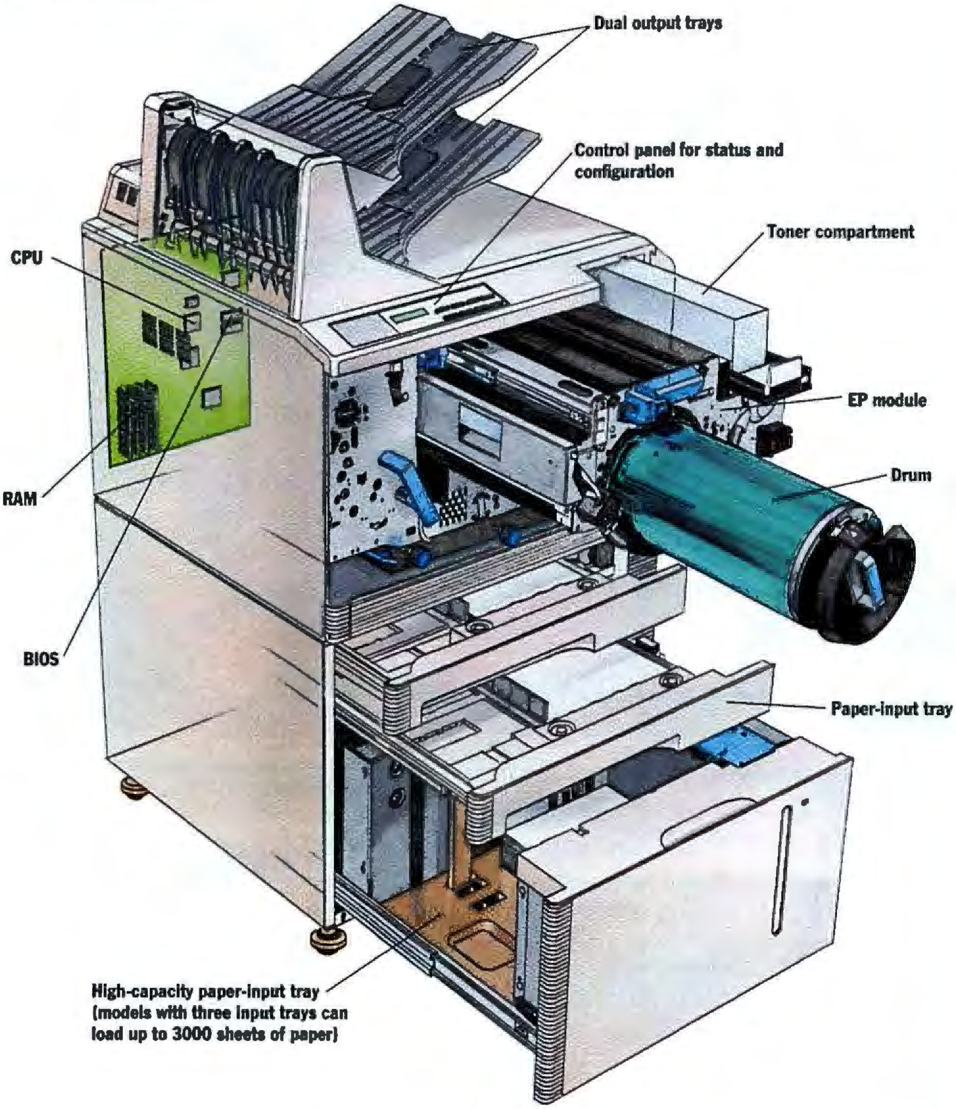
A composite rating for text- and graphics-output quality; based on a 10-point scale, with higher numbers indicating better print quality.



PHOTOGRAPHY: STEVE BELKOWITZ © 1995

# SET THE PACE

## Built for Speed




smaller, slower, dedicated print servers distributed evenly throughout the building would solve your printer problems? Or do your users queue up 100-page jobs regularly, making it more cost-effective to wait 4 minutes for a print job to get to the front of the line, and 4 minutes more for it to print, instead of fighting through the local queue only to wait 15 minutes for the print to complete?

You must also take into account the normal duty cycles of these printers. The higher-end, faster printers are supposed to last significantly longer between maintenance and consumables replacement. The median duty cycle for the 30- to 32-ppm printers is 200,000 pages, compared to 50,000 pages for the 16- to 20-ppm units.

NOVEMBER 1995 BYTE BEST NETWORK PRINTERS

**BEST**

### 16- TO 20-PPM PRINTERS

**BEST OVERALL**

**Xerox 4520mp Desktop Laser Printer**

This 20-ppm desktop printer is great for midsize workgroups and is affordably priced at $4335. It offered excellent across-the-board performance in our PostScript, Printer Control Language (PCL), and EtherTalk performance tests. **PAGE 241**

**HIGH-QUALITY**

**Lexmark Optra Lx**

For quality output, the 16-ppm Optra Lx ($3997) bests all other printers in this group with its support for resolutions of up to 1200 dpi. But the drawback of this high quality is reduced performance: The Optra performed poorly in our PostScript and PCL performance tests. It supports up to 64 MB of memory, has two external font slots, and supports three paper-input trays. **PAGE 241**

**MACINTOSH**

**Kyocera Ecosys FS-3600A**

Number one in both EtherTalk and PostScript performance in this group, the 18-ppm Kyocera Ecosys achieved an overall EtherTalk score of 9.5 ppm, second only to that of the QMS 3225 Print System, which swept the higher-end 30- to 32-ppm category. **PAGE 241**

### 30- TO 32-PPM PRINTERS

**BEST OVERALL**

**QMS 3225 Print System**

With a blazingly fast 19.2-ppm rating in our PCL performance tests, the QMS 3225 Print System is by far the fastest printer that we put through the paces. **PAGE 243**

**HIGH-QUALITY**

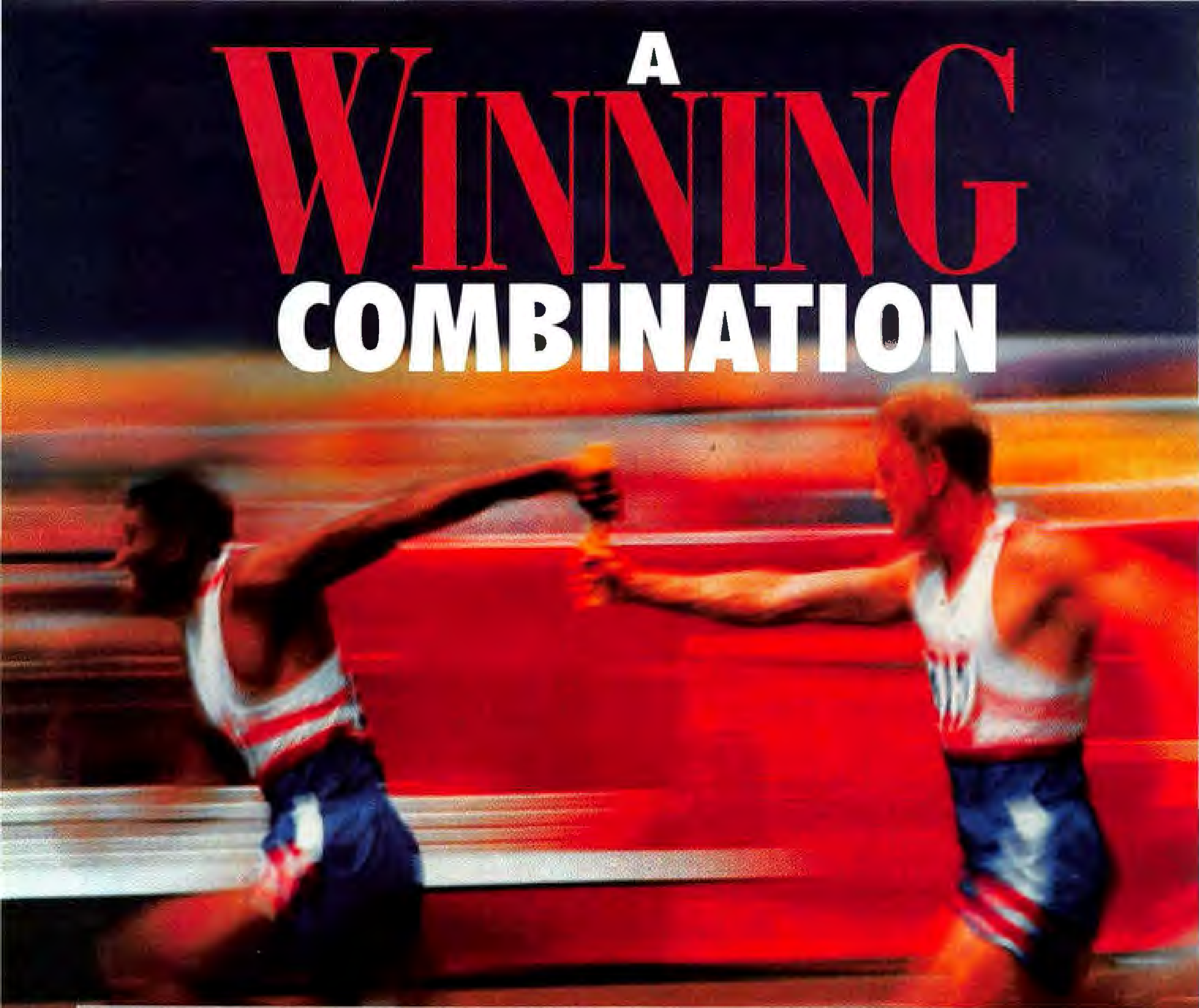
**QMS 3225 Print System**

This printer's 400-dpi output breaks through the 300-dpi-resolution barrier. This $17,149 console system has the highest quality-index score of the three printers in this category. **PAGE 243**

**MACINTOSH**

**QMS 3225 Print System**

It's a sweep for the 3225 as it takes the Mac category, too. With its support for three paper-input trays and 3000 sheets of paper, it can stave off the needs of many networked users. The unit also has a 200,000-page monthly duty cycle. **PAGE 243**

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***Stardock System Inc.'s™ Star Emperor™***
***Stardock System Inc.'s™ Havoc™***
***Starpress Multimedia's 808 Great Letters***
***T/Maker's ClickArt Newsletter Art***

BYTE BEST

# 16- TO 20-PPM PRINTERS

For most needs, one of the nine 16- to 20-ppm laser printers that we tested should be fast enough for midsize offices with 25 to 75 users wired to a network. These printers generally can handle enough volume so that you won't have to call crowd control whenever multiple print jobs are sent to the queue. Although the 30- to 32-ppm lasers offer more speed and paper-handling capabilities, the 16- to 20-ppm units have the ability to print higher-quality documents with integrated graphics.


Most of these printers are desktop units that support 600-dpi output and let you print general graphics relatively quickly. Some support resolutions of up to 1200 dpi, which is great for detailed reports; however, you may have to wait a bit if your text report is in the queue behind a coworker's complex newsletter. The average cost of the printers in this category is $4236, and only two exceed $5000 for their as-tested configurations.

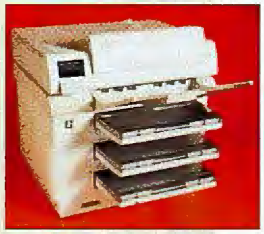
Our overall winner in this category is the Xerox 4520mp Desktop Laser Printer, by virtue of its 20-ppm print speed and high quality. Also ranking high is the Kyocera Ecosys FS-3400A; it ripped through our PCL tests with the best score in the group. However, it didn't come with a PostScript option, which eliminated it from our PostScript and EtherTalk tests. The FS-3400A printed at 11.7 ppm in the PCL tests, and if you just need to print in PCL mode, it's a bargain at $3578.


At $3699, the 16-ppm Dataproducts Typhoon 16 is another outstanding lower-priced network printer. The unit's performance scores were below average, but only Lexmark's Optra Lx had a better quality-index rating. In addition, the Typhoon 16 had the best features score in this category, as well as one of the best ease-of-use ratings.

Finally, HP's 600-dpi LaserJet 4MV ($3549) and LaserJet 4Si MX ($5299) put up strong performance numbers in our three subcategories and had above-average quality scores. HP is rumored to be introducing a replacement model for the 4Si, a new 24-ppm laser that will be available sometime in November.

## High speed and quality

**BEST OVERALL** Xerox 4520mp Desktop Laser Printer



With its excellent performance (due to its 20-ppm print engine) and good usability and quality scores, the Xerox 4520mp was our overall winner. It comes with three paper-input trays and supports up to five. Its maximum resolution of 800 dpi helps when printing graphics-intensive documents. It has standard parallel, serial, and unshielded-twisted-pair (UTP) Ethernet ports; LocalTalk and Token Ring ports are optional.

| | | PRICE AS TESTED | OVERALL SCORE | PPM PCL | PPM POSTSCRIPT | PPM ETHERTALK | CPU SPEED (MHZ) | SCORES QUALITY | SCORES FEATURES | SCORES USABILITY |
|---|---|---|---|---|---|---|---|---|---|---|
| BEST | Xerox 4520mp | $4335 | 8.71 | 11.4 | 8.9 | 7.4 | 25 | ▲▲▲▲ | ▲▲ | ▲▲▲▲ |
| RUNNER-UP | Kyocera Ecosys FS-3400A | $3578 | 8.65 | 11.7 | N/A | N/A | 16 | ▲▲▲ | ▲▲ | ▲▲▲▲ |
| RUNNER-UP | HP LaserJet 4Si MX | $5299 | 8.44 | 10.7 | 9.4 | 7.1 | 25 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | HP LaserJet 4MV | $3549 | 8.41 | 10.6 | 8.3 | 7.6 | 33 | ▲▲▲▲ | ▲▲▲ | ▲▲▲▲ |

## When looking sharp counts...

**HIGH-QUALITY** Lexmark Optra Lx

If detailed documents are your main concern, then the 1200-dpi Lexmark Optra Lx deserves a close look. It may not have lightning-fast performance, but it achieved the highest quality scores in this report. With its accompanying MarkVision management and monitoring software, the Optra Lx is one of the easiest-to-use printers we tested. The unit in this group that outscored it in usability was the 1200-dpi QMS 1660E Print System.

| | | PRICE AS TESTED | OVERALL SCORE | PPM PCL | PPM POSTSCRIPT | PPM ETHERTALK | CPU SPEED (MHZ) | SCORES QUALITY | SCORES FEATURES | SCORES USABILITY |
|---|---|---|---|---|---|---|---|---|---|---|
| BEST | Lexmark Optra Lx | $3997 | 8.34 | 7.1 | 5.3 | 4.9 | 25 | ▲▲▲▲ | ▲▲ | ▲▲▲▲ |
| RUNNER-UP | QMS 1660E Print System | $3999 | 8.12 | 9.5 | 7.5 | 6.9 | 33 | ▲▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Dataproducts Typhoon 16 | $3699 | 8.08 | 6.7 | 7.0 | 6.6 | 25 | ▲▲▲▲ | ▲▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | HP LaserJet 4MV | $3549 | 8.05 | 10.6 | 8.3 | 7.6 | 33 | ▲▲▲▲ | ▲▲▲ | ▲▲▲▲ |

## A fast paper-pusher

**MACINTOSH** Kyocera Ecosys FS-3600A

Our choice for best overall printer for the Mac is the Kyocera Ecosys FS-3600A. With its as-tested price of $4278, this printer supports resolutions of up to 600 dpi. The FS-3600A blew away the other printers in the EtherTalk ppm ratings with a score of 9.5. The nearest competitor in the group was the HP LaserJet 4MV, which sported a 7.6-ppm rating. The Dataproducts Typhoon 16, boosted by quality, features, and usability all superior to that of the top-rated Mac printers, was a close third.

| | | PRICE AS TESTED | OVERALL SCORE | PPM PCL | PPM POSTSCRIPT | PPM ETHERTALK | CPU SPEED (MHZ) | SCORES QUALITY | SCORES FEATURES | SCORES USABILITY |
|---|---|---|---|---|---|---|---|---|---|---|
| BEST | Kyocera Ecosys FS-3600A | $4278 | 7.4 | 9.4 | 10.0 | 9.5 | 50 | ▲▲▲ | ▲▲ | ▲▲▲▲ |
| RUNNER-UP | HP LaserJet 4MV | $3549 | 6.9 | 10.6 | 8.3 | 7.6 | 33 | ▲▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Dataproducts Typhoon 16 | $3699 | 6.8 | 6.7 | 7.0 | 6.6 | 25 | ▲▲▲▲ | ▲▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Xerox 4520mp | $4335 | 6.75 | 11.4 | 8.9 | 7.4 | 25 | ▲▲▲▲ | ▲▲ | ▲▲▲▲ |

**KEY**

Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

# 20- TO 32-PPM PRINTERS

The three high-end network printers we tested—the Dataproducts Typhoon 30, QMS 3225 Print System, and Xerox 4230/MRP—are all built for speed and durability. These workhorses are best suited for offices with high-volume-text and duplex print jobs. They range in price from approximately $17,000 to $30,000 and feature multiple paper-input trays and high-capacity loaders and stackers that help differentiate them from the 16- to 20-page-per-minute lasers.

With resolutions of 300 and 400 dpi, these printers produce output that's not as high-quality as that of the 16- to 20-ppm units, but they can produce acceptable charts, spreadsheets, and simple graphics for use in typical business reports.

Although it's seemingly a stretch to rate printers with resolutions of 300 and 400 dpi for quality, remember that these printers are not designed to spit out presentation graphics, but rather to satisfy the needs of larger workgroups. We rated them on the same quality scale as their 16- to 20-ppm counterparts; as a result, their scores are low.

Although the QMS 3225 received top honors in all categories in this group, the other two units in our test-bed also had strong performance scores. The Xerox 4230/MRP comes closest to the QMS 3225 in speed, with an average rating of 11.5 ppm when its PostScript, PCL, and EtherTalk test scores are combined. The QMS 3225 zips through the tests at an average of 15.5 ppm, while the Typhoon 30 averages out at 9.8 ppm.

At $20,245 as tested, Xerox's 4230/MRP is the least expensive of the group. Its accompanying printer management software makes network configuration a breeze. The 4230/MRP has a 230,000-page monthly duty cycle and supports five paper-input trays, for up to 1800 sheets of paper, and a high-capacity output tray.

