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AUGUST 1994

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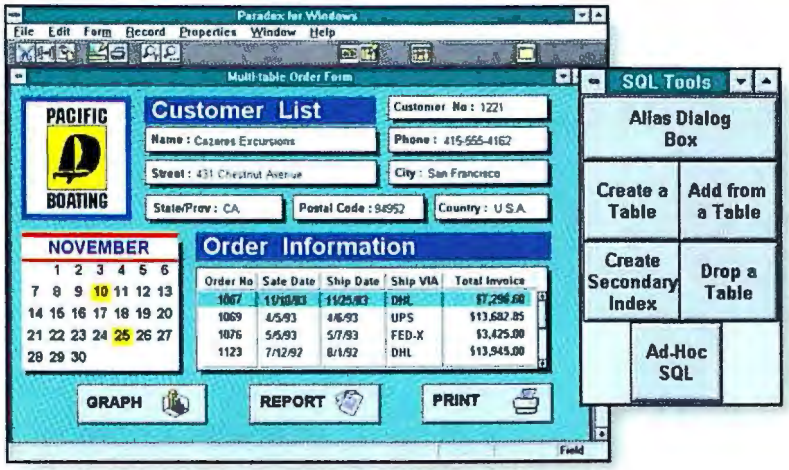

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Productivity Experts show you the easiest way to complete any task

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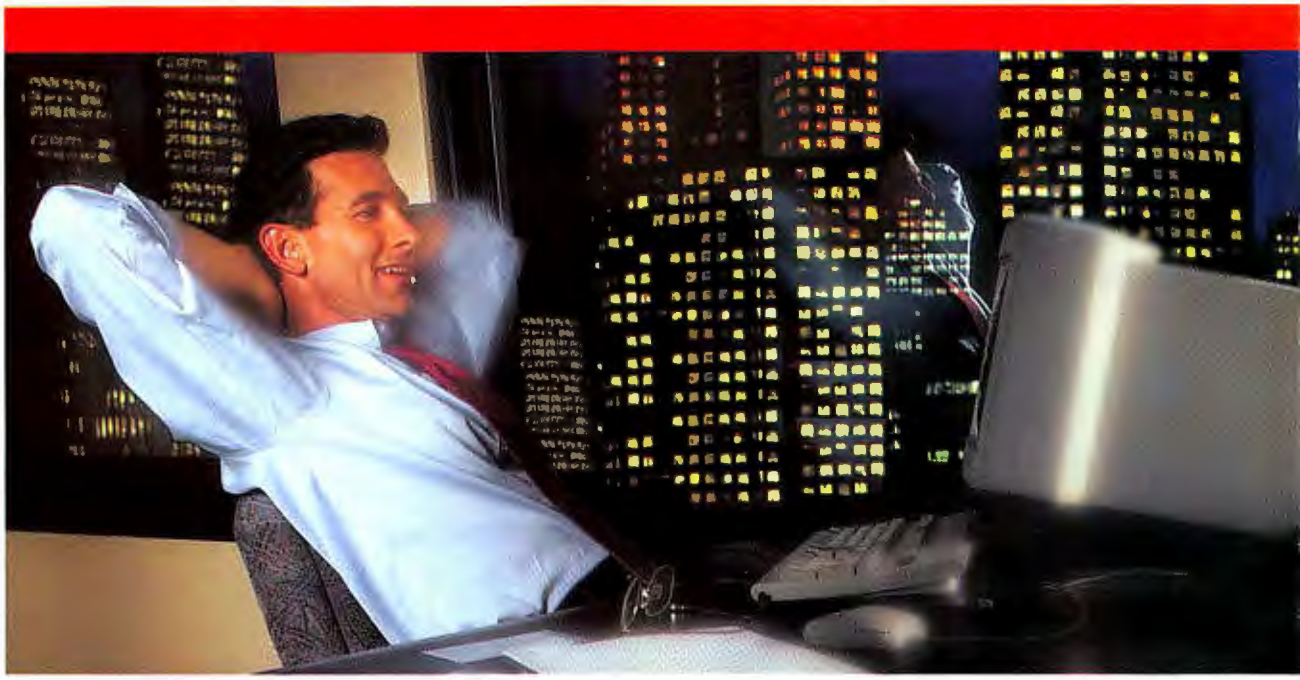

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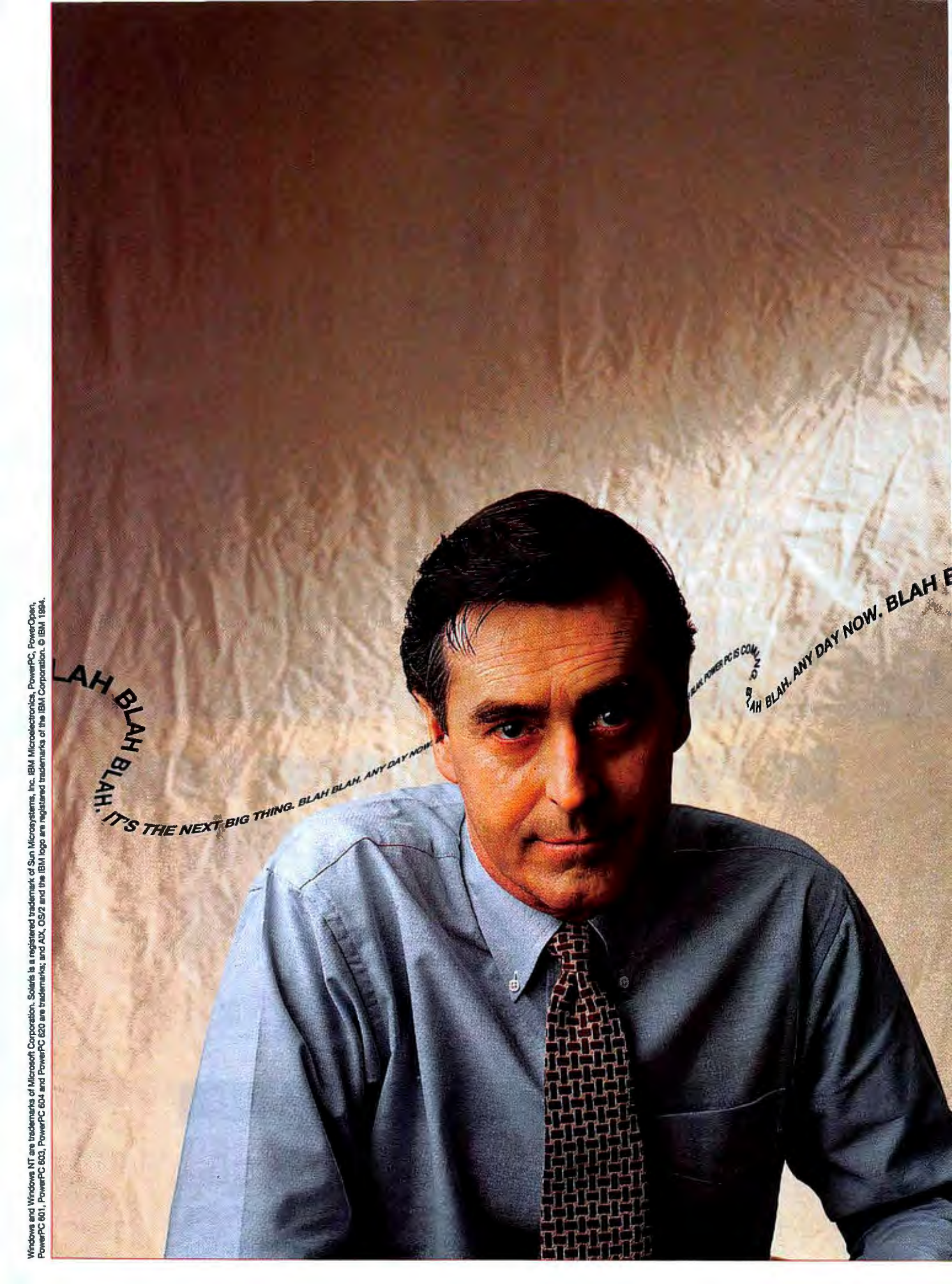


Everyone keeps saying PowerPC is coming. We believe you'd rather know where it's going.

In the past year, no doubt you've heard quite a lot about our PowerPC™ family of microprocessors. How they offer unprecedented, RISC-based performance. And how, according to nearly every industry publication, PowerPC processors are poised to revolutionize personal computing.

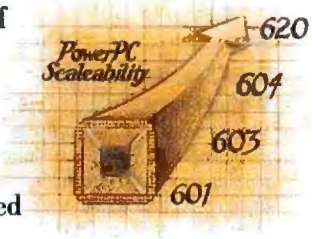
Update

The PowerPC alliance of Apple, IBM and Motorola reached a significant milestone recently with the development and fabrication of the high performance PowerPC 604.

Yet for all this, we at IBM Microelectronics™ Division understand you might still have questions. Not so much about how fast our PowerPC processors run, but how soon you can confidently put them to work for you and your customers.

The answers are closer than you think. As proof, consider that IBM Microelectronics has shipped nearly a half-million PowerPC 601™ processors to the OEM market since September. Which means, by the time you read this ad, they'll already be powering a range of computing products throughout the world. To quote John Dunkle, president of the market research firm WorkGroup Technologies Inc., "It won't take long for the PowerPC to turn up in every segment of the market."

And that's only the beginning. Right now, our PowerPC 603™ microprocessor, ideal for mobile and energy-efficient desktop systems, is available for immediate sampling. By the fourth quarter of 1994, we plan to begin volume shipments of our PowerPC 604,™ a next-generation processor targeted at the high performance desktop market. Close behind will be our PowerPC 620,™ which will offer exceptional performance in high-end workstation and server applications. This impressive timetable is due to the extraordinary scaleability of our PowerPC architecture, a sharp contrast to the limited headroom of CISC-based processors.



Of course, our momentum isn't confined to products. Today, PowerPC processors are poised to run such popular operating systems as AIX,® OS/2,® Solaris,® System 7, Windows* and Windows NT,™ plus Taligent. In the not-so-distant future, PowerPC adopters can also look forward to the PowerOpen™ Environment (POE), a next-generation, standards-based platform.

Need more proof? Well, major application developers like Adobe, Aldus, Claris, Microsoft, Quark and WordPerfect are busy creating PowerPC-based versions this very minute. And current DOS/Windows™ users can already count on state-of-the-art emulation technology for popular applications. Most impressive of all, IBM Microelectronics plans to provide an outstanding array of PowerPC support, including software development tools, evaluation boards and a network of design centers.

1993 BYTE AWARD OF EXCELLENCE

So as you can see, the real news isn't that PowerPC is coming, but what it already has going for it. To learn more, call IBM Microelectronics at 1-800-PowerPC, ext. 1430 (OEMs), ext. 1440 (programmers) or ext. 1450 (end users).

* Not in native mode.

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IBM

BYTE
AUGUST 1994 VOL.19, NO.8

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This month's cover image was a collaborative effort by five computer artists. Clockwise from top left: Daniel Pelavin; John Corbitt; Chris Spollen; Robert Burger; and Marc Yankus, who also imported the other illustrations and created the background © 1994

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From BIX: Join "listings/frombyte94" and select the appropriate subarea (i.e., "aug94").

From the UUNET:ftp to ftp.uu.net, log on as "anonymous," and enter your user ID as your password. Type "cd/published/byte" and type "DIR." Files appear in subdirectories by month.

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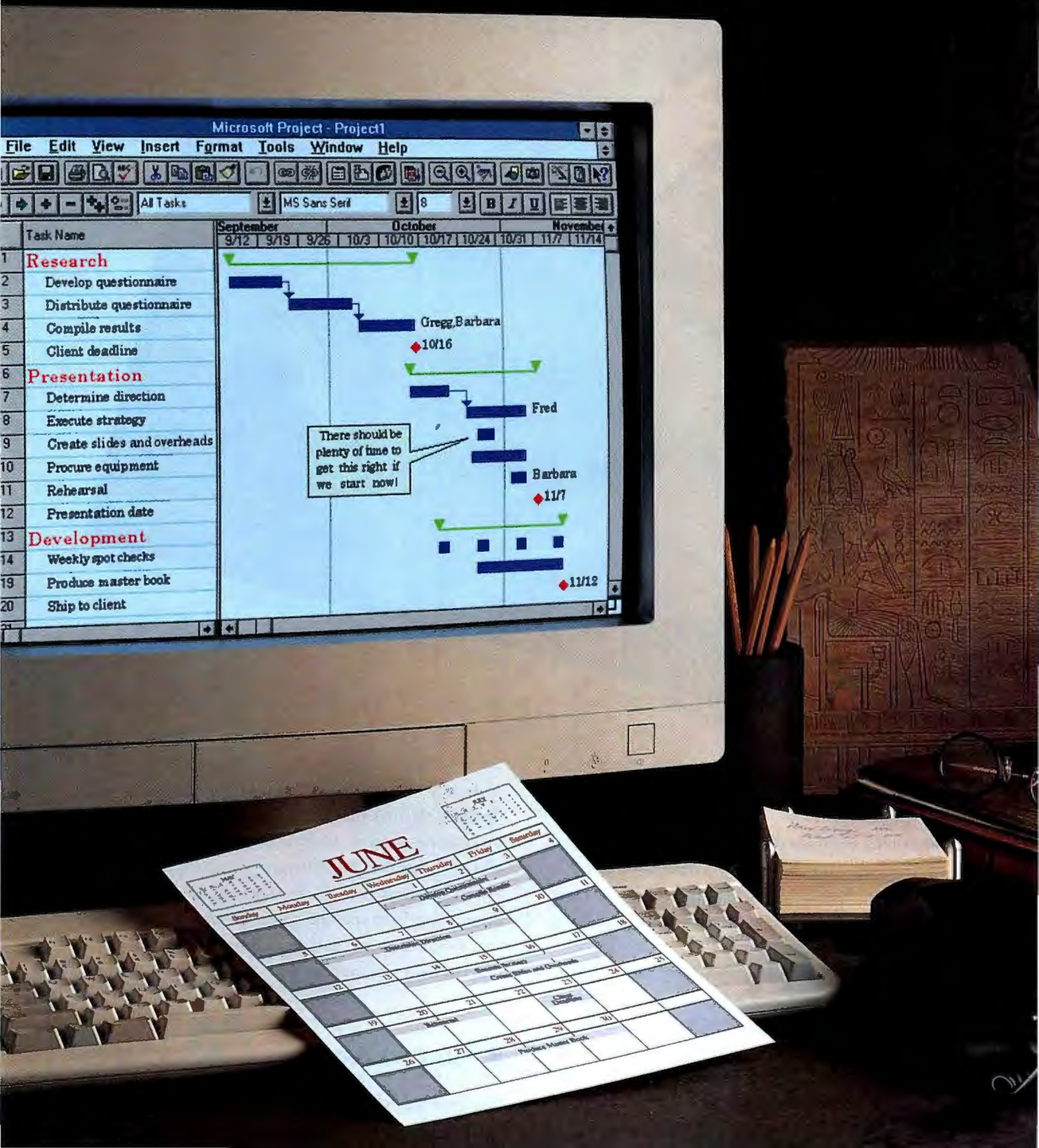

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PowerPCs from Taiwan

IBM still commands a following, and a clone market in PowerPC systems is emerging

At the Computex computer show in Taiwan during June, the big news was PowerPC systems. Computex is an annual trade show held in Taipei, where mostly Taiwanese manufacturers trot out their wares in an effort to sell them to distributors and OEMs. Getting lost in a sea of steel computer cases, power supplies, and the omnipresent "green PCs" at Computex is an easy task. Taiwan is now a manufacturing giant, although it isn't generally known for its technological leaps and innovations.

Nonetheless, some standout manufacturers are setting their own pace. Notable among these companies are U-Lead Software, which developed PhotoStyler, and D-Link, which makes sophisticated networking hardware. Also notable are the companies participating in the Taiwan New PC Consortium, which were showing prototype systems that are compliant with PReP (PowerPC Reference Platform).

The TNPC Consortium includes companies like Tatung that were demonstrating working PowerPC-based systems. Interestingly, the system motherboards did not come from IBM Microelectronics—like the prototype PowerPC systems BYTE saw at the CeBIT show in Hannover, Germany, in March. Instead, these manufacturers claimed the designs as their own, and the moniker "TNPC" was etched alongside the circuitry on the board.

The operating system running on the machines was a preliminary version of Windows NT. It was a later version than had been used on PowerPC systems demonstrated at CeBIT. Given that the TNPC demonstrations were held jointly with IBM (which was *not* showing its Power Personal systems), it's worth noting that none of the systems were running OS/2 for PowerPC.

Because the companies claim their systems are PReP-compliant, it's fair to assume that the TNPC systems will run all five operating systems that IBM has announced its Power Personal systems will run: AIX with Wabi (Windows Application Binary Interface), OS/2 for PowerPC, Windows NT, Solaris, and Taligent. Like the systems, none of the operating systems are ready for prime time.

Just which operating system will come with PowerPC systems is still in question. The key point that should not be lost is that no one—except Mac users—wants to buy desktop systems that do not adequately run existing Windows applications. While that point may lead a lot of folks to a knee-jerk decision in favor of Windows NT in the short term, there's a non-Windows long-term consideration, too.

Specifically, OS/2 for PowerPC looks promising for large organizations from a strategic point of view. While we cannot fully consider the technical merits of each operating system until all of them and the hardware systems are available, we can ponder IBM's announcement about its future. That future, according to Lou Gerstner, CEO of IBM, is the Workplace operating system. And Workplace for the PowerPC is spelled "OS/2."

The scenario is this: All IBM systems, from portables to mainframes, will eventually be based on the Power (as in PowerPC) architecture. That will allow all IBM systems to run a version of the same operating system—namely, Workplace. Sounds like real potential for seamless integration, doesn't it? It also sounds like Utopia, which it will not be. Still, it's the argument that IBM will be making, and it's going to be a compelling one.

How long will it take for IBM to move its entire product line to the Power architecture, and can IBM implement Workplace seamlessly across all its platforms? Only time will provide those answers.

Meanwhile, the TNPC Consortium is hedging its bets that IBM might succeed. Other companies are doing the same. You can expect the big rollout of PowerPC systems at Comdex in Las Vegas in November. There may be earlier announcements, but the unavoidable focus of discussion at Comdex will be PowerPC.

Several of the TNPC companies will be at Comdex to officially introduce their PowerPC systems. Some may carry the private label of another computer company. The impact of the TNPC companies, however, will be clear: IBM still commands a following, and as the Taiwanese companies demonstrate their willingness and ability to deliver PowerPC systems, there will be no doubt that a new clone market is emerging. ■

DENNIS ALLEN, EDITOR IN CHIEF
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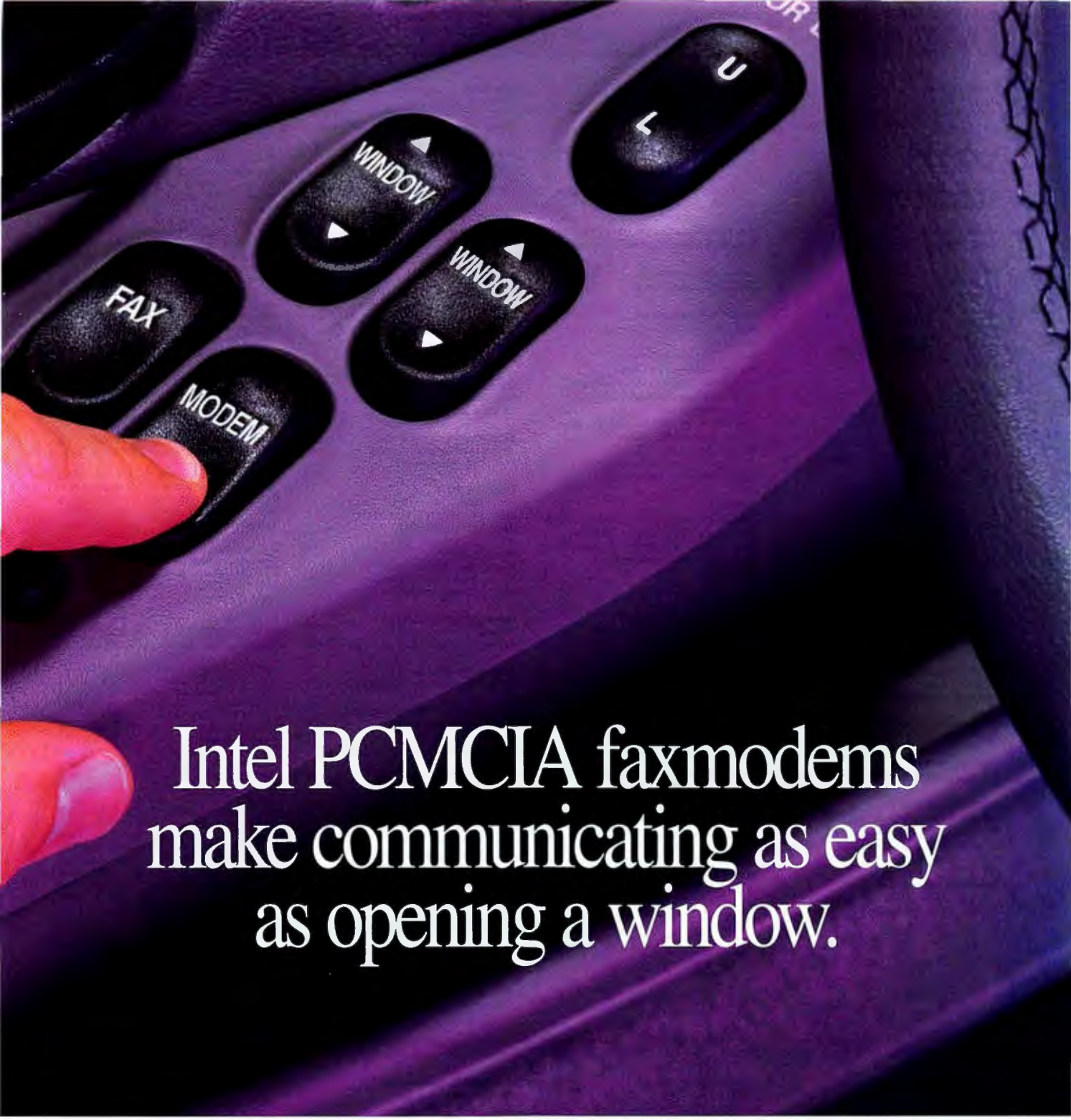

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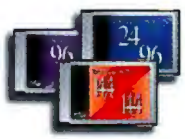

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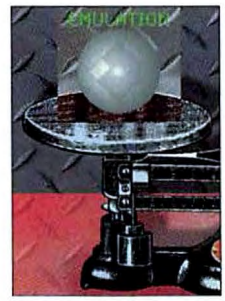
Letters

Emulation Alternatives

Tom R. Halfhill's article "Emulation: RISC's Secret Weapon" (April) fascinated me. But I have a question: With all the effort going into writing good run-time translators and emulators, why not put that effort into writing a good batch-mode binary-code translator?



Instead of translating at run time every time an 80x86 program needs to be run, such a translator would just translate the entire program once and store the translated binary on disk. This way, the run-time speed would be faster because no time would be spent translating on-the-fly, and more effort could be devoted to optimizing the output code. With this technique, virtually any program written for the 80x86 could easily be ported to the PowerPC (barring legal issues).

I hope that someone reading this letter will develop a program to do this. I think it would solve the compatibility problem—and make my life using the PowerPC easier as well.

Peter Shell
Pittsburgh, PA

Several other people wrote with the same idea, and it's already been done. Echo Logic (Holmdel, NJ) has a tool called FlashPort that translates 680x0 binaries into PowerPC binaries. Some Macintosh developers are using it to port all or parts of their 680x0-based software to the new Power Macs. DEC has a similar technology that translates legacy software written for its minicomputers to the Alpha-series RISC processors. It's not trivial, though, and there are legal issues that emulation neatly sidesteps.

—Tom R. Halfhill

Virtual Communities vs. the Neighborhood

The commentary "The Introversion of America" by Tom R. Halfhill (May) relates directly to my experiences living in a circa-1920 house—with a porch—in the small town of San Luis Obispo, California, and to my own ambivalence surrounding the prospect of virtual communities emerging on computer networks.

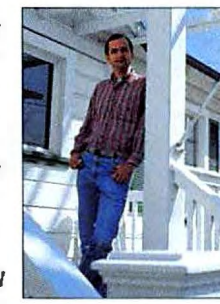
You may have read that the San Luis Obispo city council was considering an addition to the city's general plan that would require front porches on new residential construction, with the explicit intention of fostering neighborhood interaction. I'm in love with the little town I live in, but artificial attempts to preserve the closeness of this community will probably be overwhelmed by the inevitable reasons why a growing population turns away from relationships that are arbitrary and involuntary.

The front porches of our neighborhood are almost always vacant. It has to do with the ever-expanding range of choices we have. When we gain a new freedom, we tend to exploit it immediately without realizing what we're giving up. Perhaps San Luis Obispo's porch proposal and the attention it's received indicate that people are starting to question the choices they've made. Thanks again for your excellent essay.

Ken Broomfield
San Luis Obispo, CA

There are much better ways for a city to foster a sense of community in its neighborhoods than requiring builders to add front porches. Front porches don't cause *social interaction; they facilitate the social interaction that's already happening. What next—will the government mandate fireplaces and hearths to promote family togetherness? If nothing else, however, at least it signals an awareness of the problem.*

—Tom R. Halfhill



I appreciated your May commentary. A few months ago, I got a Unix/Internet account after a long period of going without, and I have been enjoying it very much. But it can absorb a lot of time. Today was one of a series of beautiful days in Seattle, and I decided to turn off my computer and take a walk around the neighborhood. I took my issue of BYTE and my dog along with me, and I came upon your article while lying in the sun in the park. Thanks for a thought-provoking article.

Doug Johnson
Seattle, WA

Superb article! While walking to the train station in San Bruno, I passed through a residential district in the downtown area. There stood an old house with a nice, old-fashioned front porch. It was encased, top to bottom, all the way around, with metal bars. Thought you'd be interested.

Brad Taylor
Sunnyvale, CA

Something to Think About

Do you think it feasible to attempt to organize the users of Internet into a town-meeting-style representational democracy that would eventually become the authority in any disputes that might arise between parties in far-flung jurisdictions?

I'd propose the enforcement of rules against what are now generally accepted forms of rudeness. For instance, I'd support keeping records of—and blacklisting—"criminals" who send mail bombs that crash systems, send inappropriate Usenet News and cross-postings, or harass people by sending junk E-mail. Business advertising could also be regulated.

David L. Nicol
Kansas City, MO

The kind of policing you describe probably won't happen on the Internet because nobody controls it. The Internet is just that—an "internetwork." It's up to the sysops on individual systems to decide what is and is not acceptable; the Internet now seems to thrive on anarchy.

However, I believe this is also the Internet's greatest weakness. As more and more people gain access to computers, the more unruly behavior we'll see. The Internet could eventually go the way of CB radio, which was ruined by nitwits who spent hours whistling into their microphones and would-be disc jockeys who played country-music records all night. On-line equivalents of these behaviors are evident already. —Tom R. Halfhill

Upgrading to the Old Version

I just finished Terje Mathisen's review of Novell DOS 7 ("Novell's Newest DOS,"

continued

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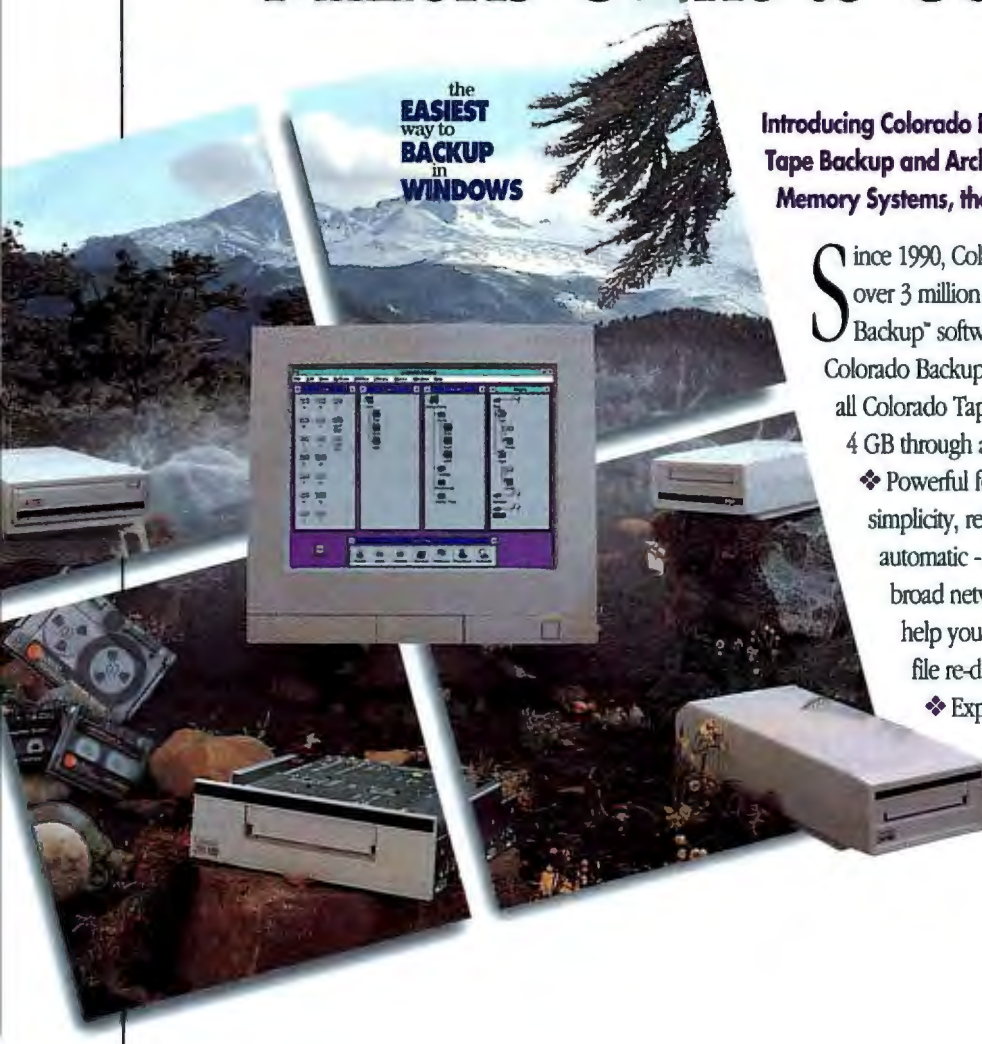

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June). While some of the problems he was having with OS/2 and Windows for Workgroups 3.11 can be avoided by turning DPMI=OFF in his EMM386.EXE statement, I sympathize with him. It seems that Microsoft's DPMI [DOS Protected Mode Interface] implementation clashes with that of Novell.

A friend introduced me to DR DOS 6.0 years ago. After much tweaking, it worked flawlessly with any program I tried. Despite the excellent technical assistance I have had from Novell, Novell DOS 7 still crashes randomly, with a screen dump citing invalid commands. This happens with something as simple as CHKDSK.

But I have come up with the perfect solution. Until Novell fixes Novell DOS 7, I've reverted back to DR DOS 6.0. It's too bad...this DOS really would have given Microsoft something to strive for in its upcoming 7.0 version.

Ed Berlot
Toronto, Ontario, Canada

That parallels my own thinking; I loved DR DOS 6 and hoped that Novell DOS 7 would be good enough and stable enough to use on any machine. No such luck! —Terje Mathisen

I am very unhappy with Terje Mathisen's review of Novell DOS 7. Instead of showing the two products side-by-side in the real world, he suggested how much more "complicated" ND7 is than MS-DOS 6.2. Why the real, substantive differences between MS-DOS 6.2 and ND7 were completely bypassed is beyond me.

I suppose if you're a Windows user and are used to that "one size fits all" mentality, then, yes, Novell's DOS is too much for you. You've probably got Chicago already charged to your Visa and got dizzy reading OS/2's box. Forget NextStep.

The hope is that ND7 will inspire a war among operating systems: Who can provide the best multitasking (MS-DOS 6.2 misses), who can link the PCs in a network (Hello, Microsoft? We're waiting!), and so on. The sad reality is, we're slipping into a Neanderthal void as the ease-of-use advocates pound the daylights out of the functionality advocates.

Carl H. Payne
Orem, UT

Executive Information Systems

I am the architect of the data-replication products for IBM's DB2 family of database managers, so I am disappointed that I did not see IBM products represented in "The Changing World of EIS" by Karen Watterson (June). IBM is the only DBMS vendor supporting differential refresh function among mainframe relational and nonrelational databases, midrange and Unix databases, and PC databases.

DEC was the first relational database vendor to have snapshot support in an RDBMS, with a product called VAX Data Distributor, around 1987. Terminology in the industry changed when Sybase dropped the term *database snapshot* and began using *data replication*. So, if you search for early references in the field, you will find them by looking for the *snapshot* keyword.

Rob Goldring
Architect, IBM Data Propagation Products
Santa Teresa, CA

Who Profits from Technical Support?

PC software companies are trying to make customers pay extra for technical support. This is a stake in the heart of personal computing. It drives the industry in the wrong direction and sets up the wrong incentives.

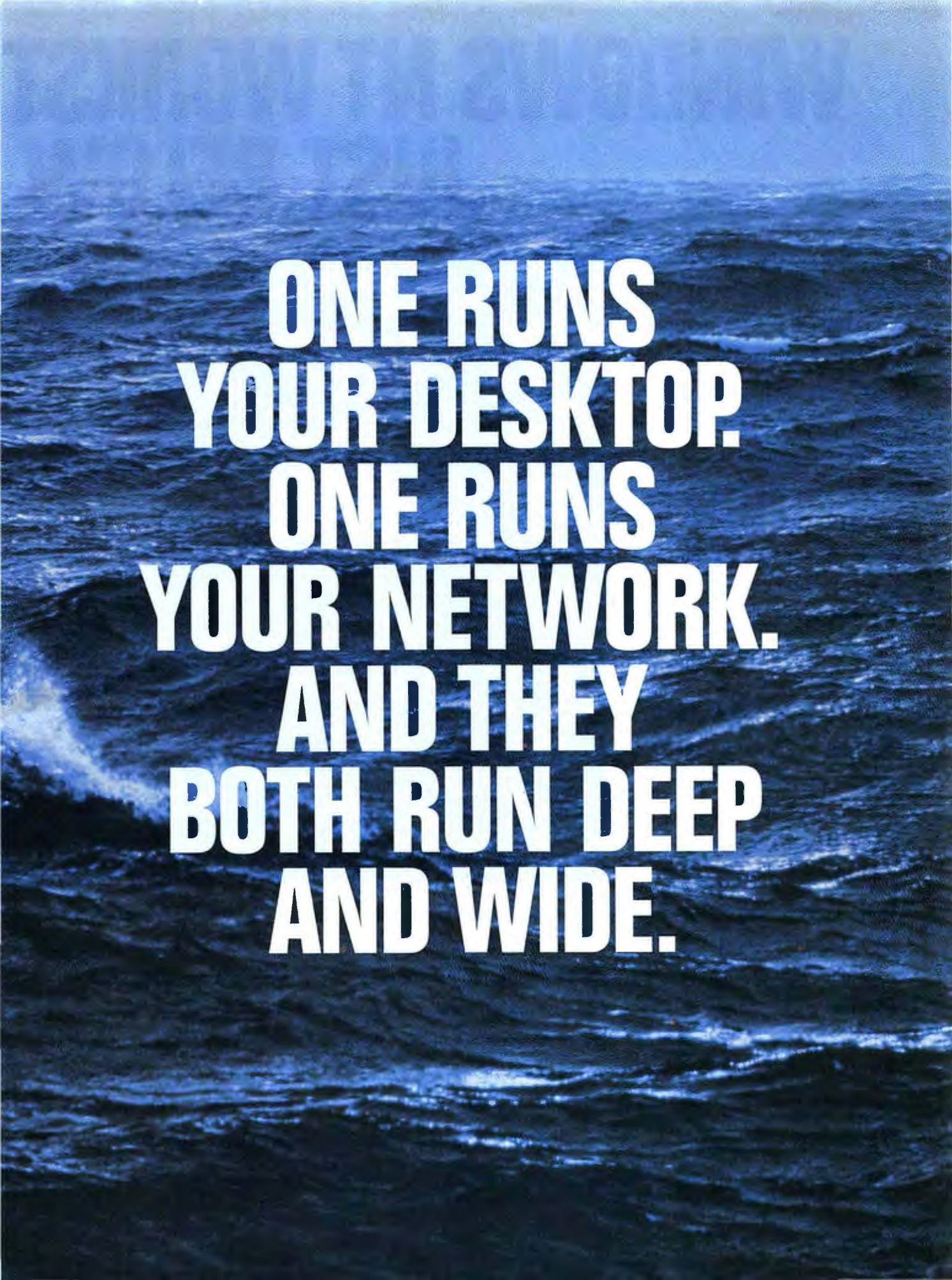
Imagine the scene in corporate meeting rooms across America: Customer advocates ask, "Has our product gotten a little bloated? Should we do another round of usability testing?" And someone with a little smile says, "Well, perhaps we don't want our product to be *too* easy to use. Remember, support is a profit center for us now."

There's also another factor. A neighbor of mine needed help in setting up her mailing list. She had no manual because she had "borrowed" the software. I started to give her my usual lecture, stressing that it was in her own interest to buy a legal copy. I started to point out the vendor's legendary support, a toll-free number with unlimited free calls. Then I remembered that that company doesn't offer free support anymore. If she wants a legal copy, she will have to pay a three-digit price that hasn't changed much in three years. If you were in my place, what would you have said to her?

Daniel P. B. Smith
Norwood, MA

FIX

To clarify the circumstances surrounding Intergraph's porting of its software to RISC platforms (June News&Views, page 40), we have been notified by Intergraph that its Clipper processor engineering staff became Sun employees at the beginning of 1994 and that the software engineers who are porting Windows NT to Sun's SPARC microprocessor are employees of Intergraph's Advanced Systems Division. The ASD is located in Mountain View, California, and specializes in Windows NT porting, development, and consulting. ■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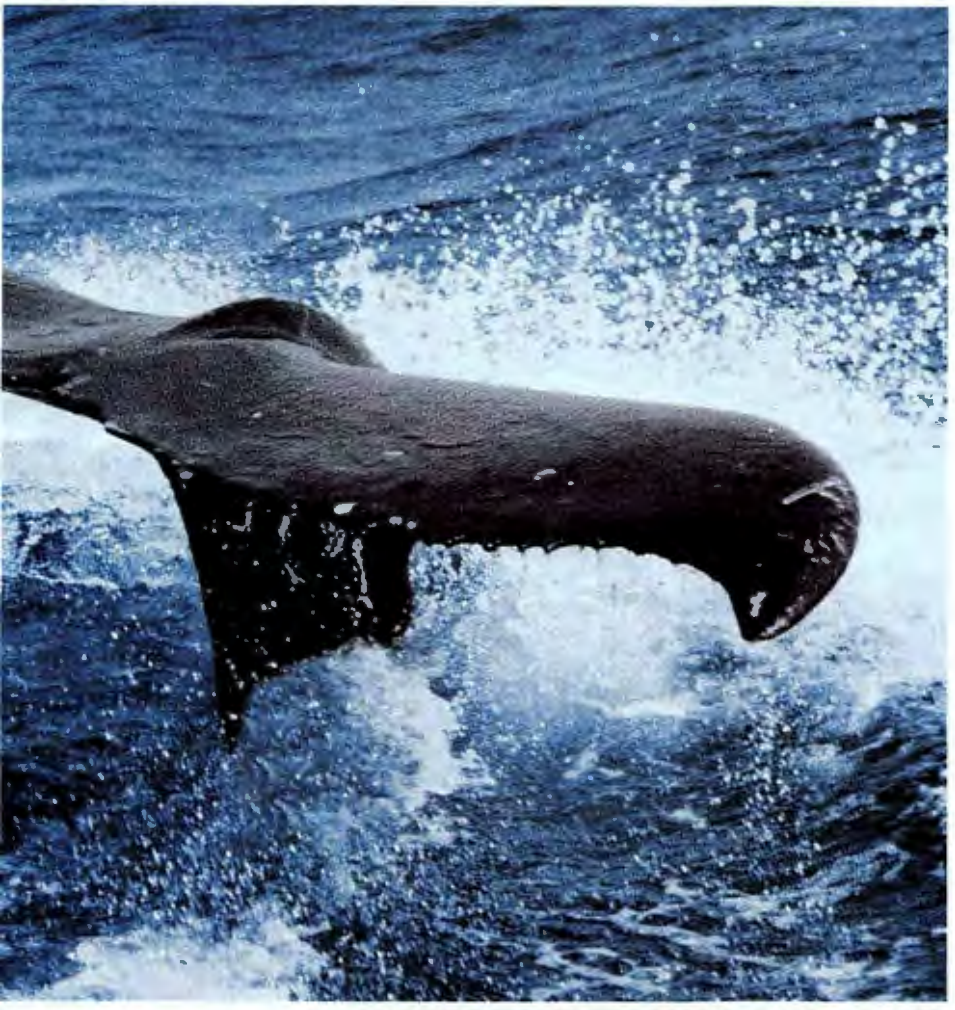

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News & Views

32-BIT OPERATING SYSTEMS

OS/2 Gets Lean and Mean

IBM is continuing its strategy of releasing customized versions of OS/2 that are targeted at different markets. A forthcoming version of OS/2 that runs well on PCs with 4 MB of RAM targets users who want a robust, 32-bit operating system.

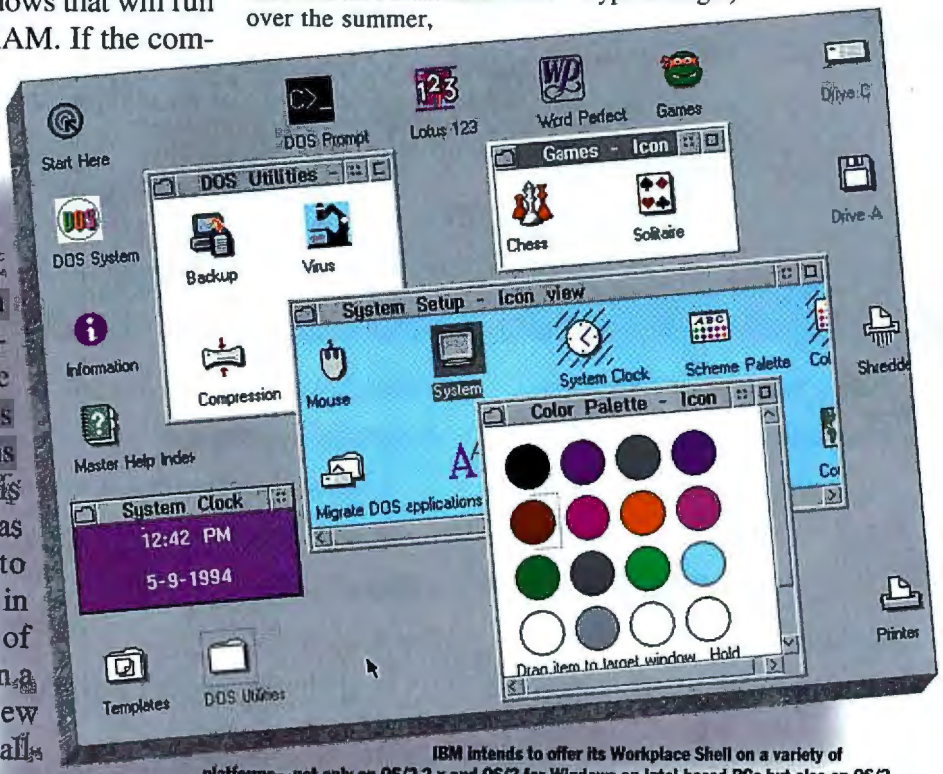
DAVE ANDREWS AND MATT TRASK

IBM has released the first beta version of its new version of OS/2 for Windows that will run well on PCs with 4 MB of RAM. If the company is able to meet all its milestones, it should release this new version of OS/2 sometime this fall. With the new version of OS/2 for Windows, IBM is targeting businesses and end users who want to run a 32-bit operating system that supports preemptive multitasking and multithreading, while being able to run DOS, Windows 3.11, and native OS/2 applications on a modestly configured PC. This new "Performance Beta," which was code-named Warp, is similar to IBM's OS/2 for Windows product in that it installs on top of a copy of Windows that's already present on a PC. You can get a copy of the new version of OS/2 for Windows by calling (800) 251-2177.

IBM says it will add capabilities to the Performance Beta over the summer, including support for Windows for Workgroups 3.11 and Win32s applications. BYTE was able to evaluate a preliminary version of the Performance Beta that was running on a 486DX/33 system with only 4 MB of RAM.

When running a selection of sample applets (including Pulse, the Klondike Solitaire game in auto-play mode, and the Tune Editor) while formatting a floppy disk in a VDM (Virtual DOS Machine), the Performance Beta performed well: The Tune Editor didn't miss a note, and Solitaire played smoothly. Even though this is a rudimentary test of the Performance Beta's functionality, it is a strong illustration of some of OS/2's advantages over 16-bit Windows, under which almost all activity ceases when you format a floppy disk.

Other features have been added to the Performance Beta to increase functionality and system performance. The new Fast Load option starts a common Win-OS/2 session during system start-up and can save 50 percent or more of the time required to load Windows applications. ATM (Adobe Type Manager)

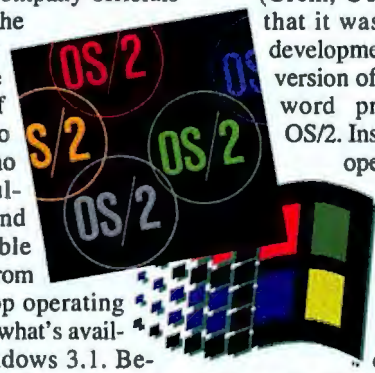


IBM intends to offer its Workplace Shell on a variety of platforms—not only on OS/2 2.x and OS/2 for Windows on Intel-based PCs but also on OS/2 on PowerPC and even DOS-based PCs, as shown in this screen shot. The company plans to begin beta testing this summer a version of the Workplace Shell that provides task switching, applets, drag-and-drop operation, file management, and other functions for PCs running DOS in real mode. IBM plans on releasing the Workplace Shell for DOS in the first half of 1995.

provides OS/2's native font support. The Performance Beta's new configuration option for Win-OS/2 sessions lets you load ATM only when you use it, thus saving memory and extra load time.

In addition, VDM support in OS/2 2.1 only provided a single priority level for DOS programs, and the Performance Beta now permits DOS tasks to be adjusted to 32 different priority levels. APM (Advanced Power Management) support has been added for laptops (e.g., the AST PowerExec 4/25SL and IBM ThinkPad 750) that have 32-bit APM BIOS code. A new PlayAtWill object manages your PCMCIA slot to support the dynamic loading and unloading of hot pluggable PCMCIA adapters and drivers.

IBM says it has already sold 500,000 copies of the first version of OS/2 for Windows, which was released in November 1993. Company officials say most of the product's sales were "off-the-shelf retail" sales to end users who wanted multitasking and a more stable foundation from their desktop operating system than what's available in Windows 3.1. Because of the end-user focus, the Performance Beta will also have an easy, "one-button" default installation option that should appeal to novices. Enhancements and performance tuning that appears in the new version will likely appear in a future version of OS/2 2.x as well.



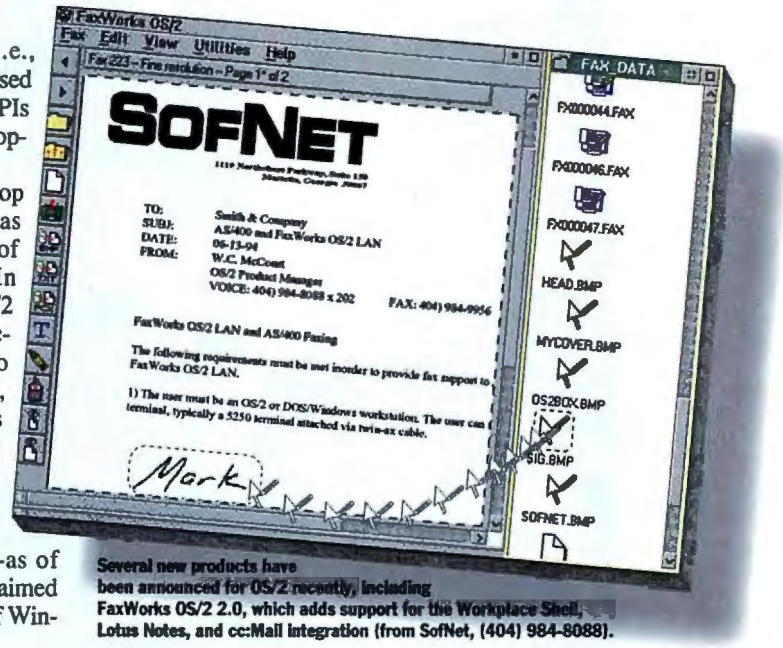
The Performance Beta is just one example of how IBM is customizing its operating system for different markets. IBM is adding support for today's 486-based and higher SMP (symmetric multiprocessing) platforms to OS/2. Also this year, the company plans on shipping its first Workplace (formerly called Workplace OS) product for PowerPC, which will deliver the same features available with OS/2 on Intel hardware today (i.e., IBM's Workplace is based on a common set of APIs that are scalable across operating environments).

But in the Intel desktop API wars, Windows has captured the majority of developers' efforts. In terms of unit sales, OS/2 has enjoyed modest success in the past two years, but in this regard, Microsoft's Windows still reigns as king of the Intel desktop environments. IBM says that it has shipped about 5 million copies of OS/2—as of early June, Microsoft claimed over 50 million copies of Windows have shipped.

Noting Windows' success, independent-software developers have flocked to the platform—some developers are even putting their OS/2 development efforts aside. Last fall, for example, WordPerfect (Orem, UT) announced that it was suspending development on a 32-bit version of its namesake word processor for OS/2. Instead, it developed OS/2 WPS (Workplace Shell) Integration Tools that let WordPerfect 6.0a for Windows users who are running OS/2 take advantage of the WPS's drag-and-drop capabilities.

WordPerfect continues to use OS/2 on the server side, however. The next version of WordPerfect Office (which will be called Symmetry, starting with version 4.1) will include many back-end servers that run on OS/2, such as the Message Transfer Agent and the post-office server.

Symmetry 4.1's Telephone Access Server, which lets remote users call in and retrieve their E-mail messages over the phone via text-to-speech technology, is a native OS/2 server. "It had to be OS/2 because of the [operating system's] support for multithreading," says Bennett Anderson, director of development for WordPerfect Office. "To do the text-to-speech technology is a very CPU-intensive operation, and the task manager has to do a good job of spreading the CPU cycles around to the different threads." The bad news for OS/2 in Orem on the client side is offset by good news on the server side. Says Bennett: "We've built servers for Windows NT, but a lot of our customers are saying, in regard to NT, 'Well, we're interested [in NT], but maybe in 1996.'"



Several new products have been announced for OS/2 recently, including FaxWorks OS/2 2.0, which adds support for the Workplace Shell, Lotus Notes, and cc:Mail integration (from SofNet, (404) 984-8088).

Other companies are working hard on new OS/2 applications. Lotus Development has released SmartSuite 1.1 for OS/2, which adds new features such as a stand-alone Lotus Application Manager that lets you switch between SmartSuite applications, Lotus Notes, and an OS/2 window. Other SmartSuite features include support for multithreading, multitasking, REXX (in Ami Pro), and IBM's Configuration, Installation, Distribution technology that supports unattended remote installation of software applications to networked PCs.

Smaller companies are also developing for OS/2. In August, Athena Design (Boston, MA, (617) 734-6372) says it will release Mesa 2 for OS/2, a spreadsheet that takes advantage of SOM (System Object Model), OpenDoc, multithreading, and the WPS while offering real-time data feeds, SQL database access, and an object library for integrating Mesa's spreadsheet functionality into custom applications. Mesa 2's spreadsheet and graphics objects will be packaged as SOM objects so that they can be integrated into a line-of-business application. "We're confident that OS/2 will continue to capture a sizable share of the market for Intel and PowerPC desktop machines," says David Pollak, president of Athena Design, "that's why we're committed to the platform." He adds, "Chicago will not run on the PowerPC."

One big unanswered question regarding OS/2 is whether it will support the forthcoming 32-bit version of Windows, code-named Chicago. IBM will only say that if its customers demand Chicago support in OS/2, it will provide it. But for now, OS/2 and OS/2 for Windows are attracting a few million users who need OS/2's capabilities today and are unwilling to wait for Chicago. "I think both [Windows and OS/2] have their places in the market, and I don't think that's going to change anytime soon," says Chris Shanks, product manager for Windows products at SofNet (Atlanta, GA), a company that sells stand-alone and network versions of fax software for DOS, Windows, and OS/2. "Windows has the bigger part of the market, but the OS/2 side is growing."

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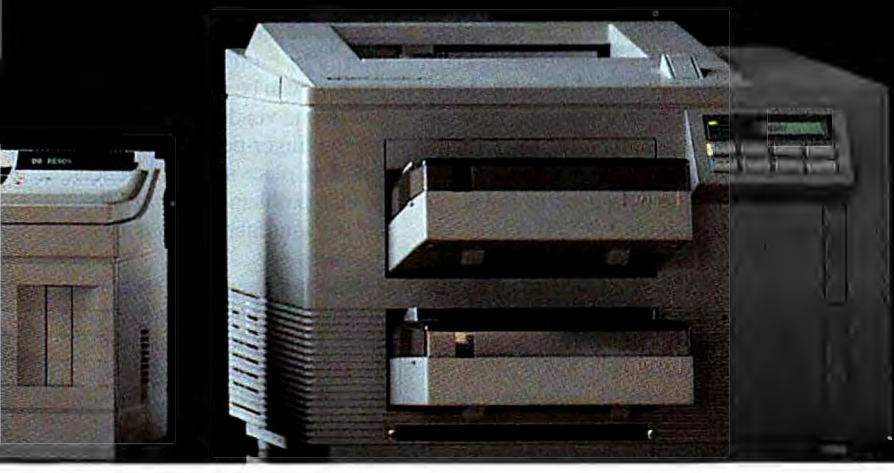


WIDE-AREA NETWORKS

Hubs Branch Out of the Wiring Closet

Network administrators looking to provide enhanced management, remote access, problem resolution, and LAN-to-LAN connectivity solutions for their networked users are increasingly turning to one place, their network hub vendor. When combining hubs with devices that give users WAN (wide-area network) access, vendors are making sure the components complement each other so that the combination is often better than what you would get if you had bought the pieces separately (see the table "Advantages of Integrating WAN Access into Hubs"). These developments mark a fundamental shift in a network hub's role from a departmental wiring concentrator to that of the single point in a network that gives users LAN and WAN access.

Today's network managers are faced with trying to satisfy the growing demand to connect LAN-based users at different sites and to provide users with dial-out access to commercial E-mail services. Additionally, managers have to provide mobile workers (i.e., those who travel with portable computers or who work at home) with dial-in access to network resources.

In the past, these levels of connectivity would be handled using stand-alone routers, terminal servers, communications servers, modems, and other line-termination devices such as ISDN terminal adapters, multiplexers, and CSU/DSUs (channel service unit/data service units). These devices were typically purchased separately—a Forrester Research (Cambridge, MA) survey of 50 large U.S. businesses found that 60 percent of the companies bought these components individually.

However, purchasing patterns are changing. Forrester Research found that 54 percent of network managers said that in the future, they will buy WAN access products from their hub vendors.

Advantages of Integrating WAN Access into Hubs

Benefit	Example
Simplified management	Manage hub and WAN access device through one management system (typically, the hub's), rather than using a different system for each product.
Enhanced management functions	SNMP support for WAN devices, which have typically lacked this type of management.
Improved reliability	Can plug WAN access device into hub and share hub's redundant power supply rather than using independent power supplies. Integration into hub means fewer cables are required to connect devices.
Easier to resolve equipment problems.	Less finger pointing when you buy components from one vendor.

The reason for the shift is that a hub with WAN access integrated into it is easier to manage compared to using stand-alone solutions. "We can consolidate our entire remote-access solution into the hub, thereby improving network management, reliability, and security," says Brian Perry, director of information services at Vertex Pharmaceuticals (Cambridge, MA). Perry's sentiments are at the heart of the integration trend. According to Val Sribar, program manager for the consultancy the Meta Group (Reston, VA), "Managing the total infrastructure—the hubs, routers, and muxes—is the key issue."

Responding to this demand, virtually all the major hub vendors including 3Com (Santa Clara, CA), Cabletron Systems (Rochester, NH), IBM, Optical Data Systems (Richardson, TX), and Synoptics Communications (Santa Clara, CA), have introduced products to provide WAN connectivity. And a number of other vendors that have expertise on the WAN side, including Shiva (Burlington, MA), Xylogics (Burlington, MA), and Xyplex (Littleton, MA), have been enhancing their offerings and partnering with the high-end hub vendors.

The evolution of hubs into the single LAN/WAN access point is changing the way WAN access products are managed. In the past, managing this mix of equipment was not easy because each piece of equipment had its own proprietary management system. But the integrated approach allows all devices to be managed by one system, typically the hub's management system. This reduces the complexity of managing the network.

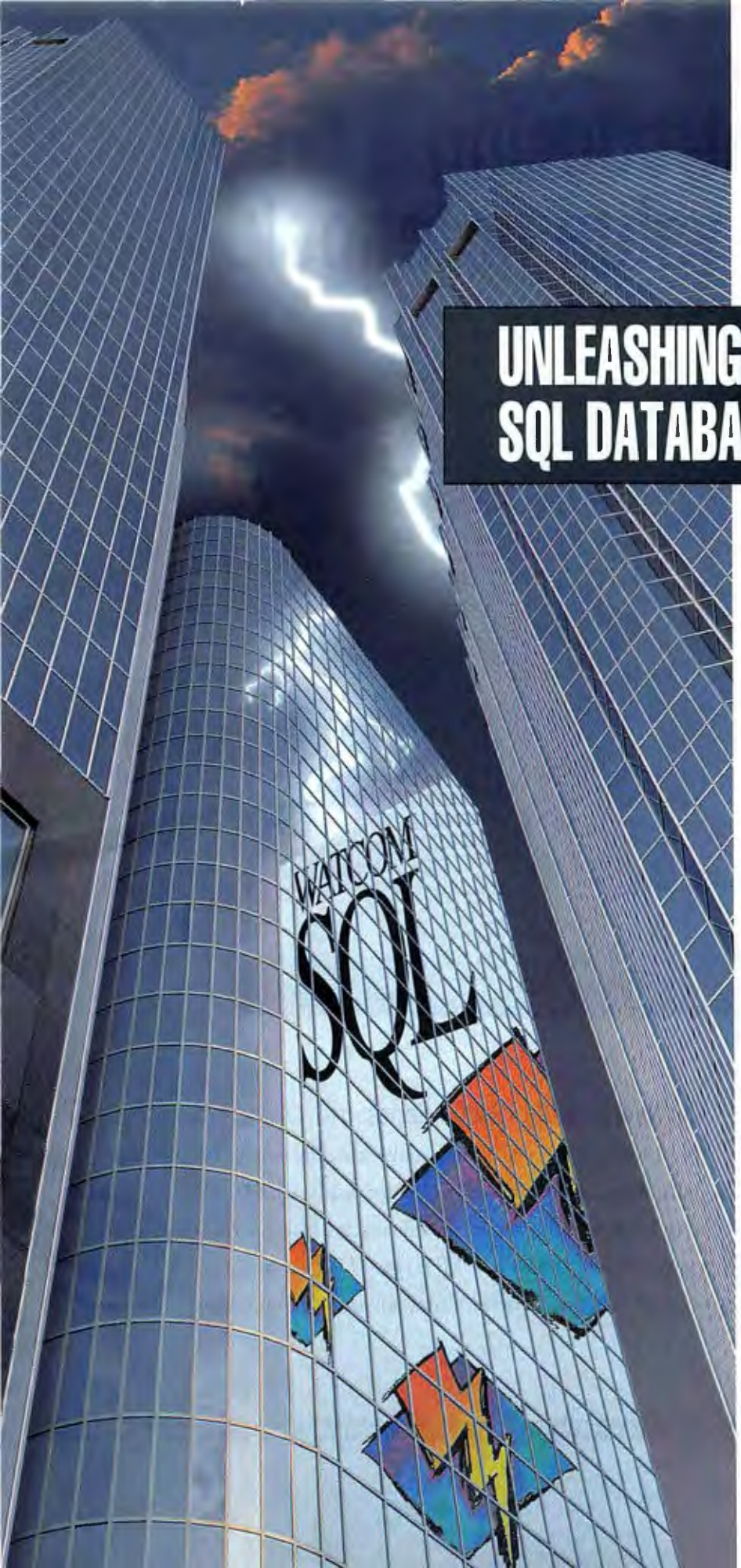
Besides simplifying management, integration most often provides better management capabilities. That's because stand-alone WAN access devices, such as communications servers, CSU/DSUs, modems, or ISDN terminal adapters, have often lacked even the most basic management utilities.

Vendors who are integrating such products into their hubs often provide enhanced management tools for remote management. For instance, many are adding SNMP (Simple Network Management Protocol) support to these products. With SNMP, management of the WAN devices is easier. For instance, products that include SNMP agents can send alerts to higher-level management systems like Hewlett-Packard's OpenView, Sun Microsystems' SunNet Manager, or IBM's Netview.

Integration of WAN access products into hubs helps in other ways. Installation is typically much easier. Rather than configuring separate products, the combination is usually configured as one device. In addition, any conflicts between products can be resolved with a call to one vendor, thus avoiding the finger-pointing that often takes place among vendors when a problem occurs that involves a number of vendors' products.

Another benefit to integrating products is improved reliability. If separate units are used, they must be connected by cables. And each cable is a potential source of failure in a network. Additionally, reliability is improved because there are fewer pieces of equipment. For instance, a plug-in card with 12 integrated modems uses the redundant power supply of the hub chassis. In contrast, 12 stand-alone modems would each have their own power supplies.

—Salvatore Salamone



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WIDE-AREA NETWORKS

IBM Plans Ambitious Network

This fall, IBM will introduce an ambitious set of new communications services, collectively called Intelligent Communications, that span the gulf among different access providers, mail systems, delivery media, and user devices. The aim is to hide from mobile customers the complexity of navigating different networks and addressing schemes, while letting them more easily personalize their service options and user interface through which they communicate.

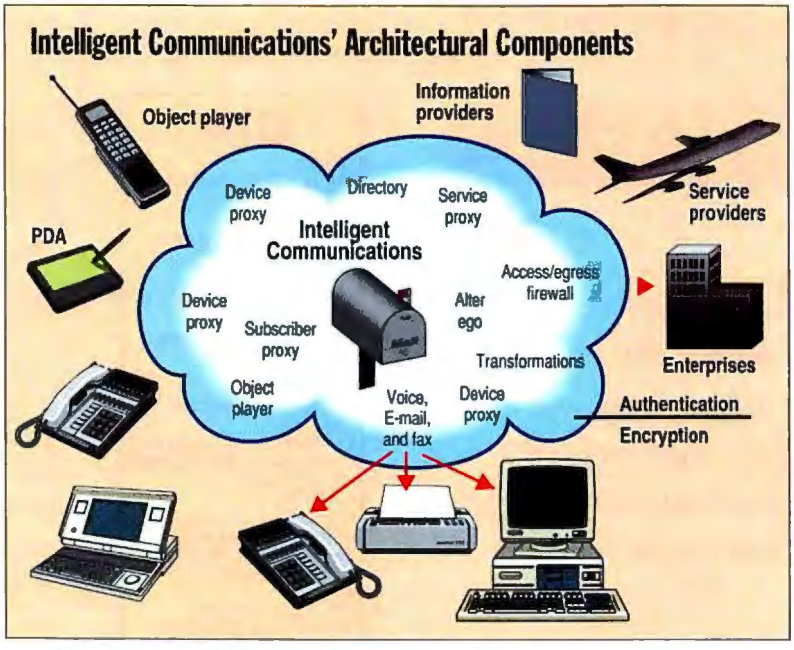
Intelligent Communications supports a range of media, including public and private E-mail, voice and voice mail, fax, paging, and data. Customers can use a variety of access devices, such as a phone or cellular phone, pager, notebook computer, or PDA (personal digital assistant); the network will automatically transform messages into a format appropriate for delivery to a given device. And subscribers will be able to establish rules for routing and handling messages so that, for instance, E-mail from the CEO will trigger a page, urgent messages will be forwarded to a fax machine at a hotel, and routine messages will stay in an E-mail box. Intelligent Communications will offer a "universal" mailbox, where a subscriber can check for messages of all types.

The service uses the latest communications technologies, especially agents, filtering, and security. "We use intelligence to mask the complexity of the network, and we use agents to help you gather, prioritize, and automate handling of messages," says Doug Sweeney, the IBM general manager for Intelligent Communications. Security provisions include encryption and authentication.

The service is designed to be open and to ride on top of other systems, or, as IBM says, "to be neutral with respect to devices, networks, and back ends." IBM hasn't disclosed its third-party partners yet (these are expected to be carriers), but Intelligent Communications will work with the IBM/Motorola Ardis packet-radio joint venture, as well as with Prodigy, IBM's Advantis value-added network, and the Internet. All the system specifications and interfaces will be published, and IBM is encouraging development of next-generation applications that ride on top of Intelligent Communications.

In concept and architecture, Intelligent Communications is similar to the PersonaLink service announced by AT&T, which uses General Magic's Telescript language and agents. The difference, says IBM, is that PersonaLink is aimed at consumers, whereas IBM's service is for businesses (i.e., to give mobile users access to legacy data). Another distinction is that, at least initially, PersonaLink will require unique devices and software to use it, whereas Intelligent Communications is more like a bridge among existing services. Over time, the services from these two giants, both battling for primacy in computers and communications, will almost inevitably interoperate, giving users the benefit of choice.

—Andy Reinhardt



A typical scenario in IBM's Intelligent Communications network would involve one user querying another user's "alter ego" to find out how to best route a message of a given type to the recipient at a specific moment; the response provided by the alter ego might be a user pager number or an E-mail address. Subscriber proxies insulate people who are sending messages from having to know the intimate details of a recipient's routing path. Proxies also insulate users from details regarding phones, land-line modems, and other devices. With this flexible architecture, IBM aims to support a range of devices and media types across the network.

ON-THE-ROAD BACKUP

Karl Malden notwithstanding, "Don't leave home without it" could well be the motto of Datasonix. The company is positioning its Pereos "mobile companion" as a portable tape backup unit. Using tiny tape cartridges that are about the size of a pad of butter—yet hold over 600 MB of uncompressed data—you can travel with every file from your server in your briefcase, so Datasonix ((303) 545-9500) claims.

That might not be the most compelling reason to use Pereos, which is slated to ship in the third quarter. Its small size, large capacity, and relatively low price make it attractive for many types of nonnetwork backup. The product falls in the "genuinely cute" category. It weighs a mere 10 ounces and looks like an electric razor mounted in a recharger. In fact, the tape unit detaches from the base, which houses two AA batteries. Datasonix claims a respectable 10-MBps backup rate using compressed data over a parallel-port connection. Windows-based backup and data management software, designed specifically for Pereos, comes with the package. The company expects the price to be less than $600. Tapes are about $28 each.

Datasonix's portable tape backup unit uses tiny tape cartridges that can hold over 600 MB of uncompressed data.

Despite the respectable speed and what appears to be a well-designed software front end, Pereos is still a linear storage technology. It cannot match a hard drive for access speed. Still, such a small, battery-powered unit could be very useful in other situations. For example, its small form factor and low cost make it attractive for small or home office use. Or a company could buy one for a workgroup to share.

—Michael Nadeau

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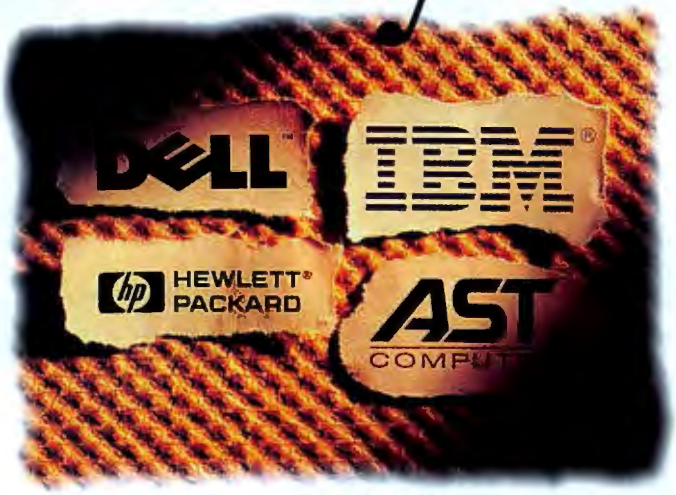

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BEST OF COMDEX

New Operating Systems Take Honors

BYTE editors scoured the floors at the Spring Comdex show in Atlanta to find new products and technologies that will impact the industry. IBM's OS/2 "Performance Beta" (see story on page 26) won **Best of Show**. It also won the award for best **System/Development Software**.

Microsoft's OLE Custom Controls captured the **Most Significant Technology** award. The architecture combines OLE 2.0 with VBXes (Visual Basic custom controls). The 16-bit VBX architecture was closely tied to Visual Basic, making it difficult for other development tools to support. OLE Custom Controls will be both 16- and 32-bit and may be available in the future on operating systems such as Unix and the Mac. A wide variety of applications will be able to host OLE Custom Controls.

Best Rookie winner Medio Multimedia ((206) 867-5500) publishes various multimedia titles, including *Medio Magazine*, a magazine on CD-ROM that integrates full-motion video, audio, text, and graphics.

In the **Multimedia Software** category, Elastic Reality ((608) 273-6585) won for its morphing and special-effects software for film and video professionals. The program is available for Silicon Graphics, Mac, and Power Mac. A Windows version is slated to ship in the third quarter. The **Multimedia Hardware** winner was Video Machine Lite. From Fast Electronic ((415) 802-0772), the video-editing system has much of the functionality of the Video Machine Desktop Video Studio for PCs.

In the **Portable** category, Apple's new line of PowerBook 500 notebook computers won (see "Apple Redefines the Notebook" on page 143). In the **Best System** category, Intergraph's dual 90-MHz Pentium-based TD-4 Personal Workstation won. The TD-4 ((205) 730-2000) system runs DOS and Windows applications natively, offers a high-performance graphics subsystem, and runs CAD, modeling, and imaging Windows NT applications.

Number Nine ((617) 674-0009), which demonstrated a new graphics and multimedia board based on the Imagine-128, a 128-bit graphics and multimedia processor, won in the **Peripherals** category. In the **Printer** category, Epson won for its Stylus Color inkjet printer that delivers near-photographic color images for about $600 ((310) 782-0770).

Best Software winner Lotus Forms 1.0 ((617) 577-8500) lets you design, route, and track forms that automate business processes over cc:Mail, Notes, and Microsoft Mail–based messaging systems. In the **Communications** category, Scanfx from Plustek ((408) 745-7111) delivers a multipurpose scanner that can send and receive 300-dpi faxes and print images at up to 600-dpi for under $800. Artisoft's CorStream server software ((602) 670-7100), which adds a dedicated server (based on NetWare 4.0) for the LANtastic peer-to-peer network, won in the **Networking** category.

Whatever Happened to . . .

The plans to make Avid Technologies' OMF (Open Media Format) compatible with Apple's QuickTime format (see Microbytes, October 1992 BYTE, page 30)

Avid recently announced two renewed efforts to make OMF—a format for the exchange of video, audio, graphics, and animation—and QuickTime work together. Greg Clukey, OMF program director at Avid, says that by year-end, Avid will release bridging software that lets you move multimedia and data compositions back and forth between QuickTime and Open Media Framework Interchange digital-media file formats. Avid says it is also working to make QuickTime a public data type within OMF files so that video producers can incorporate QuickTime files as objects into their movies.

BEST OF COMDEX FINALISTS

Most Significant Technology: DEC's Alpha microprocessor blazing at 333 MHz and Kurzweil Applied Intelligence's Voice for Windows (see "Kurzweil Brings Voice Dictation to Windows" on page 48).

Multimedia Software: MediaShop for Windows, a multimedia development and delivery program from Motion Works ((415) 541-9333) and Razor digital video software for Windows from In:sync ((301) 831-5008).

Multimedia Hardware: MediaPlayback PC and Macintosh lets a CD-ROM-equipped computer play full-screen CD-I (CD Interactive) programs, Philips Digital Video movies, and VideoCD CDs from International Interactive Media ((617) 890-6565); and Matrox Graphics MGA Impression Plus 64-bit graphics and video accelerator board ((514) 685-2630).

Portable: Zenith Data Systems' ((708) 808-5000) modular Z-Noteflex notebook PCs with the optional Flexshow multimedia companion unit that includes a CD-ROM drive and stereo speakers and IBM's ThinkPad 755 family (both active-matrix and dual-scan passive matrix) with its portable multimedia expansion unit ((800) 426-2968).

System: ALR's Revolution Q-SMP Symmetrical Multiprocessor server that supports up to four Pentium processors ((714) 581-6770) and NekoTech's low-cost Mach 1-166 workstation ((714) 580-0055) based on the Alpha AXP 21066 processor.

Printer: HP's LaserJet 4 Plus and LaserJet 4M Plus 12-ppm printers and ((800) 752-0900) and the PrimeraPro Color Printer from Fargo Electronics with 600- by 300-dpi dye-sublimation and wax thermal printing ((612) 941-9470).

Software: XRES, a painting/editing system from Fauve Software ((919) 380-9933) and Target Software's Windows-based CashGraf accounting, reporting, planning, and financial-tracking system for businesses ((800) 872-4813).

Peripherals: The ViewSonic ((909) 869-7976) 17 Monitor (which has a vertical frequency of up to 160 Hz) with OnView, a menu controlled, on-screen control and adjustment system, and Distributed Processing Technology's ((407) 830-5522) SmartRAID self-contained RAID storage subsystem.

System/Development Software: Microsoft's Windows NT Workstation operating system (code-named Daytona) and WinG (also from Microsoft), which enables fast, smooth graphics animation in Windows 3.1, NT, and Windows Chicago.

Communications: CommCard, a wireless fax/modem with land-line and voice capabilities from Open Sky ((508) 442-4367), and Connection Pro, a multifunction 19.2-Kbps data/fax/voice modem from DigiCom ((408) 262-5017).

Networking: SkyLAN, a LocalTalk wireless network from Anam S&T ((215) 692-3290), and the Ben110 16-bit ISA Ethernet network adapter from Boca Research ((407) 997-6227).

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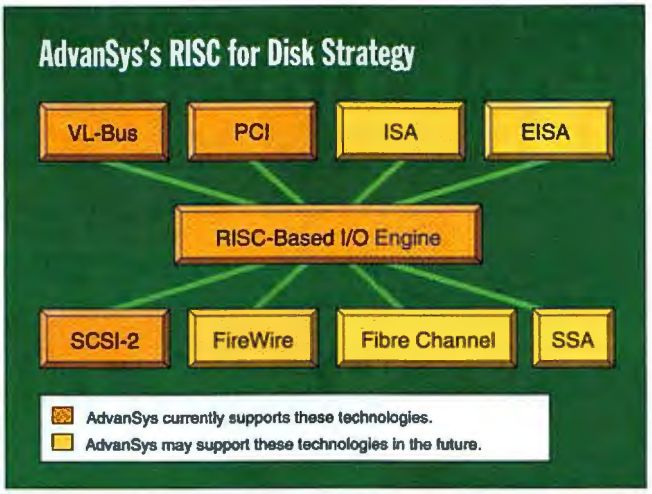
PERIPHERALS

AdvanSys Uses RISC for Faster Disks

A major problem with today's fast processors is that it is increasingly difficult for I/O subsystems to keep up. As a result, a fast processor must often wait until instructions and data become available from peripheral devices such as hard drives. One solution to the problem is faster I/O interfaces.

A start-up called AdvanSys (San Jose, CA, (408) 383-9400) has developed two new SCSI-2 controller chips to help reduce the I/O bottleneck. According to AdvanSys, its ASC1000 (for VL-Bus systems) and ASC1200 (for PCI [Peripheral Component Interconnect] systems) controller chips are 2.5 times faster than other SCSI controllers. The performance figures are for I/O events handled per second, with from one to seven devices connected to the controller. Both controller chips are priced at $21.95 each in quantities of 1000. The VL-Bus version is available now, with the PCI version coming in September.



The modular nature of AdvanSys's SCSI controller chips lets the company marry other bus interfaces and other peripheral interfaces to the I/O engine. In the future, the same AdvanSys I/O engine may be used to support Fibre Channel, Storage System Architecture, or FireWire peripherals, in addition to SCSI.

AdvanSys is also selling two SCSI host adapters based on its controller chips. AdvanSCSI Gold ($599) is targeted toward servers, while AdvanSCSI Silver ($379) is meant for single-user systems. Both AdvanSCSI adapters automatically configure the I/O port address, BIOS address, and IRQ (interrupt request) channel, as well as automate the SCSI configuration.

AdvanSys chips use an I/O engine based on the company's own 10-MIPS RISC processor instead of using dedicated silicon as Adaptec and others do. Also, unlike most other SCSI controllers that feature hardware-based registers, the AdvanSys chips contain no registers. Instead, they have a high-speed connection to local memory that lets them store up to 255 I/O requests at a time, which is useful in a multitasking environment containing multiple SCSI devices. Other SCSI controllers must swap requests to system memory when the number of requests rises above the number of registers—usually four.

The AdvanSys controller chips consist of three key components on a single die: the expansion bus interface (VL or PCI), the I/O engine, and peripheral bus interface. Having the bus interface on the controller chip reduces the chip count on the host adapter, which reduces design and implementation costs. **—Bob Ryan**

DOCUMENT CONFERENCING

Voice/Data Technologies to Coexist

The promoters of two incompatible technologies that let document-conferencing applications send voice and data signals over the same analog phone line have avoided a potential standards skirmish by agreeing to work together for interoperability. Eliminating a battle between AT&T's VoiceSpan and Radish Communications Systems' VoiceView should help grow the market for voice-and-data modems for analog phone lines.

VoiceSpan, or SVD (Simultaneous Voice/Data), allows a new kind of modem that modulates voice and data onto a single carrier, letting you converse on the phone while exchanging data files. Because it uses unusual techniques for merging digitized voice and data, VoiceSpan doesn't work with some digital-phone switches and interactive-voice response systems. VoiceView's technique involves switching between voice and data signals. With VoiceView, speech is transmitted with maximum analog fidelity, and data moves along at a 9600-bps clip. But conversation ceases when you're sending a file or waiting for a screen update.

VoiceView is economical because you can add it to existing modems with a firmware upgrade, whereas VoiceSpan entails sophisticated new modulation techniques. VoiceView supporters like Intel, Hayes, and Microsoft say that the low cost of licensing Radish's multiplexing technique will make it a cinch to add to some existing products.

Now AT&T has licensed the Radish VoiceView technology for incorporation into its VoiceSpan modems. This means that a VoiceView switching modem will be able to talk to a VoiceSpan modem (which will revert to a switching mode). VoiceView modems still won't support simultaneous voice and data communications.

VoiceSpan's and VoiceView's window of opportunity is framed by how quickly digital telephony services like ISDN are deployed in the U.S. "Radish is not a perfect technology for us because we're assuming people have a constant line for voice," says Gary Gysin, vice president of marketing for document-conferencing supplier Crosswise. AT&T's SVD, he says, is "a better approach for document conferencing." Despite their appeal today, Gysin contends, both AT&T's and Radish's techniques are merely "stopgaps until ISDN."