## Eat my dust

### BEST OVERALL — QMS 3225 Print System

NOVEMBER 1995 BYTE BEST 20- TO 32-PPM PRINTERS

This 32-ppm printer is the only unit to achieve double-digit performance in our PCL, PostScript, and EtherTalk tests (with scores of 19.2, 14.6, and 12.8 ppm, respectively). It offers duplexing capability, two regular input trays, and a high-capacity input tray. The QMS 3225 also has two output trays, a hard drive, and a floppy drive. This printer has good features and usability, but its performance really puts it over the top in this category: It's 7 ppm faster than the first runner-up, the Xerox 4230/MRP.

| | | PRICE AS TESTED | OVERALL SCORE | PPM PCL | PPM POSTSCRIPT | PPM ETHERTALK | CPU SPEED (MHZ) | SCORES QUALITY | SCORES FEATURES | SCORES USABILITY |
|---|---|---|---|---|---|---|---|---|---|---|
| BEST | QMS 3225 Print System | $17,149 | 9.0 | 19.2 | 14.6 | 12.8 | 33 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Xerox 4230 MRP | $20,245 | 7.3 | 12.5 | 12.9 | 9.2 | 20 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Dataproducts Typhoon 30 | $29,616 | 6.8 | 11.1 | 10.5 | 7.9 | 33 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |

## Scale up for quality output

### HIGH-QUALITY — QMS 3225 Print System

At 400 dpi, the QMS 3225 has the highest quality scores, which, combined with its excellent performance, make it the best-quality printer of these lower-resolution lasers. Its standard features include auto-sensing between emulations, PostScript Levels 1 and 2, and Hewlett-Packard LaserJet III (PCL 5) emulation. The first runner-up, the Dataproducts Typhoon 30, also supports 400 dpi, and its quality scores are similar to those of the QMS 3225.

| | | PRICE AS TESTED | OVERALL SCORE | PPM PCL | PPM POSTSCRIPT | PPM ETHERTALK | CPU SPEED (MHZ) | SCORES QUALITY | SCORES FEATURES | SCORES USABILITY |
|---|---|---|---|---|---|---|---|---|---|---|
| BEST | QMS 3225 Print System | $17,149 | 8.0 | 19.2 | 14.6 | 12.8 | 33 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Dataproducts Typhoon 30 | $29,616 | 7.5 | 11.1 | 10.5 | 7.9 | 33 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Xerox 4230 MRP | $20,245 | 7.3 | 12.5 | 12.9 | 9.2 | 20 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |

## It's a sweep

### MACINTOSH — QMS 3225 Print System

With an EtherTalk rating of 12.8 ppm, the QMS 3225 easily outperformed the other printers in all aspects of Mac printing, except for the font test, for which the Typhoon 30 took top honors. A 9.2-ppm EtherTalk rating, combined with excellent features and usability, made the Xerox 4230/MRP the first runner-up. The Typhoon 30 offered good EtherTalk performance, but it wasn't good enough to beat the other printers in the group.

| | | PRICE AS TESTED | OVERALL SCORE | PPM PCL | PPM POSTSCRIPT | PPM ETHERTALK | CPU SPEED (MHZ) | SCORES QUALITY | SCORES FEATURES | SCORES USABILITY |
|---|---|---|---|---|---|---|---|---|---|---|
| BEST | QMS 3225 Print System | $17,149 | 9.0 | 19.2 | 14.6 | 12.8 | 33 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Xerox 4230 MRP | $20,245 | 7.5 | 12.5 | 12.9 | 9.2 | 20 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |
| RUNNER-UP | Dataproducts Typhoon 30 | $29,616 | 7.0 | 11.1 | 10.5 | 7.9 | 33 | ▲▲▲ | ▲▲▲ | ▲▲▲▲ |

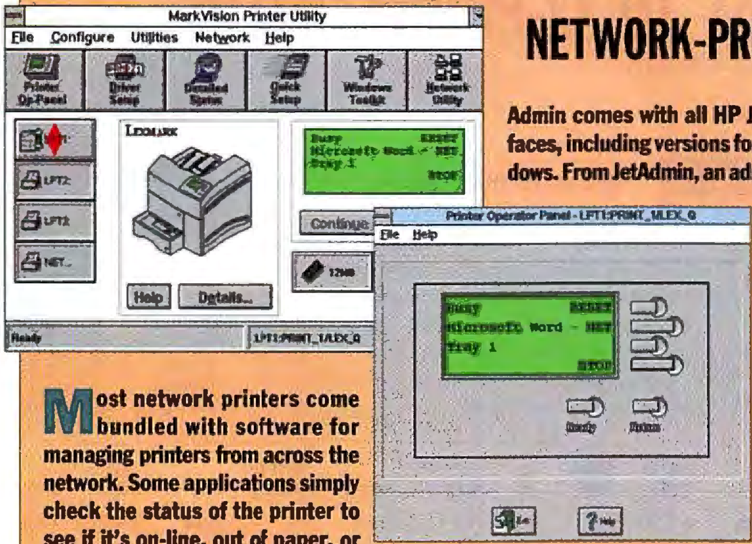
**KEY**

Ratings from 1 to 4: ▲ is the lowest; ▲▲▲▲ is the highest.

The 30-ppm Dataproducts Typhoon 30 is the most expensive printer in the group, sporting an as-tested price of $29,616. However, it offers some technological advances that set it apart from the others. A paper-feed mechanism enables you to refill one paper tray while the printer feeds from another tray, allowing continuous operation. The toner compartment can also be filled on the fly. In addition, the Typhoon 30 uses Dataproducts' Virtual Printer Technology (VPT), which adds network smarts to printers by acknowledging and receiving up to 64 different printer configurations concurrently.

The Typhoon 30 supports five paper-input trays and 3500 sheets of paper. The device offers a 200,000-page monthly duty cycle.

## NETWORK-PRINTER-MANAGEMENT SOFTWARE




Most network printers come bundled with software for managing printers from across the network. Some applications simply check the status of the printer to see if it's on-line, out of paper, or busy. Most include some sort of configuration capability. But some applications go further. Below are some notable features of the software we tested.

*PrintWatch.* Dataproducts' PrintWatch for Windows can monitor the print server and its status via TCP/IP, as well as configure the printer. Although it's more difficult to configure and install than some other utilities, it's easy to use once you set it up.

*JetAdmin and JetPrint.* Hewlett-Packard's JetAdmin provides configuration capabilities and printer-status information for users and administrators. Easy to use and install, JetAdmin comes with all HP JetDirect interfaces, including versions for DOS and Windows. From JetAdmin, an administrator has the ability to lock the printer's physical control panel. It also allows you to see what jobs are active on all queues. JetPrint configures both the print server and queue and maintains status information on the printer.

*Printset.* Kyocera's Printset utility for Windows creates a Novell Print Server and provides TCP/IP and AppleTalk configuration information. Printset also keeps track of the printer's status, but the status information is not as detailed as it is with many of the other utilities.

*MarkVision.* LexMark's MarkVision for Windows uses bidirectional communications to maintain, configure, and track the printer's status. A graphical representation of the printer's control panel and a detailed printer-status window let you know what's going on. The utility is a little confusing to install, but it's easy to use.

*CrownAdmin.* QMS's CrownAdmin for Windows and the Mac manages and configures QMS network printers. It searches out the printers by address and allows on-line configuration, but without any TSRs. CrownAdmin does not create your Novell Print Server for you, but it provides the name and printer descriptions in the NetWare configuration-menu item. It's easy to install and use.

*Document Services for Printing (DSP) and XRXADMIN.* Xerox offers two network-printer-management utilities for DOS. The DSP management/utility software installs easily and sports an easy-to-use interface. It helps you select a "best-fit" printer, depending on your output needs. DSP can track the status of multiple printers on the network as well as install the Novell PSERVER for you. The only downside: two TSRs for the printer-status application and terminal emulation.

XRXADMIN is easy to install and use and doesn't require a TSR. However, it seems to be designed more for printer configuration and management than for keeping tabs on printer status. The Xerox NICPRINT.EXE utility finds the printer for you and creates a PSERVER. However, it didn't run reliably under Windows as a DOS session.

# HONORABLE MENTIONS

Masochistic as it may sound, we actually enjoyed clearing paper jams with a couple of these printers. The control panel of the **Xerox 4230/MRP** directs you to the paper jam's specific area and requests that you open the correct doors to clear the jam. The LED of the **Dataproducts Typhoon 30** also gives on-target directions on how to find and clear paper jams. Note that, aside from a small mechanical failure in one printer, we had to cause the jams ourselves; the units showed no desire to jam on their own.


Xerox 4230/MRP


Dataproducts Typhoon 30

Interesting and innovative if nothing else, the **Lexmark Optra Lx's MarkVision** software alerts you of any problems with audio messages. Through the PC's speaker, you can barely hear the message "clear paper jam" when a paper jam occurs or "thank you" when you fix it. However, with better sound capability, it works great. This may be a little annoying to some, but mainly just to those who don't expect sound or who don't have a high-quality sound card.

## Dubious Achievement

Although the **QMS 3225 Print System** has many attributes we like, it has one feature that we really can't stand: Page Sensing Tabs for the paper-input trays. These tabs tell the printer what kind of paper you're using. As with the paper-tray *keys* found on other printers, these devices help you use the same paper tray for different-size paper. From experience, we know that small pieces like these can vanish in an instant—down a heating duct or somewhere inside the printer.

# How We Tested

To pick the top network laser printers, we test the devices' performance (i.e., speed), quality of printed output, features, and usability. We test and score each of these elements separately, and then we compute the overall score by assigning a weight to each element. For example, we assign weights in the overall performance category as follows: 40 percent for performance, 30 percent for quality, 15 percent for features, and 15 percent for usability. For the high-quality category, the weighting is 10 percent for performance, 70 percent for quality, 10 percent for features, and 10 percent for usability. In the Mac category, we use the same formula that we use for the best overall category. The only difference is that we use the EtherTalk rating for the performance score.

## PERFORMANCE

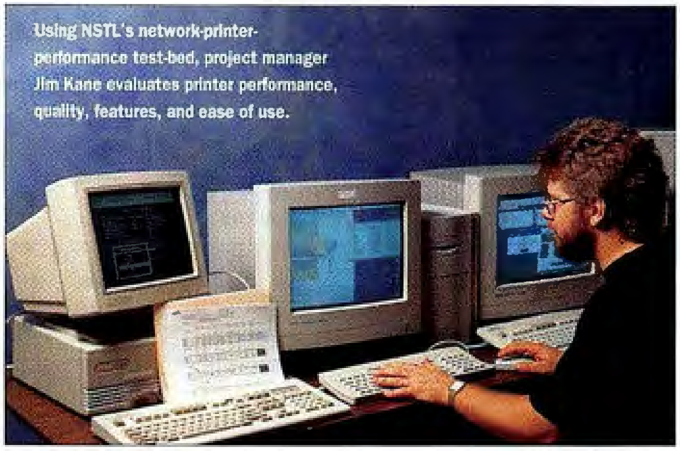
We set each printer to poll the network as frequently as possible to ensure we get the most consistent times attainable. NSTL's performance tests measure how fast a printer can print text, graphics, and fonts. The dense-text test requires printing a 2-KB file of ASCII text with little white space. Performance in this test correlates to raw speed, because there are no fonts or graphics for the printer to interpret.

The graphics tests use bit-mapped images to simulate documents with custom fonts or screen shots. These tests help us determine how efficiently each printer communicates with a computer. One test measures the printer's ability to draw complex lines and filled areas. A second test produces curves and gray scales. An additional complex-graphics test, created in CorelDraw, includes gray-scale shading, lensing, and other complex images. This test stresses the printer's processor and RAM capabilities.

We also use the font test to measure the speed of a printer's processor. This test requires printers to create Times (serif) and Helvetica (sans serif) fonts in regular and boldface in 30 different point sizes. We immediately repeat this test without resetting the printer to determine the unit's font-caching capabilities.

## PRINT QUALITY

NSTL's print-quality tests measure a unit's ability to produce a photographic image; print attractive, legible text in a wide range of sizes; and draw lines. Because most laser printers produce monochrome-only output, color-print-quality tests are not included in this review. The line-squeeze test forces a printer to draw two lines increasingly closer together until the gap between them vanishes, which indicates the printer can no longer make the black-to-white-to-black transition. The test suite also gauges other print-quality considerations, such as how accurately the unit positions paper and how well it displays reversed (i.e., white-on-black) text and graphics.



Using NSTL's network-printer-performance test-bed, project manager Jim Kane evaluates printer performance, quality, features, and ease of use.

## OTHER FACTORS

Participating vendors supplied us with responses to a printer-features survey that included a wide range of questions about what emulations are supported, the printers' maximum horizontal and vertical resolutions, and what services are included with the standard warranty. We verified these responses and assigned a features score based on the most important features. We also evaluated how easy the printers are to use, based on such aspects as ease of ink-medium installation, intuitiveness of the control panel, ease of driver installation, ease of network setup, and clarity of the user's manuals.

## CONFIGURATIONS

We tested all the printers in a network configuration using a Compaq Deskpro 66M network file server with 16 MB of RAM and Novell NetWare 3.12 installed on the hard drive. For a PC workstation, we used a Dell Dimension XPS P75 with 8 MB of RAM running DOS 6.22 and Windows for Workgroups 3.11. Our network file server used an NE3200 EISA Ethernet adapter: the workstation used an Intel PCI EtherExpress Pro/100 Ethernet adapter.

Each network adapter is bound to a variety of protocols to ensure it connects with each printer's network interface card (NIC). Our technicians tested printers with a Mac interface on a Quadra 640AV workstation with System 7.1, 16 MB of RAM, and EtherTalk installed. We tested each printer with the drivers that were supplied or recommended by its vendor. We disabled all print servers, spoolers, and buffers during performance testing.

On the PC platform, we used an NSTL-designed Windows applet to launch test files to each printer. After the last page of a test file dropped into the tray, a tester pressed Enter; the applet then displayed the number of seconds it took the printer to print the file. We used a similar applet to measure EtherTalk performance. On the PC platform, we tested printers in both PCL and PostScript emulations; on the Mac platform, we tested printers in PostScript only. Tests in both emulations were run with the printer set to its highest resolution.

### Contributors

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# ROLL CALL

| | DATAPRODUCTS CORP. TYPHOON 16 | DATAPRODUCTS CORP. TYPHOON 30 | DIGITAL EQUIPMENT CORP. PRINTSERVER 17/600 | HEWLETT-PACKARD CO. LASERJET 4MV | HEWLETT-PACKARD CO. LASERJET 4SI MX |
|---|---|---|---|---|---|
| Price as tested | $3699 | $29,616 | $5390 | $3549 | $5299 |
| **MONOCHROME PERFORMANCE (PPM)** | | | | | |
| PostScript | 7.0 | 10.5 | 4.9 | 8.3 | 9.4 |
| PCL | 6.7 | 11.1 | 6.4 | 10.6 | 10.7 |
| EtherTalk | 6.6 | 7.9 | N/A | 7.6 | 7.1 |
| **PERFORMANCE SCORES** | | | | | |
| Quality | 8.3 | 7.6 | 7.7 | 8.1 | 7.9 |
| Features | 8.1 | 7.3 | 5.3 | 7.0 | 7.1 |
| Usability | 8.4 | 8.3 | 5.0 | 8.2 | 8.3 |
| Overall | 7.2 | 6.8 | 5.9 | 8.4 | 8.4 |
| **MEMORY** | | | | | |
| Memory as tested (MB) | 12 | 24 | 20 | 12 | 10 |
| Memory base/maximum (MB) | 12/68 | 16/32 | 16/32 | 12/44 | 10/26 |
| Engine model | Fuji-Xerox Haruna | Hitachi | Canon 174-PCB | Canon P380 | Canon MXP174 |
| Maximum resolution (vertical/horizontal; in dpi) | 600/600 | 400/400 | 600/600 | 600/600 | 600/600 |
| ppm monochrome at maximum resolution* | 16 | 30 | 17 | 16 | 17 |
| **INPUTS** | | | | | |
| Auto-switching between inputs/emulations | ●/● | ●/● | ○/● | ●/● | ●/● |
| Monthly duty cycle (pages) | 30,000 | 200,000 | 70,000 | 50,000 | 75,000 |
| Interfaces as tested | LocalTalk, Ethernet, SCSI, Centronics, RS-232, RS-234 | Ethernet | Ethernet | LocalTalk, Ethernet, Centronics, HP BiTronics Parallel | LocalTalk, Ethernet, Centronics, HP BiTronics Parallel |
| **INTERFACES** | | | | | |
| RS-232/RS-422 | ●/● | ●/● | ○/○ | Opt./Opt. | Opt./Opt. |
| SCSI-1/SCSI-2 | ●/● | ○/○ | ○/○ | ○/○ | ○/○ |
| Ethernet/LocalTalk/Token Ring | Opt./●/Opt. | Opt./○/○ | ●/○/○ | ●/●/Opt. | ●/●/Opt. |
| **PDLS** | | | | | |
| HPGL | ● | ○ | ○ | ● | ● |
| PostScript Level 1/Level 2 | ○/● | ●/○ | ●/● | ○/● | ○/● |
| PostScript/Vendor | ●/Adobe | ●/Phoenix | ●/Adobe | ●/Adobe | ●/Adobe |
| Intellifont | ● | ● | ○ | ● | ● |
| True Image | ● | ● | ○ | ○ | ○ |
| HP LaserJet III (PCL5/PCL4) | ●/● | ●/● | ●/● | ○/○ | ○/○ |
| **SUPPORTED PAPER SIZES** | | | | | |
| Letter (8.5 x 11 in.) | ● | ● | ● | ● | ● |
| Legal (8.5 x 14 in.) | ● | ● | Opt. | ● | ● |
| A4 (8.26 x 11.69 in.) | ● | ● | Opt. | ● | ● |
| B5 (7.17 x 0.12 in.) | ● | ○ | ● | ● | ● |
| Tabloid (11 x 17 in.) | ● | ● | ○ | ● | ○ |
| Executive (7.25 x 10.5 in.) | ● | ○ | Opt. | ● | ● |
| Number of input trays standard/maximum | 1/3 | 3/5 | 2/3 | 2/3 | 2/3 |
| Envelope tray | ● | ○ | Opt. | ● | ● |
| Envelope/transparency/adhesive-backed labels | ●/●/● | ○/○/● | ●/●/● | ●/●/● | ●/●/● |
| Envelope feeder | Opt. | ○ | Opt. | ● | ● |
| Duplex printing | ○ | ● | ● | ○ | Opt. |
| Dimensions in inches (W x L x H) | 17 x 23 x 11 | 26 x 25 x 40 | 17.9 x 22.4 x 19 | 18.1 x 20.6 x 12.5 | 21.5 x 23.5 x 16.5 |
| Weight (lbs.) | 42 | 132 | 98 | 51 | 94 |
| FCC class/noise in high-speed draft mode (decibels) | A/53 | A/55 | A/50 | B/55 | B/55 |
| Energy Star–compliant | ● | ○ | ● | ● | ● |
| Voltage | 120 | 120 | 120 or 220 | 220 | 220 |
| Warranty (years)/coverage | 1/P, L | 90 days/P, L | 1/P, L | 1/P, L | 1/P, L |
| Phone | (703) 648-0930 | (703) 648-0930 | (508) 493-5111 | Call local HP dealer | Call local HP dealer |
| Toll-free phone | (800) 980-0374 | (800) 980-0374 | (800) 777-4343 | (800) 752-0900 | (800) 752-0900 |
| On-line address | http://www.dpc.com | http://www.dpc.com | http://www.digital.com | http://www.hp.com | http://www.hp.com |
| **Inquiry number** | 1396 | 1397 | 1398 | 1399 | 1400 |

= **BYTE Best.**

● = yes; ○ = no; N/A = not applicable.

*Scores for monochrome performance are actual, real-world performance scores.

**Warranty:**
P = Parts L = Labor F = Freight to repair center R = Return to customer

| KYOCERA ELECTRONICS, INC. ECOSYS FS-3600A | KYOCERA ELECTRONICS, INC. ECOSYS FS-3400A | LEXMARK INTERNATIONAL OPTRA LX | QMS, INC. 1660E PRINT SYSTEM | QMS, INC. 3225 PRINT SYSTEM | XEROX CORP. 4520MP DESKTOP LASER PRINTER | XEROX CORP. 4230/MRPA |
|---|---|---|---|---|---|---|
| $4278 | $3578 | $3997 | $6798 | $17,149 | $4335 | $20,245 |
| 10.0 | N/A | 5.3 | 7.5 | 14.6 | 8.9 | 12.9 |
| 9.4 | 11.7 | 7.1 | 9.5 | 19.2 | 11.4 | 12.5 |
| 9.5 | N/A | 4.9 | 6.9 | 12.8 | 7.4 | 9.2 |
| 7.8 | 7.9 | 8.8 | 8.2 | 7.8 | 8.0 | 7.1 |
| 6.1 | 6.0 | 6.7 | 7.0 | 7.7 | 6.7 | 7.9 |
| 8.0 | 8.0 | 8.7 | 8.8 | 8.5 | 8.3 | 8.9 |
| 6.3 | 8.7 | 7.1 | 8.1 | 9.0 | 8.7 | 7.3 |
| 6 | 5 | 12 | 48 | 16 | 12 | 20 |
| 2/66 | 1/5 | 4/64 | 12/64 | 16/32 | 8/52 | 20/20 |
| Kyocera FS-3600 | Kyocera FS-3400 | Lexmark Optra | Canon BX II | Ricoh M32 | Fuji-Xerox XP-20 | Fuji-Xerox 4230/MRP |
| 600/600 | 1200/300 | 1200/1200 | 1200/1200 | 400/400 | 800/800 | 300/300 |
| 18 | 18 | 8 | 16 | 32 | 20 | 30 |
| ●/● | ●/● | ●/● | ●/● | ●/● | ●/● | ●/● |
| 50,000 | 50,000 | 75,000 | 35,000 | 200,000 | 75,000 | 230,000 |
| Ethernet, Centronics | Ethernet, Centronics | Ethernet, Centronics, RS-232, RS-234 | Ethernet, SCSI, AppleTalk, RS-232 | Ethernet, Centronics, Centronics, AppleTalk, RS-232 | Ethernet, RS-232, RS-234 | LocalTalk, Ethernet, Centronics, RS-232 |
| Opt./Opt. | Opt./Opt. | ●/● | ●/○ | ●/○ | ●/● | ●/○ |
| ○/○ | ○/○ | ○/○ | ●/○ | ●/● | ○/○ | ○/○ |
| Opt./Opt./Opt. | Opt./Opt./Opt. | Opt./Opt./Opt. | ●/Opt./Opt. | Opt./●/Opt. | ●/Opt./Opt. | Opt./Opt./Opt. |
| ● | ● | ● | ● | ● | ○ | ○ |
| Opt./○ | Opt./○ | ●/● | ●/● | ●/● | ○/● | ○/● |
| ○ | ○ | ○ | ●/QMS | ●/Adobe | ●/Adobe | ●/Adobe |
| ● | ● | ● | Opt. | N/A | ● | ● |
| ● | ● | ○ | ○ | ○ | ○ | ● |
| ●/● | ●/● | ●/● | ●/○ | ●/● | ●/○ | ●/○ |
| ● | ● | ● | ● | ● | ● | ● |
| Opt. | Opt. | Opt. | ● | ● | Opt. | ● |
| Opt. | Opt. | ● | ● | ● | Opt. | ● |
| Opt. | Opt. | ● | ● | ● | Opt. | ● |
| ○ | ○ | ○ | ● | ● | ● | ● |
| ● | ● | ● | ● | ● | Opt. | ● |
| 1/4 | 1/4 | 1/3 | 3/2 | 2/3 | 4/5 | 5/5 |
| ● | ● | Opt. | ○ | ○ | ● | ● |
| ●/●/● | ●/●/● | ●/●/● | ○/●/● | ○/●/● | ●/●/● | ●/●/● |
| Opt. | Opt. | Opt. | ○ | ○ | Opt. | ● |
| ● | ● | ● | ○ | ● | ○ | ● |
| 13.6 x 13.8 x 9.7 | 13.6 x 13.8 x 9.7 | 16.1 x 21.1 x 17.2 | 18 x 23.2 x 11.8 | 37.4 x 25.8 x 29.5 | 20.5 x 22 x 20.8 | 39 x 26.7 x 41.7 |
| 23 | 23 | 50 | N/A | 187 | 83 | 356 |
| B/50 | B/50 | B/50 | B/N/A | A/<55 | B/53 | A/55 |
| ● | ● | ● | ● | ○ | ● | ● |
| 120 | 120 | 120 | 120 or 220 | 120 or 220 | 120 or 220 | 220 |
| 1/P, L, F | 1/P, L, F | 1/P, L, F, R | 1/P, L | 90 days/P, L | 1/P, L | 3 months/P, L |
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| (800) 232-6797 | (800) 232-6797 | (800) 891-0331 | (800) 523-2696 | (800) 523-2698 | (800) 349-3769 | (800) 349-3769 |
| john_storch@kel-us.cc: mail.compuserve.com | john_storch@kel-us.cc: mail.compuserve.com | http://www.lexmark.com | http://www.qms.com | http://www.qms.com | N/A | N/A |
| 1401 | 1402 | 1403 | 1404 | 1405 | 1406 | 1407 |

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# PixelFlow: Scalable Image Processing

**It divides and conquers rendering by drawing the objects first, then combining them**

**DICK POUNTAIN**

PixelFlow is a new chip architecture for generating photo-realistic images in real time. Created by researchers at the University of North Carolina, PixelFlow is aimed squarely at the very top end of the graphics market, presently dominated by such exotic hardware as Silicon Graphics' RealityEngine² (see "Damn the Torpedoes!," November 1993 BYTE). To compete in this arena, a system must offer full color (with fog and transparency effects), high resolution, photo-realistic Phong shading, antialiasing, and bump- and texture-mapping, all while delivering up to 60 video frames per second.

The sort of customers who can afford this high level of realism right now include Hollywood studios chasing another *Jurassic Park*-class blockbuster film, and military departments. The latter is looking into PixelFlow for use in sophisticated VR combat simulators (research on PixelFlow has been partly supported by the U.S.'s Defense Advanced Research Projects Agency).

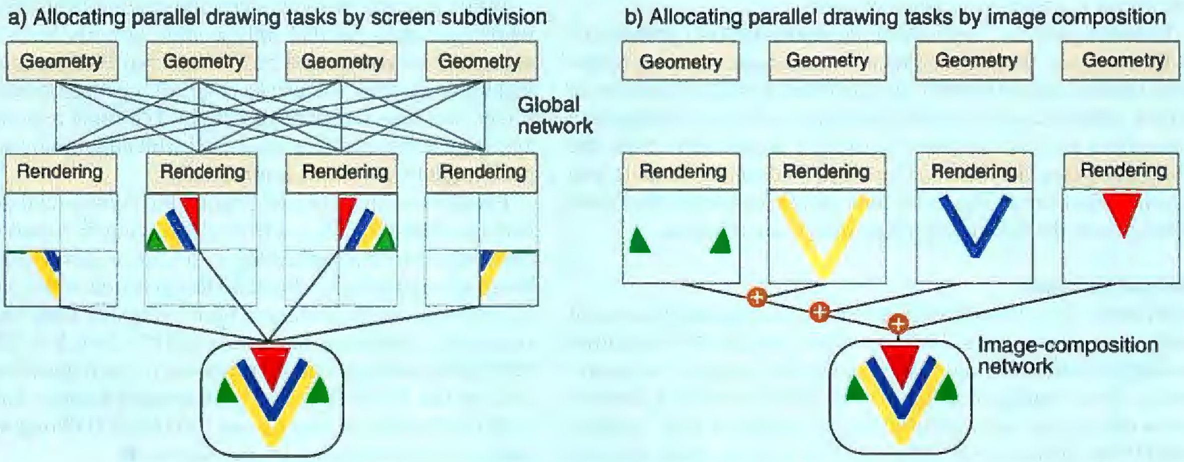
PixelFlow shares some of the same design decisions that went into the RealityEngine². First, it employs massive parallelism, since there's no way to get sufficient bandwidth from a single processor. Second, it separates the floating-point-intensive geometry processing from the rendering process, which uses high-performance integer calculations. This is explained by the fact that geometry processing works on a database of real numbers—the 3-D coordinates that describe objects—using matrix math. These calculations transform this data into a current screen view composed of triangles. Conversely, rendering works on bit maps at the pixel level, coloring in the triangles to give the illusion of a scene with lighting and shadows.

Where the PixelFlow architecture differs from its competitors is that it's fully scalable in both the geometry and the rendering dimensions. It splits the rendering process itself into separate rasterizing and shading steps (so-called "deferred shading") that are implemented on separate boards. A PixelFlow system consists of a backplane into which you can fit the appropriate mixture of rendering and shading boards to achieve the performance you require (see the figure "PixelFlow Hardware" on page 250).

### Subdivision vs. Composition

Key to PixelFlow's scalability is the way it distributes tasks among its parallel processors, using a technique called *image composition*. The more obvious way to distribute graphics tasks is through *screen subdivision*, where you divide up the screen into a number of nonoverlapping regions and assign a different renderer to each region. This approach scores on conceptual simplicity but complicates implementation. Most of the objects in any

## Imaging Architectures Compared

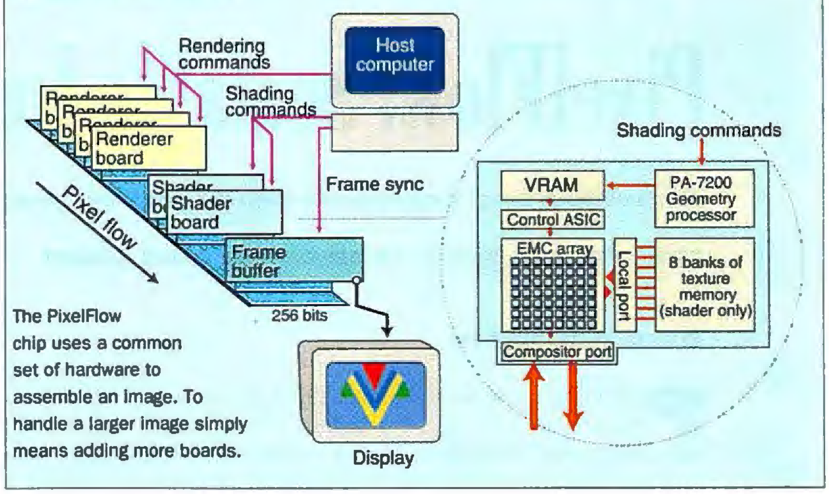



**Screen-subdivision designs require a high-bandwidth network to relay image data; the image-composition design relays only the data for the object it has rendered and composited.**

scene will cross region boundaries, and they'll also move around the screen as the viewpoint changes. Hence, a global routing network is needed so that any geometry engine can deliver objects to any renderer (see section (a) of the figure "Imaging Architectures Compared" on page 249). This network needs a very high bandwidth and, crucially, the bandwidth required rises with the rendering rate. Having to sort the drawing primitives by screen region also complicates software implementation.

In image composition, by contrast, each graphics processor works over the whole screen area but renders only some of the primitives (see section (b) of "Imaging Architectures Compared"); the partial images so produced are then composited (hence the name) into a single picture. This does away with the global switching network completely, as each geometry engine always serves the same renderer. Instead, you need a compositing network to combine the partial images; however, as this carries only local traffic from each renderer to its neighbor, its necessary bandwidth (though still high) remains constant as you add more renderers. Therefore, you have scalability.

**PixelFlow Hardware**




The PixelFlow chip uses a common set of hardware to assemble an image. To handle a larger image simply means adding more boards.

Composition-network bandwidth depends on the screen size and frame rate. Say we want a 1280- by 1024-pixel image that's 48 bits deep, displayed at a 30-Hz frame rate. This amounts to a base bandwidth of 2.3 Gbps. In PixelFlow, however, antialiasing requires each pixel to be super-sampled four times over, and the deferred shading algorithm multiplies the required bandwidth further by a factor of 2 or 3. The architecture that handles these operations is based on a 256-bit-wide image-composition network running at 132 MHz, for a total of 33.8 Gbps. The very name PixelFlow stems from the fact that a stream of pixels flows in one direction along this compositing data path, with each rendering board adding its own contribution to the image as it passes through.

The compositing port on each board contains hardware comparators that implement a z-buffering scheme, so only those pixels that should be visible (that is, those pixels that have a smaller *z* coordinate and so are in front of any other pixel) pass over the network to the next renderer. This comparison hardware works in parallel, so that a board can be rendering the next frame while the current one is passing over the network.

"Deferred shading" implies that the renderers don't generate final RGB values. They generate an intermediate pixel representation that encodes attributes such as intrinsic color, direction of surface normals, and texture coordinates. These intermediate values flow into the shaders (all located downstream from the renderers) where they are converted to RGB using shading and texturing algorithms. The last station on the network is the frame buffer, where the final composited image accumulates.

### PixelFlow Hardware

At the heart of the PixelFlow architecture is a processing array of enhanced memory chips (EMCs), which you can think of either as a single-instruction multiple-data parallel computer or, equivalently, as an intelligent memory. This EMC, for which first silicon is due this quarter, is the latest in a family of UNC designs called Pixel-Planes. It's a 16 by 16 array of cells, each of which consists of an 8-bit ALU, a linear expression evaluator, 2048 bits of local memory to store pixel data, and an 8-bit memory bus. The linear expression evaluators compute the value of bilinear expressions of the form Ax+By+C for each cell's *x,y* coordinates. The ALUs perform arithmetic (including 16-bit multiplies) and logic operations on the cell's pixel data, in parallel across the whole array.

Programming involves broadcasting the parameters A, B, and C for each of the three corners of a triangle to the whole array, along with an ALU micro-instruction specifying an operation. All the cells compute in parallel whether their own pixel lies within this triangle (A1x+B1y+C1<0, etc.) and perform the requested operation if the pixel does.

This EMC array is equally useful for rendering or shading operations, so all PixelFlow boards contain the same core components: a floating-point RISC geometry processor and an array of EMC chips. The EMC array is dual-ported. One port connects to the composition network. The second port is used differently, according to the type of board: On a renderer board it's unused; on a shader board it connects to eight banks of RAM used for storing texture maps; on a frame-buffer board it connects to the frame buffer itself. Since shading and frame-buffer boards perform no geometry calculations, their underused RISC processors can be redeployed for image-processing operations, such as warping, and for procedural texturing (running Renderman, for example.)

While it would be nice to provide enough EMCs to render the whole screen in parallel, this would currently be prohibitively expensive, as you'd need 5120 (80 by 64) EMCs per board. Real PixelFlow systems will use just 64 EMCs per board and render the screen as a time sequence of 128- by 128-pixel regions. This image sequencing, and that associated with antialiasing sampling, is performed by a custom control ASIC.

PixelFlow is now poised to enter the commercial arena. Division Inc. (Bristol, U.K.), a firm specializing in virtual reality systems, has formed a partnership with UNC to develop a PixelFlow board set, and Hewlett-Packard has invested in this project with an option to use the system in future graphics workstations. Consequently, Division has chosen HP's own PA-7200 (250+ SPECfp92) as the geometry processor (to be replaced when available by the PA-8000). The performance target—for a system with 128 PixelFlow boards—is 100,000,000 Phong-shaded, antialiased, textured triangles per second. ■

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# Open(ing) VMS to Win32

**Adding Win32 support to Digital's OS will allow developers to target OpenVMS and NT machines**

**MARK FENIELLO**

Good things come to those who wait. Digital Equipment Corp. and Microsoft have had an agreement for several years to help each other develop, promote, and market products. Soon after this relationship was formed, Digital's Alpha AXP machines were among the first to support Windows NT. Since then, however, there have been few tangible results to support the flurry of marketing and PR announcements. But finally this alliance is starting to bear real fruit.

The two companies have agreed to exchange engineers, license some of each other's patented technology, and provide access to each other's source code. And Microsoft will fund the training of at least 1500 Digital employees to support Microsoft products. But perhaps the biggest news is Digital's announcement that its OpenVMS operating system will soon support Microsoft's Win32 API.

### Word for OpenVMS?

So does this mean Microsoft Word will run on OpenVMS? That's a question Wes Melling, Digital vice president of OpenVMS Systems Business, hears often. And his answer is "No." The long version of the answer is that when enough of the Win32 API is supported by OpenVMS, you could get Word to run under OpenVMS by recompiling and relinking the source code. That is not likely to be a high priority for either Microsoft or Digital, so Melling is probably right; the answer remains "No."

On the other hand, many OpenVMS developers want to know if they can now develop Windows applications and then run them on an OpenVMS system. This is the question Digital wants to hear, because the answer is a resounding "Yes." Digital wants developers to build applications for Windows and then keep OpenVMS in mind when deciding which platforms to support with these new applications. This is the message Digital must keep telling developers as desktop machines play an ever-increasing role in the day-to-day business operations of Digital's traditional user base—medium to large scientific and commercial sites.

The announcement of OpenVMS support for the Win32 API is part of a much larger picture Digital is painting. OpenVMS is already widely accepted as a bulletproof operating system capable of providing 24-hour-a-day, 365-day-a-year reliability to business-critical, enterprise-wide applications. But Digital knows that business desktops are dominated by PCs, most of which are running Windows. Digital wants to make it easier for developers to create client/server applications for a single OS (i.e., Windows) and then deploy those applications on a combination of Windows, Windows NT, and OpenVMS systems.

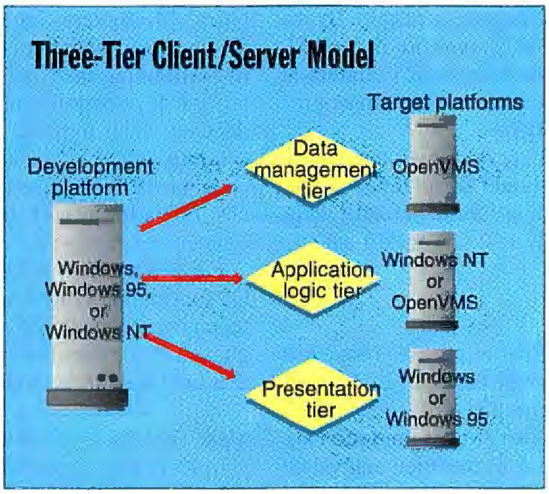
### The Three-Tier Approach

Digital and others in the industry are now promoting a new model for client/server applications. They are warning that applications with a "fat client" or a "fat server" will not scale or perform well in the future.

An application with a fat client is one in which the client handles not only the user interface but most of the application's decision logic as well. This leaves only the data-retrieval and update functions to the back-end server. A fat server application results when the client is little more than a GUI that issues SQL requests to a database server. In this type of application, the server handles most of the decision logic and calculations. The server then sends packets of formatted information back to the client for display.

Some analysts and makers of development tools are now advocating a three-tier client/server model (see the figure). In this model, the decision logic and heavy calculations are separated from the rest of the application and put into a partition of their own. This becomes the middle tier of the three-tier model. The first tier contains only the presentation services, the GUI. The third tier provides all the data management services.

With an application partitioned in this way, you have the flexibility to deploy each piece of the application on the system that gives it the best performance. Instead of running a CPU-hogging number cruncher on a 66-MHz 486, let it rip on a blazingly fast 275-




**OpenVMS with Win32 will enable developers to deploy three-tier client/server applications.**

MHz Alpha AXP system. If you have to work with huge amounts of data, why try to cram a small piece of it into the 8 MB on the desktop client when you could fit everything into memory at once by accessing 512 MB of shared memory on an application server?

Some development tools take this even further by allowing you to replicate the application logic across multiple servers. With this configuration, automatic load balancing can be performed, letting the application server with the most available resources handle the clients' requests for services. Having multiple application servers also provides another benefit: Even if one or more servers goes down, requests can still be processed by the remaining servers. You can quickly envision a system that is as fast and as reliable as you want to make it. All you need to do is throw more hardware at the problems until there are no more problems left to solve.

#### Platform Oblivious

If you are a developer, you may wonder what hoops you have to jump through to get a program to work like this. That is one of the main reasons that Digital is building support for the Win32 API into OpenVMS. It is already possible for you to build and partition a client/server application using the three-tier model, and you have a number of development tools to choose from to help you. The problem comes when you need to choose the target platform.

With most of the existing tools, you need to be very aware of the target platform for which you are writing the application. If you don't continually take this into account, your beautifully designed program will probably not run properly when it gets to the target system. According to Digital's Melling, it is Digital's goal to make things so transparent that the developer can be "platform oblivious."

By supporting the Win32 API on OpenVMS, Digital has brought developers one step closer to being "oblivious." You will be able to develop a client/server application on a Windows or Windows NT machine and then deploy it on any combination ofWindows, Windows NT, or OpenVMS systems.

Support for the entire Win32 API will not come all at once (see the chart above). First, Digital will support what Microsoft used to call the Win32s subset of the API. This portion of the API provides everything needed by a typical Windows program, such as I/O functions, memory management, and object management, plus the common graphics- and window-management calls. By the time you read this, support for the Win32s portion of the API, along with support for OLE 2 and the Microsoft Foundation Class, should be available. Within six to nine months, some of the Win32 server API calls will be supported.

Digital is now in the process of surveying customers as to which calls are most important and should be included in this second phase of support. Then, in the next 12 to 24 months, Digital intends to support the rest of the Win32 server API calls as well as the BackOffice API.

#### Presto Change-o

Bristol Technologies (Ridgefield, CT) is performing the magic that allows OpenVMS to understand and handle the Win32 API calls. Bristol is writing a library of callable routines that translate the Win32 API calls into the appropriate OpenVMS system services. The routines translate GUI-related API calls into their equivalent Motif calls. To enable an application designed for Windows to run under OpenVMS, you simply recompile your source program on an OpenVMS system and link it with this library. Except for minor differences between the Motif and Windows interfaces, you shouldn't know or care about the operating system on which your application is running.