—Andy Reinhardt

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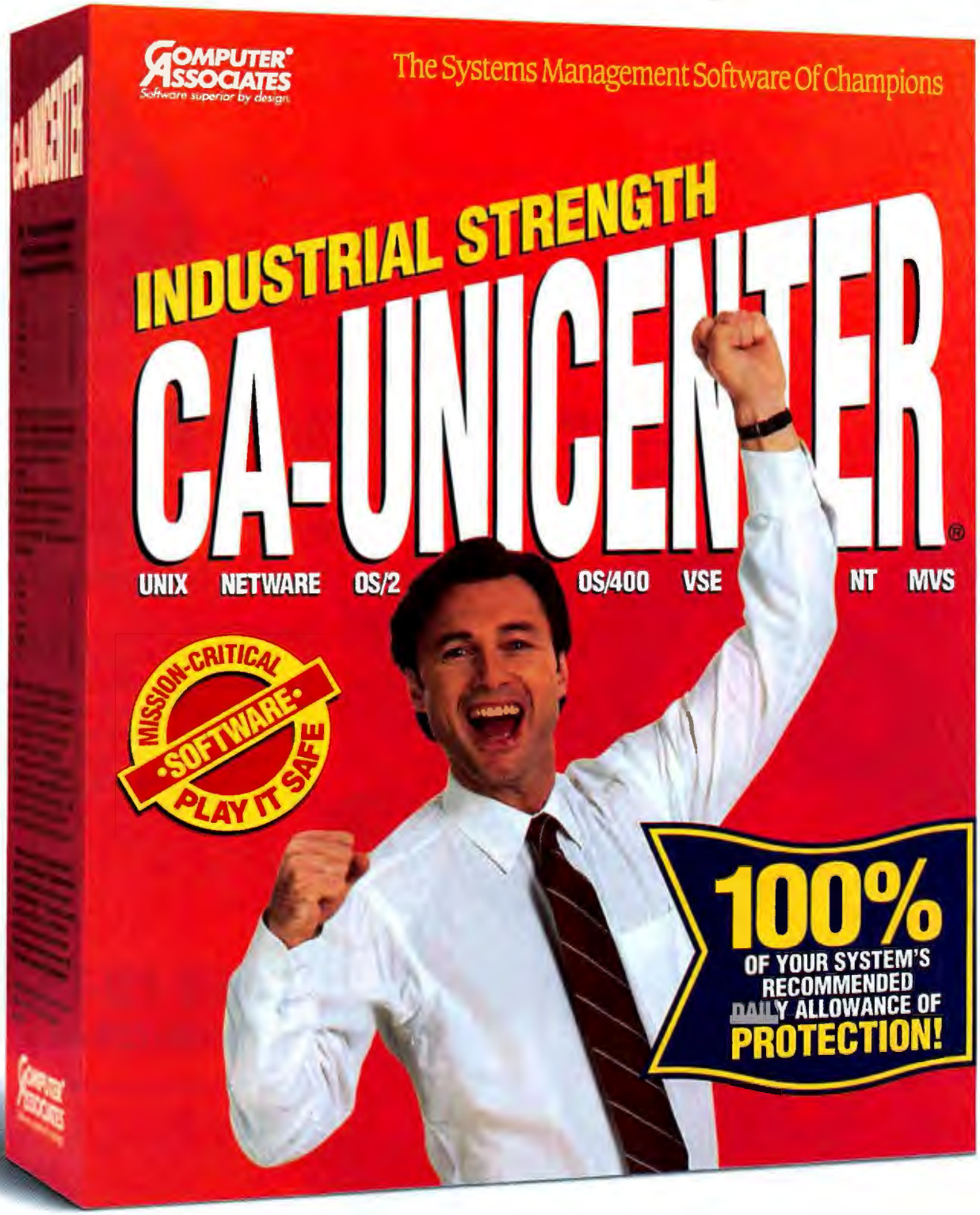

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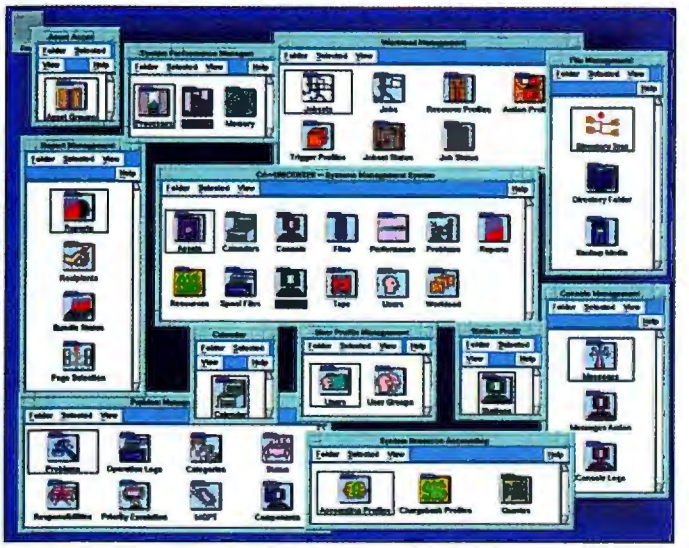

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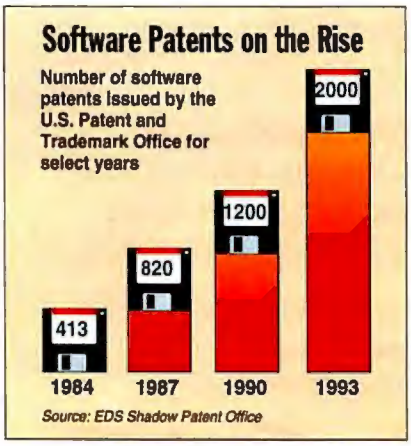
NEW PRODUCT DEVELOPMENT

Help for Patent Fever

The number of software patents that the Patent Office issues is rising (see the figure "Software Patents on the Rise") as companies use this form of intellectual property law to protect their intellectual assets. Several companies have introduced products and services that can help a developer file a patent application or search for prior patents.

Electronic Data Systems (Plano, TX) recently announced a system that lets you search for the existence of patents by sending mail to spo_patent@spo.eds.com over the Internet. The system, called the SPO (Shadow Patent Office), includes a database of the complete text of patents issued by the U.S. Patent and Trade Office after 1972. You can search the database in various ways ranging from simple keyword searches to a more sophisticated approach called a *concept search*, in which you enter an entire description of an invention. EDS offers specific text-only patents for $4.50 each.



EDS's service, however, is currently text only, and patents also have associated drawings and figures. After you have identified the patents that you want to examine, you can use services such as the one offered by SmartPatents (Menlo Park, CA): The company will send you the entire text—as well as associated illustrations—of specific patents on CD-ROM. SmartPatents' fee is about $100 per patent; that may sound expensive until you consider that a subscription to Lexis (Dayton, OH), the electronic legal research service, costs $125 per month, $46 per hour for connect time, and additional money for downloads and searches.

When you file for a patent, you need to include a statement of prior art that lists references that may have been published in a book or magazine that are relevant to the invention. Source Translation & Optimization (Belmont, MA) maintains a database of over 100,000 references to technical books, papers, and journals for patent searches. STO must perform the search services for now, but it may make the system available on-line through a service provider like Lexis/Nexis.

For people who want to avoid expensive patent attorney fees, EDS and Nolo Press (Berkeley, CA) have created an electronic version of David Pressman's, *Patent It Yourself* to help make it easier to file a patent application. The software will help you keep many of your application's details straight.

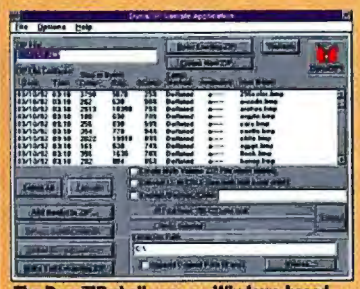
Each of these products can help many developers pursue patents for their creations while saving money on expensive lawyer fees and search services. They will also be useful to others who wish to avoid expensive R&D on a technology that someone else has already invented. **—Peter Wayner**

CODE TALK

RICK GREHAN

Add Seamless ZIP Support to Your Windows Applications

MS-DOS users—yes, I'll bet there are still lots of you out there—are familiar with the ubiquitous ZIP file-compression format. Windows users are familiar with ZIP files as well; and, until now, a Windows user working with a ZIP file is someone dropping into Windows' MS-DOS prompt.



The DynaZIP shell wraps a Windows-based GUI around all the capabilities of PKZip and PKUnzip. The pick-list provides easy access to an archived file's contents.

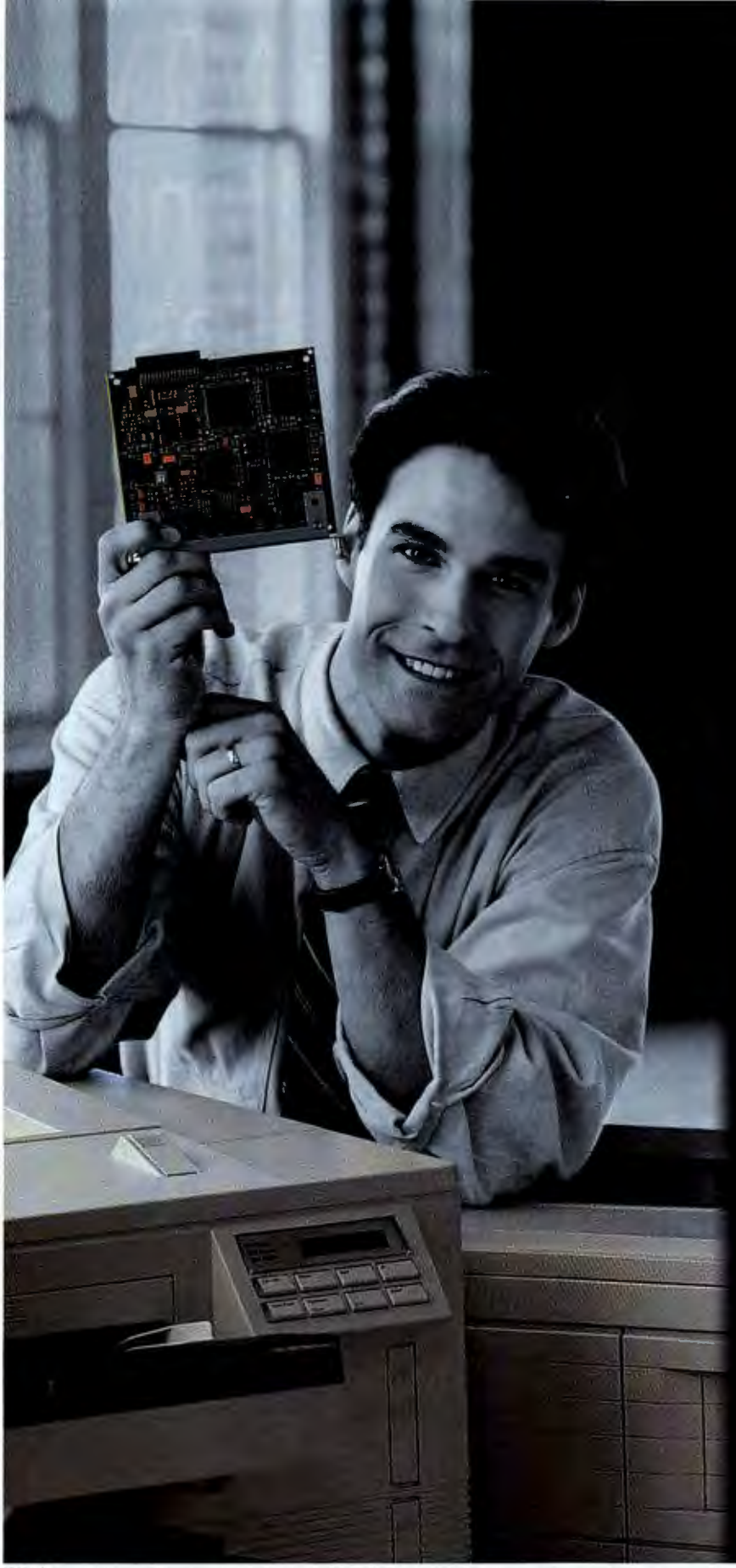
DynaZIP, a programmer's toolkit from Inner Media ((603) 465-3216 or (800) 962-2949) will probably change that. With DynaZIP, which sells for $249, you can build Windows-based C/C++ or Visual Basic programs that can read and write industry-standard ZIP files. Actually, since the engine that does all the work is supplied in a pair of DLLs (one ZIPs, the other unZIPs) whose APIs are well documented, just about any language that can get at a DLL can use DynaZIP. I looked at version 2.0, which included interface files for Pascal, as well as an interconnection DLL called DZPIPE that lets you get at the DLLs through either Paradox or FoxPro. It's likely that by the time you read this, Inner Media will have connections to DynaZIP for many more languages and application builders.

The DLLs are certainly well crafted. They allow your application to specify callback functions, so you can put a "percent completed" bar graph into your program. (Code is supplied for a Visual Basic custom control that makes just such a bar graph.)

Callback functions can also abort an ongoing ZIP or unZIP operation, which means you can put a "cancel" button under that bar graph. Furthermore, you can use the callback functions to place a "message pump" into the process, so other Windows applications won't come to a halt while your ZIP program is at work.

One of the nicest components of the package is actually a gimmie. Called the DynaZIP shell, it began life as a sample DynaZIP C application, but its creators decided to include it as a Windows utility program. It's basically a ZIP file maintenance program; you can open a ZIP file, step through a pick list of its members, selectively extract or add files, and all without having to step down into DOS. You can even extract and execute a member of the ZIP file (provided that you have set the association between application and extension in File Manager). Finally, the authors have graciously included the source code, so you get an excellent example of how to use DynaZIP.

The package allows royalty-free distribution of the DLLs, as well as whatever applications you build to access them. You can even build Windows-based self-extracting ZIP files. If you are doing Windows programming and you require compression, you won't go wrong with this one.



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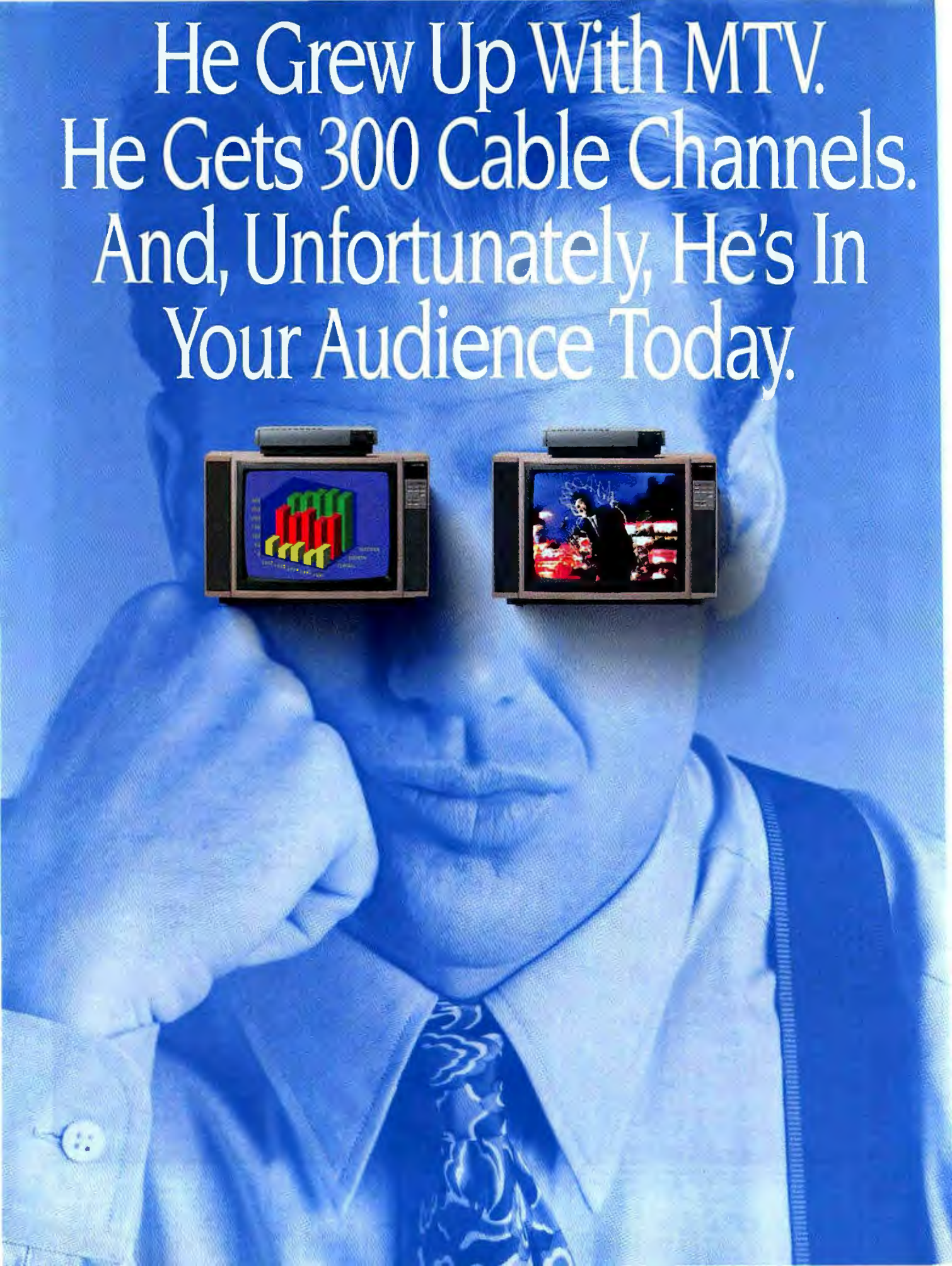

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WINDOWS GRAPHICS SUITES

CorelDraw 5.0 Adds Better Image-Editing Tools

Stephen Arscott, a graphics artist at the Arscott, Ticar & Kobli Integrated Communications advertising firm, won Best of Show at the CorelDraw World Design contest. He used CorelDraw 4.0's freehand drawing tools to draw the two people and powerlines (i.e., customized shapes from the pen tool) to create the feathers in the headdress.

The new CorelDraw 5.0 offers a significant improvement in the PhotoPaint image-editing application, as well as numerous new image-editing tools. CorelDraw 5.0 ($695 for the CD-ROM version, (613) 728-8200) offers morphing support in the CorelMove animation application, a run-time engine for the CorelShow presentations module, more consistent menus, an Adobe Acrobat reader for Corel Ventura, support for PhotoShop plug-in filters and many other features. Users say these are CorelDraw 5.0's highlights:

• **New lenses** These let you apply photographic effects to any graphical object. Once you apply the lens, the object maintains its status as an editable vector image. "With the transparency lens, you can overlay a semitransparent object on top of another drawn object to create a tinted window effect," says David Metcalf, president of DM2 Design (Cape Canaveral, FL), a multimedia and publishing consulting company. "Before, you had to fake a transparency by manually modifying colors." Metcalf also says the magnification lens is useful for technical illustrators who need to magnify a portion of an image.

• **PowerClip** Used to mask objects by pasting them into other objects, PowerClip lets you take an image and place it into another object, such as a circle. You can also use it to paste an image of a person's face into letters that spell out the person's name.

• **Better color management** Corel incorporates the color management technology of Candela (Burnsville, MN) for improved color consistency among desktop peripherals like scanners, printers, and monitors.

• **Better support for OLE 2.0** You can now drag and drop images among the various CorelDraw 5.0 applications. OLE's in-place editing will only be supported in Corel Ventura 5.0, the desktop publishing program that ships in August.

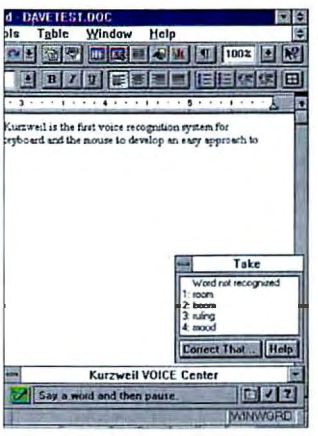
• **Much improved image editing** PhotoPaint, first introduced in CorelDraw 3.0, is vastly improved and can now compete with high-end imaging programs like Micrografx's Picture Publisher, users say. PhotoPaint now lets you move and edit photographic images on separate independent layers, and improved memory management lets you work with much larger images than previously. In fact, Corel will release PhotoPaint as a standalone program for $199 (CD-ROM version) this summer. "Low-cost scanners and low-cost color output devices, combined with high-powered PCs, are fueling the interest in image editing," says David Huss, director of technical marketing at Express Star Systems (Austin, TX). "PhotoPaint is the everyday person's photo-editing package without the high price tag." —D.A.

SPEECH RECOGNITION

Kurzweil Brings Voice Dictation to Windows

People looking for a more "hands-off" approach to interacting with their PC running Windows should be able to pick from at least three voice dictation programs by the end of the year. Kurzweil Applied Intelligence (Waltham, MA, (617) 893-6525) has released Voice for Windows 1.0, a $995 program that lets you create text and control Windows applications by speaking into a microphone. At press time, at least two other companies were working on Windows speech-dictation programs: Dragon Systems (Newton, MA), which already has a dictation program for DOS, says it will release a Windows version this summer, while IBM is expected to release a Windows version of the company's Personal Dictation System this year.

Kurzweil's Voice for Windows lets you dictate speech at the rate of about 50 words a minute. You can also use the program to open and close files and perform operations like cutting and pasting. The program doesn't require training—you can use the program as soon as you install it—but you can improve the program's ability to recognize your spoken words in brief training sessions. While trying out Kurzweil Voice for Windows, I was able to dictate text at a rate of about one word per second, with one or two mistakes per paragraph.



Kurzweil's Voice for Windows dictation program delivers a significant level of hands-off operation and should appeal to anyone with limited typing skills or whose job is keyboard- and mouse-intensive. The program is speaker independent, but you can improve its recognition accuracy in brief training sessions (shown).

The package includes Kurzweil's 16-bit, DSP-based (digital signal processor) sound board with a microphone. The company says future versions of the program will support DSP-based sound boards from third parties. Voice for Windows requires a 33-MHz, 486-class PC and 8 MB of dedicated RAM to support a 30,000-word active vocabulary (16 MB of RAM for the 60,000-word vocabulary). These are not minimal hardware requirements, but then voice dictation is not a lightweight application. —D.A.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- ▲ VESA Local Bus IDE Hard Drive Controller
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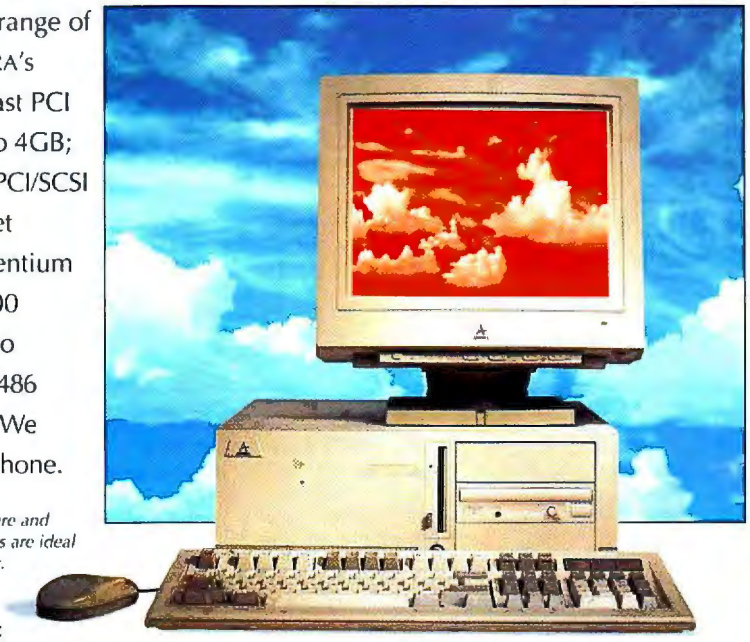

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Embedded Systems Programming

RICK GREHAN

It must have been providence that arranged to have these two books arrive almost simultaneously. Here's a topic—developing embedded systems—explored by authors in two occasionally overlapping dimensions.

Although these books are complementary and not contradictory, I did encounter passages that suggested placing the authors together in a closed room would make for lively conversation. John Forrest Brown's *Embedded Systems Programming in C and Assembly Language* has a "roll up your sleeves and do it" attitude; Karen S. Ellison's *Developing Real-Time Embedded Software in a Market-Driven Company* is all about planning. I'll examine *Embedded Systems Programming* first.

I'm going to admit up front that I was confused about the audience that Brown was targeting. Initially, I was convinced that the audience was embedded systems software developers; specifically, those working in C and assembly language.

Not far into it, I decided I was wrong. True, there are plenty of code examples (and an included disk if you don't want to type everything in), but the book also contains guidelines on the design process. Admittedly, these guidelines are brief, but the appendixes hold reasonably complete requirements and design documents. I concluded that the person most likely to read this book would be a software engineer contemplating an embedded systems project.

For hardware platforms—specifically, CPUs—the book examines only the Intel 80x86 and Motorola 680x0 processors. In all assembly language examples, the author provides source code for both CPUs. Although Brown handled the parallel presentation of both CPUs well, I found it disturbing that he ignored a huge slice of the embedded CPU pie. Where are the Intel 8051s or the Zilog Z8s? And the Motorola 6800s?

The author suggests that most embedded architectural schemes are built around either a VME bus—and therefore will use a 680x0—or an STD bus—and therefore will use an 80x86. It seems to me that a more likely answer is that the examples given in the book, which consist of a pilot control panel and an interface box for a guided-missile-to-aircraft interface, are simply too complex to be easily handled by 8-bit embedded processors.

This *is* a book on C and assembly language, of course, and the author divides the work between those two languages as you might expect. C handles most of the computational work; assembly language picks up the ball when there's an interrupt service routine or start-up code to be managed. Start-up code is important enough that Brown devotes an entire chapter to it. In embedded systems, the start-up code is what starts all the digital blood flowing.

Meanwhile, *Developing Real-Time Embedded Software* is a case study of a "hypothetical" design project of an 80188-based drive controller. I put hypothetical in quotes because the documentation is so complete, the author's explanations and analyses so detailed, that I can't be certain that the described system isn't sitting in a computer somewhere.

Where Brown's book is heavy on programming tools and techniques, Ellison's is all on design guidelines. Ellison justifies the book's emphasis: "System problems

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Karen S. Ellison
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A HOLOCAUST STORY

THE COMPLETE MAUS: A SURVIVOR'S TALE
THE VOYAGER CO., 578 Broadway, Suite 406, New York, NY 10012, (212) 431-5199, $49.95

The Complete Maus contains the two graphic novels (or in the lingo of my youth, comics) of *Maus: A Survivor's Tale*. This Pulitzer prize–winning work by Art Spiegelman chronicles the experiences of his father, Vladek, during the Holocaust. In this missive, persecuted Polish and German Jews are portrayed as mice, preyed upon by feline Nazis. Although the premise seems odd, the predator-prey situation conveys all too well the horrors that occurred during World War II.

What does The Complete Maus offer over the original work? For starters, you get most of the transcripts and sketches that Spiegelman used to make *Maus*. You also get a glimpse of the painstaking attention to detail he lavished on the work. A scene where Vladek enters Auschwitz is shown to be carefully researched as to which camp gate was used and the direction used by the truck carrying the prisoners into the camp.

You glimpse penciled images being carefully laid out to conform to a comic-book grid and then witness the text accompanying the artwork's voice balloons being edited and pruned to fit the panels. CD-ROM's big advantage here is that both graphic novels are richly reproduced at full size. A small page layout adjoining the full-screen image is marked with colored panels that act as links to drafts of the artwork, while other icons supply voice commentaries by either Spiegelman (describing the assembly of the page) or Vladek (his recounting of the incidents appearing on the page).

If you're keenly interested in what went into the making of *Maus*, Voyager's The Complete Maus will be of interest to you. If not, you might be better off finding *Maus* on the bookshelf. However, The Complete Maus is a good example of how the CD-ROM medium can enhance the original work, provided the subject matter is of interest to you.

—Tom Thompson

usually are not due to poor coding of individual components, but to poor design." I was gratified to see Ellison pay so much attention to performance analysis, three chapters in all. The first two such chapters concentrate on the analysis of individual system components (again, using the drive controller as the model project); the third chapter shows you how to pull all the components together and build an overall performance view of the system.

The entire design document—diagrams, tables, text, and all—is in the appendixes. I am tempted to say that if you learn by example, you should go straight for the appendixes. That would, however, be a mistake here. The author's style is too illuminating to miss. Besides, toward the beginning, Ellison suggests three alternative reading approaches. Pick the one you like best.

Earlier, I wrote that anyone contemplating software development in the embedded marketplace would be a likely buyer of *Embedded Systems Programming*. I will now modify that and suggest that you seek out both books: *Embedded Systems Programming* to see the kind of software you'll be dealing with, and *Developing Real-Time Embedded Software* so you'll get your project right the first time. ■

Rick Grehan is technical director of the BYTE Lab. He can be reached on the Internet or BIX at rick_g@bix.com.

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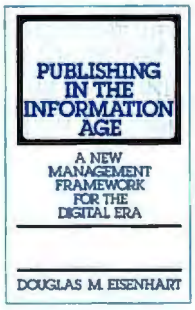

Technology is forcing print-publishing professionals to ask a lot of hard questions. What role do paper books play in the age of digital media? How do they make the transition to electronic media? What types of information are appropriate for a given medium? *Publishing in the Information Age* guides those professionals through these and other issues.

Although the book is intended as a management guide for people who work in print media, anyone interested in electronic delivery of information will appreciate Eisenhart's insights. He sees publishing on digital media as extending traditional publishing, not replacing it. Eisenhart effectively counters the view that the days of print media are numbered.

An executive of publisher Houghton Mifflin, Eisenhart discusses each type of medium, including CD-ROM, film, and "electronic highways," in terms of a "media matrix." Along one axis are the products and services broken down by stand-alone products, periodicals, and "open channel," which includes broadcast and networked information; on the other axis are the medium modes—textual, visual, and audio. Each medium is then blocked out according to where it falls within the grid.

Written in an academic style with an industry-specific focus, *Publishing in the Information Age* will not appeal to anyone with a casual interest in publishing. But if you want a realistic, no-hype view of the future of information delivery, this book is the one to buy. ■

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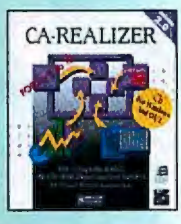

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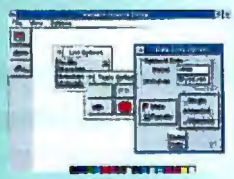

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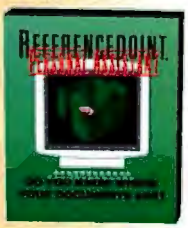

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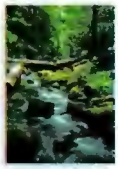
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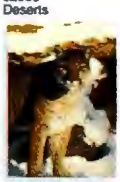
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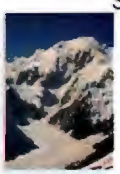
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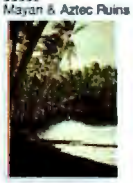
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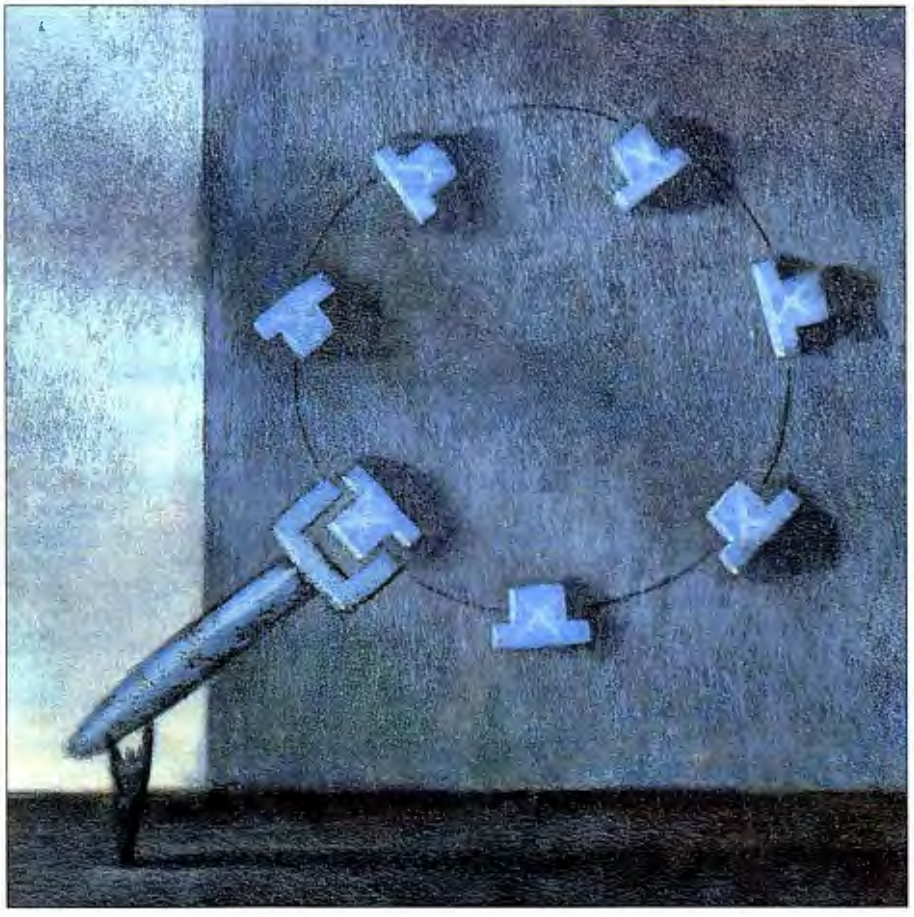

GREG HALLY © 1994

One of the hottest network products on the market, Artisoft's LANtastic is noted for its ease of setup and use. Less well known is the fact that—via programming—you can access several added features of LANtastic to create your own custom applications utilities. When we expanded our five-node network to 30 nodes at the University of Dayton's Department of Electronic Engineering Technology, we needed additional capabilities not available in the standard release. After considerable research, we discovered the LANtastic API.

With a diverse group of users requiring everything from word processing to CAD, the department was looking for a convenient way to manage faculty and student demands in a somewhat "hostile" environment. The first priority was security. Faculty teaching ECAD and Digital Design classes wanted the flexibility of shared libraries and data files for students without providing write privileges to network drives. Concern about the proliferation of viruses and the illegal distribution of copyrighted software forced us to seek an unconventional network configuration. Second, access to certain network resources such as laser printers and CD-ROM drives had to be restricted and audit trails maintained to track software use. Even though LANtastic's NET command was capable of addressing these issues, the custom programs we wrote using the API provided a more elegant and secure solution.

By accessing LANtastic via its API, you can improve the performance and security of your network

The Downside of NET

All versions of the LANtastic NOS (network operating system) provide users and network administrators with the NET command. Through a menu-driven interface, the NET command lets you log in and out, make drive and printer connections, manipulate print queues, use E-mail, and monitor network activity. The NET command provides a command-line interface that the network administrator can use for extra tasks, such as customizing a user's machine to fit the network layout; this is particularly true in dedicated-server-based LANtastic networks. For example, an administrator may create a batch file (or place the following sequence of commands in a user's AUTOEXEC.BAT file) to automatically log in to a server after prompting for a user name and password, then map a network drive and printer to the user's machine, synchronize the time-of-day clock on the user's machine with the server's clock, check for any E-mail messages, and return control to the DOS prompt:

```
NET LOGIN/wait \\server1 ?"Username: " ^"Password:"
NET USE E: \\server1\X-DRIVE
NET USE LPT2 \\server1\@PRINTER
```

```
NET CLOCK \\server1
NET POSTBOX
```

The sequence of commands shown in the code fragments above is extremely slow because the 16-KB NET.EXE file has to be loaded and executed five times. The performance hit is even greater for more complex batch files with several more NET commands or for batch files that are executed from workstations containing only floppy drives.

The LANtastic API allows you to perform the same tasks that the NET command provides and more. By writing a short (about 1900-byte) assembly language program, you can complete the same sequence of commands shown above in less than a tenth of the time required for execution of a batch file. Additionally, a desirable side effect of writing such customized programs is that the NET commands are now no longer visible to the user and cannot be modified in any way. Several network administrators would like to eliminate or restrict the use of the NET command to prevent users from changing the mapping of network resources. Compiled batch files can be used to hide the sequence of NET commands that do the mapping, but they are slower than customized programs written to do the same job—and they still require the presence of the NET command.

The LANtastic API is by no means limited to providing an alternative to the NET command. You can use it to develop any application program for LANtastic.

About the API

All application programs that interact with the NOS make use of the LANtastic API, a set of NetBIOS-compatible functions and extensions that let you access the NOS services from assembly language or high-level languages such as BASIC and C. The LANtastic API consists of 46 services grouped into two main categories: DOS-compatible function calls and LANtastic NOS-specific extended function calls. The table "LANtastic API Functions" lists the available services. You will find a more detailed explanation of each function in Adrian King's book *Running LANtastic* (Bantam Books, 1991). Because LANtastic is a NetBIOS-compatible operating system, the standard NetBIOS functions are also available using the INT 5Ch interface or the alternative INT 2Ah. All the services listed in the table are accessed through INT 21h, and because these functions provide most, if not all, of the capabilities of INT 5Ch, only they will be discussed.

LANTASTIC API FUNCTIONS

FUNCTION NUMBER	DESCRIPTION	NET EQUIVALENT
DOS-compatible calls		
5E00h	Get Machine Name	NET SHOW
5E02h	Set Printer Setup*	
5E03h	Get Printer Setup*	
5F02h	Get Redirected Device Entry	NET SHOW
5F03h	Redirect Device	NET USE
5F04h	Cancel Device Redirection	NET UNUSE
LANtastic NOS extend calls		
5F80h	Get Log-In Entry	NET SHOW
5F81h	Log In To A Server	NET LOG IN
5F82h	Log Out Of A Server	NET LOG OUT
5F83h	Get User Name Entry	NET SHOW
5F84h	Get Inactive Server Entry	NET SHOW
5F85h	Change Password	NET CHANGEPW
5F86h	Disable Account	NET DISABLEA
5F87h	Get Account	
5F88h	Log Out From All Servers	NET LOG OUT
5F97h	Copy File	NET COPY
5F98h	Send Unsolicited Message	NET SEND
5F99h	Get Last Received Unsolicited Message	NET RECEIVE
5F9Ah	Get Message-Processing Flag	
5F9Bh	Set Message-Processing Flag	
5F9Ch	Pop Up Last Received Message	NET MESSAGE
5F9Dh	Get LPT Notification Flag	NET SHOW
5F9Eh	Set LPT Notification Flag	NET LPT NOTIFY
5FA0h	Get Queue Entry	NET QUEUE STATUS
5FA1h	Set Queue Entry	NET QUEUE
5FA2h	Control Queue	NET QUEUE
5FA3h	Get Printer Status	
5FA4h	Get Stream Information	NET STREAM
5FA5h	Set Stream Information	NET STREAM
5FA7h	Create User Audit Entry	NET AUDIT
5FB0h	Get Active User Information	
5FB1h	Get Shared Directory Information	
5FB2h	Get User Name From Account File	
5FB3h	Translate Path	NET EXPAND
5FB4h	Create Indirect File	NET INDIRECT
5FB5h	Get Indirect File Contents	
5FC0h	Get Server's Time	NET CLOCK
5FC8h	Schedule Server Shutdown	NET SHUTDOWN
5FC9h	Cancel Server Shutdown	NET SHUTDOWN
5FCAh	Stuff Server Keyboard Buffer	NET RUN
5FD0h	Get Redirected Printer Time-Out	NET SHOW
5FD1h	Set Redirected Printer Time-Out	NET LPT TIME-OUT
5FE0h	Get DOS Service Vector	
5FE1h	Set DOS Service Vector	
5FE2h	Get Message Service Vector	
5FE3h	Set Message Service Vector	

* Not supported by LANtastic. However, these calls can be issued, but they don't affect anything. Printer initialization must be done through the NET_MGR program.

Accessing the NOS Services

To access the NOS services, you pass the function number of the service using register AX. For many functions, register BX serves as an index to multiple pieces of data returned by the function as you will see in the following examples. By convention, most functions set the carry flag on return to indicate an error condition with the error number in register AX. The error codes returned are the standard DOS error codes documented in Microsoft's *MS-DOS Programmer's Reference* (Microsoft Press, 1991). Except for the carry flags, the contents of unused registers are preserved.

To illustrate the use of a LANtastic API service, consider the listing "The Log-in Function," which contains the code fragment to log in the user JONES having a password of SECRET to the server SERVER1. The log-in function number is 5F81h. To access the function, you move the number into AX and point to the server, user name, and password information using register ES:DI.

Notice that the log-in string actually contains two ASCIIZ strings: The first is the server name formatted as a network path followed by the user name, and the second contains the user's password. The format of such strings varies according to the type of function being accessed as you will see in subsequent examples. Also note that BL contains an adapter number to allow log-ins to a server connected to a network on another adapter card. It is not necessary to initialize segment register ES if the string is located in the same segment as the code.

It is a good idea to perform error checking after calling a NOS service. For example, in the listing "The Log-in Function," if the carry flag is set on return from the function, register AX should be checked for pos-

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Test Button	YES	NO	NO
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Waveform Output	Simulated Sinewave	Simulated Sinewave	Simulated Sinewave
Line-Interactive	YES	NO	YES
LED Status Indicators	YES 4-LED's	NO	YES 4-LED's
Site Wiring Fault Indicator	YES	YES	NO
Test Button	YES	YES	NO
Self Diagnostic Test	YES	NO	NO

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sible error codes that could be returned if the log-in attempt failed. Failed log-in attempts could occur for several reasons, including the following:

- The server is off-line (error number 35h).
- The user's account has expired (error number 4Ah).
- The user's password has expired (error number 4Bh).
- The user has logged in too many times (error number 54h).
- The user is already logged in (error number 55h).
- An invalid user name or password was entered (error number 56h).
- Log ins to the server are temporarily disabled (error number 46h).

Other network operations such as mapping resources and setting up printers are usually performed immediately after a log-in. Checking the carry flag and associated error codes lets you trap and recover critical NOS errors before proceeding to the next step of the log-in procedure.

The Log-in Function

```
        MOV     AX,5F81H                ;NOS log-in function#
        MOV     DI,OFFSET LSTRING       ;point to log-in string
        MOV     BL,0                    ;adapter# is 0
        INT     21H
        JC      ERROR                   ;check for log-in errors
                                        ;else proceed
LSTRING:  DB    '\\SERVER1\JONES',0,'SECRET',0
```

Log-in with C

```
#include <dos.h>
#include <stdio.h>
char far *lstrg = "\\\\server1\\jones\0secret";
union REGS inregs, outregs;
struct SREGS segregs;
int result;

main()
{
    inregs.x.ax = 0x5F81;
    inregs.h.bl = 0;
    inregs.x.di = FP_OFF(lstrg);
    segregs.es = FP_SEG(lstrg);
    result = int86x(0x21, &inregs, &outregs, &segregs);
    if (outregs.x.cflag)
        printf("Network error  %d\n", result);
    else
        printf("Login Okay");
}
```

Log-in with BASIC

```
' $INCLUDE: 'QB.BI'

COMMON SHARED InRegs AS RegTypeX, OutRegs AS RegTypeX

DIM Lstrg AS STRING * 50

Lstrg = "\\SERVER1\JONES" + CHR$(0) + "SECRET" + CHR$(0)
InRegs.ax = &H5F81
InRegs.bx = 0
InRegs.es = VARSEG(Lstrg)
InRegs.di = VARPTR(Lstrg)
INTERRUPTx &H21, InRegs, OutRegs
IF OutRegs.flags AND 1 THEN
   PRINT "Network error"; OutRegs.ax
   ELSE
   PRINT "Login Okay"
END IF
```

Using C and BASIC

Most high-level languages such as C and BASIC provide access to DOS interrupts, thus giving you direct access to low-level DOS and BIOS services. This is done in exactly the same way as in assembly language; you simply set up the registers according to the requirement of a specific function and then initiate an INT 21h call.

For example, the listing "Log-in with C" contains a log-in sequence written in C. You need the header file `dos.h` to access the `int86x` function. Also defined in `dos.h` are the union variable `REGS` and structure `SREGS`, which are used to access the CPU registers.

To access function 5F81h (i.e., log in to a server), you must first initialize a log-in string containing the server's name, user name, and password formatted as previously explained. You define the log-in string using a string constant and then assign far pointer `*lstrg` to it. You set register AX to the function number by assigning the value 0x5F81 to the union variable `inregs.x.ax`. Similarly, you assign the adapter number to register BL (`inregs.h.bl`). Register DI (`inregs.x.di`) is then set to the offset address of the log-in string, and register ES is set to the segment address of the log-in string (using the `FP_OFF` and `FP_SEG` macros also defined in `dos.h`). Finally, you call the `int86x` function with the INT number (0x21), and the values of the input, output, and segment registers are passed as parameters. The function accesses the DOS service and returns the modified register values in `outregs`. The carry flag is then checked. If the flag is set, an error message and number is printed out.

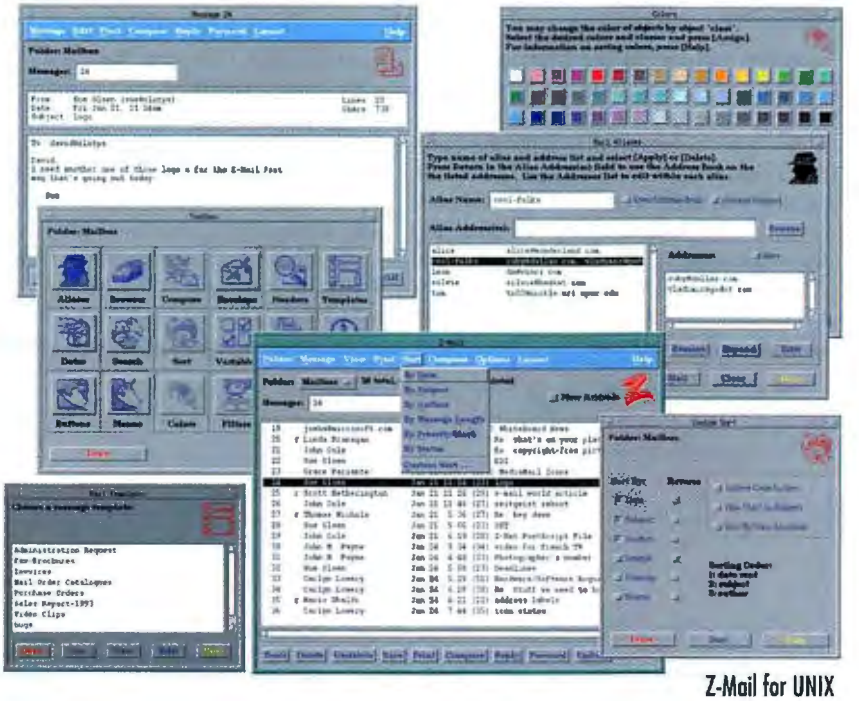
The listing "Log-in with BASIC" shows the log-in function accessed from BASIC. The include file QB.BI (VBDOS.BI, if you're using Visual Basic for DOS) contains the necessary support for the `INTERRUPTx` function. The data type `RegTypeX` defined in the include file allows access to the CPU registers. As in the C program example, the log-in string is first constructed in the proper format and assigned to the variable `Lstrg`. Registers AX and BX are then set to the function number and adapter number, respectively. A pointer to the string variable is assigned to register DI (offset address) and register ES (the segment address). The `INTERRUPTx` function is called to access DOS INT 21h with the `InRegs` and `OutRegs` variables passed as I/O parameters. The function accesses the service and sets `OutRegs` to the modified register values. The carry flag is checked by examining the least significant bit of the variable `OutRegs.flags`; if the flag is set, an error message and number are reported.

Function Examples

Regardless of the type of programming language you use, the LANtastic API functions are all accessed through a low-level call to INT 21h. Even though the rest of the code fragments illustrating the use of the API are implemented in assembly language, it should be easy to adapt them to BASIC, C, or any other language that provides access to INT services.

The process of logging out of a server is similar to logging in. The log-out function (5F82h) need specify only the name of the server in ASCIIZ form. Note that the function 5F88h is also available to log you out of all servers attached to the workstation.

To redirect network resources and cancel redirections, you access NOS functions 5F03h and 5F04h, respectively. For example, the listing "Redirecting Drive Mappings" maps drive E to the server's network drive X. To redirect a local DOS device (printer or disk) to a network



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resource, registers SI and DI must point to ASCIIZ strings that hold the device name and network path. Register CX must be set to 0 for compatibility with the NOS functions. If you redirect a hard drive or a printer, you must set register BL to 4 or 3, respectively. In the listing "Redirecting Drive Mappings," for example, you could redirect LPT2 to the server's @PRINTER resource by changing the value in register BL to 3, changing the LDEVNAME to LPT2, and changing NPATH to point to the redirected resource.

To cancel a redirection, you need specify only the name of the local device that is to be canceled; no other inputs are necessary to the 5F04h function call.

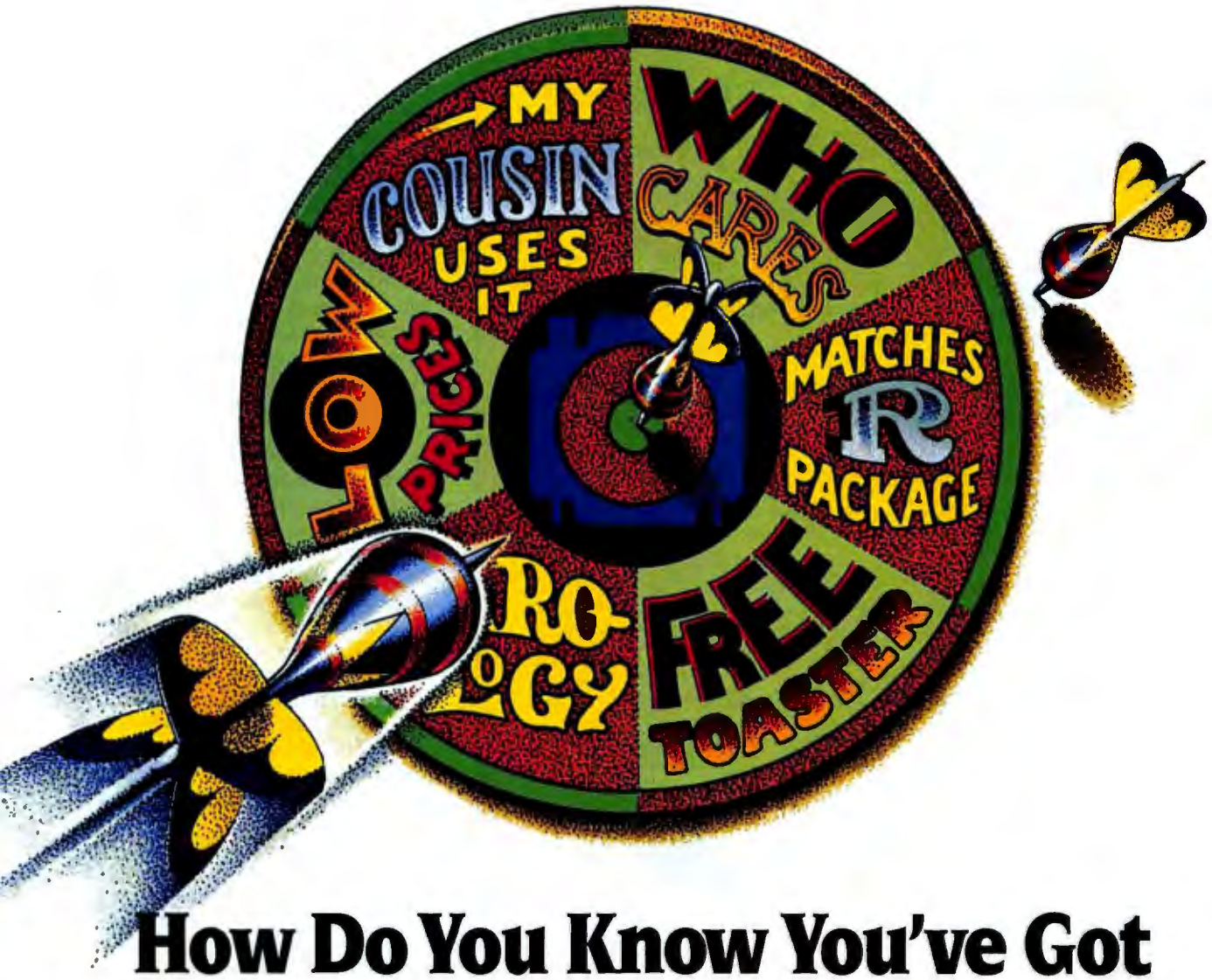
Another function normally accessed in a log-in sequence is the NET CLOCK command. This command synchronizes

Redirecting Drive Mappings

```
        MOV  AX,5F03H                ;NOS redirect function#
        MOV  BL,4                    ;type of device 4 = disk
        MOV  CX,0                    ;must be 0
        MOV  SI,OFFSET LDEVNAME      ;name of local device
        MOV  DI,OFFSET NPATH         ;redirected network path
        INT  21H
        JC   ERROR                   ;check for redirect error
        .                            ;else proceed
        .
LDEVNAME: DB   'E:',0 NPATH:    DB   '\\SERVER1\X-DRIVE',0
```

Accessing the Network Clock

```
SETTIM:MOV      AX,5FC0H             ;get server's time
       MOV      SI, OFFSET TIMEBLK   ;data structure to receive time
       MOV      DI, OFFSET SRVZ      ;point to server1
       INT      21H
       JC       ERROR                ;NOS error
       MOV      SI, OFFSET TIMEBLK   ;set pointer to data
       MOV      CX, WORD PTR[SI]     ;get date into CX
       INC      SI                   ;point to day
       INC      SI
       MOV      DL,[SI]              ;get day into DL
       INC      SI                   ;point to month
       MOV      DH,[SI]              ;get month into DH
       PUSH     SI                   ;save pointer
       MOV      AH,2BH               ;DOS set system date function
       INT      21H
       CMP      AL,0FFH              ;see if error
       JZ       ERROR                ;DOS error processing
       POP      SI                   ;restore pointer
       INC      SI                   ;point to minutes
       MOV      CL,[SI]              ;get minutes into CL
       INC      SI                   ;point to hours
       MOV      CH,[SI]              ;get hours into CH
       INC      SI                   ;point to one-hundredth second
       MOV      DL,[SI]              ;get one-hundredth second into DL
       INC      SI                   ;point to seconds
       MOV      DH,[SI]              ;get seconds into DH
       MOV      AH,2DH               ;DOS set system time function
       INT      21H
       CMP      AL,0FFH              ;see if error
       JZ       ERROR                ;DOS error processing
       .                             ;continue with program
       .
ERROR:                              ;error-handling code
       .
       .
;
;time block to receive server's time and date
;
TIMEBLK:
YEAR    DW      ?                    ;year
DAY     DB      ?                    ;day
MONTH   DB      ?                    ;month
MINUTES DB      ?                    ;minutes
HOURS   DB      ?                    ;hours
HUND    DB      ?                    ;hundredths of a second
SECONDS DB      ?                    ;seconds
SRVZ    DB      '\\SERVER1',0        ;ASCIIZ server name
```



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the server's clock with the workstation's clock. To accomplish the same task, you can use the program fragment shown in the listing "Accessing the Network Clock," which accesses the NOS Get Server's Time function (5FC0h).

The code shown in the listing first calls the NOS Get Server's Time function to move the server's time and date into a data structure defined as `TIMEBLK`. Register SI points to the data structure while register DI points to the ASCIIZ server name on input. On return, the `TIMEBLK` data structure is filled in with the server's date and time. The code then extracts the date information from `TIMEBLK` and places it in the appropriate registers for the DOS function Set Date (2BH). The code then executes an INT 21h to set the date of the local workstation. Next, the time is extracted from `TIMEBLK` and placed in the appropriate registers for the DOS Set Time function (2Dh), and again, an INT 21h is executed to set the time of the local machine.

Some NOS services can be invoked several times in succession to obtain multiple pieces of information. One such function is Get Queue Entry (5FA0h), which obtains a list of all mail and print queues posted for a particular user on a server. For example, if you spooled two files for printing and sent three mail messages, there would be five queue entries on the server for that user name. Each time the Get Queue Entry function is called, NOS releases information on one of the entries until there are no more.

To accomplish this task, register BX is used as a queue-entry index. When the function is initially called, register BX must be set to 0 to identify the first queue entry. On each subsequent call to the function, BX is automatically incremented to the next entry while a 162-byte buffer pointed to by register ES:DI is filled with the queue information. When register AX returns an error code of 12h (i.e., no more files), there are no more entries, and you can terminate the process. A certain byte (called the Queue type) in the information block identifies the entry as a mail or print queue; if desired, this byte can be examined to obtain a count of only the mail queues or print queues.

The listing "The Mail Subroutine" shows a subroutine called MAIL that determines how many mail messages exist on a specified server whose ASCIIZ name is pointed to by ES:DI. On entry, ES:DI points to the ASCIIZ server name. On return, register CX contains a count of the mail messages posted on the server.

Within the subroutine, register CX is

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used to keep track of the number of queue entries being held on the server. Register BX is used as an index into the list of queue entries and is initially set to 0 to allow the Get Queue Entry function to read the first queue entry. If the function returns a 12h (no more entries), then the subroutine terminates with the count in CX. The Get Queue Entry function reads each queue entry into the data structure defined as QUEUE. The byte at OFFSET QTYPE in the data structure identifies the entry as either a mail message (1) or a printer queue (0). If the entry is a mail entry, then it is counted; otherwise, the entry is ignored. The function automatically increments BX to point to the next queue entry, and the process is repeated. The subroutine will count all mail messages (sent and received) that are posted on the server for a particular user. To be more selective and to count only mail received for a particular user, the QDEST information must be examined.

A detailed explanation of the information block returned by the Get Queue Entry function described in the above subroutine is beyond the scope of the article, but it provides a powerful means of manipulating and examining queues. The book *Running LANtastic* includes more detailed information on the format of the information blocks returned by this and other similar NOS functions.

Putting It All Together

The LANtastic NOS services examined so far have been sufficient to implement the five NET commands that were used as an example at the beginning of this article. The sample program LOGIN.ASM integrates these functions and others into a complete assembly language program to perform the following task:

- Prompt the user for a name and password
- Map a network drive resource
- Map a network printer resource
- Set LPT notification on
- Set the LPT time-out to 10 seconds
- List all mail messages received

The program uses two additional functions not discussed earlier: Set Redirected Printer Time-Out (5FD1h) and Set LPT Notification (5F9Eh). To set the LPT time-out value for a redirected printer, the Set Redirected Printer Time-Out function is called with register CX containing the printer time-out in ticks (18.2 ticks = 1 second). A value of 0 in register CX will disable the time-out. No information other than a possible error code is returned. The Set LPT Notification function is called with register DX set to 0 to disable the LPT notification pop-up message when a file has been despooled to the printer or to 80h to enable the pop-up notification message. Like the set time-out function, no information is returned other than a possible error code in AX. After a user logs in, the program lists all mail messages destined to the logged-in user. This is not simply a count of the mail messages, but a list that identifies the sender's name and the comment attached to the mail message. Again, the Get Queue Entry function is used to extract this information but in a different form.

LOGIN.ASM is formatted to be assembled into a .COM file rather than an .EXE file. The resulting .COM file produced is only 1972 bytes in size and executes in a fraction of the time that a batch file takes to execute a sequence of NET commands.

The sample program USERS.BAS, written in Visual Basic for DOS, illustrates the use of the Get Active User Information function (5FB0h) to obtain a list of all user activity on the server. Like the Get Queue Entry function, this service uses the same procedure to obtain information on all log-in entries to a specified server. The information that this program displays is similar to the Display Server Activity screen in NET. Because of the close compatibility between QuickBasic and Visual Basic for DOS, the program can be easily modified for QuickBasic.

WHOAMI.C is an example of a short program written in C that uses the LANtastic API to display information on the current log-in. The program identifies the name of the machine, the user name, and the server that the workstation is logged in to. This is accomplished by accessing NOS functions 5E00h, 5F83h, and 5F80h, respectively. See the "Program Listings" on page 5 for more information about how you can obtain these programs electronically.

With custom applications developed using the API, we found network administration simplified, security improved, and performance enhanced. A tailored environment combining the user's needs and the administrator's concerns proved advantageous to all, increasing overall productivity. Plans for additional nodes are in the works, and user satisfaction remains high. ■

The Mail Subroutine

```
MAIL:
        MOV     CX,0                    ;count of mail messages
        MOV     BX,0                    ;index to data
MAIL2:
        MOV     AX,5FA0H                ;get queue-entry function
        MOV     SI, OFFSET QUEUE        ;point to queue data structure
        INT     21H                     ;assume that DI points to the server name
        CMP     AX,12H                  ;see if no more entries
        JZ      QUIT                    ;quit if so
        MOV     DI, OFFSET QTYPE        ;get QTYPE value
        MOV     AL,[DI]                 ;into AL
        CMP     AL,1                    ;see if it's mail queue
        JNZ     MAIL2                   ;bypass rest if not
        INC     CX                      ;count the entry
        JMP     MAIL2                   ;continue until done
QUIT:   RET
;
; data structure to receive queue entries
;
QUEUE:
QSTATUS DB      ?                       ;status of queue entry
QSIZE   DD      ?                       ;size of spooled file
QTYPE   DB      ?                       ;type of queue entry
QOUTCON DB      ?                       ;control of despooled file
QCOPIES DW      1                       ;number of copies
QSEQ    DD      ?                       ;sequence number of entry
QSPFILE DB      48 DUP(?)               ;path name of spooled file
QUSER   DB      16 DUP(?)               ;user name of who spooled file
QMACH   DB      16 DUP(?)               ;machine name user was on
QDATE   DW      ?                       ;date file spooled (DOS format)
QTIME   DW      ?                       ;time file spooled (DOS format)
QDEST   DB      17 DUP(?)               ;ASCIIZ user name/device destination
QCOMM   DB      48 DUP(?)               ;comment field
```

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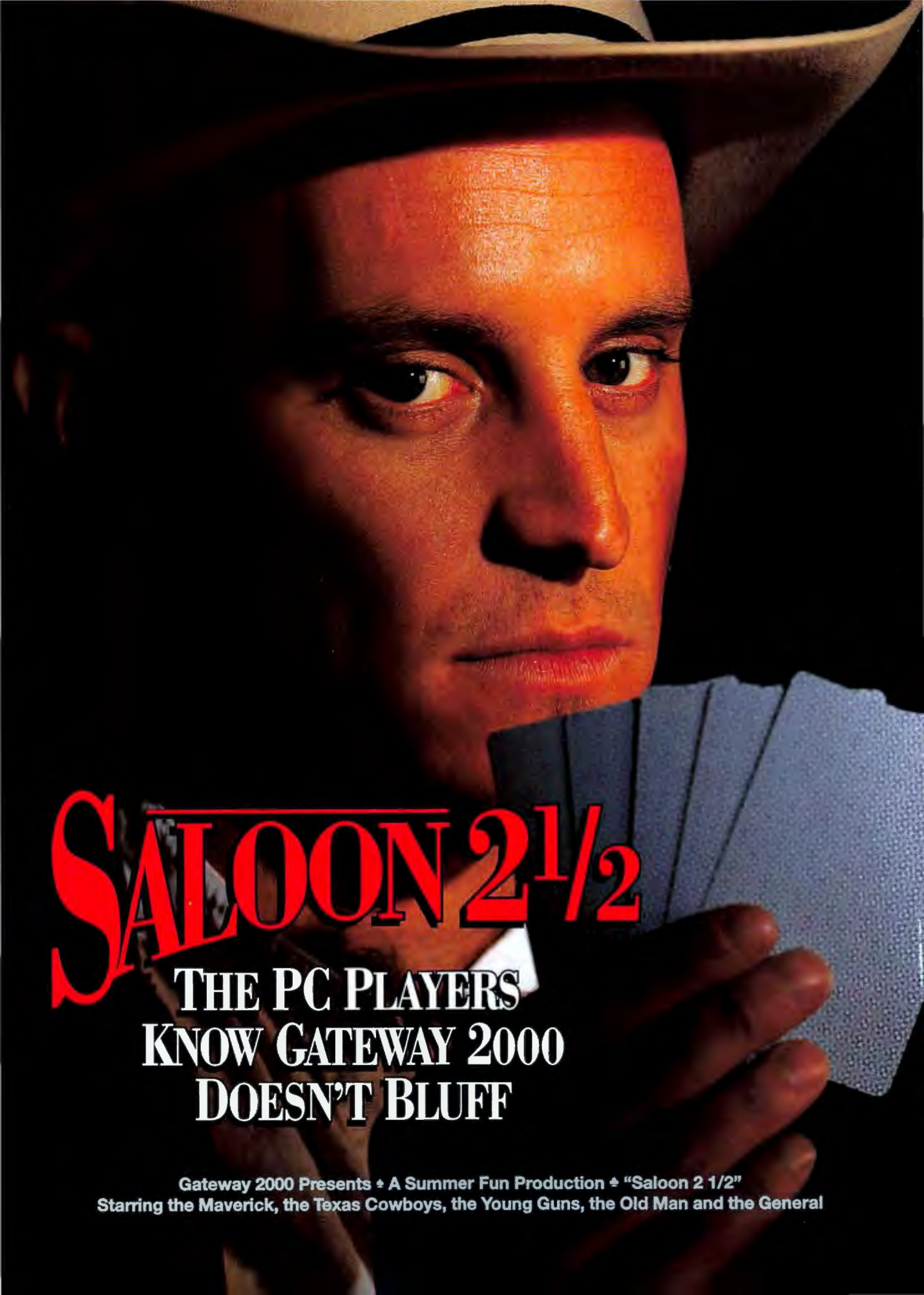
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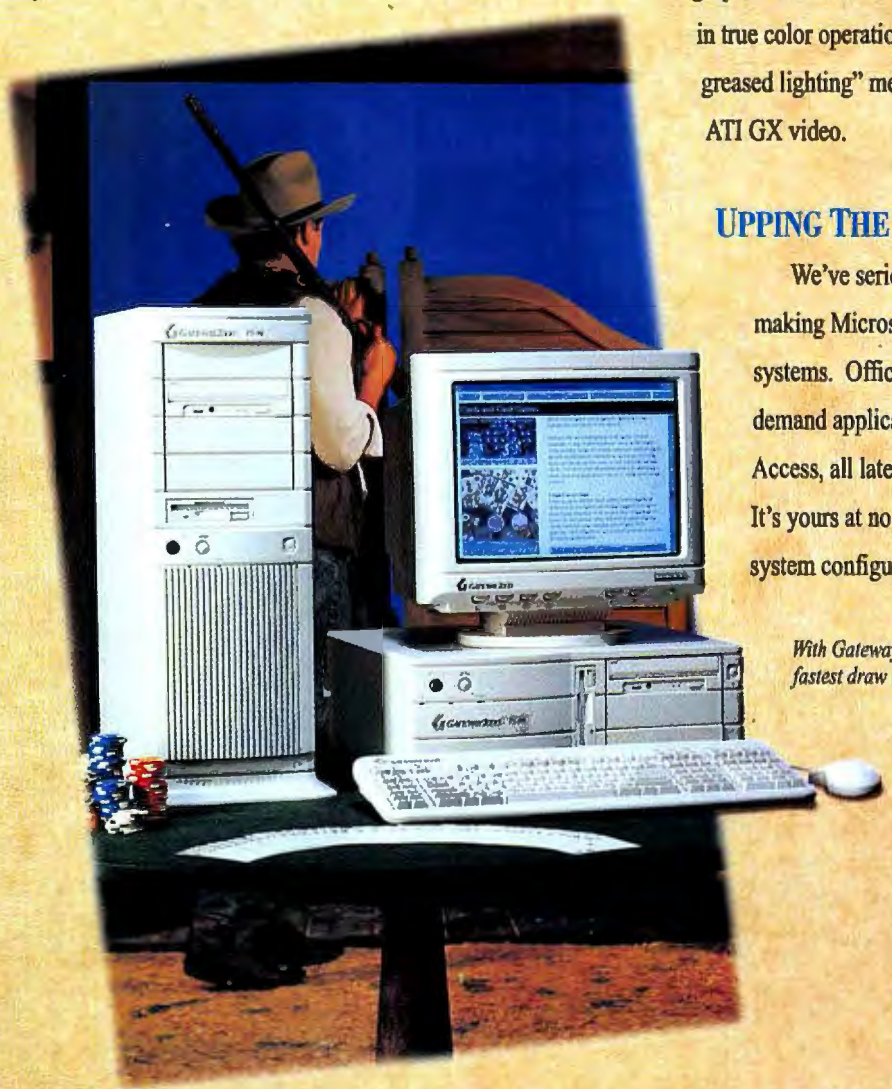

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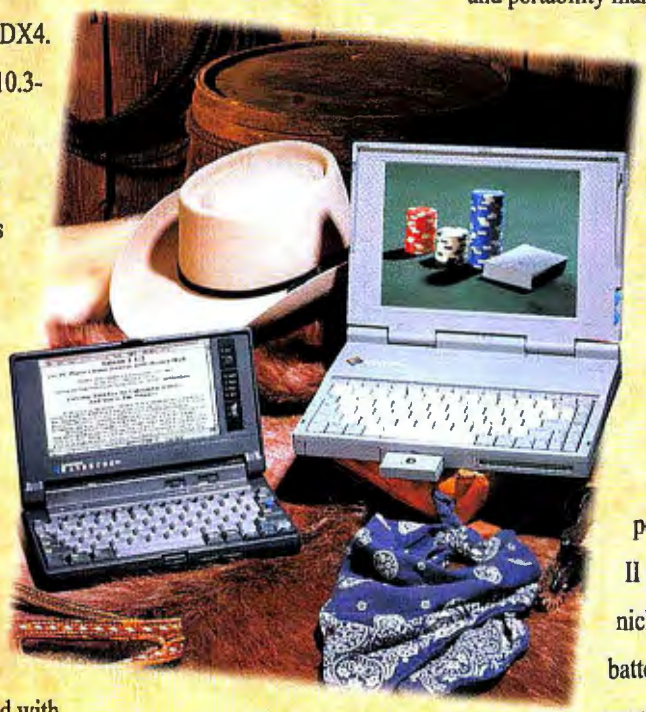

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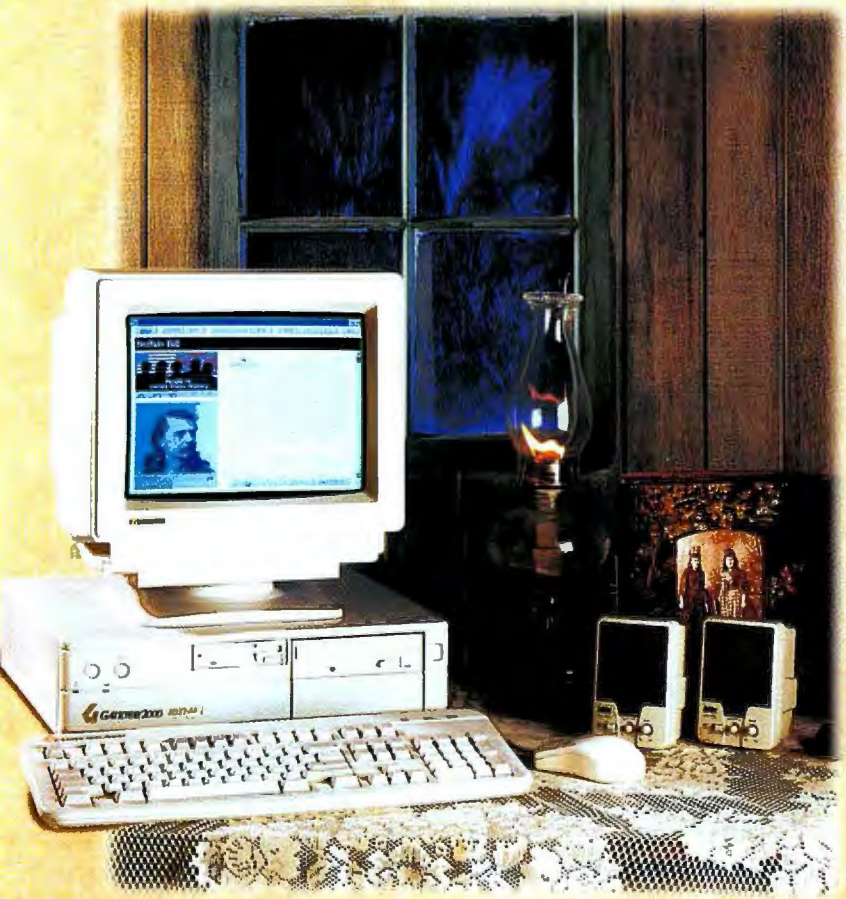

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Silicon in Reverse

PETER WAYNER

DON ARDAY © 1994

To cope with the ever-increasing power demands of VLSI chips, researchers are looking to circuit technologies that use reversible logic to conserve power

Over the next decade, the amount of power that's consumed by computer chips is likely to become one of the biggest headaches for chip designers and end users alike. Many VLSI designers hope to lower power consumption in two ways: by pushing well-known power-saving tricks to new levels and by dramatically retooling the fundamental structure of VLSI to let it recycle power by reversing the results of circuit-based operations. The first approach is common; the second approach is just appearing.

Two complementary forces are behind the drive to limit power consumption in microprocessors. One is heat; as processors get bigger and faster, the heat they dissipate increases proportionally. If ignored, this heat can literally melt the components of a system. The second force is the explosion of the use of portable computers, which depend on batteries to get through their day. The less power their chips use, the longer these portable devices can run.

Powerful Lessons

In the past, power use by computer chips was a problem that was often either pushed aside or solved with brute force. Mainframe and supercomputer manufacturers routinely traded high-power consumption for speed and found themselves creating specialized cooling systems for their machines. Both Cray and IBM built refrigerators into their big machines to remove the heat produced by the large amounts of power consumed by the CPU.

As has become apparent in recent years, microcomputer manufacturers are not immune to power problems. As microprocessors have got bigger and faster, cooling fans have proved insufficient to deal with all the power such chips dissipate as heat. Heat sinks are now de rigueur on powerful chips, as are multiple fans and sophisticated case designs that help keep air circulating across hot components.

Moreover, people are discovering that the power use of personal computers is significant. The *Wall Street Journal* estimates that computers are responsible for 5 percent of a typical business's electric bill. In the summer months, the companies pay again when they run air conditioners to remove the heat generated by their computers. And, while they gain some heat from them in the winter, electrical heating is not economically competitive with gas or oil heat.

For notebook computers, power-consumption issues are, in many instances, insurmountable. No one makes Pentium-based notebook computers because no one can make a reasonable-size battery to keep such systems in operation for more than a few minutes. As portable computers become more indispensable, we

need to be able to use the latest and most powerful processors in them.

Where the Power Goes

The physics of power consumption in VLSI circuits is straightforward. A transistor switch consists of two wires. The flow of current through one wire is switched on or off by a packet of charge on the second. A microprocessor consists of millions of transistors that are turned on and off many millions of times per second. Every time one of these transistors is turned off, the electrons that were stuck on one wire to switch the flow of the second are sent to the grounding wire. In the process, heat is generated and power is consumed or dissipated.

Many factors influence the amount of power consumed, for both well and ill. The push for miniaturization has the nice side effect of reducing the power consumed by chips. Smaller transistors need less power because they require fewer electrons to saturate the wire that controls the flow. The smaller amount of power consumed by each transistor means that doubling or quadrupling the number of transistors does not double or quadruple the amount of power used.

The push for greater speed, however, does increase the amount of power consumed. Each operation in a microprocessor must flip a certain number of transistor switches, and each flip consumes electrons. Doubling the clock speed doubles the amount of power consumed.

The quest for speed also has another effect on power consumption. If you want each transistor to switch quickly, you must use more electrons to make sure that the transistor becomes saturated as quickly as possible. This means that faster computers must use more charge per transistor flip. Therefore, doubling the speed of a chip in running a computer.

The PowerPC 603 chip, for instance, can switch off the floating-point logic unit when only integer calculations appear. It can also turn off the data cache or the bus interface if it doesn't need them. The latest version of the Pentium also has the ability to shut off parts of itself.

In the near term, then, low-power chips will rely on two complementary strategies: lower voltage levels and active power management at the functional-unit or circuit level. In the longer term, new power-saving technologies will be needed to complement these strategies.

Low-Power Chip Technology

Today, many conventional technologies and techniques are available to manufacturers looking for ways to reduce the power consumption of chips. The easiest solution is to simply lower the voltage gap. When a switch is opened, a wire with no charge is connected with a source at the basic voltage. The sudden surge of charge causes the wire to dissipate power as if it were a tiny heating element until it rises to the source voltage.

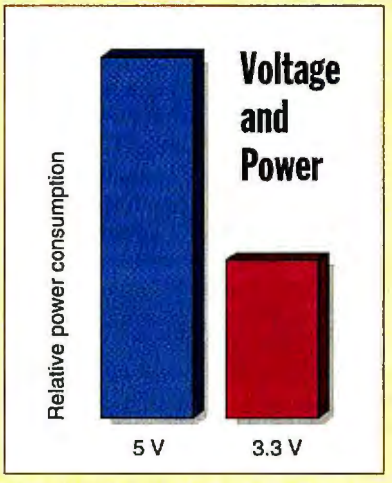
By lowering the general voltage level of a chip, you lower the voltage gap, which is the difference between the source voltage and ground. The power dissipated varies roughly as the square of the voltage gap, so dropping a chip's general voltage level from 5 V to 3 V can have a tremendous effect on the power that is lost. This is why 3.3 V is quickly becoming the new standard for the CMOS logic that is used in chips today.

Lowering the voltage level is not a simple process. The effectiveness of a transistor depends on a firm distinction between on and off. As the source of the voltage on the chip gets closer to ground, the electronics grow less stable. Random noise can easily confuse the logic. More important, the electronics take longer to settle into the correct on or off state. This means that designers must lower the chip speed to give the electronics time to give the correct answer.

It's possible for manufacturers to avoid these problems by using much greater precision in the chip fabrication process. If transistors are etched in the silicon with more precision, there will be less variation among transistors. In addition, manufacturers can tune the length of the lines between the transistors and be more careful while laying out the transistors so that they will all settle into the correct answer with better precision.

Manufacturers can also lower power consumption by slowing the clock used to drive the chip. This reduces the amount of power dissipated, because the switches are not switching as often. The savings incurred by this process are usually matched by an equal loss in processing power: Cutting the speed in half cuts the processing power in half. While this may reduce the need for refrigeration and special packaging with heat sinks, it does not change the overall power cost per operation.

One of the simplest techniques that is receiving widespread attention is simply turning off functional units on the chip whenever they are not needed. For example, floating-point processing power is important for graphics and some spreadsheets, but it isn't necessary for most of the fundamental tasks involved



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may actually require more than twice as much power.

Reversing the Computation

Today, chip makers and computer manufacturers employ a number of well-known techniques to lower the power consumption of microprocessor-based systems (see the text box "Low-Power Chip Technology"). These techniques will certainly lower the power consumption of chips significantly over the next several years, but they'll reach a natural limit when the voltage levels on the chip drop to the point where signal levels are indistinguishable from noise. Many physicists estimate that this point will be reached when voltage levels hit the range of 0.5 to 1.2 V.

At the industrial labs of IBM, Xerox, and AT&T, some scientists are attempting to reduce power consumption by recycling the power and reversing the computation. This work started when Rolf Landauer and Charles Bennett of IBM wrote theoretical papers showing that there is no minimum barrier to power consumption if the work in a VLSI circuit is done in a reversible way.

The idea of a reversible computation is straightforward. A system is reversible if no information is lost along the way. In a VLSI circuit, this means that all the extra charge that represents bits normally lost in combinatorial-logic AND and OR gates must be kept around so the system can be reversed. For example, if you're going to compute 2+2, a reversible system would pass on 4 as the answer, as would a standard one. But a reversible system would also save at least one of the operands so it could reverse the computation. If it didn't, then it wouldn't know if the two operands were 1 and 3, 2 and 2, or 0 and 4.

In theory, when a computation finishes, a reversible chip would copy over the answer and then work its way backward. The copy operation would dissipate some energy, but the process of reversing the computation would return most of the charge to its original location. That would save much of the dissipated energy by recycling it.

Many people are skeptical of this entire process of reversing the mechanism because it seems more at home in a Rube Goldberg contraption than in a physics textbook. What's important to realize is that the standard method of building VLSI switches is very crude: It is equivalent to placing a car at the top of a cliff and pushing it off. The computation of switching a bit from 1 (the top of the cliff) to 0 (the bottom of the cliff) works, but all the stored energy is dissipated at the bottom.

On the other hand, if the car was at the top of a steep hill instead of a cliff, it would roll down to the bottom and pick up sufficient speed to carry it up the other side. Some energy would doubtlessly be lost to friction in the system, but much less would be lost than if the car fell off a cliff. The process of running the car up the opposite side of the hill is the functional equivalent of putting a computational system in reverse. The trick is timing the system so that the results of the computation are captured at the point that's equivalent to when the car is at the bottom of a steep hill.

Slow Down and Conserve

Many physicists were also skeptical of the notion of reversible computation until 1992, when a number of different scientists, including Bill Athos of the University of Southern California (Marina del Rey), Josh Hall of Rutgers University (New Brunswick, NJ), and Ralph Merkle of Xerox PARC (Palo Alto, CA), developed a model showing how to convert standard CMOS circuits into low-power reversible

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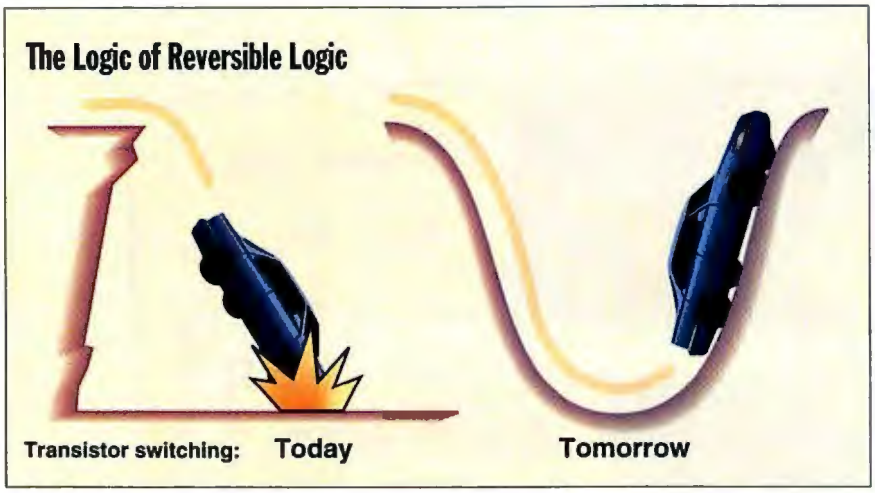

Chips today consume so much power because of the way in which transistors switch on and off. When a transistor switches from a high-logic state to a low-logic state, all the energy required to get to the high state is dissipated, just like a car going over a cliff dissipates its potential energy at impact. Reversible logic aims to conserve the energy so that it can be used to switch again.

ones. The basic concept is to move charge gradually instead of instantaneously. This limits power dissipation and allows the charge to be recycled effectively.