It will take benchmark tests to determine comparative performance figures based on real applications. But Digital expects that performance will be almost identical between a Windows application running under Windows NT and the same application running under OpenVMS on the same hardware. Mike Cuccia, director of OpenVMS marketing at Digital, says that application performance on an OpenVMS platform is within 10 percent plus or minus of the performance on a comparable NT platform. Some calls are faster under OpenVMS and others are slower, so the performance of your specific application will vary depending on what it does.

**Win32 API Support on OpenVMS**

| Expected Release Time | Features Supported |
|---|---|
| Now to 3 months | Win32s API, OLE 2, Microsoft Foundation Class |
| 6 to 9 months | Selected Win32 Server API calls |
| 12 to 24 months | Remaining Win32 Server API, BackOffice API |

Large applications that can be scaled over multiple processors can benefit from the better symmetric multiprocessing performance of OpenVMS. Windows NT tops out at three or four processors, while OpenVMS can go up to 10 or 12 processors. Another potential benefit of OpenVMS is that it will soon support 64-bit memory addressing. If your application manipulates massive amounts of data, you could see performance increases of up to 200 times by being able to get all the data into memory at once instead of having to bring it into memory in smaller pieces.

Digital expects that most client/server application development will continue to be done on Windows or Windows NT platforms. The company is therefore concentrating on making its OpenVMS development tools integrate with existing Windows development tools. Digital is making its compilers compatible with Microsoft compilers and is porting its development tool set to run under Windows NT.

Digital is working with other development-tool makers to ensure that these tools integrate well with Windows clients and OpenVMS servers. Some of these third-party environments help the developer with both the design process and the complex task of partitioning the final application. These environments insulate the developer from the underlying hardware and OS dependencies. Their ultimate goal is allowing the developer to concentrate on the application. The details of splitting the source code into different parts for compiling and deploying on different OS platforms will all be handled automatically by the development environment.

For years, OpenVMS has proven to be a secure, highly reliable OS for mission-critical applications. If Digital can pull off the integration of OpenVMS with Win32, it will have a powerful argument to convince developers of future client/server applications that they should continue using Digital's operating system. ■

*Mark Feniello has worked with various Digital systems, including OpenVMS, for 15 years. He is currently a systems analyst for Spokane Computer in Spokane, Washington. He can be reached c/o editors@bix.com.*

# Windows NT Threads

**To truly reap the rewards of a multiprocessor NT system, you have to use threads**

**SHASHI PRASAD**

Multithreading (MT) is becoming increasingly attractive for applications; it offers one of the best choices for harnessing the power of SMP (symmetric multiprocessing) machines. In my article "Weaving a Thread" (October BYTE), I discussed multiprocessing and MT on Solaris and Windows NT. In this article, I'll take a closer look at the Win32 interface in Windows NT for developing MT applications.

### Processes and Threads

A *process* in NT is a running instance of an application; it has its own virtual address space and owns system resources, such as memory, windows, and open files. When a process is created by a call to `CreateProcess`, an initial thread is automatically built for the process. You create additional threads by calling the following function:

```
HANDLE CreateThread(LPSECURITY_ATTRIBUTES lpsa,
   DWORD cbStack,
   LPTHREAD_START_ROUTINE lpStartAddr,
   LPVOID lpThreadParm,
   DWORD fdwCreate,
   LPDWORD lpIDThread);
```

The newly created thread starts executing the routine specified by `lpStartAddr`, and this routine can take the optional argument `lpThreadParm`. The thread-routine argument is generally a dynamically allocated variable or a global variable. Each thread in NT has its own user and kernel stack, and the size of the stack for the newly created thread can be specified in `cbStack`.

Threads in NT have 32 different priority levels. The *dispatcher*—the module responsible for thread-scheduling—uses a preemptive priority scheduler. In Windows NT, the highest-priority thread is always scheduled to run. Threads can change their priority by calling the function `SetThreadPriority`.

NT threads can be suspended and resumed by other threads in the process via calls to `SuspendThread` and `ResumeThread`, respectively. You can also create a thread in suspended state, which means it doesn't start execution until the creating thread calls `ResumeThread`.

A thread can terminate in one of the following ways: It can return from the initial routine; it can call the function `ExitThread` to terminate itself; or it can be terminated by some other thread in the process that calls `TerminateThread`. When a thread terminates, the thread object becomes *signaled*—all other threads waiting for the thread to terminate are notified. A waiting thread can determine the exit status of a terminated thread with the function `GetExitCodeThread`.

Each thread has a unique identifier that can be retrieved by calling the function `GetCurrentThreadId` (this identifier is also returned in the `lpIDThread` argument during thread creation). However, several Win32 functions require an object's handle, which, for a thread, is separate from its ID. The handle to the thread object can be retrieved by calling the function `GetCurrentThread`. (The handle is also returned by the function `CreateThread`.) For example, when a thread wants to change its priority class, it can call the following:

```
SetThreadPriority(GetCurrentThread(),
THREAD_PRIORITY_LOWEST);
```

### Thread Synchronization

In a multithreaded program, all threads within the process run in a single address space. Threads allow easy data sharing; however, safeguards against corruption of the shared data are required. All access to shared resources must be protected by mutual exclusion.

In NT, mutexes are used to serialize critical sections of code. A *critical section* is defined as a segment of code in which a thread accesses shared, modifiable data, and where state changes happen over several instructions. Hence, only one thread can be executing that section at a given time. Access must be serialized by some form of locking mechanism.

Before entering the critical section, the calling thread acquires the mutex lock by calling the `WaitForSingleObject` function. If the lock is held by some other thread, the calling thread is suspended until the thread holding the mutex lock releases it by calling `ReleaseMutex`.

*Critical-section objects* are similar to mutexes but can be used only by threads of a single process. `EnterCriticalSection` is used to acquire ownership of a critical section, and `LeaveCriticalSection` releases ownership. This is one of the fastest mechanisms for mutual exclusion; only a few instructions are executed when there is no contention for the critical section. (If contention occurs, a kernel synchronization object is automatically used.)

In a multithreaded application, it's common to divide work among multiple threads. In such cases, one thread might wait for another thread to reach a particular state before proceeding. NT provides event objects for thread synchronization. One thread can call `WaitForSingleObject`, thus blocking its execution until a certain condition is satisfied. The other thread, after satisfying the condition, can notify the waiting thread by calling `SetEvent`.

*Semaphore objects* are similar to mutexes, except there is no ownership associated with semaphores. Additionally, semaphores have resource counts, which allows multiple threads to acquire a semaphore at the same time.

Finally, NT provides atomic memory operations for integer variables. The functions `InterLockedIncrement` and `InterLockedDecrement` increment and decrement a variable, respectively, while the function `InterLockedExchange` reads the value of a variable.

### Threads and Performance

Once you've grasped the basic concepts of NT threads, you need to consider the performance and scalability of threaded applications. A thread in NT can normally be in one of the following states at any given time: waiting for a specified event to occur (it cannot run); ready to run and waiting for an available processor; or running on a processor.

Threads in the ready or running state can take advantage of the CPUs (presuming they are running on a multiprocessor system). Excessive interthread synchronization can cause too many threads to be in the waiting state, and the creation of too many threads can cause multiple threads to be in the ready state. The number of threads in the running state can never be more than the number of processors. When the number of threads in the ready state is much higher than the number of running threads, the kernel spends a lot of time doing thread-context switching.

As an illustration, consider the various threading models used in the design of a multithreaded TCP/IP server. (This assumes you're familiar with Windows socket APIs on Windows NT.)

The first model is single-threaded. The main thread does an accept call on the socket and handles the client request. The disadvantage of this model is that while the server is processing a client request, all other requests are being queued.

The second model is also single-threaded: The main thread does a *select* call on all the connected sockets. The select call indicates which connected sockets have data available (i.e., they are waiting to be serviced). Now multiple clients can be serviced concurrently, but—as in the previous model—this does not exploit the power of multiple CPUs.

In the third model, the main thread creates a thread for each client. This model is extremely easy to program, but it does not scale well for a high number of active clients. Creating multiple threads takes advantage of multiple processors but uses excessive system resources and causes scheduling overhead. The performance of the system degrades under "burst" traffic. As the number of ready threads increases, the system spends lots of time context-switching threads in and out of the running state.

Finally, in the fourth model, a pool of worker threads is created to handle client requests. The main thread does a select on all the connected sockets; each new request gets passed to one of the worker threads. The number of worker threads should be slightly greater than the number of processors, because some of the worker threads might become blocked.

This model uses less system resources than the third model, but there's a built-in context switch on every transaction between the main thread and the worker threads. The context switch might not be a problem for longer transactions, but the overhead could be high for short transactions. Also, unless the main thread does some rotation on the results of the select call, this model does not have built-in fairness (i.e., an active client may block other, less active ones).

### I/O-Completion Ports

To overcome the limitations of these four models, the engineers of NT 3.5 created a mechanism called *I/O-completion ports*. These ports are designed to handle asynchronous or overlapped I/O. `CreateIoCompletionPort` associates a port with a collection of file handles, and the port acts as a synchronization point. When a pending I/O operation on any of the file handles completes, an I/O-completion packet is then queued to that particular port. A number of worker threads can manage I/O for clients by calling `GetQueuedCompletionStatus` to wait on the I/O-completion port.

**SYNCHRONIZING THREADS**

**Mutex**—Serializes access to shared data.

**Critical-section object**—Faster than a mutex; cannot be shared across processes.

**Event object**—Used to signal occurrence of an event.

**Semaphore**—Controls multithreaded access to a shared but limited resource.

**Interlock call**—Provides atomic access to integer variables.

I/O-completion ports have built-in concurrency control. The kernel tries to limit the number of runnable threads associated with a port, never to exceed the port's concurrency value (which is specified when the port is created). When a thread calls `GetQueuedCompletionStatus`, it returns when I/O is available. When one of the threads associated with a completion port is blocked, the kernel selects another thread waiting on the completion port to run. Thus, the system isn't deluged with runnable threads.

Threads that block on a completion port are awakened in last-in/first-out (LIFO) order, while I/O requests are serviced in first-in/first-out (FIFO) order. Running threads—after completing a transaction—can pick up the next request without causing any context switch. I/O-completion ports work efficiently under all loads; their performance does not suffer under heavy traffic.

If my sample TCP/IP server were implemented using I/O-completion ports, the main thread would create an I/O-completion port along with a pool of worker threads to wait on the port. This model is the most efficient; it does not suffer from context-switching overhead (as the fourth model would). The thread that reads the transaction services it. Fairness is built into the completion-port model, since I/O requests are satisfied in FIFO order.

### The Common Thread

MT on an SMP machine can provide optimal performance and scalability if the applications are designed correctly. You should not be surprised to see poorly designed applications run slower on an SMP machine than they do on a uniprocessor machine.

Windows NT is a good environment for developing multithreaded applications, but it's important to remember that the OS alone is not responsible for performance and scalability. Understanding such features as I/O-completion ports and overlapped I/O are key to building scalable multithreaded applications on Windows NT. ■

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# ATM with a Twist of LAN

**LAN Emulation brings legacy LANs onto the ATM bandwagon**

REX BALDAZO

LAN Emulation (LE) may be the killer application that brings asynchronous transfer mode (ATM) networking into the mainstream. ATM is a fast, modern networking technology that is considered by many to be the biggest thing since Ethernet (see "On the Road to ATM," September 1994 BYTE). But corporations with huge investments in mission-critical applications running on Ethernet and Token Ring networks have been loath to make the transition, slowing the acceptance of ATM.

The reason was simple—interoperability, or rather the lack thereof. Computers directly connected to an ATM network couldn't run legacy applications that depended on a LAN's unique properties. Instead, the only way to bring some of the benefits of ATM to legacy networks required devices such as Ethernet-to-ATM switches (see "Merging ATM and Ethernet," August BYTE). But perhaps ATM's biggest strength is as an end-to-end solution, connecting desktops across the enterprise—one network architecture, from LAN to WAN. LE is just the ticket, allowing legacy applications to run essentially unchanged, while also allowing the computers on which the applications run to be directly connected to the ATM network.

ATM was developed by telecommunications companies. It is based on fast ATM switches and is connection-oriented (see "All-Terrain Networking," August 1993 BYTE). In contrast, LANs such as Ethernet and Token Ring are based on a shared, not switched, medium, and the protocols are connectionless.

LE, which was developed by the ATM Forum's LAN Emulation Subworking Group, bridges the gap by hiding the underlying ATM network at the media access control (MAC) layer. This layer provides device-driver interfaces such as Open Data-Link Interface (ODI) and Network Driver Interface Specification (NDIS), so higher-level applications dependent on these protocols work without modification. A group of ATM stations acting as a traditional LAN is called an emulated LAN (ELAN).

Performing this magic requires four components: LAN Emulation Client (LEC), LAN Emulation Server (LES), Broadcast and Unknown Server (BUS), and LAN Emulation Configuration Server (LECS). (See the figure "Getting from Here to There.") The LEC resides on all ATM-attached stations (e.g., bridges and workstations) that are participating in the LE service. The three server components may reside on one ATM-attached workstation or on separate workstations. Some vendors may even implement one or more of the server functions inside an ATM switch.

### The Client

The LEC is responsible for the MAC-layer connectionless service that hides ATM from LAN-based applications. In a basic configuration, each LEC possesses two addresses: an IEEE-format 48-bit MAC address and a 20-byte ATM address. If the LEC is running on a bridging device such as ATM-to-Ethernet, the LEC might have multiple IEEE MAC addresses for which it is responsible.

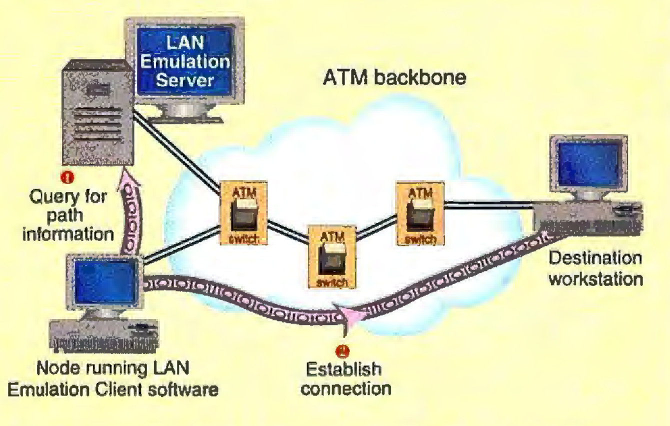
When a new outgoing message arrives from a higher-layer entity to the LEC, that message includes a MAC address for the intended destination. The LEC must translate that address into the appropriate 20-byte ATM address, establish a connection (if one is not already open), and transmit the message.

The LEC begins by looking at the connections, called Virtual Channel Connections (VCCs), it has open. The LEC maintains a translation table of destination MAC addresses to VCCs. If the destination address for the new message is in the table, the LEC can simply send the message using the existing VCC.

If the destination address is not in the translation table, the LEC has to perform an address resolution using the LAN Emulation Address Resolution Protocol (LE-ARP). It sends an address-resolution request to the LES. When the LEC receives back the valid destination ATM address, it performs standard ATM signaling to establish a VCC and transmit the message.

LECs are able to register their ATM-to-MAC address

## Getting from Here to There




**For two virtual LAN clients to make a connection, a client first queries the LAN Emulation Server for the destination client's asynchronous transfer mode (ATM) address. The server looks up the address and determines the appropriate path (over the ATM network) to that address.**

### Key Components for ATM LAN Emulation

- **LAN Emulation Client—a software driver that runs on a network client**
- **LAN Emulation Server—maintains a mapping between ATM and LAN addresses**
- **Broadcast and Unknown Server—maintains lists of Virtual Channel Connections**

translation with the LES. Then, when the LES receives an address-resolution request, it can reply directly with a message containing the matching ATM address. Otherwise, the LES must forward the message to the destination ATM station, which replies with the correct address.

Each LES entity represents one ELAN. On any ATM network, there might be multiple LESes maintaining independent networks. The LECS is responsible for maintaining configuration information about the various ELANs. An LEC is assigned to an ELAN based on the configuration stored in the LECS.

#### The BUS to Everywhere

When an LEC has a multicast or broadcast message to send, it does not know a priori the MAC addresses of all the recipients. Even if it did, repeatedly querying the LES and setting up an ATM VCC for each station would be wasteful of bandwidth and computing resources. The solution is the BUS.

During the initialization of an LEC, it has to determine the ATM address of the BUS. It transmits to the LES an address-resolution request for the broadcast address (hexadecimal FFFFFF) and receives back the ATM address for the BUS. The LEC must then establish a VCC to the BUS.

ATM supports a one-way point-to-multipoint broadcast mechanism. One station becomes the root. It sets up one-way VCCs to each receiving station. The BUS sets up such a tree, with the BUS as the root node and all stations of the ELAN as branches. This tree is maintained as long as the ELAN is in service. New LEC stations joining the ELAN are added to, and stations leaving the ELAN are pruned from, this broadcast tree.

Thus, the BUS has several two-way VCCs, one to each LEC, that are established during the initialization of each LEC. The BUS also maintains a one-way broadcast tree to those same LECs. Data to be broadcast from each LEC, as well as control information between the BUS and LECs, travels on the two-way VCCs. The BUS uses the one-way broadcast tree to send the actual broadcast messages.

It is important to mention here a limitation of the LE scheme. To achieve its high bandwidth, ATM relies on fixed-size packets called cells. An ATM cell contains 53 bytes (48 bytes of payload and a 5-byte header containing the VCC), an error-control code to protect the header, and some control bits.

The format of the payload is left up to what are called ATM Adaptation Layers (AALs). LE uses AAL5, which is the most efficient in terms of the 48-byte payload. Other AALs use part of each cell's 48-byte payload for things such as cyclic redundancy checks (CRCs) and sequencing numbers. This allows multiplexing different cell streams onto the same VCC, but it wastes part of every cell's payload. LE eschews such services by using AAL5, which breaks up an incoming message into 48-byte blocks and passes them onto the ATM physical layer for transmission.

The upside is efficient use of bandwidth. The downside is that the BUS is limited to sending out a broadcast message from only one LEC at a time. The BUS has to accumulate all the cells of a broadcast message, unpack them into the original frame to make sure a valid frame has been received, and repackage and send out the broadcast message. Incoming broadcast messages from other LECs must be queued up, awaiting their turn.

The LEC sends to the BUS all messages for which the LEC does not yet know the corresponding ATM address. This includes broadcast and multicast messages. However, it also includes any regular message whose destination address has not yet been received from the LES. This is where the "Unknown" component in the BUS acronym comes from.

As mentioned earlier, when an LEC has a message with an unknown destination MAC address, it transmits an address-resolution request to the LES. While awaiting the reply from the LES, the LEC does not sit idle. It begins transmitting the message to the BUS. If the LEC receives an ATM address from the LES, the LEC stops transmission to the BUS and connects directly to the destination station. Thus, some frames may arrive at a receiving station from a VCC connected to the BUS, and some from a VCC connected directly to the source LEC.

This may be undesirable in some cases. In a shared medium such as 802.3 and 802.5 LANs, frames will usually arrive in order. But in an ELAN, where some frames get sent via the BUS and some over a direct LEC-LEC connection, there is a real possibility the frames will arrive out of order. So the LE specification includes an optional flush protocol.

The sending LEC suspends transmission of the data frames and transmits a flush message down the old path, in this instance to the BUS. The BUS in turn broadcasts the flush message to all the stations in the ELAN. The destination station whose address matches the flush message replies to the flush. When the sending LEC receives this response, it begins transmitting again on the new path, in this case the direct VCC to the destination LEC.

#### Still on the Road to ATM

The success of technologies such as switched Ethernet and fast Ethernet is not due solely to technical merit. These technologies leverage the existing investment in software, providing greater throughput without requiring a total rewrite of all applications. This lesson has not been lost on the ATM Forum.

All the extra protocol baggage may seem like a lot of effort on the part of an ATM network just to accommodate old LAN software. But it is probably the key to the acceptance of ATM. It allows incremental deployment of ATM. You can replace the physical wiring of your existing LAN with an ATM network but keep existing applications intact. When you're ready, you can make the leap to applications that take full advantage of ATM.