Consider, for example, two ways to charge a capacitor—a simple model of the process of switching a transistor. In one case, the voltage is raised gradually over a period of time T. In the other, it is switched on instantaneously. In the first case, the power dissipated is also governed by a factor that is inversely related to the time it takes to charge the capacitor. The same model works when a capacitor is discharged.

This extra factor of T makes a big difference. If you slow down each gate by a factor of T, you use a factor of T less power. The chip also uses a factor of T less power per second because it is doing a factor of T less computations. This means that a reversible chip would save a factor of T^2 power, but it would do a factor of T less computations.

At this point, physicists doing reversible computation like to propose putting T circuits on the chip, which operate in parallel. If everything works perfectly, then you should have a total of T circuits, each doing 1/T work using $1/(T^2)$ power. The net result is that the same amount of work could get done while cutting the power used by a factor of T.

There are several barriers to actually putting T circuits on a chip. First, the packing density of transistors on a chip must increase. This is not a major concern because the packing density has been steadily increasing since the development of the IC over 30 years ago. In fact, some physicists estimate that power consumption, not packing density, is becoming one of the main limitations of the size of current chips. Still, a circuit that uses a factor of T less power must consume at least a factor of T more silicon if it is to run at the same

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rate. In addition, there is a natural limit to the amount of parallel structure in a circuit that can be exploited by designers.

Recycling the Charge

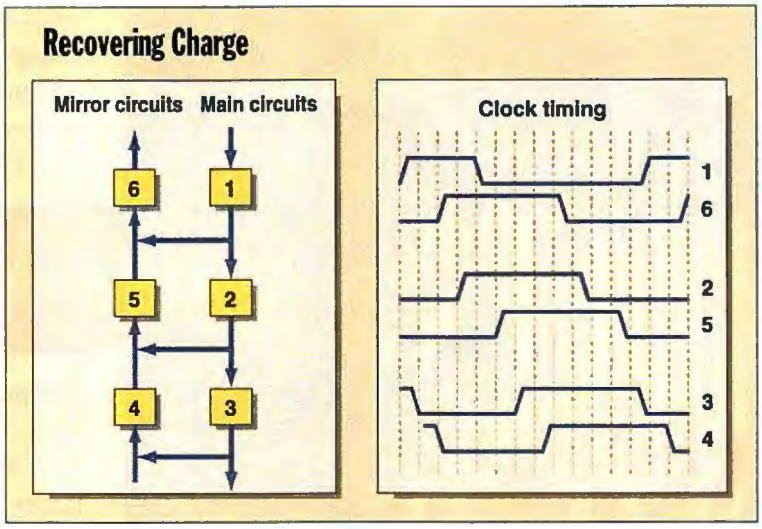
Although circuits that are loaded and unloaded at a slower rate dissipate less power, they still must move a charge from one place to another. A true low-power chip must find a way to recycle the power by reversing the computation. There are many different proposed solutions in this new field of study.

One simple approach, called SCRL (Split-Level Charge-Recovery Logic), was co-developed by Saed Younis and Tom Knight of MIT. The idea is to create a mirror image of a circuit that computes the inverse of the original. As each stage in the circuit finds its answer, it passes the result on to its mirror image, which computes the inverse. In the main circuit, charge moves toward the end, while in the mirror circuit, charge is recycled back to the beginning.

The figure "Recovering Charge" illustrates such a circuit. Each circuit in the line starts its computation just after the one before it. The idea is to switch the transistors when the voltage gap is low or nonexistent. Then when the clock pulse rises, the switch will already be open and the power will flow gradually across a small voltage gap. The size of this gap determines how much power is lost as heat.

Since there must be a mirror image of the circuit constructed to return the charge, this approach doubles the number of transistors that are needed to implement a piece of logic. The chip designer must also create multiple clock lines that run each level of transistors at different times. This also complicates the design.

Other developers are using a more practical approach to the reversible-logic problem. A team of scientists (Stephen Avery, John Denker, Alex Dickinson, Alan Kramer, and Thomas Wik) at AT&T's Bell Labs in Holmdel, New Jersey, report that they have successfully built and tested a circuit consisting of 1000 inverters using a different formation of gates that does not contain an array of circuits mirroring the main gates.



With split-level charge recovery, circuits are paired with their inverse circuits (1 with 6; 2 with 5; 3 with 4). The results of the main circuit chain are passed to the mirror-image chain, thus preserving the results and the energy used to generate them. The timing diagram shows how the clocks that drive the circuits must cascade so that the system uses as little power to switch as possible.

In their simulations, they show that their inverters consume a third less power because they switch themselves gradually. This design is less pure because it loses some information—and thus some power—but they estimate that a few circuits built with this approach will actually be smaller than their high-powered cousins.

At this point, it is difficult to guess what approaches will succeed in producing reversible-logic circuits. With new people approaching the topic all the time, the designs will undoubtedly change significantly in the next few years as the technology moves toward the marketplace.

The Clock Problem

No matter what approach you take toward reversible logic, the most difficult problem is finding a way to construct stable clock circuits that will drive the different circuits in the chain. Ideally, the results of the computation will gradually propagate down a chain of gates, with each gate performing its work just after the gate before it completes its work. In a sense, the computation travels along the circuit in much the same way that Tarzan swings among the trees on vines. As long as the clocks (or the vines) are in the correct phase, then everything moves smoothly.

VLSI circuit designers are not experienced with designing clocks that move gradually up and down. Most current VLSI chips provide clock circuits that make abrupt changes when the clock ticks. Creating new ones that produce gradual swings in voltage is a challenge.

This challenge is important, because the speed and continuity of the clock signal will directly affect the consumption of power throughout the chip. Any sudden jumps in voltage will dissipate power throughout the chip. More important, there must be a separate signal for each of the successive parts of the circuit. If any of these clock signals gets out of phase, there is a slight voltage gap between the gates. Power disappears across these gaps.

The Future

In the near future, chip designers will need to pay more attention than ever to the power requirements of chips. Already there are indications that some designers are sacrificing additional cache and floating-point performance to keep power consumption in line.

Over the next 10 years, chip designers will continue to pursue a variety of different approaches to lowering power consumption. Lowering the operating voltage and slowing the chips will be popular solutions, because they offer substantial power savings and do not require the adoption of radically new circuit designs.

Reversible logic offers to lower the cost of computing independently of changing the voltage. More important, when these circuits slow down, they save power based on the square of the speed loss. The overall speed of the circuits can be maintained, but the cost will certainly be larger circuits. However, this may be much more desirable than putting built-in refrigeration units on microcomputers.

There is much debate about the limit to the amount of power that can be saved with reversible computation. Many scientists actively pursuing reversible-logic research think that a factor of 10 in power savings is a conservative estimate; some are willing to offer up the hope of a factor as high as 100 to 1000. But one thing is certain: As low-power chips become more important, there will be lots of opportunities to try many different approaches. ■

FOR FURTHER READING

Proceedings of the 1994 International Workshop on Low-Power Designs. Sponsored by ACM-SIGDA and IEEE-CAS, April 24–27, 1994, Napa Valley, California.

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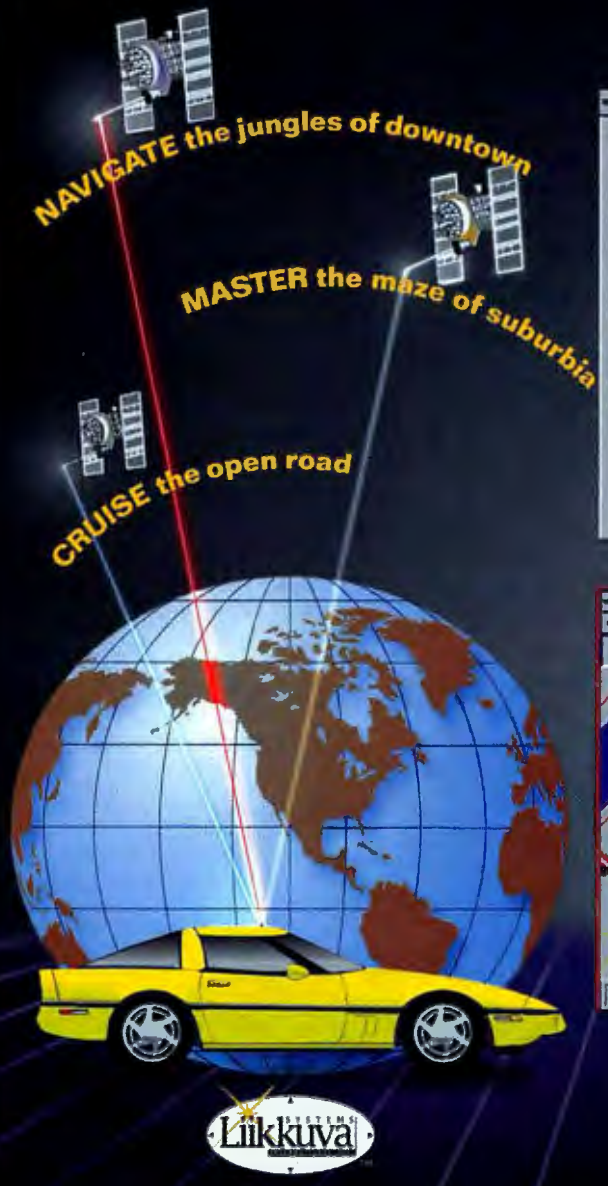

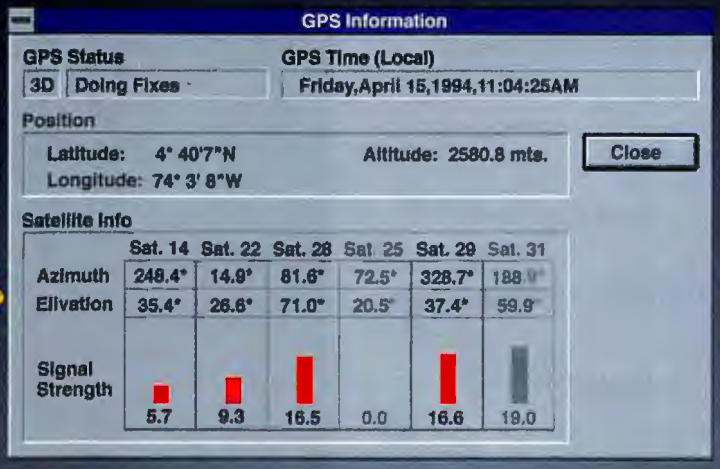

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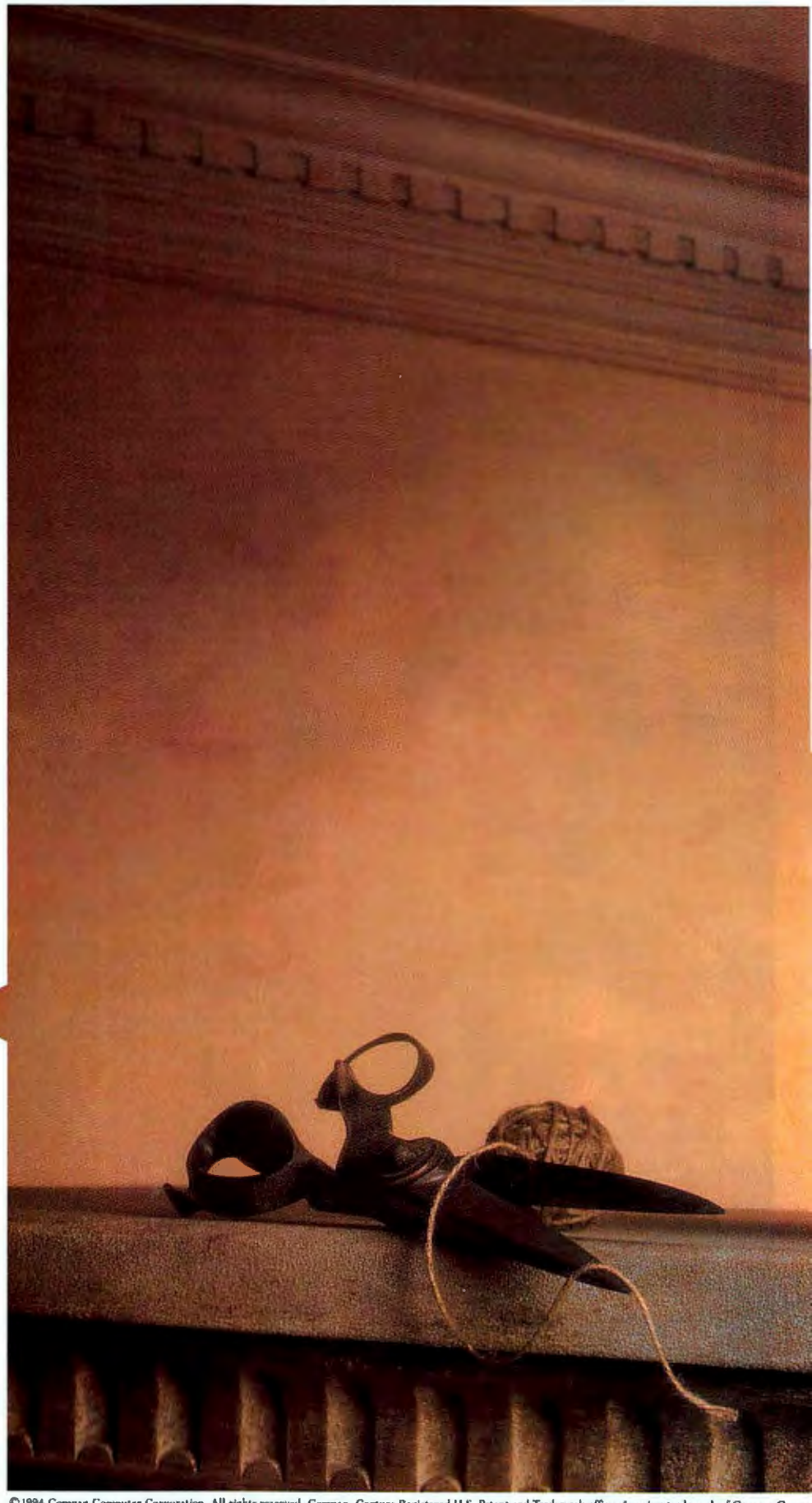

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Feature

CACHE ADVANTAGE

Cache design and implementation can make or break the performance of your high-powered computer system

DAVID F. BACON

Modern CPUs have one overriding concern—keeping the processing pipelines filled with instructions and data. But this is becoming an increasingly difficult task because although CPU performance doubles every 18 to 24 months, the speed of the DRAM chips that constitute main memory increases by only a few percent each year.

As a result, the high-speed cache memory that acts as a buffer between main memory and the CPU is an increasingly significant factor in overall performance. In fact, upgrading your cache may give you more of a performance boost than upgrading your processor.

The basic rule of thumb for today's various memory technologies is that smaller is faster, but it's also more expensive. As a result, all computers are organized around a storage hierarchy, with the fastest elements at the top and the slower, less expensive, denser storage elements at the bottom (see the figure "The Storage Hierarchy" on page 81).

At the top of this hierarchy are the registers, of which there are typically 64 (32 integer and 32 floating-point), for a total of 256 bytes in a typical CPU. These registers can be read or written to in a single cycle. The cache makes up the next level of the hierarchy: Typical sizes range from 16 KB to 256 KB, and access times are on the order of a few CPU cycles. With the advent of on-chip caches, many machines now have a larger, off-chip, second-level cache.

As a program executes, the system moves data up and down the memory hierarchy. Data is moved up when it is accessed, and it's moved back down when it is displaced by new data moving up. Data is transferred in units called *blocks*, and a block in the cache is called a *line*. Generally, the data at one level is a subset of the data stored at the next level down (see the figure "Blocks of Memory in the Cache" on page 81).

The storage hierarchy works because programs don't access memory at random. If a program accesses a word of memory, chances are high that in the near future it will access the same word again. Chances are also high that in the near future it will access a word close to the one just accessed. These two observations are known as the principles of *temporal* and *spatial* locality, respectively. Because of temporal locality, it pays to keep a word in the cache once it has been brought there. Because of spatial locality, it pays to load several adjacent words at once.

Cache Design

As mentioned earlier, a cache is organized into lines—units of contiguous memory of the same size. The first question to be decided in a cache design is: Into which cache line should a block loaded from memory be stored? In a *direct-mapped* cache—the simplest cache design—the memory address uniquely determines the cache line used to store the block.

Consider a system that uses 32-bit addressing. If the size of a block is 64 (2^6) bytes, then the low 6 bits of the address—the *offset*—determines which byte within the block is being addressed. If the cache consists of 1024 (2^{10}) of these 64-byte lines, then the next 10 bits of the address determines which line the block is placed in. The upper 16 bits of the address—the *tag*—is kept with the cache line. A direct-mapped cache stores one tag per line in its tag array.

During a memory access—a load, for example—the cache uses the middle bits of the address as the index to its array of tags. The indicated tag is then checked against the upper 16 bits of the current address. If these match, the data indicated by the offset is sent to the CPU; if not, the line is replaced with the desired block of main memory (see the figure "Cache Design" on page 82).

The advantage of using a direct-mapped cache is that you need to make only one comparison per access to the cache. The line is a hard-wired index, so only the tag of the current address needs to be compared to the tag of the indicated line. This relatively simple lookup is an advantage in designs that push clock speeds aggressively. The problem with a direct-mapped cache is that if two frequently accessed blocks map into the same cache line, they will constantly be evicting each other from the cache. This is easy to see by looking at the figure

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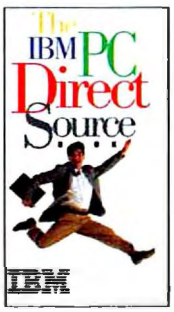

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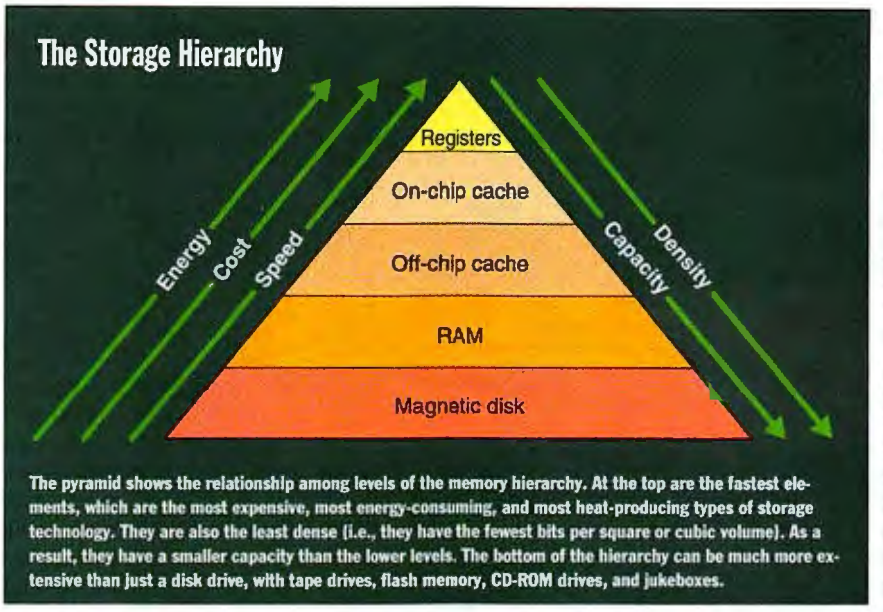
"Cache Design": The part of the address that makes up the tag is not used in mapping the address to a cache line, so if the addresses differ only in their tag bits, they will conflict with each other.

The other extreme in cache design is a *fully associative* cache, in which a block can be placed into any cache line. In this case, the address is simply divided into low bits, which make up the offset into the cache line, and high bits, which make up the tag that is matched against subsequent references.

With an associative cache, there must be some mechanism for deciding which line the block is placed into. Initially, blocks can be placed into empty lines, but when the cache is full, some block must be selected for eviction. Ideally, the LRU (least recently used) block is replaced, but keeping exact track of this can become expensive, so some sort of approximation of an LRU policy may be used.

A fully associative cache solves the problems of conflicting addresses, but at the cost of a lot of extra hardware for comparing the tag against all the cache lines. A solution that falls between the two extremes of direct-mapped caches and fully associative caches is a *set-associative* cache.

In a set-associative cache organization, the lines are divided into sets, and the middle bits of the address determine the set into which a block is placed. Within each set, the cache is fully associative. A cache with two lines per set is called two-way set-associative and requires two comparisons per access. Besides requiring fewer comparators than a fully associative cache, a set-associative cache also makes implementing an LRU policy easier. You need only a single bit, for example, to implement an LRU policy in a two-way set-associative cache.



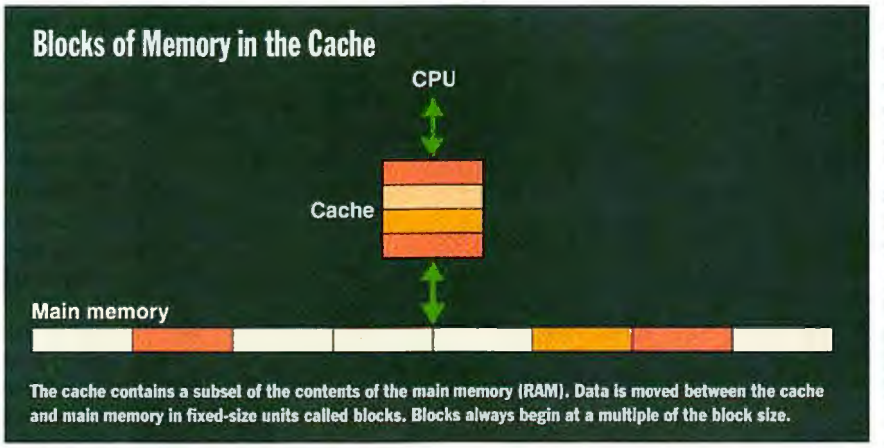
The pyramid shows the relationship among levels of the memory hierarchy. At the top are the fastest elements, which are the most expensive, most energy-consuming, and most heat-producing types of storage technology. They are also the least dense (i.e., they have the fewest bits per square or cubic volume). As a result, they have a smaller capacity than the lower levels. The bottom of the hierarchy can be much more extensive than just a disk drive, with tape drives, flash memory, CD-ROM drives, and jukeboxes.

Design Effects

The *miss rate* of a cache is the percentage of memory references that are not satisfied by the cache and require a fetch from main memory. A primary goal of machine designers is to minimize the miss rate, because each miss can cost many cycles. A general rule of thumb is that a direct-mapped cache of size *n* has the same miss rate as a two-way set-associative cache of size *n*/2. Thus, when comparing machines, it is important to look not only at the cache size but also at the associativity.

Another consideration is whether instructions and data are both stored in a single unified cache or split between two different caches. A split-cache machine design is called a *Harvard architecture* (see the figure "Harvard vs. Princeton" on page 84). Separating the caches has the advantage of eliminating interference between data and instruction references, and it allows for the cache size, line size, and associativity of each cache to be selected and optimized independently. It also makes it easier to fetch data and instructions simultaneously.

There are two principal disadvantages of using a Harvard architecture. If a program modifies itself by writing new instructions, they are written into the data cache. Before the program can execute these instructions, both caches must be flushed, and modifications must be written to main memory so that the instruction cache will pick up the new instructions from main memory. Second, when a program requires more instruction-cache memory but less data-cache memory (or vice versa), a split cache cannot change the allocation, as would happen automatically in a unified cache.

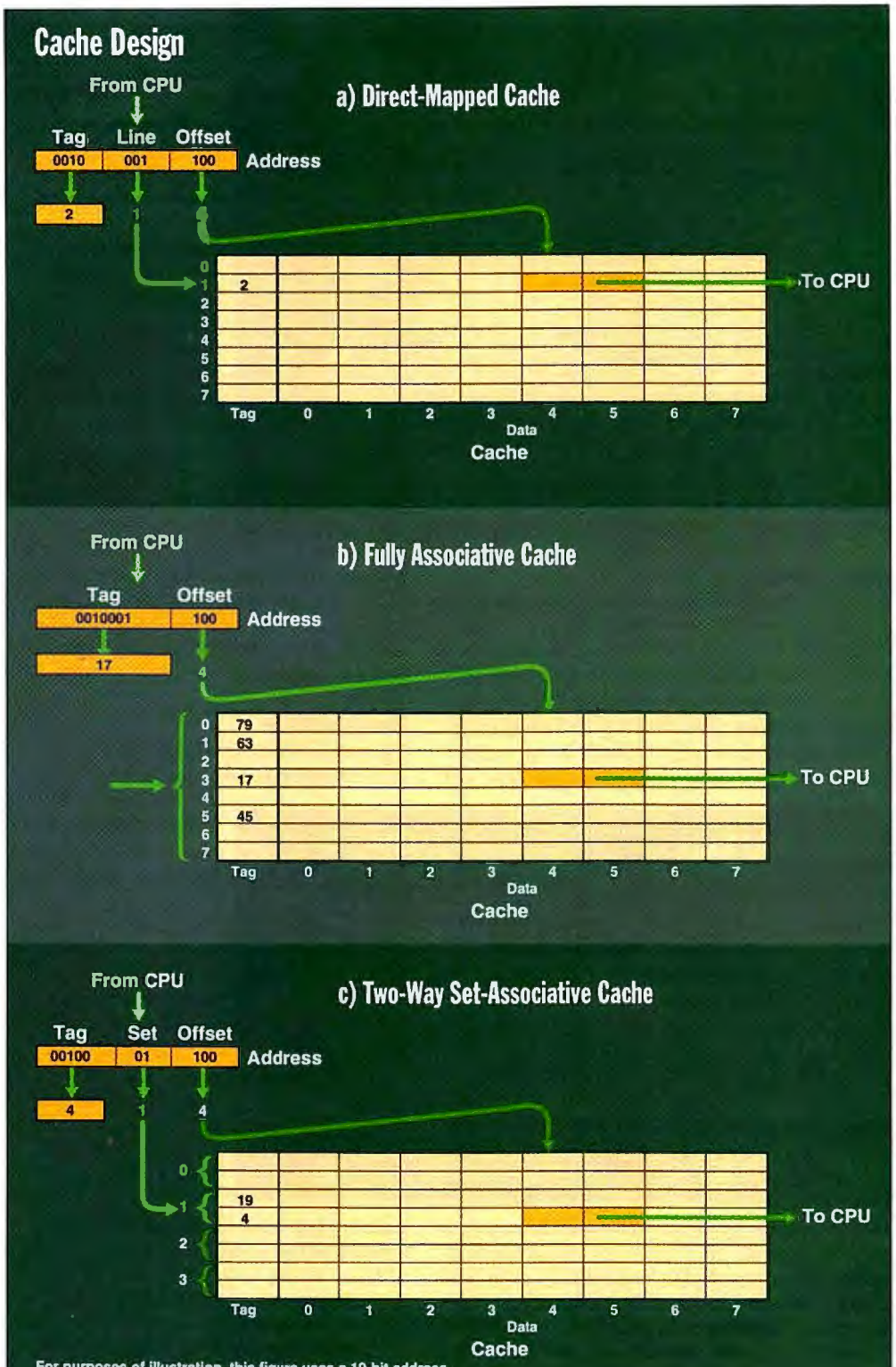


The cache contains a subset of the contents of the main memory (RAM). Data is moved between the cache and main memory in fixed-size units called blocks. Blocks always begin at a multiple of the block size.

Tuning for Cache

The most fundamental cache-related issues for an application are whether most of the data being operated on will fit in the cache and whether the data being loaded includes unused information. If the data fits in the cache and none of it is extraneous, then its organization and the order in which it is accessed will not substantially affect performance; all the information must be loaded sooner or later, and once it has been loaded, most of the subsequent references will hit in the cache. Here's a look at how various ways of organizing program data can interact with different cache-design parameters.

Cache optimization vs. instruction optimization. A common mistake programmers make is to optimize a program with the assumption that all references hit in the cache, forgetting the fact that a cache miss may burn as many cycles as a dozen or more instructions. The most common example of this problem is when a programmer stores Boolean values as integers or characters instead of as bits. This organization lets you manipulate the data



For purposes of illustration, this figure uses a 10-bit address, an eight-line cache, and an 8-byte line size.

a) The CPU requests 2 bytes of data stored at address 0010001100 (binary). The cache controller divides the address into three portions: the middle bits, which determine the line number; the low bits, which determine the location within the line (offset); and the high bits, which are matched against the tag field in the cache line. If the tags match, the data is returned as shown. If not, the controller first checks to see whether the selected line has been modified and writes it back to main memory if it has. It then requests the desired block from main memory and writes it into the selected line, updating the tag field. b) In a fully associative cache, the address is divided into two parts: the tag and the offset. The tag is matched against the tags of all the cache lines. c) In a set-associative design, the middle bits of the address select a group of lines (rather than just one, as in a direct-mapped cache). The tag of the address is then matched against the tags of all the selected cache lines.

with fewer instructions, but it also increases the number of cache lines required—and therefore the number of potential cache misses—by a factor of 8, 32, or even 64, in the case of 64-bit CPU architectures.

An example of this is the eqntott application from the SPEC benchmarks, in which small integers are stored in 16-bit short words. By storing these values in a single byte, you improve performance by 11 percent on a DECstation 5000/125.

Improving locality. When the data does not fit in the cache, locality becomes much more important. When a load misses in the cache, the entire line containing the desired word is loaded from memory. Therefore, data items that are accessed together should be arranged close together in storage. For example, if your application uses two data items for every employee, then it is much better to keep these items together in a structure rather than in two arrays.

A final optimization for locality also applies when large amounts of data are accessed that will not fit in the cache. For instance, if the data items being accessed are records of 6 bytes and the cache-line size is 8 bytes, then half the records (i.e., two out of four) will be spread across two cache lines. This means that accessing a single record will often result in two cache misses. By padding the record out to 8 bytes and aligning the records on 8-byte boundaries, the number of cache misses per record is reduced to one (see the figure "Padding" on page 84).

Conflicts and associativity. Two addresses that differ only in the tag portion of the address (i.e., the high bits) will map to the same cache set; this is called a *conflict*. When conflicting addresses are accessed repeatedly and the number of conflicts exceeds the associativity of the cache, the same address will repeatedly generate a cache miss, because conflicting references cause it to be evicted before it can be referenced again. When the cache is direct-mapped (which could be called one-way associative), it is particularly prone to this because even relatively random reference patterns can gen-

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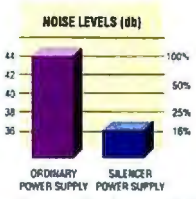

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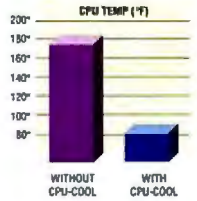

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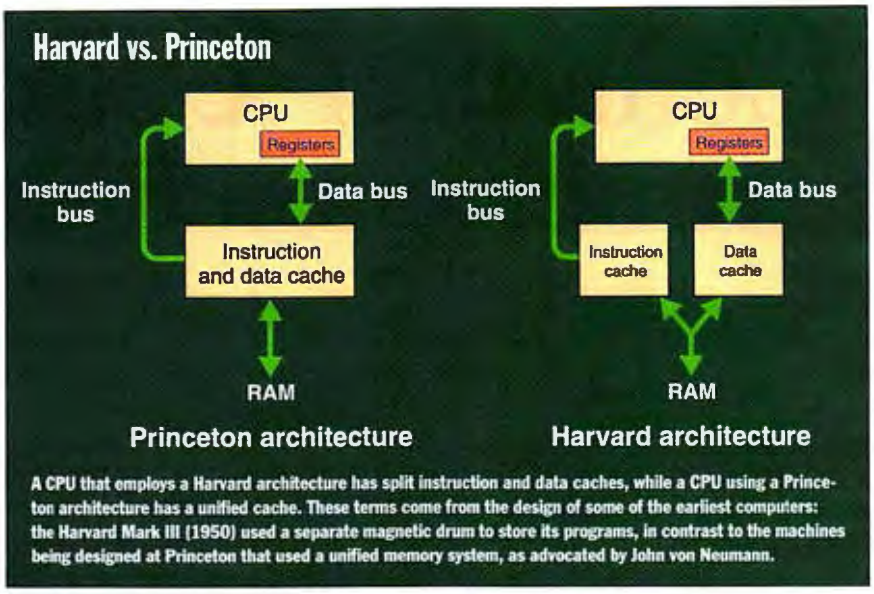
erate some conflicts. This is the reason why a two-way set-associative cache may be as effective as a direct-mapped cache that is twice the size.

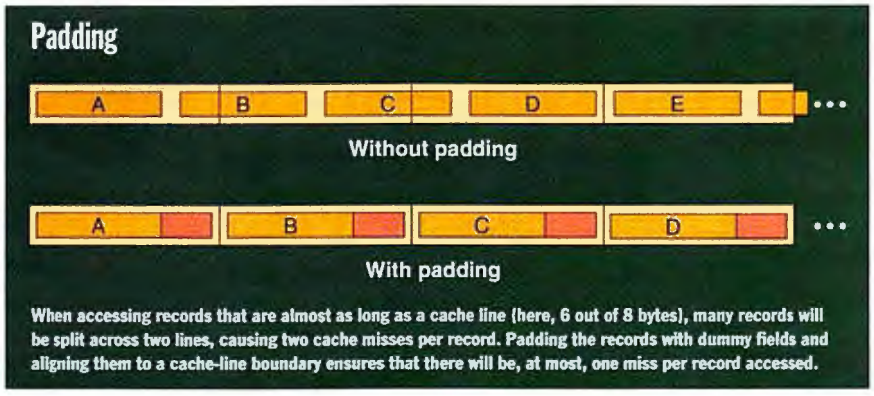
Conflicts become an even greater problem when memory is accessed in a regular pattern. This often occurs when accessing an array along a column. The C language, for example, specifies that arrays must be laid out one row after the other. For example, the array elements a[3,0] and a[3,1] are adjacent in memory, while a[3,0] and a[4,0] are an entire row's worth of bytes apart. If the cache size is an exact multiple of the distance between successively accessed elements, then the elements will repeatedly map to a small number of cache sets.

Even worse is when the distance is greater than the cache size and is an exact multiple of the cache size. In this case, every element maps to the same set. The effect is the same as if your four-way set-associative, 1024-line cache had only four lines.

The best solution is for programs to access data along rows so that accesses are always to successive memory locations. If this is not possible, array dimensions that are powers of 2 (especially large powers of 2) should be avoided. This can be done by padding each row with a few dummy columns.



A CPU that employs a Harvard architecture has split instruction and data caches, while a CPU using a Princeton architecture has a unified cache. These terms come from the design of some of the earliest computers: the Harvard Mark III (1950) used a separate magnetic drum to store its programs, in contrast to the machines being designed at Princeton that used a unified memory system, as advocated by John von Neumann.



When accessing records that are almost as long as a cache line (here, 6 out of 8 bytes), many records will be split across two lines, causing two cache misses per record. Padding the records with dummy fields and aligning them to a cache-line boundary ensures that there will be, at most, one miss per record accessed.

Virtual vs. Physical

Thus far, I've simply spoken of "the address" of a particular item that's cached or in memory. In fact, systems use two types of addresses, virtual and physical, and two different types of caches, depending on which type of address is used.

Operating systems that provide advanced multitasking facilities, such as Unix and OS/2, create the illusion that each program is running on its own machine. This lets each program access and allocate memory independently of all other programs without having to worry about stepping on another program's memory space.

But in reality, each byte of RAM has just one address. The operating system and hardware cooperate to create this illusion by defining two types of addresses—virtual and physical—and handling the translation between the two. Programs use virtual addresses, while the system-memory controller requires physical addresses.

The operating system allocates memory to programs in fixed-size units called *pages*, which are typically 4 KB in size. The operating system also keeps a table for each program that maps the virtual pages to physical ones. Every time a program accesses a virtual address, the system must look up the virtual-to-physical translation in its tables so that the proper location can be accessed.

Page lookup is a time-consuming operation. To minimize the performance penalty, processors use a special-purpose cache called the TLB (translation look-aside buffer) to store the most recent address translations. Thus, only when the required page translation is not in the TLB does the operating system have to interrupt a program, look up the page translation in the memory-resident tables, load the translation into the TLB with a privileged instruction, and return control to the program.

Whereas cache misses may cost less than 10 cycles, TLB misses are expensive; pipelines must be drained, registers must be saved, the lookup routine must be executed, and the registers must be restored. This can require dozens—or perhaps hundreds—of cycles. For this reason, TLBs typically have much greater associativity than other caches.

To look up and store data in a memory cache, either the physical or the virtual address can be employed. The design of the cache itself hardly changes, but the choice has an effect on other aspects of systems design and applications performance. Here's a closer look at the two different types of caches.

Virtually addressed caches. Using a virtually addressed cache has several advantages. The cache controller does not have to wait for address translation to complete before it can begin looking up the address in the cache, which means that the cache can supply the data faster. Also, because the program's virtual addresses are being used, identical runs of a program will lead to identical cache-usage patterns.

This is not the case with physically mapped caches, where the operating system may allocate different physical pages to the program on different runs. As a result, the cache tags for the addresses from one run will differ from those of another run, even if the same computation is being performed. This means that some runs may generate more set conflicts than others, and performance may vary significantly, especially when using a direct-mapped physical cache.

Physically addressed caches. While physically addressed caches suffer from

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variations in performance, they have two distinct advantages. First, if an off-chip cache is being designed for a CPU with an on-chip MMU (memory management unit), the address transmitted by the CPU has already been translated, and a physically addressed cache is the only choice.

Second, because all the addresses are for a single physical-address space rather than a different virtual-address space for each application, the data can be left in the cache when the operating system transfers control from one application to another. With a virtually addressed cache, the data must be flushed each time such a control transfer, or *context switch*, occurs. Otherwise, application A might, for example, read the contents of application B's address 0 instead of its own address 0.

For this reason, physically addressed caches often lead to better performance in multithreaded, multitasking environments in which context-switching is very frequent. Virtually addressed caches can be modified so that they keep a "process tag" along with the address tag in the cache, but this means that the operating system must allocate process tags to applications and still needs to flush the cache at times when there are more applications running than there are process tags available.

Asynchronous Operations

A cache miss costs many cycles, and because memory speeds are not increasing nearly as rapidly as CPU speeds are, this cost is only going to increase. As a result, processors are being designed with extra hardware that minimizes the cost of a cache miss.

In the simplest processor design, when the cache signals a miss, the processor waits for the data to be returned before proceeding. Such a design requires little circuitry, but it forces subsequent instructions to wait until the cache is loaded. More sophisticated processors execute subsequent instructions that do not depend on the cached value while waiting for the result. This is significantly more complicated because the processor may end up executing instructions out of order.

If another miss occurs before the first one completes, the processor stalls, ensuring that at most there is one outstanding miss. In general, two or more outstanding misses can be allowed before the processor stalls. Current high-end processors typically allow one or two outstanding loads.

In the simplest cache design, when there is a miss, the entire line containing the value is loaded; then the value is provided to the processor. This ensures that a subsequent miss in the same line does not occur while the line is in the process of being transferred, but it can double the amount of time a cache miss takes.

A more sophisticated approach loads the cache line starting at the requested word of data and wraps around to fetch the words at the beginning of the line. The requested word is supplied to the CPU as soon as it arrives from memory, and the rest of the data is transferred while the CPU continues processing.

Executing beyond misses and split fetches can lead to complications in cache performance. Say that a processor is executing a loop that begins with two load operations that fetch elements from two different arrays. Each time through the loop, the next array element is loaded.

Assume that the line size is 16 bytes and the array elements are 4 bytes each. Each load operation will cause a miss once every four times through the loop. If both arrays happen to start on a cache-line boundary (i.e., an address that is a multiple of 16), then there will be two misses in the same iteration, followed by three iterations with no misses, and so on.

When the first load misses in the cache, processing continues until the second load misses as well. At this point, processing is stalled until the first load is satisfied. This will cause performance degradation in two distinct ways, which correspond to the two different improvements to the cache and CPU design described earlier.

The first source of performance loss is due to the fact that instructions that come after the second load cannot be executed until the first load completes. These instructions could otherwise be executed during the handling of the miss for the second load. The second source of loss is due to the fact that the first load has to wait not only for the first value to be retrieved, but also for the rest of the cache line containing the first value to be fetched from memory. If the misses were to occur in different iterations, this extra delay would never occur.

This problem, which I call *cache jamming*, can be solved by placing a dummy variable between the arrays so that they are forced to start at different points within a cache line. Note that cache jamming is unaffected by the associativity of the cache.

Cache jamming occurs in the swm256 program from the SPEC benchmark suite. Its main loops make up to 14 array references per iteration. The difference in performance between a data layout that eliminates all jamming and one that causes significant jamming to occur is about 10 percent on an IBM RS/6000 Model 590. The Power2 chip set used in the 590 has two integer execution units that handle loads and stores. Each integer unit can handle one outstanding miss without stalling instruction execution.

Does this mean that hardware support for outstanding loads is a bad idea? No. In most cases, jamming is unlikely to be significant. Even when it is, performance is never worse than it would be if the advanced hardware features had been omitted, unless the extra features complicate the processor so much that the cycle time is increased. However, it does mean that an additional source of variation is introduced and program performance will be harder to predict.

Cache Roundup

There are many parameters of cache design, and each has different implications for performance: cache size, associativity, line size, physical versus virtual, and degree of asynchrony (i.e., number of outstanding misses). While you generally have relatively little control over these parameters, you should keep them in mind when selecting or evaluating a machine. Benchmark results for a specific processor and cache configuration may change substantially when the same processor is combined with a different cache configuration.

With respect to caches, with all other things being equal, a higher level of associativity is better. Direct-mapped caches in particular are sensitive to conflict problems. Virtually addressed caches provide more uniform performance, but physically addressed caches are better for environments where context switching is very frequent.

For the programmer, cache-consciousness can help avoid pitfalls that could lead to order-of-magnitude performance losses. If you are designing or tuning a CPU-intensive application, try to maximize locality and avoid memory-access sequences that increase by large powers of 2. ■

David F. Bacon is a researcher at the IBM T. J. Watson Research Center in Hawthorne, New York, and is a doctoral candidate at the University of California–Berkeley. You can contact him on the Internet at dfb@cs.berkeley.edu or on BIX c/o "editors."

ACKNOWLEDGMENTS

I learned a great deal about caches from my colleagues while on assignment at the IBM Application Development Technology Institute in San Jose, California. In preparing this article, I also made use of Computer Architecture: A Quantitative Approach *by John Hennessy and David Patterson (Morgan Kaufmann, 1990), and a technical report by Alvin Lebeck and David Wood of the University of Wisconsin.*

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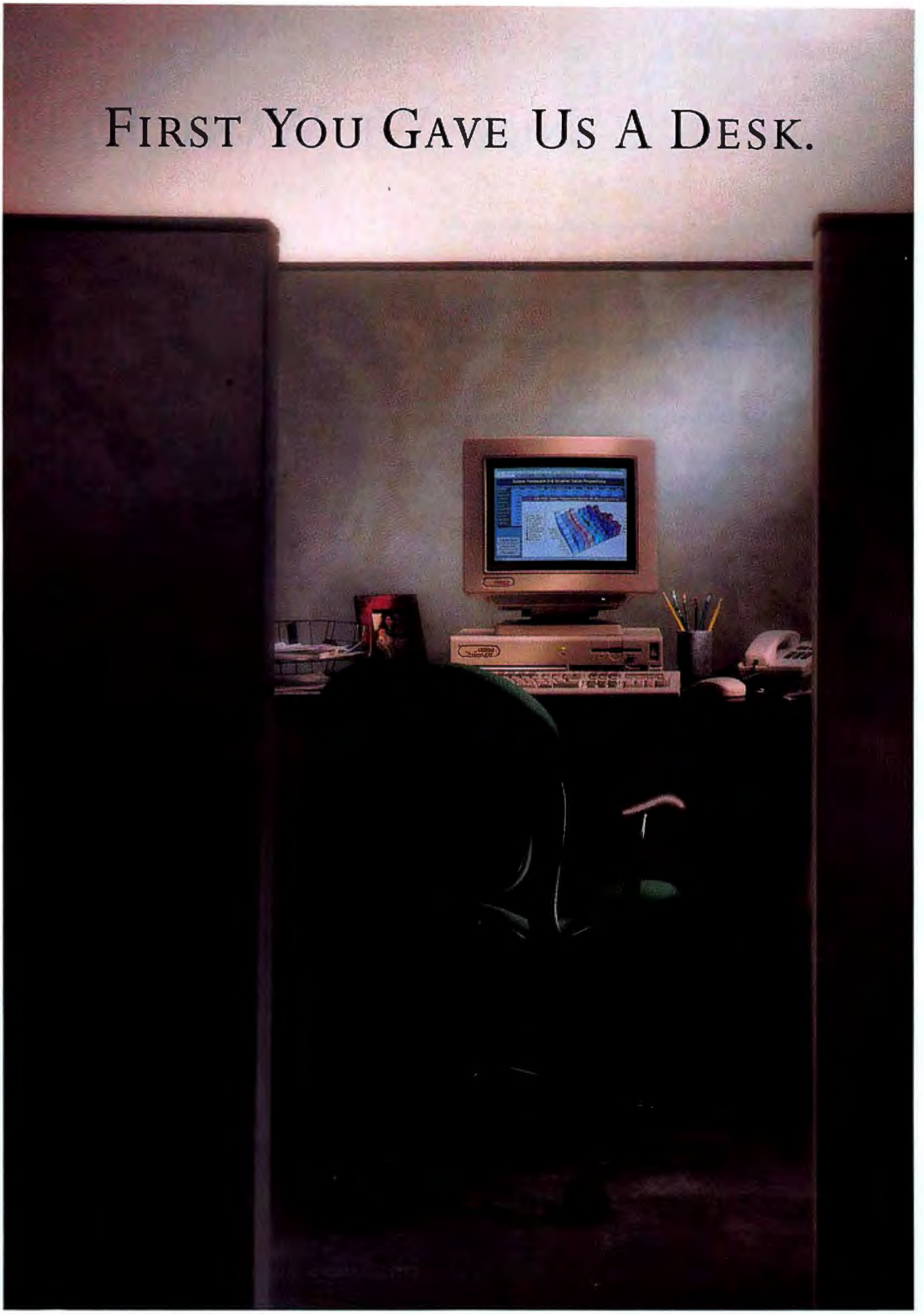

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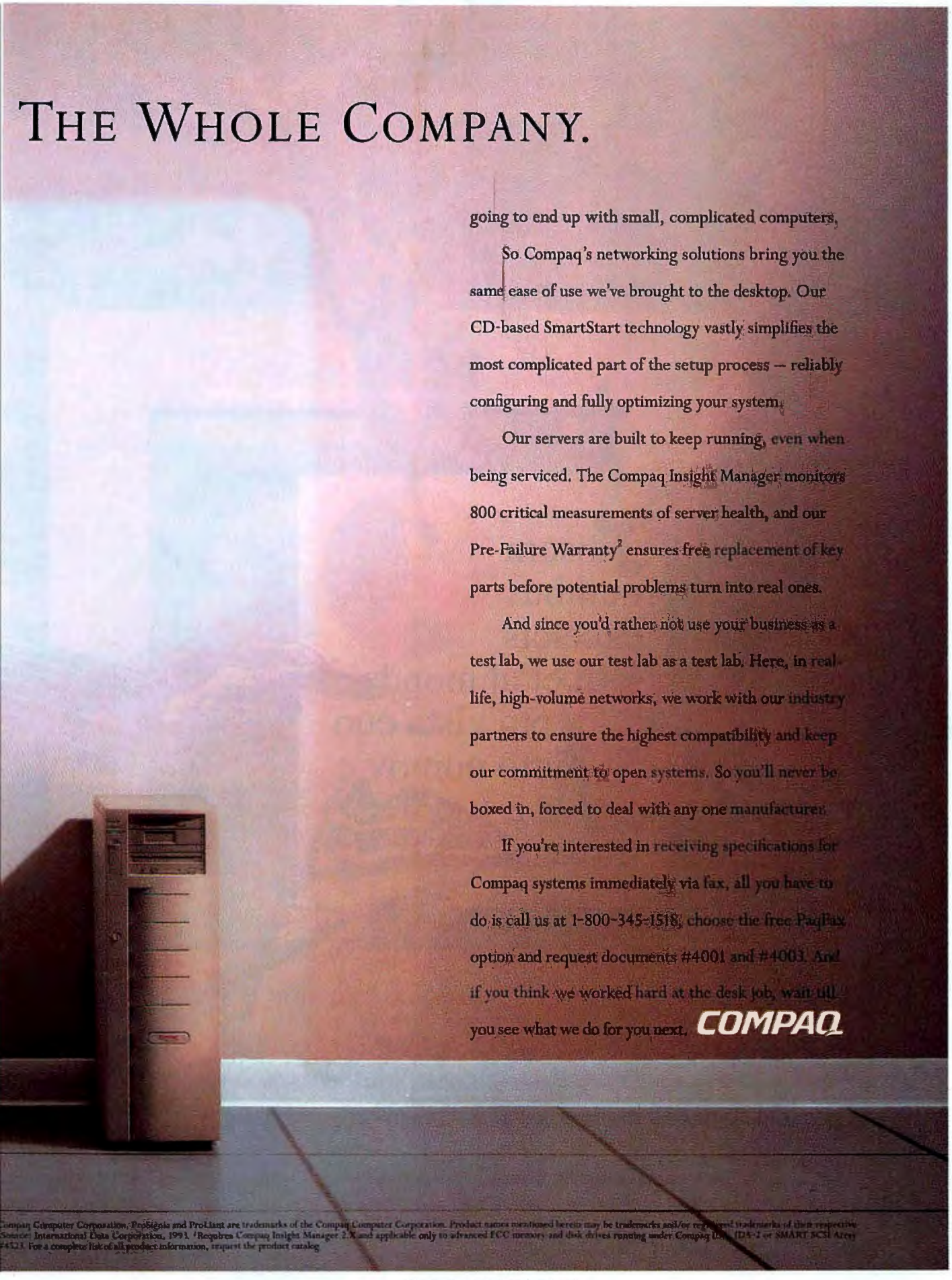

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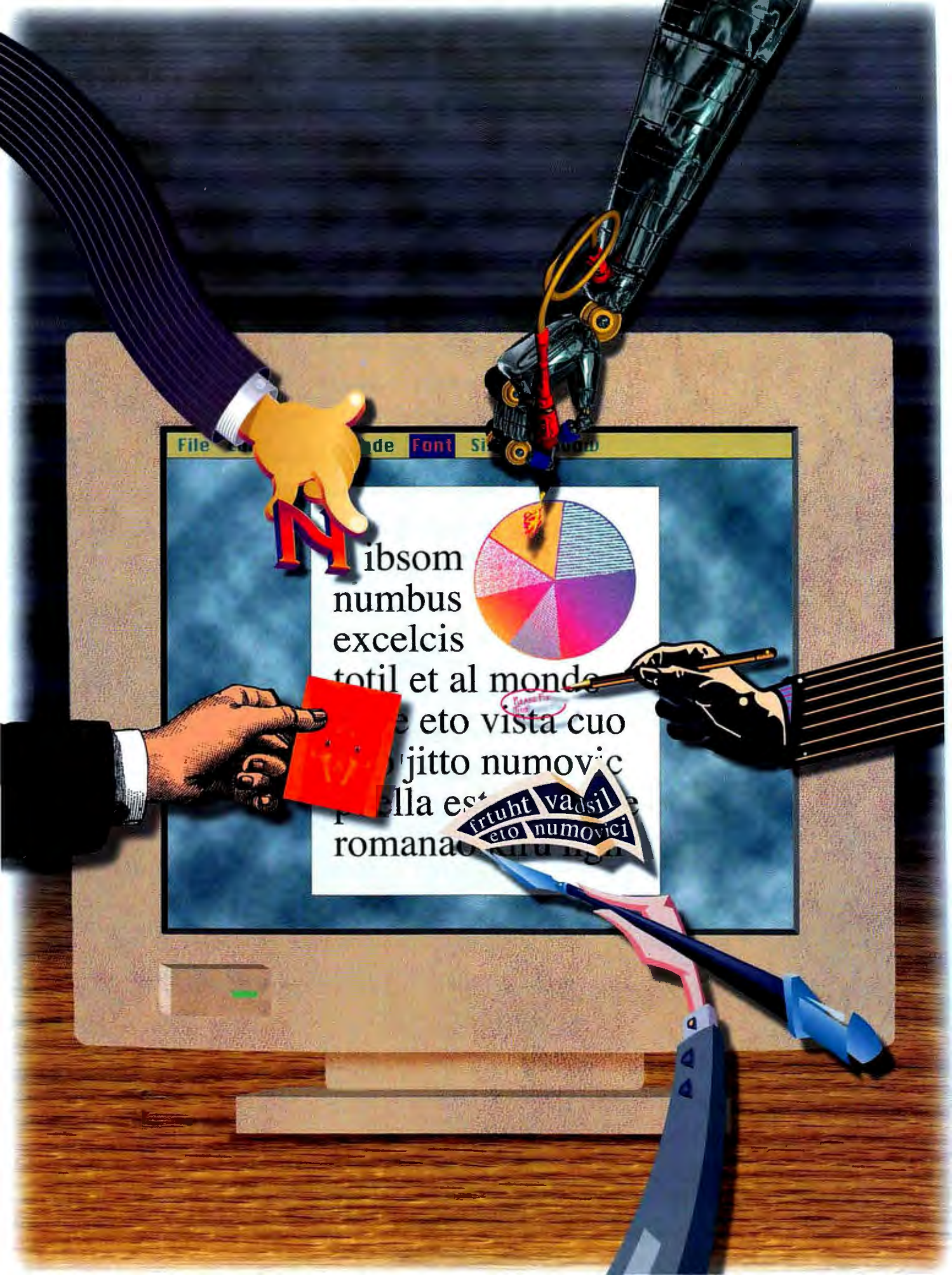
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Managing the New Document

As files proliferate and become containers for multimedia objects, document management is more necessity than luxury. Now, it's becoming part of the system software, with profound implications for networks and the user interface.

ANDY REINHARDT

Today, the primary use of computers by far is for document processing. According to Dataquest (San Jose, CA), 98 percent of business computer users employ word processing software on their PCs; many use their PCs only for word processing. Says Frank Gilbane, president of Publishing Technology Management (Cambridge, MA) and editor of *The Gilbane Report on Open Information and Document Systems*, at least 80 percent of corporate electronic information is in the form of documents, as opposed to structured database records.

Now, the role of documents is poised to become even more central. Documents are no longer merely an electronic analog to paper, but rather dynamic, modular, multimedia entities. At the same time, documents are becoming the focal point for the user interface and the design center of software programs. This is being done through initiatives such as Microsoft's OLE and the OpenDoc standard from Apple, IBM, WordPerfect, and others.

The rise of documents also has a dark side: the information glut. The explosion of desktop documents has spilled over onto servers, and many people are hooking up to the Internet and other on-line services, where millions more documents reside, ready for the taking and misplacing. The average user has enough trouble creating directories or structuring files into folders, much less remembering later where he or she has put files. The inadequacies of contemporary file systems—especially the limited file attributes and "8.3" naming convention of DOS—have never been more apparent, nor the need for powerful document management tools greater.

"If you go into most companies and ask them to track their capital assets, they can do so with unfailing detail," says Scott Wells, product line manager for the NetWare applications services group of Novell (Provo, UT). "But if you ask them to do the same with intellectual assets—documents, memos, letters—they can't."

Given the importance of documents, it's ironic that PCs have handled them so badly until now. The dominant paradigm of operating systems, files arranged in rigid hierarchical directories, is fundamentally computer-based, not human-based. People arrange their desktops and documents in ad hoc folders and piles, clipping together related papers and rearranging groupings to reflect changing priorities and tasks.

The new document-computing model reflects and embraces this reality while at the same time adding a uniquely computational capability: Documents can carry with them information about their origin and identity, as well as executable code that knows how to manipulate or render them. No piece of paper can match that.

As documents become the center of computing activity, users will require new tools to identify, store, track, retrieve, and present them. Operating systems now provide these functions in only the most rudimentary fashion, so users resort to third-party software or even dedicated systems. Eventually, operating systems will take on some of the management functions now assumed by stand-alone packages.

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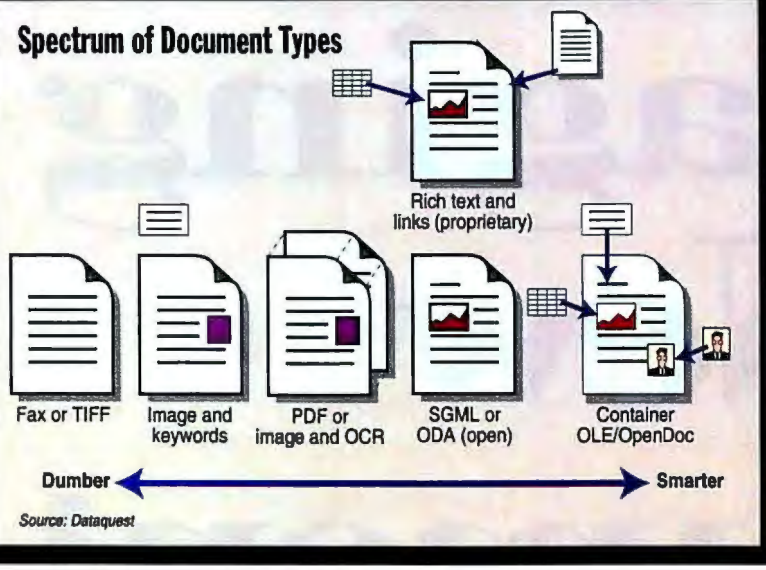


Some documents are smarter than others. Plain image files or faxes are inflexible and unscalable, and they can't be searched. With keywords, images are more easily retrieved. Full-text retrieval is possible only by using OCR or a portable document format that preserves both the appearance and content of the document. Documents prepared with SGML (Standard Generalized Markup Language) or the ODA (Open Document Architecture) know their own content and structure, but they don't necessarily appear the same across platforms. Structure allows more exact searches, such as occurrences of a word in a caption. Formats such as Microsoft Word address content, structure, and appearance, but they are proprietary. Containers are the "smartest" documents of all, holding objects or pointers to objects that know their own behavior and characteristics.

"Users see document management as a tool, not an application," says Bruce Silver, vice president of BIS Strategic Decisions (Norwell, MA).

At the same time, document management is following the architectural model exemplified by databases and mail systems, toward a layered design in which client tools, middleware, and back-end services are separated and wrapped in published interfaces. Document management clients are being rewritten to support APIs such as ODBC (Open Database Connectivity), MAPI, and Lotus Notes, and document engines are migrating from proprietary to industry-standard platforms.

Two standards efforts are occurring in document management. ODMA (Open Document Management API) is an interface that will let any program talk to a document client. The Shamrock group, led by Saros and IBM, has proposed a wrapper for document engines (see the text box below).

This convergence of emerging technologies gives rise to an intriguing scenario. Growing demands on file systems are driving them to become more like distributed databases. Eventually, in operating systems such as Microsoft's Cairo or Taligent from the Apple/IBM joint venture of the same name, file systems will become "universal" object stores able to contain documents, messages, data records, and executable program modules.

Meanwhile, on the desktop, traditional file managers are blending with query tools, which are typically forms-based front ends for databases, such that you may end

Standards Efforts Aim to Ease Interoperability

Like database, E-mail, and telephony vendors, suppliers of document management systems are now turning to published interfaces as a way of opening up their clients and services. This reduces the cost of developing for multiple platforms and broadens the applicability of their offerings.

Two industry-led efforts could ease cross-application and cross-platform communication. ODMA (Open Document Management API), supported by Borland, Documentum, Interleaf, Novell, Oracle, PC DOCS, SoftSolutions, Sybase, WordPerfect, and XSoft, among others, is meant to standardize desktop access to document management clients. "ODMA lets applications talk to document managers without having to hard-wire them together and rewrite every time there's a change," says Scott Kadlec, president of PC DOCS.

Now a Win16-based API, but intended eventually for Win32, Motif, and the Mac, ODMA lets applications such as word processors or spreadsheets call through a DLL to a local document manager, which in turn talks directly or through a middleware layer to document stores. With ODMA, "your word processing application's Open menu launches a dialogue to the document management system," says Scott Wells, product line manager for NetWare applications services at Novell.

ODMA and Novell/Xerox Document-Enabled Networking serve similar but slightly different needs, and they don't really compete. ODMA lets desktop programs access a document front end, whereas the DEN API gives them programmatic access to middleware services, including connections to DEN-compliant back ends. It's not clear how closely the two APIs will track one another. Given Novell's participation in both efforts, however, it's possible that ODMA calls may become a subset of the DEN API, so that an application could transparently call a local document management client, or if none is present, go through the DEN coordination layer.

The other standards effort, the Shamrock Document Management Coalition, is in some ways much more ambitious. Spearheaded by Saros and IBM, Shamrock aims to provide a layer for accessing multiple document management engines, or servers, through a common set of services and calls. Built on technology from Saros, Shamrock hides differences in document repositories, providing a uniform set of security, administration, and data-access tools. In its potential to open up formerly proprietary document engines, Shamrock is reminiscent of SQL. Eventually, it will also define ways for document engines to interoperate (especially important for server-based document assembly) and to access legacy engines.

The Shamrock group includes big names, including Adobe, EDS, Frame Technology, Hewlett-Packard, Microsoft, Verity, ViewStar, and Wang, as well as ODMA members, Documentum, Interleaf, PC DOCS, Sybase, and XSoft. But observers are less sure of its prospects because it is so closely tied to Saros. "The idea is good, because there needs to be a way for these different systems to talk to each other," says Heidi Dix, an analyst at Forrester Research. "But talking to vendors, some say this is driven by Saros, which has the technology already and isn't being incredibly open."

Alvin Tedjamulia, executive vice president of SoftSolutions, offers a more technical critique. "Shamrock tries to define a single view across multiple object repositories," he says. "[Its] Enterprise Library Services

up needing only a single dialog box to access any distributed object. With a unified front end and open back ends, the battle shifts to middleware such as Lotus Notes or the new Document-Enabled Networking initiative from Novell and Xerox, and to client differentiators such as better retrieval techniques or a more intuitive and informative user interface.

The New Document

The document has traditionally been static: a memo, a book, or a photograph. On PCs, documents were typically owned by a given application and stored in a unique format. Until PCs were networked, these files usually belonged to only one user and passed from one person to another in printed form. Documents also tended to be "dumb," knowing nothing of themselves.

The emerging definition is more dynamic. Old distinctions between different data types are fading away, as all of them find their way into document containers, such as those used in the object-oriented OpenDoc technology. Explains Alan Adamson, director of product management for Symantec/Peter Norton Group (Santa Monica, CA): "A document defines an object model and query model, and says this is how objects ought to look. It requires all the individual document-collection engines to retool their front ends to be accessible via a common view."

In this regard, the battle between the DEN SPI (Service Provider Interface) and the Shamrock ELS may turn out to be like the E-mail standards fight between Microsoft's MAPI SPI and the VIM (Vendor-Independent Messaging) model from Lotus. At the back end, Lotus required mail-service providers to bolt a VIM front end to their engines, whereas MAPI compliance required writing through an interface. Quips A. J. Dennis, strategic planner for WordPerfect: "VIM isn't even on the radar screen anymore." Nevertheless, to keep up with Shamrock, Novell and Xerox plan to add support for legacy back ends and searches across multiple document stores through DEN middleware.

will no longer be a single file, but rather a book of pointers to text objects, data objects, images, fonts, and so on."

New documents are also multidimensional. In the temporal domain, their component parts can be linked back to other documents and updated with fresh content. In the spatial domain, work-flow software can automatically route documents, some with built-in intelligence, around a network and present them to users through a variety of forms. Taken together, these attributes define virtual documents, which exist only at the time you view them and via the lens through which you are able (or allowed) to do so.

Responsibility for managing documents is normally shared between operating systems and applications. Some applications, especially databases, have traditionally implemented their own storage systems, optimized for performance and security. Others, such as spreadsheets and word processors, leave the job of file I/O to the operating system, which means that the only information stored about the file are the fields built into the file system.

More up-to-date programs, such as Microsoft Word, go beyond the limited fields built into DOS and attach a summary box to each file. The data in this summary box, including author, title, keywords, version number, description, and file statistics, is bound into the file and isn't readable to other applications. Document management packages essentially perform the same function, but in a nonapplication-specific way. They usually employ proprietary user interfaces and file repositories.

Merging Definitions

Document management has traditionally been divided into two broad categories: products for cataloging and retrieving editable files stored locally or on a server; and products for inputting, tagging, storing, and recalling the images of documents, usually from paper originals created outside the organization. These uses have led to different feature sets and a bifurcation of suppliers, but observers believe the distinctions will disappear over time.

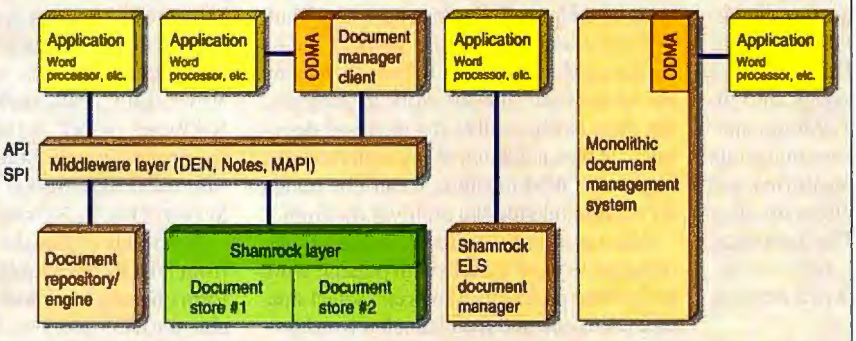
"Document management, work flow, images, forms, and OCR are all getting married together," says Scott Cooper, a senior product manager for Lotus Development Corp. (Cambridge, MA). One example is PageKeeper from Caere Corp. (Los Gatos, CA), a desktop-class document manager designed to handle both editable files and images.

User requirements for document management and image management differ for two reasons. First, in imaging applications, the documents are static, imported into the system in their final form. In document management systems, they are dynamic. Image managers thus focus on moving and handling fixed files, while document managers concern themselves with policing the creation of content. "The purpose of document management," says Alvin Tedjamulia, executive vice president of technology at SoftSolutions Technology (Orem, UT), "is to know that an original is an original, and who touches it, and when."

Second, in imaging applications, the documents are bit maps, and, as such, are faithfully reproducible but not editable or searchable. In document management, they're editable, which can mean that their appearance is not consistent to all users. Being able to render electronic documents accurately across multiple platforms is of

As with all standards efforts, what users really care about in the end is easy yet secure access to data across multiple platforms. "What users want is the ability to file and find documents, revise them, etc., in a more standard way," says Bruce Silver, vice president of BIS Strategic Decisions. "ODMA will let multiple apps deal with the same document system, and Shamrock will provide tools to access multiple corporate repositories." But, he adds on a skeptical note: "Nobody is very confident that these things are really going to work."

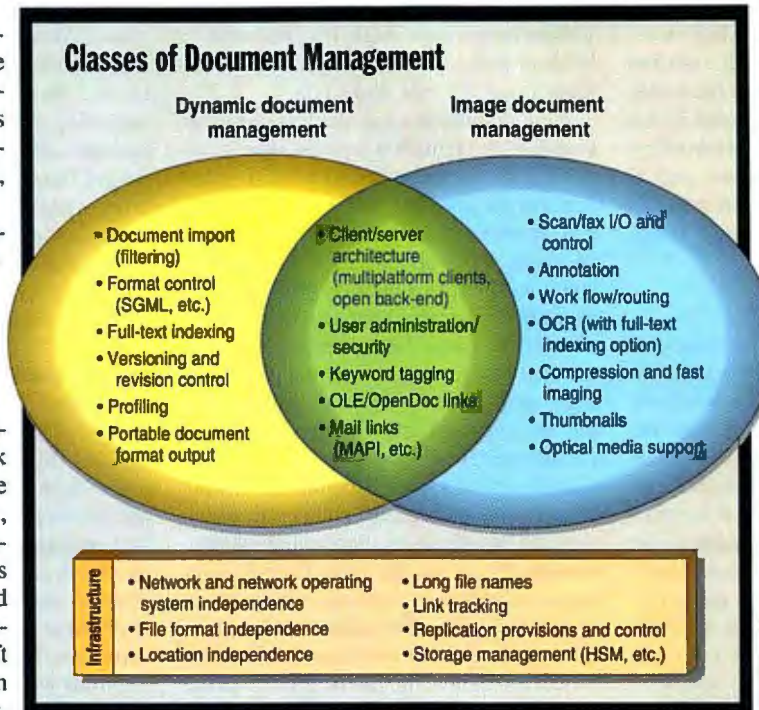
The Emerging Document Management System Architecture



The document management infrastructure of the future uses a layered architecture now common in other client/server systems. Desktop applications will talk to other clients and/or to middleware services (e.g., DEN or Microsoft's Extended MAPI DLL), which in turn will communicate with back-end services. Some of these connections will be through open APIs and others through proprietary or hard-wired links, but the result will be a diversity of choices.

growing importance. It's driving interest in portable file formats such as Adobe Acrobat, Farallon Computing's Replica, No Hands Software's Common Ground, and WordPerfect Envoy.

Both imaging and document management systems generally run on networked infrastructures that should provide protocol independence, locationless file access, security, and storage management. Ideally, server replication, link tracking, and extended file attributes are also built in, which is one reason that environments such as Lotus Notes, NetWare 4.x, and Microsoft's pending Windows NT–based Microsoft Exchange Server (known until recently as the Enterprise Messaging Server, or EMS) are becoming such attractive platforms for document management.



Systems for managing dynamic documents and image documents share many underlying capabilities, but they offer starkly different feature sets to users. Both also typically ride on top of a rich network infrastructure.

A third class of document management products, favored by big engineering firms, supports document assembly, or the creation and presentation of large, fast-changing, or customized documents. These high-end systems, from suppliers such as Documentum, Frame Technology, and Interleaf, combine attributes of desktop publishing and databases. Source materials are maintained in huge repositories and assembled into customized views for electronic or paper distribution. The document, as such, is not a fixed entity; rather, it exists only as a slice or snapshot of a flexible, evolving information base.

This publishing model will become more prevalent as compound document architectures move onto the desktop. Document assembly will no longer be a high-end application, but rather the way you put together a routine report. Some low-end products are already starting to appear. For instance, Capsoft Development (American Fork, UT) sells a $99 utility called HotDocs that lets you turn Word, WordPerfect, and Ami Pro documents into templates for custom publishing.

"What we are headed for is an integrated desktop where you can work on spreadsheets, documents, data, voice, and it doesn't make any difference," says imaging consultant Harvey Spencer (East Northport, NY). If document management is now a niche market, soon it will be synonymous with file management, data access, and data presentation. The document manager will be the user interface.

However, compound document architectures also present difficulties that still must be addressed. For instance, says Mark Walter, a senior editor for Seybold Publications (Media, PA), OLE links among documents are fine for work in progress, but they're impossible for archived documents. Once a document is committed to a tape or WORM medium, it can't be reliant on objects outside the archival medium.

Most desktop document managers are designed to work closely with popular word processing programs. Users can select documents to edit and then launch a word processor. An alternative approach, typified by market leaders PC DOCS (Tallahassee, FL) and SoftSolutions, ties the document manager directly to a word processor's file I/O operations. When you open or save a file within WordPerfect, these packages intercede and take over the function.

For a save operation, the document manager forces you to fill out an on-screen form, or profile, which specifies information such as the author, title, and subject of the document; a job or case number; and keywords for categorizing the file. Sophisticated packages fill in some of these fields by default, such as author, typist, date, and version. Advanced packages also store a complete inverted-tree index of the document for full-text retrieval.

File-open operations invoke the opposite action, presenting you with a blank copy of the profile form that you use to query the document database. Using a QBE (query by example) technique, you fill in one or more fields with search criteria that you use to locate a document.

Changing Model

Both PC DOCS and SoftSolutions now use client/server architectures as a means of supporting multiple platforms, improving performance and robustness, and tapping into industry standards. Like most DOS-based packages, PC DOCS used to have a monolithic architecture, providing both the client interface (a TSR program for DOS) and the document store (Btrieve). The networked version used Btrieve to store the document profiles, which pointed to documents stored on a NetWare server.

In the latest version, PC DOCS Open, the company has taken a huge step toward platform diversity and openness. The client portion now runs on Windows (DOS and Macintosh versions will follow), and the back end runs on a plethora of servers. Documents can be stored on Banyan Vines, DEC Pathworks, LAN Manager, NetWare, or NT Advanced Server. And the profiles live in SQL databases such as Microsoft SQL Server for OS/2, NT SQL Server, Oracle, Sybase, and Watcom.

SoftSolutions has also made the transition from a DOS-based solution to a multiplatform client/server model. Clients are available for DOS and Windows; servers run on NetWare and various flavors of Unix. On Windows, you can run the SoftSolutions Document Desktop, a Norton Desktop–like home page that eliminates the Windows Program Manager/File Manager duality and hosts documents, applications, folders, search tools, and saved searches.

Through DLLs, SoftSolutions is able to work from inside several Windows programs, including Ami Pro, Excel, Lotus 1-2-3, Microsoft Mail, Word, WordPerfect, and WordPerfect Office. Through OLE 2, it can link directly with other Windows applications. For instance, SoftSolutions bundles in a copy of Watermark Software's Discovery Edition, a set of low-end imaging tools (i.e., compression, fax, and OCR support; optical media management), and uses OLE to communicate with it.

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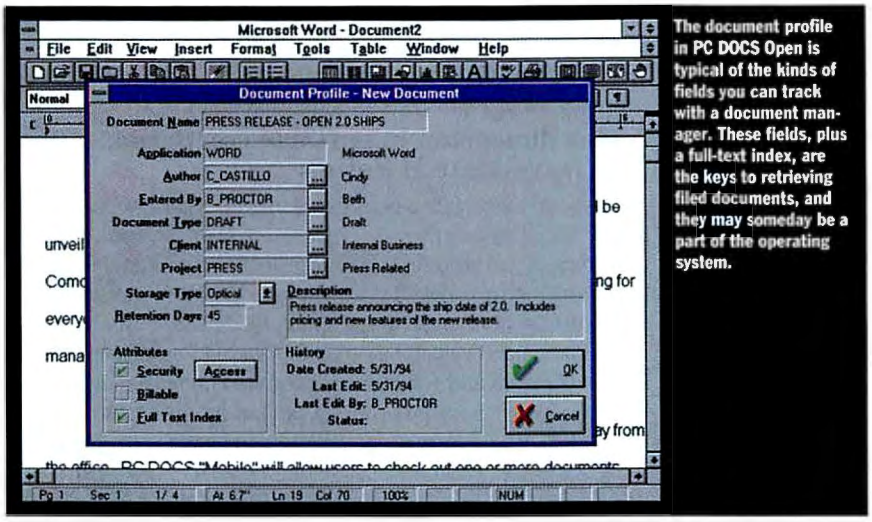

The document profile in PC DOCS Open is typical of the kinds of fields you can track with a document manager. These fields, plus a full-text index, are the keys to retrieving filed documents, and they may someday be a part of the operating system.

server model is Apple, whose $1800 AppleSearch tightly couples text retrieval into the Mac OS. Implemented as an AppleShare server engine with front-end clients, AppleSearch lets desktop users search across the network for documents using fairly conventional criteria (e.g., Boolean with proximity, wild cards, and creation date) and see results ranked by relevance, using technology licensed from Personal Library Software (Rockville, MD).

Middleware Is Key

One of the most powerful ways to use SoftSolutions is in conjunction with Lotus Notes. Notes provides useful middleware services—multiplatform support, user administration, security, a messaging transport, form views, and, most important, database replication—but by itself, it's not suited for document management. SoftSolutions fills in where Notes falls short, providing library services, such as document checkout and revision control. "Your entire world view is through Notes, and the SoftSolutions document profile becomes a form," explains Tedjamulia of SoftSolutions.

Riding on the Notes database, profiles are automatically replicated throughout the Notes network. But the original documents are kept on a single SoftSolutions server. "If you store the documents themselves in Notes, they're replicated and you lose control of them," Tedjamulia says. This hybrid architecture increases security and preserves bandwidth, he says, yet still allows Notes users to search for documents and call them up from the SoftSolutions server across the LAN or WAN.

The SoftSolutions engine is now accessible via ODBC drivers. Later this year, the company says it will add support, including fast text searching, for 19 third-party databases. The company is committed to supporting both OS/2 and NT, as well as the ODMA interface.

Lotus sees big opportunities for Notes in document management. "We don't position Notes as a document manager, per se," says Chris Reed, director of market development for Lotus Notes. "Rather, it's a layer of services that anyone doing document management can leverage off of."

Lotus argues that low-level file managers are not the best tools for document management. "You need a middleware/groupware layer," says Judy Jalbert, the Notes product manager for DBMS integration and document management. "That's the appropriate place for it because you need to be cross-platform, and one operating system won't solve that."

Through aggressive partnering, Lotus has already added significantly to the basic Notes package. Verity (Mountain View, CA) provided a version of its well-regarded Topic full-text search engine, which is bundled into release 3.0 of Notes. Action Technologies (Alameda, CA) has built a sophisticated server-based work-flow system on Notes. And in conjunction with Kodak, Lotus has delivered Lotus Notes: Document Imaging, or LN:DI (commonly pronounced "Lindy"), a set of client and server tools that support image files.

LN:DI includes Windows client software that performs basic imaging functions, such as scanning documents, compressing/decompressing files, and zooming, panning, and rotation. The server component, which runs on its own OS/2-based system, implements an image database with integrated HSM (Hierarchical Storage Management). Notes was able to handle images already, but without LN:DI, they were treated like any document and replicated indiscriminately, which had repercussions for WAN bandwidth. With LN:DI, images can be stored centrally and referenced with 100-byte pointers in distributed Notes databases, much as SoftSolutions does with its document manager.

Following the same middleware model, Kodak has also partnered with Novell to enhance NetWare 4.x's image support. The companies have created Image-Enabled NetWare, a set of client components, NLMs, and APIs that implement storage management, server-based imaging, and a document management front end. The storage management piece, written by Kodak, consists of optical media drivers (the High Capacity Storage System) and HSM capabilities (Mass Storage Services) for NetWare 4.x. Document Management Services is a scheme for organizing network files into folders according to keywords or ad hoc groupings.

Image Management Services implements functions on the server such as inbound and outbound fax and mail support; raster operations like cropping, scaling, and rotating; and support for image file types (i.e., TIFF, GIF, and Group 4 fax). "This means that developers like Kofax can create IMS-aware apps and save having to write all these capabilities themselves," says Novell's Wells. "Using IMS to render or handle images lets most of the work be done on the server." IMS also implements client- and server-based scanner drivers. "We've made them into network services so that ISVs [independent software vendors] don't have to worry about the details," he says.

Is This NOSA?

A separate initiative between Novell and Xerox may turn out to be the most significant development of all for document management. The partnership aims to create a middleware layer and published programming interfaces, known collectively as Document-Enabled Networking, that should make it easier for developers to create networked document management applications. "For document management to become more pervasive, we need broader tools for end users, VARs, and system integrators," says Dennis Hamilton, the major architect of DEN and principal software scientist for Xerox's XSoft applications subsidiary. "DEN empowers them to implement document management solutions more readily."

Architecturally, DEN bears a striking similarity to the model used in Microsoft's WOSA (Windows Open Services Architecture). Applications talk through an API to a set of middleware services (DLLs in the Windows case, NLMs in Novell's case), and back ends write through an SPI (Service Provider Interface) to the mid-

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Adding a Mac-like foldering scheme to Windows, the Document Desktop from SoftSolutions is an integrated launch pad for documents or applications. Microsoft's Chicago release of Windows will also do away with the current distinction between the Program Manager and the File Manager.

dleware. The result is that any compliant client can talk to any compliant server.

Initially slated to ride on NetWare 4.x (it will be ported to other operating systems in the future), DEN consists of network services for accessing and managing documents and development tools. The initial specification will be available by the time you read this, and the software development kit will ship this year, says Hamilton.

The DEN coordination layer, built on NetWare 4.x's distributed file system, is intended to provide a consistent mechanism for getting at documents anywhere on the network, or at least those housed in NetWare servers or DEN-compliant libraries. It will provide integrated text and attribute indexing, security, commenting, and library services (e.g., checkin/checkout, access control, and usage tracking). A Xerox partnership with Mastersoft (Scottsdale, AZ), will also provide file-format conversions. DEN's SPI will let third parties deliver enhanced back-end services, such as indexing or conversion engines.

Xerox and Novell also plan enhanced network printing capabilities, including server-based printing, a critical capability for document assembly. Says Hamilton, "People want to print from the server, not bring the document back to the desktop, load it up, and then spool it back out to a print server." High-end publishing systems do their composing on the server, he says, whereas on PC LANs, the client and the application do all the work. "With big enough documents, you can't even afford to do it on the client."

NetWare and DEN have some advantages over Notes in the DMS middleware arena. First, Novell controls the underlying operating system, while Lotus is beholden to IBM, Microsoft, Novell, and other platform providers. More important, the automatic replication in NetWare 4.0 distributes directory information but not the data itself, whereas Notes replicates the content of the databases. Obviously, Notes replication is beneficial for messaging and groupware applications, but document management, unless it is enforced at the operating-system level, prefers a more controlled and centralized model.

To strengthen its hand, Novell also plans to add extended file attributes to NetWare's file system. "Extended attributes attach more information that people can inspect to the raw material," says XSoft's Hamilton. "This could thin the layer you have to build on top of the raw material in order to describe it. But you will still need a layer between the operating system and the document manager, because different search engines look for different things."

Another Contender

Remarkably quiet so far in document management has been Microsoft, but the company is about to enter the fray with its much-delayed Exchange Server. Designed to run on NT and to be accessed through the Extended MAPI programming interface, MXS is an ambitious effort to accommodate a range of messaging-based applications on a single dedicated server.

MXS began as a project to create an NT message store—in effect, a high-end post office for Microsoft Mail. Over time, however, it has evolved into a platform for implementing message-enabled client/server applications, such as work flow, forms routing, and group communications. For this reason, it has been called a "Notes killer," a label Microsoft vigorously rejects. Unlike Notes, MXS isn't a programmable database engine. Rather, it's a repository onto which Win32 applications can be layered. Microsoft hopes, for instance, that third parties will develop document management programs that use MXS as a file store.

Like Notes, MXS contains data files, not just pointers to them, and it automatically replicates itself. "It's a storage system, closer to a database than to a file system," says Thom McCann, MXS product manager for Microsoft. The contents of the repository will be visible to MAPI and ODBC, but not directly from the NT file system. But while MXS supports ODBC, it doesn't have a programmable schema. "We take care of that," McCann says. "We've optimized the info store for the kinds of things we do."

MXS is the core of Microsoft's push into enterprise messaging. As such, it's designed for heterogeneous environments. It has TCP/IP and NetWare support built in, and it uses native implementations of the ISO's X.400 addressing scheme/message transport agent and X.500 directory services. This means MXS will have a separate user directory from the NT network to which it belongs, but Microsoft will provide tools that let network administrators set up user accounts on both NT and MXS simultaneously. MXS will also be able to import user directories including those from NetWare 3.x Bindaries, and NetWare 4.x NetWare Directory Services.

McCann contends that the advantages of MXS over an NLM-based solution accrue in part from NT's inherent strengths: manageability, scalability, and GUI-based administration tools. MXS, he says, "can be a fairly good platform for document management," because out of the box it will take care of basic features such as checkin/checkout and versioning. Advanced capabilities like revision control, full-text indexing, and global file management will have to be provided by ISVs (e.g., Microsoft is working with Watermark on a MAPI-enabled version of its image store).

In support of more advanced groupware applications, MXS can store multimedia data types, custom forms, and calendar/scheduling information. It will maintain the integrity of OLE links among documents, but only within the information store. "We're trying to take a lot of the functionality that needs to be driven down into the operating system or into the server and put that into MXS," says McCann.

Third-party developers mostly applaud the potential for MXS. To effect document management, says Albert Behr, product manager for forms products at Delrina Software (Toronto, Ontario, Canada), "the plumbing needs to be both in the operating system and the workgroup infrastructure." MXS and Notes both provide workgroup

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So, as *Windows Magazine* recently put it **"If you're seeking a Windows project management product that does it all and then some, Project Scheduler 6 fills the bill."**[3]

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capability, but Microsoft also controls NT.

Scott Kadlec, the president of PC DOCS, calls MXS "very strategic" for his company. "In the past, we've been so focused on overcoming problems the operating system should have solved itself that we haven't been able to step up to the next level," he says. If the company is freed of responsibility for low-level file management, he says, PC DOCS can concentrate its engineering efforts on creating better ways to find documents or to present search results.

Of course, not everybody welcomes MXS. Lotus's Reed chides Microsoft for being too Windows-based. "MXS misses the mark," he says. "Microsoft's fundamental approach is to get everyone on one platform, but cross-platform apps are the ones winning in the market."

Foundation Support

For document management to become a true mass-market capability, better information and object management tools have to migrate down to the average desktop, not just to the server, because many files are still stored and accessed locally. In the Windows marketplace, some functionality will be shifted down into the operating system when Microsoft delivers Chicago, and much more so with the future object-oriented successor to NT, known as Cairo.

Chicago offers limited but important enhancements that improve support for document management, says Rogers Weed, the lead project manager for Chicago. At the lowest level, a small number of additional file attributes have been added to the FAT (file allocation table) file system, using previously reserved but unused fields. Chicago will support long filenames, breaking at last the hard-coded "8.3" DOS file-naming scheme and vastly improving your ability to name files with memorable descriptors. And in addition to date/time of the last modification, Chicago will store the date/time of creation and most recent access to files, even if that access produced no changes. These fields will help track file activity and will be especially useful for network management and backup, but also for document management.

Outside the confines of the FAT file system, Chicago will let developers attach additional fields of information (e.g., the contents of the Word and Excel summary boxes) to files and then publish, via an API, the structure of those records. This could be a boon to document management systems, which would gain a standardized way of reading summary boxes and importing the data into document profiles.

At a higher level, Chicago introduces a new user interface, called Explorer, that merges file and program management onto a single desktop, like the Mac or OS/2. This is a critical step toward document-based computing, because it exposes documents at the desktop, rather than burying them inside the context of their creating applications. In conjunction with OLE and OpenDoc, it moves the Microsoft/Intel computing world into a more document-centered user interface (see the text box "Distributed Document Management with OLE and OpenDoc"). Explorer will also offer an improved finder that lets you search for files over the network, and it will ship with built-in file viewers, a critical aid to document management.

Explorer also supports Mac-style aliasing, which means that an icon on the desktop can be a pointer to another entity anywhere on the network. Called Shortcuts, these desktop-level links are a new data type managed by the operating system. They fully support OLE, which means you can drag and drop an object from the desk-

Distributed Document Management with OLE and OpenDoc

JON UDELL

The GUI revolution rewrote most of the rules for applications. But the File Open menu item in nearly all Windows and Macintosh software betrays one deeply rooted assumption that has yet to change. Programs still expect to create, write, and read ordinary disk files.

A programmer awakened from a 25-year coma would be overwhelmed by the snazzy APIs that control graphics, fonts, messaging, and other system services, but he or she would find the humble I/O functions used to store and retrieve documents quite familiar. Some of today's document managers can intercept File Open, but that's a stopgap. Robust, flexible control of shared documents won't really be possible until applications abandon direct file access in favor of the sort of mediated access that OLE's structured storage and OpenDoc's Bento provide.

A compound document stored using either of these technologies is more like a mountable volume than a file. It has its own internal directories and files that supply persistent storage for the pieces of a document. OLE 2.0 objects use *storages* and *streams*; OpenDoc parts use *storage units* and *values*. Because each piece of content stores to its own "directory" or "file," fast incremental saves can occur. There's no need to rewrite the entire "volume," as current applications typically do.

Because the compound document is self-contained, OLE and OpenDoc can track links within compound documents. (Tracking them across documents, however, remains a thorny problem that can only really be addressed once these storage architectures migrate into the operating system and network substrate.) Transaction controls enable users to undo and redo changes. The first release of OpenDoc will also support multiple drafts of a document, a feature that's still on the drawing board for OLE.

For vendors of document managers, the key point is that OLE and OpenDoc will spawn a new generation of applications that access compound documents only by way of high-level APIs. Because both storage systems are built to be replaceable, these APIs can in theory be redirected across networks to document servers. How might that work in practice? Microsoft OLE architect Tony Williams points out that in the near term, on Windows 3.x and Chicago, a document manager might embed content handled by OLE 2.0 applications in a shell that communicates with a server-based implementation of OLE structured storage.

That's better than hooking File Open, but it's still less than ideal because nothing prevents users from making an end run around the document manager and using applications in a stand-alone manner. Cairo will enable a more robust solution, says Williams, because document engines will be able to use its installable file-system mechanism to make server-based document storage available to clients in a way that's transparent to all applications.

Jon Udell is a BYTE senior technical editor at large. You can reach him on the Internet or BIX at judell@bix.com.

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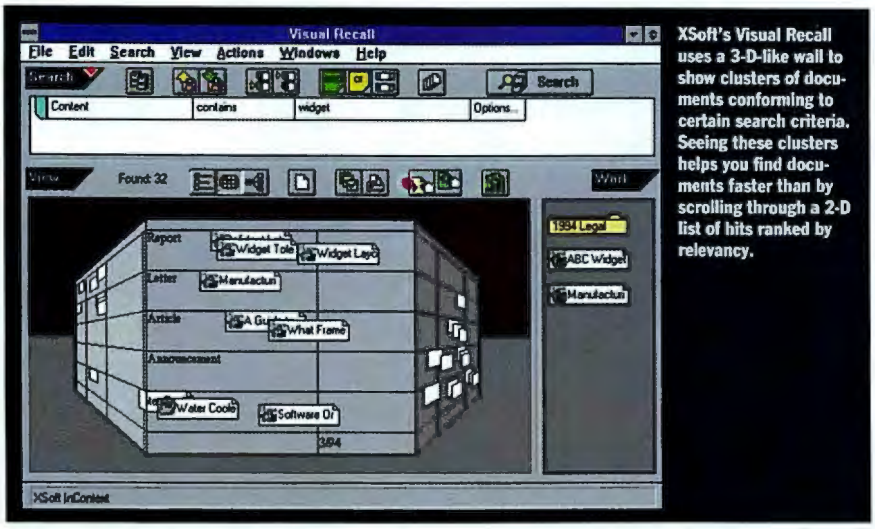


XSoft's Visual Recall uses a 3-D-like wall to show clusters of documents conforming to certain search criteria. Seeing these clusters helps you find documents faster than by scrolling through a 2-D list of hits ranked by relevancy.

top into another application or onto a service such as printing or backup.

It's important to note, however, that the integrity of these links is not ensured at the operating system or network level; you can easily break the link by moving or deleting the target of a pointer. And to perform really fast searches against a large directory of files and objects, you need a better file system than FAT. That's where Cairo comes in. "Cairo is a fundamental revisiting of the file-system structure," says Weed. "It includes indexing, security, and management of lots of objects."

The Cairo object store won't necessarily be a single entity that contains all data types. Rich Tong, the general manager of product marketing for Microsoft's business systems division, explains that OLE wrapping will be a standardized way of representing what an object is—"a way to label the outside of something"—but that the actual file stores and retrieval engines could vary depending on the nature of the data. "A half-gigabyte financial database needs a different structure from a thousand documents or a million objects," he says. "With OLE wrappers, you can use any kind of store as your back end: a legacy VAX, a Notes database, or MXS."

Cairo's OLE file system will support richer attributes than FAT or even NTFS (NT File System), and the definition of those attributes is flexible because of object orientation. At a minimum, Tong says, it might include fields such as object ID, author, and version, while more specialized attributes could be laid down by the host document manager. Document managers like FileNet could write drivers to route document calls into the Cairo file system, thus preserving their customers' existing application and databases. This tie into legacy systems will be accomplished largely through the use of COM (Common Object Model), which will also tie to object models such as SOM/DSOM (System Object Model/Distributed System Object Model), CORBA (Common Object Request Broker Architecture), and DOE (Distributed Objects Everywhere) through a DEC-authored object broker (see "Componentware," May BYTE).

Finding It

Once you have documents stashed in an appropriate file system and wrapped with identifying information, you still need an object browser or some other means of quickly locating the information or function you need. Microsoft hasn't said much about the Cairo user interface, but you can draw some conclusions from other object and information managers.

There will likely be a wealth of choices for accessing distributed object stores. Imagine a query tool that brings together elements of a Mac or Chicago desktop; a Borland or Gupta QBE database-access dialog box; a custom business form from Delrina, JetForm, or WordPerfect; and a customized data view from Lotus Notes.

Things start to get even more interesting when you consider technologies used to formulate queries, organize searches, and represent search results to the user. A leading researcher in these areas is Xerox PARC (Palo Alto Research Center), which is pioneering more effective ways of scanning unstructured textbases and presenting the results. The goal is to help users find the information they need, so the first line of attack addresses formulating queries.

Simple, often inflexible, Boolean searches can produce unintended or incomplete results, including no hits or too many hits, and many people don't understand how to effectively formulate a Boolean query. Researchers are experimenting with natural-language techniques that parse out the meaning of a user's request and search for hits based not only on exact matches but also on word associations and semantics. Most of these tools use thesauri or semantic networks. For instance, if you searched for occurrences of the word *tooth*, citations for *molar*, *incisor*, *fang*, and *tusk* might also be returned.

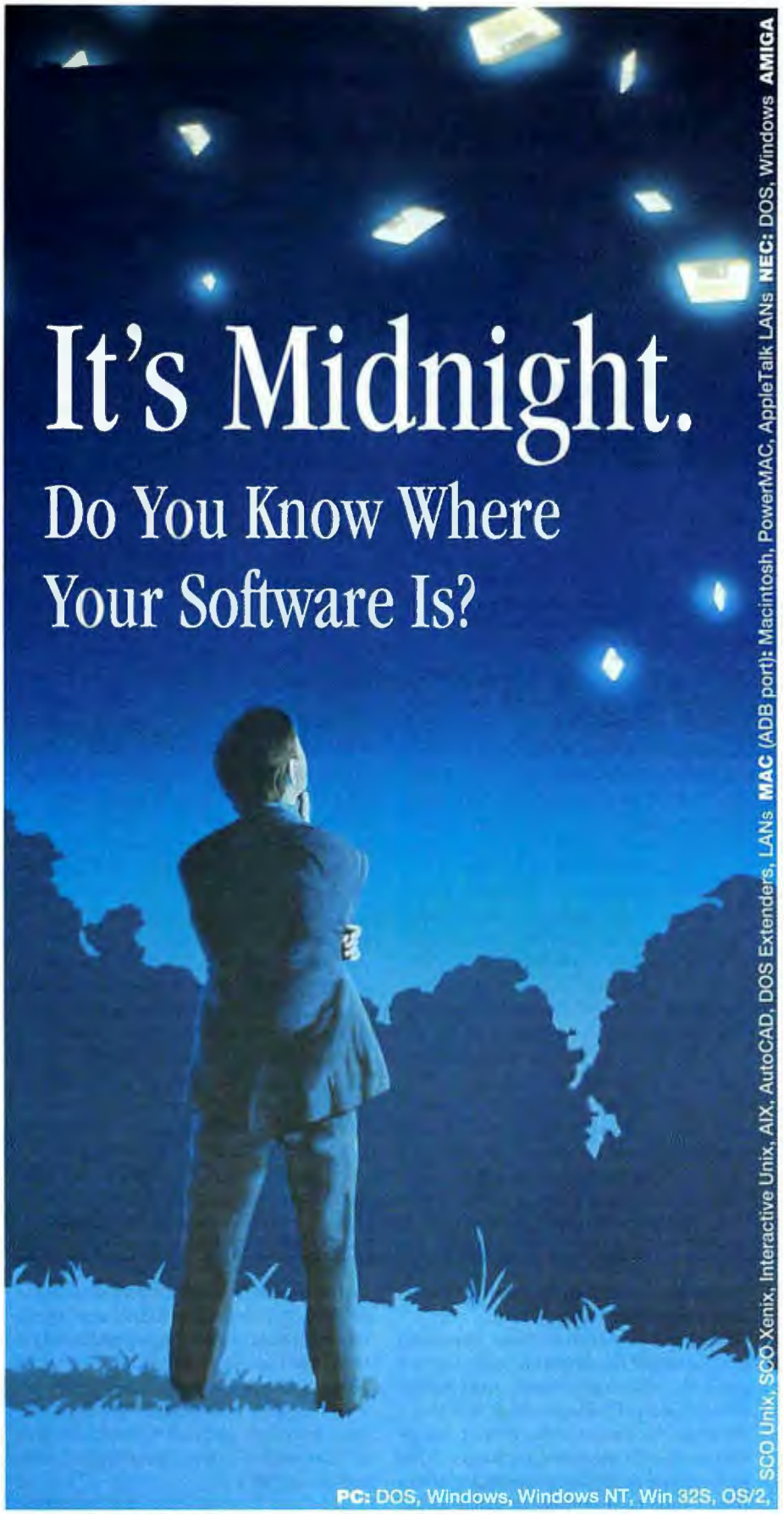
Sometimes, users don't know even what they're looking for, so the Xerox PARC information-retrieval project, led by Jan Pedersen, is experimenting with a technique called *scatter/gather*, which reads huge collections of documents and intelligently groups them into categories based on the frequency of word occurrences. Without understanding actual content, scatter/gather can examine unindexed data sets and progressively narrow the universe of choices such that a query you issue is more likely to result in hits.

Scanning a reference database of 1 million documents maintained by the Federal government, for example, produces "clusters" of subjects such as foreign policy, computers, and defense. These can be scanned again for finer clusters. By doing this, searchers can find documents they might otherwise not know to look for.

The flip side of not finding enough documents is finding too many. Much of text-retrieval research is now directed at ways to make searches more productive by returning only meaningful hits. A new technology from Oracle (Redwood Shores, CA) called ConText goes beyond thesaurus-based tools, performing syntactical analysis that can determine the subject of a sentence by isolating the main clause.

Brett Newbold, senior director of Oracle's text server division, says that ConText helps users find only documents that are really about the subject of the query. If you were looking for information about the Federal Reserve Bank, he says, a conventional search tool might return an unrelated article that merely quotes a bank official. "ConText knows this document isn't about the Fed, even though the words Federal Reserve Bank appear in the article," he says.

What happens if, even after sophisticated filtering, you are inundated with documents that match your search criteria? PARC researchers Stuart Card, Jock Mackinlay and George Robertson have created an Information Visualizer that explores ways to present orders of magnitude more data on a computer screen than is now possible with GUIs. One technique involves creating 3-D trees of linked objects, which can be rotated in space to select certain topics. Another concept, "rooms" of flexibly grouped files and pro-



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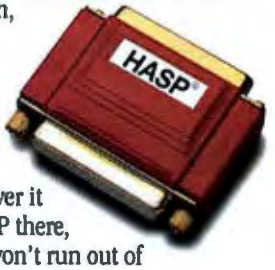

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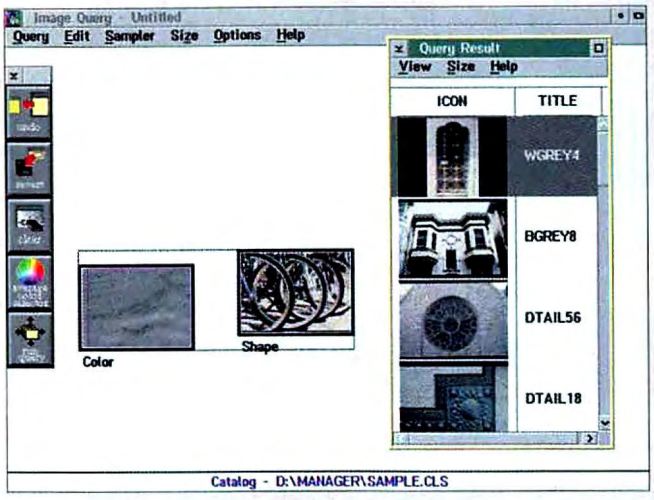
Image Retrieval for Compound Documents

TOM R. HALFHILL



IBM's Visualizer Ultimedia Query can locate images from a database by shape or color. In this example, the product has located all gray, circular-shaped architectural images. Results are displayed in a closest-to-sample order.

Archived information is useless if it can't be retrieved, and the easiest kind of information to retrieve is textual: documents that either originated in machine-readable form or were converted to ASCII text by OCR scanning. A much more difficult challenge is to retrieve image files or compound documents in which the target of the search is a graphic, a video clip, or a sound bite. As the definition of what constitutes a "document" evolves to include files with multiple embedded data types, the ability to search for attributes unique to those data types becomes increasingly important.

Fortunately, image-recognition technology is advancing at a rapid pace, driven by industrial, military, and law-enforcement needs, as well as business applications. Manufacturers are relying more and more on machine vision and pattern recognition to automate their inspection and grading processes. For example, a Windows-based color vision program called Way-2C from Ronald A. Massa Associates (Cohasset, MA) is used to grade lumber, inspect soda crackers, and sort pills. The military uses similar technology for target acquisition and automated sentry posts. Police departments are using pattern recognition to identify fingerprints and match photos of suspects to digitized mug shots in computerized databases.

In the past, the only reliable way to index images was to tag them with keywords describing their content. This is still a worthwhile method, but the effort required to keypunch a caption for each image is justified only if you expect to retrieve the images often, as in the case of a stock-photo agency. Another drawback is that you can't always anticipate the parameters of a search; someday, you may want to locate an image that isn't described by any of its keywords.

Pattern-recognition algorithms, some based on neural networks, are getting smart enough to search common image formats such as TIFF files for specific shapes, colors, or textures. A leading product in this field is the Excalibur EFS document imaging system from Excalibur Technologies (San Diego, CA), which runs on PC, Macintosh and X-Terminal clients. Excalibur has developed a technique called adaptive pattern recognition that can analyze all types of digital data, including graphics and sound. The vision routines are so accurate that Weyerhauser uses them to sort different grades of hardboard siding by examining the wood grain.

IBM (White Plains, NY) recently announced a similar product called Visualizer UltiMedia Query, an OS/2-based DB2 client. Visualizer uses a technology known as QBIC (query by image content), developed by IBM's Almaden Research Center and the Santa Teresa Laboratory. A photo editor could use Visualizer to retrieve pictures of flowers containing a specific shade of yellow or a particular arrangement of blossoms.

Highly specialized applications may require custom solutions, and tools are available for this purpose. For instance, Excalibur sells its recognition routines as a collection of C libraries called the XRS toolkit. A similar package of C routines, the Matrox Imaging Library, is available from Matrox (Dorval, Quebec, Canada). You can even buy PC-based tools for creating pattern-recognition programs with neural networks, such as DS2000 from Design Sciences (Vienna, VA), which supports several different network models.

As computers become more adept at handling multimedia data types, the need to efficiently store and retrieve compound documents will become as crucial to business as the paper-filled file cabinets that comprise the bulk of corporate archives today. Luckily, the technology isn't lagging too far behind the demand.

Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach him on the Internet or BIX at thalfhill@bix.com.

grams, resulted in a commercial product from XSoft called Rooms for Windows.

Perhaps the most promising commercialization of PARC technology is XSoft's Visual Recall, which uses both file trees and a 2-D grid to present query results. The grid, or wall, shows documents arranged along the *x*-axis according to a linear criterion, such as date, and on the *y*-axis by another criterion, such as file type, author, or subject. The grid folds back into 3-D space, letting you view a great deal of data, and slides back and forth so you can quickly narrow in on specific clusters of documents or files.

Technologies such as these, combined with powerful document stores and search engines, will make locating information much easier. (Finding images remains a challenge, however; see the text box "Image Retrieval for Compound Documents".) The next step is to make the presentation of that information more consistent and aesthetic, an area now being addressed with cross-platform portable document formats such as Adobe Acrobat and WordPerfect Envoy.

The final step is to enable those portable documents to be encapsulated and linked into other files, which is being addressed by OLE and OpenDoc. When all these technologies are in place, document management, as such, will cease to exist as a category unto itself and will become, as it was always meant to be, synonymous with computing. ■

Andy Reinhardt is BYTE's West Coast bureau chief. You can reach him on the Internet or BIX at areinhardt@bix.com.

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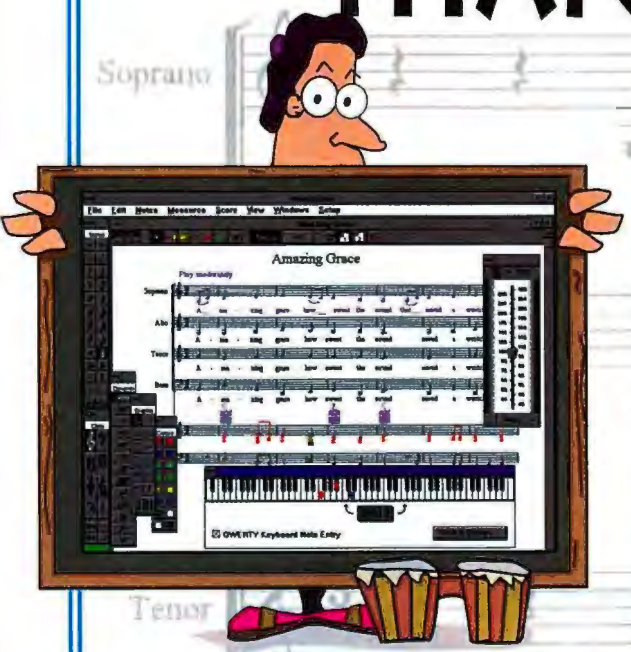

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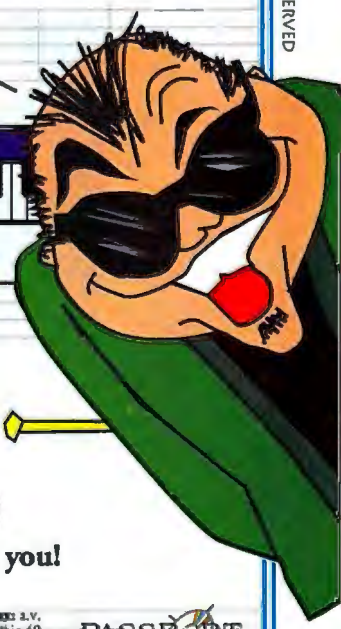

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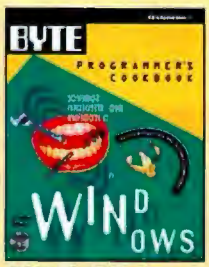

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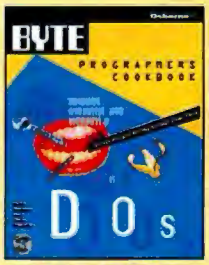

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State of the Art

BACK OF THE BUS

To hook up any peripheral to your computer, you use a bus that defines what happens on each end of the connection. Here's a look at the latest contenders.

RUSSELL KAY

A bewildering array of bus technologies confronts the computer user today, and more are on the way. Expansion buses (e.g., the VL-Bus and EISA) are the route by which components can communicate directly with the CPU. A mezzanine bus, such as PCI (Peripheral Component Interconnect), Multibus, and Futurebus+, is a type of expansion bus that puts a bridge controller between processors and peripherals—in other words, it attaches another bus to the local bus—to add flexibility or extra processing capabilities. Other buses are designed to solve specific problems, such as the need for frequently removing or replacing small devices in laptops; PCMCIA addresses this with its "hot-swapping" capability, and more solutions are on the way.

But this month's state-of-the-art section isn't about any of those buses. Instead, it focuses on some of the newer peripheral buses designed primarily for hooking up external devices. While not so glamorous as the mezzanine buses, peripheral buses are generally more accessible and visible to the end user, especially nowadays when you try to connect more and more devices—tape backup units, CD-ROM drives, scanners, hard drives, RAID systems, video cameras, MIDI devices, sound systems, floppy drives, MO (magneto-optical) drives, network adapters, and more—to your computer.

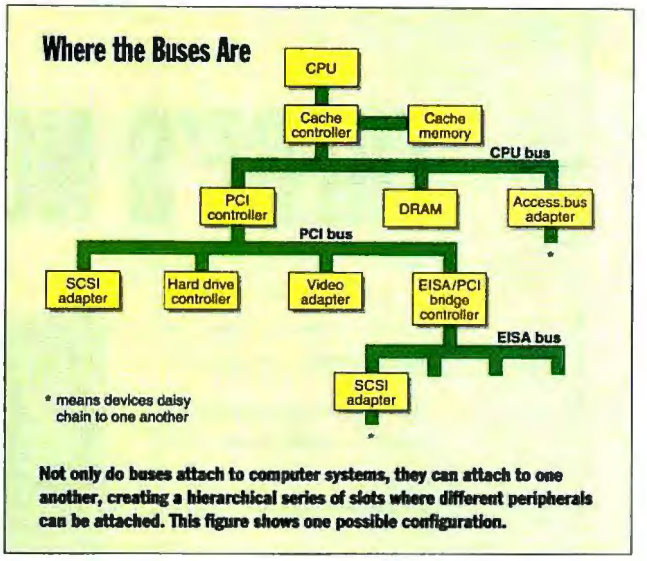
In the past, the primary options for connecting these devices were the traditional parallel, serial, and SCSI ports. While those are still around, they are being souped up, redefined, and engineered to handle significantly increased bandwidth.

An important standard bus for hooking up peripherals is SCSI, which comes in a wide and sometimes bewildering array of flavors—narrow, fast, wide, fast and wide, SCSI-2, SCSI-3, and now serial. In "SCSI and Beyond," Dinah McNutt sorts these out, showing where SCSI came from and, more important, where it's going.

Mark Clarkson's introduction "Seriously Serial" takes an in-depth look at the latest in serial interfaces, including the IEEE P1394 (Apple's version is known as FireWire) and the DEC/Signetics Access.bus. (Another high-speed serial bus that deserves future examination is Serial-Storage Architecture, or SSA, which IBM and Micropolis are developing.)

Clarkson also looks at what's being done with the enhanced parallel port to permit faster speeds and expanded capabilities for peripherals designed to hook up to or piggyback on existing PCs. After researching the field, Clarkson concludes that, while the new parallel-port standard is a useful interim measure, in the end, it stretches the port so far beyond its original design that it is unlikely to become a primary peripheral bus; the serial buses are likely to carry the day.

Finally, another bus that shows significant promise for the future is Fibre Channel. In his examination of the standard, John Bryan describes how it can host a wide variety of interfaces and is usable for optical fiber and copper wire transmissions.



Not only do buses attach to computer systems, they can attach to one another, creating a hierarchical series of slots where different peripherals can be attached. This figure shows one possible configuration.

What's a Bus?

One of the problems in discussing peripheral buses starts with the term *bus*. For example, you can argue that SCSI is not really a bus but, instead, an interface—after all, that's what the *I* in the acronym stands for. So what are the differences, if any, between a bus, an interface, and a protocol? We used to make clear-cut distinctions among these terms: A *bus* was the hardware standard that governed how add-in boards would connect to the CPU and described the physical connections or connectors involved. An *interface* was a low-level description of the electrical signals that each side of a connection expected to see and how the hardware would interpret them. A *protocol* was a higher-level description of how software would deal with the signals coming from the interface. Those differences are often quite blurred today. We talk almost interchangeably about buses and interfaces, and when you look at the nitty-gritty details that define these various standards, it's not necessarily clear where hardware stops, what needs to be done in firmware, and how much of the job is left to system and application code.

Nor is that the end of the confusion. Some of the peripheral buses that BYTE looks at here do not, for the most part, represent an either/or type of hardware standard as we used to understand it. Frankly, it's confusing when you discover that one thing you're calling a bus can be attached to or made to operate on another thing that you're also calling a bus. What do you call a SCSI device hooked up through a Fibre Channel bus that's been implemented on a card containing a SCSI host adapter that plugs into an EISA slot that's part of a PCI bus? The figure "Where the Buses Are" illustrates some of the hierarchical complexity that can occur when more than one bus is attached to a computer system.

The articles in this section should help you make sense of some of the technologies, capabilities, and options that are available in today's peripheral buses, as well as those that are likely to be incorporated into tomorrow's computers. ■

Russell Kay, a BYTE technical editor who writes sitting in front of his computer's bus, has been reporting on the computer industry since 1981. He can be reached on the Internet or BIX at russellk@bix.com.

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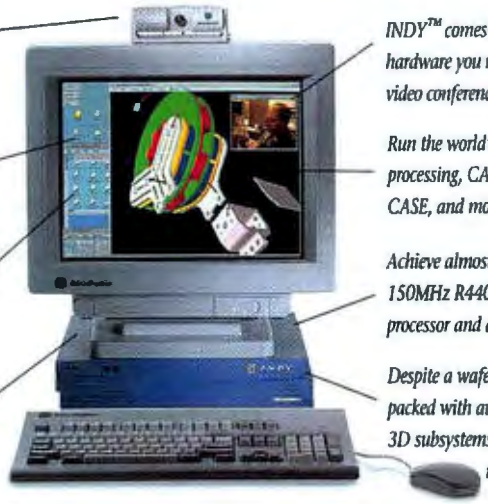

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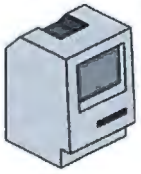

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SCSI AND BEYOND

The old standby for connecting peripherals to Macintosh and DOS computers is more important—and more capable—than ever as it rises to the multimedia challenge

DINAH MCNUTT

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Of all the peripheral "buses" in common use today, SCSI has been around nearly the longest—and yet its future is still bright. First popularized on Apple's Macintosh in 1984, SCSI is now widely used in IBM PC–compatible systems—its acceptance hastened by the rapid growth of multimedia. SCSI is the standard interface for CD-ROM drives, and several popular sound cards now incorporate a SCSI connection. But most SCSI products still use the original SCSI-1 standard, finalized in 1986.

Although SCSI-1's immediate successor, SCSI-2, has been in the works for years, as of this writing, it has not yet been adopted as an official standard; however, it is generally accepted and is in wide use. SCSI-2 had its genesis when many manufacturers wanted to increase the number of mandatory requirements of SCSI and to define further features for direct-access devices. A committee was formed to pursue this independently of SCSI-1, so the standard wouldn't be delayed. What resulted was the CCS (Common Command Set), which defines a set of commands that a device must support to be considered compatible with the SCSI specification. The developing specification for SCSI-3 is well under way, but it probably won't be adopted until late 1995 or 1996. (Note: From now on, the acronym SCSI refers to the SCSI-1 and SCSI-2 specifications, unless otherwise specified.)

SCSI is an 8-bit parallel I/O bus. What makes it special is that it hides the internal structure of the peripherals from the host computer. Up to eight SCSI devices can be attached to a single SCSI bus. (One of these devices is the host adapter.) However, only one pair of devices can communicate at a time. SCSI uses a 3-bit addressing scheme, where each device is assigned an address ranging from 0 to 7; device 7 has the highest priority, and the host computer is normally assigned as

Purchasing Hints, Troubleshooting Tips

With the various SCSI standards and devices, how do you choose what equipment to buy? First off, I recommend purchasing devices that support an external terminator; this will let you add another SCSI device to the chain without the hassle of taking apart a hard drive to remove a terminator from an internal component. This will also make troubleshooting easier, because you can add and remove devices from the chain simply by moving the external terminator and changing a few cables. (The SCSI-3 specification states that devices may not be internally terminated.)

Often a failure can occur if a power supply is inadequate. The terminator needs power and will not get enough if it is coming from a marginal bus or power supply.

One of the biggest problems is when a bus becomes too long. As the number of connected devices increases, the total length of your SCSI bus increases. Cheap cables, terminators, and connectors mean you will have to have a shorter bus for devices to work. When you determine the bus length, don't forget to allow for the impedance that devices add. You can check with your vendor on how much impedance to allow. If they don't know, find another vendor.

Even with perfect cables, the maximum cable length for single-ended SCSI is only 6 meters. And because neither cables nor connectors in the real world are perfect, you want to stay below the maximum cable length. Thus, when ordering devices, you should request short SCSI cables. Many vendors routinely ship 6-foot-long cables, which limit you to a chain of only three devices. Another way of keeping the bus short is to use cabinets that can house multiple disks; this simplifies the use of shorter cables. If you buy a packaged system of SCSI disks, ask the vendor how much cable length to allocate for the internal cabling. If you are close to the 6-meter-maximum length, adding another SCSI device may require that you buy and add another SCSI controller. Or, you might have to replace two small disks with a single, larger-capacity drive. Note that if you are using fast SCSI devices, you need to be well below the 6-meter-length limit. Ask your vendor what bus length it recommends.

The biggest problems with SCSI devices generally involve connectors. You might move a working hard drive from one office to another, only to find that it no longer works. I recommend keeping an extra supply of SCSI cables that can be swapped around to help troubleshoot these problems when they occur. After eliminating the cables, the system configuration, and the terminator as potential offenders, you may find that the problem is in the enclosure itself. Sometimes the connection between the internal SCSI ribbon cable and the external connectors is marginal; moving the box causes the cable to shift and perhaps short out. Many drive failures get diagnosed as a problem with the hard drive when the fault really lies with the connector inside the enclosure.

Unless you have the equipment and skills to diagnose and fix this problem yourself, you will have to return the whole enclosure or replace the suspect drive (and hope that it is still under warranty or a maintenance contract). Many times, the root of the problem is sloppy work by the drive's distributor or OEM. By keeping track of failures, you may discover that hardware from some vendors suffers from a usually high failure rate, while similar equipment from other vendors does not.

Also, be wary of warranties. All five-year warranties are not the same. Some vendors require you to return the faulty device to them first. Other vendors will ship a replacement on notification before they receive the returned unit. This kind of service is usually worth paying a little extra for, especially when it can get your system back up and running in one or two days.

Finally, whenever you buy a SCSI adapter, make sure your vendor provides good support for the particular software you use. Alternatively, consider buying the set of drivers offered by Corel (Ottawa, Ontario, Canada). Paying extra for any given adapter may be well worth it if the vendor provides good support.

device 7. Communication between devices occurs when the initiator, which is typically the host computer, originates a request, and the target (e.g., a device controller) performs the request.

The SCSI standard lets all devices communicate with one another. But some devices are implemented in such a way that they cannot initiate communication. There are four distinct configurations in a SCSI I/O system:

- single initiator, single target
- single initiator, multiple targets
- multiple initiators, single target
- multiple initiators, multiple targets

Some devices can act as either initiator or target, while others have a fixed role as one or the other. Theoretically, it is possible to have more than one host on a SCSI bus, providing that the operating systems on both hosts share the device or that you let only one host have exclusive use of the device at a time.

The SCSI specification groups devices into related types, which makes it easy for hardware vendors to develop SCSI bus controllers for new devices. Currently available device types include the following:

- direct-access drives (e.g., hard drives)
- sequential-access devices (e.g., tape drives)
- printer devices
- processor devices
- WORM devices
- read-only, direct-access devices

Therefore, there's no need to develop a new device driver for the host computer to handle each new device. For instance,

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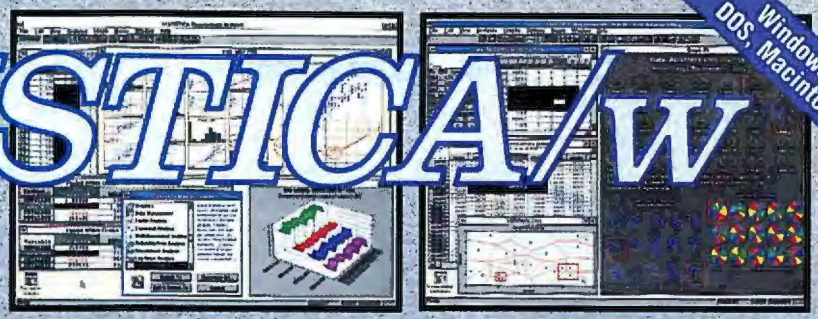

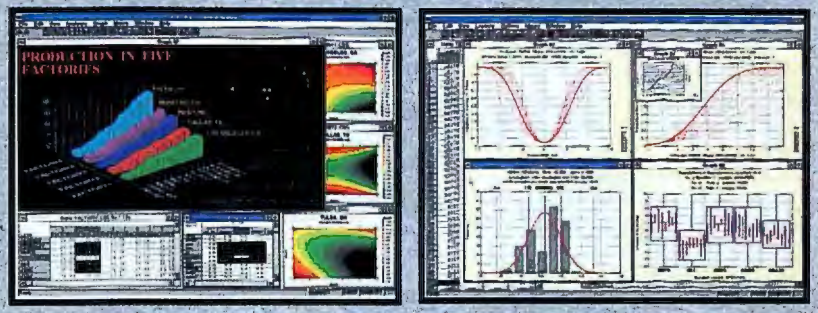

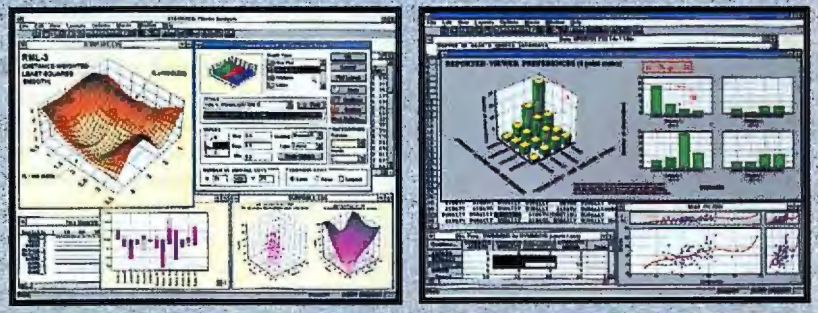

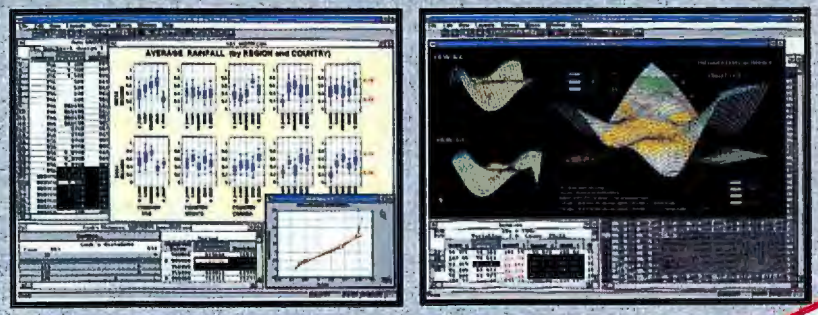

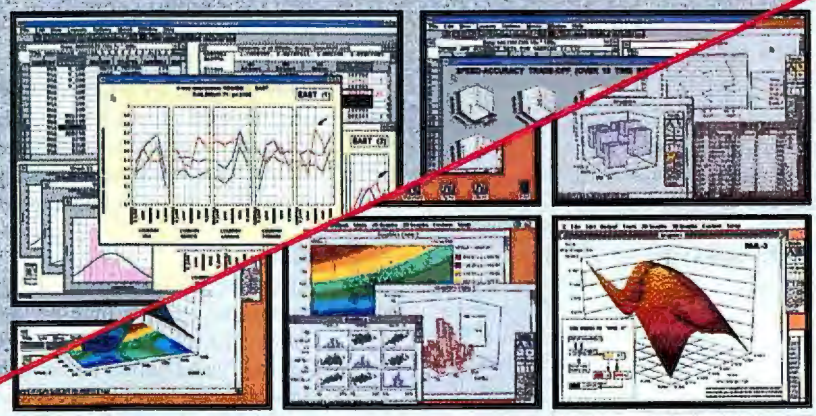

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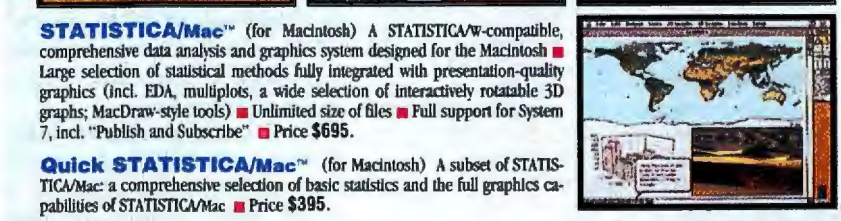

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A Glossary of SCSI-Related Terms

ASPI (advanced SCSI programming interface)
A competitor for CAM, this has become the de facto standard.

ATA (AT attachment)
A 16-bit ISA specification for embedded devices. This is the most prevalent type of disk drive interface found on PCs today. It is sometimes incorrectly referred to as IDE.

CAM (common access method)
A programming standard that encapsulates the SCSI functions into a standardized calling interface.

CCS (Common Command Set)
A set of commands that were specified as part of the SCSI-1 specification and expanded in SCSI-2. CCS makes it easier to write device drivers for SCSI devices, because you can rely on there being a certain functionality in each class of device (e.g., hard drive, tape drive, and so on).

ESDI
Developed by Maxtor (San Jose, CA), this standard improved on the ST506 by providing better error checking and supporting more types of devices: hard drives, floppy drives, and tape drives. With ESDI, the interface is an integral part of the device, so the controller must be certified to work with the device. In addition, a device driver must be written for each ESDI controller/device combination.

IDE
Most of an IDE drive's intelligence is built into the drive itself. IDE refers to any drive with an integrated controller.

SASI (Shugart Associates system interface)
NCR and Shugart Associates (now Seagate Technology of Scotts Valley, CA) developed SASI in 1981. That same year, the ANSI X3T9 standards committee adopted SASI as a working document for an ANSI interface standard. The resulting ANSI standard was named SCSI. The current SCSI standard was finalized in 1986.

ST412/ST506 Interface
Shugart Associates developed this specification in 1980. In 1981, it was revised to include a feature called *buffered seek* for the ST412 10-MB (formatted) hard drive. Many smaller-capacity hard drives on personal computers have used this interface. It has a limitation of 140 MB and a data transfer rate of 5 Mbps.

Terminator
A device that attaches to both ends of an electrical bus and prevents reflection or echoes of signals that reach the end of the bus. It also makes sure that the impedance is correct.

the SCSI disk driver on a typical Unix system will work with almost every SCSI hard drive. The only exception to this occurs when a vendor adds new commands that are outside the SCSI specifications. The standard allows for this, because sometimes performance or functionality requirements make it necessary to use SCSI hardware and software in ways that don't strictly conform to the specification.

There are two different electrical specifications for SCSI: single-ended and differential. *Single-ended SCSI* uses one line for each signal, with all lines using a common ground reference. This approach lets you use less expensive hardware. One disadvantage of single-ended SCSI is its vulnerability to noise, because all lines share the same ground reference. Also, it is limited to a maximum cable length of 6 meters.

Differential SCSI distinguishes actual signals from noise by using two lines, one carrying a positive signal and the other a negative. Any noise will affect both lines in the same direction, so the voltage difference remains the same. It also supports cables of up to 25 meters in length. Differential SCSI devices are much more expensive to design and manufacture, because they require twice as many pins and chips. Thus, single-ended SCSI is most common today. Some vendors sell a converter that lets you use differential SCSI devices on a single-ended SCSI bus.

SCSI devices can use either asynchronous or synchronous protocols for communication. The asynchronous protocol uses a traditional REQ/ACK handshake. The synchronous protocol allows the device to issue several REQs before receiving an ACK; this can increase the transfer speed by a factor of three. In the original SCSI specification, synchronous communication allowed speeds of up to 5 MBps. Note that if your SCSI bus is short, asynchronous communication can be fast.

SCSI-2

After the initial use of SCSI products pointed out areas for improvement, a SCSI-2 standard was developed to allow more flexibility and higher performance. SCSI-2 extends the original CCS specification to include support for devices such as CD-ROMs, scanners, communications devices, and optical memory drives (e.g., WORM and erasable media.)

SCSI-2 supports a faster, wider bus than the original. In addition to the standard 8-bit SCSI bus, you can have 16- or 32-bit buses. SCSI-2 provides for speeds of 10 MBps on the 8-bit bus, which means you can get up to 40 MBps on the 32-bit bus. SCSI-2 implementations that support the 10-MBps speed are called fast SCSI. Implementations that use the 16- or 32-bit bus are called wide SCSI. You may also find SCSI-2 with both (i.e., fast and wide SCSI) or neither (i.e., the slow and narrow 5-MBps 8-bit bus). The SCSI-2 specification allows fast SCSI only on differential SCSI buses, but in practice, vendors sell single-ended fast SCSI devices. SCSI-2 offers a specification for smaller, denser connectors for use with smaller devices.

SCSI-3

While SCSI-2 makes its way through the standards-acceptance process, work has already begun on its successor, the SCSI-3 specification, which will address some of SCSI-2's limitations. Plans include support for optical fiber, longer cables, and more than eight targets per bus. It will also be faster than the SCSI-2 bus, running at 20 MBps.

Although SCSI has thus far been a parallel interface, a proposal for serial SCSI is included as part of SCSI-3. Serial SCSI will involve using fiber-optic or high-speed copper, similar to the way FDDI (Fiber Distributed Data Interface) or ATM (asynchronous transfer mode) does. The current proposals include speeds ranging from 51 Mbps to 1 Gbps. The serious serial proposals are IEEE P1394, Fibre Channel, and SSA (Serial Storage Architecture).

In addition to the high speeds of these new proposals, serial cable lets you use fewer wires, which simplifies cabling. SCSI-3 supports older-style cabling, but the new cabling specifications will provide a challenge for the initial implementations, especially if you want to mix SCSI-2 and SCSI-3 devices on the same bus.

My sources tell me not to expect SCSI-3 to become adopted until there are products on the market using the draft specifications. This is what happened with SCSI-2. It has become a de facto standard because of the number of products available. (The problems with getting it adopted seem to be primarily political, not technical or economical.) My sources also tell me to expect a CAM (common access method) specification to be included in SCSI-3; this should simplify programming for these devices.

Termination

The SCSI bus must be terminated on both ends. Where all SCSI devices are external,

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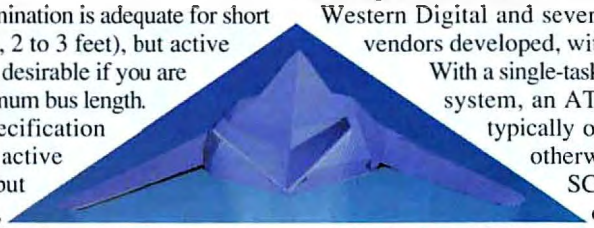
the host adapter provides termination on one end, while an external terminator is usually attached to the last device on the external chain. However, if there is a mixture of internal and external devices, the host adapter is in the middle of the physical chain and must not be terminated. You should use the same terminator on both ends of the bus. Three types of termination can be used after the last device on the SCSI bus:

- Passive termination consists of resistors only.
- FPT (forced perfect termination) uses diode clamps to eliminate overshoot and undershoot.
- Active termination (only for SCSI-2) uses a voltage regulator to ensure that the SCSI signals are always terminated to the correct voltage level.

Passive termination is adequate for short distances (i.e., 2 to 3 feet), but active termination is desirable if you are near the maximum bus length. The SCSI specification recommends active termination, but in practice, passive termination and FPT are most common, simply because they are less expensive.



Configuring SCSI Devices

Unlike traditional buses—such as DEC's Unibus, the VMEbus, or the PCI (Peripheral Component Interconnect)—SCSI is rarely implemented as a card cage with card slots. SCSI devices can be, and often are, external to the computer and daisy chained together with cables. Therefore, each SCSI device enclosure has two connectors: one for input and one for output. (An enclosure may contain more than one SCSI device.)

On most devices, it doesn't matter which cable you connect to which port, but it's a good idea to check the documentation for any particular piece of equipment, in case it is different. The bus must be terminated, either by placing a terminator on the output port of the last device on the bus or by choosing as the last device a SCSI peripheral that has an internal terminator.

Each device on the SCSI bus must have a different address, ranging from 0 to 7. Most SCSI devices have an external thumbwheel or switch that allows you to easily view and change the SCSI address.

Traditional Microcomputer Interfaces

To appreciate the specific advantages of SCSI, it helps to look at its primary competitors. The most popular type of storage device interface for PCs has been ATA (AT attachment), a specific type of IDE drive. Because of its popularity, ATA is often used interchangeably (and incorrectly) as IDE. Properly speaking, the acronym IDE refers to any drive with a built-in drive controller.

The ATA interface is simple, requiring only a signal cable and a power cable. Data transfer has a low overhead (1 to 2 milliseconds per command) and is 16 bits wide.

As with SCSI, there is the original specification (ATA-1) and two successors. ATA-1 is still in the process of being adopted as a standard. ATA-2 adds more advanced data transfer modes and speeds of up to 16.6 MBps. ATA-3 is a proposal to merge the ATA Packet Interface, which Western Digital and several CD-ROM vendors developed, with ATA-2.

With a single-tasking operating system, an ATA drive will typically outperform an otherwise-identical SCSI drive, because of the overhead of the SCSI bus. In a multitasking environment, however, the SCSI drive will outperform the IDE drive because it lets you make multiple requests to multiple devices at the same time.

At the moment, an ATA drive is less expensive than a SCSI drive. Once you have added a SCSI adapter, however, the incremental cost of adding a SCSI device becomes competitive. This is because a SCSI adapter can connect to as many as six devices, while the ATA interface supports only two. Also, until quite recently, the only type of peripheral device that ATA supported was a hard drive.

Driving Miss Daisy Chain

On most Unix systems, the operating system already has all the drivers you are likely to need for most SCSI devices, and there is a wide variety of vendors and hardware to choose from. On IBM PC compatibles, however, things are quite different. To use a SCSI adapter, you may need to obtain device drivers for each of the different devices you wish to connect to your PC. Most vendors of SCSI adapters will provide these.

To ease the job of writing new device drivers, a proposed standard called CAM encapsulates the SCSI functions into a standardized calling interface. CAM is not currently a part of the SCSI specification, but it may be included as part of SCSI-3. More advanced PC operating systems (e.g., OS/2 2.1 and higher and Windows NT) support CAM.

At present, the de facto standard for creating device drivers is ASPI (advanced SCSI programming interface). This was originally developed by Adaptec, and a number of other vendors have adopted it. By using one of these standards (or a CAM-to-ASPI converter, which is what Future Domain of Irvine, California, does), vendors can provide device drivers for new hardware much more quickly. In addition, vendors are working on other tools to make it easier to install SCSI devices. In the future, you can expect SCSI devices to configure automatically and load their own drivers. The irony is that SCSI gets easier to deploy the more competent it becomes. ■

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Another reference is the FAQ (frequently asked questions) list from the Usenet newsgroup comp.periphs.scsi. Gary Field currently maintains this list, and it is available via anonymous FTP from cs.columbia.edu in the file /archives/mirror2/faq/comp.periphs.scsi.

On-line SCSI-3 specifications are available from ncrinfo.ncr.com:/pub/standards and ftp.netcom.com:/pub/standards. A full set of specifications is available from Global Engineering Documents, 15 Inverness Way E, Englewood, CO 80112, (800) 854–7179.

ACKNOWLEDGMENTS

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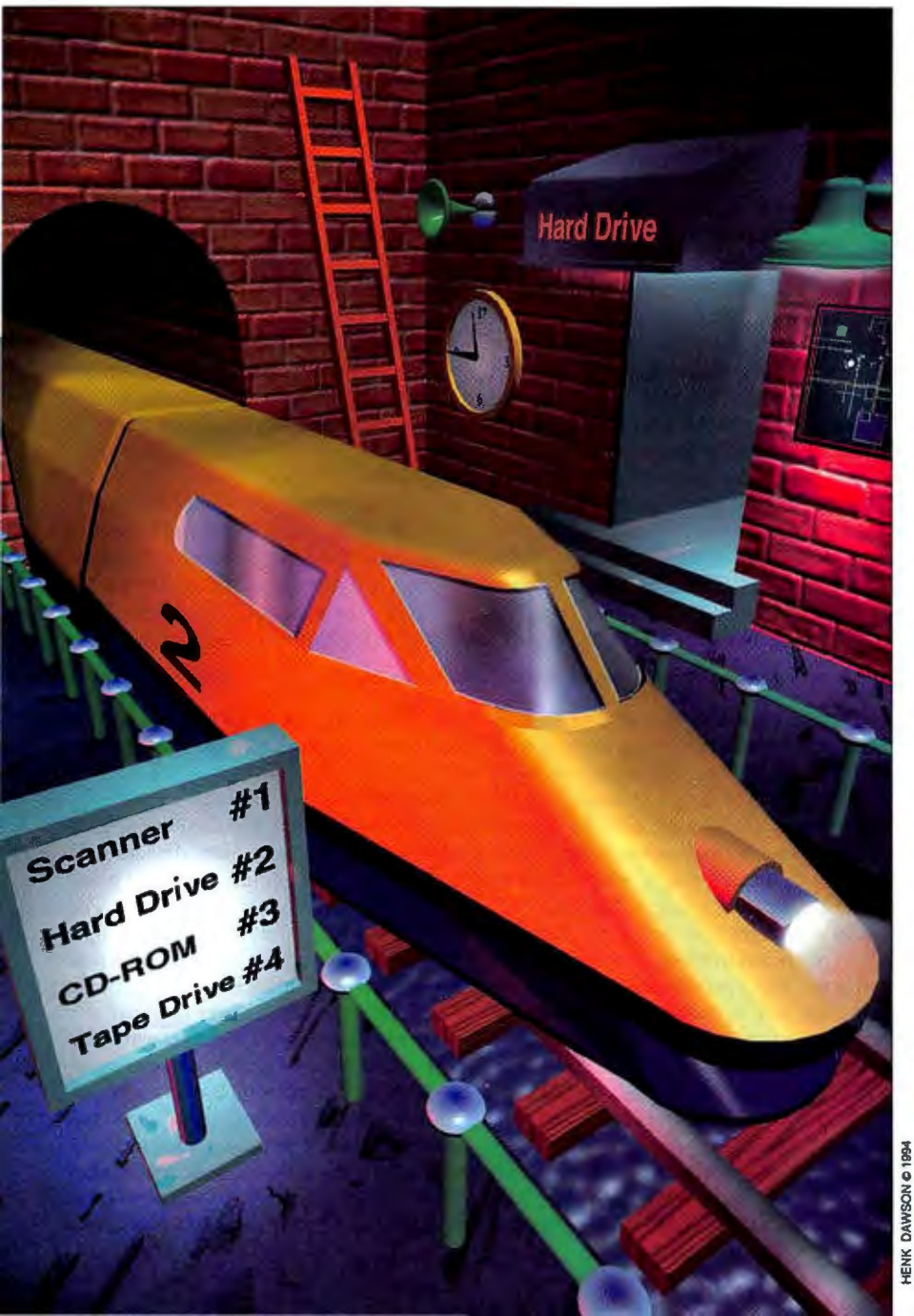
SERIOUSLY SERIAL

The venerable RS-232 standard may be showing its age, but Access.bus and FireWire demonstrate that there is a lot of life left in serial technology

MARK CLARKSON



HENK DAWSON © 1994

Those new gigabyte hard drives, flat-screen true-color monitors, quad-spin CD-ROM drives, and V.Fast modems are all very nice, and they add a lot of functionality to your computer system; however, the PC still has a long way to go in terms of letting you connect these devices quickly and easily to your computer. If you want proof, you need look no further than the rat's nest of cables that's coiled behind my computer—and probably behind yours, too. There must be a better way to hook all those fancy peripherals up to our computers.

Yes, Serial

It appears to many in the industry that most of the next generation of peripheral connections will be serial, transferring data 1 bit at a time rather than 8 or more bits in parallel. Why? Parallel communications require more wires to carry the signals. More wires means fatter, more expensive cables and wider, more expensive connectors with more pins to bend and break. Also, the more wires bundled together into a cable, the more electrical interference there is between signal wires, and the more thoroughly they have to be shielded. The more signals you deal with at the same time, the harder it is to keep them all in sync. And the faster and farther you try to push that signal, the worse the problems become.

Add to this the fact that the size of computers continues to shrink. Some fit into a shirt pocket; they have little room for connectors today and will have less tomorrow. Yet even as computers become smaller in size, their power increases, and more than ever, people need to be able to hook them up in the real world. What they want then are small connectors and darned few of them. Serial links, with intrinsically fewer wires, require smaller connectors.

continued

Pumping Up the Parallel Port

An alternative to high-speed serial is sitting right in your PC

The Centronics-style parallel port, says Larry Stein, president of Farpoint Systems (Jersey City, NJ), "became an industry standard the day IBM introduced the personal computer with a parallel port on it." At that time, a screamingly fast peripheral was a 240-character-per-second dot-matrix printer, which received its data in ASCII. Today, you're more likely to be hooked up to an 8-page-per-minute laser printer, pumping down megabyte-size color graphics files. Yet if you own a newer PC, the parallel port on the back of it is identical in performance to the 1981 model whose speed tops out at around 150 KBps. Maintaining even that rate is processor-intensive—your CPU has to oversee moving data to and from the port, including all the handshaking between the computer and peripheral.

The 150-KBps parallel port is woefully slow for many new printers, which can accept data at much higher speeds, as well as for other peripherals such as tape drives. It is inadequate for even the slowest of single-spin CD-ROM drives. It's obvious that the parallel port needs major pumping up if it's going to survive on the multimedia desktop.

The IEEE 1284 standard defines a newer, faster, and better parallel port with some major muscle in it. The good news is that 1284 ports are backward-compatible with existing parallel ports; the Hewlett-Packard DeskJet will plug right in, using existing cable and connector. Even better news is that, for only the cost of a new cable, a 1284 parallel port can inject new life into your old printers.

Current parallel connections are notoriously flaky at distances of more than 10 feet. "With 1284," says Stein, who is also chairman of the 1284 committee, "we wanted to go a minimum of 10 meters. It's important to realize that, in some cases, 1284 has the parallel port going 100 to 200 times faster than it was meant to originally. You can't do that using $2 cables, so the 1284 standard defines the cable as well. Now we can guarantee that when a user buys a 1284 port, a 1284-capable product, and a 1284 cable, it'll work at 2 feet, 10 feet, or 30 feet."

IEEE 1284 actually defines four different modes for the new parallel port: nibble, byte, ECP (Enhanced Capabilities Port), and EPP (Enhanced Parallel Port). All modes have at least some bidirectional ability, allowing the printer to talk back to your computer. Data passing from the peripheral to the host is called *back-channel communication.*

The first two modes, nibble and byte, provide for relatively slow back-channel communication, 4 and 8 bits at a time, respectively. ECP, intended mainly for host-to-printer connections, can achieve data rates of up to 4 MBps in both directions. The maximum speed depends on the peripheral and host computer.

EPP allows you to attach devices such as CD-ROM and hard drives, which would normally plug into the internal bus, to the parallel port. In addition to high data speeds, EPP allows the system to regard the parallel port as an extension of the system bus. Although not as sophisticated as FireWire, EPP lets you hang multiple peripherals off a single port.

All 1284-compliant devices can identify themselves and their capabilities to the host computer, letting the system know whether to speak in EPP, ECP, nibbles, or plain old Centronics. Microsoft has announced support for ECP-

Get on the Serial Bus

Ideally, people want to hook together lots of peripherals—and many different kinds of peripherals—with as little muss and fuss as possible. The way to do that, says Apple research scientist David James, is by using a bus: "People already know how to transfer data on buses, to and from a large number of devices. There's really no problem mapping a keyboard, a network, a disk, a storage device, or other things to a bus because everybody's been doing that for years."

"But until the last few years," James continues, "people had always thought that buses had to be constrained to a backplane—inside a chassis." A serial connection, however, extends the idea of a bus outside of the computer, to the desktop and beyond.

Computers and peripherals simply read from and write to addresses on the serial bus. Those addresses represent other peripherals. These reads and writes can be interleaved, allowing multiple devices to communicate across the bus at the same time, so you can string a whole slew of peripherals off of a single port on a PC. James also points out that these transfers aren't restricted to those between the host computer and a peripheral: "They can go from one disk to another or from disk to printer, autonomously. The computer would tell the disk to start dumping data to some device, and then the disk would continue on its own, while your processor does something else."

Sound good? A number of people think so. Two new serial-bus standards, Access.bus and P1394 (or FireWire), are hot candidates to become the primary peripheral ports on your desktop computer.

Access.bus

Access.bus is a new standard intended to connect relatively low-speed devices such as keyboards, mice, modems, and printers. Originally conceived by DEC and Philips/Signetics and similar to the Apple Macintosh desktop bus, Access.bus is now being developed under the auspices of the ABIG (Access.bus Industry Group).

Access.bus runs on a thin four-wire cable that resembles the one that currently connects the keyboard or mouse to your computer. Each end sports a single small connector that's a little bigger than an RJ-11 modular phone jack. Most Access.bus devices offer two sockets—in and out—to let devices be daisy chained together, similar to

compliant devices within Chicago, the next version of Windows. Chicago will use the ID string returned by ECP-compliant peripherals to automatically install the proper drivers.

An EPP can even drive your existing printers much faster. Copy some graphics files to your plain-Jane, non-1284 printer today, comments Stein, and you'll get throughput ranging from 6 to 14 KBps. With an EPP port and a new 1284 cable, however, you could get as much as 500 KBps. "By the end of the year," Stein says, "you should see ECP printers capable of 400 KBps to 2 MBps."

And the 1284 port has one thing going for it that none of the proposed serial standards do: an installed base of millions on millions of parallel-port-equipped devices, all of which will plug right in.

But there's still a serious question about how well these new parallel ports will work when you add in all the extra baggage needed to allow them to compete with the new serial buses. To me, this technology stinks of death. The more I read about it and how much work goes into tweaking parallel ports to run 100 times faster than what was intended—with special cables, strict capacitance rules, and so on—the more convinced I am that the serial-port solutions are going to take over pretty quick.

the way SCSI devices are interconnected.

Access.bus has a significant advantage over standard RS-232 serial connections. Today, for each and every serial peripheral, you need a separate port, interrupt, system address, and perhaps more. In theory, Access.bus will let you run up to 125 peripherals—over a total cable distance of 8 meters—from a single jack in the back of your computer. "The beauty of Access.bus," says David Rogers, manager of new business development for Computer Access Technology (Santa Clara, CA), "is that I'm using only one hex address, whether I've got one device on that port or 125."

Hot Plugs, Cold Boots

Every Access.bus peripheral, from laser printer to lowly mouse, is intelligent. Each contains a microcontroller that can identify the device to the bus and pass data along to the next peripheral in the chain.

According to Rogers, Access.bus intelligence will improve your system's performance. "The messages passing over the Access.bus are off-loaded from your computer and CPU. The Access.bus host and the peripherals in the line are handling the passage of the messages, the bus arbitration, and so on. The system will actually run faster, because you don't have so many interrupts to the CPU." Where an RS-232 serial port interrupts the processor with every bit of information received, data moves along the Access.bus in the form of messages that are up to 127 bytes long, and each message generates only a single interrupt. This translates into far better system performance.

But there's more. Access.bus also supports *hot plugging*. This means that you can disconnect peripherals and plug them in without having to power the computer down or reconfigure the system. There are no jumpers to set, no DIP switches to throw, and no IRQs (interrupt requests) to reconfigure. Everything is automatic.

When the system is first powered up, the Access.bus master inside your computer sends a message to every device on the bus. Each device responds with its ID number and a string that identifies what type of device it is—for example, a locator, keyboard, or text device—and gives any special capabilities and characteristics.

The bus master assigns each peripheral an address on the serial bus and maintains a table of attached devices and their addresses. The individual peripherals watch the bus for reads or writes to their particular addresses and move data onto and off the bus accordingly.

And whenever you pull a peripheral off the bus or plug in a new one, the Access.bus master notices this and dynamically reconfigures the bus, requiring no user input at all. "For example," says Rogers, "we have a demo blackjack game for Windows, which uses Access.bus drivers for multiple mouse input. I can hang six mice on my PC. Each has its own address, and each can only manipulate the chips and cards associated with it," he continues. "As I add or subtract players from the game, by adding and subtracting mice, the Access.bus automatically reconfigures the system accordingly."

Open Access

Access.bus is an open standard that promoters hope will find a place on a variety of platforms, including PCs, Macs, and workstations. And the industry *needs* a new standard, especially in the fast-expanding arena of notebooks, subnotebooks, and PDAs (personal digital assistants)—smaller products with smaller connection space, where port real estate is at a real premium. Currently, users of such small computers who want to connect multiple peripherals must often suffer with proprietary interfaces and ungainly docking stations.

According to Rogers, "If a notebook manufacturer can add a small phone-jack-type port without having to add a proprietary connector, then it has opened up its product line to additional third-party solutions."

Another limitation involves the number of access ports available. "Even on the desktop," Rogers notes, "where port economy is not as important, I'm still limited to four comm ports. If I want to go to a multiple RS-232 connection, I'm paying a premium, and I still have to worry about lower-level interrupts and DMA calls and older software that's unable to find the additional ports."

A new specification for Super VGA monitors, called DDC2, calls for Access.bus to be incorporated into the monitor-to-PC connection. This will let you manipulate the front-panel controls—video mode, tint, brightness, and color—through software. In addition, manufacturers will be able to put Access.bus receptacles on the monitor, allowing you to plug your keyboard or mouse into your monitor, which will be more convenient than the standard back-of-the-computer location.

How far away is Access.bus? Very close indeed, says Rogers. "Today, I can buy a host adapter, keyboards, trackballs, joysticks, mice, modems, and RS-232-to-Access.bus converters for older 232-based products. And I can operate under Windows 3.1, Windows NT, Solaris 2.3, and DOS. And if Chicago was shipping today, I could run under Chicago, too, because those drivers already exist."

How Fast Is Relatively Slow?

For all its advantages, Access.bus won't serve for every type of peripheral because it doesn't have enough bandwidth. Access.bus runs at speeds of up to 125 Kbps, which is not fast enough for multimedia applications involving high-quality audio and video or for hooking up hard drives. It is fast enough to run any device (e.g., mice, trackballs, joysticks, printers, keyboards,

Seriously Serial

"The marketplace clearly wants a connection to carry high-performance video and audio. It wants a connection that provides much higher bandwidth than has been required in the past and that connects to both PCs and consumer products. For the first time, we have a [P1394, or FireWire] cable that is being designed into both the computer and consumer worlds."

Bryan Bell
Texas Instruments

and so on) that you might have attached to a serial port.

"With Access.bus today," says Rogers, "I could have a 19.2-Kbps modem transmission in progress, be using my keyboard or my mouse, and have a bar-code scanner operating—all at the same time, on the same bus."

FireWire

If Access.bus isn't fast enough for you, then maybe it's time to step on up to FireWire. This new high-speed desktop serial bus, based on the ANSI draft standard P1394, is being developed jointly by Apple and Texas Instruments.

FireWire also uses a flexible cable plus a nice, small connector inspired by the one used in the Nintendo Gameboy. You can reach behind your machine, without looking, and plug it in.

FireWire offers many of the same advantages as Access.bus. You can daisy chain peripherals on a FireWire bus, hanging up to 63 devices off a single port. Up to 1022 FireWire buses can be bridged together, which should provide enough peripherals for anybody. As with Access.bus, FireWire provides hot plugging and automatic configuration. There's no need to set DIP switches or pull jumpers; you just plug in your cables and, as long as everything's connected correctly, everything works. (See the figure "P1394 Serial-Bus Physical Topology" on page 122.)

But FireWire takes this concept to a whole new level. The goal is for each and every FireWire-compatible device on the planet to have its own unique 64-bit ID number. If you plug in a mouse (e.g., a Logitech three-button mouse), FireWire can identify it. It not only knows it's a Logitech three-button mouse but also exactly which Logitech three-button mouse it is. If two identical mice are connected to the system, FireWire can tell which is which.

For example, says Apple's James, "Say you had a disk drive with the unique identifier ABCD at location one. Then you move that disk, and the system finds that ABCD is now at location five. That's all right, because it just adjusts the operating-system tables accordingly. The unique identifier makes it very easy to find out where a peripheral has moved to."

How Far, How Fast?

Even if you use Access.bus, says James, "you still need another, faster bus for your disk. Well, why shouldn't you just use that faster bus for everything? The clear win is not in adding another connector to the computer but in eliminating one."

Although it's significantly faster than Access.bus, FireWire is still strictly limited in the bandwidth it can deliver and the distance it can push a signal. It was, after all, designed for the desktop, and reasonable compromises had to be made to meet FireWire's low-cost objectives. According to James, "You certainly wouldn't want to run FireWire [over a cable length of] 50 meters."

FireWire is no slouch. It operates at speeds ranging from 100 Mbps to 400 Mbps, which—protocols and overhead aside—should translate into 5 to 20 MBps of data actually humping across the wire from point A to point B.

To drive data reliably at such high speeds, FireWire uses a technique called *differential signaling*. The cable contains two data lines (I'll call them A and B), and it uses both together to signal 1 bit of data. For a logical 1, A is high and B is low; for a logical 0, A is low and B is high. A FireWire cable also distributes power of from 8 to 40 VDC, at up to 1.5 amps.

continued

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There Are Two Times When Modem Reliability Is Critical.

ZyXEL desktop modems offer high reliability without high cost.

The new ZyXEL portable— the first autoswitch modem for land and cellular lines.

Some modem users don't care if their data gets hung up, transmits inaccurately, or if they have to redial several times. Most modem users do. For them there's ZyXEL, the full-featured fax modem for serious users.

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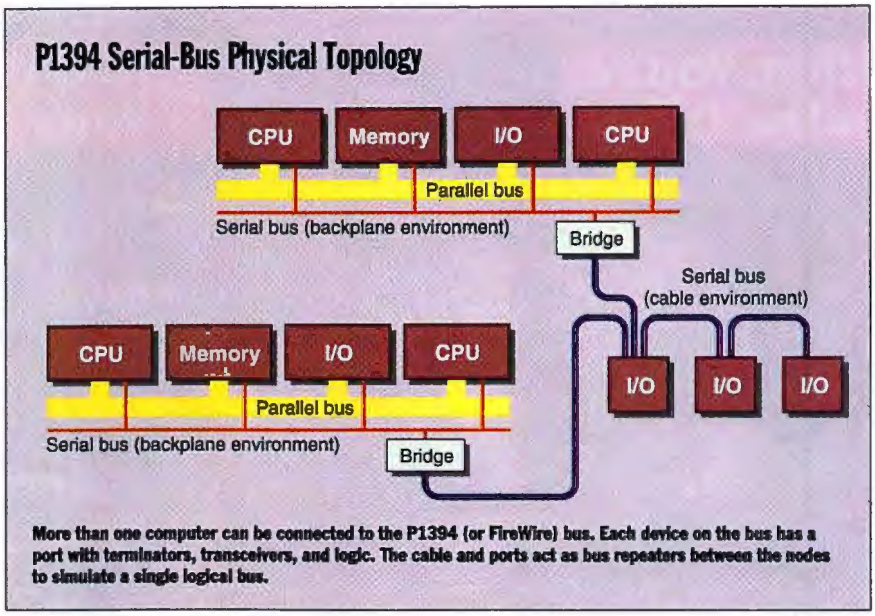

More than one computer can be connected to the P1394 (or FireWire) bus. Each device on the bus has a port with terminators, transceivers, and logic. The cable and ports act as bus repeaters between the nodes to simulate a single logical bus.

FireWire's speed is not only fast enough for normal serial communications between mice, modems, and such; it's also fast enough to support real-time video and high-fidelity audio. FireWire supporters want to see it break out from the desktop and into the consumer electronics arena. They predict that FireWire ports will appear on camcorders, VCRs, and CD players. And if you can hook up camcorders and VCRs, why not just hook your camcorder to your VCR *through* your computer? Just think how easy that would make it to get video into your FireWire-equipped, multimedia computer.

"The marketplace clearly wants a connection to carry high-performance video and audio," says Bryan Bell, manager of computers and computer peripherals at Texas Instruments. It wants a connection that provides "much higher bandwidth than has been required in the past and that connects to both PCs and to consumer products. For the first time, we have a cable that is being designed into both the computer and the consumer worlds. It's really revolutionary."

Will They Fly?

Which of these serial standards is likely to catch on: Access.bus or FireWire? Maybe both? Or something like serial SCSI-3? Access.bus is basically a replacement for aging RS-232 technology, while FireWire has its sights set on new multimedia applications and consumer electronics. In addition, higher bandwidth comes at a price. Where Access.bus compliance might add 10 or 25 cents to the cost of a peripheral, FireWire will likely add about $1 to $10.

Some pundits doubt Access.bus's usefulness as a printer connection. The communications needs of printers far exceed those of simple keyboards, mice, and modems. At 125 Kbps, Access.bus runs at only one-quarter the speed of today's Centronics-style parallel ports. PostScript documents that run 250 KB per page are not uncommon, even today, and that's just text with fancy fonts. Increasingly, printed documents are incorporating complex, computer-generated charts, drawings, and bit maps. As video and multimedia emerge as mainstream applications, we'll be seeing captured video stills, which will inflate document sizes even more. Adding color to this mix makes the problems more acute.

At present, neither of these two standards has any installed base to speak of. "It's a Catch-22," says Apple's James. "It's hard to justify putting connectors on a motherboard before peripherals exist that connect to it." Still, the advantages of size, speed, and standardization are too great to be ignored. A trickle of serial-bus products is already appearing and should turn into a torrent by the middle of next year.

"The idea of the serial bus," says James, "has allowed the bus to creep out of the box and onto the desktop. The interesting question then is how far will it creep? Will it just be to the desktop or will it eventually cover the whole building?" ■

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FIBRE CHANNEL SPEEDS UP

Making its move onto the data superhighway, the Fibre Channel promises to break the speed limit for serial data transmission

JOHN BRYAN

HENK DAWSON © 1994

There's a new fast lane under construction on the data superhighway. Fibre Channel, a technology developed under the guidance and impetus of the ANSI X3T11 Fibre Channel committee and companies like Hewlett-Packard, IBM, and Sun Microsystems, promises high-speed serial data transmission over significant distances.

Microprocessors like the Pentium, PowerPC, and other RISC chips can deliver hundreds of MIPS to the desktop. However, their component subsystems cannot deliver data to these CPUs at anything close to processor capacity. Also, applications demand ever more resources. The result is an I/O bottleneck.

Although you may not find it in any computer design textbook, "Amdahl's Law" says that 1 Mbps of I/O capability is required for every MIPS of processor performance. Today's network technologies top out at about 100 Mbps, an order of magnitude slower than the fastest microprocessors.

Channel Speed vs. Network Flexibility

Two basic methods—channels and networks—are used for interprocessor communication. A channel is a direct point-to-point or switched communications link, predominantly hardware-based and designed for high speed. But a network is a heterogeneous collection of interconnected access points with a software structure that enables communication. The network approach allows many different types of data transfer, but the software overhead takes its toll in performance. Fibre Channel combines aspects of both types.

The ANSI group set ambitious goals for this new standard, including speeds of 133 to 1062 Mbps on a single fiber (either optical or metal cable), simultaneous bidirectional communication, support for distances of up to 10 km, small connectors made with off-the-shelf components,

Fibre Channel Speeds Up

Fibre Channel's Five-Layered Structure

FC-0 Physical Media

- Optical cable with laser or LED transmitters for long-distance transmissions.
- Copper coaxial cable for highest speeds over short distances using ECL.
- Twisted-pair cabling for 25-MBps data transfers to up to 50 meters.

FC-1 Byte Synchronization and Encoding

- 8B/10B encoding/decoding scheme requires transmitting 25 percent more bytes total.
- Developed by IBM, available to Fibre Channel developers at nominal cost.
- 8B/10B code is extremely well balanced and simple to implement, and it provides useful error-detection capability.
- A special code character maintains proper byte and word alignment.

FC-2 Actual Transport Mechanism

- Framing protocol and flow control between nodes. Four classes of service between ports:

  Class 1: Hard-wired or circuit-switched direct connection between devices.

  Class 2: Frame-switched through the fabric, with guaranteed delivery and receipt confirmation.

  Class 3: One-to-many, no confirmation of receipt.

  Class 4: This optional mode, Intermix, reserves the entire fabric bandwidth for a Class 1 connection but may also allow simultaneous connectionless traffic (i.e., a virtual switched, automatically routed connection) if bandwidth is available.
- Frame controls ensure that Class 2 or Class 3 data arriving out of sequence is presented to the receiving port buffer in the appropriate order.

FC-3 Common Services Layer

- Framing protocol and flow control between ports. Three services defined thus far, with more expected.

  Striping: Uses multiple N_ports in parallel to transmit a single information unit, achieving higher aggregate bandwidth. Most likely used for transferring large data sets in real time, as in video-imaging applications.

  Hunt Group: A set of N_ports attached to a single node. All set members are assigned an alias identifier that allows routing of data associated with a primary N-port to any port in the hunt group. Roughly equivalent to having a multiline telephone under a single business number.

  Broadcast, Multicast: Can send a single data transmission to all N_ports on a fabric (broadcast) or to a subset of the total (multicast). A single fabric may have up to 2^{24} or just over 16 million addresses.

FC-4 Upper Layer Protocols

- Practically every significant channel, peripheral interface, and network protocol is already mapped to the Fibre Channel transport structure:

  SCSI

  IPI (Intelligent Peripheral Interface)

  HIPPI (High Performance Parallel Interface)

  IP (Internet Protocol)

  AAL5 (ATM Adaptation Layer for computer data)

  FC-LE (Link Encapsulation)

  SBCCS (Single Byte Command Code Set Mapping)

  IEEE 802.2 (TCP/IP) data

a variety of price/performance levels, and more. Perhaps most important was the decision to support several industry standard transport protocols, such as SCSI, IPI (Intelligent Peripheral Interface), HIPPI (High Performance Parallel Interface), and the IP portion of TCP/IP.