Of course, dangers lie ahead. Early implementations of LE may have initial interoperability problems, as with any new specification. And because the specification leaves open the question of where the various servers reside—on one or multiple machines, or even in the ATM switch itself—there will be numerous solutions offered from numerous vendors. You may not be able to take one vendor's LES and another's BUS. Pick one vendor's solution and stick with it for now. It's going to be a minefield for the IS department, but with users clamoring for bandwidth, you will have to negotiate that minefield sooner or later. ■

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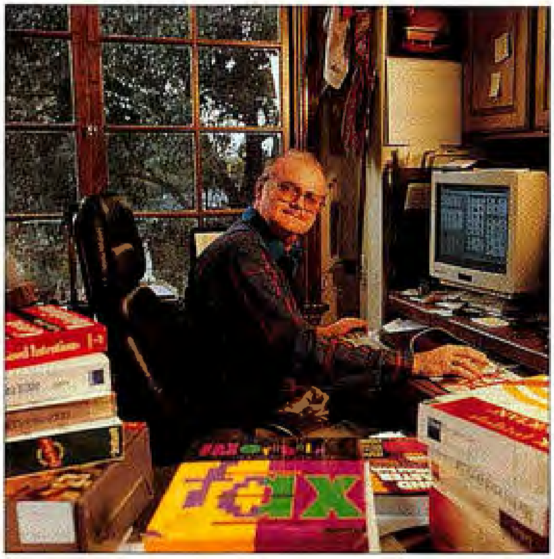
JERRY POURNELLE

# Digital Models



AMY ETRA © 1995

**I've just come back from Siggraph,** the graphics convention, where the big theme was "see what's possible." The short answer to that is "practically anything."

The key word there is *practically*. We're a lot closer to Robert Heinlein's Adam Selene—a computer complex that became self-conscious and sentient when the networked hardware got complex enough in *The Moon Is a Harsh Mistress*—than I'd have predicted even five years ago, but we're not quite there.

They're pretty close with the graphics. The computer-generated humans at Siggraph look good from a moderate distance, but you can tell they're not "real" in close-ups. The expressions are good, but not quite good enough. Give it a few years, though, and I suspect you won't be able to tell whether you are looking at a live actor or a screen-generated person, even in love scenes. Is simulated sex and violence considered the real thing for ratings?

**Digital images are available for everything from an Iowa-class battleship to Denzel Washington. Seeing is no longer believing.**

**MIT's Media Lab booth featured** a computer-generated dog who could interact on-screen with a human. That is, the human stands in an open area and is seen by a camera. The human and the dog then appear life-size on a projection screen. The dog tries to get the human to play with him and will react to being petted. He'll bring you his ball, and when he's done something vigorous, he gets a drink of water.

Dog, ball, and water bowl are all computer images. The computer tries to be aware of the human, and the dog will generally avoid being stepped on. It's up to the human not to step on the spot onstage occupied by the nonexistent water bowl.

The dog interacts well with the human. If you encourage him, he rubs up against your legs; if you reject his advances, he becomes visibly sad. It's a long way from Adam Selene, but it's quite impressive.

**On a more practical level,** Viewpoint DataLabs has the 3-D Model Library CD-ROM, containing 3000 3-D video models. These aren't models of the sort we used to build out of balsa wood and tissue paper, but full 3-D CAD descriptions that can be put into a program like Macromedia Director.

The models include civilian and military objects, creatures, a *Godzilla*-like movie set, and a partridge in a pear tree. These are very realistic—a Viewpoint T-38 video model was used for the flyover scene in the movie *Apollo 13*. (And if you haven't seen that film, go see it; it has some terrific computer-generated effects.) They also modeled Denzel Washington for *Virtuosity*.

Viewpoint DataLabs was giving away CD-ROMs of some of their models at Siggraph. Others are in the public domain and available for downloading. The best, of course, are for sale. Complexities range from relatively undetailed real-time models, such as a Los Angeles–class sub with 394 polygons, to an Iowa-class battleship with 30,113 polygons, to a model of what looks to me like the *Bounty* with 102,857 polygons. Viewpoint DataLabs' 3-D Model Library CD-ROM catalog is gorgeous. It's a lesson in the state of the art in image modeling.

**For photo images, you aren't likely to do better** than the Corel Stock Photo Library 2, which contains 200 CD-ROMs and 20,000 photographs

ILLUSTRATIONS: DIANNE BENNETT © 1995

on every imaginable subject, from the Grand Canyon to tall ships, bobcats and deer, highway signs and bobsledding, foliage and flowers, old master paintings—the list is endless. Software is included to let you use the photos as screen savers. Resolutions can be altered in a range from 128 by 192 pixels to 2048 by 3072 pixels. The library comes with software to allow the images to be exported in TIF, BMP, EPS, PCX, or GIF for Windows, and TIFF and PICT for the Mac.

These are all in Kodak Photo CD format, so you can use them to build slide shows or paste them into documents. They're royalty-free. I'm using mine to illustrate lectures; it's quite easy to integrate them with pictures I took myself. For that matter, I can, with programs like Adobe Photoshop or Macromedia Director, combine pictures and put myself into a better photo of me at the Leaning Tower of Pisa than I was able to take myself.

It's now possible to take pictures, have Kodak put them on a CD-ROM, read the digital image into a program like CorelDraw, alter it almost any way you like, put the image back on disc, and then print it. Want to see yourself shaking hands with President Clinton? Then add Newt Gingrich. Add angels, or trolls, as you prefer. Put clouds in the sky. It's all possible now. Seeing isn't believing anymore.

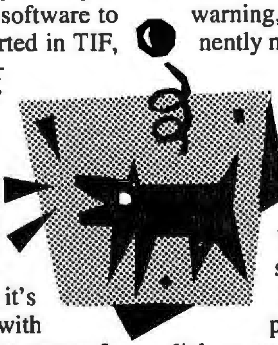
Even if all you want is eye candy, the Corel Stock Photo Library 2 is wonderful. Highly recommended.

**Corel's box of 200 CD-ROMS cries for a good library program.** I've got one, but first an aside.

I never sell evaluation software, and I'm pretty careful whom I give it to; schools, mostly. I suppose that's not true of every writer, but even so, I am constantly amazed at the lengths publishers will go to to protect their stuff. As an example: Aldridge has for weeks been trying to get me to look at CD-Cabin (with Link'N'Logging). Their PR people had already persuaded me, and the Corel Stock Photo Library 2 package was the clincher; but when I went looking for a copy, I couldn't find it. This was probably because I took it to the beach house with the intent of trying it there, got involved with fiction writing, and left it when I came back to Chaos Manor. In any event, I asked Aldridge to send another copy.

As usual, there was an "Evaluation Copy: Not For Resale" sticker on the outside of the shrink-wrap. In addition, there was another one inside the shrink-wrap. So far, nothing unusual—but inside the box, not only is the manual stamped in big red letters, but someone has written "EVAL" on the disk labels.

Of course, this makes me wonder whether what I have is really what my readers can buy. I presume it is, but fair warning, what I have is very prominently marked "EVAL."



Despite the terminally cute title, CD-Cabin with Link'N'Logging is a very useful program. Although it's a Windows 3.11 program, installation under Windows 95 (Win 95) was simple.

Using it is pretty intuitive: put a CD-ROM in your drive, click on new, and stand back. CD-Cabin scans the CD-ROM and builds a directory tree. Because Aldridge's Tree 86 was for a long time one of the best of the DOS directory shell programs, I expected this to work properly, and it does. While it's building the tree, it scans the program file extensions and builds a database of what's in there. Alas, there seems to be no way to cut and paste from it; CD-Cabin doesn't seem to be Windows-aware. I had to make notes by hand to tell you that it found 19 executable, no compressed, 141 graphics, 10 help, and five sound files on the Corel CD-ROM.

There's a nifty viewer that's quite fast for throwing visual images on the screen. It works with most popular image file formats. You can also use CD-Cabin to listen to sounds, including wave sounds. Fair warning, though: be sure you want to listen, because once CD-Cabin starts playing a sound, you have to either wait for it to end or turn off your computer.

The cataloging program has provisions for making volume (but not individual file) notes, as well as for creating program categories like OSes, utilities, games, accessories, and sounds. A CD-ROM can be associated with more than one category. You can also give each disc a Library ID and record not only when you got it, but where. All this stuff can be sorted in various ways. When it's all done, CD-Cabin builds a compressed database containing the catalog information and a directory tree with all the filenames.

Most of those filenames will not be useful. For example, Lightbinders' Darwin CD-ROM has such uninformative filenames as 000001.001, and a lot of CD-ROMs have a HELP.TXT file. The Library of the Future volumes, many of which contain the only copies of some works of literature, have no filename clues as to what their contents are, and thus neither does the CD-Cabin catalog (unless you make such a list as a comment). Still, this is about the best you can do without doing your own index.

CD-Cabin's data compression is pretty good, but the database can grow like anything if there are a lot of files on a disc. One Corel Art Show disc takes up nearly 100 KB for its catalog. I don't know how big a database I'll have after I put all 200 Corel Stock Photo Library 2 CD-ROMs through this wringer, but I expect it will be many megabytes.

Given the pile of CD-ROMs I have acquired, I desperately need some way to catalog them, and CD-Cabin is surely the easiest to use of any I have found. However, there's one major defect. The program only builds an on-line catalog; if there's any provision for printing a list of cataloged CD-ROMs, I haven't found it. Given the information this program stores, you wouldn't want a printed copy of everything, but a simple listing of titles, Library ID, and comments would be a useful thing to have. It wouldn't be all that hard to add. Given time, I suspect I could crack their compression code and write a BASIC program to print my list, but maybe they'll provide that in an update.

Given the infinity of weird formats that CD-ROMs use for their tables of contents and databases, I don't suppose there will ever be a program that can automatically catalog everything contained on a CD-ROM, although I sure wish someone would figure out how to do that and let me print an indexed list. Until then, Aldridge's CD-Cabin with Link'N'Logging is at least as good as anything else I've seen, and I expect to use it. It is limited, but it's also fast and convenient, and I had no problems with it in Win 95. Recommended, with hope for improvements.

**I'd hoped to get through this column without logging** yet another problem with Win 95, but that was not to be. In attempting to catalog my CD-ROMs, I inserted Strategic Simulation's The Definitive Wargame Collection CD-ROM. This is one of the better CD-ROM game collections.

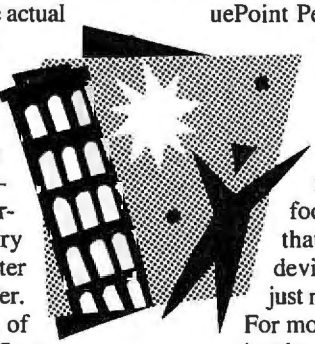
Alas, they've included a batch file for running the installation program, and Win 95 finds that and tries to run it—and you can't eject the silly CD-ROM until you run the installation program. I had to use a paper clip to release the CD-ROM carrier and pliers to pull it out of the drive; *nothing* I could do short of turning the machine off would make Win 95 release that disc.

Understand, these are mostly DOS

games, and Strategic Simulations didn't try to make it one of the famous Win 95 plug-and-play CD-ROMs; it just works out that they used a format that Win 95 recognizes that way. It sure was frustrating to try to catalog a disc and end up using a bent paper clip and pliers to get it out of the machine.

On the other hand, the game collection is excellent, and any two of the games are worth the price of the whole thing.

**Models and Photo CDs,** and images drawn with programs like CorelDraw, Macromedia Freehand, and AutoCAD are pretty standard for games and movies now. Some of the models are dynamic: *Jurassic Park* showed the way, and now a great many movies use computer animation scenes. Most of the space scenes in *Apollo 13* are computer-generated; the actual filmed footage looks like newsreels, not as realistic as what the computer can do. While a lot of *Waterworld* was filmed on an ultraexpensive location, the supertanker deck was on dry land, with the wide water vistas added by computer.



In its time, the state of the art for movies was *Star Wars.* Physical, not computer, models with stop-action camera work produced most of those marvels. Today, much of that would be done by computer, but for those interested in how things used to be, Ballantine Del Rey Books has a series called *The Art of Star Wars*, with photographs of the models, early sketches and paintings, portions of the scripts, cartoons, and spin-off art. They're good history, but what's striking is just how much of that can now be done with computers.

On that subject, LucasArts Entertainment has its LucasArts Archives Vol. I CD-ROM, which features a number of adventure and simulation games. These are all fancier games than those in Strategic Simulations' collection; if you like great graphics with lots of action sequences and sound, this is a pretty good collection. As games, I prefer Strategic Simulations' group, but there's no doubt at all that the LucasArts collection, which comes on six CD-ROMs, has better graphics. Like all Lucas games, these are clean fun, with no sex, and the violence is fairly muted.

**Depending on the machine, some of my modems are faster** than my serial ports. That is, with one machine, I can never connect faster than 9600 bps regardless of the modem or what service it's connected to. Doubtless this is a defective chip in the serial port. On the other hand, serial ports are inherently slower than parallel, and we're rapidly running up against their limits as modems get faster and faster.

Microcom has a remedy for this: use a parallel-port modem. Parallel ports are inherently faster than serial ports. Many communications programs assume serial connections, but that's no problem either. The Microcom DeskPorte Fast 28.8 modem (which also comes with a serial-port connection) comes with software that will fool your system into thinking it's communicating through serial ports. Of course, you can't have this attached to your LPT1 port and still print through that; but around here, all printing is done through LPT2, which is a network connection to the ValuePoint Pentium running OS/2 Warp as the print server. That works just fine.

Microcom's modem works pretty well. By the time you read this, they'll have drivers for OS/2 Warp and a way to fool Windows NT into believing that it's a serial communications device. Parallel communications is just new enough to have a few kinks. For most users, though, installation is simple, the modem locks on even to noisy lines, and you'll get true 28.8-Kbps communications if your telephone lines are clean enough. Most aren't, but the Microcom DeskPorte Fast 28.8 modem will get as much out of them as possible. I suspect that parallel-port modems are the wave of the future.

**The gadget of the month is CoStar's LabelWriter SE200 Plus.** It consists of a triangular box 8 inches at the base, 6 inches high, and 4 inches thick. It has its own power source and connects to the computer through a serial port. You load it with labels of whatever size you like—wide or narrow—install the printer drivers, and print labels.

I've had units that came with software to capture addresses or other printable data off the screen, but this is a kind of do-it-yourself kit: you get the unit, BASIC source code for all kinds of printer commands, some drivers, a programmer's guide, and the good wishes of the manufacturer. Doing label programs isn't difficult. The LabelWriter accepts escape codes that let you control margins, characters per line, and everything else you need. It will do bar codes and Proprinter XL graphics. It's pretty easy to connect this up with a database program.

continued

POURNELLE

A small business could use this to generate disk and shipping labels complete with bar codes and serial numbers. This is one of those gadgets that not everyone needs, but if you need it, you need it bad.

**I've just had another lesson, although I'm not sure what it means.** I now have the final "gold" Win 95; I also have the "gold" Norton Utilities for Win 95. Both are on CD-ROMs.

Back in earlier builds of Win 95, I had an earlier version of Norton Utilities installed, and I liked it; there are a number of useful features, including Norton Unerase and Disk Doctor. However, the early beta version did something odd to my local network; removing Norton Utilities cured the difficulties. Since it was all beta-test software, it wasn't worth recording details.

About the time I had the final Win 95 running and all was stable, Symantec sent the final Norton Utilities. The installation seemed to go well, but to finish I had to restart the machine—and it would *not* restart. First, it said it couldn't open Explorer, then something else, then it offered to open Win 95 in "safe" mode, and then it crashed utterly and completely. I was dead.

When I installed Win 95, I made a start-up disk, so I tried it; nothing happened. Finally, I found an MS-DOS 6 boot-up disk, installed enough CONFIG.SYS that the system would recognize my CD-ROM drive, and reinstalled Win 95 from scratch. It took a long time. First, Win 95 Setup ran a DOS SCANDISK program, and it found about 25 MB of what it thought were corrupted files; it also said there were "long filename" problems, but I'd have to run Windows SCANDISK to fix those.

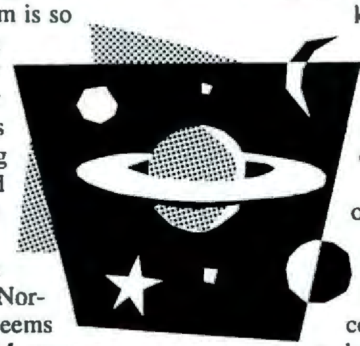
Eventually, DOS SCANDISK was done and Win 95 began to install. When it came up, it was in generic 640- by 480-pixel VGA mode and the network wouldn't work—but Norton Utilities was running. I had to reinstall all the network software. I also had to tell Control Panel I have a ViewSonic 17GA Monitor and reset my fonts. After each correction, I had to restart the computer, and I sure got sick of watching the Win 95 start-up screen.

Then Norton Utilities found all kinds of problems with my disk. Eventually it got done correcting them. I'm now back where I was 3 hours ago, except that I have Norton Utilities for Win 95 installed.

Installed but not running. I'm writing this in Q&A Write. That's a DOS program with a character-based text editor, and it's the editor I use for text creation. There's only one problem. It's jerky. That is, with Norton Utilities running, I can from time to time type most of a word before the first letters of the word appear on-screen. If I backspace, it may take a moment before the cursor moves.

It took about 3 minutes of that before I turned off Norton Utilities. That seems to have cured the jerkiness.

There are a lot of things I like about Win 95, but none of them is so great that I'll put up with a jerky text editor. I'd rather go back to Zeke under CP/M and an S-100-bus system! I make my living doing creative writing, and I don't need my computer adding distractions.



I suppose all's well that ends well. Win 95 with Norton Utilities turned off seems to be running smoothly. Moreover, the new build has fixed the problem I had with pasting into DOS Q&A under Win 95. The release version seems pretty clean. I do worry that a simple background process can make a DOS character-based editor jerky; what happens when we have a dozen threads running at once?

**Win 95 uses a new system called the registry** for keeping track of what Win 95–compliant programs do to your system, and its "remove programs" feature works fine. However, Win 95 does not do well at uninstalling older Windows programs. For that, you need Quarterdeck's new CleanSweep.

I've been using a test version, and it's useful, not only for uninstalling old stuff, but also for finding duplicate files. It's also safe, which is important. When you delete files, CleanSweep bundles them into a package, compresses them, and archives them where it can find them again.

For example, CleanSweep tries to find DLLs that are never called by any program. It then offers you a chance to delete them. In my case, the test version got rid of a few system DLLs that Win 95 needs. There was no harm done. CleanSweep keeps a log of everything it has done and will restore all or any of the archived files. I told it to restore my DLLs, and everything works again.

They're still working on CleanSweep, and they're implementing several suggestions I made. More when it comes out, but this looks to be, like Norton Utilities, one of the must-have Win 95 supplementary programs.

**I previously recommended Internet in a Box.** It has now ceased working, giving me the message "A2S4LWP.DLL The library is too old to use with this application." I don't know if the program has somehow expired or if it can't handle Win 95 upgrades. Attempts to contact Spry's technical support for the last three weeks via E-mail have been frustrating and useless. You have been warned.

**The CD-ROM of the month is Voyage to the Outer Planets** from NRSpace. NASA/JPL have accumulated a lot of data, but the formats make it hard to look at their pictures. NRSpace provides a viewer. You get two CD-ROMs of data and pictures of the planets, 2000 photos, and half an hour of video.

Grolier has come out with The 1995 Guinness Multimedia Disc of Records. It's more fun than just looking things up in the book. Want to see a picture of a woman with hair 14 feet long?

I mostly played old games this month. One thing I had fun with was Interactive Image Technologies' Electronic Workbench 4; this is an update of a program I've reviewed previously. When I was a kid, my dream was to have a box full of electronics components and a bucket of solder. This gives you the same thing, except that if you let the blue smoke out of a component, you can fix it on-screen. Build and test electronic circuits of amazing complexity. I wish I'd had this in high school, or college, or when I was at Boeing, for that matter.

The book of the month is Peter Magid and Ira Schneider's *OS/2 Warp Uncensored* (IDG Books, 1995). The title is meaningless, but the book is very complete. If you use or contemplate using OS/2, you'll find this valuable.