Fibre Channel Structure and Terminology

The Fibre Channel standard is defined in five separate layers, from the physical media (FC-0) to the highest-level protocol interfaces (FC-4). (See the text box "Fibre Channel's Five-Layered Structure.") A Fibre Channel installation has at least one link between two nodes (i.e., cable endpoints). Data flows between hardware entities called N_ports. Each node must have at least one N_port and generally has two, one inbound and one outbound; either may serve as originator, responder, or both. In addition, an N_port contains a Link_Control_Facility, a sort of firmware traffic cop that handles logical and physical control of the link.

Fibre Channel is a hardware-intensive, switched technology, with each port uniquely addressed by an N_port Identifier. Everything between the ports on the Fibre Channel is called the *fabric*—in most cases, a switch or series of switches provide the interconnects. Ports on the fabric are called F_ports. Hardware triggers in the frame header route control information—commands and responses—to control buffers, while sending data directly to memory allocated by the requesting task.

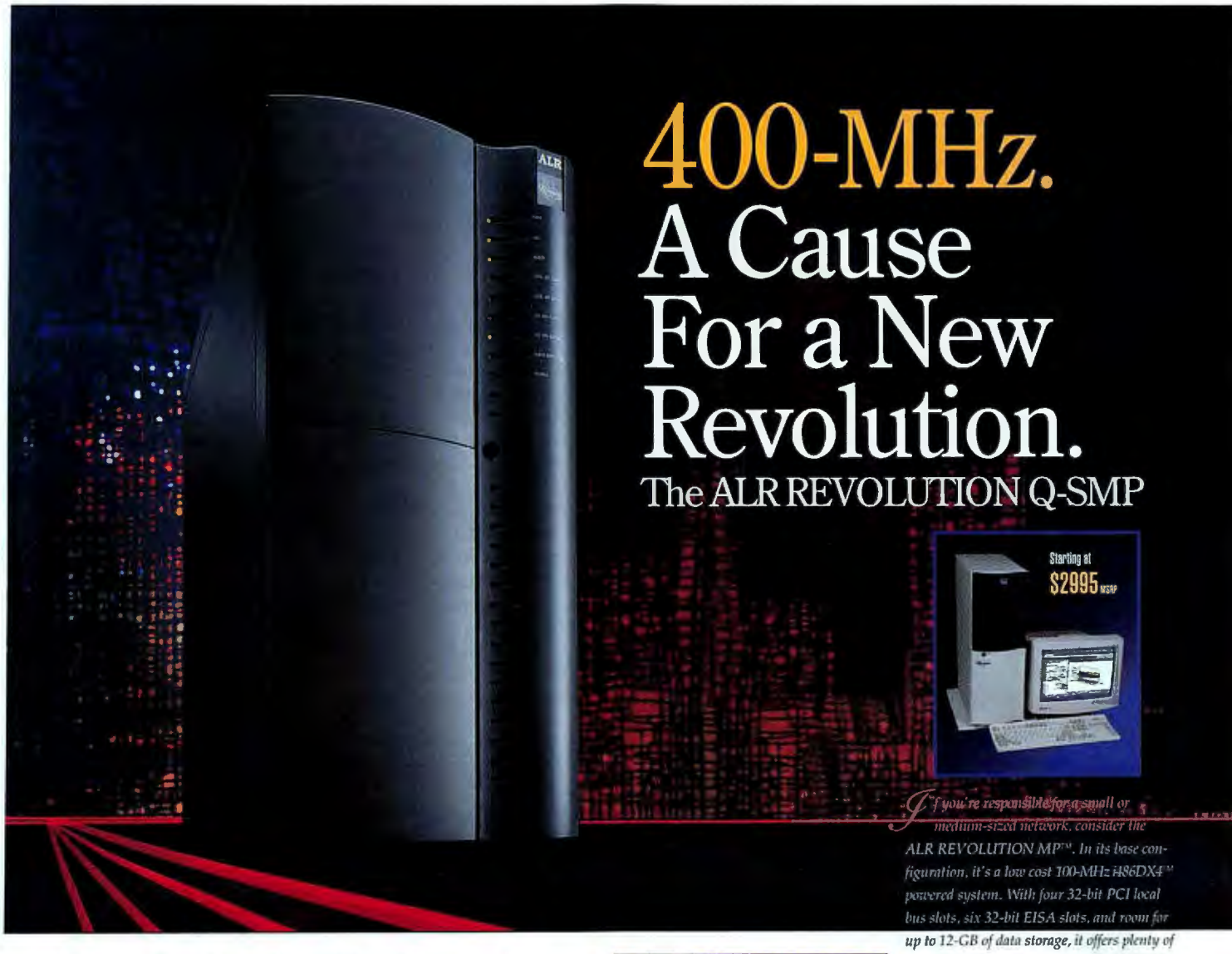
The Products

While few consumer products are yet available, many have been announced; chip- and component-level products are shipping. Cypress Semiconductor, Western Digital, AT&T, NCR, Vitesse Semiconductor, Triquint, AMCC, and Raytheon are all making chip sets for OEMs to use in Fibre Channel–based switches, interface cards, or disk products.

Dan Brown, vice president of the I/O Products Group at Western Digital, says the company will have a PCI (Peripheral Component Interconnect) host bus-adapter card for Fibre Channel sampling in the fourth quarter.

Cypress—which also makes FPGAs (field programmable gate arrays), SRAM (static RAM), PROMs, and other logic devices—makes chip sets that support either copper or optical Fibre Channel communications (the specifications on the logic side of the wire are the same). Ed Grivna, principal engineer of Cypress's DataCom Division, explains what these logic components do: "The biggest function of these parts are phase-lock loops, which are required on both the transmit and receive sides. On each Fibre Channel circuit, there is both a slow parallel side and a fast serial side. The parallel side talks to the device, while the serial side delivers [data] to the Fibre Channel. As data traffic passes through in either direction, phase-lock loops are used to synchronize the operations."

Cypress, NCR, Raytheon, and Triquint currently make components that run at 266



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Sorting Out the Players

ANSI's Fibre Channel Working Group was chartered in 1988. In February 1993, IBM, Hewlett-Packard, and Sun Microsystems formed the FCSI (Fibre Channel Systems Initiative) to support and advance Fibre Channel and to help the development of market products. All three vendors have been concentrating their efforts on midrange systems. In August 1993, these vendors and several smaller ones—including Ancor Communications, Eldec, and Cypress Semiconductor—formed the Fibre Channel Association, which will carry on FCSI's goals.

Mbps only. Vitesse manufactures a 1-Gbps-only product. AMCC is the only vendor whose chip sets are compatible with all speed standards, but it cannot switch speeds dynamically; you must select one setting. All vendors of logic devices will be producing alternative rate chips in a year or so.

At the subsystem level, the first products are just beginning to hit the market. Early Fibre Channel market entries focus on I/O rather than on communications technologies, primarily because improving system I/O offers the greatest immediate benefits. The first products to debut are fast disk array subsystems, but LAN-type products will not be far behind. IBM and HP showed clustered computing applications at the InterOp trade show in early May.

Sun announced its SparcStorage Array subsystem in late March, the first complete Fibre Channel product to hit the market. This compact (8.9- by 19.5- by 21-inch) mechanism can attach up to 30 disk drives to a single I/O port. The cabinet contains three racks, each holding up to 10 535-MB fast SCSI-2 or 1.05-GB fast/wide SCSI-2 disks. Current maximum capacity of the unit is 30 GB. The drives all use a special single connector that simplifies connection to the array.

The SparcStorage Array supports RAID levels 0, 1, or 5 at the low cost of about $1.65 per megabyte. This economy is possible because the array logic uses CMOS-like technology, which is considerably less expensive than other alternatives, such as GaAs (gallium arsenide). However, CMOS can't operate at 1 Gbps, so components for that higher speed will be expensive.

The array comes with the SparcStorage Volume Manager, which provides on-line data administration and configuration. The Volume Manager uses the same GUI as other Sun Solaris products, and it allows a full range of configuration operations even while the system is on-line. Pricing for the SparcStorage Array ranges from $24,900 for a 6.3-GB unit to $50,900 for the fully loaded 31.5-GB configuration.

To support the high data rates that Fibre Channel delivers, Seagate is implementing

a serial hard drive interface. This will be a serial SCSI implementation allowing 106 MBps across the interface. To maximize performance and minimize cost, Seagate will implement only a subset of the Fibre Channel features. Its drives will be dual-ported and support port bypass for reasons of reliability and performance. That is, while each drive can only transmit data to a single port at a time, commands will be able to bypass a busy device and go on to the next address.

Although data transfer rates are currently in the 6-MBps range, areal densities are increasing and should double by 1996. Jim Coomes, a senior engineer for Seagate, says, "Our computer modeling and simulation systems indicate that with 64-KB transfers and 16 devices, we should be able to achieve just over 90 MBps out of an arbitrated loop or string of drives." Seagate's first Fibre Channel product will join its 4-GB "Barracuda" family of drives. The goal is to produce these drives at the same price point as their fast/wide differential SCSI siblings. Sample units should be available by September, with production scheduled for the end of the year.

Besides its speed, one of the best features of the Fibre Channel standard is the modularity and interchangeability of its components. According to Bryan Yunker, engineering specialist for Eldec, "Fibre Channel is not just for disk drives or even storage products, but instead, it is extremely adaptable, lending itself to a wide variety of LAN applications." Originally an aerospace company, Eldec began producing Fibre Channel components a couple of years ago; they manufacture the physical interface for SparcStorage. At present, Eldec products use Triquint chips.

HP's initial offering will be an as-yet-unnamed switch with four slots supporting up to 16 card-mounted ports. Each card can have four 266-Mbps ports, two 532-Mbps ports, or a single 1-Gbps port; users will be able to mix and match cards according to their requirements. Announced in May, the product is due by year-end.

The HP switch will feature speed matching in Class 2 and Class 3 connections, tuned to the requirements of the connected port. Ed Frymoyer, HP's program manager for the Fibre Channel Systems Initiative, says, "The first iteration of the product will have communications based on the GLM (Gigabit Link Module), which will be powered by shortwave CD laser over fiber-optic cable, but the card connectors have a modular design, so customers will be able

to use copper as it becomes available." Even with Class 2 operation, latency will be less than 10 microseconds, the best currently available.

At the May InterOp, HP also demonstrated a similar product, available from Ancor Communications (Minnetonka, MN), supporting its 700-series workstations in a clustered computing application. When available, the switch will connect to workstations via "Lighthouse" interface cards, which are EISA-bus Fibre Channel boards also made by Ancor. The target price of the HP switch is approximately $1500 to $1600 per port/connector.

HP is also working on Tachyon, a chip-level product that will perform SCSI-to-Fibre-Channel and TCP/IP-to-Fibre-Channel transitions using Class 1 or Class 2 type connections at speeds of up to 1 Gbps. Vendors will be able to use Tachyon, some glue logic, and modular connector units to create Fibre Channel host adapters with low chip counts.

Besides creating OEM products for HP, Ancor is also an OEM partner with IBM, which used Ancor cards and switches in its RS/6000 Fibre Channel demonstration at InterOp. Like the other major vendors in this market, IBM is concentrating its early efforts on midrange and workstation computers, presumably because users of these systems can best afford the costs of early release hardware.

What's Next?

The Fibre Channel Association plans more than just I/O and clustering products. According to Eldec's Yunker, "the proliferation of Fibre Channel is going to be gated by the cost per port of connection, and despite its performance advantage, it will have to be priced competitively with more established technologies. It is the responsibility of the early hardware providers to ensure that goal is achieved."

One of those technologies is ATM (asynchronous transfer mode). (See "All-Terrain Networking," August 1993 BYTE.) Fibre Channel and ATM are not competing technologies. Instead, they are complementary. ATM will provide the network bandwidth required, but it won't offer the error correction and guaranteed delivery of Fibre Channel. Also, ATM's small frame size (53 bytes) means prohibitive overhead for some applications. What ATM can provide is high-speed, long-distance connections and a substantially lower connection cost. MicroAccess (Fremont, CA) will deliver a sub-$500 ATM interface card this summer.

Right now, disk access is driving Fibre Channel implementations. But an important future consideration is that PCI and other local-bus systems have high-frequency loading, which limits the number of slots. System designers will need multiport I/O, something Fibre Channel provides. With Fibre Channel, you can have an Internet Protocol connection, multichannel disk and storage peripheral access, a link to an ATM switch, and more—all from the same host adapter card. ■

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Virus-Prevention NLMs

Seven convenient and effective programs that defend against the threat of computer viruses

When virus prevention is handled strictly from the workstation, protection is only as good as its weakest point—be it lax security, the disabling of workstation protection, or the passing of files to the network without first checking for viruses during the file-copy process. Thanks to its built-in security, Novell NetWare is a much safer environment than individual workstations. It minimizes virus infection by using the operating system's internal security measures.

For instance, loading the SERVER.EXE file on the server machine clears the system memory and then lets you work from a NetWare partition, effectively diminishing the problems of boot-sector viruses and file viruses residing in server memory. In addition, viruses cannot infect files to which the originating user does not have modify or write access. Also, NetWare's virus control is effective and virtually tamperproof; no known NetWare-specific viruses have been discovered.

However, network usage contributes to the virus problem by providing viruses with a means of storage and transport: Copying files to a network and giving users unlimited access to directories containing executable files gives viruses an opening through which to infect individual workstations. As the computing world becomes increasingly interconnected through LANs, wide-area links, the Internet, on-line services, and other external connections, corporations are becoming ever more vulnerable to the threat of computer viruses.

Virus-prevention NLMs (NetWare loadable modules) provide an extra layer of virus protection to network systems. Because NLMs load first and cannot be disabled by casual users, they provide administrators with an effective tool for combating virus infections.

Evaluation Criteria

NSTL evaluated five NLMs as tools for virus prevention. In addition to these full-featured workstation and NLM products (Central Point Anti-Virus for NetWare, Command Software Systems' Net-Prot, Ontrack Computer Systems' Dr. Solomon's Anti-Virus Toolkit for NetWare, McAfee's NetShield, and Symantec's Norton AntiVirus for NetWare), we also looked at Cheyenne's InocuLAN and Intel's LANDesk Virus Protect for comparison purposes. Both of these network-only products provide TSR programs for workstation protection, but they lack the depth of workstation features, such as integrity checking, found in the other products.

At a minimum, NLMs should offer the ability to scan immediately (i.e., they should be user driven), schedule a scan for off-peak hours, and perform real-time scanning (i.e., check files as they copy or execute). NLMs should also be compatible with other NLMs, have little impact on network performance, and offer a full range of management features, including reporting and alerting options. Dr. Solomon's Anti-Virus Toolkit, a limited NLM without real-time scanning capability, is included in this evaluation based on the strength portrayed by its companion workstation product.

Protection Against Viruses

A multilayered defense is mandatory for protection against computer viruses, be they file infectors, boot infectors, multipartite viruses, stealth viruses, polymorphic viruses, or Trojan Horses. The most common type of defense is *scanning*, a method of handling viruses that is reactionary: By the time a virus is detected, it has already managed to infect files. Scanning is versatile because the user can look for virus signatures (which consist of known code strings) or scan files using algorithmic rules, ranging from complex heuristic techniques to matching strings, before confirming a virus's identity.

Integrity checking, another reactionary method, requires an initial active step. The user inoculates or validates the files by having the virus-prevention program make a validation code called a *fingerprint* (a calculated value using CRCs [cyclic redundancy checks] or complex checksums) for each file. Once these fingerprints have been calculated, the user can then have the program recalculate the values to ensure the file has not changed. This procedure does not work well for self-modifying executable files, however.

A more proactive virus-detection method known as *monitoring*, or behavior blocking, is designed to stop viruses before they infect a file. Monitoring employs a TSR module that scans a file before it executes to see if it is infected (thus stopping further infection), checks the file with its validation code before it executes, and looks for virus-like behavior. Such behavior may include terminating but staying resident, working beneath typical DOS calls (e.g., writing directly to the hard disk), attempting to change executable files, and attempting to change file attributes.

The *access-control* virus-prevention technique works by denying users the abil-

OVERVIEW: VIRUS-PREVENTION NLMS

NSTL RATING		VERSION	PERFORMANCE	QUALITY	VERSATILITY	EASE OF LEARNING	EASE OF USE	PRICE
★★★★	Central Point Anti-Virus	2.0	▲	▲	▲	▲	▲	$1199
★★★★	Net-Prot	1.24	▲	▲	▲	▲	▲	$995
★★★★	Norton AntiVirus	1.0	■	▲	■	▲	▲	$995
★★★	LANDesk Virus Protect	2.1	▼	▲	▲	▲	■	$995
★★★	NetShield	1.6	▼	▲	▲	▲	▲	$595
★★	InocuLAN	2.56	▼	▲	▲	▲	▲	$495
★	Dr. Solomon's Anti-Virus Toolkit	1.03	▲	▼	■	▼	▼	$640

KEY

★★★★★	Outstanding
★★★★	Excellent
★★★	Average
★★	Below average
★	Poor
▲	Good
■	Fair
▼	Unacceptable

ity to write to certain disks, directories, and boot tracks. Hardware-control and password-protection programs are good examples of this type of virus prevention.

Performance

For this review, we defined NLM performance as the overhead required when an NLM is loaded and monitoring files. For example, a score of 10 seconds on our benchmark tests means that the tested procedure was delayed by 10 seconds because of the virus-prevention activity. Products that add less delay time boast better performance.

Our benchmarks measure this time in two general categories. In the first, a small two-node network with one workstation copying over 500 files to the server measures the raw speed of the NLM while it has the server's full attention (i.e., nothing else is running on the network). In the second category, performance degradation is measured on a larger 32-node network with heavy traffic, with the server being utilized to the fullest.

Scanning speeds differ among the products but have no bearing on performance. All the products allow the user to schedule a scan at any time; thus, a scan can be scheduled to take place in the middle of the night, on a weekend, or when network usage is known to be low.

Net-Prot, Norton AntiVirus, and InocuLAN allow the user to enter a maximum CPU utilization rate that, when reached, causes the product to suspend virus scanning to allow other applications to access more of the server's resources. Dr. Solomon's Anti-Virus Toolkit and NetShield allow network administrators to enter a priority number that slows scanning and enhances performance by entering delays between file scans. Although the latter option is a plus, the former is a more useful feature, as it allows the NLM to make full use of the server CPU when it's available and then suspend operation, instead of slowing down, when utilization of the server peaks.

The best option is to go with a lean, fast NLM, and Net-Prot fits the bill. The program uses only 46 KB of RAM for the NLM itself and allocates approximately 60 KB for the tests that we ran. It uses two threads, and its performance is fast. Only Dr. Solomon's Anti-Virus Toolkit required less time for our tests to run, but it does not have real-time scanning capability. Thus, it just sits in memory, waiting for a scheduled scan to begin. Net-Prot really differentiated itself on the Heavy Load benchmark, recording speeds that were four to five times faster than those of its nearest competitors.

Quality

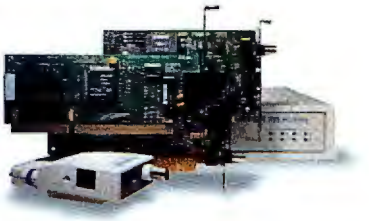
The quality tests evaluated the programs' ability to detect infected files. Using a list of 1953 infected files provided by the National Computer Security Association (10 South Courthouse Ave., Carlisle, PA 17013, (717) 258-1816; fax (717) 243-8642), we ran the scanner to identify infected files and attempted to copy the infected files to the server with the real-time scanning capability invoked. The number of infected files detected gauged product effectiveness; however, the number of files that a product flags changes frequently as vendors update the virus signature to incorporate new viruses and virus strains.

All the programs except Net-Prot give excellent protection against viruses. Net-Prot caught a good number of viruses, but fewer than the other programs did. Its sibling workstation product, F-Prot Professional (which comes bundled with the NLM), catches many more viruses than the NLM does. In fact, when we ran the quality tests on the bundled F-Prot package, F-Prot caught more viruses than any of the other NLM products.

Net-Prot's lower virus-catching capability should be no cause for concern, however, because research shows that the 10 most common viruses account for 80 percent to 95 percent of all infections. Net-Prot catches the most common viruses, and F-Prot Professional provides more

HIGHLIGHTS

	Strengths	Limitations
Central Point Anti-Virus	Catches the most viruses. Alerts administrators via broadcast, E-mail, and pager. Best at maintaining virus protection across multiple servers.	Loads eight modules. Cannot configure from the server console. Scheduled scanning could be easier.
Dr. Solomon's Anti-Virus Toolkit	Little server-performance degradation. Caught a good percentage of infected files. Excellent virus encyclopedia.	No real-time scanning. Doesn't check Macintosh files. Limited reporting features.
InocuLAN	Caught a good percentage of infected files. Alerts administrators via broadcast, E-mail, fax, and pager. Stops scanning at user-specified CPU-utilization level.	Slow performance. High server-resource requirement. No integrity-checking or file-validation capability.
LANDesk Virus Protect	Caught a good percentage of infected files. Scans compressed files. Alerts administrator of infections even if infection occurs while off-line.	Configuring options is tedious. Cannot configure from the server console. No integrity-checking or file-validation capability.
Net-Prot	Little server-performance degradation. Stops scanning at user-specified CPU-utilization level. Scans compressed files.	Cannot configure from the server console. Limited reporting features. Doesn't check Macintosh files.
NetShield	Caught a good percentage of infected files. Can configure from workstation or server console. Scans compressed files.	Slow performance. High server-resource requirement. Doesn't check Macintosh files.
Norton AntiVirus	Caught a good percentage of infected files. Alerts administrator via broadcast, E-mail, and pager. Stops scanning at user-specified CPU-utilization level.	Requires Microsoft Windows to configure. Cannot configure from the server console. Cannot password-protect NLM configuration.



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[800]

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	CENTRAL POINT ANTI-VIRUS	DR. SOLOMON'S ANTI-VIRUS TOOLKIT	INOCULAN	LANDESK VIRUS PROTECT	NET-PROT	NETSHIELD	NORTON ANTIVIRUS
Protection Parameters							
Check DOS files	●	●	●	●	●	●	●
Check Macintosh files	●	○	●	●	○	○	●
Check for unknown viruses	●	○	⑪	●	⑪	●	●
Supply a TSR monitor for workstations	●	●	●	●	●	●	②
Password-protect NLM configuration	●	③	●	●	●	●	○
Scanning Options							
Determine executable file types	●	④	●	●	●	●	●
Scan drives, directories, or files	●	④	●	●	⑤	●	●
Scan specific volumes	●	●	●	●	●	●	●
Scan by domain	●	○	○	●	○	○	○
Include subdirectories	●	●	●	●	●	⑤	●
Exclude subdirectories	○	○	●	●	○	⑤	●
Automatically run periodic scans	●	●	●	●	●	●	●
Set priority for CPU usage for scan	○	⑥	●	○	●	⑥	●
Real-time scanning	●	⑤	●	●	●	●	●
Scan using wild cards	●	●	○	●	⑤	●	●
Interrupt scan	⑤	○	●	●	●	●	●
List detectable viruses	●	○	●	●	⑤	●	●
User can add virus signatures	○	○	○	○	⑤	●	●
Company supplies signatures to add	●	●	●	●	●	●	●
Heuristic-/rules-based scanning capability	●	○	●	●	⑤	○	○
Scan compressed files	⑦	○	○	●	●	●	○
Scan migrated files	●	○	○	○	○	○	○
Encrypt virus signatures	●	●	●	●	●	●	●
Integrity Checking							
Calculate CRC or checksum codes	①	○	○	○	①	●	●
Seed CRC with password	○	○	○	○	①	○	○
Copying files maintains validation codes	○	○	○	○	○	●	○
Remove validation codes	①	○	○	○	①	●	●
Maintain validation-exception list	①	○	○	○	①	●	●
Encrypt validation-code database	①	○	○	○	①	●	○
Check for validation before executing file	①	○	○	○	①	●	○
Specify groups of files to validate	①	○	○	○	①	●	●
List files that have been validated	①	○	○	○	①	○	○
Repair							
Remove known viruses	⑩	●	●	●	⑩	●	○
Restore file from unknown viruses	①	○	○	○	①	①	○
Restore overwritten files	①	○	○	○	○	○	○
Delete infected file upon detection	●	●	●	●	●	●	●
Purge or overwrite file	●	○	●	●	⑩	●	○
Move infected file to a specific directory	●	●	●	●	●	●	●
Network Capability							
Automatically update nodes	●	●	●	●	●	●	○
Automatically update other servers	●	○	●	●	●	●	○
Automatically configure nodes	●	○	●	●	●	○	○
Update configurations from server to server	●	○	○	●	●	○	●
Configure NLM from workstation	●	●	●	●	●	●	●
Specify NLM to load after scanning	●	○	⑧	●	○	○	●
Alerting/Reporting							
Alert administrator even if infection occurs while off-line	⑨	○	○	●	●	○	○
Notify administrator upon log-in	●	○	○	●	●	○	○
Send message to administrator beeper	●	○	●	⑩	○	○	●
Send message to administrator via E-mail	●	○	●	●	●	○	●
Broadcast alert to designated users	●	●	●	●	●	●	●
Send message to administrator via fax	○	○	●	⑩	●	○	○
Display customizable alert to workstation	●	●	○	●	⑤	○	●
Server-to-server communication of alerts	●	○	●	○	○	○	○
Store virus activity to audit file	●	●	●	●	●	●	●
Create custom reports	●	○	○	●	○	○	●

① Workstation product only; provided free of charge.
② Workstation product only; provided for additional cost.
③ Password-protects from unloading the NLM.
④ User must create a list of files to be scanned.
⑤ Only through the workstation.
⑥ Can set delays in milliseconds between file scans to minimize performance degradation.
⑦ Using NetWare 4.0 only.
⑧ Allows concurrent scanning and backup when using Cheyenne's ARCserve 4.0 or 5.0 only.
⑨ Only if network drivers are loaded and user is logged off.
⑩ Can accomplish this through LANDesk Manager add-on for additional cost.
● = yes; ○ = no.

	CENTRAL POINT ANTI-VIRUS	DR. SOLOMON'S ANTI-VIRUS TOOLKIT	INOCULAN	LANDESK VIRUS PROTECT	NET-PROT	NETSHIELD	NORTON ANTIVIRUS
Resource allocation							
System module	232,287	55,211	328,983	94,143	46,112	188,537	137,736
Small memory allocations	41,356	18,924	26,348	12,584	1124	86,736	161,780
Large memory allocations	467,320	156,140	628,780	215,220	12,660	730,060	198,340
Total memory resources	740,963	230,275	984,111	321,947	59,896	1,005,333	497,858
Number of threads	10	7	15	8	2	5	14
Number of modules loaded	8	1	6	3	1	1	2
Default file extensions scanned							
386	●	⊖	○	○	○	○	○
APP	○	⊖	●	○	●	○	●
BIN	●	⊖	○	●	●	○	●
CMD	●	⊖	○	○	○	○	○
COM	●	⊖	●	●	●	●	●
DLL	●	⊖	○	○	●	○	○
DRV	○	⊖	●	○	○	○	○
DSK	○	⊖	○	●	○	○	○
EXE	●	⊖	●	●	●	●	●
FON	●	⊖	○	○	○	○	○
ICO	●	⊖	○	○	○	○	○
LAN	○	⊖	○	●	○	○	○
NAM	○	⊖	○	●	○	○	○
NLM	○	⊖	○	●	○	○	○
OV?	●	⊖	●	OVL	●	●	●
PGM	○	⊖	○	○	●	○	○
PRG	○	⊖	●	○	○	○	●
SYS	●	⊖	●	●	●	●	●
VAP	○	⊖	○	●	○	○	○
VIR	○	⊖	○	●	○	○	○
VLM	○	⊖	○	○	●	○	○
XTP	○	⊖	○	○	○	○	●

⊖ No real-time scanning. ● = yes; ○ = no.

in-depth scanning (as well as impressive heuristic scanning for suspicious files).

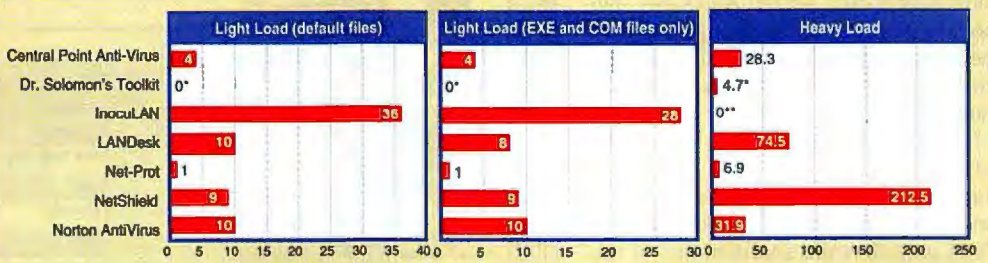
Management

Management of programs and the alerts they generate is an important NLM feature. When an alert is received on a workstation, the user knows where it is coming from. In a network environment, however, the administrator must know where an infection occurs in order to isolate a department, a set of computers, or a set of files and quickly eradicate a virus before it becomes an epidemic. Reporting features must be able to quickly merge all virus-detection information for the entire enterprise and allow the administrator to manipulate that information.

Central Point Anti-Virus did the best job at management. It provides a wealth of options for reporting, updating, and gathering virus-detection information. The program also provides the best enterprise-wide management, allowing cross-server updating and gathering of virus-detection data from other servers and workstations.

When the number of workstations on a network reaches into the hundreds, it becomes impossible for the administrator to go to each workstation and update signature files and configure products. All the products reviewed except Norton Anti-

NLM Performance



*Dr. Solomon's Toolkit does not perform real-time scanning.
**InocuLAN could not complete the Heavy Load benchmark because of a sharing violation.

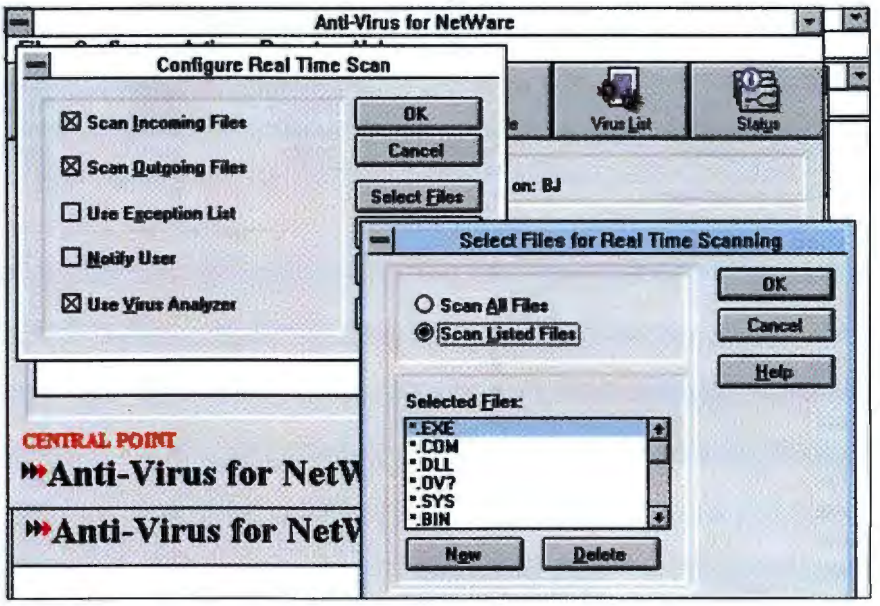
The NSTL performance benchmarks measure the delay of executing files when the antivirus NLM is scanning the files as they execute. All times are in seconds; lower numbers indicate faster performance. The Light Load benchmark copied 594 files in 22 directories from a workstation to the server, measuring the raw speed of the NLM. In the first iteration, the product's default file list was used; in the second iteration, only EXE and COM files were scanned, forcing the NLMs to scan the same number of files. The Heavy Load benchmark used a 32-node network with the server being utilized to the fullest. Unlike the other products tested, Dr. Solomon's Anti-Virus Toolkit does not perform any real-time scanning, so the program just sits in memory, waiting to perform a scheduled scan. InocuLAN could not complete the Heavy Load test because of sharing violations. NSTL believes this problem occurs because of the concurrent hitting of a single file and InocuLAN's inability to quickly scan the file and then release it.

Virus either automatically update signature files or compare the files and update all instances of the virus-prevention package with the latest-dated file. Central Point Anti-Virus, Net-Prot, LANDesk Virus Protect, and InocuLAN also let the administrator configure all nodes from one location. Central Point Anti-Virus, LANDesk Virus Protect, and Norton AntiVirus can also update other servers automatically from a central server.

All the programs provide audit files or log files so the administrator can determine where and when any infections take place. Central Point Anti-Virus, Norton AntiVirus, and LANDesk Virus Protect provide the most in-depth reporting capabilities. These programs allow the administrator to determine which information goes in the report and permits the searching, sorting, and filtering of data according to date, virus name, and other criteria. NetShield and Dr. Solomon's Anti-Virus Toolkit have simple audit logs that can be viewed, printed, or saved to a file. Net-Prot's reporting features are somewhat limited, as a file can be saved only as an ASCII file and cannot be printed from the program.

Another important aspect of protecting against viruses is the alerting of users and administrators. User alerts are achieved by broadcasting a message that a file is infected. Alerting the administrator is more difficult, however. All the reviewed products broadcast virus alerts and allow the administrator to determine a list of users to receive such alerts. Central Point Anti-Virus, Norton AntiVirus, LANDesk Virus Protect, and InocuLAN all have the ability to send an E-mail message to the designated person upon detection of a virus in addition to broadcasting alerts. Central Point Anti-Virus, Norton AntiVirus, and InocuLAN can also be set up to send a beeper message. InocuLAN can send a fax notification for the enterprise-wide accounting of virus detection.

LANDesk Virus Protect will alert the network administrator about any infections that occur when an infected workstation is not logged on. Central Point Anti-Virus will alert the administrator if the infected user is logged off but the network drivers remain loaded. Both of these programs notify the administrator of infections when he or she logs on, and both can define domains (i.e., more than one server) for scanning. Central Point Anti-Virus communicates alerts from server to server for a truly centralized account of virus activity over a WAN (wide-area network).



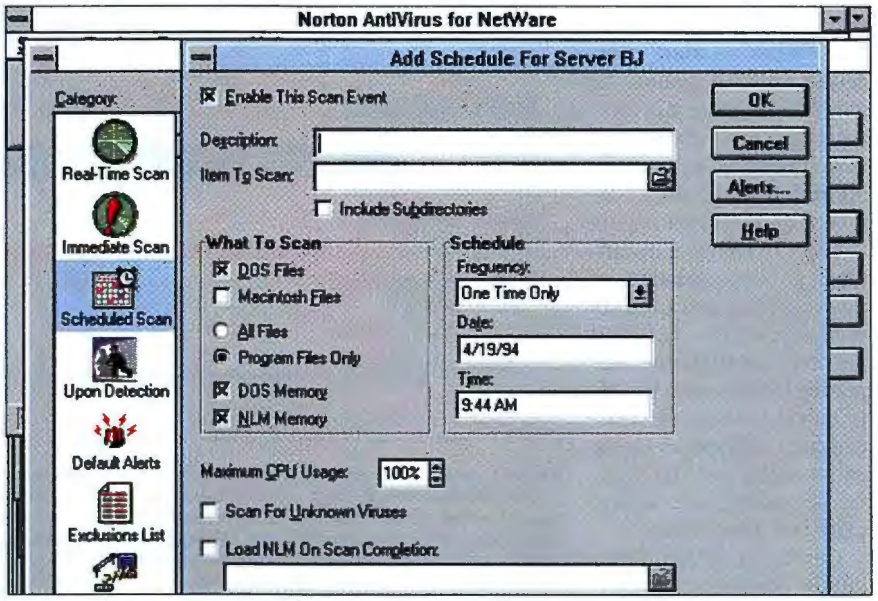
Real-time scanning slows the server because the NLM must immediately stop the file being executed to check for viruses. Such performance delays can be minimized by limiting the scan to specific extensions. All the NLM products reviewed have this capability. Shown here is the top-rated Central Point Anti-Virus for NetWare.

Other Features

The most important feature in a virus-prevention NLM is three-pronged scanning capability: manual or on-demand, scheduled, and real-time. Reporting, alerting, and performance issues are also very important. Other features, such as integrity checking, full-featured workstation products, scanning Macintosh files, and virus cleaning, are desirable but not as important.

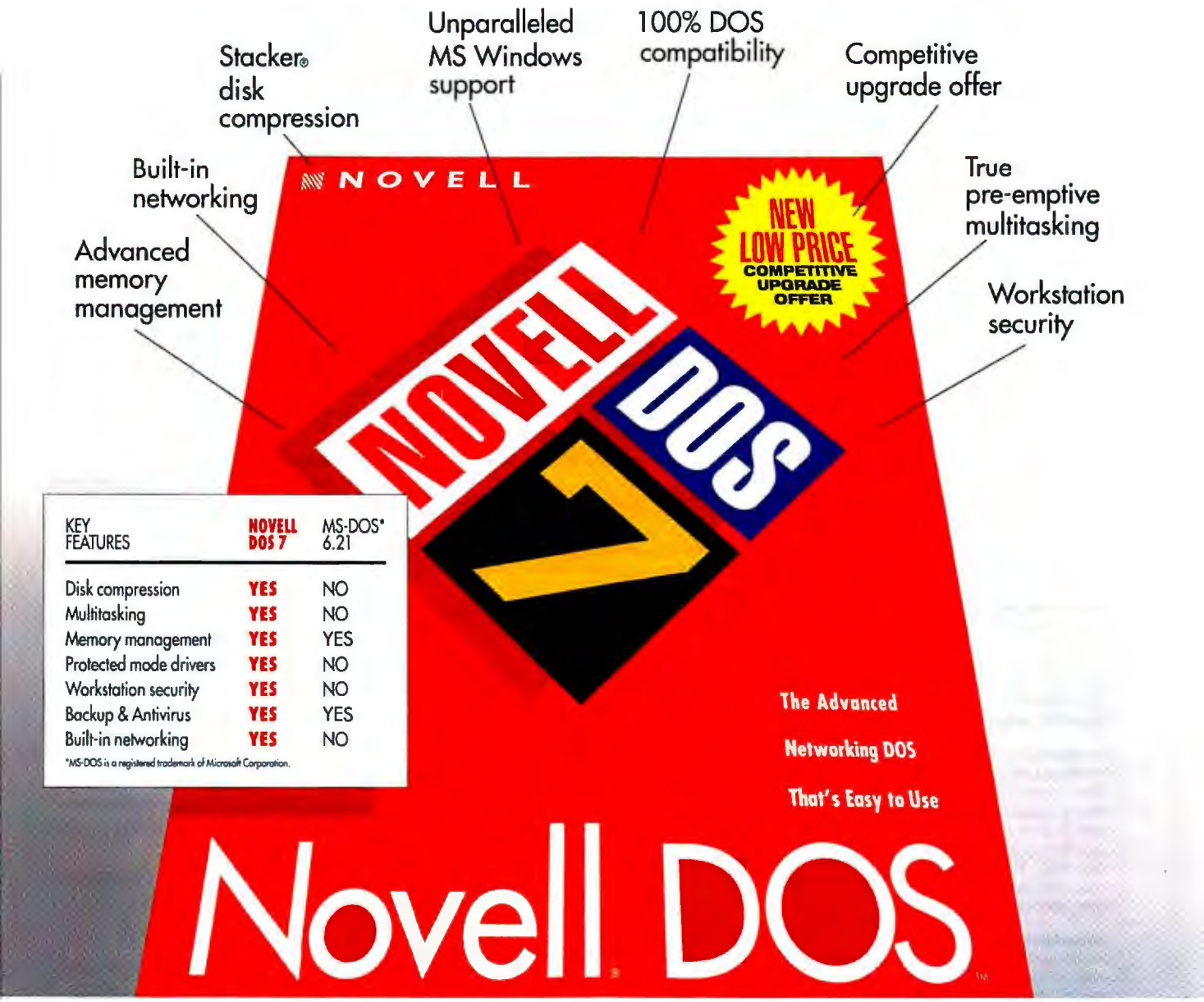
Central Point Anti-Virus includes the entire Macintosh workstation product with the NLM, so the product not only scans Macintosh files on the server but also protects Macintosh workstations. Norton AntiVirus, LANDesk Virus Protect, and InocuLAN also provide scanning capability for Macintosh files on the server.

Central Point Anti-Virus, Net-Prot, and NetShield bundle their workstation products with the NLM. NetShield now includes printed documentation for the workstation version as well. Note that the products from Central Point Software and Command Software Systems scored the highest overall ratings for virus preven-



All the antivirus NLMs let you schedule a scan at any time. For example, a scan can be scheduled in the middle of the night, on a weekend, or when network usage is known to be low. Shown here is Norton AntiVirus for NetWare.

This DOS is Boss.



KEY FEATURES	NOVELL DOS 7	MS-DOS* 6.21
Disk compression	YES	NO
Multitasking	YES	NO
Memory management	YES	YES
Protected mode drivers	YES	NO
Workstation security	YES	NO
Backup & Antivirus	YES	YES
Built-in networking	YES	NO

*MS-DOS is a registered trademark of Microsoft Corporation.

New low price! Take advantage of our limited-time competitive upgrade offer on Novell® DOS™ 7 – the world's most advanced, 100% DOS-compatible operating system. With more MS Windows utilities than any other DOS. Plus our exclusive space-saving Stacker disk compression. The productivity of true multitasking. Better memory management with DOS Protected Mode Services. And built-in networking. Sounds good, but you want to know more? Call us and we'll fax you a detailed competitive comparison. Better yet, why not meet The Boss right away and save money, too. See your local reseller today.

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tion for single systems, and both of these companies bundle these products with their NLMs.

Although compressed infected files will not infect other files until they are decompressed, an NLM that scans compressed files can catch such infected files while they reside on the server. Otherwise, many files might be compressed, copied to the network, copied to another workstation, and then decompressed, thus bypassing the network security guards. Net-Prot, NetShield, and LANDesk Virus Protect can all scan certain types of compressed files.

New Versions

New versions of three of these programs will be released by the time you read this. Unfortunately, they were not available in time to be tested for this review.

Central Point Anti-Virus for NetWare 2.5 will include a feature called Central-Command, which allows the network administrator to centrally configure and manage virus protection on networked Windows workstations. It will also enable the administrator to remotely clean infected workstations. A Workstation Sentry feature will provide transparent virus protection and scheduled scanning for Windows workstations. Version 2.5 will also forward alerts to NetControl, expand LAN-Alert support, check the version of the signature file automatically, and then update the signature file to the current version. In addition, it will have improved compatibility with Novell's new client SDK (software development kit) and add EMS 2.0 support, making it compatible with all versions of PC Tools for Windows.

Version 1.25 of Net-Prot will be able to scan specific volumes, update other servers, and update configurations from server to server. The new version will also greatly expand the alerting features, adding the ability to alert the administrator even if an infection occurs while the affected workstation is not logged on to the network, the ability to alert the network administrator via pager or fax, and server-to-server communication of alerts.

Version 3.0 of InocuLAN will add domain support so that modifications made to the master server's configuration will automatically establish each member server's default configuration. The audit logs of each member server will upload to the master server, thus centralizing the monitoring of possible virus infections. Reporting features allow you to query the data using such criteria as file server, date, and time.

The new version will also include both DOS and Microsoft Windows managers, enabling supervisors to perform administrative tasks from their workstations. The program will add a full Windows interface for graphical access to all functionality. InocuLAN 3.0 will also allow an administrator to designate file servers to automatically download virus-signature files from Cheyenne Software's BBS.

NSTL Recommendations

The workstation version of Central Point Anti-Virus has only one glaring weakness: performance (it finished third). But because it has excellent usability and the best quality and most features of the products we reviewed, it captured the top overall position for virus-prevention NLMs. It offers the utmost in enterprise-wide virus prevention and management, allowing the administrator to configure workstations and other servers from a central server and gather virus alerts from any server or workstation and put them on a central server. The product's quality is top-notch, and its only usability flaw is the difficulty involved in attempting to learn the myriad options provided.

Net-Prot provides the best performance by requiring the least amount of server degradation. It also provides excellent usability, good versatility, and good quality. It requires the least system resources of any of the reviewed products, making it the product of choice if system resources are your primary concern. ■

This report contains the results of The Software Digest Ratings Report, *a monthly publication from National Software Testing Laboratories (NSTL). To obtain complete test results and in-depth analysis, contact NSTL (P.O. Box 551, Hightstown, NJ 08520, (609) 426-7070; fax (609) 426-5434). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc.*

About the Products

Central Point Anti-Virus for NetWare 2.0
$1199 per NetWare license; free download of updated virus signatures from BBS
Central Point Software, Inc.
15220 Northwest Greenbrier Pkwy.,
Suite 150
Beaverton, OR 97006
(800) 964-6896
(503) 690-8088
Circle 1060 on Inquiry Card.

Dr. Solomon's Anti-Virus Toolkit for NetWare 1.03
$640; quarterly updates for virus signatures, $95
Ontrack Computer Systems, Inc.
6321 Bury Dr.
Eden Prairie, MN 55346
(800) 752-1333
(612) 937-1107
Circle 1061 on Inquiry Card.

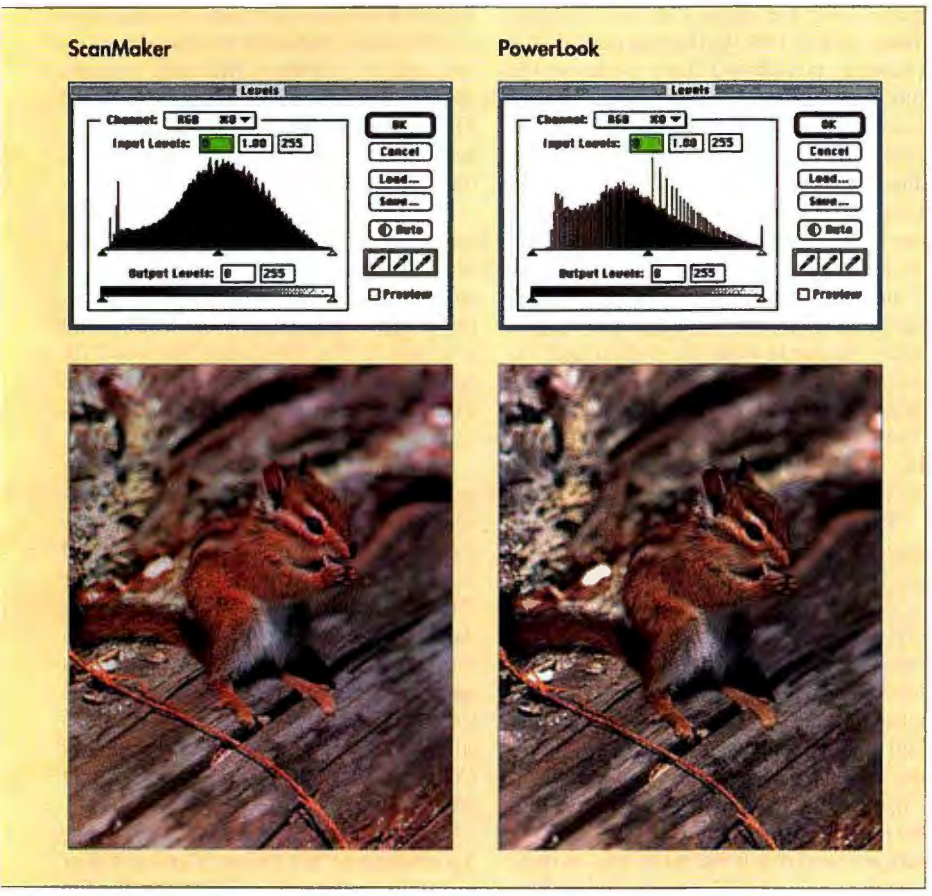
InocuLAN 2.5d
$495 for up to 25 user servers; $995 for unlimited servers (includes unlimited workstation managers); free download of updated virus signatures from BBS or CompuServe forum for one year
Cheyenne Software, Inc.
3 Expressway Plaza
Roslyn Heights, NY 11577
(800) 243-9462
(516) 484-5110
Circle 1062 on Inquiry Card.

LANDesk Virus Protect 2.1
$995 for a single server; free download of updated virus signatures from BBS
Intel Corp.
734 East Utah Valley Dr.
American Fork, UT 84003
(800) 538-3373
(801) 763-2200
Circle 1063 on Inquiry Card.

Net-Prot 1.24
$995 for 25 users; free download of updated virus signatures from BBS
Command Software Systems, Inc.
1061 East Indiantown Rd.,
Suite 500
Jupiter, FL 33477
(800) 423-9147
(407) 575-3200
Circle 1064 on Inquiry Card.

NetShield 1.6
$595 for first server; virus-signature upgrades free with two-year license
McAfee Associates, Inc.
2710 Walsh Ave.,
Suite 200
Santa Clara, CA 95051
(800) 866-6585
(408) 988-3832
Circle 1065 on Inquiry Card.

Norton AntiVirus for NetWare 1.0
$995 per server; free download of updated virus signatures from BBS
Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(800) 441-7234
(408) 253-9600
Circle 1066 on Inquiry Card.



Scan results and histograms from a service bureau drum scanner (Crosfield Scantex) and the three reviewed scanners. I scanned the test image using each vendor's automatic calibration and ranging features, with no color modification or image sharpening. The histograms represent the number of light and dark pixels in each scanned image, from darkest on the left to lightest on the right. The Arcus Plus scan is the only one of the four scan images I don't consider printable without modification. Although its histogram is solid, applying the needed balancing, brightening, and saturation corrections would exacerbate the dips in the curve, leaving almost no advantage over the PowerLook scan but taking a much greater time investment. The ScanMaker scan matches the body of the chipmunk most accurately, but it introduces a slight rosy shift in the gray areas of the weathered log. However, its histogram indicates that the scan will support removing the magenta bias if desired. To be sure nothing had upset the calibration, I recalibrated the ScanMaker with a test target immediately before scanning this image. The PowerLook scan is the most neutral in color, needing only an increase in saturation to match the original. Its discontinuous histogram is cause for caution, indicating that certain tone values are completely absent; subsequent adjustments can make these dips noticeable.

(see the scans). The photo provides plenty of detail, as well as subtle color data in the out-of-focus background. I assumed that the manufacturers had done plenty of scanning of standardized calibration targets and didn't expect that one more such test would be meaningful.

The general rule of thumb for scanning is to sample at twice the expected halftone value, but my experience is that anything over the square root of 2 to 1 wastes scanning and manipulation time, as well as storage space. For the sake of testing, however, I used a 2-to-1 ratio to scan the image. Based on the 133-line screen that most heat-set web offset magazines use, I attempted to scan the test images at 266 dpi.

A drum scanner, the Crosfield Scantex at a Seattle-area color service, provided a comparison scan (the first scan in the sequence on page 138). I instructed the service bureau to use the basic "closest match" settings of the scanner and to scan and save the file at an appropriate resolution for PostScript output. The color service scanned the original at 120 samples per centimeter (304.8 dpi), creating a 31.5-MB image file.

The basic scan is pleasing, with a very slight green cast that you could run unmodified or compensate for readily in Photoshop. The master channel histograms (see the screens above the scans) show that each scan has enough information across the tonal range to provide a good image. The smooth and continuous curve in the drum-scanner image's histogram indicates that you could make reasonable adjustments without creating problems. The ScanMaker's scan came closest to the results from the service bureau, providing a smooth distribution of light and dark pixels without gaps and spikes.

Such discontinuities in the Arcus Plus and PowerLook images indicate that, once the scans are balanced, there will be gaps that can lead to some posterization and other artifacts during subsequent editing of the file. Shifting the midpoint of the Arcus Plus scan in Photoshop to lighten the image created a histogram almost as spiky in the dark half of the range as the PowerLook scan, with lower saturation. Increasing the saturation would increase the discontinuities in the histogram, which eventually become visible in the final printed image, particularly in areas of gradual and subtle changes in tone.

The ScanMaker accomplishes its smooth histogram by scanning at 12 bits per color and sending all that information to the computer. Tonal adjustments are made to this data, and only then is the image sampled down to 8 bits per color. The other scanners start with 10 bits and work down from there. When a standard format is established to use 48 bits of color information instead of 24 (32 bits after conversion to CMYK), the ScanMaker will be able to take advantage of the additional information immediately.

Because PostScript output devices can image a theoretical maximum of only 256 grays regardless of the incoming information, there would be little change in the final results of scans handled automatically. However, scans that require significant color correction could be processed at the higher bit depth and sampled down to 8 bits after all corrections have been made, resulting in a final histogram that looks like the drum-scanner or ScanMaker curve shown. Because Photoshop is currently limited to 8 bits, any modification to the ScanMaker scan would result in a spiky histogram in the final file.

While the differences in scanning output between the three review scanners are important, just as important are differences in the features and ease of use provided by the bundled scanning software, particularly if you deal with less-than-perfect images.

Arcus Plus FotoLook

Although it certainly has every useful option, the Agfa FotoLook software that

comes with the Arcus Plus is confusing. When you're first starting the plug-in, for example, it is obvious how to choose the mode and order a preview. As with all scanning software, you then adjust the area that you will actually scan. Unlike with any other software I've used, however, the frame of this area must be dragged back out to full screen manually or the next preview will be only the size of that previous scan. Also, FotoLook's ability to select the black point and white point in the image—similar to what Photoshop lets you do in the Levels dialog box—is a nice feature, but it takes two prescans to get there. The software urgently needs usability testing to eliminate clumsy and counterintuitive elements such as these.

The software manual doesn't help, either. The first half has instructions that apply to all Agfa scanners, replete with notations that a given feature doesn't apply to one or more scanners in the line. The same information covers both Windows and Mac software, although all the screen captures are from the Mac version. The second half of the manual is devoted to installing the scanner in every European language. I'm sure I saw an index, but it's hidden in the middle of the volume. The manual is in serious need of a good set of tabs to indicate the sections and locate the index. Better yet, Agfa should edit this manual down to a single model, platform, and language.

I scanned the test image at 266 samples per inch, 50 percent scaling, with all other defaults set. This should have resulted in a 4- by 5-inch image of about 4 MB in size, but Photoshop reported that the final image was 8 by 10 inches at 150 dpi, for a file size of 5 MB. This additional file size is not enough to explain the slow scanning time of 5 minutes, 8 seconds.

ScanMaker III Software

The Microtek software includes DCR (Dynamic Color Rendition), the company's calibration and color-matching software that ensures the color integrity of the raw scanned image, and ColorSync, an Apple System Extension that aims to reduce color differences between the scanner, monitor, and color printers. Microtek includes device profiles for Apple monitors and Microtek scanners; profiles for most monitors and color printers are available from their manufacturers.

The DCR calibration utility, which Microtek recommends you use as a monthly task, takes only a couple of minutes and results in the color most closely matching the original image. The closest setting available to the 266 called for was 270, and I scanned the test image at that value. The scan completed and displayed in Photoshop in 2 minutes, 22 seconds.

Software installation on the Mac consists of dragging one folder of device characteristics into the Preferences folder, one Control Panel to the System folder, and two plug-ins to the appropriate folder for Photoshop. In addition to running a standard installer program, Windows users must allow for a 16-KB address block in upper memory between 640 KB and 1 MB for the interface card and be prepared to edit WIN.INI and any memory manager CONFIG.SYS entries to account for that address block.

Documentation for the Windows product is adequate, but you won't need it after installation. The documentation for the Mac product is best left in the box, as it doesn't properly describe this scanner and software combination. In both cases, the documentation is in too many pieces and lacks clear organization.

The software lacks one important feature and includes one aggravation. No facility is included for descreening. The software included with the other two scanners does a better (and certainly faster) job of this than can be done in Photoshop with the Despeckle and Sharpen filters.

The aggravation is that only inches and centimeters are available for scan size—two choices I rarely use. For page layout, I need picas. The rest of the scanning that I do (a growing part in this age of multimedia) is for on-screen display, where the

About the Products

Arcus Plus $3495
transparent media adapter $750
Agfa Division, Miles, Inc.
200 Ballardvale St.
Wilmington, MA 01887
(508) 658-5600
fax: (508) 658-5168
Circle 1078 on Inquiry Card.

ScanMaker III $3499
transparency adapter $699
Microtek Lab, Inc.
3715 Doolittle Dr.
Redondo Beach, CA 90278
(800) 654-4160
(310) 297-5000
fax: (310) 297-5050
Circle 1079 on Inquiry Card.

PowerLook PS2400x $3495
(transparency adapter included)
Umax Technologies, Inc.
3353 Gateway Blvd.
Fremont, CA 94538
(800) 562-0311
(510) 651-8883
fax: (510) 651-8834
Circle 1080 on Inquiry Card.

desired size is known in pixels.

The preview window is also the smallest of those of the three software bundles and is too small for accurate cropping. Thanks to this and the lack of appropriate units of measure, I found myself scanning a generous area of most photos at a slightly higher resolution than I was likely to need, and then cropping and resampling in Photoshop.

PowerLook MagicScan

The Umax MagicScan software is the best of the bunch. Installation also consists of an installer for Windows and for the Mac—three files (four if you install the Help file) that you drag to the predictable locations on the desktop. The Umax interface card for the PC requires only an I/O address; if you know the address of your network card or other I/O addressed peripherals, the installation is trivial.

The MagicScan software offers a wide range of useful controls for dealing with less-than-ideal originals. If the print of the chipmunk had started with an off-color tone, the overall color cast could have been changed in the preview so that color information wouldn't be lost in Photoshop during corrections. There are three levels of unsharp masking available, although this operation is normally the last stage and should not be applied if other corrections are going to be made in Photoshop.

MagicScan allows easy and intuitive inversion of negative images, as well as flipping of images from transparent originals that were placed upside down on the scanner. A simplified histogram and tone curve are available for correction. The only feature I missed was scanning in picas, although pixels are directly supported.

The MagicScan manual, a slender paperback, is a model of clear and complete explanations and careful organization, and yet it's hardly needed because the basic functions of the plug-in are so obvious. I didn't even open it until the review was almost finished.

Like the Agfa software, MagicScan allowed me to enter the exact resolution I wished to scan in; unlike the Agfa software, it then delivered it. The scan, which could benefit from a slight increase in saturation, was quite pleasant, with the automatic balance selected and all other settings left at their defaults. The image was ready to edit in Photoshop in the remarkable time of 50 seconds. This is the only scanner that would not be objectionably slow if you also handled moderate amounts of OCR.

Clear Choices

Can these scanners eliminate the need for a service bureau? In many cases, the answer is clearly yes.

A scan from a service bureau typically costs $75 and takes two days, so just the speed and cost advantages of desktop scanning are enough to overcome a significant quality difference. Moreover, the benefits of drum-scanner quality will be lost if the film is destined for output on PostScript imagesetters. And in many cases, the original image is not good enough to reveal the quality difference of a drum scanner anyway.

The advertised features of the three scanners are similar, and the final quality of the scans is, in all cases, very high. With any of the three you can obtain image quality similar to that in this magazine or the national newsweeklies. The differences between them lie in the amount of work needed to get pleasing color.

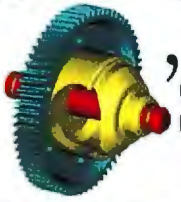
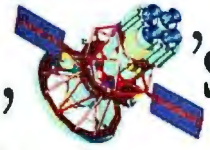
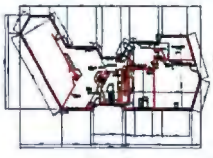
Slow scanning speed, poor color accuracy, and a clumsy interface combine to keep the Agfa Arcus Plus off the recommended list. Agfa will be replacing the Arcus Plus with the Arcus II soon after you read this. The new scanner promises to be better all around, providing increased scanning speed and better image quality, with a 3.0 dynamic range and 12-bit sampling per color. The scanning area will increase to 8 by 14 inches. The price, somewhere under $4000, will include a built-in transparency adapter. Until that new scanner proves itself, however, the clear choice is between the Microtek ScanMaker and the Umax PowerLook.

The ScanMaker offers the best color rendition, and the dense histogram it produced means that more image modifications can be made without losing important information. The increased bit depth will be valuable when and if Photoshop supports a 12-bit-per-pixel file format. Shops doing predominantly color reproduction with good originals should put the ScanMaker III at the top of their list.

The PowerLook has the convenience of quick scanning and software with suitable units of measure and a good descreening algorithm. These features make the PowerLook the more productive choice for shops that handle a wide range of scanning tasks. ■

G. Armour Van Horn is a production artist as well as a consultant and writer on electronic imaging and prepress. His studio is on Whidbey Island, northwest of Seattle. You can reach him on the Internet or BIX at vanhorn@bix.com.

Yes,

you can do Windows™ and walls and doors and floors, ceilings, whole  's,  's, trains, boats,  's, chains,  's, diamond rings,  's and things,  's, power plants, topo maps,  's, helicopters, roads and bridges, circuit boards,  's power lines,  's, airports, furniture, digital terrain models,  's, skateboards, the  ,  's, chemical plants,  's, golf courses, anything you can think of ... even the kitchen  .

Apple Redefines the Notebook

The latest PowerBooks set a new standard: built-in Ethernet, a trackpad, optional PCMCIA, 16-bit color, stereo sound, and a fast 68040 CPU upgradable to PowerPC

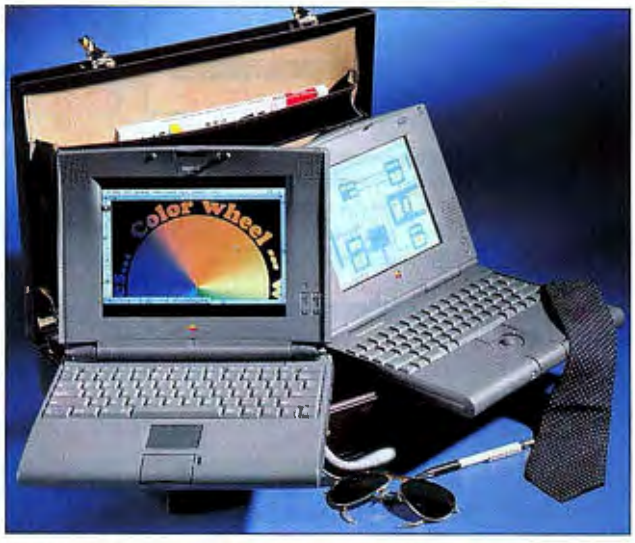
TOM THOMPSON

When Apple introduced its Macintosh notebook computers, the PowerBooks, in 1991, it set new standards for what such portable systems should do. The design was termed "all-in-one" because these Macs were literally self-contained desktop systems. For example, they had a high-density floppy drive that could read and write PC disks, built-in networking hardware and software, and a slot for an optional internal modem. However, for the past few years, most of the improvements to the design have been incremental, such as faster 68030 processors, an external video port, and color displays. The all-in-one design was becoming long in the tooth.

With the introduction of the 500 series PowerBooks this May, Apple not only brought the all-in-one PowerBook design up-to-date but also set new standards. The PowerBooks now use the high-performance 68LC040 processor. Battery life has been beefed up by the addition of a second battery compartment. A new solid-state trackpad makes the computer easier to use. There's substantial capacity for memory and large hard drives, and an Ethernet port boosts the system's network capabilities. An optional PCMCIA Expansion Module fits in one of the battery compartments and lets you expand the PowerBook's functions using third-party PCMCIA cards. What hasn't changed is that the computer still weighs 7.3 pounds, even with a second battery. (It weighs a pound less with one battery.) These capabilities make the 500 series PowerBook a powerful desktop computer in its own right, and therefore a superb notebook computer.

The 500 series PowerBooks come in two families. The low-cost 520 models run at 50 MHz, and the high-performance 540 models operate at 66 MHz. These speeds represent just the processor clock rate; the rest of the system runs at half the processor's speed—25 MHz and 33 MHz, respectively. The 520 models sport passive-matrix screens; the 540 models use active-matrix technology.

In addition to the all-in-one systems, there is a new PowerBook Duo, the 280, that uses a 66-MHz 68LC040 processor. I'll make only a few references to the Duo, since it's primarily a Duo 270c design with a new processor. I'll focus primarily on the new features in the 500 series PowerBooks.



The 500 series PowerBooks (left) provide a much-needed overhaul for the all-in-one design. Improvements include storage and RAM capacity, built-in Ethernet support, an innovative trackpad, stereo sound, a PCMCIA Expansion Module, and a 68040 processor upgradable to PowerPC. The Duo 280 systems (right) bring the might of the 68040 processor to the PowerBook Duo line.

What's New Outside

I received a PowerBook 540c and a Duo 280c for evaluation. Both use the active-matrix color display. The 540c came with 4 MB of RAM and a 240-MB hard drive, and the Duo had 12 MB of RAM and a 320-MB hard drive.

Some of the 540c's new features were immediately obvious. Flipping the back panel open revealed an Ethernet port that uses the 14-pin AUI (Apple Auxiliary Unit Interface) connector. This connector lets you use your choice of thick, thin, or 10Base-T Ethernet modules to connect the 540c to the office network. There's the usual complement of ports: the RS-422 serial port (which does double duty as the LocalTalk network connection), stereo sound input and output jacks, an ADB (Apple Desktop Bus) port, an external video port (for using a second monitor), and an HDI-30 SCSI port.

The power switch is no longer awkwardly placed among these ports, thank goodness. When you open the PowerBook's lid, you spot the power switch just above the keyboard, a location that makes the computer easy to switch on.

Along the top of the full-size keyboard are 12 function keys and the Escape key (which in previous PowerBook designs was in an awkward position by the space bar). Some of the keyboard layout was borrowed from the PowerBook Duo, and it's nice to see it on the all-in-one design. Another cool feature swiped from the Duo design puts the computer in sleep mode when you close its lid. An LED in the lid blinks when the computer is asleep.

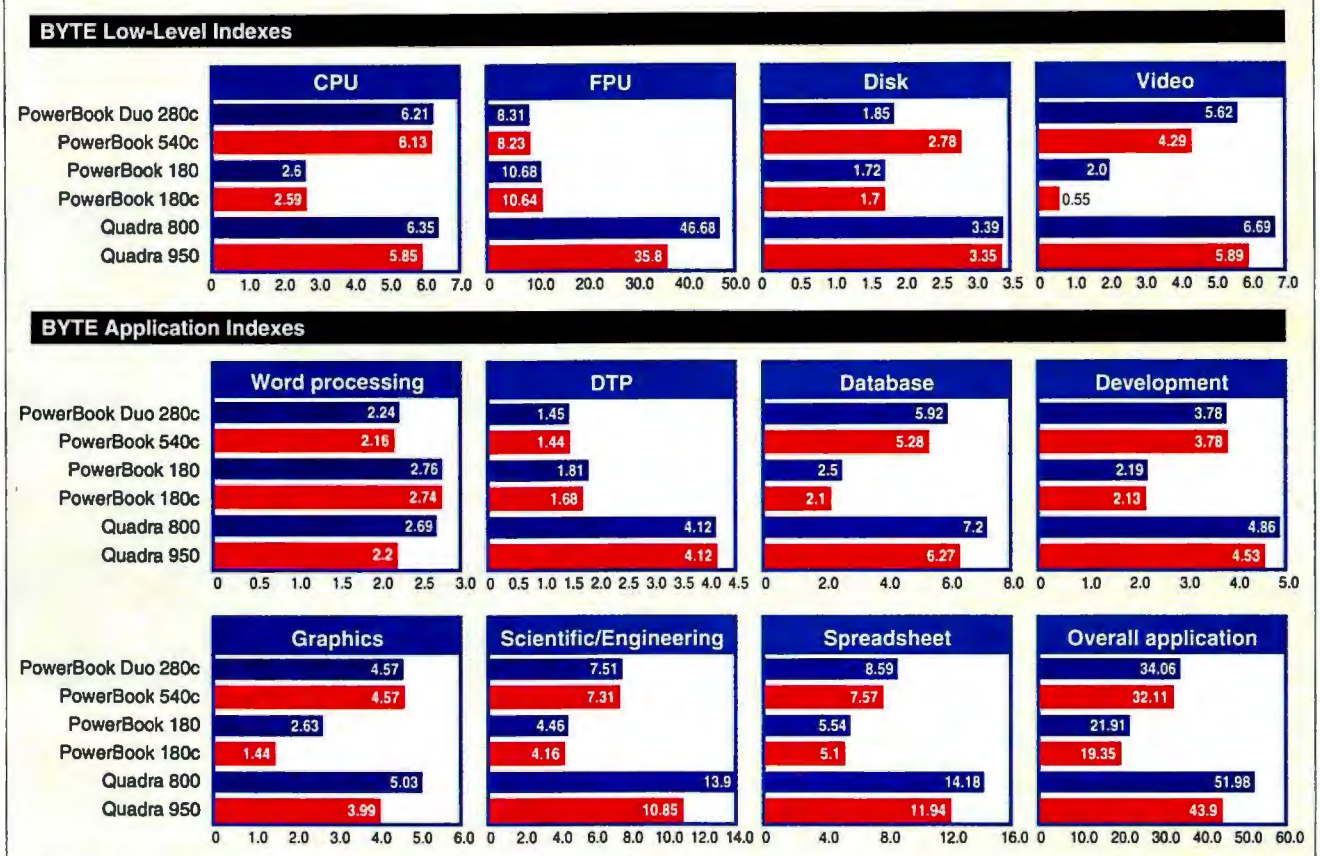
The active-matrix color display has a 640- by 480-pixel screen. At 9.5 inches diagonal, this display is slightly larger than the 9-inch diagonal on previous color PowerBooks. The Duo 280c still uses an 8.4-inch-diagonal screen.

The 540c's screen is flanked by two small speakers that supply stereo sound. With the new design, you can buy a lower-cost PowerBook 520 with a passive-matrix screen and upgrade it to the 540's active-matrix display later by just swapping the PowerBook lid. However, at $2199, this upgrade isn't cheap.

The biggest visible difference in the new machine is a flat plate that replaces the computer's trackball. This is Apple's trackpad, which uses capacitance sensing to accurately detect and track the motion of a fingertip on its surface (see "Apple, Cirque Unveil Trackball Alternative," June BYTE, page 33). Although the trackpad can sense pressure, Apple opted instead to use a single mouse button for clicking on objects.

Based on my use of the trackpad, it works much better than a trackball for text selection and editing, and it's better suited for drawing. Also, with no moving parts, it's less likely to fail than a trackball. With

PowerBook Performance



Results are indexed. For each individual test, a Mac Classic II = 1.0; for the Overall Application Index, a Classic II = 7.0. The Classic II used 512- by 342-pixel screens; the Quadras and the PowerBook 180c, 280c, and 540c used 640- by 480-pixel screens; the PowerBook 180 used a 640- by 400-pixel screen. For the 68040-based Macs, caches were disabled only for Word Processing tests, and PageMaker 4.2 was used for DTP tests.

The heart of the 540c is a Motorola 68LC040 clocked at 66 MHz. Because the rest of the system is clocked at 33 MHz, overall system performance should be around that of a 33-MHz system, except when portions of an application's code reside in the processor caches. Since the 68LC040 lacks an FPU, floating-point math performance suffers. These conclusions are confirmed by the BYTE low-level and application benchmarks: The 540c's performance was nearly equal to that of a 33-MHz Quadra 950 except in floating-point performance. Similar results were obtained on the Duo 280c.

an active-matrix display, controlling the pointer with the trackpad is quick and precise. However, on a PowerBook 520 with a passive-matrix display, where the pointer disappears or ghosts when it's moved, steering with the trackpad becomes tricky.

Each side of the PowerBook 540c contains a bay for an NiMH (nickel-metal-hydride) battery. (Previous all-in-one designs used nickel-cadmium batteries.) A new power charger cranks out 40 W to charge both batteries if the computer is idle, or one at a time if it's in use. Power is drawn from one battery and then the other, so you can swap a fresh battery for a dead one without turning the PowerBook off.

Apple estimates that the PowerBook 540c can operate on battery power for up to 7 hours, and the Duo 280c for 2 to 4 hours. The BYTE battery-life tests show that with two fully charged batteries, the PowerBook 540c can operate for about 6 hours, and the Duo 280c for about 3½ hours. In personal tests going about my office work, I obtained about 3 to 4 hours' worth of battery life from the 540c—a definite improvement in battery life, especially with a 68040 processor in the system.

What's New Inside

The heart of the 540c is a Motorola 68LC040 clocked at 66 MHz. Because the rest of the system is clocked at 33 MHz, overall system performance should be around that of a 33-MHz system, except in those cases where portions of an application's code reside in the processor caches. Also, since the 68LC040 lacks an FPU, you can expect floating-point math performance to suffer. These expectations are confirmed by the BYTE low-level and application benchmarks: The 540c's performance was about that of a 33-MHz Quadra 950 except in floating-point performance (see the graph). Similar results were obtained on the Duo 280c.

The 500 series PowerBooks use 2-MB ROMs that contain the Mac Toolbox, plus code that implements power management for the 68040 processor. The computers start with a base 4 MB of 80-nanosecond RAM, and a RAM expansion slot can expand RAM to a total of 36 MB (up to 40 MB on the Duo 280c). The RAM signals and timings for the 500 series PowerBooks differ from those of other PowerBooks, so you can't use existing memory expansion cards. The processor, ROMs, and base memory are located on a removable secondary logic board, which can be replaced with a PowerPC upgrade board. No price or details on the PowerPC upgrade were available at press time. *continued*

The frame buffer for the 540c's display now uses 512 KB of dual-ported VRAM (video RAM), rather than DRAM as in older all-in-one color displays. This makes for faster screen redrawing, a fact borne out by the BYTE low-level benchmarks. Timing for the slow graphics test, which was 13 seconds or more with previous color PowerBooks, plummeted to several seconds. Screen updates and document-scrolling operations were faster, making the system's response noticeably snappier.

A new Display Manager lets you change the screen resolution on the fly from 640 by 480 pixels to 640 by 400 pixels. The smaller screen size enables the surplus VRAM to be used for larger pixels: The screen then shows 16-bit color (actually 24,000 colors, due to limitations in the LCD panel). This makes the PowerBook 540c and Duo 280c suitable for viewing digital video QuickTime clips or scanned images. The color capabilities of this display at this resolution, combined with improved audio (16-bit CD-quality stereo), makes the PowerBook 540c an excellent multimedia computer.

Inside the left battery compartment on the 540c is a 90-pin PDS (Processor Direct Slot) connector, so instead of a battery, you can plug an expansion board into this bay. PDS is a bit of a misnomer here, since the slot is not directly connected to the processor bus. Instead, an interface chip provides 68030 processor signals and timings, making the slot compatible with the Mac LC slot. However, this slot has different power requirements, which must meet the power budget of a notebook computer. Also, the I/O bus that the PDS connector sits on is only 16 bits wide, which constrains the use of any high-throughput peripherals. Whether third-party vendors will make hardware for this slot remains to be seen.

The more interesting use of this bay and the PDS is Apple's PCMCIA Expansion Module. It accepts two stacked Type II PCMCIA slots or one Type III slot. The module shipped in July and costs under $200. You have to switch the PowerBook off to plug the module into the battery bay, but once it's installed the system software allows "hot docking" of PCMCIA cards. For example, you can insert a Type III card with a hard drive into the module, and an icon of the drive will appear on the Mac Desktop. You can drag files to the card and then eject the card by dragging the icon to the Trashcan. No motors are required for this: A nitinol (nickel-titanium alloy) wire contracts and ejects the card a good 20 millimeters when current passes through it. The Expansion Module will let you add wireless LAN, cellular modem, flash memory storage, and other mobile options as these cards appear on the market.

Timely Improvement

The Duo 280 systems bring the might of the 68040 processor to the PowerBook Duo line. The 500 series PowerBooks provide a much-needed overhaul for the all-in-one design. Improvements include the function keys, the built-in Ethernet support, and the 68040 processor.

The performance, storage capacity, and RAM expansion limits of these systems make them powerful yet portable knock-around desktop systems and superb notebook computers. However, the design also pushes the envelope with the innovative trackpad, the stereo sound system, and the PCMCIA Expansion Module. When various third-party wireless cards arrive, they should help make the 500 series PowerBook the ideal mobile computer. Finally, this PowerBook has the future built in with a planned PowerPC upgrade. It's safe to say that Apple has once again defined the standards for notebook computers—standards that the competition will be hard pressed to duplicate. ■

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About the Products

PowerBook 520 (with 50-/25-MHz 68LC040, 4 MB RAM, 160-MB hard drive, and FSTN gray-scale display).....$2269

PowerBook 520c (with 50-/25-MHz 68LC040, 4 MB RAM, 160-MB hard drive, and dual-scan color display).....$2899

PowerBook 540 (with 66-/33-MHz 68LC040, 4 MB RAM, 240-MB hard drive, and active-matrix gray-scale display).....$3159

PowerBook 540c (with 66-/33-MHz 68LC040, 4 MB RAM, 320-MB hard drive, and active-matrix color display).....$4839

PowerBook Duo 280 (with 66-/33-MHz 68LC040, 4 MB RAM, 240-MB hard drive, and active-matrix gray-scale display).....$2639

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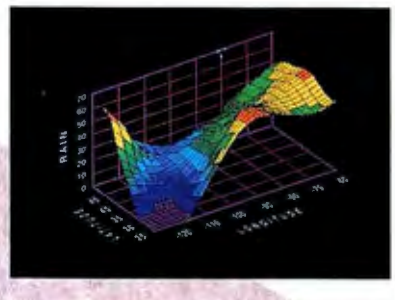
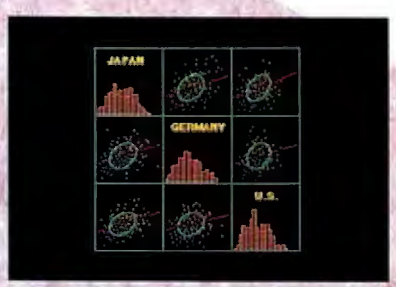
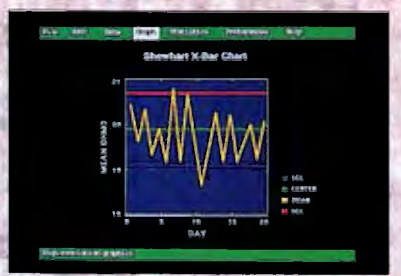
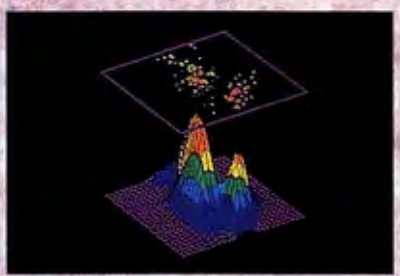
SYSTAT 6.0 for DOS adds several new analyses to the SYSTAT package: ■ design of experiment procedures for quality control, including D-optimal, Taguchi, Plackett-Burman, Box-Behnken, and other designs ■ matrix algebra commands and functions ■ RAMONA, a powerful path analysis procedure.









New! QuickGraphs & 3-D Charts

SYSTAT 6.0 for DOS provides QuickGraphs, plots that are automatically generated with each analysis. New 3-D bar, pie and ribbon charts give you three dynamic ways to present your analysis results. The package now also supplies Shewhart, Pareto, and CUSUM charts for quality control. Other SYSTAT graphs include: ■ box plots ■ density plots ■ function plots ■ icon plots ■ probability plots ■ quantile plots ■ stem-and-leaf plots ■ 2-D and 3-D scatterplots ■ maps with geographic projections ■ contour plots.

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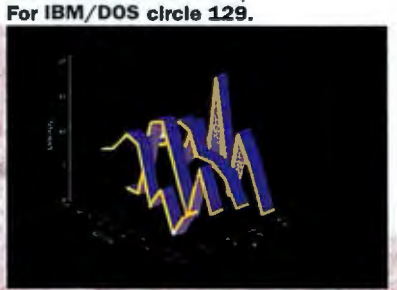

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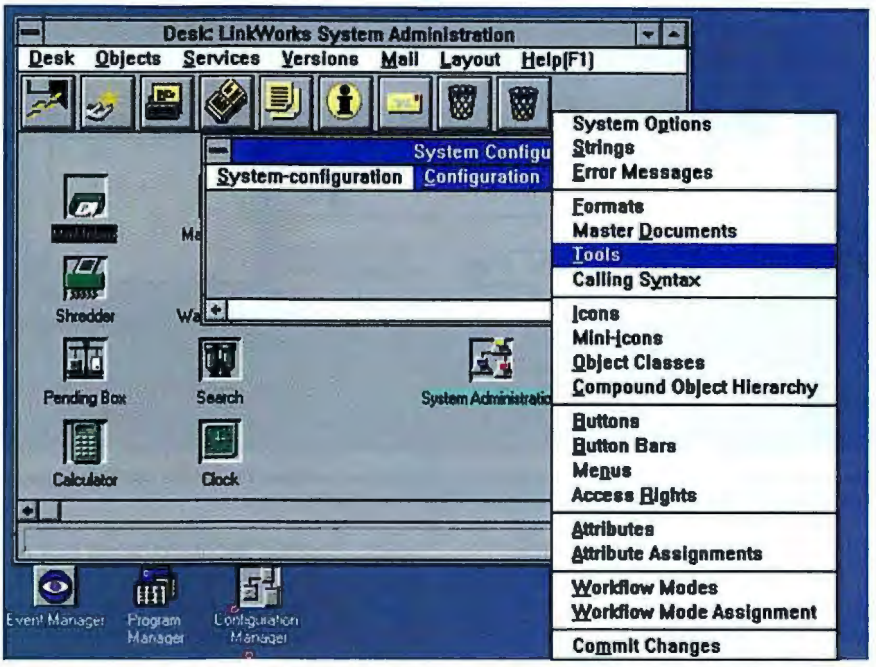
*SYSTAT for DOS rated highest in overall evaluation by ***Software Digest Ratings Report, Vol. 8, No. 5,*** May, 1991. Software Digest is a registered trademark of NSTL, Inc.

Blazing the Path

DEC's LinkWorks is an open design for multiplatform work flow

BEN SMITH

The promise of groupware is greater productivity through collaboration. Few products embody this ideal better than DEC's LinkWorks, a multiplatform (Unix, OpenVMS, PC, and Macintosh) work-flow system. If groups in your organization collaborate on the creation and development of documents, images, or data, LinkWorks delivers an effective set of tools for automating your most complex work-flow tasks.



The entire structure of LinkWorks hides within two deceptively simple-looking objects on the administrator's Desk window: the System Configuration and System Administration desks. The administration and configuration menus are poorly designed.

The Local View

On a local desktop, LinkWorks appears as a window in your graphical environment, with each icon representing an object. LinkWorks objects can be just about anything, but they fall into one of three general classes: *information* (text or data), *containers* (e.g., folders), or *actions*.

The information objects are typically files associated with application programs—for example, an Excel spreadsheet, an Ami Pro document, or a bit-map image file. Unlike in the basic file system, LinkWorks information objects (analogous to files) and containers (analogous to subdirectories) have wrappers that contain far more information than just owner, creation date, and permissions. They have full text names, like those on the Mac; associated icons; application programs; descriptive text; an extensible list of permissions; and even work-flow paths.

Some of the actions show up as toolbar buttons; others are accessible only from drop-down menus. Click on an object icon in the window, and the icon launches an action or application that is appropriate for the file type on your workstation. Drag an object icon to the mail outbox icon, and your mail is sent automatically.

Despite its rich structure, the LinkWorks environment is not intimidating. You'll find the usual elements of any GUI file manager with just a few additions, including an In box, an Out box, and a Pending box. These containers are crucial to the work flow; you send and receive your work through them. The Pending box is for the inevitable projects that are held up for one reason or another.

If an object doesn't have a default routing path, you can still route or share it. You choose points in a routing path and recipients for mail by selecting from an organizational chart. You can share the object by mailing a link to other users, thereby creating a collaborative work environment. LinkWorks includes built-in E-mail that can gateway with other, dedicated mail systems.

Whenever you create a new object, you need to specify what kind of object you want, give it a name, and designate the access rights for it. For example, you might create an Address Book object with the name Local Contractors and give it For Information access rights. A For Information designation gives other recipients read-only access to the object; only you can modify it.

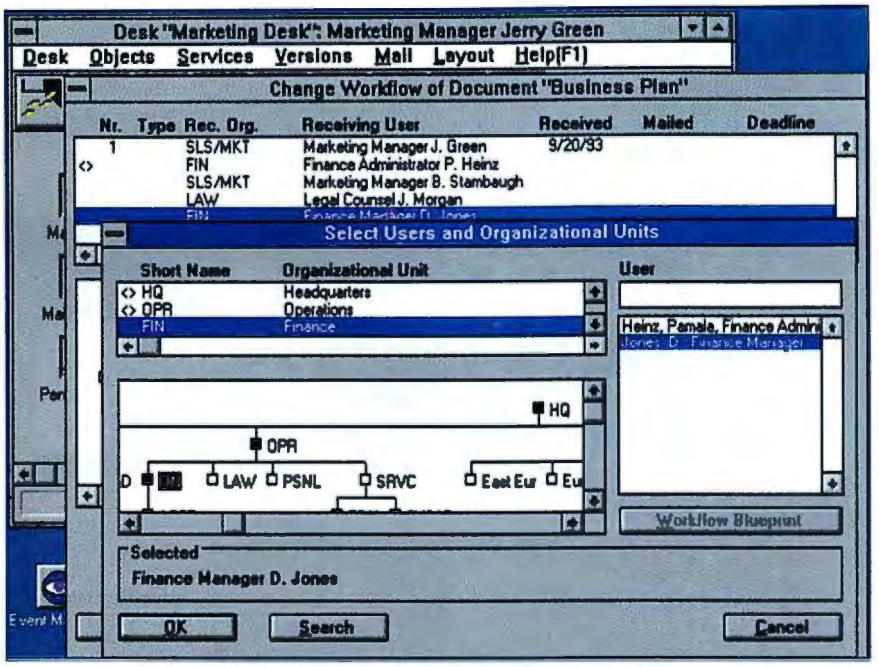
You can use any object as a template by placing it in the template box. Dragging an object from the template box back out onto the Desk window copies the object but, unfortunately, without copying any of its LinkWorks attributes.

The object types that are on your system and the associated application programs for each workstation are defined by the LinkWorks administrator. In fact, just about everything about LinkWorks can be customized by the administrator.

Configuration and Administration

The true nature of LinkWorks is apparent only to the administrator. LinkWorks' paradigm is that of an object-oriented database. LinkWorks objects are very much what a programmer would expect, with base classes, subclasses, inheritance, and instantiation. The entire structure of LinkWorks hides within two deceptively simple-looking objects on the administrator's Desk window: the System Configuration and System Administration desks.

From the LinkWorks Configuration desk, you define object classes and subclasses that you'll be using in your operations, and you associate tools (i.e., application programs) with data objects for each different user environment. You can also define menus and workspaces for different classes of users from the Configuration desk. It is the most complex and the most static of the two administrative work areas. If you've worked with object-oriented systems before, you will find LinkWorks'



The organizational chart is an intuitive way of pinpointing stages in the work flow. The (hidden) work-flow diagram follows the same model. Unfortunately, you cannot resize the chart window.

Object Class browser very familiar.

From the System Administration desk, you create your organizational chart (it even looks like a tree-structure organizational chart), set user accounts, and administer workstations and working environments. You also define the keyword list from the administration area. The keyword list works like a miniature document management system by organizing and retrieving documents and other objects. Many of the objects that you need will probably have a predictable work flow. The administrator can define work-flow blueprints and attach these blueprints to objects.

The Ins and Outs of Work Flow

Whether you, as an administrator, define a work-flow blueprint for an object class or, as a user, build a work flow for an individual object, the process of defining the flow is the same: You select the work-flow stages from the organizational chart. As you make your selections, you are building a graphical design of the work-flow process. Dragging and dropping stages creates the paths of work flow. A simple path would resemble a list with lines connecting the positions that the object passes through during its processing.

In addition, you can define *branches*, points when the object gets simultaneously distributed to several recipients. You specify what you consider "processing" at any stage. It might be as simple as the recipient opening the object when it is received, or it might require one of the three levels of signature: Initial, Approve, and Sign off. The signatures require password verification.

Any path or branch in work flow can be conditional—that is, dependent on the status of any of the object's attributes after processing at the source stage. For example, you might require that the recipient modify the document or image, thereby changing the date stamp. In that case, the work-flow test would check for a new date stamp and would allow the file to be passed on only after the date stamp had been changed.

Any stage in the work flow can be associated with a *mode*—an indication of what the recipient should do with the object (e.g., "For comment"). Any stage can also have a deadline and a more verbose description. In the current version of LinkWorks, these object attributes are little more than text fields, but in the next release some of these fields will be able to trigger actions.

Not all organizations need work flow. If your organization's operation (or a particular class of object) is more collaborative than state- and stage-oriented, you may find that LinkWorks' shared objects still fit your needs. A shared object can exist on several desks at once. Since LinkWorks maintains all its objects on the server, simple shared objects can be modified by only one person at a time, whereas compound objects (e.g., file folders and boxes) can only be added to or deleted from. You can "register an interest" in a shared object, prompting LinkWorks to notify you of any changes to the object.

Objects and the Database

Despite the object-oriented nature of LinkWorks, the infrastructure is an RDBMS (relational database management system). You can select your database choice from a supported list: Ingres, Oracle, Informix, or DEC Rdb.

The RDBMS points to where the objects are stored on the server. The objects reside in their native format in subdirectories deep in the LinkWorks directory tree. The only protection from curious eyes is the server's file-access control. Since the server can be an OSF/1, OpenVMS, Ultrix, SCO Unix, HP PA-RISC/HP-UX, or IBM RS/6000 running AIX, the security can be anywhere from pretty good to very good, provided that the server is well protected from attack. Only the superuser and the RDBMS have read permission on the files.

Because LinkWorks manages all kinds of objects—binary images, sound and motion files, and compound documents, as well as simple text documents—the version control consists of complete copies of each version of a file. This design makes it nearly impossible to corrupt an earlier version of a file when retrieving it, but it has the distinct disadvantage of consuming huge amounts of storage if your objects and documents tend to be large.

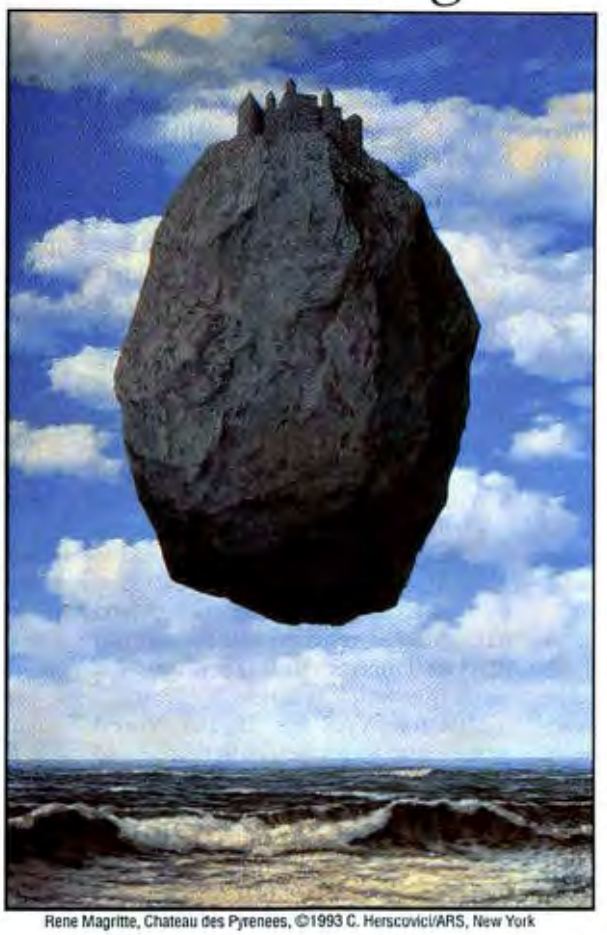
LinkWorks has no utilities for automatically archiving older versions, so it is the user's responsibility to delete older versions of documents. You could solve this problem by backing up the system with software that supports file migration, a feature that moves dated files to off-line storage.

An Open Architecture

The controlled fashion in which LinkWorks maintains all its files and objects might suggest that it is not an open architecture. This is not the case; it is as open as you wish to make it. LinkWorks has provisions for importing from and exporting to foreign file systems and mail systems.

On the other hand, you can turn off these features and require that all documents and other objects within the LinkWorks system be created, revised, and retained only on the LinkWorks server—even if programs external to the server are modifying the files. The obvious loophole is

Outstanding.



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that most application programs let you make copies of documents to more than one storage device. The only sure stopper is to deny client machines any write permissions except through LinkWorks.

Using a common SQL RDBMS system as the infrastructure lets you extend LinkWorks by writing your own SQL operations and reports. For instance, the operating system's scheduled batch processing could generate a status report of all projects that are in the queue. Since the SQL source statements that make LinkWorks run reside on the system, you can hack copies of them to process your own files automatically.

The RDBMS infrastructure also makes it easy to scale up to a LinkWorks site. You aren't limited to a single LinkWorks database (internally referred to as a *cell*) or server. A single LinkWorks administrator can manage several cells from the same interface. The one extension that you cannot make is out over a store-and-forward WAN (wide-area network) stream. LinkWorks needs TCP/IP.

On the downside of the RDBMS design, the object-oriented model doesn't map efficiently to a relational model. Any operation that changes the hierarchical structure requires updating the database structure, not just the data. LinkWorks locks you out of doing any other operations until these are complete.

Modeling BYTE

I evaluated LinkWorks using a DECstation 3000 (64 MB of RAM and 2 GB of disk space) running OSF/1 as the server. As client machines, I had four 486 PCs with 8 MB of RAM (the minimum memory recommended for this application) and a Mac Quadra 950. Engineers from DEC installed the software, including the RDBMS and the TCP/IP stacks in the PCs and the Mac.

The installation was not trivial: It took three worker days. The most difficult part of the task was installing a second network protocol stack in each of the client computers. The DEC engineers also configured LinkWorks for each of the client machines, associating application programs with object classes on each client.

After an afternoon of training, I was on my own. I started simple: I designed a BYTE logo for the log-in window. Once I had established a feel for the menus and general operations, I was ready to begin a model of BYTE's editorial process.

At first, I became disoriented in organizational chart design. I didn't understand how to optimally model our organization. I found that it was important to group users together in departments or workgroups. A group of people, any member of which could complete a specified task, often represents a work-flow stage. It took three tries before I had a decent model of the organization and an article (a compound object that I defined from the Configuration desk).

I spent roughly 40 hours developing this working configuration, but I still had to develop work-flow blueprints. Different kinds of articles follow different paths and have different requirements for text and graphics. Properties such as deadlines also differ from article to article.

DEC (or a VAR that sells LinkWorks) will be glad to do the configuration and administration for you, for a fee. If you don't have technical people in-house or if your technical staff doesn't have the time to manage yet another system, using DEC or a VAR is your best bet. All in all, the configuration and administration were complex and tedious, not because of the complexity of LinkWorks, but because modeling work flow is complex.

The Long and Short of It

Shrink-wrapped work-flow systems have been slow in coming to market. There are hundreds (if not thousands) of custom-built systems—in-house, proprietary, and requiring large dedicated staffs to maintain the programs and systems they run on. Most work-flow packages that you find at groupware trade shows are limited in one way or another. Either they run in only a single environment (e.g., Reach Software's WorkMan works only in the PC LAN, MS-DOS/Windows environment), or they only move documents of a limited type. Some are only tracking systems, independent of the documents themselves. DEC's LinkWorks supports clients on the three most common corporate computing environments—Unix workstations, PCs (albeit running Windows), and Macintoshes—and at the same time contains, controls, and routes data objects (and collections) of any type.

About the Product

LinkWorks.....$299 per client or server
Digital Equipment Corp.
LinkWorks Marketing Group
110 Spitbrook Rd.
Nashua, NH 03062
(603) 881-6146
fax: (603) 881-2550
Circle 1076 on Inquiry Card.

Of course, there's always room for improvement. The most obvious, and most difficult, improvement would be enhancing performance by moving from an RDBMS to an object-oriented database. But this move would result in a considerable loss of openness, and the net benefit is questionable.

The other improvements that I would like to see are in the details. For example, LinkWorks doesn't fire off a notice when a deadline is approaching or past due. If you have the same user in a work flow more than once, the path becomes confused and looping. There are far too many verify-process notifiers; for that matter, far too many windows are necessary to do many operations. The menus (particularly the system configuration and administration menus) are poorly organized and almost primitive in design.

It is a long list of little details. You can handle some of them by simply reconfiguring LinkWorks to your own tastes, but some will require in-depth, source code changes. For example, LinkWorks requires TCP/IP or DECnet. It will not run on an IPX/SPX (NetWare) or AppleTalk/EtherTalk network. Improvements in these and many other areas are in the works.

To the user, LinkWorks is deceptively simple. To the manager, it is deceptively inexpensive, costing just $299 per client or server (not including the DBMS license and potentially high training costs). You can even save on that by $30 if you don't need printed documentation for any of the licenses.

LinkWorks is extremely complex, but then so is managing work flow manually. Before you even consider installing an automated work-flow system, spend some time making sure you understand the various forms of work flow in your operations. If your organization can be diagramed in a few boxes, you probably don't even need LinkWorks.

If your organization has groups that need to collaborate on the development of documents, images, or data, or if your work flow is complex enough that you need to automate, track, and control it, then LinkWorks is as good as it gets. But if you don't have the in-house expertise to study operations and to model work flow using LinkWorks' object-oriented paradigm, you'd better budget some serious consulting money. ■

Ben Smith is a testing editor for the BYTE Lab. You can reach him on the Internet at ben@bytepb.byte.com or on BIX as "bensmith."

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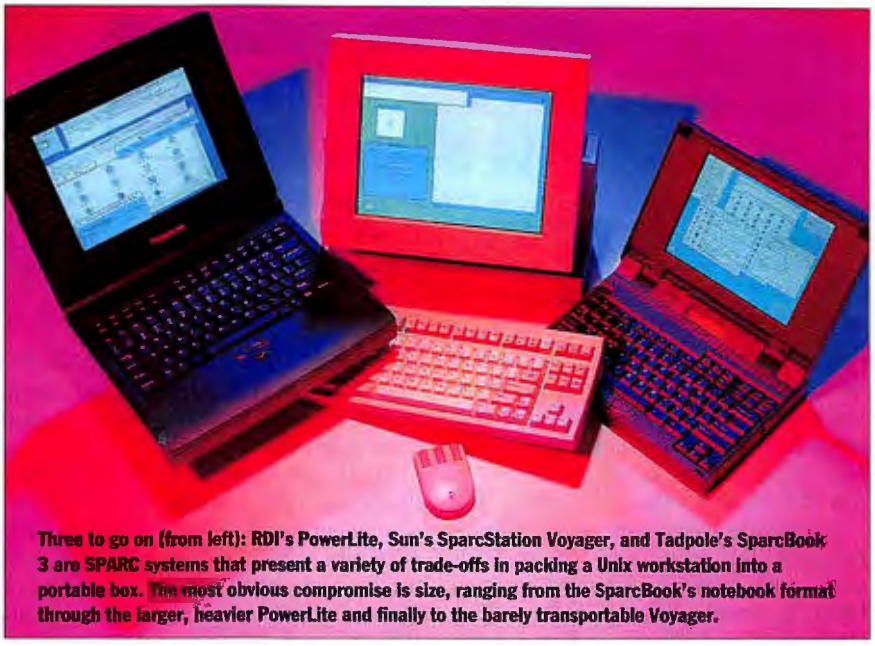
SPARC Workstations to Go

SPARC portables from RDI, Sun, and Tadpole make workstation computing more or less mobile

STEVE APIKI



Three to go on (from left): RDI's PowerLite, Sun's SparcStation Voyager, and Tadpole's SparcBook 3 are SPARC systems that present a variety of trade-offs in packing a Unix workstation into a portable box. The most obvious compromise is size, ranging from the SparcBook's notebook format through the larger, heavier PowerLite and finally to the barely transportable Voyager.

For the most part, technical workstations and mobile computers live at opposite ends of the computing universe. Technical workstations have fast and power-hungry processors, enough storage to handle a full Unix installation with room to spare, high-resolution displays, and built-in networking capability. Mobile computers, on the other hand, must be small, light, and generally wimpy by workstation standards.

Bringing these two ends of the computing spectrum together into a mobile Unix workstation is no mean feat. Until Tadpole introduced its first SPARC notebook just over two years ago, practical portable Unix systems didn't exist. Technologies like the MicroSparc processor, color TFT (thin-film transistor) displays, and PCMCIA 2.0 have made portable Unix systems more practical. But even with these advances, putting a Unix workstation into a totable box is still a technical challenge that requires significant compromise between power and portability.

In this review, I evaluate three portable SPARC workstations: the RDI PowerLite, Sun SparcStation Voyager, and Tadpole SparcBook 3. All are capable workstations with at least a 50-MHz MicroSparc CPU, 32 MB of RAM, 340 MB of internal SCSI storage, a color TFT display, Solaris 1.1.1 or 2.3, and OpenWindows 3.0 or 3.3. And all include software to handle problems germane to mobile systems, such as rapidly reconfiguring between different network situations.

Ultimately, however, these are still transportable workstations, not portable systems with workstation power. They'll spare you from taking the SparcStation on your desk to a client site, but they won't replace a PowerBook or HP OmniBook for general mobile applications.

SPARC Performance

The PowerLite and SparcBook are more portable than the Voyager—they each fit in a clamshell case, while the Voyager is really a marginally transportable, compact desktop system that can run off a battery. The Voyager, therefore, makes fewer concessions to size and power requirements.

For example, the Voyager has a 60-MHz MicroSparc II processor. With its 8-KB data cache and 16-KB instruction cache, this CPU has a SPECint92 rating of 46.9 and a SPECfp92 rating of 36.9. The 50-MHz MicroSparc used in the other two portables has 2 KB of cache for data and 4 KB for instructions. It provides a SPECint92 rating of 26.4 and a SPECfp92 rating of 21.0. In terms of current SPARC desktops, these CPU ratings make the PowerLite and SparcBook equivalent to a SparcClassic, and the Voyager somewhat slower than a SparcStation 5.

BYTE's Unix benchmark tests, which measure operating-system and disk-subsystem performance as well as raw CPU power, bear out these ratings (see the benchmark graph). On synthetic processor tests like the Dhrystone 2, the Voyager was more than twice as fast as the other two, whereas on the file copy test (a measurement of disk performance) the three systems were close, with the PowerLite coming out on top. Note that the PowerLite had somewhat more memory than the other two systems (48 MB versus 32 MB) and was running Solaris 1.1.1 (its standard configuration) while the Voyager and SparcBook ran Solaris 2.3. The SparcBook comes with either Solaris 1.1.1 or 2.3 for the same price.

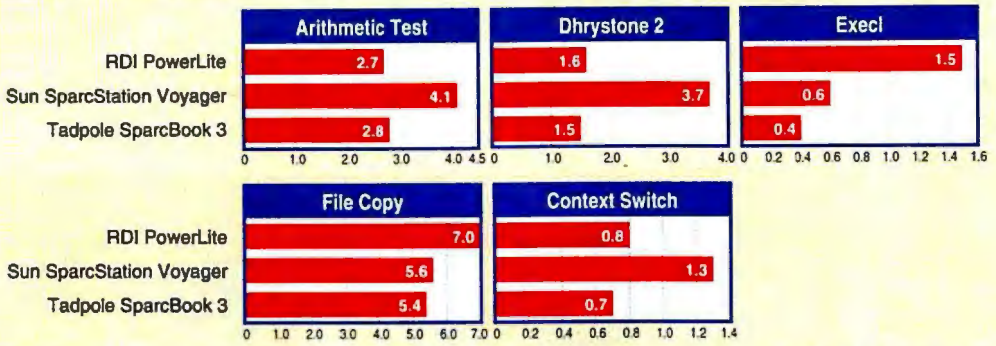
With all caveats in place, the PowerLite and SparcBook come in with roughly equivalent performance, about twice the speed of a SparcStation 1+ (the benchmark baseline). The Voyager is about 50 percent faster than the other two. In day-to-day use, I found the Voyager considerably faster than either the PowerLite or the SparcBook, which after all are no faster than the underpowered SparcClassic. None is as fast as IBM's PowerPC 601–based AIX notebook (a Tadpole design), tested by BYTE in July (see "PowerPC Hits the Road"), which came in around 20 percent faster than the Voyager.

Mobile Networking

One less obvious but critical point of comparison between portable Unix systems is their ability to integrate into different network environments quickly and easily. Each of these machines provides some facility to make mobile networking practical, ranging in sophistication from the PowerLite's fully automated AutoNet facility to a few Solaris configuration hints provided with the Voyager's documentation.

RDI provides two programs, AutoNet and Join, which together can automatically

Unix Benchmark Results



As expected, the Voyager's 60-MHz MicroSparc II CPU puts it ahead of the other two portables on BYTE's Unix benchmarks. Benchmarks are indexed against a Sun SparcStation 1+; for each test, the SparcStation 1+ = 1. All these machines are somewhat slower than IBM's 50-MHz PowerPC 601 notebook (reviewed in the July issue). Note that the PowerLite ran Solaris 1.1.1, while the other machines ran Solaris 2.3 (standard configurations); differences in the Execl benchmark are related more to operating-system than hardware performance.

configure the PowerLite for networked operation with a variety of networks or for stand-alone use. Join is hosted on each network and can provide the PowerLite (a Join client) with an IP address for use on that network at configuration time.

AutoNet is a detection and configuration utility that selects a host name, IP address, and set of network configuration files (e.g., a hosts file and a printcap equivalent) based on the network it detects when it's run (usually at start-up). AutoNet can use Join information to identify the network, or it can gather what information it can from passing network packets. You can use both services on NIS networks or on networks without a name service. With or without Join, AutoNet is a great utility for moving between multiplenetworks.

The Voyager has no automated network configuration utility. Instead, it relies on Solaris 2.x's ability to switch between naming services to let you run satisfactorily either stand-alone or connected to an NIS network. However, if you switch between multiple networks, you will still need to go through quite a bit of configuring each time you connect. Sun does provide Roam, an application for reading and responding to E-mail while disconnected from your home network.

While not as automatic as AutoNet, Tadpole's NCE (Nomadic Computing Environment) supplies some network configuration capability. Through NCE, you can change your IP address on the fly or choose which hosts database to use, although again you must do this by hand at each connection. NCE also supports remote mail processing through POP servers.

Screen Considerations

All the systems I tested included an active-matrix color display. The best screen was the SparcStation Voyager's, a gorgeous 12-inch 1024- by 768-pixel panel with excellent contrast and clarity. The difference in size between the 12-inch panel on the Voyager and the next-largest (10.4-inch) display on the RDI PowerLite makes a significant difference in usability (and contributed largely to the Voyager's higher price). The Voyager can also use an external Sun-compatible monitor with 1152- by 900-pixel resolution.

Both the SparcBook and the PowerLite sport 640- by 480-pixel displays with 8-bit color depth. RDI also offers a 1024- by 768-pixel color LCD option ($6000) for the PowerLite. The standard PowerLite display offers greater color range than the SparcBook's, with a 262,000-color palette versus the SparcBook's 4096 colors. Since 640 by 480 pixels is too small to reasonably support a windowing system, both systems offer a virtual screen display that is greater than the physical size of the screen.

The SparcBook's 2-MB video buffer allows it to support up to 1280- by 1024-pixel displays. With the 640- by 480-pixel LCD panel, you can define a virtual frame buffer of up to 1280 by 1024 pixels in size. You can then pan with the mouse cursor along the display or zoom in and out as needed. It takes some getting used to, but the panning and zooming is fast, and the simulated 1280- by 1024-pixel display is reasonable for getting a quick overview of the desktop. Compared to the PowerLite, the SparcBook exploits its limited display resolution much more capably.

The SparcBook also provides a virtual-desktop utility for switching between workspace screens. The PowerLite, which lacks the other display features of the SparcBook, provides a similar software utility that lets you pan between virtual desktop panels. Both the PowerLite and the SparcBook support external VGA, SVGA, and Sun displays, and 640- by 480-pixel simultaneous internal and external displays.

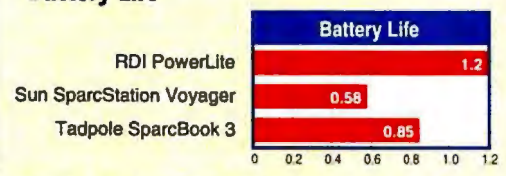
RDI PowerLite

The PowerLite is too big and bulky to make a comfortable laptop, but it could make an excellent transportable desktop replacement with the addition of better display support. Unfortunately, the 640- by 480-pixel display just doesn't work in this capacity; if you can afford a $6000 premium, the upgrade to a 1024- by 768-pixel panel is a good idea.

The PowerLite is more self-contained than the SparcBook, with much more room for expansion, a better keyboard, and a nice integrated trackball. With support for two 3½-inch SCSI drives (three if you remove the floppy drive) and space for a PCMCIA Type III device, the PowerLite can handle up to 1 GB of internal storage. RDI also offers an optional expansion unit, called the PXU, that clips onto the bottom of the PowerLite (increasing its height by about 1.5 inches) and supplies two more drive bays and two SBus slots.

The PowerLite's battery life is the best of the three systems tested (see the battery-

Battery Life



Results are in hours. The PowerLite is the best choice for running without AC power, as its 1.2-hour battery life (measured by BYTE's Thumper) attests. But compared to more common Intel-based notebook PCs, which average 2.5 hours of battery life on this test, all these systems are far behind. Battery life is limited enough, even for the PowerLite, that I wouldn't consider using any of these systems without access to AC power.

UNIX NOTEBOOK FEATURES

The SparcBook 3 and the PowerLite are smaller than the Voyager but somewhat less powerful. The Voyager's 60-MHz MicroSparc II makes it significantly faster than the two 50-MHz MicroSparc portables, and its larger, high-resolution screen makes it a real desktop replacement. However, the two smaller machines, both with a built-in modem and integrated pointing device, make better choices for heavy mobile use.

	RDI POWERLITE	SUN SPARCSTATION VOYAGER	TADPOLE SPARCBOOK 3
Base price[1]	$9995	$14,995	$10,950
Price as tested	$12,785	$16,320	$13,700
Processor	MicroSparc	MicroSparc II	MicroSparc
Clock speed	50 MHz	60 MHz	50 MHz
RAM (as tested, MB)	48	32	32
Maximum RAM supported (MB)	80	80	64
Internal video	10.4-inch 640- × 480-pixel color TFT	12-inch 1024- × 768-pixel color TFT	9.4-inch 640- × 480-pixel color TFT
Max. external resolution (pixels)	1152 × 900	1152 × 900	1280 × 1024
Storage (as tested)	Two 340-MB SCSI hard drives, 3½-inch floppy drive	340-MB SCSI hard drive, 3½-inch floppy drive	520-MB SCSI removable hard drive (no floppy drive)
Networking connections	10Base-T Ethernet, AUI Ethernet	10Base-T Ethernet	AUI Ethernet
Other ports	SCSI-2, serial (2), parallel, 8-bit audio	SCSI-2, serial, parallel, 16-bit audio, ISDN, infrared interface	SCSI-2, serial (2), parallel, 16-bit audio, ISDN
Other devices	Internal speaker and microphone, internal fax modem, integrated trackball	2 Type II PCMCIA slots, microphone, mouse	2 Type II PCMCIA (or 1 Type III), internal fax modem, integrated TrackPoint
Licensed software	Solaris 1.1.1, VWA	Solaris 2.3	Solaris 2.3, NCE
Dimensions (H × W × L, in.)	2.2 × 12.75 × 11.18	13 × 14 × 5	2.0 × 11.8 × 8.5
Weight with battery (lb.)	8.5	15.8[2]	6.5

[1] Base price configuration: 16 MB of RAM, 340-MB SCSI, internal graphics as noted

[2] Includes power supply, keyboard, and mouse

life graph), and its battery management software conducts an orderly shutdown as power expires. But at 1.2 hours, the battery life is still too short to do any real work away from an outlet. Also, the machine is too big and heavy to use for any length of time except on a real desk.

AutoNet and built-in 10Base-T and AUI (attachment unit interface) Ethernet interfaces make the PowerLite the easiest to move from network to network, and a built-in modem and dual serial ports make remote communication and connection to printers and other peripherals simple. One minor complaint: Contrary to convention, the system's serial port connectors are female, even though the PowerLite is a DTE (data terminal equipment) device.

Sun SparcStation Voyager

Stretching the definition of portable a bit, the Voyager comes in several pieces; weighs over 15 pounds with power supply, keyboard, and mouse; and doesn't fold down into a conveniently transportable shape. However, it can run off a battery, and the display and system unit are integrated into a nice, compact package. Sun offers a carrying case for the Voyager, but the unit is still considerably more fragile than the other two systems. The unit I tested was shipped in a hard-shell Zero case, a good idea if you intend to transport the Voyager on a regular basis.

Once you get the Voyager where it's going, it's hands-down the best system among those I tested in terms of performance and usability. It requires little desk space, and the power supply is built into the case so you don't have to hook up an external unit. The external keyboard and mouse are much better than the devices built into the PowerLite and SparcBook, and, as mentioned above, the screen is a capable CRT substitute.

To prolong battery life, Sun provides control over screen and hard drive power time-outs through a Power Manager tool. The Power Manager also displays remaining battery life while you're working. Tested battery life for the Voyager, however, was only 35 minutes—hardly worth bothering with.

Besides portability, the Voyager's weakest points are a single internal SCSI device (340 MB standard), requirement for 10Base-T Ethernet, and relatively poor support for moving from network to network.

About the Companies

RDI Computer Corp.
(PowerLite)
6696 Mesa Ridge Rd.,
Building A
San Diego, CA 92121
(619) 558-6985
fax: (619) 558-7061
Circle 1081 on Inquiry Card.

Sun Microsystems Computer Corp.
(SparcStation Voyager)
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300
fax: (415) 969-9131
Circle 1082 on Inquiry Card.

Tadpole Technology, Inc.
(SparcBook 3)
12012 Technology Blvd.
Austin, TX 78727
(512) 219-2200
fax: (512) 219-2222
Circle 1083 on Inquiry Card.

Tadpole SparcBook 3

The SparcBook 3 is the lightest, smallest, and most easily transported system, weighing in at just 6.5 pounds and featuring a lightweight, compact external power supply. Although screen resolution is only 640 by 480 pixels, the SparcBook makes good use of its virtual screen system to provide a usable display.

Tadpole put a lot of thought into the design of this mobile system, and it has a raft of useful features. The 2½-inch SCSI drive is removable, making the SparcBook shareable among multiple users. An LCD on the front panel shows battery life and other status information. NCE provides access to management and configuration features, and hot keys simplify save-and-resume and screen controls.

NCE's strongest asset is its save-resume capability. NCE can save the entire contents of memory to a reserved area on disk before shutdown and reload when you next power up the system, saving a great deal of time (and some power). To implement this feature, Tadpole had to make some driver and kernel modifications to the standard SunOS installation, and this can be disconcerting; however, the company says the suspend-resume capability has been in the field for years without problems.

continued

Reviews System

Battery life was under an hour, so a quick resume or save (as opposed to a 3-minute full boot or full shutdown) is doubly important. Tadpole ships the system with a spare battery, which doubles its road life, and offers an optional 4-pound external battery pack that should boost life considerably. (Tadpole claims 5 hours minimum.) Despite poor battery performance, the SparcBook's size made it the only one of these three systems I took traveling.

Like the Voyager, the SparcBook is limited to a single internal SCSI device; however, you can upgrade from the standard 340-MB drive to the tested 520-MB drive, and the Type III PCMCIA slot will support an additional 105-MB drive. The SparcBook 3 lists for $10,950. A monochrome version, the SparcBook 3LC, goes for $7500 with 8-bit audio and no ISDN.

Best and Brightest

Since running on batteries isn't really practical for any of these machines, I'll consider the two applications for which portable workstations are most useful: field support, where a system running a dedicated application (e.g., a network monitor) is carried from site to site; and transportable computing, where a consultant might need to move a system from one client location to another. For the first application, portability is key; for the second, a self-contained, fully functional workstation is the most important consideration.

The SparcBook 3 would be my choice for a truly portable system. Although it makes compromises in expansion capability and screen size, it's small and lightweight, and its NCE save, resume, and location customization features make it almost a pick-it-up-and-go system.

My overall favorite, however, is the SparcStation Voyager, although I'll admit a bias in that my traveling requirements mostly consist of toting machines from site to site, not using a workstation on the road. For that application, the Voyager's fully functional environment makes it worth the hassle of transporting and reconfiguring at each location. ■

Editor's note: *As we went to press, RDI announced a new base price of $7995 for the PowerLite.*

Steve Apiki is a BYTE contributing editor. He is senior developer at Appropriate Solutions, Inc., a consulting firm based in Peterborough, New Hampshire, and specializing in cross-platform application development. You can reach him on the Internet or BIX at apiki@bix.com.

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"The" Debugger Is Aptly Named

This Mac software development tool helps you easily debug programs written for both 680x0 and PowerPC processors

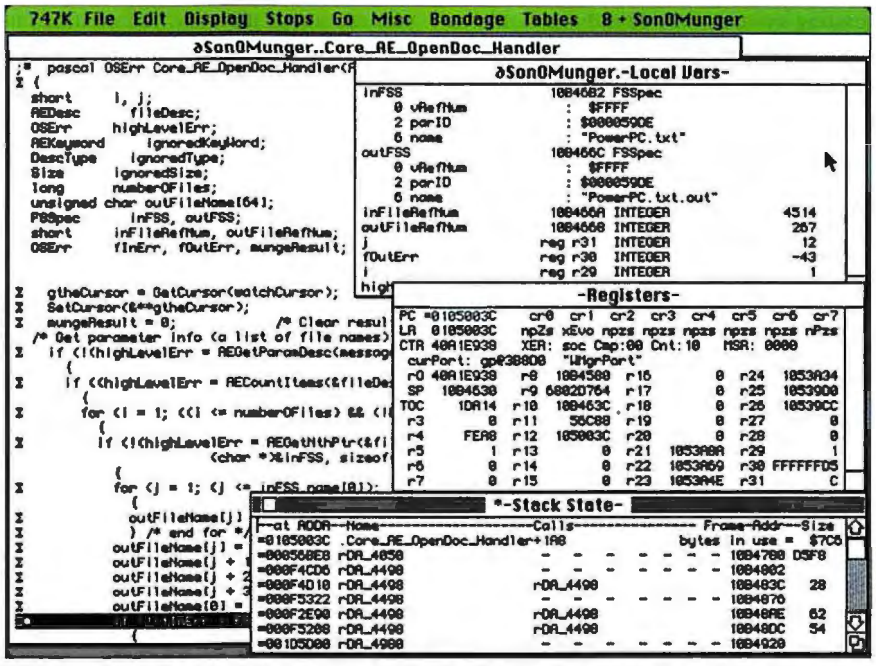
TOM THOMPSON

The Mac programmer's life got complicated when Apple introduced the PowerPC-based Power Macs. There are new choices in development tools that generate PowerPC object code. Also, the Power Mac's run-time architecture has been revamped to support DLLs and objects called *code fragments* (see "The Power Mac's Run-Time Architecture," April BYTE). This means there are two new volumes of *Inside Macintosh* to read, along with the usual complement of technical notes, to obtain information on this new system software.

However, since the Power Macs provide better native performance than other platforms, they promise great opportunities for those who make the effort to write native (i.e., PowerPC) programs. Furthermore, those code fragments, which are the building blocks of Power Mac programs, let you readily access system globals or other application data without resorting to assembly language. This simplifies a Mac program's design tremendously.

You've still got to debug those native programs, though, especially as you learn the nuances of code fragments and other PowerPC-specific details. This means using a native debugger. Surprisingly, there are very few of those for the Power Mac. There's Apple's Macsbug 6.5, a debugger written in 680x0 code that relies on the Power Mac's 68LC040 emulator to operate. This version of Macsbug still only interprets 680x0 processor instructions and registers. There are special resources called *dcmds* (shorthand for debugger commands) that can enhance Macsbug's capabilities, much as a Photoshop plug-in adds new features to Photoshop. Apple provided early Power Mac developers with dcmds that enabled Macsbug to interpret PowerPC instructions and display the processor registers. However, at this writing, Apple has not decided whether to offer these dcmds to the developer community at large.

This leaves serious PowerPC program debugging to a product from Jasik Designs called The Debugger V2. Either the program's author, Steve Jasik, has a lot of brass, or The Debugger is loaded with enough unique features to justify the name.



The Debugger displaying a PowerPC program as source code. The sigma symbols indicate executable statements. The bulleted source line has a breakpoint set on it, and the highlighting shows that the program execution has stopped on the breakpoint.

Based on my experience using The Debugger on several Power Mac programming jobs, it earns its title easily. It's an industrial-strength debugger that runs on both 680x0-based Macs and Power Macs. On Power Macs, whose operating system is a mix of 680x0 and PowerPC code, The Debugger handles both processor instruction sets simultaneously. It provides low-level glimpses of either processor's instructions and registers, yet it can supply a high-level view of a faulty program as source code. It also lets you easily display the contents of the program's variables and data structures. These and other features that I'll describe below make The Debugger well worth its $350 price tag.

Types of Debuggers

Before going into specific details on The Debugger, it's important to review what types of debuggers there are. Macsbug is a *low-level* or assembly language debugger. Low-level debuggers typically operate as close to the metal as they can, using a minimum number of operating-system resources. Thus, such debuggers are very robust. They typically continue to run even when a program bug wreaks havoc on most of the operating system.

Because they rely so little on the operating-system code, low-level debuggers can be used to debug parts of the operating system or specialized code such as menu definition functions (used to create floating tool palettes), drivers, and Extensions. The big disadvantage of low-level debuggers is that because they shun the use of system services, they must sport a rudimentary interface. This interface requires that you remember what commands to type in to adjust the program counter, set a breakpoint, or dump a section of memory.

A *high-level* or source debugger levers off the services of the Mac OS to provide easy access to the program being debugged. It typically displays the program as source code rather than as processor instructions. Variables and data structures can be examined by name, and the contents can be displayed in a variety of data formats. You don't have to remember arcane debugger commands—they're a

choice on a menu. You can easily test a problem program because the high-level debugger presents it in the programming language you wrote it in. Typical high-level debuggers are Metrowerks' MW Debug and Symantec Think C's Think Debugger.

The downside to high-level debuggers is that, since they make heavy use of the operating system, they're only as stable as the operating system itself. A program bug that mangles the Mac OS often takes out the high-level debugger as well. And such debuggers cannot be used to debug code that exists on the fringes of the operating system, such as drivers or Extensions.

In a Class by Itself

What category does The Debugger belong to? Both. It's a low-level debugger in that you can display the errant program's code as 680x0 or PowerPC machine instructions and examine the processor registers, the program's heap and stack, and any section of memory. But it also sports a boatload of high-level features. It has menus that let you point and shoot numerous debugger commands. Separate draggable Mac windows supply displays of the heap, the stack, and any Mac OS data structure you select. You view the code of the active (or current) function and can examine the contents of its local variables. If you compile your program so that special symbolic debugging information is available to The Debugger, it shows the program as source code.

With all these high-level features, you'd expect The Debugger to have the vulnerability of other high-level debuggers, but appearances are misleading. At boot time, The Debugger has two Extension files that copy the device driver tables, trap tables, and system resources that it uses to implement the high-level interface into a private section of memory. It then uses this clone of system resources as it runs. Thus The Debugger can present a high-level interface to the programmer but has the immunity of a low-level debugger to all but the most severe system crashes. Steve Jasik definitely knows his way around the Mac OS, because this technical feat required some serious rocket science. Also, because The Debugger runs independently of the operating system, you can use it to debug system code, drivers, MDEFs, Extensions, and other exotic code fare.

Bug Hunt

As I mentioned, The Debugger works on 680x0- and PowerPC-based Macs. Like Macsbug, it's composed mostly of 680x0 code that runs in the 68LC040 emulator. The software fits on a single high-density floppy disk. On the disk are The Debugger, which weighs in at a mere 400 KB; MacNosy, a 680x0 disassembler that understands Mac traps and code resources; and CoverTest, a code-execution profile utility. Two slim manuals, a quick reference card, and a sheaf of printed technical notes accompany the disk.

About the Product

The Debugger V2.....$350
Jasik Designs
343 Trenton Way
Menlo Park, CA 94025
(415) 322-1386
Internet: MacNosy@NetCom.Com
Circle 1077 on Inquiry Card.

I used The Debugger on a Quadra 800 and a Power Mac 8100/80. You install The Debugger by copying the contents of the floppy disk to your hard disk. Next, you drop the Extension files into the System Folder and reboot. A supplied MPW script automatically performs the installation and resolves some Extension conflicts, but if you're using Think C or Metrowerks CodeWarrior, you're stuck with the manual installation. The Debugger can be configured to work on a second monitor, so that the other monitor is available to operate the problem program.

You call up The Debugger at any time by typing Option-\. Of course, The Debugger also seizes control any time an exception occurs. In either case, a distinctive green menu bar appears instead of the Apple menu. The Debugger menu bar shows how much remaining memory it has to work with, and at the far right is the program counter's location. Also present are windows that display the offending function, the stack, and the PowerPC processor's registers. If the program crashes in the emulator or a function written in 680x0 code, 680x0 processor instructions and registers are displayed instead—an essential feature on a computer whose operating system is a mix of PowerPC and 680x0 code.

If you have generated a symbols file (.SYM for 680x0 programs and .xSYM for PowerPC programs) using MPW C or Metrowerks CodeWarrior, The Debugger loads this information and presents the function as source code, as shown in the screen on page 159. Local and global program variables are displayed and updated

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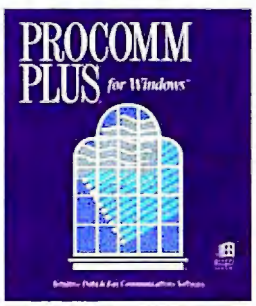

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in a separate window. The Debugger can also obtain some symbol information from Think C 7.0 project files, but the display is limited mainly to source code: There are no names associated with the displayed local variables and no data types for both local and global variables.

In the source code window, you set breakpoints by just pointing and clicking: You highlight the source code statement of interest (executable statements are marked with a Σ) and then type Command-B or choose *Toggle\Set Bkpt at* from the Stops menu. You can select a function or variable to display by highlighting it and selecting *Code\Data blk* from the Display menu or by typing Command-D. For example, you can click on a function name that appears in the source code window, highlight it, and type Command-D, and the function's source code will appear in a new window. If you haven't selected a function, a dialog box prompts you for a function name. This lets you examine functions that might not be available in the current source window.

If you hold down the Command key and click on the source code window, its contents appear as source code lines interspersed with the machine code that implements the source line. For PowerPC code, a "training wheels" feature automatically comments the machine instructions; this is handy in aiding your understanding of the PowerPC instruction set.

You can single-step through the program as source code statements or by each machine instruction. On PowerPC branch instructions, as you step through the machine code, The Debugger informs you whether the branch was taken or execution fell through to the next instruction. A Step Continuous menu item lets you set the rate at which The Debugger automatically steps through the program. This lets you feed the program events and watch how the code responds until it crashes.

A CFM (code fragment manager) menu item in the Tables menu lets you explore code fragments. By default, a window displays all of the program's code fragments, including the shared libraries associated with the program. As with all other debugger windows, you can highlight an address in this window and display it. This enables you to "spelunk" through shared library code or examine transition vectors, which describe the linkages between your program and shared library functions. This feature alone should minimize some of the headaches that occur when programming the Power Mac run-time architecture.

Improvements Coming

The Debugger's most serious limitation is its documentation. The technical information sprawls across the entire range and history of the Mac, mentioning peculiarities in the Mac Plus, SE, and II as well as more recent machines. Most of this old material should be pruned. Worse, there's little PowerPC-specific material. Luckily, since The Debugger uses the same interface no matter what processor is driving the Mac, some of the PowerPC capabilities can be inferred from documented 680x0 features. However, not all of the 680x0 features are currently implemented in the PowerPC, and there's no description of the PowerPC-specific CFM item at all.

Jasik Designs has a revision of the major documentation in the works. By the time you read this, the new documentation will be distributed along with The Debugger on a CD-ROM. Buyers of The Debugger also get free periodic updates of the product for a year, so users can expect these missing PowerPC features to appear in The Debugger as the year progresses. In addition, MacNosy should be able to disassemble PowerPC code this fall.

Despite the minor shortcomings, The Debugger provides ample PowerPC-specific support that reduces the debugging efforts of anyone writing native Power Mac code, regardless of whether it's an application, a shared library, an Extension, or a plug-in module. The Debugger's ability to display and debug two different processor instruction sets simultaneously is an extraordinary piece of programming. Its high-level source code display, combined with the ability to examine the program as low-level machine code, makes program tracing easy and the detection of obscure program bugs practical. The documentation could use some work, but serious programmers who are used to ferreting out information won't see this as a problem. The Debugger is thus *the* program for serious Power Mac development. ■

Tom Thompson is a BYTE senior technical editor at large. He is an Associate Apple Developer and author of Power Macintosh Programming Starter Kit *(Hayden Books, 1994). You can contact him on AppleLink as T.THOMPSON or on the Internet or BIX at tom_thompson@bix.com.*

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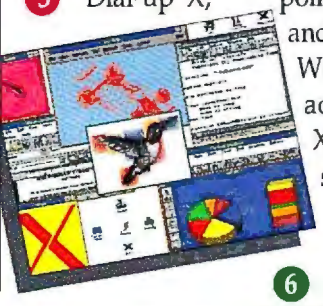

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21 PYROTECHNIC PENTIUMS

Our Windows and Unix benchmarks identify the best 60- to 100-MHz Pentium systems for high-performance computing

SCOTT HIGGS AND JIM KANE

Power users have never had it so good, as long as you stick to Windows and DOS applications. We tested 21 Pentium systems, with speeds ranging from 60 to 100 MHz, and found that even the slowest systems scream through Windows applications at least 30 percent faster than 66-MHz 486DX2-based systems.

That's the good news. The problems come if you're a Unix user who wants to take advantage of Pentium performance. Our attempts to run Unix on these high-speed systems were often thwarted: 10 of the state-of-the-art video cards used to complement these fast processors did not offer Unix drivers to support our SCO Unix–based benchmarks (see "The Best Pentiums for Unix," page 171).

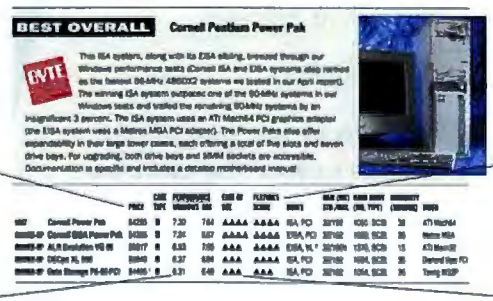
The introduction of 90-MHz and the currently rare 100-MHz Pentium processors (both of which run not only faster but, at 3.3 V, cooler, too) is helping to drive down prices of the 60- and 66-MHz systems that began appearing late last year. As a result, wise buyers can now save thousands of dollars on high-end Intel-based systems.

For example, the two 66-MHz Pentium systems available for our last systems Lab Report in April carried an average price of $8300. Today's equivalent Pentiums are more plentiful and more economical: The nine

How to use this guide

To find the best Pentium system for your needs, follow the main headings until you come to the applications category that most closely matches yours. Then look to the Best Overall or Low Cost summaries to find the appropriate rankings.

List prices are for the as-tested configuration, which includes 32 MB of RAM, a minimum of 1 MB of video memory, a 1-GB or larger hard drive, a 15-inch color monitor (unless otherwise noted), and a CD-ROM drive.

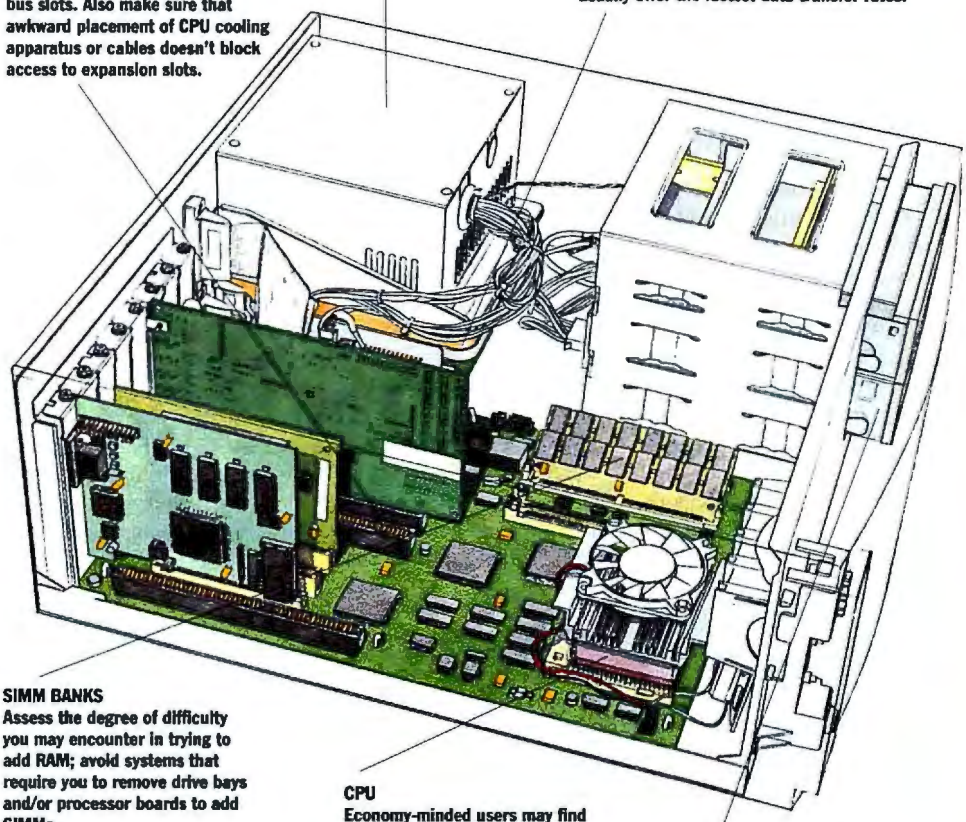


Features scores rate systems for expandability and flexibility.

Speed scores are calculated from either Windows low-level and application benchmarks or BYTE and SPEC Unix tests. In each case, higher scores indicate faster performance.

Ease-of-use scores indicate how easy it is to configure and upgrade a system; they include the quality of the documentation.

Pentium Components



EXPANSION SLOTS
All systems offer some room for expansion, but flexibility varies widely. If you plan to use the system for disk- or video-intensive applications, look for available local-bus slots. Also make sure that awkward placement of CPU cooling apparatus or cables doesn't block access to expansion slots.

POWER SUPPLY
The power supply must be large enough to support all the mass-storage devices that may be installed in the system. Power supplies rated for 200 W are generally the minimum for systems in this class; 300 or 400 W is better.

HARD DRIVE STORAGE
Standard system configurations specify capacities of about 500 MB; however, many high-performance Windows and Unix users will be better served by 1-GB drives, which we specified for this report and which are reflected in our performance and pricing information. Choose tower designs for network servers or other applications that require space for mass-storage expansion. Choose a hard drive with a fast controller and access times at or below 11 milliseconds. Local bus (VL-Bus or PCI) drives usually offer the fastest data transfer rates.

SIMM BANKS
Assess the degree of difficulty you may encounter in trying to add RAM; avoid systems that require you to remove drive bays and/or processor boards to add SIMMs.

CPU
Economy-minded users may find the 60- and 66-MHz models' lower prices appealing; 90- or 100-MHz CPUs are best for applications that are calculation and graphics intensive. Pentiums generate heat, so be sure the chip is adequately cooled: A heat sink and fan combination is best. There should also be plenty of room around the chip for air to circulate.

CD-ROM
Choose double- or triple-speed CD-ROM drives for multimedia, text search and retrieval, and convenience in loading software. If the system will stand on its side, the CD-ROM drive should have a caddy load. If the system will sit vertically, direct or caddy loads are both options. Some units now offer a locking center spindle for use in either orientation.

AUGUST 1994 BYTE BEST PENTIUM SYSTEMS **BEST**

GENERAL-PURPOSE WINDOWS

Cornell Pentium Power Pak

This 66-MHz ISA system has Windows performance that approaches that of 90-MHz systems. Its $4295 price tag, more than $700 below the average for its class, includes 512 KB of cache, an ATI Mach64 PCI graphics card, and a large tower case. Cornell's EISA system with comparable performance costs $100 more. **PAGE 166.**

HIGH-PERFORMANCE WINDOWS

Siemens Nixdorf PCE-5S

This 100-MHz Pentium tower posted the fastest Windows scores of all the systems we tested in this roundup. The VL-Bus EISA system provides a Matrox local-bus-based graphics card, 256 KB of cache, and built-in SCSI. The highly expandable PCE-5S offers a series of external and internal locks to keep it secure enough for server applications. **PAGE 169.**

BEST UNIX

Tangent PCI 5100

Peerless in Unix performance, this 100-MHz tower ran an average of 20 percent faster than its closest competitor in integer calculations. The design is unique in offering both VL-Bus and PCI local-bus slots. The $5621 price (without monitor) includes 512 KB of cache, 2 MB of VRAM on the Diamond video card (with a Power9000 chip set), and a 2-GB Seagate SCSI hard drive. Documentation is thorough and easy to read. **PAGE 171.**

66-MHz systems we tested averaged $5200. What's more, the top-end 90- and 100-MHz systems averaged about $6900 in this report. This indicates how quickly the cost of Pentiums has dropped since last fall, due in part to 80x86 and PowerPC competition (see "80x86 Wars," June BYTE, and "Apple, IBM Bring PowerPC to the Desktop," April BYTE).

To identify today's best Pentium performers, we rank systems in three categories: general-purpose Windows, where we consider 60- and 66-MHz systems; high-performance Windows, which ranks 90- and 100-MHz systems; and Unix, where we rank systems of any speed that currently support this platform. We tested these systems with an array of low-level and application tests for Windows, Unix, and DOS that give real-world comparisons of overall system performance, as well as performance for individual system components such as video and hard disk subsystems. We combined these results with our hands-on evaluation of features and ease of use.

THE BEST PENTIUMS FOR

GENERAL-PURPOSE WINDOWS

For Windows users who need spreadsheet calculations or screen graphics updates in an instant, these 60- and 66-MHz Pentium systems are a delight. The newer and more expensive P54C (90- and 100-MHz clock speeds) Pentium chips have moved the 60- and 66-MHz chips quietly into the mainstream of the high-end desktop market. Even though these chips are no longer the fastest Pentiums available, they still scream through Windows tasks an average of 30 percent faster than 66-MHz 486DX2s (their speed advantage over the latest 100-MHz 486DX4 systems isn't as clear-cut, however; see the text box on this page).

Prices for these systems are falling but are still at levels only power users can easily justify: The average was $5100. Note that the prices we quote include a minimum of a 1-GB hard drive, 32 MB of memory, a CD-ROM drive, 1 MB of video memory, and a 1024- by 768-pixel 15-inch monitor (unless otherwise noted). Also, we ranked six Pentium systems for Low Cost honors that all sold for under $5000.

All these systems offer more than just a high-end processor. The rule was a video accelerator with 1 MB of RAM and PCI (Peripheral Component Interconnect) or VL-Bus (VESA Local Bus) local-bus slots to accelerate video and hard disk access (PCI far outnumbered VL-Bus: It was the choice for 12 of the 15 systems with local bus). The Duracom Mini Pro 586/66 came configured with all its PCI slots empty. Using a standard ISA hard drive controller and a 1-MB ISA video adapter, it finished predictably last in our Windows performance tests. The Wyse Series 6000i Model 665 doesn't offer local bus; its Windows performance was the third slowest.

Although most of these systems are designed with an IDE controller integrated into the motherboard, our 1-GB storage requirement prompted most vendors to supply a fast SCSI hard drive and install a SCSI adapter card in one of the expansion slots. Tangent's PCI 566 came with a new 1-GB IDE hard drive from Connor. Our low-level tests showed that random-access times were equivalent to those of the Micropolis 1-GB SCSI drive in the Cornell Power Paks. We did note that sequential reads and writes were faster with the IDE drive.

IDE is widespread on the 80x86 platform, usually with a motherboard-based IDE controller, which offers easier system assembly and no overhead cost for an adapter card. The new IDE standard expands capacities beyond its traditional 528-MB

486DX4: A 100-MHZ ALTERNATIVE TO PENTIUMS?

Systems built around Intel's new 100-MHz DX4 CPU offer faster performance and twice the on-chip cache of 486DX2 chips. And like the high-end (90 and 100 MHz) Pentiums, the DX4 runs at 3.3 V for low-power operation.

The low power consumption, low heat levels, and fast processing power of the DX4 chip are helping to make it the high-end processor of choice for many notebook designers (you'll find performance rankings in our October portables Lab Report, which is currently in its testing cycle). A handful of vendors began offering DX4 desktop systems as we prepared this report. But the DX4 as a desktop-system CPU is in doubt. For example, Gateway supplied a DX4 system for testing, but as we went to press, the company decided to stop marketing it.

Our tests showed that these systems provide an excellent alternative to the lower end of the Pentium market when used as Windows workstations (see the table; systems are listed in order of Windows speed). The fastest DX4 we tested, Micro Express's MicroFlex, was equivalent to the fastest 66-MHz Pentium (Cornell's Pentium Power Pak) in our Windows tests, and it undersold that relatively low-cost Pentium by around $1100 (the MicroFlex had a 500-MB hard drive and 16 MB of memory, versus 1 GB and 32 MB, respectively, in the Power Pak).

Micro Express MicroFlex-PCI/100

Nevertheless, the Pentium processor does offer some performance advantages. Data buses on the 486 are 32 bits wide, compared to the 64 bits on the Pentium. Also, the 486 includes 1.2 million transistors, compared to the Pentium's 3.1 million transistors. These differences become noteworthy in more computationally intensive applications. For example, the Hewlett-Packard Vectra VL2 posted the fastest SPECint Unix score among DX4s but was slower in this test than all the 60- and 66-MHz Pentiums (see the Roll Call for Pentium Unix scores).

VENDOR/PRODUCT	PRICE	CASE TYPE	WINDOWS	DOS	UNIX SPECINT	UNIX SPECFP	UNIX BYTE	BUSES	RAM (MB) STD/MAX.	HARD DRIVE (MB, TYPE)	VIDEO
Micro Express MicroFlex-PCI/100	$3174	▮	7.34	7.36	—[1]	—[1]	—[1]	EISA, VL[2]	16/128	500, SCSI	ATI Mach64
Dell OmniPlex 4100	$5360	▬	6.46	6.74	—[1]	—[1]	—[1]	EISA, PCI	16/128	500, SCSI	ATI Mach32 68800AX
HP Vectra VL2	$3627	▬	5.27	6.49	45.68	23.13	3.26	ISA, VL[2]	16/64	340, IDE	Cirrus Logic 5428
Compaq ProLinea DX4/100	$3048	▬	5.06	5.30	37.68	21.09	1.94	ISA, proprietary	16/100	525, IDE	Compaq QVision

[1] System could not run test. [2] VL-Bus Case type: Tower ▮ Desktop ▬

limit to enable IDE to compete better in high-end systems. As a point of reference, the IDE drive–based Tangent system is $3795 (without a monitor), making it the lowest-priced 66-MHz Pentium we tested.

Although the 66-MHz Pentium Power Pak from Cornell took top honors in our Best Overall rankings, a number of competitors also made strong showings. Advanced Logic Research's Evolution VQ 66, a 66-MHz tower with 13 drive bays (and a winner in three categories in our April systems report) performed near the top against the current Pentium field. It relies on EISA combined with VL-Bus video and a DPT EISA SCSI controller.

The intelligent design of the ALR Evolution earned the top rating for features because its large motherboard is unobstructed by cables and wiring and there's a separate section for mass storage. This section helps keep drive racks from overhanging bus slots and other areas of the motherboard. Two large fans reside in the front of the motherboard to cool the main section, where the CPU resides. Another fan cools the power supply. Outside, nine LED displays give system status information at a glance. These features and solid documentation made this system one of the easiest to configure and use.

The DECpc XL 566, third-runner-up for Best Overall honors, is a well-designed tower system that can be easily expanded. The case fits together without screws, allowing quick entry to system internals. The idea behind this design is good; unfortunately, in practice, the cover is difficult to remove and replace.

This system uses a proprietary CPU board, useful for systems integrators or others who want the option of upgrading to a 90- or 100-MHz system. However, you must remove the CPU board to add memory. The system's Toshiba XM-4101B CD-ROM drive has a locking center spindle that works whether the system sits horizontally or stands vertically.

Duracom's Mini Pro 586/66, a mini-tower, is congested inside with mass storage and power cables. A drive bay blocks one expansion slot, and the CPU fan blocks full-length cards from two more slots. On the plus side, the system has clear, complete documentation.

The Hertz P 6e has similar congestion problems: The CPU fan blocks three slots from accepting full-length cards. The situation is somewhat alleviated by pop-out 3½-inch drive bays that reside over the motherboard: Removing the runners on the drive bays gives you easy access to the SIMM slots.

Data Storage's P5-60 PCI was the only 60-MHz system we ranked for Best Overall (its $4495 price also made it a runner-up in Low Cost). Its Windows speed, while the lowest in the Best Overall group, was only imperceptibly slower than the 66-MHz DECpc XL 566's. The system uses the same motherboard as the winning Cornell system. The P5-60 PCI's drive bays and SIMM slots are all easily accessible.

The Insight PCI P60 is a notable Low Cost runner-up for its expansion possibilities: All of its 13 drive bays—among the highest number of bays of the systems we tested—are accessible. The SIMM slots are partially obstructed by one of the drive bays, making it difficult but not impossible to add memory.

BYTE BEST GENERAL-PERFORMANCE WINDOWS

Need the best all-around Windows performance?

BEST OVERALL — Cornell Pentium Power Pak

AUGUST 1994 BYTE BEST PENTIUM FOR GENERAL-PURPOSE WINDOWS

This ISA system, along with its EISA sibling, breezed through our Windows performance tests (Cornell ISA and EISA systems also ranked as the fastest 66-MHz 486DX2 systems we tested in our April report). The winning ISA system outpaced one of the 90-MHz systems in our Windows tests and trailed the remaining 90-MHz systems by an insignificant 3 percent. The ISA system uses an ATI Mach64 PCI graphics adapter (the EISA system uses a Matrox MGA PCI adapter). The Power Paks also offer expandability in their large tower cases, each offering a total of five slots and seven drive bays. For upgrading, both drive bays and SIMM sockets are accessible. Documentation is specific and includes a detailed motherboard manual.

		PRICE	CASE TYPE	PERFORMANCE WINDOWS	PERFORMANCE DOS	EASE OF USE	FEATURES SCORE	BUSES	RAM (MB) STD./MAX.	HARD DRIVE (MB, TYPE)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell Power Pak	$4295	▮	7.30	7.64	▲▲▲▲	▲▲▲▲	ISA, PCI	32/192	1050, SCSI	36	ATI Mach64
RUNNER-UP	Cornell EISA Power Pak	$4395	▮	7.24	6.67	▲▲▲▲	▲▲▲▲	EISA, PCI	32/192	1050, SCSI	36	Matrox MGA
RUNNER-UP	ALR Evolution VQ 66	$8817	▮	6.53	7.95	▲▲▲	▲▲▲▲	EISA, VL[2]	32/1024	1370, SCSI	15	ATI Mach32
RUNNER-UP	DECpc XL 566	$5948	▮	6.37	6.84	▲▲▲	▲▲▲▲	ISA, PCI	32/192	1024, SCSI	36	Diamond Viper PCI
RUNNER-UP	Data Storage P5-60 PCI	$4495[1]	▮	6.31	6.49	▲▲▲	▲▲▲	ISA, PCI	32/192	1054, SCSI	36	Tseng W32P

For high speed and economy . . .

LOW COST — Cornell Pentium Power Pak

The cost for this 66-MHz system's 90-MHz-class speed is relatively economical: At $4295, the Power Pak is one of the lowest-priced Pentiums we tested. The system comes with 512 KB of secondary cache on the motherboard. If fast Windows speed is essential but your budget is even more limited, consider the 66-MHz Tangent PCI 566, which places second among Low Cost winners for speed and costs $3795 (not including monitor) in our configuration.

		PRICE	CASE TYPE	PERFORMANCE WINDOWS	PERFORMANCE DOS	EASE OF USE	FEATURES SCORE	BUSES	RAM (MB) STD./MAX.	HARD DRIVE (MB, TYPE)	WARRANTY (MONTHS)	VIDEO
BEST	Cornell Power Pak	$4295	▮	7.30	7.64	▲▲▲▲	▲▲▲▲	ISA, PCI	32/192	1050, SCSI	36	ATI Mach64
RUNNER-UP	Tangent PCI 566	$3795[1]	▮	6.86	7.65	▲▲	▲▲	ISA, PCI	32/128	1024, IDE	12	Tseng ET4000W32P
RUNNER-UP	Swan Pentium 60	$4299	▬	6.08	6.31	▲▲▲	▲▲▲	ISA, PCI	32/128	1024, SCSI	12	Tseng ET4000W32P
RUNNER-UP	Insight PCI P60	$3999	▮	6.04	6.46	▲▲▲	▲▲▲	ISA, PCI	32/128	1052, SCSI	12	ATI Mach32/68875
RUNNER-UP	Cornell EISA Power Pak	$4395	▮	7.24	6.67	▲▲▲▲	▲▲▲▲	EISA, PCI	32/192	1050, SCSI	36	Matrox MGA
RUNNER-UP	Data Storage P5-60 PCI	$4495[1]	▮	6.31	6.49	▲▲▲	▲▲▲	ISA, PCI	32/192	1054, SCSI	36	Tseng W32P

[1] Without monitor [2] VL-Bus

KEY

Ease of Use:
Excellent ▲▲▲▲ Good ▲▲▲
Fair ▲▲ Poor ▲

Case:
Tower ▮ Desktop ▬
Mini-tower ▯

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MODEL	6468GM	1451GM	1462GM	1562GM	1565GM	1765GM	1785GM
Size	14"	14"	14"	15"	15"	17"	17"
Dot Pitch (mm)	0.28	0.28	0.28	0.28	0.28	0.27	0.26
Hor. Freq. (KHz)	30-38	30-50	30-62	30-62	30-65	30-65	30-85
1600 x 1280 NI	—	—	—	—	—	—	Yes(60Hz)
1280 x 1024 NI	—	—	—	—	Yes(60Hz)	Yes(60Hz)	Yes(75Hz)
1024 x 768 NI	87Hz/I	60Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI	75Hz/NI
Mac Compatibility	—	—	Yes	Yes	Yes	Yes	Yes
Flat Square	—	—	—	Yes	Yes	Yes	Yes
Color Match	—	—	—	—	—	Yes	Yes
Digital Controls	—	—	—	—	Yes	Yes	Yes
MPR-II & ISO9241-3	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Power Savings	<30W	<30W	<30W	<30W	<5W	<5W	<5W

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*Based on official 1993 Monitrak U.S. monitor sales research.

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BYTE BEST

HIGH-PERFORMANCE WINDOWS

Bang for the buck continues to expand rapidly: All but one of these 90- and 100-MHz systems had faster Windows performance than the fastest 66-MHz systems. (The exception was the Hewlett-Packard Vectra XU 5/90C, which provided Windows speed that was essentially the same as that of the Cornell Pentium Power Pak, the fastest 66-MHz Pentium we tested for Windows.) The average price for the high-performance class was about $6900, with one solid performer selling for about $5000.

Not surprisingly, a 100-MHz system, the Siemens Nixdorf PCE-5S, won the Best Overall honors. Among the runners-up, Tangent's PCI 5100, the only other 100-MHz system in our sample, stands out for performance and expandability. The Tangent system runs Windows significantly faster than the 90-MHz competitors, and its large tower case provides space for up to nine drives.

The Tangent PCI 5100 is unique in this roundup for having both VL-Bus and PCI local-bus slots available. Tangent says that it offers both types of slots to give users as much flexibility as possible. As the market matures, however, users may be more likely to standardize their purchases on one local-bus type or the other. We note with dismay that the PCI 5100's CPU fan blocks three potentially full-length slots, so that these slots are serviceable for only half-length cards.

The 90-MHz Dell OmniPlex 590 is a desktop design with an EISA bus and a SCSI hard drive. Although this system is slower than the 100-MHz Pentiums ranked for Best Overall, its Windows speed ranked near the top for 90-MHz computers. What's more, the OmniPlex is among the easiest-to-use Pentium systems we tested. The documentation is comprehensive, with numerous charts and diagrams, and there are step-by-step instructions for installation. Also, an expansion-card chassis lifts out from the system to provide easy access to the SIMM sockets on the motherboard. Side latches release drive rails, which makes installing and removing drives a breeze. Adapter slots are free of obstructions.

Dell also plans to introduce a low-cost Dimension XPS P90, which we tested but didn't rank because it was a prerelease model. With a projected list price approximately $2000 lower than that of the OmniPlex, the ISA-bus Dimension can be configured with a 1-GB Connor IDE drive. Windows performance for the two Dell units was equivalent, although the Dimension ran significantly faster in the DOS tests.

The HP Vectra XU 5/90C does not stand out for performance, but this system reveals some impressive engineering. Its design is remarkable: integrated SCSI, IDE, and high-resolution video, which saves slots, cable, and aggravation (see "Honorable Mention" on page 176 for more details). HP's integration and sophisticated power-supply design also cut power consumption.

When only the fastest Windows speed will do...

BEST OVERALL — Siemens Nixdorf PCE-5S

Unmatched in this roundup for Windows speed, this 100-MHz system also ranked as having the best set of features of any system we evaluated. It comes with 256 KB of secondary cache and a Matrox video accelerator connected via the VL-Bus. An NCR SCSI controller resides on the motherboard. The documentation is easy to understand (and it's written in several languages) and helps make the system easy to configure. Able to function as a network server, the huge tower design offers seven 32-bit (EISA) slots and 10 drive bays. The PCE-5S may frustrate some users who need to reach the motherboard, which lies hidden behind modules that require keys, screwdrivers, and even information from the manual to access.

		PRICE	CASE TYPE	PERFORMANCE WINDOWS	PERFORMANCE DOS	EASE OF USE	FEATURES SCORE	BUSES	RAM (MB) STD./MAX.	HARD DRIVE (MB, TYPE)	WARRANTY (MONTHS)	VIDEO
BEST	Siemens Nixdorf PCE-5S	$9149	▮	8.57	9.79	▲▲▲▲	▲▲▲▲	EISA, VL	32/512	1000, SCSI	36	Matrox MGA
RUNNER-UP	Tangent PCI 5100	$5621 [1]	▮	8.36	9.14	▲▲▲▲	▲▲▲	ISA, VL [2], PCI	32/128	2048, SCSI	12	Diamond Power9000
RUNNER-UP	Gateway P5-90	$5014	▮	7.45	7.68	▲▲▲▲	▲▲▲	ISA, PCI	32/128	1000, SCSI	36	Matrox MGA
RUNNER-UP	Dell OmniPlex 590	$7386	▬	7.44	7.69	▲▲▲	▲▲▲	EISA, PCI	32/192	1024, SCSI	12	ATI Mach32 68800AX

Need economy at the high end?

LOW COST — Gateway P5-90

Among systems priced under $6000, the $5014 P5-90 stands out as the most economical high-performance system we ranked. Its Windows performance was near the bottom for this class of high-performance systems but was still fast enough to beat any of the 66-MHz systems we tested. Although the interior of this tower system is spacious, the location of the SIMM sockets prevents using a full-size board in one of the slots.

		PRICE	CASE TYPE	PERFORMANCE WINDOWS	PERFORMANCE DOS	EASE OF USE	FEATURES SCORE	BUSES	RAM (MB) STD./MAX.	HARD DRIVE (MB, TYPE)	WARRANTY (MONTHS)	VIDEO
BEST	Gateway P5-90	$5014	▮	7.45	7.68	▲▲▲▲	▲▲▲	ISA, PCI	32/128	1000, SCSI	36	Matrox MGA
RUNNER-UP	Tangent PCI 5100	$5621 [1]	▮	8.36	9.14	▲▲▲▲	▲▲▲	ISA, VL [2], PCI	32/128	2048, SCSI	12	Diamond Power9000

[1] Without monitor [2] VL-Bus

KEY

Ease of Use:
Excellent ▲▲▲▲ Good ▲▲▲
Fair ▲▲ Poor ▲

Case:
Tower ▮ Desktop ▬
Mini-tower ▯

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"The CA1507 offers controls that let you adjust image size and position, correct image tilt and pincushioning, recall factory mode settings, and set the power down delay interval.... Its image-quality score was well above average."

- BYTE Magazine, January 1994 -

PC Digest RATINGS REPORT

★★★★ **Recommendation**

"The KFC CA 1507, recipient of the EPA's Energy Star, offers a full range of image adjustment controls. This monitor complies with the DPMS power management standards suggested by the VESA and will work with any VESA-compliant computer."

- PC Digest, November 1993 -

KFC's new green monitors consume less than 1.5 Watts when inactive, and less than 20 Watts when on stand-by. Compared to the average of 85~100 Watts for an ordinary monitor, each KFC monitor contributes substantially to a greener environment. And you're not just sharing the contribution, you're also saving money.

CA1718 was the Best Value Runner-up for Spreadsheet & Graphics Color Monitor in BYTE Magazine's January 1994 BYTE/NSTL Lab Report. CA1507 (picture not shown) was awarded the "Best Value: General Business Color Monitor" by BYTE Magazine in January 1994 BYTE/NSTL Lab Report.

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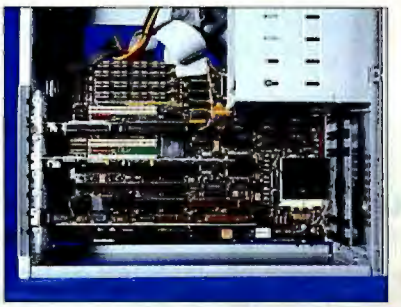
BEST OVERALL — Tangent PCI 5100



The big story when comparing Pentium systems in this roundup for Unix performance is the lack of video drivers for SCO Unix. Because of this problem, the three 90-MHz systems were unable to run our Unix benchmarks. In addition, eight of the 16 60- and 66-MHz systems couldn't accommodate our SCO Unix–based tests. Although the Siemens Nixdorf PCE-5S ran the tests, the results were much slower than its architecture would suggest: Neither we nor the vendor could determine the cause during our test cycle.

Buyers should note that specialized high-speed video can make a great deal of difference in performance, but it can also block access to alternative operating systems. Most 64-bit graphics cards are brand-new and will eventually provide Unix support, however.

Among the systems that performed well under Unix, Tangent's 100-MHz PCI 5100 tower was the clear leader in both the BYTE and SPEC92 benchmarks. The ALR Evolution VQ 66 deserves special note, too. It runs both SPEC test suites markedly faster than the other 60- and 66-MHz systems. Its large tower case is well designed to provide easy access to components, which are sectioned off and protected by a door. Users who require a server will welcome this system's 13 drive bays and 10 slots. The documentation is good, as is overall ease of use.

Trailing behind the ALR Evolution, the DECpc XL 566 and the Data Storage P5-60 PCI provide respectable Unix performance in less expensive tower units. The Data Storage system supports its 60-MHz Pentium with a large (512-KB) secondary cache. For expansion, the $4495 tower provides nine drive bays—all easily accessible—and seven expansion slots. There are four unshared ISA and three PCI slots. As is typical in PCI designs, a fifth ISA slot shares space with one of the PCI slots and can't be used at the same time. The system's hard drive is a 1-GB Seagate SCSI model. The DECpc and Data Storage systems also stand out from the leaders and from most of the pack with their relatively long (36 months) warranties.

Xinetron's X/Lan Pentium 66, a VL-Bus system, provides similar Unix results with a 24-month warranty. This $5299 tower provides its 66-MHz CPU with 512 KB of external cache. It also has a generous seven 5½-inch drive bays; only ALR's Evolution VQ 66 provides more space for larger drives.

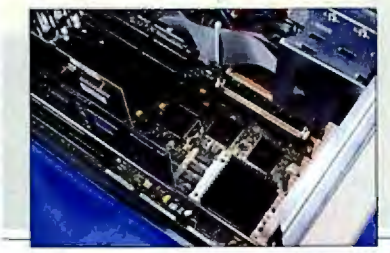
AUGUST 1994 BYTE BEST PENTIUM FOR UNIX

This unique VL-Bus and PCI tower runs away from the field in Unix performance tests, thanks in part to being one of only two faster-than-66-MHz systems to run our Unix benchmarks. The result: a BYTE Unix score almost double that of some 66-MHz Pentiums. The system offers 512 KB of secondary cache and 2 MB of VRAM on the Diamond video board (with a Power9000 chip set). Our test model used a 2-GB Seagate SCSI hard drive. The PCI 5100 leads this group in expandability. Its large tower case provides room for up to eight slots (six local bus) and nine drives. SIMMs are easily accessible. However, the CPU fan is positioned near the expansion slots and blocks three potentially full-length openings. Thorough and readable documentation makes configuration and use easy.

		PRICE	CASE TYPE	UNIX PERFORMANCE SPECINT	SPECFP	BYTE	EASE OF USE	FEATURES SCORE	BUSES	RAM (MB) STD./MAX.	HARD DRIVE (MB)	VIDEO
BEST	Tangent PCI 5100	$5621[1]	▮	75.65	62.59	4.56	▲▲▲▲	▲▲▲	ISA, VL[2], PCI	32/128	2048, SCSI	Diamond Power9000
RUNNER-UP	ALR Evolution VQ 66	$8817[1]	▮	61.49	52.07	2.65	▲▲▲	▲▲▲▲	EISA, VL	32/1024	1370, SCSI	ATI Mach32
RUNNER-UP	DECpc XL 566	$5948	▮	51.57	47.56	3.86	▲▲▲	▲▲▲▲	ISA, PCI	32/192	1024, SCSI	Diamond Viper PCI
RUNNER-UP	Data Storage P5-60 PCI	$4495[1]	▮	47.11	43.39	3.54	▲▲▲	▲▲▲	ISA, PCI	32/192	1054, SCSI	Tseng W32P
RUNNER-UP	Xinetron X/Lan Pentium 66	$5299	▮	54.33	45.21	3.41	▲▲▲	▲▲▲	ISA, VL[2]	32/128	1052, SCSI	ATI Mach32

For reliable Unix performance on a tight budget...