Now I'm off to Korea to be keynote speaker at a conference on the unity of the sciences, while Mrs. Pournelle gives a paper on the future of education. ■

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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, Jerry cannot guarantee a personal reply. You can also contact him on the Internet or BIX at jerryp@bix.com.*

## Product Information

**CD-Cabin with Link'N'Logging** ($99.95) is at least as good as anything else I've seen, and I expect to use it. Contact The Aldridge Co., Houston, TX, (800) 548-5019 or (713) 953-1940; 75462,2340@compuserve.com. **Circle 1246 on Inquiry Card.**

Even if all you want is eye candy, the **Corel Stock Photo Library 2** ($995) is wonderful. Contact Corel Corp., Ottawa, Ontario, Canada, (800) 772-6735 or (613) 728-3733; http://www.corel.com. **Circle 1247.**

The **Definitive Wargame Collection** (estimated street price, $34) is excellent, and any two of the games are worth the price of the whole thing. Contact Strategic Simulations, Inc., Sunnyvale, CA, (800) 245-4525 or (408) 737-6800. **Circle 1248.**

The **DeskPorte Fast 28.8 Modem** ($519) works pretty well. Contact Microcom, Inc., Norwood, MA, (800) 822-8224 or (617) 551-1000; http://www.microcom.com. **Circle 1249.**

**Electronics Workbench 4** ($299) lets you build and test electronic circuits of amazing complexity. Contact Interactive Image Technologies, Ltd., North Tonawanda, NY, (800) 263-5552 or (416) 977-5550; http://www.interactiv.com. **Circle 1250.**

The **LabelWriter SE200 Plus** ($499) is one of those gadgets that not everyone needs, but if you need it, you need it bad. Contact CoStar Corp., Greenwich, CT, (800) 426-7827 or (203) 661-9700. **Circle 1251.**

If you like great graphics with lots of action sequences and sound, the **LucasArts Archives Vol. I** (estimated street price, $29.95) is a pretty good collection. Contact LucasArts Entertainment Co., San Rafael, CA, (800) 782-7927 or (415) 472-3400; http://www.lucasarts.com. **Circle 1252.**

**The 1995 Guinness Multimedia Disc of Records** ($49.95) is more fun than just looking things up in the book. Contact Grolier Electronic Publishing, Inc., Danbury, CT, (800) 285-4534 or (203) 797-3530; http://www.grolier.com. **Circle 1253.**

The **3-D Model Library CD-ROM** ($19.95) is gorgeous. It's a lesson in just what is the state of the art in image modeling. Contact Viewpoint DataLabs International, Orem, UT, (800) 328-2738 or (801) 229-3000; http://www.viewpoint.com. **Circle 1254.**

The CD-ROM of the Month is **Voyage to the Outer Planets** ($49.95). Contact NRSpace, Seattle, WA, (800) 548-7766 or (206) 783-2707. **Circle 1255.**

PREVIEW PROCESSOR UPGRADES

## Intel Delivers a Better Pentium OverDrive

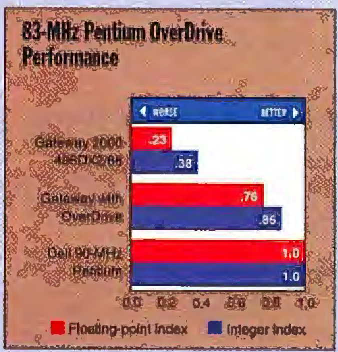
With a street price of approximately $400, Intel's first Pentium OverDrive chip, which was released earlier this year, offers a moderately appealing solution for upgrading your PC's processor from a 25-MHz 486 to a 63-MHz Pentium. The chip's design has compromises, however: It uses a 32-bit, 486-style I/O bus instead of a true Pentium 64-bit internal/external data pathway.


DENNIS WARNESKY © 1995

**Intel Corp.**
Santa Clara, CA
(800) 538-3373 or call your local Intel dealer
http://www.intel.com/procs/ovrdrive
**Circle 976 on Inquiry Card.**

The newest OverDrive still has the 32-bit I/O bus, but its lower price and higher performance make it a better bargain. BYTE's cross-platform BYTEmark CPU/FPU benchmark tests (see the figure below) on the new 5-V, 83-MHz Pentium OverDrive show that this upgrade chip will boost an Intel 66-MHz 486DX2 PC (or any other PC with a 33-MHz I/O bus and a #3 socket) up to performance levels that are slightly less than that of a 90-MHz Pentium. Intel expects the 83-MHz Pentium OverDrive to sell for about $270. (Intel is also lowering the price of the 63-MHz chip to under $300.)

Installing the chip is easy if your PC has a ZIF slot, such as the one in the Gateway 2000 486DX2/66 that we tested. You simply raise the latch, pull out the 486 chip, and plop in the OverDrive chip. As with the previous OverDrive, the 83-MHz version comes with a fan attached to the top of the chip (see the photo), as well as a program that monitors the fan. If the fan slows down or stops, the program generates an error message and the CPU throttles back its clock speed.




The 83-MHz Pentium OverDrive chip is an inexpensive and effective upgrade if you want to squeeze more power out of your PC instead of taking the plunge of purchasing a new system.

**—Dave Andrews**

### SIX-SPEED CD-ROM DRIVE

The SCSI Express CD6X (internal, $695; external, $875) offers a 900-KBps data transfer rate, an access speed of 145-ms random access, 115-ms random seek, and a 256-KB buffer. A variety of hardware configurations are available, ranging from single internal drives to one to four external drives in interlocking enclosures, seven-drive towers, and 28- and 49-drive cabinets with MDI's CD-ROM Extenders. Extenders are a bundled option allowing as many as 49 CD-ROM drives on a single host adapter in NetWare environments.

*Contact: Micro Design International, Winter Park, FL, (800) 228-0891 or (407) 677-8333; info@microdes.com.*

**Circle 993 on Inquiry Card.**

### ACCESS NETWARE LANS VIA ISDN LINES

The PacketBlaster/ISDN PRI ($9995) lets you connect remote sites over switched on-demand ISDN networks or a router-based backbone using ISDN. You can integrate up to 23 B channels in North America or 30 B channels in Europe, with simultaneous server-to-server and remote client–to–server dial-in access. The PacketBlaster/ISDN BRI ($5495; branch-level version, $3995) incorporates a four-port ISA-bus card that supports up to eight concurrent LAN or remote-user B-channel connections. The PacketBlaster ISDN cards provide MPR routing features such as IPX, TCP/IP, and AppleTalk routing; NLSP and Open Shortest Path First (OSPF) link-state routing; packet, service, route, and protocol filtering; data and header compression; synchronous and asynchronous PPP; and remote installation and configuration management.

*Contact: Eicon Technology, Dallas, TX, (800) 803-4266 or (214) 239-3270; http://www.eicon.com.*

**Circle 981 on Inquiry Card.**

### PENTIUM MOTHERBOARD WITH PCI FAST AND WIDE SCSI

Available in three models—the P54TS (fast SCSI) ($495), P54TSW (wide SCSI) ($565), and P54TSW2 (ultra-wide SCSI) ($635)—the P54TS Pentium PCI motherboard features 128 MB of memory; 75- to 200-MHz processor speeds; five ISA and three PCI expansion slots; and 256 to 512 KB of cache. The P54TS supports EDO/burst EDO DRAM, COAST (for "cache on a stick"), pipelined burst synchronous cache SRAM, two high-speed 16550 UARTs, PS/2 mice, two IDE channels with Bus Master/DMA, and EPP and ECP IEEE 1284 printers.

*Contact: Quick Technology, Tustin, CA, (800) 950-8999 or (714) 258-4500.*

**Circle 986 on Inquiry Card.**

### PENTIUM NOTEBOOK WITH CD-ROM ▼

Based on Intel's 75-, 90-, or 100-MHz Pentium CPU, the 7.1-pound PowerCD features an 800- by 600-pixel or 640- by 480-pixel 9½-, 10.4-, or 11.3-inch dual-scan color or active-matrix color display; a CD-ROM drive; a 3½-inch floppy drive; a center-based TouchPad; a PCI local bus; a microphone and stereo speakers; and a PC Card Type III slot. The PowerCD's ($3550 to $5900) options include an MPEG playback module, a video-capture module, and an internal 14.4/14.4 fax modem. You can upgrade the 8 MB of RAM to 16 or 40 MB, the double-speed CD-ROM drive to triple- or quad-speed, and the 340-MB hard drive to 1 GB.

*Contact: Associates Mega Sub-System, Irwindale, CA, (818) 814-8851.*

**Circle 988 on Inquiry Card.**

## ALPHA WORKSTATIONS

**Powered by a 266- or 300-MHz Alpha 21164 RISC microprocessor, the AlphaStation 600 Models 5/266 and 5/300 can process more than 1 billion instructions per second. The Model 5/266 includes 32 MB of ECC RAM; 2 MB of cache; a 1-GB hard drive; a quad-speed CD-ROM drive; a 3½-inch floppy drive; a 17-inch color monitor; ZLXp-E1 graphics; an audio card; a headset; a microphone; a keyboard mouse; and Windows NT, Digital Unix, or OpenVMS ($29,300 to $31,800). The AlphaStation Model 600 5/300 ($44,995) adds 64 MB of ECC RAM, 4 MB of cache, and a 21-inch monitor to the Model 5/266's configuration. Multimedia enhancements include programming interfaces, video-capture boards, speech-recognition software, and collaborative computing software.**

*Contact: Digital Equipment, Maynard, MA, (800) 344-4825; http://www.digital.com/info/alphastation.*

**Circle 977 on Inquiry Card.**

## ADD SEVEN 32-BIT PCI SLOTS

With the Model 2102 PCI Expansion Unit ($995), you can transparently add seven 32-bit PCI slots to a host computer. The unit supports throughput to 132 MBps and zero-wait-state burst operations. The mini-tower-style cabinet contains an eight-slot PCI motherboard, a PCI backplane controller card that plugs into one of the eight backplane slots, expansion bays for three 3½-inch and two 5¼-inch peripherals, a 250-W power supply, and a 115-/230-V input line-voltage switch.

*Contact: Bit 3 Computer, Minneapolis, MN, (612) 881-6955; info@bit3.com.*

**Circle 979 on Inquiry Card.**

## ALPHA-BASED WORKSTATION

Based on Digital Equipment's 21064A Alpha processor, a fully configured Telluride Power Workstation ($9994 to $14,607) includes a 200- or 275-MHz Alpha 21064A CPU; 2 MB of secondary cache, upgradable to 8 MB; a double-speed CD-ROM drive; a 1-GB fast SCSI-2 hard drive; a PCI fast SCSI-2 drive controller; 32 MB of DRAM, upgradable to 1 GB; a 4-MB PCI video adapter; 1 MB of flash ROM; a 17-inch, 85-kHz monitor; a high-speed Ethernet PCI combo adapter; a 3½-inch 1.44-MB floppy drive; a full-size tower case; a Keytronics AT keyboard; and a Microsoft PS/2 mouse. The workstation comes with six dedicated PCI slots (three full-length), one dedicated ISA slot, and one PCI/ISA shared slot. Two high-speed serial connectors and one high-speed bidirectional parallel port are included, along with a dedicated serial port for remote diagnostics and maintenance. The Telluride Power Workstation supports Windows NT Workstation, Windows NT Server, Digital Unix, and Digital OpenVMS and is also available as a fully redundant, hot-swappable RAID 5 client/server.

*Contact: Aspen Systems, Wheat Ridge, CO, (303) 431-4606; http://www.aspsys.com.*

**Circle 1000 on Inquiry Card.**

## 30-BIT SINGLE-PASS FLATBED SCANNER

The high-performance 30-bit Z1-600 scanner can distinguish more than 1 billion colors and 1024 shades of gray and, with a maximum of 2400 dpi (300- by 600-dpi optical resolution), hold fine line tolerances and provide razor-sharp details for clearer images. The scanner features an 8½- by 11-inch scanning size combined with dark correction, dark point, white point, histogram display, and automatic threshold control. Also, the Z1-600 ($699) is available with an optional transparency adapter for slides, transparencies, and negatives, plus an optional automatic document feeder.

*Contact: Tamarack Technologies, Orange, CA, (714) 744-3979.*

**Circle 994 on Inquiry Card.**

## TWO-LINE VOICE/DATA/FAX/AUDIO SYSTEM

A two-line voice/data/fax and 16-bit audio system, the VoicePro+2 ($329) includes a 14.4-Kbps fax/data modem, dual-line voice-mail, fax-message forwarding, auto-paging, a speakerphone, an external fax switcher, music on hold from internal or external audio sources, and caller ID with four message formats. VoicePro+2 also provides local voice recording and playback for both lines; voice/fax message remote retrieval and delivery; 1000 user-defined voice/fax mailboxes; fax-on-demand/fax back on both lines; and page/hold/park/transfer calls. The fax/data modem includes V.32bis and V.17 with CCITT V.29, V.27ter, and V.21 ch2; automatic voice/data/fax recognition; V.42 and MNP 2 through 4 error correction; data compression in V.42bis and MNP 5; and Group 3 fax support.

*Contact: Teledapter Systems, San Marcos, TX, (800) 997-7762 or (512) 392-6600; 74011.2572@compuserve.com.*

**Circle 983 on Inquiry Card.**

## POWER FOR 3-D, IMAGING ▾

The Indigo² Impact workstations' graphics subsystem generates 100 million trilinear interpolations per second and provides texture mapping, volume rendering, HDTV resolution, and digital media features. Base configurations include 64 MB of memory, a 2-GB hard drive, 2 MB of cache, and a 19-inch monitor with 1280- by 1024-pixel resolution. Models include the Indigo² High Impact, which is available with a 200- or 250-MHz Mips R4400 microprocessor ($35,000 and $40,000, respectively); the Indigo² Maximum Impact, which has a 250-MHz Mips R4400 microprocessor ($51,000); and the Power Indigo² Maximum Impact, which has a 75-MHz R8000 microprocessor ($60,000).


*Contact: Silicon Graphics, Mountain View, CA, (800) 800-7441 or (415) 960-1980; http://www.sgi.com/Products/Indigo2/IMPACT.*

**Circle 982 on Inquiry Card.**

# WHAT'S NEW Hardware

## MULTIMEDIA PENTIUM NOTEBOOK ▲

The 6½-pound SENS800 ($2799 to $3799) comes with an Intel 75-MHz P54LM CPU (upgradable to 90 MHz); 8 MB of RAM (expandable to 40 MB via 8-, 16-, or 32-MB memory cards); a 10.4-inch DSTN or TFT color screen with a resolution of 640 by 480 pixels; a microphone and speakers; a 340-MB to 1-GB removable hard drive; a 3½-inch floppy drive; one PC Card Type II slot; one PC Card Type III slot; an 84-key AT-compatible keyboard; an Internal Tracking Ball; 1 MB of video memory; 16-bit stereo sound; local-bus video; and Microsoft Windows Sound System compatibility. Samsung's Power Management System provides up to 4 hours of mobile-computing time and includes such functions as hibernation mode, Smart sleep, suspend/resume, battery-charge control, and a low-battery alarm. Options include a multimedia docking station with a built-in CD-ROM drive ($599).

*Contact: Samsung Electronics America, Ridgefield Park, NJ, (800) 316-9914 or (201) 229-4000.*

**Circle 987 on Inquiry Card.**

## QUAD-SPEED MULTIMEDIA KIT

The MPC3-compliant Diamond Power Kit 7000 ($399) combines a 16-bit Wavetable Diamond sound card, a quad-speed CD-ROM drive, speakers, an ergonomic joystick, a microphone, and 22 entertainment and reference titles. The sound card uses advanced data-compression technology to fit 2 MB of prerecorded audio samples into 1 MB of memory. The Photo CD– and Multisession XA–compatible CD-ROM drive transfers data at 600 KBps with an access time of 240 ms and a buffer size of 128 KB. The amplified 15-W-per-channel speakers offer separate volume, bass, and treble controls.

*Contact: Diamond Multimedia Systems, San Jose, CA, (800) 468-5846 or (408) 325-7000; http://www.diamondmm.com.*

**Circle 984 on Inquiry Card.**

## UPGRADE YOUR SPARCSTATION

You can increase the performance of your SparcStation 10, SparcStation 20, and SparcServer 630/670/690 machines to 90- or 125-MHz performance. Available in single-, dual-, and quad-processor configurations, the HyperSparc CPU upgrades (90-MHz, from $3918; 125-MHz, from $6758) offer high-performance symmetric multiprocessing on a standard MBus CPU module. The company also offers a 110-MHz processor (from $10,272) with 1 MB of onboard cache.

*Contact: Ross Technology, Austin, TX, (800) 774-7677 or (512) 892-7802; http://www.ross.com.*

**Circle 980 on Inquiry Card.**

## FULL-SCREEN VIDEO PLAYBACK

A 64-bit DRAM card, the Paradise Pipeline 64 (from $169) accelerates 8-, 16-, and 24-bit color depths at resolutions of up to 1600 by 1200 pixels. Available for the PCI and VL-Bus with up to a 4-MB DRAM frame buffer, the card features Western Digital's RocketChip WD9710 graphics and motion-video accelerator. This accelerator combines a high-performance RAMDAC, a programmable clock, a VGA core, a graphics engine, and a motion-video engine with built-in logic for YUV-to-RGB color-space conversion, horizontal and vertical scaling and interpolation, and shared frame-buffer control.

*Contact: Western Digital, Irvine, CA, (714) 932-5000; http://www.wdc.com.*

**Circle 989 on Inquiry Card.**

## V.34 MODEMS ▲

Four V.34 fax modems, which are available in external and internal configurations, offer ITU-TSS V.34, for connect speeds up to 28.8 Kbps, and V.42bis and MNP 5 data compression, to allow throughout up to 115.2 Kbps. Performance and accuracy are provided through V.42 (MNP 2 through 4; LAP-M) and MNP 10 error correction. The Fax and Fax II lines support V.34, V.FC, V.32bis, V.32, V.22bis, V.22, V.21, and Bell 212A and 103 standards, as well as the fax standards of V.17, V.29, V.27ter, and V.21. Models include the EC288Fax external modem ($449), PCM288Fax internal modem ($399), EC288Fax II external modem ($549), and the PCM288Fax II internal modem ($499). The Fax II modems offer a system security feature, which restricts the unauthorized access of confidential data or the uploading of damaging files, and Ven-Tel's proprietary Remote Options Access and Downloading, which enables access and reconfiguration of the Fax II modems from any location.

*Contact: Ven-Tel, San Jose, CA, (800) 538-5121 or (408) 436-7400.*

**Circle 995 on Inquiry Card.**

## TWO-WAY WIRELESS PC CARD MODEM

**Designed for use with the ARDIS wireless data communications network, which provides dual 4.8-/19.2-Kbps operation, the Personal Messenger 100D (about $700 to $750) PC Card modem for Type II and III slots lets you send and receive E-mail from your office network or the Internet, send faxes, and access corporate databases. Depending on the application, the battery-powered modem card can continue to receive and store messages even when it's not connected to your portable computer.**

*Contact: Motorola Wireless Data Group, Schaumburg, IL, (800) 894-7353; http://www.mot.com/wdg/.*

**Circle 978 on Inquiry Card.**


BYTE
WEARHOUSE
Celebrate BYTE's 20th Anniversary with Special Limited Edition Merchandise
All products are officially approved by BYTE.
BYTE 20 Years 1975-1995
BASEBALL CAP
Soft brushed cotton free-form cap with adjustable Velcro closure back. Black. (BYT 11) $10.00
MUG
11oz. ceramic mug with logo on both sides. (BYT 8) $4.50
MOCK TURTLENECK
Outer Banks 100% cotton mock turtleneck. White. Sizes M(BYT 4), L(BYT 5), XL(BYT 6). $26.00
INSIGNIA PEN
Parker Insignia ball point pen. Lacquer black. (BYT 9) $34.50
SWEATSHIRT
11 oz. cross grain Lee sweatshirt features generous athletic cut and side gussets. 95% cotton, 5% polyester. Ash. Sizes M(BYT 1), L(BYT 2), XL(BYT 3). $31.00
COMPUTER TOOL KIT
Deluxe computer device tool kit in black vinyl zipper case features: 2 nut drivers, 3-prong parts retriever, torx driver, IC extractor, 1 phillips and two slotted screwdrivers. (BYT 12) $20.00
MOUSE PAD
Hard top mouse pad. 7.5"x 8.5". (BYT 7) $5.25
VECTOR PEN
Parker Vector Sport roller ball pen. Black. (BYT 10) $6.25
T-SHIRT
100% cotton Oneita Power-T. White. Sizes L(BYT 13), XL(BYT 14). $8.00
HA-LO
Call 1-800-676-4256
or 1-708-647-4906 in Illinois, 8:30 a.m.-5:00 p.m. Central Time.
We accept VISA, MasterCard, American Express, and Discover.
Merchandise in stock will ship within 3 days of receipt. HA-LO notifies customers of out-of-stock items and gives the option to back order, substitute, or cancel the item. Sales tax additional where applicable. UPS ground shipping on domestic orders: up to $50 - add $5.75, $50 to $100 - add $7.75, over $100 - add 8%. Additional shipping charges apply to international orders.