LOW COST — Swan Pentium 60



In this category, where we rank systems selling for under $5000, the $4299 Pentium 60 provides unspectacular but respectable Unix performance. The 3½-inch drive bays partially obscure the SIMM sockets on the motherboard, but the drive bays themselves are accessible. For those who need faster speed and have a larger budget, the Data Storage P5-60 PCI had the highest Unix scores in this group.

		PRICE	CASE TYPE	UNIX PERFORMANCE SPECINT	SPECFP	BYTE	EASE OF USE	FEATURES SCORE	BUSES	RAM (MB) STD./MAX.	HARD DRIVE (MB)	VIDEO
BEST	Swan Pentium 60	$4299	▬	46.55	41.62	2.82	▲▲▲	▲▲▲	ISA, PCI	32/128	1024, SCSI	Tseng ET4000/W32P
RUNNER-UP	Insight PCI P60	$3999	▮	45.73	41.08	3.22	▲▲▲	▲▲▲	ISA, PCI	32/128	1052, SCSI	ATI Mach32/68875
RUNNER-UP	Data Storage P5-60 PCI	$4495[1]	▮	47.11	43.39	3.54	▲▲▲	▲▲▲	ISA, PCI	32/192	1054, SCSI	Tseng W32P

[1] Without monitor [2] VL-Bus

KEY

Ease of Use:
Excellent ▲▲▲▲ Good ▲▲▲
Fair ▲▲ Poor ▲

Case:
Tower ▮ Desktop ▬
Mini-tower ▯

The ZEOS® Pantera™: Simply Can't

EXPERTS NAME THE ZEOS PANTERA #1

"Rocket fast performance and a great price make this our favorite Pentium of the lot," *PC/Computing* said.

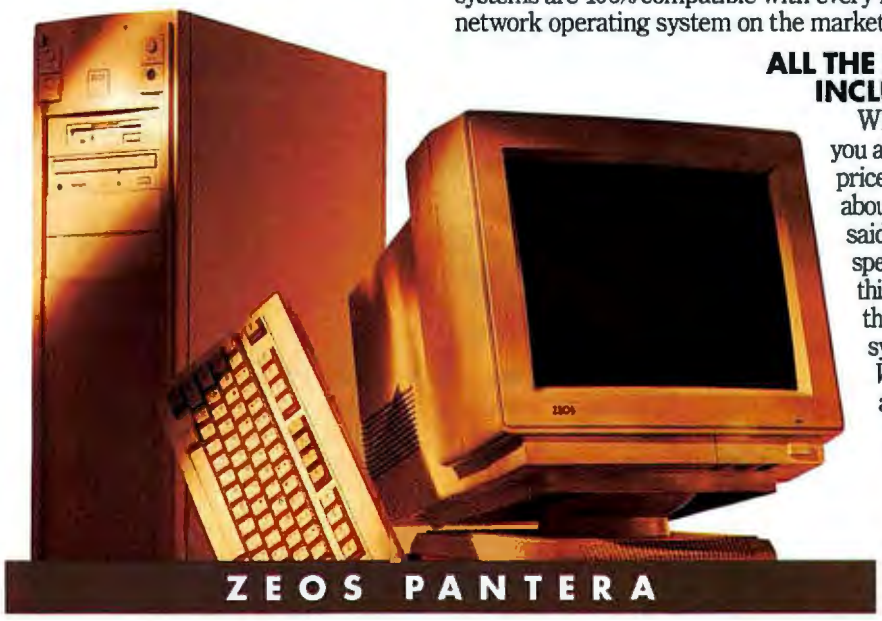
Top computer experts at five leading publications agree that the ZEOS Pantera is the best Pentium-processor based system available.

The ZEOS Pantera has earned:

- *PC Magazine* Editors' Choice (April 12, 1994)
- *Computer Shopper* "top choice" (April 1994)
- *PC/Computing* BEST (May 1994)
- *PC World* Best Buy (June 1994)
- *Windows Sources* Experts' Pick (June 1994)

These prestigious awards all add up to one thing–ZEOS computers are your #1 choice.

Don't settle for less. The Pantera has it all. *PC/Computing* concurs: "Hot performance, room for expandability, and a low price make this system our top choice."



POWER BEYOND POWER

"At the top is the new ZEOS Pantera-66, a Pentium-66 that recorded the fastest benchmark results ever to come out of the PC World Test Center," reported *PC World.*

PC Magazine said: "ZEOS Pantera-66 combines quality features, good price, and high performance.... A consistently above-average performer on all our benchmark tests...."

The ZEOS Pantera received the highest marks on many benchmark tests including the important Graphics WinMark and Disk WinMark tests run by *PC Magazine.* In fact, its Disk WinMark surpassed the next closest competitor by 35 percent!

What makes the Pantera fly at supersonic speeds? A ZEOS designed motherboard with exceptional features such as a hot new integrated PCI Local Bus IDE Controller (supporting up to four IDE devices) that, as *PC Magazine* said, "pushes disk access into new territory."

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PROCESSORS	PACKAGE 1	PACKAGE 2	PACKAGE 3	PACKAGE 4
486SX-33	$1495 Lease $63/mo.	$1845 Lease $67/mo.	$2245 Lease $81/mo.	$2795 Lease $101/mo.
486DX-33	$1645 Lease $60/mo.	$1995 Lease $72/mo.	$2395 Lease $87/mo.	$2945 Lease $107/mo.
486DX2-66	$1745 Lease $63/mo.	$2095 Lease $76/mo.	$2495 Lease $90/mo.	$3045 Lease $100/mo.
DX4-100	$1995 Lease $72/mo.	$2345 Lease $85/mo.	$2745 Lease $99/mo.	$3295 Lease $108/mo.
PENTIUM-66	$2195 Lease $79/mo.	$2545 Lease $92/mo.	$2945 Lease $107/mo.	$3495 Lease $115/mo.
PENTIUM-90	$2395 Lease $87/mo.	$2745 Lease $99/mo.	$3145 Lease $104/mo.	$3695 Lease $122/mo.
More processors available. Call for details.	■ 4MB RAM ■ 214MB local bus IDE hard drive w/32K cache ■ 3.5" 1.44MB floppy drive ■ 64-bit Windows-accelerated PCI local bus SVGA color graphics card with 1MB RAM ■ ZEOS 14" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ■ Six-bay desktop case with two cooling fans ■ MS-DOS 6.2, Windows for Workgroups 3.11, Microsoft Mouse	■ 8MB RAM ■ 528MB local bus IDE hard drive w/256K cache ■ 2X CD-ROM drive, 3.5" 1.44MB floppy ■ 64-bit Windows-accelerated PCI local bus SVGA color graphics card with 1MB RAM ■ ZEOS 14" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ■ Six-bay desktop case with two cooling fans ■ MS-DOS 6.2, Windows for Workgroups 3.11, Microsoft Mouse	■ 16MB RAM ■ 720MB local bus IDE hard drive w/128K cache ■ 2X CD-ROM drive, 3.5" 1.44MB floppy ■ 64-bit Windows-accelerated PCI local bus SVGA color graphics card with 1MB RAM ■ ZEOS 14" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ■ Six-bay desktop case with two cooling fans ■ MS-DOS 6.2, Windows for Workgroups 3.11, Microsoft Mouse ■ Choice of Lotus Windows application	■ 24MB RAM ■ 1GB local bus IDE hard drive w/256K cache ■ 2X CD-ROM drive, 3.5" 1.44MB floppy ■ 64-bit Windows-accelerated PCI local bus SVGA color graphics card with 1MB RAM ■ ZEOS 14" 1024 x 768 non-interlaced SVGA color monitor, .28mm dot pitch ■ Six-bay desktop case with two cooling fans ■ MS-DOS 6.2, Windows for Workgroups 3.11, Microsoft Mouse ■ Choice of Lotus Windows application

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- Complete ZEOS Customer Satisfaction Package.

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How We Tested

PERFORMANCE

We tested each system for performance under Windows 3.1, DOS 6.0, and SCO Unix 3.2.4. The DOS and Windows suites consisted of a combination of BYTE low-level tests and NSTL application tests.

The application tests use actual business programs to provide a real-world measure of system performance. The DOS performance suite includes WordPerfect 6.0, Lotus 1-2-3 release 2.4, and FoxPro 2.5. The Windows suite uses WordPerfect 6.0, Microsoft Excel 5, FoxPro 2.6 for Windows, and Word for Windows 6.0. All applications execute macros that exercise common areas of each application. For instance, the Word for Windows test includes subtests that measure activities including file I/O, search-and-replace functions, changing fonts, scrolling by page and line, checking spelling, print previewing, and printing to a file. Windows tests ran in 1024- by 768-pixel resolution with 256 colors. DOS tests ran in standard VGA resolution (640 by 480 pixels with 16 colors).

FEATURES

We considered the following features to be among the most important for Pentium systems:

- at least one-year parts-and-labor warranty
- 32 MB of system memory
- number of adapter slots and drive bays available
- display resolution of at least 1280 by 1024 pixels

The BYTE DOS low-level tests isolate performance of subsystems: CPU, FPU, memory, video, and hard disk. These tests provide important data for analyzing the results of the application-level tests. The BYTE Windows low-level tests exercise the Windows GDI (Graphical Device Interface) to determine how well a system can execute basic Windows graphics tasks, such as drawing a line, displaying text, and executing BITBLT operations.

We also tested each system's performance under SCO Unix 3.2.4. The test suite consists of BYTE's low-level Unix tests and SPEC92, which provides scores for floating-point and integer performance. The Unix tests cover a spectrum of typical scientific and engineering tasks, such as electronic-circuit analysis, architectural analysis, and compilation, as well as general Unix system operations.

The SPEC92 suite that we use covers a variety of application-based and low-level benchmarks representative of engineering and scientific activities. The integer test (SPECint) contains six CPU integer-intensive benchmarks, mostly written in C. Floating-point benchmarks (SPECfp) contain 14 CPU-intensive floating-point benchmarks, mostly written in FORTRAN. These tests primarily measure the performance characteristics of the processor, cache, and main memory units in processor-intensive applications. They do not attempt to measure display, network, or disk performance. SPEC results are scored as ratios of the time taken for the test compared to the time taken by a DEC VAX 11/780 computer. A score of 42.3 means that the tested system ran that test 42.3 times faster than the VAX. The higher the score, the faster the system for that test.

For Windows and DOS, we scaled all application test scores from 1 to 10, using the best results in this group of systems as a 10. Note: Because this month's tests have been updated with the latest versions of application software, test results are not directly comparable to those of previous systems Lab Reports.

CONFIGURATION

Our testing was open to all Pentium-class systems and bus architectures. We required that all Pentiums have 32 MB of RAM. Hard drives had to be at least 1 GB, using a controller that had no more than 1 MB of cache memory. The video subsystem requirements included at least 1 MB of video memory and support for 1024- by 768-pixel resolution at 256 colors. Each system was equipped with a CD-ROM drive.

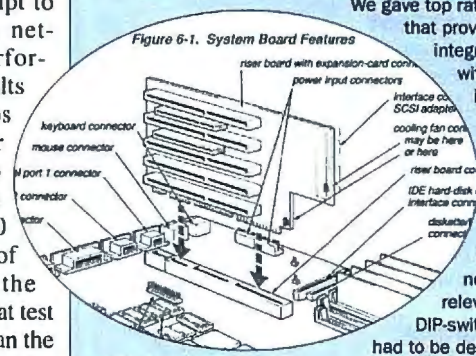
EASE OF USE

In addition to running performance tests, we examined each system for usability by focusing on two areas: system design and documentation.

We considered several factors when we looked at system design: How easy was it to open the system and install an adapter? Were any slots obstructed (a frequent occurrence with heat sinks and fans mounted on the CPU)? Were the I/O ports labeled? Could the subsystems integrated on the system board be disabled?

Congested wiring (left) makes it difficult to add cards and memory, while clean design, such as the ALR Evolution VQ 66's, makes expansion a breeze.

Clear, easy-to-reference documentation is critical in state-of-the-art systems. Adding peripherals and updating components can be a nightmare if vendors supply inadequate information. We gave top ratings to systems that provided well-integrated manuals with comprehensive indexes. Systems that did not include specifications for video and disk subsystems were judged negatively. All relevant jumper and DIP-switch settings also had to be detailed for a system to rate well.



Dell's documentation stood out for readability.

Contributors

Scott Higgs, Project Manager/NSTL, *has tested hardware for NSTL for six years. He spent last year in Europe, where he helped establish a testing facility in France.*

Alan Joch, Senior Editor/BYTE, *coordinates the combined testing between the BYTE Lab and NSTL.*

Jim Kane, Project Manager/NSTL, *led the testing for this report. He has evaluated high-end systems, peripherals, and network hardware at NSTL during the past three years.*

The Lab Report is an ongoing collaborative project between BYTE magazine and National Software Testing Laboratories (NSTL). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc. Contact the NSTL staff on the Internet at editors@nstl.com; at NSTL, Inc., Plymouth Corporate Center, Plymouth Meeting, PA 19462; or at (610) 941-9600. Contact BYTE on the Internet or BIX at ajoch@bix.com or at (603) 924-9281.

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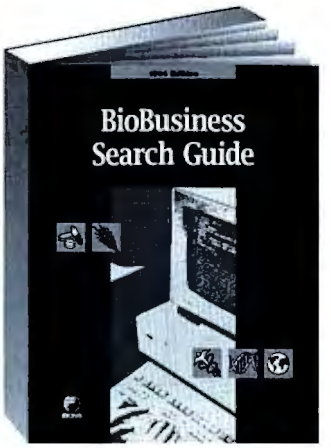

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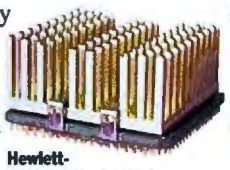
Beating the Heat

Pentium buyers still must pay careful attention to how systems designers dissipate the heat generated by these fast CPUs. The original 5-V 60-MHz Pentium chip runs hot enough to force designers to use both a heat sink and a CPU fan (typically mounted on top of the heat sink) to maximize cooling and ventilation. These small fans, attached to the system's power supply, force air down onto the Pentium processor.

Hertz P 6o fan and chip combination

The newer 3.3-V 90- and 100-MHz Pentium chips run cooler but require a large heat sink, which some designers still pair with a fan. The combinations of heat sinks and fans are generally effective but often clumsily placed, in some cases blocking as many as three of the available adapter slots. Another option we saw was a fan mounted at the front of the motherboard to blow air around the interior of the system.



Hewlett-Packard Vectra XU's heat sink

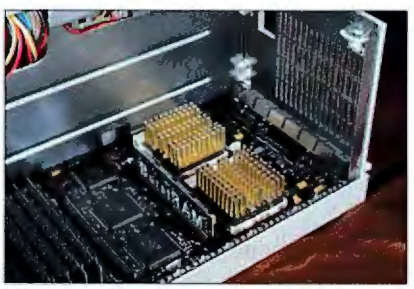
We saw a lot of variety in the ways heat sinks and fans are attached. Some fans, including the one used by Tangent in its PCI 566 system, clip onto the CPU with a sturdy wire. Others, such as the one in Austin Direct's P5-66 System, are simply glued to the processor. In at least one case, the fan in the Cornell Pentium EISA Power Pak failed, and the glue melted as the 66-MHz chip began to overheat.

The small plastic fans, which amount to an investment of $10 to $20 each for systems vendors, command a small price for peace of mind for systems that average $5000 and higher. But given the fan failures we saw during our testing, it's wise to open systems regularly to check on fan performance, especially if you leave your system running all the time.

A better idea found on some high-end Pentium servers, such as Compaq's ProLiant, is a thermostat that triggers an alarm process should the system's internal temperature climb above normal. You can also buy a third-party fan unit with a thermostat that performs the same function.

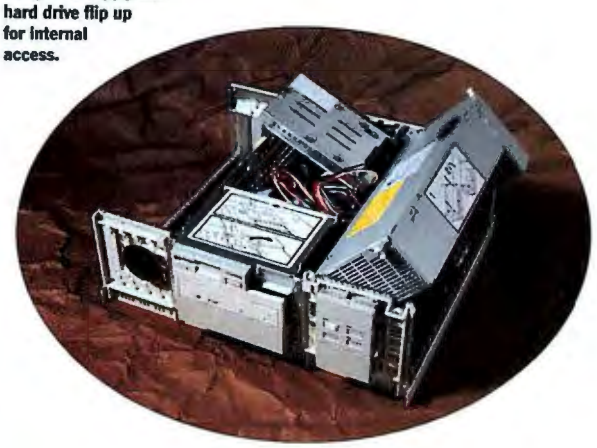
HONORABLE MENTION

We loved the well-considered design of Hewlett-Packard's new Vectra XU 5/90C. We tested the 90-MHz version of this PCI-based system; a 100-MHz version should be available by the time you read this. The XU series offers mass storage (both IDE and SCSI-2), networking, and video integrated on the motherboard via the 32-bit PCI bus. The standard on-board video accelerator is an S3 chip set that can display up to 1280- by 1024-pixel resolution. However, our test model was configured with an optional higher-performance video card, Matrox's MGA II. Standard networking features are the 32-bit PCT Ethernet interface and both coaxial and 10Base-T UTP (unshielded twisted-pair) connectors.



With the power supply up, memory and CPUs (two here) are easily accessible.

The power supply and hard drive flip up for internal access.



The internal design of the system is ingenious for making it easy to access components (see the photos). On the right side of the Vectra XU, the hinged power supply swings up onto the midsection of the system, out of the way, to expose the SIMM slots, the secondary cache, and a second available Pentium socket. The internal hard drive, at the center rear, also flips up (after the removal of one screw) to expose the backs of all the other drives, as well as all the cabling for the integrated controllers.

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VENDOR	MODEL	PRICE AS TESTED	PERFORMANCE WINDOWS	DOS	SPECINT	SPECFP	BYTE UNIX	EASE-OF-USE SCORE	FEATURES SCORE
100-MHZ									
BYTE Siemens Nixdorf	PCE-5S	$9149	8.57	9.79	31.87	37.86	2.54	▲▲▲▲	▲▲▲▲
BYTE Tangent Computer	PCI 5100	$5621 [1]	8.36	9.14	75.65	62.59	4.56	▲▲▲▲	▲▲▲
90-MHZ									
Dell Computer Corp.	OmniPlex 590	$7386	7.44	7.69	—[3]	—[3]	—[3]	▲▲▲	▲▲▲
Gateway 2000	P5-90	$5014	7.45	7.68	—[3]	—[3]	—[3]	▲▲▲▲	▲▲▲
Hewlett-Packard Co.	Vectra XU 5/90C	$7210 [2]	7.29	8.00	—[3]	—[3]	—[3]	▲▲▲	▲▲▲
66-MHZ									
Advanced Logic Research, Inc.	Evolution VQ 66	$8817	6.53	7.95	61.49	52.07	2.65	▲▲▲	▲▲▲▲
Austin Direct	P5-66 System	$4499	6.77	7.61	—[3]	—[3]	—[3]	▲▲▲	▲▲▲
BYTE Cornell Computer Systems	Pentium Power Pak	$4295	7.30	7.64	—[3]	—[3]	—[3]	▲▲▲▲	▲▲▲▲
Cornell Computer Systems	Pentium EISA Power Pak	$4395	7.24	6.67	—[3]	—[3]	—[3]	▲▲▲▲	▲▲▲▲
Digital Equipment Corp.	DECpc XL 566	$5948	6.37	6.84	51.57	47.56	3.86	▲▲▲	▲▲▲▲
Duracom Computer Systems	Mini Pro 586/66	$4793 [1]	4.90	6.91	—[3]	—[3]	—[3]	▲▲	▲▲▲
Hertz Computer Corp.	P 6e	$4688	5.65	7.08	53.26	47.38	2.36	▲▲▲▲	▲▲
Tangent Computer	PCI 566	$3795 [1]	6.86	7.65	—[3]	—[3]	—[3]	▲▲	▲▲
Xinetron, Inc.	X/Lan Pentium 66	$5299	6.00	7.00	54.33	45.21	3.41	▲▲▲	▲▲▲
60-MHZ									
CompuAdd Computer Corp.	CP60p	$4614 [1]	5.75	6.07	—[3]	—[3]	—[3]	▲▲	▲▲
Data Storage Marketing, Inc.	P5-60 PCI	$4495 [1]	6.31	6.49	47.11	43.39	3.54	▲▲▲	▲▲▲
Digital Equipment Corp.	DECpc LPx 560	$5486	4.92	6.45	47.18	42.93	3.07	▲▲	▲▲▲
Insight Direct	PCI P60 CD Sound	$3999	6.04	6.46	45.73	41.08	3.22	▲▲▲	▲▲▲
International Instrumentation, Inc.	Blue Max Business Partner P560	$4947	6.68	7.27	—[3]	—[3]	—[3]	▲▲	▲▲▲
Swan Technologies	Swan Pentium 60	$4299	6.08	6.31	46.55	41.62	2.82	▲▲▲	▲▲▲
Wyse Technology	Series 6000i Model 685	$7650 [1]	5.52	6.61	—[4]	—[4]	—[4]	▲▲▲	▲▲▲

BYTE = BYTE Best

[1] Doesn't include monitor

[2] Estimated street price

[3] No video drivers available for SCO Unix during testing

[4] Unable to run Unix benchmarks; problem unresolved during test cycle

[5] Doesn't support SCO Unix

Excellent ▲▲▲▲ Good ▲▲▲ Fair ▲▲ Poor ▲

FEATURES CONTINUE ON NEXT PAGE

EXPANSION BUS	LOCAL BUS	CASE TYPE	RAM (MB) AS TESTED	RAM (MB) MAXIMUM	SECONDARY CACHE (KB) AS TESTED	SECONDARY CACHE (KB) MAXIMUM	TOTAL SLOTS 16-BIT [1]	TOTAL SLOTS 32-BIT [1]	TOTAL SLOTS LOCAL BUS	TOTAL DRIVE BAYS 3½-INCH	TOTAL DRIVE BAYS 5¼-INCH
EISA	VL-Bus	▮	32	512	256	256	1	7	1	6	4
ISA	VL-Bus and PCI	▮	32	128	512	512	2	0	6	3	6
EISA	PCI	▬	32	192	256	256	0	3	2	2	3
ISA	PCI	▮	32	128	256	256	4	0	3	4	4
ISA	PCI	▬	32	256	256	512	3	0	2	2	2
EISA	VL-Bus	▮	32	1024	512	512	0	7	3	2	11
ISA	PCI	▮	32	128	256	256	4	0	3	4	4
ISA	PCI	▮	32	192	512	512	4	0	1	4	3
EISA	PCI	▮	32	192	512	512	0	3	2	4	3
ISA	PCI	▮	32	192	256	256	3	0	3	2	3
ISA	PCI	▯	32	128	256	256	4	0	3	3	3
ISA	PCI	▬	32	128	512	512	3	0	4	4	3
ISA	PCI	▮	32	128	256	256	5	0	3	3	6
ISA	VL-Bus	▮	32	128	512	512	5	0	3	0	7
ISA	PCI	▯	32	128	256	256	4	0	3	3	4
ISA	PCI	▮	32	192	512	512	4	0	3	3	6
ISA	PCI	▬	32	128	256	256	3	0	3	2	3
ISA	PCI	▮	32	128	256	256	4	0	3	9	4
ISA	VL-Bus	▮	32	128	2048	2048	5	0	3	6	4
ISA	PCI	▬	32	128	256	256	4	0	3	2	3
EISA	None	▮	32	192	256	256	0	7	0	0	6

[1] Not including local-bus slots or shared PCI slots

Case type:
Tower ▮ Desktop ▬ Mini-tower ▯

ROLL CALL OF PENTIUMS TESTED

		HARD DRIVE				GRAPHICS		MONITOR	
VENDOR	MODEL	INTERFACE	SIZE (MB)	CONTROLLER LOCATION	VENDOR	VIDEO CHIP SET	MAX. RESOLUTION NONINTERLACED	VENDOR	MODEL
100-MHZ									
BYTE Best **Siemens Nixdorf**	**PCE-5S**	**SCSI**	**1000**	**Motherboard**	**Quantum**	**Matrox**	**1280 × 1024**	—[1]	—[1]
BYTE Best **Tangent Computer**	**PCI 5100**	**SCSI**	**2048**	**PCI adapter**	**Seagate**	**Weitek**	**1280 × 1024**	—[1]	—[1]
90-MHZ									
Dell Computer Corp.	OmniPlex 590	SCSI	1024	Motherboard	DEC	ATI	1280 × 1024	Mitsubishi	P1528U
Gateway 2000	P5-90	SCSI	1000	ISA bus	Seagate	Matrox	1280 × 1024	Mag	GW 1572FS
Hewlett-Packard Co.	Vectra XU 5/90C	SCSI	1000	Motherboard	Seagate	Matrox	1600 × 1200	HP/Philips	D2806A
66-MHZ									
Advanced Logic Research, Inc.	Evolution VQ 66	SCSI	1370	EISA bus adapter	Maxtor	ATI	1280 × 1024	Teco	FlexView 3xNI
Austin Direct	P5-66 System	SCSI	1003	PCI adapter	Hewlett-Packard	Tseng Labs	1280 × 1024	KFC	MN2409
BYTE Best **Cornell Computer Systems**	**Pentium Power Pak**	**SCSI**	**1050**	**PCI adapter**	**Micropolis**	**ATI**	**1280 × 1024**	**ADI**	**4GP**
Cornell Computer Systems	Pentium EISA Power Pak	SCSI	1050	PCI adapter	Micropolis	Matrox	1600 × 1200	ADI	4GP
Digital Equipment Corp.	DECpc XL 566	SCSI	1024	Motherboard	DEC	Weitek	1280 × 1024	DEC	FR-PCXBV-PC
Duracom Computer Systems	Mini Pro 586/66	SCSI	1052	ISA bus	Micropolis	Cirrus Logic	1024 × 768	—[1]	—[1]
Hertz Computer Corp.	P 6e	SCSI	1024	Motherboard	Micropolis	ATI	1280 × 1024	Mag	DX15FG
Tangent Computer	PCI 566	IDE	1024	Motherboard	Connor	Tseng Labs	1024 × 768	—[1]	—[1]
Xinetron, Inc.	X/Lan Pentium 66	SCSI	1052	VL-Bus	Micropolis	ATI	1280 × 1024	Socos	1568
60-MHZ									
CompuAdd Computer Corp.	CP60p	SCSI	1024	PCI adapter	Western Digital	Tseng Labs	1280 × 1024	—[1]	—[1]
Data Storage Marketing, Inc.	P5-60 PCI	SCSI	1054	PCI adapter	Seagate	Tseng Labs	1280 × 1024	—[1]	—[1]
Digital Equipment Corp.	DECpc LPx 560	SCSI	1024	ISA adapter	DEC	S3	1024 × 768	DEC	FR-PCXBV-PC
Insight Direct	PCI P60 CD Sound	SCSI	1052	PCI adapter	Seagate	ATI	1280 × 1024	Mag	DX15
International Instrumentation, Inc.	Blue Max Business Partner P560	SCSI	1090	VL-Bus adapter	Connor	Tseng Labs	1280 × 1024	Samsung	15C
Swan Technologies	Swan Pentium 60	SCSI	1024	PCI adapter	Seagate	Tseng Labs	1280 × 1024	EMC	ND1560
Wyse Technology	Series 6000i Model 665	SCSI	1030	EISA bus adapter	Fujitsu	S3	1280 × 1024	—[1]	—[1]

BYTE Best = BYTE Best

[1] No "typical" 15-inch monitor sold with this system

SCREEN SIZE (IN.)	DOT PITCH (MM)	CD-ROM VENDOR	CD-ROM MODEL	FCC RATING	WARRANTY (MONTHS)	POWER SUPPLY OUTPUT (W)	POWER SUPPLY AC INPUT (V)	SWITCHABLE VOLTAGE	SCSI PORT	PHONE	TOLL-FREE PHONE	INQUIRY NUMBER
—[7]	—[7]	Sony	CDU 561	B	36	470	100/240	✔	✔	(805) 670-6590	(800) 268-2931 [8]	1105
—[7]	—[7]	Plextor	DM3028	A	12	300	115/230	✔	✔	(415) 342-9388	(800) 800-5550	1106
15	0.28	NEC	CDR510	B	12	224	115/230	✔		(512) 338-4400	(800) 613-3355	1107
15	0.28	Mitsumi	CRMC-FX001D	B	36	300	120/240	✔		(605) 232-2000	(800) 846-2000	1108
15	0.28	Toshiba	XM-4101b	B	36	130-170	100/240	✔	✔	None	(800) 752-0900	1109
14	0.28	Texel	DM-3028	A	15	415	110/120, 220/240	✔	✔	(714) 581-6770	(800) 444-4257	1110
15	0.28	Sony	CDU 33A-01	A	24	200	120/240	✔	✔	(512) 339-3500	(800) 752-1577	1118
15	0.28	Toshiba	XM-3401B	B	36	300	115/230	✔	✔	(909) 594-5848	(800) 886-7279	1111
15	0.28	Toshiba	XM-3401B	B	36	300	115/230	✔	✔	(909) 594-5848	(800) 886-7279	1112
15	0.28	Toshiba	XM-4101B	B	36	300	115/230	✔	✔	(508) 493-5111	(800) 722-9332	1113
—[7]	—[7]	Plextor	DM3028	Pending	12	220	115/230	✔	✔	(214) 518-1200	(800) 551-9000	1114
15	0.28	Matsushita	CR-562-B	A	12	200	110/220	✔	✔	(212) 684-4141	(800) 232-8737	1115
—[7]	—[7]	Panasonic	563	A	12	300	115/230	✔		(415) 342-9388	(800) 800-5550	1116
15	0.28	Toshiba	XM-3401TA	B	24	250	120/240	✔	✔	(408) 727-5509	(800) 345-4415	1117
—[7]	—[7]	Toshiba	XM-3401	B	12	200	115/230	✔	✔	(512) 250-1489	(800) 627-1985	1119
—[7]	—[7]	Toshiba	XM-3401TA	B	36	230	120/240	✔	✔	(303) 442-4747	(800) 543-6098	1120
15	0.28	Toshiba	XM-4101B	B	36	200	120/240	✔		(508) 493-5111	(800) 722-9332	1121
15	0.28	Mitsumi	FX001D	B	12	230	110/220	✔	✔	(602) 902-1176	(800) 998-8045	1122
15	0.28	Toshiba	XM-3401TA	A	12	250	115/230	✔	✔	(805) 495-7673	(800) 543-3475	1123
15	0.28	MediaVision	cdr-H93MV	B	12	200	120/240	✔	✔	(508) 460-1977	(800) 468-7926	1124
—[7]	—[7]	Toshiba	XM-3301B	B	12	325	115/230	✔	✔	(408) 435-2770	(800) 800-9973	1125

[8] Canadian ✔ = yes.

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Italy	(39) (0184) 231.606	(39) (0184) 231.243	United Kingdom	(923) 242222	(923) 249269
Japan	(81-3)-3296-7324	(81-3)-3296-7329	Venezuela	(58 2) 2372268	(58 2) 2399937
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Functional Programming Comes of Age

Beyond Lisp, some new functional programming languages are starting to emerge after the ongoing research of the eighties

DICK POUNTAIN

The idea of functional programming—namely, that mathematical specifications should be executed directly as computer programs—has been around since the dawn of modern computing. Lisp, the grandparent of functional languages, emerged soon after FORTRAN made its debut in the mid-1950s; in fact, FORTRAN pioneer John Backus devoted most of his subsequent career to studying functional programming systems.

What's kept FPLs (functional programming languages) out of the mainstream thus far has always been their desperately slow performance and memory greed when compared to imperative languages such as Pascal and C. Only now, following a decade of crucial research breakthroughs, are we seeing the arrival of industrial-strength FPLs that can compete with C in both time and space efficiency.

What is it about FPLs that makes people persevere in this El Dorado quest? In a word, provability. Pure functional programs possess the mathematical property of *referential transparency*, which roughly means that the same expression always represents the same value. This transparency enables you to reason about program execution, and hence to mathematically prove a program's correctness. The possibility of writing provably correct programs (rather than spending your time picking out bugs) could revolutionize the economics of software production.

Imperative languages such as Pascal and C are not referentially transparent because they're based on *destructive updating*. For instance, when you execute an assignment statement such as `x := 12`, the current contents of *x* are destroyed and replaced by 12. Subprograms that employ destructive updating have side effects that can alter the execution of other subprograms, and this destroys referential transparency.

The whole history of imperative languages so far has been a battle to gain control over these side effects, first via structured programming, then modular programming, and now via the encapsulated methods of object-oriented languages. On the plus side, destructive updating is very efficient on present-day computers whose CPU registers, RAM, and magnetic-disk storage hardware all work via destructive updating.

By contrast, the variables in a pure FPL program are like those used in algebra: They represent an initially unknown value that, once computed, doesn't change. In a pure FPL program, you can't change the value of a variable once it has become bound, and the only way to pass a value into a function is via its arguments. Execution of an FPL program starts with the evaluation of an initial expression and leads to a tree of nested sub-expressions whose results depend only on the values of their function arguments.

What's more, the order in which sub-expressions are evaluated can't affect the final result, which means that functional programs are inherently suited to parallel execution. FPLs use recursion instead of looping to perform repetitive computations, and they work with dynamic on-the-fly data structures, such as lists, tuples, and trees, whose memory is allocated and disposed of automatically by the system. A functional programmer is never exposed to memory leaks or dangling pointers. FPLs are so expressive that programs tend to be an order of magnitude shorter than their imperative-language equivalents. Look, for example, at the elegant quicksort for lists expressed in the Miranda language in the listing below.

Implementing FPLs

The downside to FPLs is that their virtues can cause the inefficiency that has made them impractical for commercial use: The functional model of program execution is too far away from the reality of register-based computers. Recursion and dynamic data structures, which must be copied to be updated, can cause the time and space complexity of functional programs to explode compared to their imperative equivalents, which reuse resources. Historically, languages like Lisp have always compromised by adding destructive assignment and explicit looping, thus abandoning referential transparency.

FPL research throughout the 1980s concentrated on the basic theory of functional computation models, and the new understanding gained is now bearing fruit in a generation of new FPLs, such as Hope, Miranda, Haskell, Concurrent Clean, and Erlang, that combine efficient execution with referential transparency (see the text box "The Erlang Language" on page 184).

A quicksort in the Miranda language

```
quick_sort:: [num] -> [num]
quick_sort[]     = []
quick_sort(a:x) = quick_sort[b | b <- x; b <= a]++
                  [a]++
                  quick_sort[b | b <- x; b > a]
```

Pure FPLs can be thought of as deriving from Alonzo Church's lambda-calculus (introduced in 1932), which, when combined with Alan Turing's work, founded the modern theory of computers and computability. Lambda-calculus is a good tool to use for investigating the semantics of FPLs, but it's not so good for implementing them because of tricky problems about variable renaming.

continued

The Erlang Language

The Erlang language, named after Danish mathematician Agner Erlang, was developed by a team of employees at the giant Swedish communications firm Ericsson, where it's used to write huge real-time control programs for telephone exchanges and network switches. Since it's targeted specifically at the communications industry, Erlang eschews many powerful features of Miranda and Concurrent Clean for execution speed, but it nevertheless remains a pure FPL (functional programming language) with no destructive variable assignment.

Erlang supports concurrency and has built-in primitives for asynchronous message-passing between processes. The language was originally developed on an interpreter written in Prolog, but the latest version generates C macros for compilation by standard C compilers. Erlang uses a fairly orthodox FPL syntax with both pattern matching and guards. Here's one possible definition of the factorial function:

```
factorial(0) -> 1
factorial(n) -> n * factorial(n-1)
```

Lists and tuples are the only compound data types Erlang supports; however, like Clean, it features an efficient interface to several GUI operating systems, so you can write interactive graphical applications. Special attention is paid within Erlang to error-handling behavior and to "hot" replacement of code modules in running systems, which is vital in the telecommunications business.

Ericsson's experience with Erlang so far is extremely encouraging. Joe Armstrong, one of Erlang's developers, tells me his team has just written "what we believe to be the largest declarative program ever written: 250,000 lines of Erlang and still growing." This would be equivalent to several million lines of a less-expressive language, such as C.

Ericsson will release Unix and Windows NT versions of Erlang as commercial products this summer. A free DOS version is planned soon.

However, several FPLs have been based on a subclass of lambda-calculus called *combinators*.

Modern FPLs tend instead to be based on TRSes (term-rewriting systems) that use pattern matching to choose among a set of rules that define how each sub-expression will be rewritten, or *reduced*, toward the result. Even if the order of reducing sub-expressions can't affect the value of the result, it can crucially affect time and space complexity, as well as whether the evaluation ever terminates.

The science of compiling FPLs hinges on this question of reduction strategy; two key issues that compiler designers must face are lazy versus strict evaluation (explained below) and which strategies are *normalizing* for a particular class of TRS (which roughly means that they will converge on a unique answer).

Recently, an extension of TRSes called GRSes (graph-rewriting systems) have come to the fore; they represent programs internally as directed graphs (i.e., pointers) rather than terms. GRSes improve efficiency by sharing computations to avoid duplication of work; for instance, where a TRS might have to evaluate the same sub-expression twice, a GRS can redirect the graph to point to the result of a first evaluation.

Concurrent Clean

The Concurrent Clean language, developed at the University of Nijmegen in Holland, is a good example of the new style of efficient FPL. Clean is a pure, lazy, higher-order functional language that supports concurrent processes and distributed execution. A *lazy* implementation is one in which sub-expressions are reduced only if they are needed to reach the result; the opposite, a *strict* implementation (e.g., Lisp), always evaluates a function's arguments before reducing the function. Although strict evaluation can be more efficient, lazy evaluation adds greatly to expressive power by handling, for example, infinite lists that would never terminate if evaluated strictly. Concurrent Clean permits selected arguments to be declared strict as an optimization.

Clean is implemented as a GRS, using a popular reduction strategy known as the Functional Strategy. Although it compiles to native machine code, internally the Clean compiler generates intermediate code for an abstract machine. This ABC machine (so called because it uses three stacks: A, B, and C) has a hybrid architecture, part of which is an idealized graph-rewriting engine with its own graph store and A stack, while the other part mimics a conventional computer that has a program counter and uses the B stack for operands, and the C stack for return addresses.

Concurrent Clean achieves speeds that are comparable to those attained by C by compiling wherever possible to this conventional part of the machine, which can be mapped into, say, Motorola 68020 code as efficiently as C. The compiler employs scores of subtle tricks to delay writing to the relatively inefficient graph store to avoid building certain subgraphs and to pass arguments via the B stack rather than via graph nodes.

Clean is structured into separately compiled definition and implementation modules along Modula-2 lines. It's a strongly typed language that supports polymorphic, abstract, algebraic, and synonym types. The compiler infers the types of objects and uses type information to generate better code.

Clean's type system also features an enormously powerful new concept called *polymorphic uniqueness types*. To describe this concept in a nutshell, any argument can be declared to be of Unique type, which means it won't be shared by any other function application and can therefore be destructively updated safely without violating the pure functional properties of the program. If such an argument is not used within its own function body, it gets put in the garbage immediately.

This scheme allows Clean to implement records, arrays, and files, which are as time- and space-efficient as those of imperative languages, to interface directly to C programs and, hence, to perform efficient windowed I/O via GUI operating systems such as the Mac's System 7 and the X Window System.

Free Unix and Mac versions of Concurrent Clean are now available from the University of Nijmegen via ftp (ftp.cs.kun.nl). DOS and OS/2 versions are promised for later this year.

A Functional Future

With the performance penalty of functional languages finally lifted, expect to gradually see more commercial use of these languages, such as Concurrent Clean and Erlang.

The functional paradigm is unlikely to displace C++ anytime soon, but as programmers become more aware that object orientation is not a perfect panacea, there should be room for both, or—dare I suggest it?—for some kind of hybrid approach. ■

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

A Different Kind of RISC

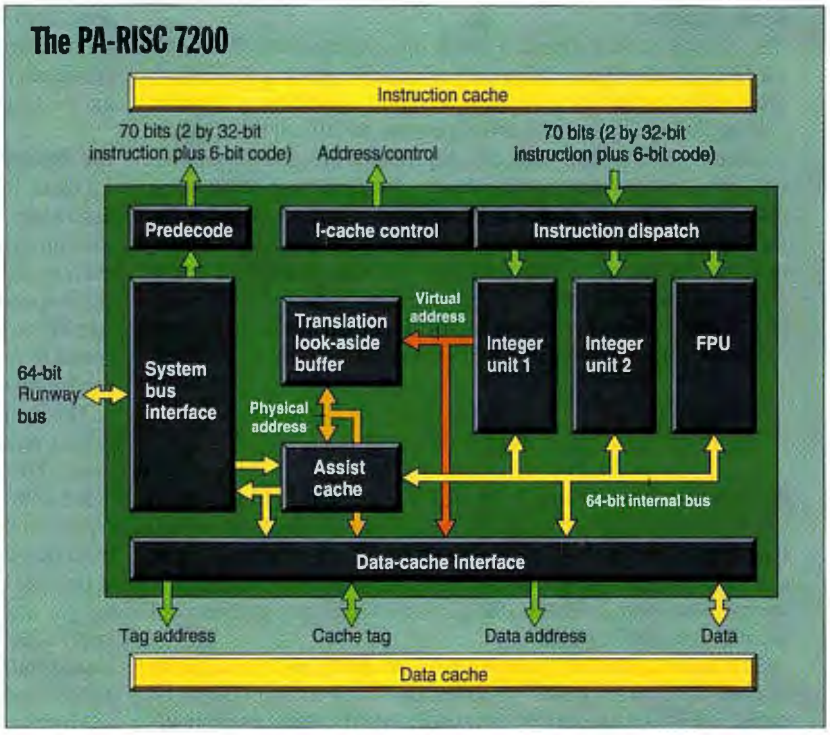
HP's elegant new implementation of its PA-RISC architecture delivers world-class performance

DICK POUNTAIN

When people argue about RISC architectures nowadays, Hewlett-Packard's PA-RISC is unlikely to figure prominently in the discussion. PA-RISC chips have a lower profile than the PowerPC, Mips, or DEC Alpha chips, because HP has so far kept them almost to itself. The company doesn't sell its PA-RISC chips on the open merchant market; instead, it sells only to partners in its PRO (Precision RISC Organization). HP has also been relatively slow in licensing second sources.

The irony of this situation is that the recently announced PA-RISC 7200 (HP's ninth implementation of the architecture) is likely to hold the "fastest RISC in town" title for the immediate future, at least until the PowerPC 620 and Mips T5 come on stream next year. This becomes even more impressive when you realize that the 7200's superscalar design is far less aggressive than that of its competitors. Nevertheless, it is expected to top 175 SPECint92 and 250 SPECfp92, just bettering the Alpha 21064A's 170 SPECint92 rating. But raw SPECmarks are perhaps less appropriate than usual for measuring the 7200, because HP has clearly stated that its aim is to optimize the PA-RISC architecture for the real-world applications that its workstation customers run—mainly scientific and commercial transaction processing on huge data sets—rather than for the best benchmark figures.

A splendid sentiment, and one that can't be dismissed as mere manufacturer's hype because the technical details support it. In the 7200 implementation, HP's design team has concentrated on an artful cache design and a fast new memory bus, rather than on the multiple instruction issue and fancy branch prediction that the competition focuses on. Combined, the new design and faster bus will tend to accelerate large programs and data sets that don't fit in the cache.



Unique in a number of ways, the PA-RISC architecture is best exemplified by its use of off-chip primary instruction and data caches. It integrates 1.3 million transistors onto a 210-mm² die.

Inside the 7200

Fabricated in HP's new three-metal 0.55-micron CMOS process, the 7200 is designed to run at up to 140 MHz. Its 540-pin ceramic PGA (Pin Grid Array) package is truly gigantic. This pin count reflects the fact that like its predecessors, the 7200 supports external data and instruction caches with separate 64-bit interfaces. It also includes a 64-bit interface to the new high-bandwidth Runway bus. The chip's RISC core operates at an unusual 4.4 V but the I/O circuitry works at 3.3 V; power dissipation is expected to be up to 29 W at 140 MHz.

By current standards, the 7200 is only a modestly superscalar design. It can issue two operations per cycle to its two integer units and one FPU. The instructions are classified into three groups; integer, load/store, and floating point. You can pair any two from different groups or two from the integer group. Branches are considered to be special integer operations that may be paired with their predecessor but not their successor. Branch instructions employ static branch prediction.

The 7200's five-stage execution pipeline is designed to minimize the stall penalties caused by data, control, and fetch dependencies between instructions; you incur only a one-cycle penalty for a mispredicted branch, for immediately using a floating-point result, and for store/load or load/use combinations. Unlike in previous PA-RISC chips, store/store incurs no penalty, as the off-chip SRAM (static RAM) cache now cycles at full processor frequency.

continued

To keep the pipeline flowing as smoothly as possible, instructions with data dependencies and resource conflicts should not be paired. The 7200 uses hardware checking for dependencies, but to save time, it performs some of this work as the instructions are loaded from memory into the instruction cache. Six extra predecode bits are stored with each pair of instructions in the cache to encode this information. On their own, these predecode bits don't completely specify whether the instructions can be paired, but they enable the final checks made in the pipeline to be fast enough so that instruction decode/issue is never prolonged beyond one cycle. The predecode bits add about 10 percent to the SRAM overhead.

As with its PA-RISC predecessors, the 7200 uses off-chip caching; however, its main innovation is an on-chip assist cache that makes the caching system much more efficient. The 7200 also separates its instruction and data caches (up to 1 MB each) in place of the single unified cache that the 7100 uses. These caches have to be built from the fastest SRAM and must be able to cycle at full processor speed, which means a 6-nanosecond access time at speeds of greater than 120 MHz. Because such memory is expensive (and hard to source), it increases system costs.

Cache Assistant

The 7200's assist cache is a 2-KB on-chip memory that holds 64 32-byte cache lines and is fully associative, storing the full address of the last 64 memory accesses. Full associativity requires a lot of lookup logic and is too expensive for all but the smallest of caches. In contrast, both off-chip caches are *direct-mapped*, which means that many main memory locations map to the same cache line. Direct mapping is inexpensive and fast, because the logic need only inspect one line to look for a hit. But it suffers badly from "thrashing" if your program continually accesses several different addresses that all happen to map to the same cache index, which can happen easily in vector calculations.

For example, in the following vector calculation

```
FOR i := 0 TO n
DO A[i] := B[i] + C[i] + D[i]
```

it is possible for elements `A[i]`, `B[i]`, `C[i]`, and `D[i]` to map to the same physical cache location. A direct-mapped cache will thrash by reloading the same line as each element is accessed, with a devastating performance penalty of four cache misses per iteration of the loop. Larger cache size can't help this problem but greater associativity can.

The assist cache sits between main memory and the off-chip primary data cache. Lines from memory move through the assist cache in FIFO (first-in/first-out) order into the data cache; in effect, acting as an overflow queue for the primary cache. The assist cache would eliminate the thrashing described above because each line can move into the assist cache without displacing the others. Both the primary and assist caches respond in a single cycle, and they behave like a single logical cache whose associativity varies dynamically with the data. The assist cache might hold 64 lines that map to the same primary cache line, or 64 different primary cache lines, or anything in between. When a processing unit requests data from the cache, 65 entries (i.e., 64 assist cache entries plus one main cache entry) get searched for a match. This work needs to be done inside one cycle, and HP had to use the fastest self-timed logic for the assist cache's lookup circuitry. In effect, the assist cache combines the high associativity of an on-chip cache with the large size of an off-chip cache. HP is so pleased with the result that it's patenting the assist cache.

Another twist is a new "spatial locality only" hint bit you can incorporate into the encoding of load/store instructions. The hint bit tells the assist cache that the data will be used only once, and that when the line needs to be replaced, it should write the data straight back to main memory (bypassing the off-chip cache). This enables efficient processing of long sequences of contiguous data without polluting the primary cache's temporally local data (i.e., variables that are being used repeatedly).

The 7200 uses simple but effective prefetch strategies for both instructions and data, which can often hide the penalties caused by cache misses and memory latency. When the instruction cache misses, it fetches not just the missing line but the next line, too. When such a prefetched line is accessed for the first time, the next line is fetched again, even if another prefetch is still in progress—up to four prefetches can be outstanding. This results in significant speed ups on long linear code sequences, but you can turn it off for programs with short routines and many branches.

Data is prefetched explicitly (i.e., by instructing a load to register zero) or automatically whenever an instruction that modifies a base register address is executed. For example, the load-word-indexed instruction `LDWX,m R1(R2),R3` loads `R3` from the address held in `R2` and then post-increments `R2` by adding `R1` to it. If this instruction causes a data-cache miss then the 7200 is smart enough to prefetch from `R2+R1` (rather than from `R2+1`) after it fills the missing line; it takes note of the "stride" of the indexed load.

The Runway Bus

To make full use of its efficient caches, the 7200 needed a high-bandwidth data path into memory—hence, the new Runway bus. This proprietary synchronous 64-bit bus runs at 120 MHz; however, it supports 1-to-1, 3-to-2, and 4-to-3 ratios between its own clock speed and the CPU's so that the CPU can be run faster. It employs a distributed arbitration scheme where each device attached to the bus contains its own arbiter logic, and arbitration proceeds in parallel with data transfer along separate wires.

The Runway bus uses a split transaction protocol in which up to six transactions can be pending at once, so the bus is available even while waiting for memory to deliver. Each transaction is labeled with an identification code—carried via yet another set of signal wires—so each device can sort out its own return data from the stream. The Runway bus multiplexes address and data at the cost of one address cycle for every four data cycles, making for a total sustainable bandwidth of 786 MBps. That's an impressive figure, not only three times faster than HP's own previous processor bus but faster than Sun Microsystems' advanced XDbus and pushing up into supercomputer territory.

More to the point, it's sufficient to support four 7200 chips in an SMP (symmetric multiprocessing) system without becoming a bottleneck. The bus interface supports a snooping cache coherency protocol, and to minimize the penalties for snooping on processor-to-cache bandwidth, the interface maintains deep coherency queues (up to 10 transactions for the main cache and three for the translation look-aside buffer, or TLB).

By building the bus interface onto the PA-RISC 7200 chip, HP will be able to build multiprocessor systems with a minimum of glue logic. In doing so, the company will keep the price and performance of its SMP workstations and servers highly competitive. ■

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System 7.5: A Step Toward the Future

Apple's new Mac OS, simultaneously released on 680x0- and PowerPC-based Macs, has new features both over and under the covers

TOM THOMPSON

Earlier this summer, Apple made a new release of its Macintosh operating system, System 7.5. What's significant is the fact that the company accomplished this release for machines using two different processors: its 680x0-based Macs and its PowerPC-based Power Macs.

At first glance, System 7.5 doesn't appear much different from its predecessor, version 7.1. This is actually a good thing, since users get very upset if the way in which their computers work changes drastically.

Nevertheless, System 7.5 is a vehicle for change in two ways. First, strategic new elements in the interface improve the user's productivity. Second, important additions to the operating system enable developers to tailor their applications to exploit features in the future release of the Mac OS (code-named Copland; more on this later). I'll start this discussion with a tour of the operating system's productivity features.

New on the Menu Bar

The one obvious change to System 7.5 appears on the menu bar: The icon for the help menu has changed from a balloon to a question mark. Balloon help has been supplanted by Apple Guide, a new help system.

But Apple Guide is more than just a help system. As its name implies, Apple Guide is an interactive assistant that actually guides you through a complex task. It does this by using a stream of Apple Events to drive the application(s) involved in a particular operation and by using *coachmarks*, which are visual cues that point out the items involved to complete the operation. Coachmarks consist of automatically highlighted files or menu items and the use of a red swath that circles critical objects (see the screen).

For example, to change the Mac's protocol stack from AppleTalk to TCP, Apple Guide first circles the Apple menu icon in red. When you pull down the Apple menu, the Control Panels item is highlighted in red. Once you open the Control Panels folder, the Network Control Panel is both selected and circled in red, and so forth. Once Apple Guide finishes its tutorial, you've actually completed the task.

This same capability can be added to applications, so users can actually make use of their sophisticated features. Because it uses Apple Events, Apple Guide can be easily integrated into OpenDoc or any componentware.

Another interface improvement becomes evident as you use QuickDraw GX, which is bundled with System 7.5. With QuickDraw GX, you no longer use the Chooser to establish a connection to a printer; instead, you construct visual "sockets" to multiple printers. You do this by selecting a printer in the Chooser and clicking on a Create button. A printer icon bearing the networked printer's name appears on the Desktop. You repeat this process for every printer you use.

Then when you want to print a file, you just drag and drop the document's icon onto the desired printer icon. Double-clicking on the printer icon opens a window displaying the printer's queue, where you can delete or reorder print jobs by clicking and dragging. Best of all, you can print simultaneously to several printers—something you couldn't do with previous versions of the Mac OS.

It's important to note that the installation of QuickDraw GX is optional. That's because QuickDraw GX doubles System 7.5's minimum memory requirement—from 4 MB of RAM to 8 MB.

System 7.5 adds several other productivity features to the interface. A time-of-day clock appears on the menu bar. In a nod to the usefulness of Now Utilities' Super Boomerang, the operating system now remembers the last folder your application used and provides pop-up menus on the Apple menu that give you quick access to the most recently accessed applications, servers, and files. A Windowshade Control Panel lets you double-click on a window's title bar and conceal the window's content area, leaving the title bar as a placeholder. A second double-click exposes the window again. This feature lets you manage screen clutter, especially on Macs with large amounts of RAM and small screens. *continued*

Apple Guide in operation.

Interiors

Beneath the surface, System 7.5 offers some significant enhancements for developers. One is the simple bundling of existing system software components, such as AppleScript, MacTCP, Telephone Manager, and PowerTalk.

System 7.5 Features

- Enhanced user interface
- Apple Guide, a new interactive help system
- AppleTalk and TCP protocol stacks
- PowerTalk collaboration software
- AppleScript
- Telephone Manager, which provides telephony functions
- QuickDraw GX, which provides new graphics functions and improved printing services
- SCSI Manager 4.3, for more efficient SCSI peripheral I/O
- Thread Manager, which offers thread capabilities for applications design

To review, AppleScript is Apple's batch-control language, which can automate operations. Importantly, Finder 7.5 is now scriptable, so you can write scripts that, say, back up the files in a certain folder by having the Finder copy them to a server at the end of the day.

MacTCP implements a TCP protocol stack alongside the AppleTalk stack so that you can make use of various Unix or Internet services (currently, File Sharing and Remote Access still use the AppleTalk stack). The Telephone Manager is an API that provides telephony functions (i.e., applications use the Telephone Manager to implement a virtual telephone, dial on-line services, and route calls).

PowerTalk is Apple's collaboration software; it provides mail services, digital signatures to validate electronic forms, and data encryption of the sensitive data in such documents. Thus, PowerTalk makes the paperless office a possibility.

Because PowerTalk uses Apple Events as its communications mechanism, document routing and processing can be done over a network. Furthermore, this enables forms automation and document tracking, which can identify bottlenecks in the work flow. When Apple revamped its documents to operate on PowerTalk, forms-processing times dropped from three weeks to just three *days*. As with QuickDraw GX, installation of PowerTalk is optional.

Most of these system components have been in use for two years or more but were available only as options. Now they are a standard part of System 7.5, which encourages applications designers to make use of these services.

In addition, System 7.5 now provides SCSI Manager 4.3 as standard fare. First implemented on AV Macs (the Centris 660AV and Quadra 840AV) and then on Power Macs, its services are now available across the entire Macintosh product line.

One of SCSI Manager 4.3's major features is its asynchronous I/O services. This enables an application to make calls to SCSI peripherals and, instead of stalling the processor to wait for the I/O to finish, work on other duties until a dedicated completion function gets called to wrap up the I/O. Hence, both the processor and SCSI bus are used more efficiently. While I'm on the subject of disk drives, the filing system has been improved to support volumes up to 4 GB in size, eliminating the current limit of 2 GB.

Other System 7.5 enhancements are new and designed to help developers revise their software so that they can exploit features in the future release of the Mac OS mentioned earlier. Code-named Copland, this is Apple's planned major revision of the Mac OS. It is a microkernel-based, multithreaded operating system, complete with memory protection and a new I/O architecture

(see "Apple's and Microsoft's System Software Road Map," May BYTE).

One of these enhancements, the Drag and Drop Manager, provides a seamless method of moving text or graphical data among applications. Rather than copying an image to the Clipboard in one application, switching to another application, and pasting the image into that application's document, you simply drag and drop the image from one window to another. The Drag and Drop Manager sweats the details of the data transfer. Both OpenDoc and Copland will rely on this Manager to mediate transfers among various software components. Thus, a user won't be aware that such data transfers occur when he or she manipulates a document's contents.

Follow the Thread

Finally, System 7.5 provides a Thread Manager. A *thread* is a lightweight process that has its own stack but makes use of the host application's memory and system resources. The Thread Manager attempts to use the existing Mac programming model to preserve compatibility with existing software. Its API handles the creation, scheduling, and deletion of threads, and it also provides routines to assign the amount of stack each thread uses, as well as set the thread type.

Threads use one of two scheduling methods: cooperative and preemptive. *Cooperative* threads, like System 7.x's Process Manager, return control to the processor at explicit times. *Preemptive* threads use a time-slice scheduling mechanism—either a default scheduler or a custom scheduler that you provide. Note that all of an application's threads, both cooperative and preemptive, execute only when the Processor Manager switches the application into the foreground (i.e., it becomes the active application).

Why use threads? One reason is to allow software designers to divvy up an application's functions. For example, one thread maintains screen updates for the application's windows, another manages the user interface (e.g., performing hit tests on menus or controls), and yet another handles file I/O. This allows for concurrent processing, especially in the critical area of I/O.

Recall that the SCSI Manager 4.3 supports asynchronous I/O and that AV Macs and Power Macs alike provide DMA channels for various I/O subsystems. By using threaded applications, these Macs can work smarter rather than harder: Certain application threads could process data or respond to your keyboard, while other threads could supervise reads and writes to a disk drive, a scanner, or the network.

Crucial Threads

Threads become even more crucial for Copland, which itself will use threads, as well as a new I/O architecture. Count on the Copland I/O architecture's reliance on concurrent I/O, if only for reasons of performance.

Keep in mind, however, that the applications that will make the best use of Copland's threaded nature will not appear overnight. System 7.5 thus serves as an important bridge: It makes the Thread Manager available now, so software designers can start rethinking the structure of their applications. As a result, such applications can make the best use of the Mac, both now and on a future Mac OS. ■

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SNMP Version 2

This protocol's new features let you better manage network devices

WILLIAM STALLINGS
AND BEN SMITH

Network management is never simple—nor are the protocols that are used to implement it. The oxymoronic SNMP (Simple Network Management Protocol) is "simple" only in comparison to the OSI (Open Systems Interconnection) management model. In fact, SNMP was originally designed and implemented as an interim specification for communicating with network devices while the OSI specification was solidifying and being implemented during the late 1980s; it was supposed to fade away once OSI came on-line.

But things haven't worked out that way. By 1993, when OSI finally matured, SNMP had a three-year head start and had already been implemented in hundreds of products. No interim solution, SNMP is now the de facto standard in network management. The reason for its popularity is the true origin of its name: It is simple to implement in hardware.

Having shaken off its "temporary" label, SNMP is maturing in its own right. This is evidenced by the added functionality of SNMP version 2 (hereafter referred to as SNMPv2).

SNMP Background

A network management system must be able to monitor and configure all the elements of a network, both hardware and software. In a network management system, each element uses a piece of software—called the *agent*—to communicate its status and configuration information to the centralized management software. Because the elements of a network and the attributes of the managed devices all fit well into a hierarchical (i.e., tree structure) model, this is the common form used to organize such information.

The OSI management model uses a MIB (Management Information Base) to store the structured information representing network elements and their attributes. The structure itself is called an SMI (Structure of Management Information). OSI defines a complex object-oriented management system around these structures.

When first considering network management during the late 1980s, the IETF (Internet Engineering Task Force) recognized the value of the work that had been put into the OSI model and used many of the concepts in SNMP, which was jointly developed by researchers on the Internet. SNMP retains SMIs and MIBs, although their definition is much simpler under SNMP than it is under OSI.

The SNMP structure is open-ended. In addition to standard MIBs, it supports proprietary MIBs that let a vendor differentiate its device's capabilities from those of competitors. The unfortunate aspect of this open-ended organization is that management tools don't know what to do with proprietary MIBs unless they have extensions for each one. Such is the agony of the open design.

Besides MIBs, the other significant component of SNMP is the communications protocol (the Protocol Data Unit, or PDU) that the manager software uses when communicating with agents. These messages travel within the structure of a UDP (User Datagram Protocol, an IP connectionless packet type).

Originally, PDUs came in just five flavors: GetRequest, GetNextRequest, GetResponse, SetRequest, and Trap. These are called SNMP PDUs. The GetRequest, GetNextRequest, GetResponse, and SetRequest PDUs share a common format; only the Trap PDU has a distinct format.

The Four Major Enhancements of SNMPv2

SNMPv2

1. It offers better security by adding request authentication.
2. It provides better performance for multitable transfers.
3. Managers can share information by acting as agents.
4. SNMP is opening up to other underlying protocols.

An SNMPv2 Wish List

The first major revision to SNMP was published in March 1991 as MIB-II (RFC 1213). Among its many additions, it expanded the list of objects used for managing networks and cleaned up the wording of some of the original definitions. By the end of 1992, the network industry recognized that SNMP had become the de facto standard and that it was in for the long term. Soon proposals began surfacing for improving it in many more ways than just cleaning up the MIBs.

For example, there was a desperate need for better security. With the existing SNMP specification, you could not authenticate the source of a management message or prevent eavesdropping. Without authentication capability, SNMP was vulnerable to attacks that could modify or disable network configurations. As a result, many vendors of SNMP equipment chose not to implement the SNMP `Set` command, which lets you change the configuration of an agent; this reduced the management capabilities of these vendors' equipment to monitoring only.

Another item on the wish list was performance. This is addressed in SNMPv2 with the addition of a PDU called GetBulk, which will reduce the number of requests and replies and thereby improve the performance of retrieving entire MIB trees. Other PDUs were added as well.

A third item on the wish list was the desire to be able to share information between managers. Large networks

have distributed management, as well as far-flung agents. The model of a single manager application didn't fit.

Most of today's networks use mixed protocols. While mixed-protocol devices were addressed in the MIB-II improvements, SNMP still allowed communication between its agents and managers only on UDP/IP networks. It needed to also exist on at least the OSI networks around which it has a strong association.

These improvements were delineated in April 1993, in IETF RFCs 1441 through 1452. Although they are still in the proposal stage, some developers are now implementing what they can.

Security Measures

The new security features of SNMPv2 are designed to provide three security-related services: privacy, message authentication, and access control. *Privacy* is the protection of transmitted data from eavesdropping or wiretapping. Privacy requires that the contents of any message be disguised so that only the intended recipient can recover it. *Message authentication* enables communicating parties to verify that no one has altered received messages and that their sources are authentic. This includes verification of a message's timeliness to ensure that it has not been artificially delayed and replayed. *Access control* ensures that only authorized users have access to a particular management information base.

SNMP security uses the concepts of party and context. A *party* is a manager or agent with assigned security attributes. A *context* specifies whether an exchange between a manager and an agent involves data that's local to the agent (in which case the context indicates the relevant subset of the agent's management information) or if it involves a remote device for which the agent acts as a proxy (in which case the context identifies the proxied device).

As with SNMP, SNMPv2 information is exchanged in the form of a message that includes a header and one of a number of different PDU types; each PDU specifies a particular management operation. The message header consists of five required fields: a destination-party field; a source-party field; a context field; an authentication field, which contains information on the desired level of authentication; and a privacy destination field, which repeats the identifier of the destination party.

When privacy is provided, then the entire message, including the header and PDU but excluding the privacy destination field, is encrypted. The privacy destination field must remain unencrypted so that the destination SNMP module can determine the destination party and the privacy characteristics of the message.

For privacy, SNMPv2 uses DES encryption; for authentication, it uses RSA (Rivest-Shamir-Adleman) encryption combined with the MD5 (Message Digest version 5) function. The latter two algorithms are the same ones that PGP (Pretty Good Privacy) uses (see "Pretty Good Privacy," July BYTE). Authentication also requires that a message be timely to ensure that it has not been artificially delayed and replayed.

SNMPv2 provides its third major security facility, access-control capability, through two concepts: view subtree and MIB view. A *view subtree* consists of a node in the MIB tree plus all its subordinate elements. Associated with each SNMP logical device is a *MIB view*, which consists of a set of view subtrees. Each view subtree in the MIB view either includes or excludes all objects that are contained in that subtree. Associated with each local context of an SNMPv2 entity is a MIB view that defines the set of objects that are visible in this context; alternatively, the context specifies a remote proxied device from which management information can be obtained.

In addition, an SNMPv2 entity maintains an *access-control list table*. Each row of this table includes several elements: the target party, whose performance of management operations is constrained by this set of access privileges; the subject party, whose requests for management operations to be performed are constrained by this set of access privileges; the context that a subject uses to access a target; and an integer that encodes the access privileges for this target/subject/context triple. The integer element is, in effect, a list of the allowable management operations (i.e., PDUs) for this pair of parties using this context.

Performance and Sharing

In real-world use, SNMP performance depends on how fast the agents can handle requests. The bandwidth requirement of SNMP messages is trivial, and managers are usually running sufficiently robust hardware that their processing is of little importance.

But by reducing the number of SNMP requests and messages that agents need to generate, their load is significantly lightened. Because many requests are for large blocks of MIB objects, the concept of a GetBulk operation is an obvious way to increase performance. After all, an agent can process a request for several table entries almost as fast as it can for a single entry.

For example, a typical RMON historical-statistics MIB might have 200 entries. Without a GetBulk operation, management software retrieving this information would generate 200 requests and 200 replies. With a GetBulk operation, there need only be one request and one reply.

The issue of sharing manager information is also solved by the party abstraction. A party can be either an agent or a manager. As an agent, a party is defined by its MIB. As a manager, it just reads and understands the same MIB. Thus, all the IETF needed to do was write the Manager-to-Manager MIB (RFC 1451). With this MIB and the party abstraction, any manager can act as an agent to any other manager, but only within the constraints of the MIB. Needless to say, access control and other security measures are imperative to implementing the Manager-to-Manager communications and control.

Using SNMPv2

SNMP by itself is not a network management system, but only a specification of how management information is encoded and transferred. It provides a common platform that allows developers of network management applications to write software that takes advantage of the common language for communicating with devices. Fortunately, enough detail was built into SNMP from the beginning that it was easy for software folks to pick it up and implement it.

In the IP world, *SNMP* is synonymous with *network management* because the infrastructure was already in place for generating and transporting SNMP. By supporting other transports, SNMP has the opportunity to also become successful in other environments. Simplicity is what made SNMP successful, but maturity, in the form of SNMPv2, is what will give it longevity. ■

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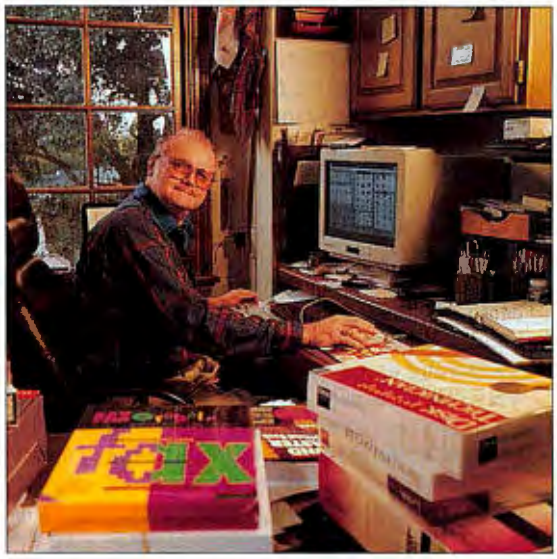
JERRY POURNELLE

Traveling Light



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A quick trip to a SCSI summit gives Jerry an opportunity to explore minimalist on-the-road computing

I've just returned from the second annual SCSI Technology Summit in Orlando, Florida, and I think I've seen a vision of the future. Of course, most of the people who come to the conference already agree that SCSI is the right way to go. But even so, both the list of attendees and their arguments were impressive. They all seem to agree that the future is the PCI (Peripheral Component Interconnect) bus and plug-and-play SCSI. It can't happen soon enough.

I'm weary of system setup problems: memory address clashes, IRQ (interrupt request) settings, DMA channels, and all the rest. I detailed some of these problems last month. I've since had more. They're interesting enough that we still don't have our new Pentium machine working properly, so you'll have to wait for the rest of the story.

A reader recently suggested that Apple ought to buy the rights to republish my columns and run them as ads for the Mac: look at how much trouble it is to set up a PC. Now see how easy it is to add new devices to a Mac. Plug and play with automatic SCSI configuration and the PCI bus are supposed to end all these problems, and I can't wait.

Incidentally, the "almost quote" I opened with is from Lincoln Steffens, known as "America's philosopher," who traveled to the U.S.S.R. in 1920 and came back to proclaim, "I have been over into the future, and it works." It turns out he was dead wrong, but it does make a good quote.

The main presentation at the SCSI Technology Summit was given by John Lohmeyer of NCR/AT&T. Lohmeyer chairs the X3T10 committee that sets standards for SCSI architecture. He noted that the market has splintered, spawning a number of interface designs. They all have their good and bad points.

One of the most significant differences is the maximum permitted cable length, and whether or not you can attach external devices. The latter alone is decisive for me: I move my SCSI-2 external DAT (digital audiotape) drive from machine to machine all the time, and I'd really hate not to be able to do that. The committee is taking due account of backward compatibility (they call it *legacy*), connectors, speed, automatic configuration, and hot plugging, and a number of both obvious and not-so-obvious details.

I'll leave discussion of the technical details of SCSI and the PCI bus to the other BYTE editors, who know far more about it than I do; but I came away with the conclusion that SCSI and the PCI bus are evolving into the system most of us will be using in the future.

The SCSI Technology Summit was hosted by Distributed Processing Technology. It was followed by a meeting of DPT dealers and distributors. That meeting included a hands-on workshop: along one wall were about 30 PC and RAID-drive cases with power supplies, while the opposite side of the room held a large pile of DPT caching drive controllers, cables, SCSI hard drives, DAT drives, and CD-ROM drives. Dealers were to mix and match, building up both simple and RAID (more on that below) systems from these components. DPT put on an impressive demonstration. They also showed new RAID enclosure boxes with controllers and

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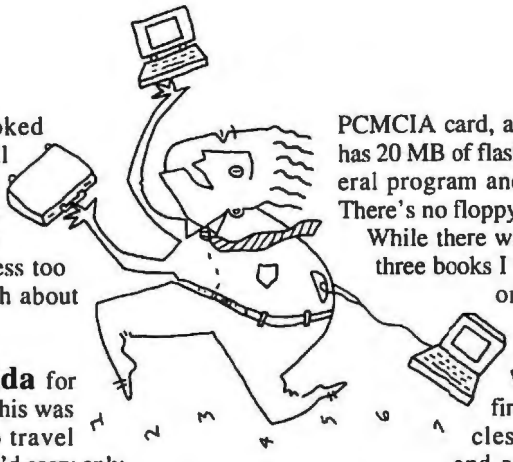


software that looked pretty good, but I'll know more about that when I've got it going here. I've been in this business too long to write much about demonstrations.

I was in Florida for only two days, so this was an opportunity to travel light, which meant I'd carry only one computer. It would have to be a Windows computer: Larry Niven, Steve Barnes, and I are finishing up *Beowulf's Children*, the sequel to *Legacy of Heorot*, and I owed them a scene immediately on my return. We're doing the book in Microsoft Word for Windows, and it exists as two large files, each about half the book.

I'd also be working on the updates to *A Step Farther Out* and *Two Steps Farther Out*; and those too are in Word, partly because it handles footnotes well. In the first book, I'm adding notes to admit where I was wrong and crow when I was right. Very little of it needs revising even now; not bad for science nonfiction that started as columns in the old *Galaxy* science fiction magazine. I find that Word for Windows does very well for editing a whole book.

The two obvious choices were Old Reliable, my Zenith Mastersport 386, and the Hewlett-Packard OmniBook 425. The Mastersport has the advantage of a backlit screen, an adequately large hard drive, high reliability, fast disk access, and one of the best portable keyboards in the business. It's heavy, but I can live with that. The real disadvantage is battery life: with new batteries, it would run for nearly 3 hours on a charge. Over the years, however, those batteries have gotten weaker and weaker, and now I get less than an hour, clearly not enough time to get any work done on an airplane.

The second disadvantage of the Mastersport is that even with new batteries, it's not much use in meetings. It's heavy and bulky, and I just don't want to carry it around in a briefcase. Instead, I carry a Gateway HandBook for use in meetings and leave the Mastersport in my room; but that's two computers, and I'm on a 12-step program to break this addiction to carrying multiple computers on trips.

All this argued for the OmniBook 425. It's light enough to carry to meetings, it runs Windows, and the battery life is extremely good. There's a price for the battery life: no backlit screen and limited hard disk space. The OmniBook has Windows and Microsoft Word for Windows on one PCMCIA card, and another one has 20 MB of flash RAM for general program and data storage. There's no floppy drive.

While there was room for the three books I wanted to work on, there wasn't much room left over for Q&A Write. I use it for first drafts of articles and columns and general meeting notes, especially since I load Q&A Write with the Word Finder thesaurus and Definitions Plus, which contains *The American Heritage Dictionary*. I certainly don't *need* all those extra goodies. For that matter, I could do drafts in Microsoft Word for Windows, but old habits die hard, and trips are precisely the wrong place to try to change the way you do things.

The remedy to limited disk space was a BSE Flashdrive. This is a 300-MB hard drive packed into a box about the size of four packs of cigarettes. The box also contains batteries that will run the drive for a good 3 hours or more. Don't confuse the Flashdrive, which is a genuine spinning metal hard drive, with PCMCIA flash RAM, as used in the OmniBook.

I used LapLink Remote, which comes on the OmniBook, to transfer the Flashdrive software from Big Cheetah to the OmniBook. Then I needed to edit CONFIG.SYS to include the Flashdrive's driver. I discovered to my horror that the OmniBook doesn't have EDIT.COM or even EDLIN, nor does it have the Windows configuration editor. More time lost transferring QBasic and EDIT to the OmniBook, but once I got the Flashdrive driver statement into CONFIG.SYS and rebooted, everything worked fine.

I connected the Flashdrive to one of the machines on the network and loaded it with everything I thought I'd need, including Q&A Write, backup copies of all three books, backup copies of columns, Norton Commander, and some other stuff. The Flashdrive with its little power supply went into my wheeled carryon along with my shirts and toothbrush. I also stuffed in a couple of PCMCIA 14.4-Kbps fax modem cards; the OmniBook I have has a built-in modem, but I figured I'd give these a try.

I tried to get an extra 5- or 10-MB PCMCIA memory card before I left, but I thought of it late, and we didn't find any in stock locally. Instead, we got a 4-MB memory-expansion module from Kingston Technology. Kingston makes RAM upgrades for most machines; they began back in the days when every company offered proprietary memory at outrageous prices, and they've been one of the leading third-party memory sources ever since.

Alex installed the 4-MB memory-expansion module in about 4 minutes, giving my OmniBook a total of 6 MB. That speeds up Windows operations quite a bit, and anyone using an OmniBook would be well advised to make the upgrade. (Of course, PCMCIA memory cards can be moved between different machines, but Windows looooves extra RAM.)

Carrying the OmniBook as my sole machine went pretty well. There was enough light on the airplane to work despite the lack of a backlit screen. The little mouse gadget was a bit frustrating, but not excessively so once I got used to it. I'd had Microsoft Word 6.0 for Windows save off my books in Word 2.0 format, so there was no problem about reading them in.

Incidentally, the change from Word 6.0 to Word 2.0 cost nothing I could see. The curly quotes (i.e., inverted commas) that Word 6.0 uses in place of the straight quotes you see in ASCII or Word 2.0 text remain in place, as do the "three em dashes" that Word 6.0 makes out of double hyphens. Of course, Word 2.0 doesn't insert those in new text, but Word 6.0 will read those files just fine and has an automatic format program. All in all, reading in and editing worked just fine on the airplane, and I got a lot done on the way to Florida.

The problem came when I'd save my work. I started writing with computers back in CP/M days, and I'm in the habit of saving early and often. Alas, saving a half-megabyte file to the flash-RAM PCMCIA card on the OmniBook takes slightly more than a minute. That's with 6 MB of RAM; if you have less RAM, it takes even longer due to the way flash RAM works. While the system is saving, you can't do anything else.

Of course, when you turn on the OmniBook, it comes back to the exact place where you were when you turned it off, so you can argue that you don't need to save your work often. That's probably true, but like most writers, I don't consider my work safe until it's saved in two places. In any event, I kept forgetting that I shouldn't save so often and wasted a lot of time.

My saves were slow because I had disabled the "fast save" feature of Word 2.0 in favor of "always make backup." If you allow the "fast save" option, the first save will still take about a minute, but saves after that take only a few seconds. By all accounts, the "fast save" feature works fine in Word 2.0, and I don't recall ever having any problems back when Larry Niven and I were using it on our desktops. However, and be sure you see this: "fast save" is *deadly* when you're using Word 6.0.

The save bugs have been reported to Microsoft, and they're working on them. As I write this, there's an upgrade to Word 6.0a that fixes a number of Word 6.0 problems, and by the time you read this, there will probably be another maintenance upgrade. Microsoft isn't always consistent about letting users know about maintenance releases, so it's important to ask.

You can tell what edition of Word 6.0 you have by pulling down the Help menu and clicking on About Microsoft Word; if it doesn't say at least 6.0a, it's only a question of time before you will lose text and have other problems. Run, don't walk, to get the upgrade. Before you do that, get into Word 6.0, pull down Tools, select Option, click on the Save folder, and select "always make backup." Don't go back to "allow fast saves" until you're absolutely certain Microsoft has fixed that bug. Niven and I lost several hours work to it.

With that caution, I still like Word 6.0. I know it's too large. I've heard it's slow, but it's just fine in the Cheetah 486/25 running Windows for Workgroups 3.11. It's also plenty fast enough in WinOS/2 on both an IBM PS/2 Model 77 and a ValuePoint Pentium.

I've already mentioned one thing I like about Word 6.0: it uses real open and close inverted-comma quotes rather than the double-quote you get in ASCII. It can also correct mistakes on the fly. I'm forever mistyping Windows as WIndows and suchlike. Word 6.0 corrects those mistakes, and if for some reason I want a word to begin with two capital letters, the Undo command will take care of that. There are other automatic corrections, all under my control. The document-comparison and merging features are quite useful. I like the way Word 6.0 works with PowerPoint.

Even when Larry and I were having real problems with Word 6.0 bugs, we didn't want to give it up. I still do many first drafts, particularly these columns, in Q&A Write, but I suspect that will change, too.

Alas, I was in Florida before I realized that in addition to EDIT, I should have imported HIMEM.SYS. That's not on the OmniBook either, and the result is DOS windows with a maximum size of 317 KB. This is too small for many programs, including Norton Commander and Q&A Write, if you're going to work on a file of any size at all; the result was that I had to use Word for Windows for all the writing I did.

HIMEM.SYS would have fixed that, if I'd had it with me. Even better would be QEMM, except that I can't get the OmniBook to work with QEMM. I may not be holding my mouth right, so I'll keep trying; meanwhile, HIMEM.SYS should be good enough.

Incidentally, MS-DOS 6 has considerably better memory management than MS-DOS 5. Even with MS-DOS 6, however, I much prefer QEMM; with MS-DOS 5, there's no contest at all. On most machines, QEMM is easy to install and puts memory management in the category of one less

thing to worry about. I've used it for years and years. Recommended.

I carried the OmniBook to most of the SCSI Technology Summit sessions. It fits nicely into my briefcase and has good quiet key action. While it's too large to hold in one hand, it doesn't take up a lot of room on a desk or table. I still made most of my notes in pencil in the margins of the conference briefing book, but when I got home, I was surprised to find I'd done over a thousand words of notes in the OmniBook as well.

All told, then, the OmniBook worked fine for writing and editing. The next test was communications.

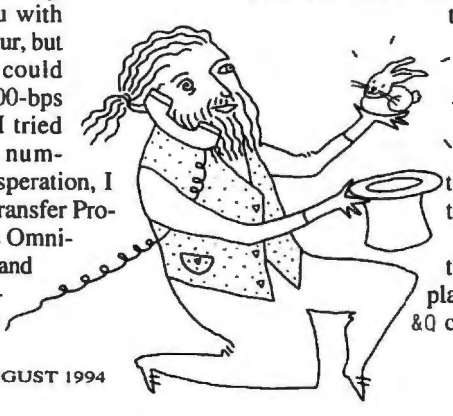
The OmniBook I use has the optional internal modem. I've never had a good experience with an internal modem in a laptop. They're almost always limited to 2400 bps, and they tend to curl up and die when they encounter really noisy phone systems, such as are common in Washington, D.C. Still, I was going to be gone only a couple of days. The OmniBook comes with built-in communications software, and this would be a good test: see if I can make it work from a hotel room with no documents.

Alas, the Disney World Hilton had one of those internal telephone systems that are utterly incompatible with any kind of computer communications. They say they're fixing that, but in any event, I didn't even attempt modem communications on this trip.