**PREVIEW** FREE-FORM TEXT DATABASES

## askSam Gets Faster and Fuzzier

Version 3.0 of askSam for Windows adds numerous features that should appeal to those who publish electronic directories, policy manuals, instruction books, and other text-based products. Highlights of version 3.0, which is primarily a 16-bit Windows application but also runs under 32-bit Windows, include faster searching, support for fuzzy searching, and the ability to import graphics images in a variety of formats (see the screen). For downloading documents from the Internet, askSam 3.0 lets you import, create, and export documents in the HTML format used on the World Wide Web.

**askSam 3.0 for Windows**
Standard version (without full-text indexing), $149; Professional version (with indexing), $295; version with freely distributable run-time readers, $1495.

askSam Systems
Perry, FL
(800) 800-1997
(904) 584-6590
http://www.asksam.com/asksam.htm
**Circle 1001 on Inquiry Card.**

Version 3.0's support for full-text indexing greatly improves its search capabilities in databases of several hundred megabytes: Searching a 500-MB indexed file, for example, now takes about a second. Also, support for fuzzy searching lets you locate information when you're unsure of the spelling. For example, I used a fuzzy search to find several documents in an electronic archive of BYTE articles with only the approximate spelling of the author's last name.

askSam lets you define data-entry forms, so end users can rapidly summarize documents they add to a database. To simplify the entry of data into a document database, askSam 3.0 supports pick lists. For example, when you're filling in an author-name field, you can pick a name from a pick list instead of typing it in.

Once you've created an electronic book, you can generate a variety of reports (e.g., all documents created by a specific author). Because askSam is not a relational database, you can't directly generate a report that summarizes information from several electronic books (e.g., all documents created by an author in both the accounting manual and the ethics manual).

But with the program's ability to generate hypertext links across files, you can create an electronic table of contents for navigating through numerous document databases. The full-text indexing should make askSam 3.0 for Windows a stronger product for corporations wishing to create 100-MB or larger electronic books.

—**Dave Andrews**

### BUILD A DATABASE IN YOUR OWN LANGUAGE

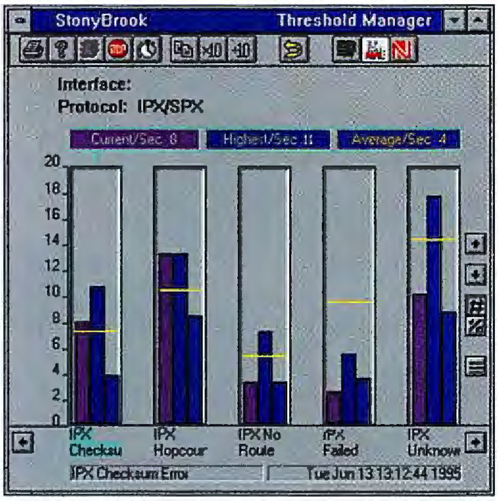
With Salsa software ($149; with starter kit, $189), you describe the things you want to track using simple drag-and-drop templates, menus, and buttons, and the program does the rest. You can use your own words, or words specific to your business, to identify a semantic object and each of its characteristics. The software automatically prompts you when it needs more information and provides simple screens for you to input it. With one keystroke, Salsa automatically produces database tables, menus, forms, and reports, and it packages them in an application with its own icon on the Windows desktop.

*Contact: Wall Data, Seattle, WA, (800) 987-2572 or (206) 442-9257.*
**Circle 1004 on Inquiry Card.**

### MANAGE ROUTERS, BRIDGES, AND SWITCHES ON WANS ▼

An SNMP-based application, RouterManager/AutoBahn (from $1995) provides network management capabilities for multivendor, multiprotocol WANs. The program automates the network-monitoring and data-collection process by monitoring critical network information on an ongoing basis, as well as in the background. With RouterManager/AutoBahn, you can manage your WANs from Windows or any major Windows- or NT-based platforms.

The ConfigurationManager manages router configurations from a central location on a domain or global basis; AlarmManager continuously monitors the status of each router and generates an alarm whenever any errors are found or when user-defined thresholds are crossed. SecurityControl allows the administrator to limit access to RouterManager/AutoBahn features to select individuals or groups; PathFinder pinpoints the problem areas when connectivity is lost between sites or when links are congested; and FlashManager supplies a directory of all the software images that are stored on the routers.




*Contact: StonyBrook Software, Bohemia, NY, (516) 567-6060; sales@sbrook.mhs.compuserve.com.*
**Circle 1012 on Inquiry Card.**

### CIRCUIT SIMULATION INSIDE MICROSOFT EXCEL

Spectre/XL embeds circuit simulation inside Microsoft Excel, so you can evaluate, develop, and optimize circuit designs. As with other Excel functions, you can combine Spectre/XL functions in formulas, use them in design calculations, organize them into tables, or chart them. From within Excel, you embed a circuit object with a SPICE-like description onto a worksheet. You then set up links between the worksheet cells and component values in the circuit. Changing the cell value—by hand, by formula, or by programming—automatically changes the circuit value. Spectre/XL ($695) returns DC, AC, or nonlinear frequency responses and lets you use Excel's built-in Goal Seek and Solver optimizing functions to improve designs.

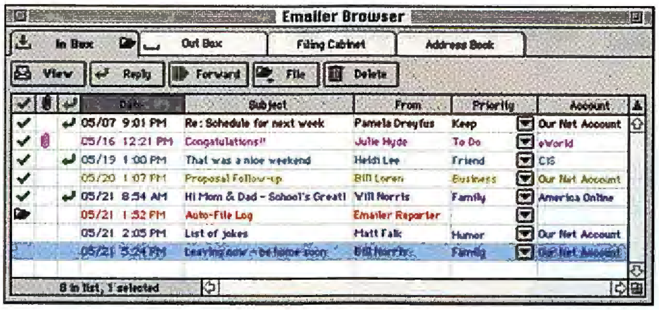
*Contact: Avista Design Systems, Folsom, CA, (800) 985-6080 or (916) 985-6080; http://www.avista.com/avista.*
**Circle 1011 on Inquiry Card.**

## AUTOMATE E-MAIL ▶ ON YOUR MAC

Whether you subscribe to an Internet service or to America Online, CompuServe, eWorld, or RadioMail, Claris Emailer lets you send, receive, reply, forward, and store E-mail messages and files. An address book of E-mail addresses can store multiple E-mail addresses for individuals, as well as group addresses, so you can send the same message to multiple recipients with a single command. The text editor lets you easily create outgoing messages and attach files from your hard disk or network. Claris Emailer ($89) supports file-compression formats such as RinHex, uuencode, Base 64, and MIME.

*Contact: Claris, Santa Clara, CA, (800) 544-8554 or (408) 987-7000; http://www.claris.com.*

**Circle 1007 on Inquiry Card.**




## OS/2 AND UNIX DICTIONARY

The American Heritage Dictionary and Roget's II Thesaurus Deluxe Edition for OS/2 and Unix ($59.95) is a package that provides an up-to-date dictionary with full definitions, parts of speech, pronunciations, abbreviations, and sample sentences for more than 200,000 words. In addition, the electronic thesaurus has more than 500,000 synonyms, word senses, and meanings. The product works within applications such as word processors, spreadsheets, databases, and even E-mail. Available in single and multiuser LAN versions, the package is also available in international versions.

*Contact: Dux Software, Palo Alto, CA, (800) 543-4999 or (415) 473-1800; http://www.rivendell.com/dux.*

**Circle 1013 on Inquiry Card.**

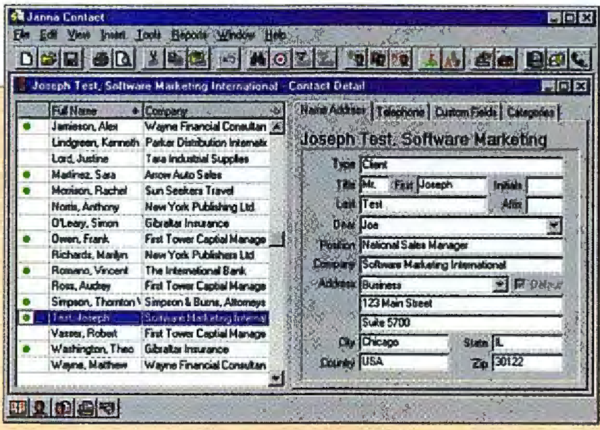
## PCB LAYOUT FOR WINDOWS 3.1

WinBoard 2.0 ($995; with WinDraft schematics, $1495) includes placement tools for *x,y* placement and Place File; enhanced editing, including the ability to edit net characteristics; select or exclude layers for routing and via placement; more than 400 new SMT footprints, including the complete IPC-SM-782 library; and improved memory management. With the Online Graphical Editor, you can create custom modules or edit existing modules on-line. WinBoard's Pad Stack Editor lets you create any number of user-definable pad shapes per layer, and Update Netlist lets you forward annotations from the schematic. A Module De-Compiler provides library source code, so you can make ASCII edits to the library files; the T-Tracks feature lets you move or drag adjoining track segments.

*Contact: Ivex Design International, Beaverton, OR, (503) 531-3555; http://www.ivex.com.*

**Circle 1006 on Inquiry Card.**

## MANAGE CONTACTS AND DOCUMENTS IN WINDOWS 95




**Janna Contact 95 (US$99) provides contact, document, and time management; communications; and a multimedia database. You can store documents, including letters, faxes, spreadsheets, presentations, and even voice notes and full-motion videos, along with your contacts. Contact management features include name, company, address, phone, and fax numbers; unlimited addresses, custom fields, and categories; and unlimited date-stamped text notes. Communications features let you send personalized letters to contacts, send and receive E-mail with Microsoft Exchange, and send and receive faxes with Microsoft Fax at Work. With OLE 2.0 support and the multimedia database, you can import data into the Microsoft Access 95 database.**

*Contact: Janna Systems, Toronto, Ontario, Canada, (800) 268-6107 or (416) 483-7711; info@janna.com.*

**Circle 1002 on Inquiry Card.**

## Software Update

**StorageManager 4.0,** backup and storage management for NetWare 3.x and 4.x servers, combines the backup capabilities of Backup Director 4.0, the automated archiving and media management of The Network Archivist, and rules-based Hierarchical Storage Management software. The program prevents, detects, and automatically recovers from system, user, hardware, or media failure. Single-server networks of up to 25 users, $995; single server with unlimited user support, $1995; multiserver with unlimited users, $3595.

*Contact: Palindrome, Naperville, IL, (800) 288-4912 or (708) 505-3300; http://www.palindrome.com.*

**Circle 1018 on Inquiry Card.**

A desktop organizer, **DragStrip 2.0** includes extensive AppleScript support; new options for icon and button styles, custom fonts, colors, and labeling; options for renaming items and editing pop-up document lists; support for Control Strip modules; the ability to apply labels and colors on a per-strip basis; and Bali, a program that lets you cancel accidental application launches with a single click. $59.95.

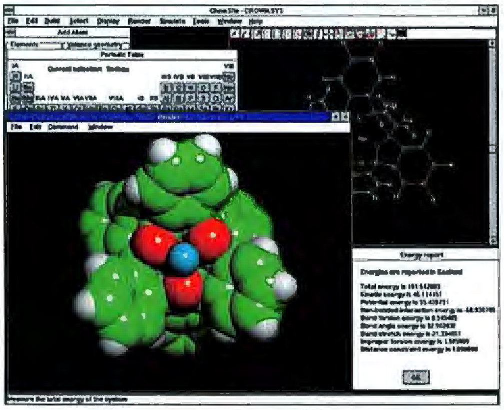
*Contact: Natural Intelligence, Cambridge, MA, (800) 999-4649 or (617) 876-4876; http://www.natural.com/.*

**Circle 1022 on Inquiry Card.**

**NetTools 5.3,** Windows desktop-configuration management, incorporates HelpPlus, an ODBC-compliant trouble-ticket generator that helps you identify improperly set or altered desktop-configuration files and supports Adobe PostScript printer drivers. Two-year subscription fee for NetWare and NT Server, $32 per node for 50 nodes to $19.50 per node for 1000 licenses.

*Contact: McAfee, Santa Clara, CA, (408) 988-3832; http://www.mcafee.com.*

**Circle 1020 on Inquiry Card.**



## MOLECULAR VISUALIZER ▲

ChemSite for Windows ($99) is a molecular visualizer for building, displaying, and simulating the dynamic behavior of chemical structures, which you can then incorporate into presentations, lectures, and laboratory studies. Built-in rules of chemistry prevent you from creating structures that are chemically impossible, or you can simply deactivate them to construct any configuration of atoms. ChemSite also reads and writes data files from other molecular-modeling and chemical-drawing programs, allows you to transport structures directly into programs that support the Windows Clipboard or BMP files, and renders collections of spheres, balls and sticks, Bézier curves, and molecular orbitals.

*Contact: Pyramid Learning, San Jose, CA, (800) 610-2436 or (415) 323-4907; pyramid @netcom.com.*

**Circle 1010 on Inquiry Card.**

## DATA RECOVERY FOR DOS AND WINDOWS

Rescue ($99) can recover data from crashed floppy disks and hard drives, even those with corrupted or deleted primary partitions, in as little as 60 seconds, according to AllMicro. The program automatically recovers virtually any DOS or Windows file, including EXE, application, compressed, deleted, binary, and graphics files; works on compressed drives and deleted files; includes antivirus features that detect and eliminate more than 5000 viruses and immunize your files from further infections; and automatically backs up your files.

*Contact: AllMicro, Clearwater, FL, (800) 653-4933 or (813) 539-7283; allmicro@ix .netcom.com.*

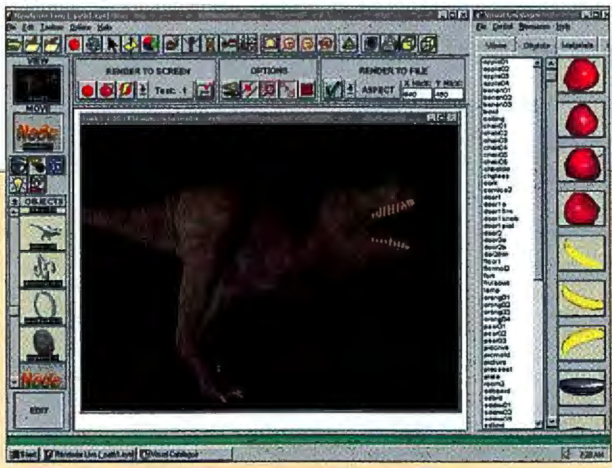
**Circle 1008 on Inquiry Card.**

## FIREWALL FOR NOTEBOOKS

EagleNomad ($99) addresses the security needs of mobile PC users by establishing a private "tunnel" between two systems, allowing users transparent, secure communication to authorized destinations in the enterprise. Another version of the product, EagleDesk ($99), protects workgroup PCs within the enterprise.

*Contact: Raptor Systems, Waltham, MA, (617) 487-7700; http://www.raptor.com.*

**Circle 1014 on Inquiry Card.**



## 3-D GRAPHICS AND ANIMATION

**Now artists, designers, and multimedia developers can work in 3-D with Visual Reality 2.0 for Windows ($259). The package, which consists of four modules—RenderizeLive, Visual Model, Visual Font, and Visual Image—lets you drag and drop objects, materials, and images between applications. RenderizeLive, a 3-D rendering and animation tool, lets you combine input from other Visual Reality 2.0 modules and images to create full-color, high-resolution, photo-realistic renderings. Visual Model lets you create 3-D models, Visual Font transforms TrueType fonts into 3-D words, and Visual Image lets you combine or collage photos and images and then perform multilayer image-processing and enhancement procedures. Visual Reality 2.0 also includes push/pull, melt, stretch, twist, and band tools; enhanced free-form modeling; key-frame object and camera animation; the ability to drag and drop 3-D data from Visual Catalog, a 3-D data module; solid-shaded modeling; 3-D Boolean operations; organic deformations; and 3-D morphing between objects.**

*Contact: Visual Software, Woodland Hills, CA, (800) 669-7318 or (818) 883-7900.*

**Circle 1003 on Inquiry Card.**

## Software Update

A query tool for AS/400 data access, **ShowCase Vista 3.1** lets you import Query/400 and SQL/400 objects; manage and control query jobs by assigning which batch subsystem a job can run in, and at what priority; and test queries in a controlled environment before handing them over to end users. Other features include OS/400 V3R1 compatibility and improved data-viewer capabilities. Single-user license, $1500.

*Contact: ShowCase, Rochester, MN, (800) 829-3555 or (507) 288-5922; http://www bismark.com/showcase.*

**Circle 1021 on Inquiry Card.**

Software that lets you run Lotus SmartSuite, Microsoft Office, and other Windows applications on Solaris, **Wabi 2.1** includes multimedia support and ODBC support, which lets you access databases such as Oracle and Sybase from your Windows productivity databases. An X Window System client application, Wabi can run in a client/server configuration, residing on one system (a server) and displaying on others (clients). Wabi 2.1 is available in French, Japanese, Italian, German, Spanish, and Swedish versions. $225.

*Contact: SunSoft, Mountain View, CA, (800) 786-7638 or (512) 434-1511; http://www .-sun.com/sunsoft/Products/ PC-Integration-products.*

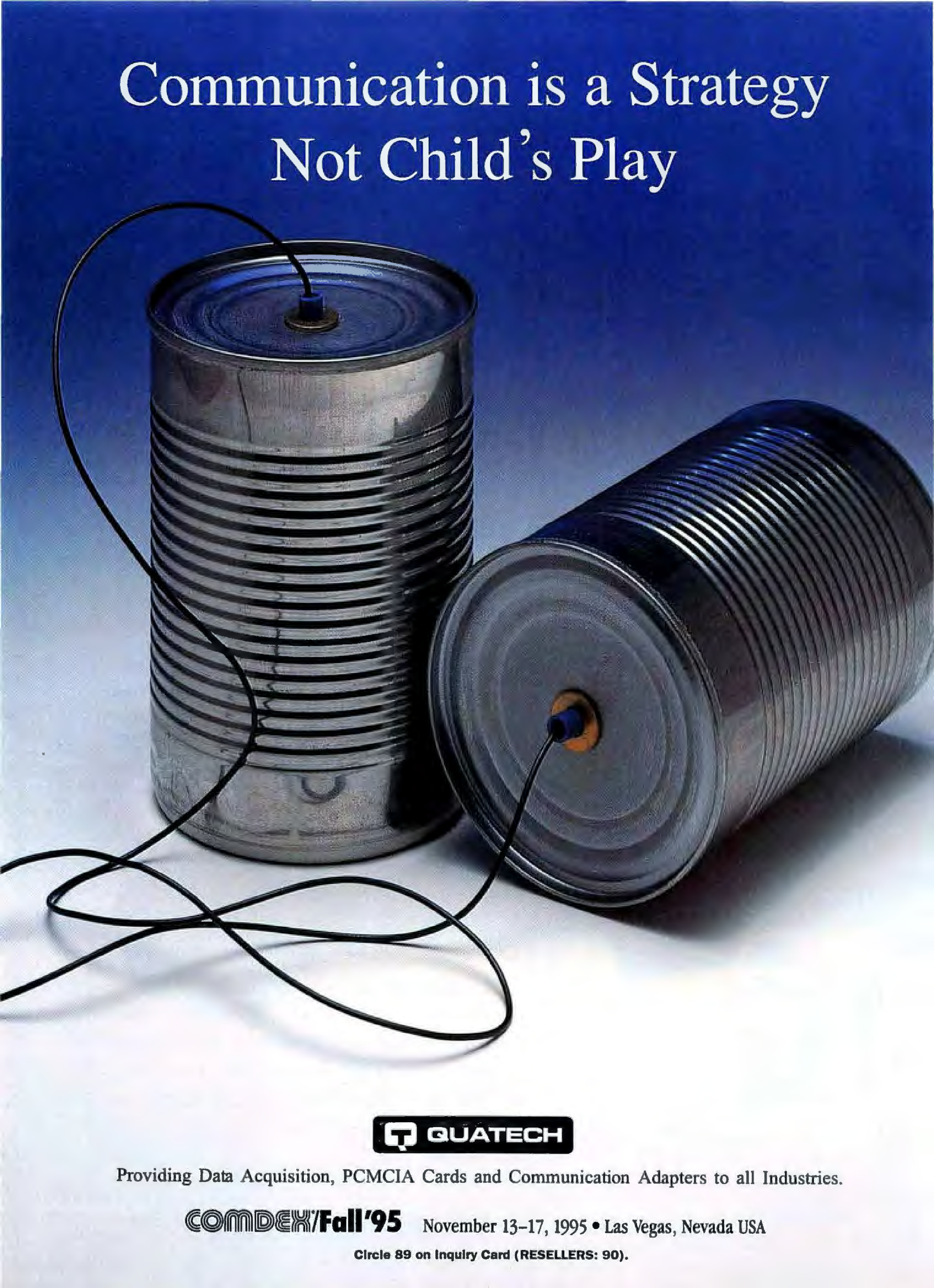
**Circle 1019 on Inquiry Card.**

A Unix-based, multifunctional, network-ready package, **OnContact Enterprise 3.53** adds enhanced security, new scheduling methods, setup features, fax integration, upgraded merging capabilities, and advanced printing functionality. $1095 per user.

*Contact: Software Development Group, Cedarburg, WI, (800) 886-0866 or (414) 375-6555.*

**Circle 1023 on Inquiry Card.**


"I oversee a
$24 million
budget and support
2400 users.
Every month
BYTE
helps me
evaluate
products & technologies that keep
Lincoln National Life
ahead of the
technology/productivity
curve."
Name: Skip Carstensen
Title: VP Product Administration Systems
Company: Lincoln National Life Insurance Company
Annual IT Budget: $24 million
BYTE Reader: 9+ years
BYTE
First PowerPCs
Apple's Power Macintosh and IBM's Power Personal Systems
CPU Wars
Intel pushes the 80x86 envelope
BYTE readers set the agenda for corporate Information Technology purchases. Their recommendations can take your products to the top – or leave them at the door. Why? Because BYTE readers are the *technology experts*. They define the short list. They specify brands. They tell the buyers what to buy.
Want to get your product in front of Skip? Advertise in BYTE. And reach more than a half-million technology experts who drive the IT buy.
BYTE Because the *Experts* Decide.
See for Yourself: To find out more about the buying power of BYTE readers, call 603-924-2618 and ask to see our *Information Technology Buying Process* video.
BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.


Communication is a Strategy
Not Child's Play
QUATECH
Providing Data Acquisition, PCMCIA Cards and Communication Adapters to all Industries.
COMDEX/Fall'95 November 13–17, 1995 • Las Vegas, Nevada USA
Circle 89 on Inquiry Card (RESELLERS: 90).


# BYTE

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**JAMECO** ELECTRONIC COMPONENTS COMPUTER PRODUCTS

# Your One Stop Component & Computer Source

**Products highlighted in yellow offer special pricing for BYTE readers only! Take advantage of these outstanding values by mentioning VIP NB5 when you call today to place your order.**

## Jameco 486SLC2 66MHz Bare-bones System

Includes motherboard, computer case and power supply. Monitor and keyboard not included.

- IBM 486SLC2-66 CPU
- Supports optional 80387SX-33 math-coprocessor
- Memory expandable to 16MB using (70ns) SIMMs
- Seven 16-bit with two 32-bit (VESA local bus) slot extensions and one 8-bit slot • AMI BIOS

121208 486SLC2 66MHz....................$279.95

## Jameco Motherboards

- Some motherboards also available without CPU. Call for details
- Diagnostic and operating system software available
- One-year warranty

79214

115941 80386SX 40MHz w/ CPU............$89.95
117481 80386DX 40MHz w/ CPU............129.95
79214 80486SX 25MHz w/ CPU............179.95
116118 80486SLC 66MHz w/ CPU..........219.95
95222 80486DX 33MHz w/ CPU............249.95
95169* 80486DX w/o CPU....................139.95
119731 486DX2 66MHz Motherboard........329.95
124652 Pentium 75MHz Motherboard........499.95
124644 Pentium 75/90/100MHz w/o CPU...299.95
*Applicable w/ DX2-66/50 or DX33/40/50

## Dynamic RAM

**DIPs**

| Part No. | Product No. | Pins | Description | Price |
|---|---|---|---|---|
| 41620 | 4164-100 | 16 | 64KB x 1 100ns | $1.39 |
| 41435 | 41256-60 | 16 | 256KB x 1 60ns | 2.39 |
| 41443 | 41256-80 | 16 | 256KB x 1 80ns | 2.19 |
| 41371 | 41256-100 | 16 | 256KB x 1 100ns | 1.79 |
| 42243 | 511000P-70 | 18 | 1MB x 1 70ns | 6.29 |
| 42251 | 511000P-80 | 18 | 1MB x 1 80ns | 6.19 |

**SIMMs**

| Part No. | Product No. | Description | Price |
|---|---|---|---|
| 53701 | 94000S-70 | 4MB x 9 70ns | $169.95 |
| 53719 | 94000S-80 | 4MB x 9 80ns | 164.95 |
| 41486 | 41256A9B-10 | 256KB x 9 100ns | 8.95 |
| 41507 | 41256A9B-60 | 256KB x 9 60ns | 14.49 |
| 41515 | 41256A9B-70 | 256KB x 9 70ns | 14.25 |
| 41523 | 41256A9B-80 | 256KB x 9 80ns | 13.75 |
| 41769 | 421000A9B-80 | 1MB x 9 80ns | 44.95 |

## IDE Hard Drives

- For laptops and standard cases

119087 7120AI 120MB 3.5"................$129.95
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## Floppy Disk Drives

- PC/XT/AT compatible
- P/N 120045 includes mounting kit & faceplate for use in 5.25" floppy disk drive bays

118957

120045 Sony 1.44 MB 3.5"......................$44.95
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- 8088/80286/80386 and compatible
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- Built-in fan

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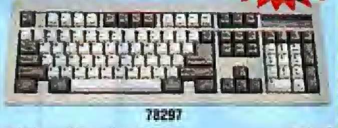
101-key as low as $19.95



78297

20431 84-key keyboard............................$19.95
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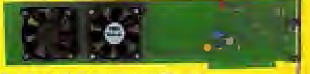

SPECIAL

- Can be installed into any PC slot
- MTBF: 30,000 hours
- Circulates air directly
- CFM: 25 • One-year warranty

79020 TSM Fancard II...............................$19.95

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- Connects to card slot (non electrically)
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- Hayes compatible
- FCC class B, part 68 certified
- Weight: 2 lbs.
- One-year warranty

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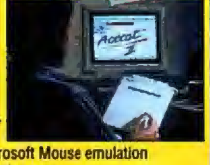
SPECIAL



- For use with PC/XT/AT and compatibles with MS DOS, MS Windows 3.x, Pen DOS or Pen Point
- Includes 2-button, feather-light pen
- MM1201 and Microsoft Mouse emulation
- Compact 5" x 5" active area
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124960 Combo CD-ROM & floppy drive...$279.95

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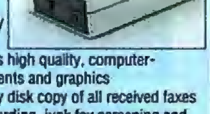

- Turns your computer printer into an intelligent, plain paper fax machine
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- Includes fax forwarding, junk fax screening and scheduled transmission • Weight: 5.5 lbs.

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- Plugs into keyboard port
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- Variable rapid-fire feature
- Includes configuration and game control
- Size: 6.5"L x 3.3"W
- Weight: 1.1 lbs.
- One-year warranty

Game Control

Configuration Control

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123060 EZ Drive software........................$29.95
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123051 Technical Library CD-ROM.........279.95
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## Jameco Fast Input/Output Card

Add four serial and three parallel ports!

SPECIAL

- UART chips emulate 16550 UARTs
- 16-bit card
- PC/XT/AT and compatible computers
- Can be used in an 8-bit system with IRQ 3, 4, 5, 7
- Four serial ports
- Three parallel ports
- All ports configurable to IRQ 3, 4, 5, 7, 9, 10, 11, 12, and 15
- Parallel ports are selectable for normal or bi-directional modes
- Weight: 1 lb. • One-year warranty

117971 Input/Output card........................$79.95

## Jameco Input/Output Card

Add four serial and three parallel ports!

- UART chips emulate 16450 UART's
- 16-bit card
- PC/XT/AT and compatible computers
- Can be used in an 8-bit system with IRQ 3, 4, 5, 7
- Serial ports addressable to 3B8, 2F8, 3E8, 2E8
- Parallel ports addressable to 3BC, 378, 278
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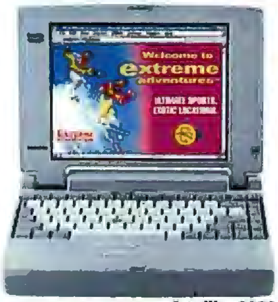
| Pentium 120 | 11.3" Active | 1.26GB | CALL |



Satellite 2130

### Satellite 2110/2130

- 10.4" Dual Scan & Active
- Built-in AC adapter - small, sleek design & reduced weight
- Integrated Accupoint - small, accurate & easy to use

| Processor | Screen | HD | Price |
|---|---|---|---|
| 486DX4/75 | 10.4" Dual Scan | 330MB | $1979 |
| 486DX4/75 | 10.4" Dual Scan | 500MB | 2459 |
| 486DX4/75 | 10.4" Active | 500MB | 3059 |

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- 10.4" Active & Dual Scan
- Built-in AC adapter - small, sleek design & reduced weight
- Integrated Accupoint - small, accurate & easy to use
- Lithium Ion battery technology
- Built-in infrared for no-hassle printer connections

| Processor | Screen | HD | Price |
|---|---|---|---|
| Pentium 75MHz | 10.4" Dual Scan | 772MB | $3539 |
| Pentium 75MHz | 10.4" Active | 772MB | 4359 |

Satellite Pro T400

90MHz Pentium

Portégé 610CT

### 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 | $4359 |



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WIN95 INSTALLED

Versa 2000

### Versa 2000

- Lithium Ion battery technology
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- LOADS of **FREE** software preinstalled

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|---|---|---|---|
| 486DX4/75 | 10.4" Dual Scan | 350MB | $1999* |
| 486DX4/75 | 9.5" Active | 350MB | 2299* |
| 486DX4/75 | 9.5" Active | 350MB | 2599 |
| 486DX4/75 | 9.5" Active | 540MB | 2799 |

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Built-In CD-ROM

WIN95 INSTALLED

Versa 4000

### NEC Versa 4000

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- 256KB Level 2 Cache to optimize performance
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| Processor | Screen | HD | Price |
|---|---|---|---|
| Pentium 75 | 10.4" Dual Scan | 540MB | $3499 |
| Pentium 75 | 10.4" Dual Scan | 540MB | 3799* |
| Pentium 75 | 10.1" Active | 540MB | 3999 |
| Pentium 90 | 10.1" Active | 810MB | 4649* |
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* Features built-in CD-ROM drive standard

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75MHz Pentium with PCI BUS

Extensa 550

### Extensa 550/550CD

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- Built-in 2X CD-ROM drive (optional on some models)
- Built-in 16-bit sound, microphone & speaker
- Integrated touchpad pointer
- 10.4" Active Matrix display/10.4" Dual Scan
- Built-in infrared for wireless communications

| Processor | Screen | HD | Price |
|---|---|---|---|
| Pentium 75 | 10.4" Dual Scan | 524MB | $2499* |
| Pentium 75 | 10.4" Dual Scan | 524MB | 2939 |
| Pentium 75 | 10.4" Active | 524MB | 3519 |

*CD-ROM Drive is an optional accessory on this model

### Extensa 450

- 10.4" Dual Scan & 9.5" Active display
- GlidePad pointing device
- Advanced battery pro
- Built-in infrared for no-hassle printer connections

| Processor | Screen | HD | Price |
|---|---|---|---|
| 486DX4/75 | 10.4" Dual Scan | 340MB | $1769 |
| 486DX4/75 | 9.5" Active | 340MB | 2349 |

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- Upgradable hard drive - easily add more storage
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| Processor | Screen | HD | Price |
|---|---|---|---|
| Pentium 75 | 10.4" Dual Scan | 500MB | $3479 |
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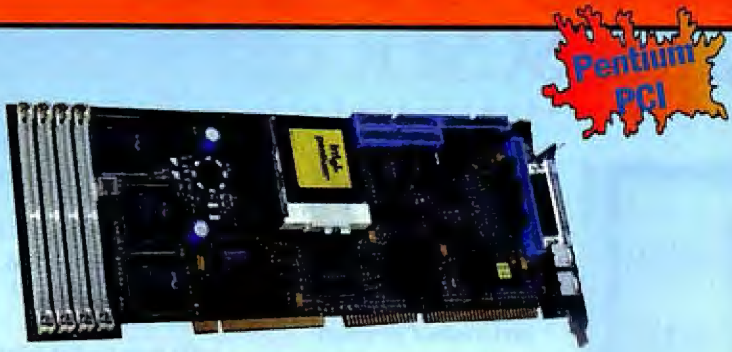


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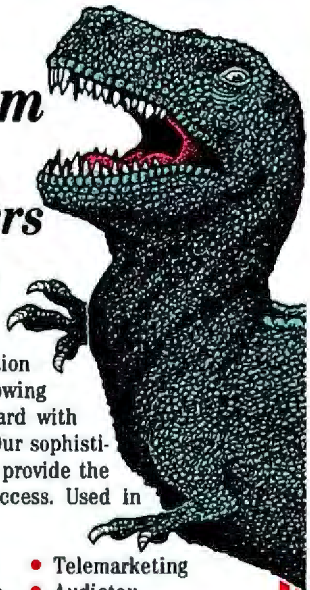

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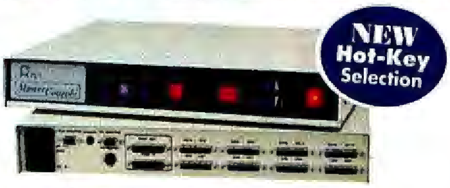

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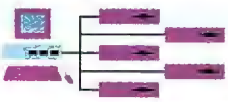

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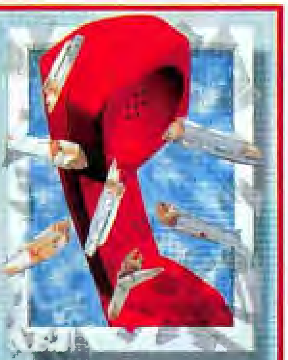

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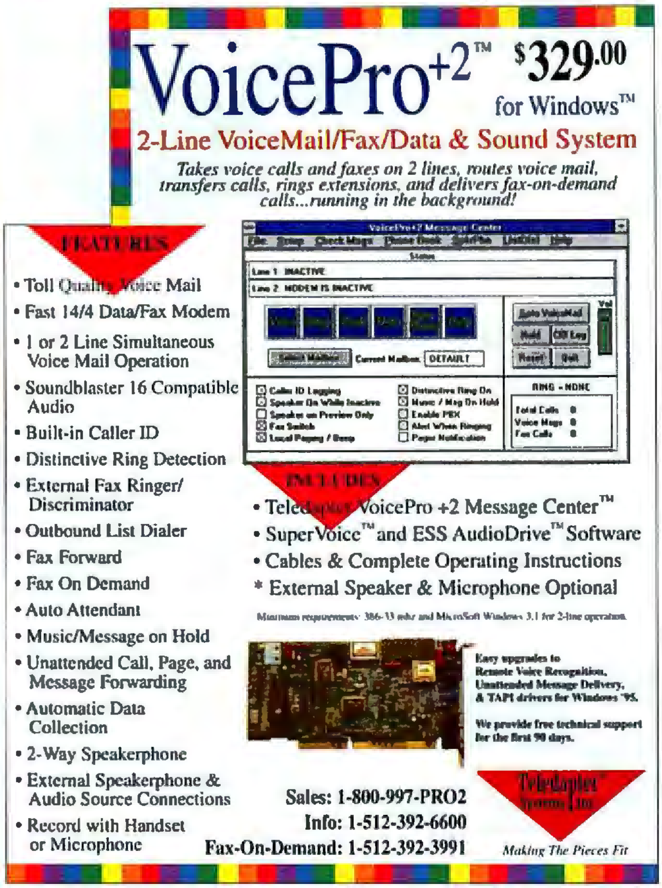


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# Things to Come

**The inventor of hypertext forecasts the future, including the demise of the human race**

### Desktop computers
Very few computers will be on the desktop in 10 years. Today's workstation capacity will be in wristwatches, on the wall, off the wall, and so on.

### Mobile computers
My favorite design, which I call the Walkie-Thinkie, is a wearable computer with a five-finger keyboard on your lapel (but there are lots of other options), a headphone, and a microphone. This device will have real-time digital recording and audio editing, a telephone, an answering machine, and voice mail built in. But I'm not holding my breath for reliable voice recognition.

### User interfaces
It won't be the Mac/Windows-type interface or the voice interface seen in *Star Trek*. Both ideas are inane. The alternative is the design of abstract worlds and spaces with new rules and topologies that people can easily understand, use, and enjoy. Everybody should have the interface they want, so it will be increasingly important for "applications" to be delivered detached from "interfaces."

### Operating systems
Linux will become very important. Then Taos, a very strong multitasking system for real-time (i.e., time-compelling) applications, set-top boxes, and so on.

### Virtual reality
That oxymoron for interactive realism will become just another interface and another big way to waste time. But it could also be very practical for lots of stuff—maps, instructions, and x-ray views.

### On-line publishing
As I've always envisioned (and built into Project Xanadu), there will be: automatic royalty on a pro rata basis for any portion of a document or object sold; stable publishing, so that materials may be reliably linked; unrestricted republication of any material, if that material uses Xanadu's "transcopyright" doctrine (i.e., a permission system that lets anyone reuse someone else's transcopyrighted material in a new document; you transmit a pointer to the desired material, and each customer purchasing your work buys each quotation from its original publisher).

### Software-development tools
C++ will sink, C will resurge, Visual Basic (which ought to be called Structured COBOL) will be big. Prograph, possibly the best, will catch on. CASE tools will become convenient.

### Componentware
We need a king to make the rules about how the components divide and fit together. Standardization politics rules. But most of the issues of software will change completely, just as they have every five years.

### Tomorrow's killer applications
My hope is that there will be no more applications, because future software will be set up to be tied together, piped together, scripted together. The real killer applications will be nanotech bugs that escape.

### Players of the twenty-first century
Microsoft has peaked. By 2000, it should be second to Netscape. Silicon Graphics will live on. So will Sun. Thinking Machines will make a comeback. Apple will be acquired by Wal-Mart. Quarterdeck will make it big, but I'm not sure what with. IBM will die a terrible death, possibly bankruptcy or being acquired by Quarterdeck.

### The data highway
It will be a conglomerate of parts on an Internet-like model, with some fast priority lanes and something like the Clipper chip for encryption—which everyone will bypass. But that doesn't matter, since it will let the government arrest whomever they choose, since we'll all be breaking the big, vague new law against everything.

### How computing technology will change the world
In every possible way. But I find it hard to believe that the human race will survive to the year 2100. ■

---

*Ted Nelson coined the concepts hypertext and hypermedia in 1965. He is best known for Project Xanadu. You can reach him on the Internet or BIX at editors@bix.com.*

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- $99 More for 2nd NiMH Battery (Slides into floppy drive to achieve extended battery life)
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