That turns out to be just as well, because I have now spent 7 frustrating hours trying to make this OmniBook communicate with Tymnet and BIX. I finally managed courtesy of BYTE's Ben Smith, who is an OmniBook enthusiast, but it wasn't easy.

First I tried the internal modem and the built-in program. That one has BIX as one of the things it says it understands: just fill in the phone number. I plugged in a phone line, called up the BIX setting on the internal program, and let fly. Heard the system dial. Heard it answer. Heard some tones indicating negotiation. And then silence as the OmniBook hung up with a "NO CARRIER" message.

I won't bore you with details of the next hour, but I did everything I could think of. I tried 1200-bps Tymnet numbers. I tried 9600-bps Tymnet numbers. Finally, in desperation, I took the trouble to transfer Procomm Plus onto the OmniBook and tried that; and I got the same results, a connection followed by total inability to get any communications. OK, thought I, it's the internal modem. I connected an ATI Technologies' external modem to port 1. I *know* I can communicate with the OmniBook through port 1 because I used that port and LapLink Remote to put Procomm Plus on there in the first place.



Same results. I hear the modem dial, I hear the answer, I hear all the tones, and the OmniBook completely ignores all that. Wait, thought I. This is DOS under Windows. Let's try DOS alone. Exit Windows. That has the side benefit of uninstalling LapLink Remote. LapLink Remote is a good communications program if you don't need the COM1 port, but as long as it's running, it continues to poll the port it's looking at, and that drives external modems crazy.

I couldn't get the internal modem to connect to Tymnet using Procomm Plus in DOS without Windows.

OK, desperate measures. Connect the USRobotics external modem to the COM1 port of the OmniBook. Now invoke Procomm Plus from DOS, calling a 1200-bps Tymnet number. Voilà!, I was connected. At 1200 bps through a 14.4-Kbps modem, but at least I was connected. Now try to connect at 9600 bps. Nope, I hear it negotiate, I hear it lock, but the carrier is dropped. OK, do `MODE COM1:9600` and try again. Voilà!, I am actually connected.

Alas, I was connected for only about 5 seconds. Something on that OmniBook just can't handle it, because after a while I could receive, but attempts to send produced no result, and soon I was dropped out with "NO CARRIER."

At that point I went to bed. This morning, I called HP's technical-support people. They confirmed that the internal modem is 2400 bps maximum. They hadn't a clue as to why it wouldn't connect to Tymnet, or why the COM1 port won't work reliably at faster than 1200 bps no matter how good an external modem you connect to it.

At that point I got smart: I called BYTE in Peterborough and asked to speak to someone who likes the OmniBook. That turned out to be Ben Smith, who'd had the same problem I did. You can cure it by going to terminal mode and sending the command `AT&Q0` to the modem.

It's easier to specify the cure than to explain why it works. The `&Q` commands set different communications modes; `AT&Q5`, for instance, sets a modem to the error-correction MNP level 5. That's my usual setting for desktops when I want to talk to Tymnet. There's also the command `ATS36=n`. If `n=0`, the modem disconnects if it fails to get an error-correcting connection. If you tell the modem `ATS36=1`, it stays on-line and falls back to basic asynchronous operation, which is what it starts with if you send `AT&Q0`. I've known about these things a long time, but since most modems default to `S36=1`, I tend to forget about them.

With the OmniBook, it doesn't matter. If you send it `AT&Q5` and `ATS36=0`, the result doesn't change: you still hear it negotiate, drop out, and you never get a connection. On the other hand, if you're happy with fairly vanilla communications at 2400 bps, you can use the OmniBook's internal modem and the software that comes with it. Just be sure to start by doing `AT&Q0` and be sure the modem returns OK. Then make certain the parity settings are done properly, and you can use the dialing program that comes with the OmniBook. I don't like it as much as I like Procomm Plus, but it does work. (On a related note, I've found that I need to use the `AT&Q0` commands with other modems, even when I use them on the Mac PowerBook.)

I'm not sure why I can't make the OmniBook work with an external modem. I'll keep trying and let you know, since it's really impossible to do reliable communications out of Washington, D.C., without good error correction, and besides, who wants to be stuck with 2400 bps? Which means that for longer trips, I'll still have to carry my old Zenith Mastersport and a Supra external modem. The combination of Zenith, Supra, and Procomm Plus *always* works.

I also have both Supra and Megahertz PCMCIA modem cards. I think I'm going to like them: a 14.4-Kbps modem with MNP level 5 and V.42bis capability on a card. Until now, the only way to get that capability was to carry the Supra external modem and its power supply. Unfortunately, I'll need a different computer to try these with, because the OmniBook operates at such low voltages that it doesn't believe there is a card in the slot. I get the same result with both modem cards.

The OmniBook 425 is a lot better than adequate. The communications are no worse than those I put up with a few years ago. If you can't stand the slow speed and limited storage space of the PCMCIA card, you can get an OmniBook 430, which has an actual 120-MB spinning metal hard drive. It operates for 6 hours on a

battery charge, as opposed to the 425's honest 12 hours. With that large a drive, you can carry all the Windows and DOS accessory programs, and configuration should be a lot easier.

There's always a trade-off between features and convenience. The OmniBook 425 was designed for those who want a laptop to be light and handy with long battery life and still run Windows, and it does that job extremely well. If that's what you're looking for, be sure to look at the OmniBook 425.

We've almost caught up after the earthquake, but mounds of new software have come in. This means it's short-shrift season at Chaos Manor: time to see how many items worth mentioning I can cover. They all deserve more space than I can give.

I've wanted a good Windows debugger kit for months. iniExpert from Landmark Research International Corp. isn't quite it, but it's valuable all the same. This looks at your various Windows .INI files and offers explanations of what many of the statements do, along with an opportunity to edit them. It doesn't understand all the statements in WIN.INI, but it knows a lot of them. Editing your initialization files is not for the faint of heart, but iniExpert does take some of the sting out of it. Recommended.

Mac fans may think I've been ignoring the Mac, but actually I'm gathering material. Roberta has been doing a lot of work with HyperCard 2.2 as well as Hyperstudio. My partner Steve Barnes uses Microsoft Word on a Mac and brings us disks we can read into Word 6.0 for Windows. I've got a ton of new Mac CD-ROMs and several simulation programs for the Mac. In general, we do more work on the Mac here than might be inferred from my columns.

One reason is that my best columns are generated when I overcome a lot of difficulties. The Mac, on the other hand, doesn't generate that kind of problem. Mac problems tend to be fewer, but when you get one, it's a brass-plated doozy. Roberta is in the middle of one right now.

The fact is, though, the Mac with HyperCard is an extremely powerful tool for getting things done, and as soon as my next novel is finished, I intend to take some time off and write a bunch of HyperCard stacks simulating things from ecological systems to strategic analysis.

Meanwhile, one neat Mac accessory is *Icons for the Masses: The Complete Guide to Creating, Editing and Customizing Icons* by David A. Lai (Peachpit Press, 1993). It comes complete with the Icon Wizard icon editor and about a thousand icons, everything from coffeemakers to hard drives to wishing wells. Mac users tend to have more fun with their computers than PC types. This book can add to the fun.

I've also got spiffy new CD-ROM updates of The Manhole and Cosmic Osmo, the precursors of Myst. They're a bit dated for us old, jaded types, but kids just love to explore the world of The Manhole, and if you have kids and a Mac and don't know about these, get them. Trust me, you have a real treat in store.

On the subject of fun with computers, if you like computer adventure games, you really have to know about Shay Addams and his QuestBusters series. He has several QuestBusters clue books, plus for the hard-core game adventurer, a monthly newsletter. I have QuestBusters: The Book of Clues (Clue Books Express, P.O. Box 85143, Tucson, AZ 85754, (602) 743-3709, $18.95), which contains solutions to 35 games, including Dusk of the Gods, Betrayal at Krondor, Star Control II, and a whole bunch of oth-

er games I've liked. Addams is a games fanatic; if you've ever been stuck in a computer adventure game, you need to know about him.

One earthquake victim at Chaos Manor was the Forminco Condor cage, a startlingly comfortable computer workstation. One of the bookcases fell on it, and while it protected the computer installed on it, some of the steel frame members were bent just enough that it's a bit lopsided. Even so, it still works better than any other computer workstation system I've seen. While I find most claims about "ergonomic design" to be mere hype, I've concluded that Forminco's claims are well founded. At first I thought their hypermodern design was mostly for appearance, but it all seems to have a purpose.

Their furniture is easy to assemble: our son Richard, who isn't mechanical at all, took a disassembled Forminco workstation to Washington, and got it together with no problems. He loves it.

They keep updating designs. The other day I got a new system for supporting a tower-configuration computer by attaching it to the side of the workstation. It works like a charm.

They also make the Mouse Arena, which is the ultimate mouse pad complete with wrist rest. I tend to do most of my work from the keyboard, but many games like Civilization and Masters of Orion are almost entirely mouse-controlled, and Microsoft Word for Windows requires a good bit of mousing around. After playing Masters of Orion for 2 or 3 hours, it sure feels better if I've been using the Mouse Arena. Try one, you'll like it.

Larry Niven, who likes to work in a chair without arms, is very fond of the Forminco typing chair. I'm waiting for their new version with adjustable arms, which should be out about the time you see this.

If you spend much of your life sitting at a computer, you should think seriously about furniture design; which means you should study the Forminco catalogs. The longer I use their stuff, the better I like it.

I don't usually do retractions, but sometimes I have to explain... Last month, I underestimated the popularity of the Kodak Photo CD. Kodak tells me there are over 13 million ROM drives that can now use Photo CD, and over 30,000 places where you can drop off negatives and get a Photo CD back.

I find that I take a lot of pictures that I look at once and stuff into a box, where they are never seen again. Photo CD is probably the remedy to that. Get my pictures put on disks, build a good database and index for retrieval, and I'll have those pictures easily available when I need them. More than that, Kodak furnishes software (Create-It and Arrange-It; see last month's column) for incorporating them into presentations to spruce up lectures.

Electronic photography hasn't gone anywhere much because of the low resolution, but Photo CD is another story. Watch for new developments.

Memorize-It, for both the Mac and Windows, makes electronic flash cards that can include art and sound. It also does quizzes. I made 3- by 5-inch flash cards by hand when I was studying for my qualifying exams. Some people don't care for this method of learning things, but I think it's nifty. Recommended.

The Shareware of the Month is Neverlock, a program to remove copy protection. It doesn't always work, but it generally will. (What I had was a version that is a few years old. A newer fully licensed

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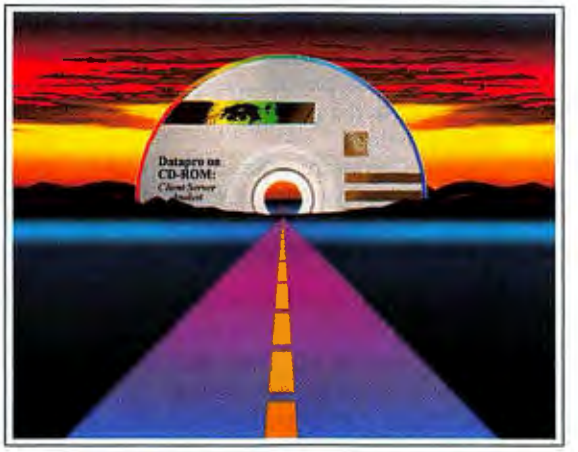

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shrink-wrapped version of Neverlock is also available. I'll be getting a copy and will report on it when I do.)

There are ethical issues here. My view is that if I legally own a program or game, I have a right not to be annoyed every time I use it; and some copy-protection schemes are really annoying. A few are downright obnoxious. One of Pournelle's laws is that any company that depends on copy-protected software should have a good expert system for going through Chapter 11 bankruptcy, but that was more relevant a few years ago than now; today, few important programs have copy protection.

Some software publishers complain that they're losing billions to pirates. A few of them may be right, but I suspect most pirated business software is either not used or is soon replaced by a legal copy.

Games are another matter. It's questionable how many stolen games represent a lost sale; many software pirates have no money and so would never buy the game. Some of the best and most popular games, like Origin's Privateer (see below), have no copy protection at all, and they seem to make plenty of money. Still, I'm sure game companies lose money to software thieves, and they have my sympathy.

Sympathy or no, I still get weary of having to find the manual and look up page 62, line 19, word 5, especially since it's seldom clear which is line 19. Moreover, software publishers are beginning to cut corners on packaging, so that the box becomes useless as a place to keep a manual you probably won't be using except to answer copy-protection questions; and if the manual is lost in the general swim, the program is useless.

Thus, Copyware's Neverlock, which can often modify a copy of your game file so that the copy protection goes away. Use it with due regard for ethics.

The computer book of the month is Michael Nadeau's *BYTE Guide to CD-ROM* (Osborne-McGraw-Hill, 1994), which is simply the best introduction to this subject I've ever seen. Naturally it comes with a CD-ROM of useful stuff, but mostly you'll want it for the text. If you think you ought to know more about CD-ROM, read this. I'm keeping mine on the reference shelf.

The book of the month is Fred Saberhagen's *Seance for a Vampire* (Tor Books, 1994), another in his series that brings Count Dracula and Sherlock Holmes together. If you don't like this sort of thing you'll hate it, but I love it.

There are two games this month. One, Privateer from Origin, is set in the world of Wing Commander, and it lets you fly around and blow away Kilrathi cats, religious fanatics, and pirates. Or, you can turn pirate and drug smuggler yourself.... The other one is Spectrum Holobyte's Fields of Glory, a Napoleonic game that comes as close to playing with miniatures as any computer game I've seen. The computer opponents aren't very smart, and it needs a modem capability to let you play against a friend; but I love the graphics, and there's a feel to this that seems right.

Once again, I'm out of space long before I'm out of stuff to write about. Next month, with luck, I'll get to more Apple and OS/2 stuff. There's wonderful new multimedia stuff from Grolier and Knowledge Adventure, and about a ton of CD-ROMs. ■

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.

For More Information

If you have kids and a Mac and don't know about **Cosmic Osmo** ($34.95), **The Manhole** ($34.95), and **Myst** ($59.95), get them. Trust me, you have a real treat in store. Contact **Broderbund Software, Inc.,** 500 Redwood Blvd., Novato, CA 94948, (800) 521-6263 or (415) 382-4400; fax (415) 382-4671. **Circle 1146 on Inquiry Card.**

Fields of Glory ($59.95) is a Napoleonic game that comes as close to playing with miniatures as any computer game I've seen. Contact **Spectrum Holobyte,** 2490 Mariner Square Loop, Alameda, CA 94501, (800) 695-4263 or (510) 522-1164; fax (510) 522-3587. **Circle 1147.**

If you spend much of your life sitting at a computer, you should think seriously about furniture design; which means you should study the **Forminco catalogs.** The longer I use their stuff, the better I like it. Contact **Forminco,** 9610-A Ignace, Brossard, Quebec, Canada J4Y 2R4, (800) 663-6764 or (514) 444-9488; fax (514) 444-9378. **Circle 1148.**

Kingston Technology makes RAM upgrades for most machines. Alex installed their **4-MB memory-expansion module** ($375) in about 4 minutes, giving my OmniBook 425 a total of 6 MB. Contact **Kingston Technology Corp.,** 17600 Newhope St., Fountain Valley, CA 92708, (800) 835-6575 or (714) 435-2600; fax (714) 435-2699. **Circle 1149.**

Editing your initialization files is not for the faint of heart, but **IniExpert** ($49) does take some of the sting out of it. Contact **Landmark Research International Corp.,** 703 Grand Central St., Clearwater,FL 34616 (800) 683-6696 or (813) 443-1331; fax (813) 443-6603. **Circle 1150.**

Memorize-It ($49) makes electronic flash cards that can include art and sound. Contact **Side-Eight Software,** P.O. Box 5004, Garden Grove, CA 92645, (714) 952-4114; fax (714) 995-6725. **Circle 1151.**

Microsoft Word 6.0 for Windows ($495) has just about become the official Chaos Manor word processor. Contact **Microsoft Corp.,** 1 Microsoft Way, Redmond, WA 98052, (800) 426-9400 or (206) 882-8080; fax (206) 883-8101. **Circle 1152.**

Neverlock is a program that removes copy protection (shareware version with 200–250 titles, $5; fully licensed shrink-wrapped version with more than 500 titles, $78). Contact **Copyware, Inc.,** 152 Nelson Cir., Newmarket, Ontario, Canada L3X 1R3, (905) 830-1961; fax (905) 830-5064. **Circle 1153.**

The **OmniBook 425** was designed for those who want a laptop to be light and handy with long battery life and still run Windows, and it does that job extremely well. If that's what you're looking for, be sure to look at the OmniBook (with 40-MB hard drive, $1795; with 10-MB flash disk, $2095; optional internal modem, $379). Contact **Hewlett-Packard Co.,** 1000 Northeast Circle Blvd., Corvallis, OR 97330, (800) 433-1254 or (503) 757-2004; fax (800) 333-1917. **Circle 1154.**

Privateer ($79.95) lets you fly around and blow away Kilrathi cats, religious fanatics, and pirates. Contact **Origin Systems, Inc.,** 12940 Research, Austin, TX 78750, (800) 245-4525 or (512) 335-0440; fax (512) 331-8559. **Circle 1155.**

On most machines, **QEMM** ($99.95) is easy to install and puts memory management in the category of one less thing to worry about. Contact **Quarterdeck Office Systems,** 150 Pico Blvd., Santa Monica, CA 90405, (800) 354-3222 or (310) 392-9851; fax (800) 354-3329. **Circle 1156.**

If your job involves understanding how to speed up disk I/O operations, you'd do well to get the **Technology Focus papers** on RAID and hardware caching controllers. Contact **Distributed Processing Technology,** 140 Cadence Dr., Maitland, FL 32751, (800) 322-4378 or (407) 830-5522; fax (407) 260-5366. **Circle 1157.**

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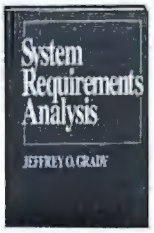

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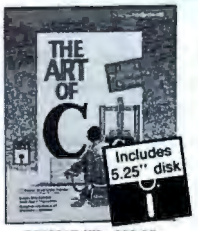

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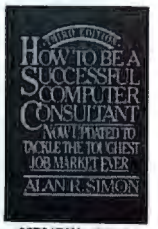

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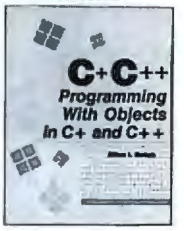
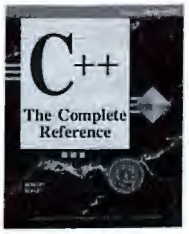
Counts as 2



029662P $29.95

3677H-XX $34.95
Counts as 2/Hardcover

0684898H $45.00
Hardcover



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020346H $45.00
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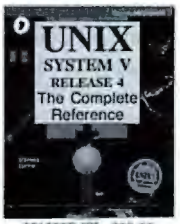
0513449H-XX $24.95
Counts as 2/Hardcover

10041P $29.95

586442P-XXX $59.95
Counts as 3

016732H $40.00
Hardcover



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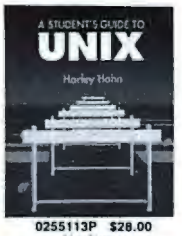
8819601P $34.95



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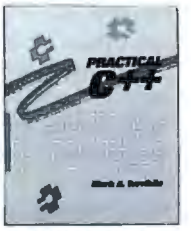
Hardcover



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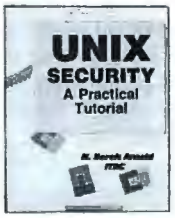
8309P-XX $29.95
Counts as 2

0566933H-XX $70.50
Counts as 2/Hardcover

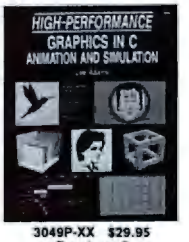


0025606P $24.95

881796P $27.95

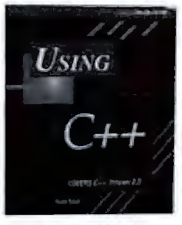
025127H $32.95
Hardcover

0405395H $40.00
Hardcover



3049P-XX $29.95
Counts as 2

054028H $45.00
Hardcover



15034P $24.95

881933P-XX $39.95
Counts as 2

If you select a book that counts as 2 choices, write the book number in one box and XX in the next. If you select a book that counts as 3 choices, write the book number in one box and XXX in the next. All books are softcover unless otherwise noted. Publishers' prices shown. A shipping/handling charge and sales tax will be added to all orders.

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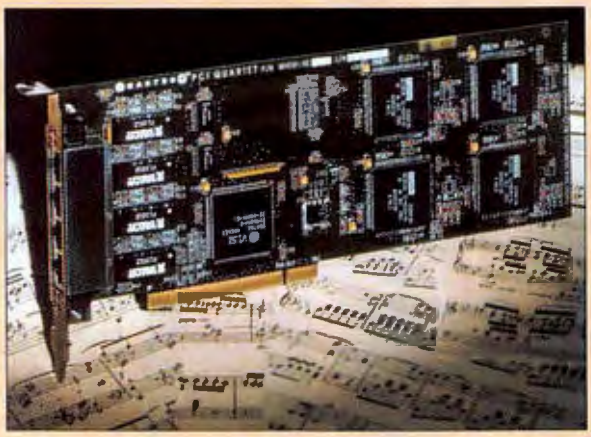
. . . you'll enjoy receiving Society bulletins every 3-4 weeks containing exciting offers on the latest books in the field at savings of up to 50% off of regular publishers' prices. If you want the Main Selection do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide and if you ever receive a book you don't want, due to late mail delivery of the News, you can return it at our expense. And you'll be eligible for *FREE BOOKS* through the Bonus Book Program. Your only obligation is to purchase 3 more books during the next 2 years, after which you may cancel your membership at any time.

BYP894

What's New Hardware



Four Ports for PCI

The EM964 PCI Quartet four-port Ethernet LAN adapter ($798) supports full 132-MBps data transfer over the PCI local bus. Predictive pipelining streamlines data transfers and minimizes system bottlenecks; an on-board bridge enables the adapter to run all four network segments at full cable bandwidth. The Quartet is compatible with full-duplex Ethernet and can increase available network bandwidth to 20 Mbps per segment in switched 10Base-T networks.

Contact: Cogent Data Technologies, Friday Harbor, WA, (800) 426-4368 or (206) 378-2929.

Circle 1271 on Inquiry Card.

PCMCIA Communications

A PCMCIA Type II card, the NovaPak 144 ($449) combines a wireless alphanumeric receiver with a high-speed data/fax/voice modem. From NovaLink Technologies (Fremont, CA), the NovaPak can be used as a standalone pager or as a full-featured 14.4-Kbps modem with voice-messaging capabilities. The less-than-4-ounce device automatically identifies incoming calls as data, fax, or voice and handles them appropriately.

Phone: (510) 249-9777.

Circle 1276 on Inquiry Card.

A CD-ROM Drive for Your Notebook

MPC- and Mac-compatible, the CD Porta-Drive T4100 ($500) has a 320-ms access time, a 300-Kbps transfer rate, and a 64-KB buffer. From CD Technology (Sunnyvale, CA), the portable, multisession Photo CD–capable drive weighs 1 pound and can be used horizontally or vertically.

Phone: (408) 752-8500.

Circle 1277 on Inquiry Card.

Jumperless Cards

The Crystalizer Multi CD card ($199.95) provides direct connection to the proprietary interfaces for Sony, Mitsumi, and Panasonic CD-ROM drives. From Crystal Computer (San Jose, CA), the card is also available with voice recognition for an additional $30.

Phone: (408) 383-2100.

Circle 1278 on Inquiry Card.

The Soft I/O card ($199) from Axxon Computer (Windsor, Ontario, Canada) has four high-speed serial ports as well as two bidirectional printer ports. The 16-bit card is register-level-compatible with 16550-type UARTs and the PS/2 printer port and has on-board BIOS support.

Phone: (800) 361-1913 or (519) 974-0163.

Circle 1279 on Inquiry Card.

Scan, Fax, and Copy

The ScanFlex 6700 is both a high-resolution full-page scanner and a fax machine. The $599 unit has 256 levels of gray, a scanning resolution of 400 dpi, and a scanning speed of 19 seconds per page, as well as a 10-page automatic document feeder and OCR for Windows. From Behavior Tech Computer (Fremont, CA), the 5.8-pound ScanFlex 6700 ships with several software packages.

Phone: (510) 249-0330.

Circle 1275 on Inquiry Card.

Petite Plug and Play Peripheral

A Plug and Play external hard drive, the RoadRunner Express XD Series (from $495) supports the enhanced parallel port and extended capabilities port in addition to the standard and bidirectional parallel ports. From Disk Technologies (Winter Park, FL), the 1.8-pound drive has a data transfer rate of 1 MBps and is available in 210-, 340-, and 540-MB capacities.

Phone: (407) 671-5500.

Circle 1280 on Inquiry Card.

SPARC-Compatible Workstation

A color workstation with an 85-MHz MicroSparc II processor, the Compstation II-385 (from $4570) features a quadrupled cache, enhanced memory management, and doubled floating-point performance. The Tatung (Milpitas, CA) unit includes an SVGA/CG3 frame buffer, a 14-inch color monitor, 16 MB of memory, three SBus expansion slots, and 520 MB of hard disk storage.

Phone: (408) 383-0988.

Circle 1281 on Inquiry Card.

Programmable Power Control

The PowerBrain ($175) from Quantum Composers (Bozeman, MT) turns your PC off and on at preset times. The Windows-based Program Launcher utility lets you turn on your network-connected system after business hours to back up your work. With the proper software, you can use it to log on to a BBS and download information at night without having to be present.

Phone: (800) 556-9686 or (406) 586-3190.

Circle 1282 on Inquiry Card.

Small-Footprint Bridge

Designed to segment workgroups from the network backbone, the MicroConnect local bridge ($499) connects workgroups of up to 256 users. From Acsys (Bedford, MA), the 4.25- by 1.9- by 0.9-inch device connects directly to a hub's AUI port to provide full Ethernet functionality. LEDs on the front indicate network status.

Phone: (800) 462-2797 or (617) 275-4455.

Circle 1283 on Inquiry Card.

Computer Speakers

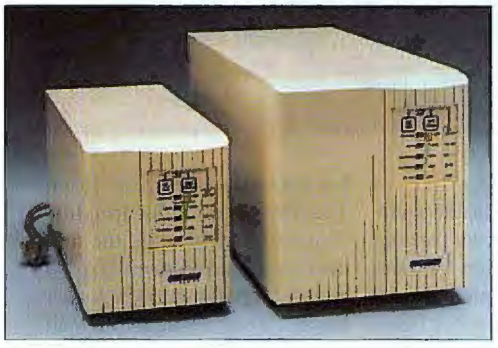
Labtec Enterprises' (Vancouver, WA) TL-50 speakers ($179.95) are magnetically shielded to protect your monitor, hard drive, and CD-ROM disc. The long-excursion, low-resonance 3¼-inch driver is computer-matched to the transmission-line enclosure for a frequency response of from 48 to 20,000 Hz. The speakers are compatible with PCs and Macs.

Phone: (206) 896-2000.

Circle 1289 on Inquiry Card.

LINE-INTERACTIVE UPSES ▼

The OnGuard LI-600 ($599) and OnGuard LI-1000 ($849) from Clary (Monrovia, CA) each have a built-in microprocessor and an RS-232 interface to enable real-time communications between the UPS and workstations, servers, or network management stations. The units are compatible with SNMP and NMS.



Phone: (800) 442-5279 or (818) 359-4486.

Circle 1284 on Inquiry Card.

ISOLATE YOUR DATA

Telebyte Technology's (Greenlawn, NY) Model 282 Async Opto Isolation module ($300) provides increased data reliability while protecting against electrical noise, surges, and the effects of ground loops on the asynchronous RS-232 interface. The device also can drive and receive signals from another device up to 1000 feet away at rates as high as 19.2 Kbps; the maximum data rate is 64 Kbps.

Phone: (800) 835-3298 or (516) 423-3232.

Circle 1287 on Inquiry Card.

TUNE IN THE RADIO ON YOUR SOUND CARD

A 16-bit CD sound card, the Sound Galaxy Orion 16 ($179) is upgradable to an FM tuner and a SCSI-2 card. The FM tuner upgradability lets you clip sound bytes and listen to the radio through your PC. From Aztech Labs (Fremont, CA), the Orion 16 ships with ComVoice voice-recognition software and Action 3.0, which lets you add digital video to presentations.

Phone: (510) 623-8988.

Circle 1288 on Inquiry Card.

HEAVY-DUTY PRINTERS

A 50-dBA line-impact dot-matrix printer, the T6082 ($8799) can print data-processing sheets and multipart forms at speeds of up to 900 lines per minute. From Mannesmann Tally (Kent, WA), the printer has the ability to handle a work load of up to 160,000 pages per month. The unit's shuttle-matrix technology provides microadjustment of vertical and horizontal dot densities; precision dot placement and variable dot densities provide text flexibility.

Phone: (800) 843-1347 or (206) 251-5500.

Circle 1285 on Inquiry Card.

Relief for heavy-duty Windows users can be found in the WinPrinter 1000 ($1095) from LaserMaster (Eden Prairie, MN). The printer provides 1000- by 1000-dpi TurboRes resolution when printing with the PostScript driver and has a rated print speed of 4 ppm. The printer ships with 50 TrueType fonts and the company's Automatic Font Management technology.

Phone: (800) 365-4646 or (612) 944-9330.

Circle 1286 on Inquiry Card.

SPILL-RESISTANT KEYBOARD

The model IDKB101-SR keyboard ($39.95) from Identity Systems Technology (Carrollton, TX) features a moisture-proof membrane underneath the keys that protects the working parts from damage from liquids and dust. The 101-key enhanced keyboard has 12 function keys and a separate numeric keypad and cursor keys.

Phone: (800) 723-8258 or (213) 323-4600.

Circle 1290 on Inquiry Card.

SCAN IN 24-BIT COLOR

The Mustek ScanMagic Color II hand scanner ($299) captures photographic-quality images in 24-bit color, 256 gray scales, and 64 dithered gray levels at up to 400-dpi resolution, according to Mustek (Irvine, CA). The TWAIN-compliant ScanMagic scanner ships with Micrografx's PhotoMagic LE and the Perceive Personal OCR package from Ocron.

Phone: (714) 453-0110.

Circle 1291 on Inquiry Card.

CORDLESS DATA COLLECTION

A portable, cordless bar code reader, the Radio/Freedom Reader ($495) collects data and then transmits it up to 100 feet away via radio frequencies. Compatible with PCs and Macintoshes, the wand scanner can read all printed media types, from dot-matrix to laser printer output. The device is from Worthington Data Solutions (Santa Cruz, CA).

Phone: (800) 345-4220 or (408) 458-9938.

Circle 1292 on Inquiry Card.

NETWORK ADAPTER FOR THE PCI BUS

The Enet32-Combo/PCI network adapter card ($179) from Compex (Anaheim, CA) operates in half-duplex and full-duplex modes. The card supports burst-mode data transfer rates of up to 132 MBps and a PCI clock speed of 33 MHz. The card is compatible with 10Base-2, 10Base-5, and 10Base-T standards and includes automatic detection and correction of 10Base-T receive polarity.

Phone: (714) 630-7302.

Circle 1294 on Inquiry Card.

MODULAR SYSTEM AUTOMATICALLY CONFIGURES ITSELF

Designed for use in small offices, the completely modular ShareWork permits as many as 32 PCs to share eight printers and up to 28 SCSI devices without a complex network operating system. Each ShareWork SCSI module includes its own control circuitry and plugs into the back of a free-standing device; you can then daisy chain up to six devices without adding more modules. ShareWork is compatible with DOS and Windows; the starter kit costs $149.

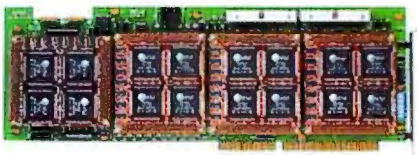
Contact: Xirlink, San Jose, CA, (408) 453-1188.

Circle 1272 on Inquiry Card.

What's New Hardware

MULTITASKING ISA BOARD ▼

The TeraDon ISA bus board (from $3995) has from four to 16 DSP3210 floating-point DSPs on-board. From Ariel (Highland Park, NJ), the TeraDon contains two Multivendor Integration Protocol serial ports and up to 256 MB of DRAM. The board implements 16 concurrent V.32bis modems and supports up to 512 concurrent phone conversations. Bundled software includes the VCOS real-time multitasking operating system and a set of multimedia and telephony modules.



Phone: (908) 249-2900.

Circle 1293 on Inquiry Card.

MULTIPROTOCOL PRINTING

An external print server, Pacific DirectNet EX ($549) lets you connect printers directly to your NetWare and TCP/IP networks. The server supports multiple network protocols and multiple printer models and provides printer management capabilities for heterogeneous networks. From Pacific Data Products (San Diego, CA), the unit has two bidirectional Centronics ports and a serial port that lets you print on as many as three printers simultaneously.

Phone: (619) 625-3663.

Circle 1297 on Inquiry Card.

MULTIFACETED MODEM

A hardware/software combination, the MultiModemPCS-Mac and MultiExpressPCS-Mac ($799) is a voice, data, and fax modem for use with Macs running System 7.0 or higher. The modem supports simultaneous voice and data transmission, and the software has an automatic mode that integrates and automates voice, fax, and voice-mail communications. The package is from Multi-Tech Systems (Mounds View, MN).

Phone: (800) 328-9717 or (612) 785-3500.

Circle 1298 on Inquiry Card.

A FLEXIBLE TRAVEL COMPANION

The Z-Noteflex family of modular notebook computers has a user-configurable architecture and upgrade flexibility, including a CPU that you can upgrade. Based on Intel's 3.3-V 486 SL-Enhanced processors, the system is available as a 33-MHz 486SX up through a 75-MHz DX4 and a 100-MHz DX4 when available. You can increase the 4 MB of 32-bit system memory to a maximum of 24 MB; the user-removable 2½-inch hard drives have a VL-Bus interface and are available with 200- to 520-MB capacity. For longer traveling power, you can swap the front-mounted floppy drive for an optional second battery pack. The notebooks are priced from $2749 to $5999.

Contact: Zenith Data Systems, Buffalo Grove, IL, (800) 533-0331 or (708) 808-5000.

Circle 1273 on Inquiry Card.

COMPACT COPIER ▲

Small enough to fit inside your briefcase along with your papers, the PassPort Portable Copier ($349.95) prints on plain paper at 400 dpi and adjusts for light and dark copies. From Quad-Mark (Rochester, NY), the unit makes full- and legal-size copies and can reduce small documents to postcard size. The replaceable single-pass film cartridge ($3.99 each) yields 20 copies per roll, and the multipass cartridge ($6.99 each) yields more than 75 copies per roll.

Phone: (716) 461-6100.

Circle 1295 on Inquiry Card.

LIQUID GUARD

An electrochemical liquid designed to eliminate problems caused by airborne contamination, Circuit Guard ($19.95) forms an atmospheric barrier to protect your electronic systems. From Circuit Guard International (Safety Harbor, FL), the liquid also discharges static by neutralizing charged particles.

Phone: (800) 365-5030 or (905) 509-8752.

Circle 1300 on Inquiry Card.

CELLULAR MODEM

Offering data reliability and throughput via cellular connection, the Noteworthy cellular-ready modem ($369) lets you access information while traveling without having to search for a hard-wired phone line. From Toshiba America Information Systems (Irvine, CA), the modem sends and receives faxes at up to 14.4 Kbps with V.32bis; it has an effective data throughput of up to 57.6 Kbps with V.42/V.42bis. An Auto Line Setup feature automatically detects whether the connection is for cellular or land-line use.

Phone: (800) 959-4100 or (714) 583-3000.

Circle 1299 on Inquiry Card.

THE MANY TRACKS OF A VOYAGER ▲

TrackMan Voyager ($89.95) from Logitech (Fremont, CA) is a trackball for portables that converts into a desktop unit. The device has a cover to protect it during travel. You can use it on the desktop as a trackball with a mouse-like look and feel or as a thumb-operated trackball. On the road, you can use it without attaching it to your portable or use the provided clip to attach it to your system; you can also use it as a hand-held device for presentations.

Phone: (510) 795-8500.

Circle 1296 on Inquiry Card.

URGENT—YOUR INPUT NEEDED

Dear Reader—

Recently, BYTE has added a new type of feature story to its monthly lineup. The Solutions Focus examines how real-world companies are using real-world technology to solve real-world problems. The purpose of the Solutions Focus is to provide you with in-depth information that you can apply to your own business.

To ensure that our coverage is in tune with you, we request that you fill out the following questionnaire and fax it back to us. It will tell us about your needs and interests, and help us focus our Solutions Focus to best address your concerns. Please take a few minutes to fill out this form and fax or mail a copy of it back to us.

Of course, questionnaires such as this are necessarily limiting. If you want to tell us your ideas about possible Solutions Focus coverage, especially if you have come up with an innovative technical solution to a vexing business problem, please contact one of the feature section editors at the following E-mail addresses. Thank you.

Scott Wallace,
Solutions Focus coordinator, swallace@bix.com
Bob Ryan, b.ryan@bix.com
Russ Kay, russellk@bix.com

SOLUTIONS FOCUS

Please rate each possible Solutions Focus topic using the following scale:

Not at all interested — Very interested

1 2 3 4 5

- ☐ Getting different E-mail systems to interoperate
- ☐ Automatic configuration management
- ☐ Coordinating information access using document management
- ☐ Work flow in a manufacturing environment
- ☐ Migrating to object-oriented development technology
- ☐ Connecting branch office networks
- ☐ Coordinating on-line, CD-ROM, and paper-based information sources
- ☐ Implementing DCE
- ☐ Technologies for hands-free computing
- ☐ Network-based transaction processing
- ☐ Network-based conferencing systems

Tell us about a particularly vexing problem you are facing in the area of information technology:

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ABOUT YOU (OPTIONAL)

Name _____

Title _____

Company _____

Phone _____

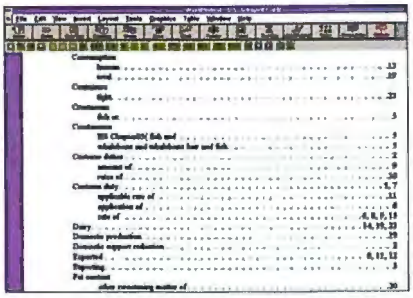
E-mail address _____

FAX the completed form (without a cover sheet, please!) to 603-924-7620. If you don't have access to a fax, you can photocopy the form and mail it to:

BYTE Solutions Focus Survey
c/o Market Research Dept.
One Phoenix Mill Lane
Peterborough, NH 03458

What's New Software

AUTOMATIC INDEXING ▶



Indexicon for WordPerfect for Windows ($149.99) provides fully automatic indexing to the level of detail that you have preset. From Iconovex (Bloomington, MN), Indexicon responds to the click of your mouse by reading your document, locating the significant terms and phrases, and then generating an index. The software seamlessly integrates with WordPerfect 6.0.
Phone: (800) 943-0292 or (612) 943-0292.
Circle 1305 on Inquiry Card.

CREATE A PROPER QUERY

Software AG's (Reston, VA) Esperant graphical query tool (from $595) lets you create accurate queries using a Windows-based point-and-click GUI. You can access information from any SQL- or ODBC-compliant database without having knowledge of either SQL or the physical structure of databases. The SQL Expert prohibits you from constructing a query that would return incorrect results.
Phone: (800) 423-2227 or (703) 860-5050.
Circle 1306 on Inquiry Card.

SCREEN MAGNIFIER

Screen Magnifier/2 ($495) from IBM Special Needs Systems (Boca Raton, FL) enables visually impaired users to interact more easily with personal computers by magnifying Windows, OS/2, and DOS applications running under OS/2 2.1. The magnification level ranges from two to 32 times the normal size, so you can make words and images on the screen the exact size that you need.
Phone: (800) 426-4832.
Circle 1307 on Inquiry Card.

INTERNET E-MAIL

A cross-platform E-mail system based on Internet-standard networking and messaging protocols, Z-Mail (single user, $295) brings the mail-transport and routing capabilities already embedded in Unix systems to Windows and Mac systems. From Z-Code Software (Novato, CA), Z-Mail's layered approach separates the user interface from the mail-transport agent; the approach is implemented via TCP/IP, SMTP, and MIME Internet protocols and eliminates the need for using gateways.
Phone: (415) 898-8649.
Circle 1309 on Inquiry Card.

CD-ROM SHARING ON THE NETWORK

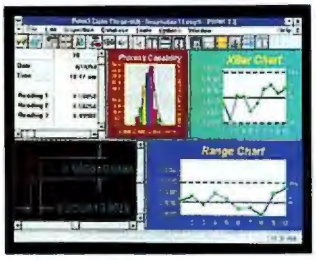
When you load CD-View (from $395) on a workstation, you create a NetWare-compatible, independent CD-ROM server. From Ornetix Network Products (Sunnyvale, CA), CD-View makes the workstation's CD-ROM drives appear as NetWare volumes to give you seamless integration with NetWare without having to load proprietary NLMs on the file server.
Phone: (800) 965-6650 or (408) 744-9095.
Circle 1310 on Inquiry Card.

MULTIPLATFORM SECURITY

NetLock for HP ($2995) provides multilayered security for networks of Hewlett-Packard workstations. You install the software from Hughes Aircraft (Fullerton, CA) at the IP layer of the network stack, where it operates transparently. In addition to encryption, NetLock provides authentication, access control, and integrity checking.
Phone: (714) 732-5352.
Circle 1312 on Inquiry Card.

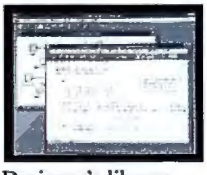
MANUFACTURING IMPROVEMENT

Continuous-improvement software for the manufacturing environment, the Point 3 Continuous Improvement Pak (single seat, $1895) integrates a strong CAD interface, SPC tools, and a



relational database management system. Modules in the suite of productivity-enhancement tools from Baystate Technologies (Marlborough, MA) can document inspection plans, manufacturing processes, and in-process data measurements with real-time displays, control-chart interpretations, a monitor mode, a problem-solving utility, and a measurement and gage database file.
Phone: (508) 229-2020.
Circle 1311 on Inquiry Card.

VISUAL DESIGNER TOOLKIT ▼

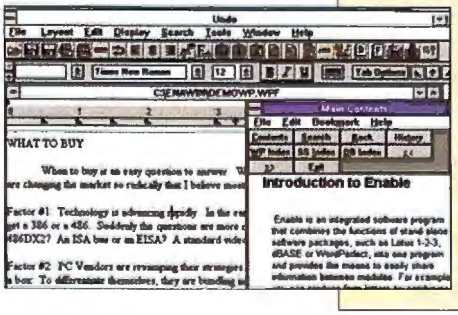


The Custom Block ToolKit for Visual Designer ($795) extends Visual Designer so that it becomes an open system, according to Intelligent Instrumentation (Tucson, AZ). The fully extensible underlying code lets you add any type of function, and you can expand Visual Designer's library of features to support custom hardware, user-defined algorithms, and special displays.
Phone: (800) 685-9911 or (602) 573-0887.
Circle 1308 on Inquiry Card.

POSTSCRIPT FILE VIEWER

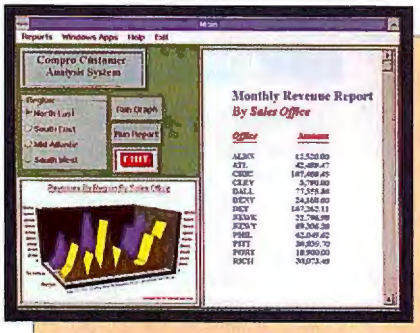
A 32-bit application, Magus PageTurner for OS/2 ($199) views PostScript files produced by most applications on any type of computer without requiring the originating application. From Magus (Mountain View, CA), the object-oriented software's PostScript interpreter is written in C for maximum performance.
Phone: (800) 848-8037 or (415) 940-1109.
Circle 1313 on Inquiry Card.

SWEET INTEGRATION



An integrated suite of five applications, Enable for Windows provides data integration among word processing, spreadsheet, database, graphics, and communications modules. The $595 suite, which occupies less than 25 MB of hard disk space, uses TrueType fonts that are supported by Windows and has a click-and-drag feature for moving data within an application. The software has a common interface between it and Enable 4.5 as well as a standard Windows interface.

Contact: Enable Software, Ballston Lake, NY, (800) 888-0684 or (518) 877-8600.
Circle 1301 on Inquiry Card.



FOCUS ON CLIENT/SERVER REPORTING

Focus Reporter for Windows ($395) provides a point-and-click graphical interface with its underlying Focus fourth-generation language, which you can instantly access to inspect your coding or make enhancements or changes to it. Useful in developing complex enterprise-reporting and decision-support applications, the client/server reporting tool accesses Focus, Btrieve, and dBase databases. It is bundled with an ODBC driver as well as interfaces to SQL Server, DB2/2, Oracle, and Teradata.

Contact: Information Builders, New York, NY, (212) 736-4433.

Circle 1302 on Inquiry Card.

STOCK PHOTOGRAPHY

ImageVault Pro ($449) from American Databankers (Tulsa, OK) is a line of royalty-free stock photography collections published on CD-ROM. Each collection contains more than 350 photos gathered from the portfolios of nationally known commercial photographers.

Phone: (800) 775-4232 or (918) 497-1201.

Circle 1314 on Inquiry Card.

UNIX TESTING SOFTWARE

Software for automated testing of terminal-based applications, V-Test for Unix/HP-UX (from $22,500) runs real applications with simulated users. From Performance Software (Newburyport, MA), V-Test can be used for any target software, such as database systems, fourth-generation-language applications, and in-house development software. Once developed, tests can be executed interactively or as batch processes.

Phone: (508) 462-0737.

Circle 1315 on Inquiry Card.

ASSESSMENTS MADE EASY

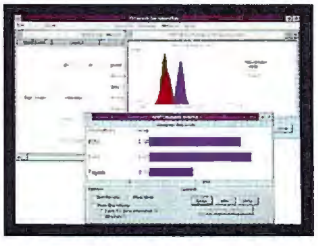
DOS-based Visual Assessor ($595) from American Information Systems (Wellsboro, PA) automates your organization's quality-assessment, client-assessment, or supplier-assessment process and instantly converts results into graphical displays. Visual Assessor provides detailed question-and-answer sessions that probe your company's performance and then identifies areas that need improvement and offers guidance regarding the action you should take.

Phone: (800) 903-4000 or (717) 724-1588.

Circle 1316 on Inquiry Card.

DECISION-ANALYSIS HELP

A Windows-based decision-analysis tool, Criterium DecisionPlus ($495) from Sygenex (Redmond, WA) lets you structure and analyze complex decisions among alternatives involving multiple criteria. The software includes uncertainty analysis, which tells you how likely the alternative that you choose as best will truly be the best choice.



Phone: (800) 869-7150 or (206) 881-5500.

Circle 1319 on Inquiry Card.

MULTIMEDIA TOOLKIT

GX Effects 1.0 for Windows ($199) lets developers manipulate images with a variety of transitional effects, such as weaves, slides, and spirals. The Genus Microprogramming (Houston, TX) software provides animation routines for animating sprites, such as flying birds, and support for MIDI and WAV files.

Phone: (800) 227-0918 or (713) 870-0737.

Circle 1317 on Inquiry Card.

ADVANCED FUNCTIONS FOR OS/2

SofTouch Systems' (Oklahoma City, OK) GammaTech REXX SuperSet/2 software ($79.95) provides an extension of REXX external functions that are registered to the REXX command processor supplied with OS/2. The more than 300 functions perform math calculations, initiate file and system operations, manipulate processes and semaphores, regulate the macrospace, execute video I/O, and issue network commands.

Phone: (405) 947-8080.

Circle 1318 on Inquiry Card.

DETECT FILE CORRUPTION

A 32-bit application, File Alert for Windows NT Advanced Server ($499) automatically detects file corruption from all possible sources, according to Executive Software (Glendale, CA). File Alert lets the network administrator oversee the data integrity of the entire network by means of a remote notification capability that simultaneously works with multiple PC platforms.

Phone: (800) 829-4357 or (818) 547-2050.

Circle 1324 on Inquiry Card.

Software Update

Media 100 2.0, Data Translation (Marlborough, MA), provides more than 1 hour of storage capacity per gigabyte in draft mode and has automated redigitizing, enhanced editing functionality, improved disk storage and file management, a graphics track to support advanced keying, near-real-time fast dissolves and real-time fades, broadcast output of QuickTime files, and input control using a built-in waveform monitor and vectorscope. $11,995.

Phone: (508) 460-1600.

Circle 1332 on Inquiry Card.

Media Suite Pro 3.0, Avid Technology (Tewksbury, MA), offers an enhanced image-quality option, true time-line editing, expanded audio capabilities, plug-in effects capabilities, a QuickTime codec, and Open Media Framework Interchange compliance. $9995.

Phone: (508) 640-6789.

Circle 1333 on Inquiry Card.

FuziCalc 1.5, FuziWare (Knoxville, TN), has an expanded function set and adds a 3-D color graphics tool set. $179.95.

Phone: (800) 472-6183 or (615) 588-4144.

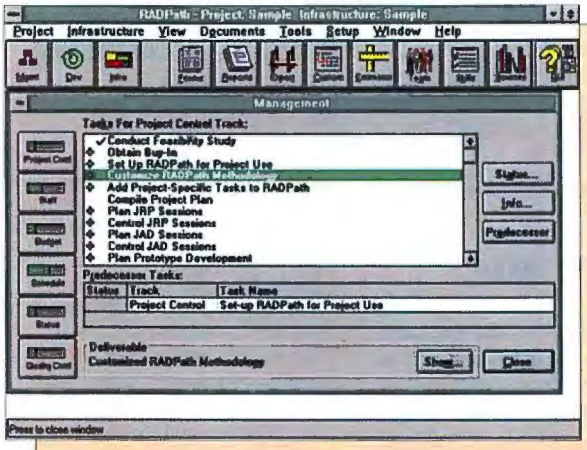
Circle 1334 on Inquiry Card.

Guide Professional Publisher 3.5, InfoAccess (Bellevue, WA), enhances the ability to automatically convert paper-based information into interactive documents, adds a table viewer, has graphics in cells, lets you scroll through cells to view hidden text, and allows multiple paragraph styles in each cell. From $15,000.

Phone: (206) 747-3203.

Circle 1335 on Inquiry Card.

What's New Software



Get Help in Developing GUI Client/Server Applications

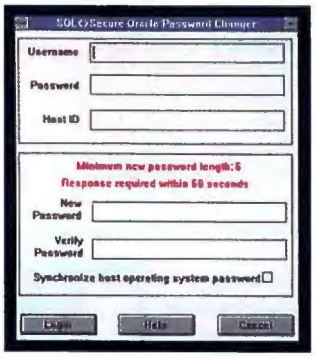
Designed to help corporations develop GUI client/server applications, RADPath stresses cyclical rather than linear development. The methodology provides infrastructure, management, and development paths, each with the capability to let you add or delete project-specific tasks. You can easily see the progress of your development team by using the forms and reports provided to ensure that tasks are consistently completed. A postproject interview shows which deadlines were not met and how processes could be improved. A 10-user license and three days of on-site training are available for $1595 per user.

Contact: Corporate Computing, Bannockburn, IL, (800) 925-1995 or (708) 374-1995.

Circle 1303 on Inquiry Card.

UNIX Network Security

SQL<>Secure (from $7500) identifies security vulnerabilities and secures database passwords in Unix client/server environments. From BrainTree Technology (Norwell, MA), the software lets you define and implement a database-security policy that includes standards such as password length, reuse analysis, aging, and guessability. According to BrainTree, SQL<> Secure is most valuable in environments supporting client/server database applications where the host operating-system log-in is bypassed.



Phone: (617) 982-0200.

Circle 1320 on Inquiry Card.

Capture a System's Behavior

Object System/CRC for Windows ($395) is a domain-analysis tool that supports responsibility-driven design. The Palladio Software (Brookfield, WI) product lets you focus on defining the responsibilities and relationships of the key abstractions in a system independently of the implementation language. It integrates with the company's Rational Rose to provide a seamless transition from analysis to detailed design and construction.

Phone: (800) 437-0019 or (414) 789-5253.

Circle 1322 on Inquiry Card.

Add Group Communications to Your E-Mail

An electronic forum that uses your existing network, E-mail, and information sources, Collabra Share (10-user license, $69.95) simplifies the organization and dissemination of group information. From Collabra Software (Mountain View, CA), the package integrates the information that a workgroup uses and organizes it into forums, which can be replicated throughout an enterprise and to other organizations. Collabra Share can be installed on a central file server or peer-to-peer network.

Phone: (800) 474-7427 or (415) 940-6400.

Circle 1321 on Inquiry Card.

Client/Server Backup Software

An enterprise-wide backup and recovery system that uses distributed client/server technology, NetArchive-Distributed Network Backup (from $2000) directs backup files to storage devices that are managed by NetArchive-Storage Vault Manager (from $3000). From Advanced Software Concepts (Escondido, CA), NetArchive-DNB supports multiplatform heterogeneous networks and uses Distributed Computing Environment protocols, which provide highly flexible and infinitely scalable storage configurations.

Phone: (619) 737-9544.

Circle 1323 on Inquiry Card.

Mutual Fund Adviser

Multimedia software that helps you select the right mutual funds, Your Mutual Fund Selector ($49.95) uses mutual-fund research information from Morningstar. The ActiveBook product from Vertigo Development Group (Cambridge, MA) is available on CD-ROM and is compatible with Windows.

Phone: (800) 688-4750 or (617) 225-2065.

Circle 1070 on Inquiry Card.

Software Update

BeyondMail 2.0 for Intelligent Messaging III, Banyan Systems (Westborough, MA), adds a routing slip, a "When Sending" event, database access, a Watermark Viewer, an alternative mailer for Lotus Notes, a new installation program, decimal-point support in forms and rule language, a native Intelligent Messaging message store, and more. From $695.

Phone: (508) 898-1000.

Circle 1336 on Inquiry Card.

MapInfo 3.0, MapInfo (Troy, NY), adds advanced data-visualization and geographic-analysis functionality and expands data access with SQL DataLink. From $1295.

Phone: (518) 285-6000.

Circle 1337 on Inquiry Card.

Serif PagePlus 3.0, Serif (Nashua, NH), includes stronger text import and editing, enhanced composition features and prepress capabilities, output in Aldus's OPI format, built-in automatic trapping, and powerful vector-graphics support. $59.95.

Phone: (603) 889-8650.

Circle 1338 on Inquiry Card.

In Control 3.0, Attain (Somerville, MA), features a multicolumn Action Outliner, Instant Lookup, Daily Views, document linking, and the capability to enter items directly into each of the calendars and then drag and drop items among all views. $129.95.

Phone: (800) 925-5615 or (617) 776-1110.

Circle 1339 on Inquiry Card.

Data Desk 4.2, Data Description (Ithaca, NY), runs in native PowerPC mode, is faster, and supports the entire Mac product line, keeping data files compatible across machines. $135.

Phone: (607) 257-1000.

Circle 1340 on Inquiry Card.

UNIX LAN INTERCONNECTION

NetcomRelay ($2500) lets Unix PCs transfer TCP/IP LAN traffic via frame-relay links. From The Software Group (Woodbridge, Ontario, Canada), NetcomRelay ships with an implementation of the Internet Standard RFC 1490 for interconnecting TCP/IP stacks over a WAN.

Phone: (800) 463-8266 or (905) 856-0238.

Circle 1325 on Inquiry Card.

ONE-LINE COMMUNICATIONS

A system that enables LAN-attached workstations in a branch office to communicate with any host computer or applications server, the Branch CommServer (from $2995) consolidates multiple low-speed lines into a single high-speed line. From CR Systems (Atlanta, GA), the system supports access-line, LAN, and WAN protocols.

Phone: (404) 767-8230.

Circle 1326 on Inquiry Card.

SOFTWARE METERING TOOL

The Frye Utilities for Networks—Software Metering and Resource Tracking 1.0 (100 users, $495) is an NLM designed to provide network administrators with a tool to meter applications software on a network and centralize software security. The Frye Computer Systems (Boston, MA) utility lets you monitor software used on standalone PCs, meter software suites, and interface with Frye's NetWare Early Warning System.

Phone: (617) 451-5400.

Circle 1327 on Inquiry Card.

EXTENDED HELP

Multimedia WinHelp ($199) from Blue Sky Software (La Jolla, CA) lets you quickly integrate video and sound, graphical push buttons, and 256-color bit maps into your Windows Help system. You can then play AVI, WAV, and BMP files directly out of the Help file.

Phone: (800) 677-4946 or (619) 459-6365.

Circle 1328 on Inquiry Card.

ELECTRONIC FILING CABINET

Electronic-filing-cabinet software, SCT*Filer (single-user license, $1600) lets you scan, store, index, search, retrieve, view, manipulate, print, and fax imaged documents. You can use the Soda Creek Technologies (San Ramon, CA) software as a stand-alone image filing cabinet or with other applications and databases for use as a document management and retrieval system.

Phone: (510) 855-3900.

Circle 1329 on Inquiry Card.

BACK UP THE ENTERPRISE

Storage Exec for Windows NT Advanced Servers (three-tape device license, $2385) lets you configure, schedule, monitor, and control local and remote data storage from a central location. From Arcada Software (Lake Mary, FL), Storage Exec is scalable and supports an easy transition from OS/2 LAN Manager to Windows NT Advanced Server by backing up both systems.

Phone: (407) 262-8000.

Circle 1330 on Inquiry Card.

TURN YOUR MONITOR GREEN

Optiquest's (Walnut, CA) OptiGreen software ($29.95) and Energy Saver adapter ($69.95) are designed to reduce the electricity consumption of monitors. The company guarantees that both will work with any computer system and comply with the EPA's EnergyStar requirements.

Phone: (909) 468-3750.

Circle 1331 on Inquiry Card.

GAIN INTERNET ACCESS

SuperHighway Access ($149) lets you connect to the Internet using your PC, Windows, and a modem. From Frontier Technologies (Mequon, WI), the software provides MIME-compliant E-mail; utilities such as Archie, Gopher+, WAIS, and WWW; a graphical File Transfer Protocol application; TALK; terminal emulation; and the NNTP Usenet newsreader.

Phone: (414) 241-4555.

Circle 1071 on Inquiry Card.

Software Update

Power Pak for Windows 4.0, PC-Kwik (Beaverton, OR), adds KwikPrint for Windows, KwikScreen for Windows, and KwikLoad. $99.95.

Phone: (800) 284-5945 or (503) 520-4299.

Circle 1341 on Inquiry Card.

TurboCAD for Windows 2.0, International Microcomputer Software (San Rafael, CA), adds more than 20 features, including drag-and-drop editing, TurboTools, OLE 1.0 support, global editing of common attributes, bit-mapped fill patterns, and the ability to insert bit-mapped images directly into a CAD drawing. $149.95.

Phone: (415) 454-7101.

Circle 1342 on Inquiry Card.

LANStor RedAlert 2.1, Storage Dimensions (Milpitas, CA), monitors all errors reported to the NetWare SFT III Error Log and includes Microsoft Mail, MHS, and SNMP error-notification methods. $295 per server.

Phone: (408) 954-0710.

Circle 1343 on Inquiry Card.

QuikMenu III, NeoSoft (Bend, OR), has an icon editor, a macro recorder, keyboard stuffing when you launch programs from the desktop, a master password override, and the capability to dial a phone or a modem from an icon. $49.95.

Phone: (503) 389-5489.

Circle 1344 on Inquiry Card.

Distributed Call Center 2.0, Teloquent Communications (Billerica, MA), adds integrated voice-response capabilities, expanded call prompting, and additional workgroup features; enhances its GUI; and expands support for ISDN. From $2500.

Phone: (508) 663-7570.

Circle 1069 on Inquiry Card.

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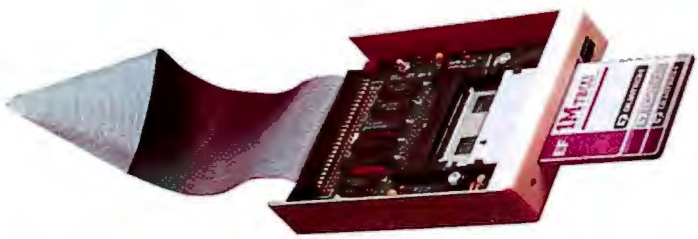

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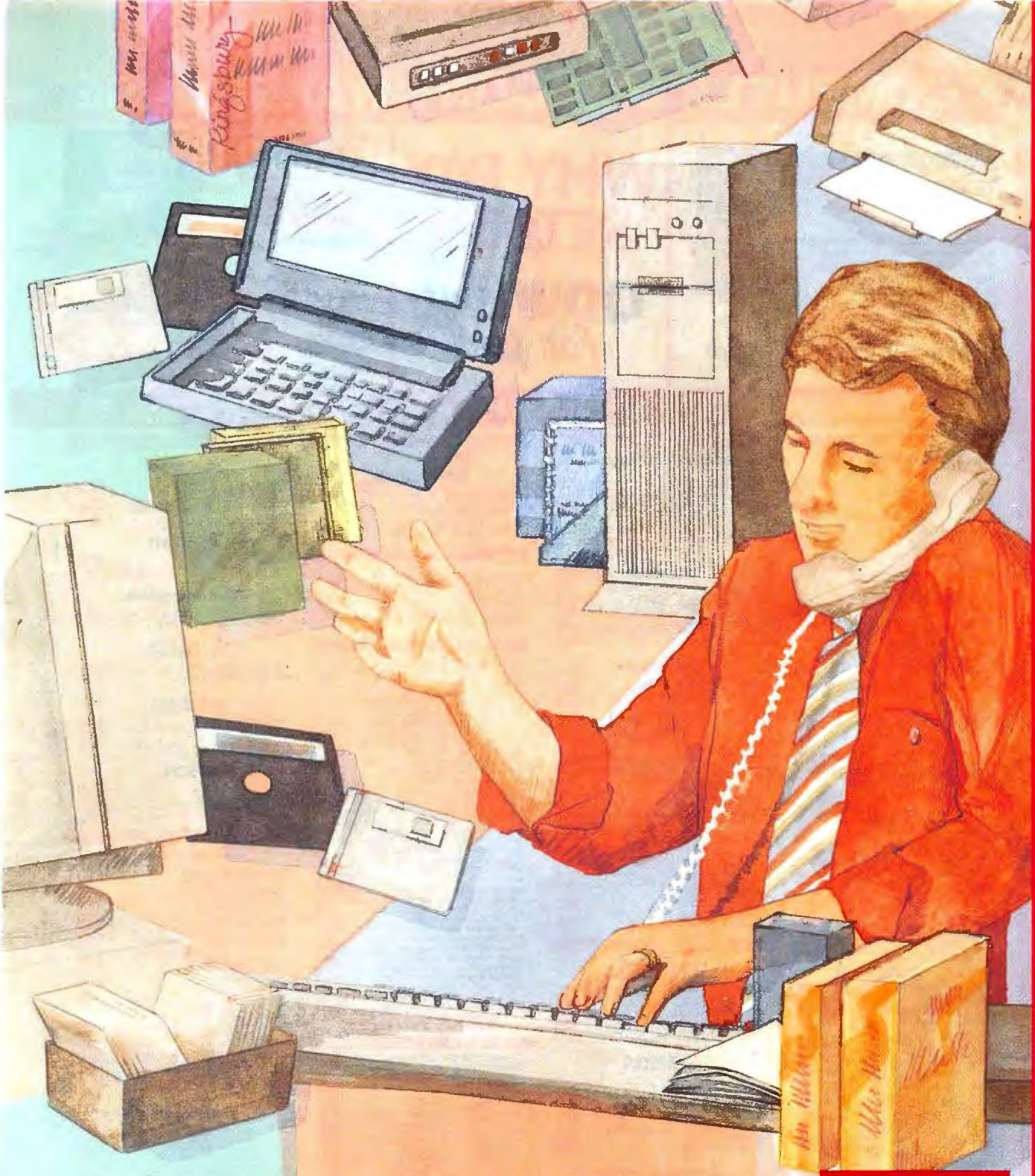

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OKILASER 800 2MB	CALL!
PANASONIC 4410, 4430 2-4MB	CALL!
PANASONIC P4450I 2MB	CALL!
TI MICROLASER 1MB	CALL!
TI TM4000 4MB	CALL!
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The Databrick™

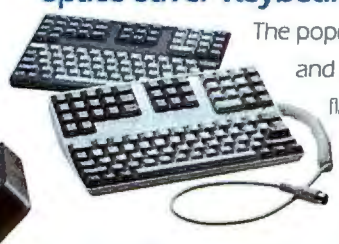
The newest addition to Datalux's family of space-saving computer products! This 1.4kg unit measures only 26x12x5cm (10"x5"x2"), yet is powerful — 486SX to 486 DX2/66 with local bus video. Intended for situations where space saving is most important, it provides a rugged, portable, flexible PC solution, bridging the gap between a laptop and a desktop PC. Databrick drives both VGA, Datalux LCD and Touch LCD monitors, making it ideal for institutional, presentation, vehicle, machine control and POS systems. It can be configured as a diskless unit (booting from flash memory or from a network) or a stand-alone system with hard disk, powerful enough for today's CAD or desktop publishing programs. Hinged lid is removable.

Orders and Information: **1 800-DATALUX**
24-hour faxed data sheets: **703 662-1675**

LCD Monitors

Datalux stand-alone monitors are available in both 1.8 kg. desk/wall (which folds for portability) and 2.7 kg mobile/industrial, 64-grey shade, mono or 256 color DUAL SCAN versions. Both are 9.4" diagonal 640 x 480 VGA and can be fitted with optional touch screen with integrated touch controller. The mobile/industrial unit (pictured with swivel mount) is in a rugged aluminum housing with sealed front bezel and controls. All models plug directly into the Databrick or are supplied with a 16-bit ISA bus controller.

Space-Saver Keyboards



The popular 1.0kg desk and 4kg portable flat models save 60% of the normal desk space, with full-travel, tactilly responsive keys. Footprint is only 28x16cm (11x6"), but the 100 keys have standard left-to-right spacing. Both models are XT/AT/PS2 compatible and are available in many languages.

Desk/Wall Package

The Databrick combined with our LCD monitor is an ideal solution when you need a complete, compact PC and screen in a single unit. Any combination of options may be ordered. When folded or mounted on a wall, this 4 kg unit measures only 29x24x11cm (4.5x9.5x11") and is rugged enough to survive as a touch system in harsh environments such as kitchens or factories.

DATALUX

American Made
Space-Saving Computer Products

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Fax (703) 662-1682

Datalux International, LTD
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Jameco Motherboards

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- Diagnostic and operating system software available
- One-year warranty

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103966	80486SLC 50MHz w/CPU	429.95
95222	80486DX 33MHz w/CPU	499.95
79214	80486SX 25MHz w/CPU	289.95
62333	80386DX 40MHz w/CPU	249.95
82350	80386DX 33MHz w/CPU	229.95
101821	80386SX 33MHz w/CPU	124.95
105321	80286 16MHz w/CPU	99.95
84945	XT 10MHz w/CPU	89.95

RAM Memory

41371	41256-100	256KBx1	$1.95
41398	41256-120	256KBx1	1.85
42251	511000P-80	1MBx1	6.25
42219	511000P-10	1MBx1	5.95

SIPPS

41451	41256A9A-10	256KBx9	$15.49
41700	421000A9A-70	1MBx9	54.95
41718	421000A9A-80	1MBx9	49.95

SIMMS

41523	41256A9B-80	256KBx9	$15.95
41486	41256A9B-10	256KBx9	12.95
41689	421000A8B-80	1MBx8	49.95
41742	421000A9B-60	1MBx9	54.95
41751	421000A9B-70	1MBx9	49.95
41769	421000A9B-80	1MBx9	48.95

SIPP to SIMM Converter

- Use SIPP's in place of SIMM's
- Upgrade from a SIPP motherboard to a new SIMM motherboard without buying new RAM
- Fits into standard 30 pin SIMM socket

93382	SIPP Module Converter	$9.95

Keyboards & Keypad

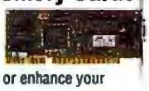
78271	32-key keypad	$59.95
67432	101-key enhanced	44.95
17128	101-key enhanced (Fujitsu)	69.95

Computer Power Supplies

- Fits most popular desktop, mini vertical and vertical cases • One-year warranty
- 8088/80286/80386 and compatible • Built-in fan

19465	150 Watt (8088)	$69.95
67467	200 Watt (8088/80286)	79.95
19545	200 Watt	89.95
19529	200 Watt mini	89.95
65728	300 Watt	139.95

Graphics/Memory Cards



- 8088/80286/80386 and compatible
- One-year warranty
- Expand your memory or enhance your graphics capabilities

67459	VGA Card	$59.95
104660	Super VGA Card	89.95
91230	Monochrome Graphics	39.95
101688	VESA Graphics Accelerator	149.95
19975	(8088) Memory Card	49.95

Parallel Printer Cables and Adapter

28695	PPC	Adapter	$5.95
28716	PPC6	6' - straight cable	4.95
28708	PPC12	12' - straight cable	8.95
28741	PPR6	6' - right angle cable	6.95

9-Pin Serial Cable

31721	SAT6	9-pin serial cable	4.95

DB25-Pin Extension Cable

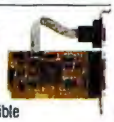
39538	25M10M	Male to male	8.95

Floppy Disk Drives

- 8088/80286/80386 and compatible
- Additional accessories available

74392	FD505	3.5"/5.25"	$149.95
74384	FD235J	2.88MB 3.5"	129.95
40774	356KU	1.44MB 3.5"	79.95
17099	FD55B	360KB 5.25"	99.95
17101	FD55G	1.2MB 5.25"	99.95
79396	SD540	360KB 5.25"	59.95

Floppy Controllers and I/O Cards



- One-year warranty
- 8088/80286/80386 and compatible

19895	8088 Multi I/O w/ floppy cntr.		$69.95
19908	286/386 Multi I/O w/ floppy cntr.		59.95
19596	8088 Floppy controller		29.95
19617	Floppy Disk Two-drive controller		34.95
19668	Floppy Disk Four-drive controller		44.95
78713	Serial Card 16450 UART		29.95
67053	Serial Card 16550 UART		39.95
104678	Serial Card - 4 serial port UNIX		79.95
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105611	I/O Card		44.95
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Conner IDE Hard Drives

- One-year warranty

113751	CFS210A	210MB	$249.95
93294	CP30254	250MB	319.95
93307	CP30544	545MB	529.95

Silicon Valley IDE Disk Drive Adapter Cards

- One-year warranty

10233	ADP20	16-bit hard	$24.95
10250	ADP20F	16-bit hard/floppy	29.95
10288	ADP50	8-bit hard	59.95
10276	ADP60	16-bit hard w/ BIOS	69.95
10284	ADP60F	16-bit hard/floppy w/ BIOS	74.95
74114	ADP65F	16-bit hard/quad floppy drive adapter	99.95
101670	ADP90VL	Super I/O Card (VESA)	99.95

Monitors

67491:
- Supports video modes up to 640 x 480 with 16 shades of gray

78676:
- 0.39mm dot pitch
- Max. resolution: 1024 x 768

67491	12" Paper White	$99.95
87978	14" Amber monochrome	129.95
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- Microsoft® Mouse compatible
- One-year warranty • Weight: 1 lb.

104441	Serial mouse	$13.95
111860	Microsoft two-button mouse	59.95
105515	Dual port game card	19.95
26307	Mouse pad	4.95
94641	Pocket auto printer switch	17.95

Surge Protectors

- Electrical Rating: 15 Amp, 120 VAC, 60Hz
- EMI/RFI noise rejection: up to 15dB
- UL 1449 suppressed voltage rating: 400volts • Clamping response time : <5 nsec
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99979	EP6M	6 Outlet Wall Plug-in/ telephone protection	9.95
99987	EP6M	6 Outlet Wall Plug-in/ Cable TV protection	9.95

7 Outlet Power Strip w/4 ft. Cord

- Audible alarm sound if surge protection is not functioning • Master power switch
- Push-to-reset 15 Amp circuit breaker
- Size: 3.25"L x 2.125"W x 1.125"H

98749	LR69225	Power Strip	$9.95

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Part #	Description	Price
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108978	PC/XT Case w/ 150 Watt Power supply	89.95
106569	2400 Baud internal modem	39.95
106577	2400 Baud external modem	49.95
104441	Serial mouse	13.95
106761	8-bit MFM HD Controller	69.95
106121	PS2/AT 106-Keyboard (82)/ keypad (24) set	59.95
106391	Universal serial/parallel converter	69.95
109049	16-bit IDE hard disk controller	17.95
105208	PC to TV Converter box	199.95

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- Size: 7"L x 3.625"W • One-year warranty

73525	Portable IC Tester	$149.95

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- 2 & 4-way Binary file shuffler programs
- Includes adapter card, software and manual
- Size: 7"L x 5.5"W x 1.75"H • One-year warranty

78457	1 Socket 16K-2MB (above)		$209.95
101400	1 Socket 16K-512KB		129.95
78465	4 Socket 16K-2MB Programmer		279.95
104651	1 Socket 16K-8MB Universal		699.95

Heatsink/Fan for 80486 CPU

Keep your 80486 cool!

- Just snap it in without having to remove your CPU from the motherboard
- Size: 1.95"L x 1.95"W x .80"H • CFM: 6.3

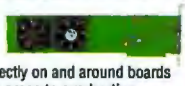
67660	486 Heatsink w/Fan	$12.95

Jameco Desert Cooler

- Exhausts hot air out
- Cools down your computer by more than 80%
- Installs on the back panel of your computer
- Size: 4.8"L x1.6"W x 1.5"H • CFM: 30

79011	Desert Cooler	$49.95

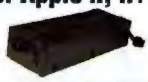
TSM Fancard II



- Circulates air directly on and around boards and components prone to overheating
- Can be installed into any PC slot
- Size: 13.4"L x 0.7"W x 3.3"H • CFM: 25

79020	Fancard II	$34.95

Switching Power Supply for Apple II, II+ and IIe



- Can handle four floppy disk drives and up to eight expansion cards
- Short circuit and over load protection inside the Apple II, II+, IIe • Data included
- Fully regulated +5V @5A, +12V @ 2.5A, -5V @5A, -12V@.5A • Weight: 2.8 lbs.
- Same size as original Apple power supply
- Apple type plug-in power cord included
- 110V/220V switchable • One-year warranty
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22269	KHP4007	Power supply	$44.95

Switching Power Supply for Apple IIGS

- Fully regulated +5VDC @ 6A, +12VDC @ 2A, 5VDC @ 0.5A, -12VDC @ 0.5A • 60 Watt
- Input Voltage: 115VAC • One-year warranty

85518	Switching power supply		$69.95

486 Bare-bones System

Bare bones system includes motherboard, computer case and power supply

- 128KB cache memory (expandable to 256K)
- Memory expandable to 32MB
- FCC approved • One-year warranty

95151	486DLC 40MHz		$429.95

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- Handheld high accuracy
- Measures AC/DC voltage, AC/DC current, resistance, diodes, audible continuity test, transistor hFE
- Manual ranging w/overload protection
- Comes with probes, batteries, case and manual • One-year warranty

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27115	3.5 digit multimeter		39.95
27140	4.5 digit multimeter with tach and dwell		69.95
27158	4.5 digit w/frequency and capacitance/data hold switch		99.95

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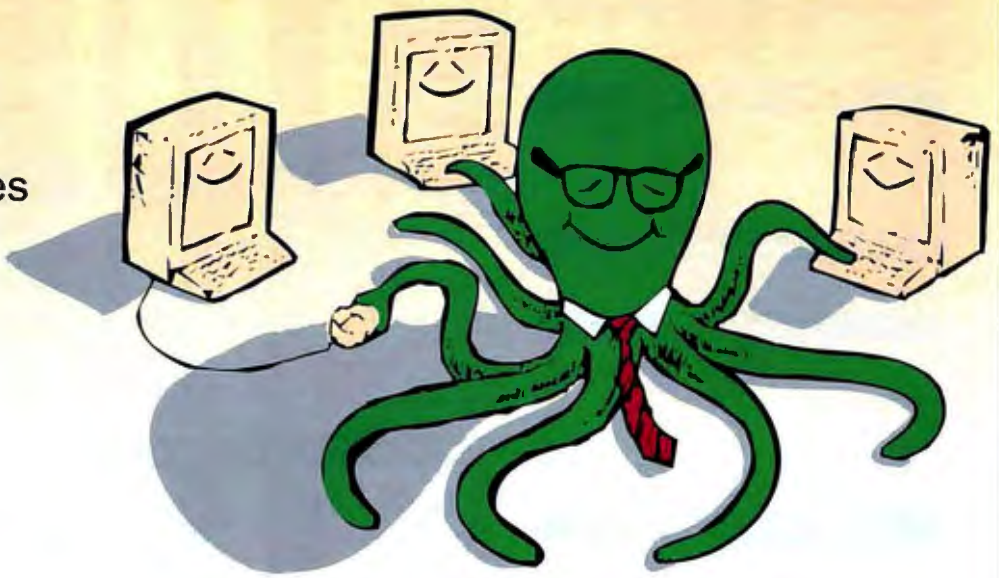

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32Kx8	19.00	9.00	8.00	7.00
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MEMORY FOR IBM & APPLE

	120NS	80NS	70NS	60NS	100NS
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1Meg x4	–	59.00	55.00	54.00	–
1Meg x4 (Zip Pk)	–	24.00	22.00	21.00	–
256x4(Page Dip)	–	7.25	6.75	6.50	3.95
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64x4	–	–	–	3.75	–
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80487-SX (Does All)	299.00
Intel SX (Does All)	69.00
Intel SL Mobil	69.00
Intel 16SX	39.00
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Ambra Sprinta, Hurdla & Enterprise 486	4/16 Meg Kit	CALL
Ambra NC 425SL	2/4/8 Meg	109.00/209.00/449.00
Ambra N Series	4/8/12/16 Meg	189.00/379.00/569.00/829.00
Ambra SN Series	4/16 Meg	189.00/829.00
Ambra Sprinta SLC II	2/8 Meg	Call/Call

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Clock Doubler

- Single chip upgrade solution
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CX486 SRX2 16/32 .... 249.00
CX486 SRX2 20/40 .... 249.00
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1Meg x 9 (9 chip)	59.00	54.00	48.50	47.00	45.00	39.00
4Meg x 9	–	–	173.00	168.00	159.00	–
16Meg x 9 (9 chip)	–	–	–	689.00	–	–

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4 x 36 (9 chip)	–	–	694.00	689.00	689.00	–
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16 x 36	–	–	2806.00	2745.00	–	–
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	4Meg	500987-002	72 pin	179.00
	8Meg	500987-003	72 pin	419.00
	16Meg	500987-004	72 pin	619.00
	32Meg	500987-005	72 pin	1399.00
Premium 486/25, 25E, 33, 33E				
Premium 386/33TE, 486/25TE, 33TE				
Prem. Serv. Prem II 386SX/20, 25				
Prem. II 386/25, 386/33, 486/33, 486SX/20	8Meg	500780-001	64 pin	388.00
Premium 386/33T, Prem. 386SX/16				
Prem. II 386SX/20, 25		500780-004	64 pin	169.00
Premium 386/25, 33, 386/33T, 386SX/16		500780-003	64 pin	59.00
Prem. II 386SX/20, 25		500780-001	64 pin	58.00
Premia 4/33S, 4/33, 4/50D, 4/66D	8Meg	501159-002		379.00
Premia	16Meg	501159-003		789.00
Premia	32Meg	501159-004		1499.00
Premia	64Meg	501159-005		3111.00
AST Cupid Bd	0-64Meg	500818-001		179.00

ZENITH MEMORY MODULES

MODEL	AMT. UPGRADED	AST PART #	PRICE
Z386/33, 25, 20, 33E	1Meg	ZA3800ME	59.00
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6450375 (1Meg)	50-0??	79.00
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6450608 (2Meg)	70-A21, A-61, B-21, B-61, 35SX, 35LS, 40SX, Val Pt. 325T	90.00
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DeskPro 386/20E	1Meg Exp Bd	113644-001	149.00
DeskPro 386/25E	4Meg Exp Bd	113645-001	279.00
	1Meg Module	113131-001	79.00
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DeskPro 286N, 386N, 386SX/20, 386/25M, 486/33M, 486S/25M, 486S/16M	1Meg Module	118688-001	55.00
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T2000SXE/2200SX/T1800, 1850, C	4Meg	PC-PA2001U	189.00
T2000SXE/2200SX/T1800, 1850, C	8Meg	PC-PA2002U	359.00
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T4400SX, SXC T6400, T6600	16Meg	PC-PA2010U	699.00
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T4500, C, T4600, T4700, T1900, C, T1910, T1950 (3.3 v)	8Meg	PC-PA2013U	399.00
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AST Power Exec 3/25C, 425EL	16Meg		819.00
AST Power Exec 425SL	4Meg	501166-001	199.00
AST Power Exec 425SL	16Meg	501166-003	819.00
AST Power Exec 4/33SL	4Meg/16Meg	501318-001,002	194.00/769.00
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HP Deskjet 500, 500C, 510, 550, 560	–	55	–	–	–	–	–	–	–	–	–	–
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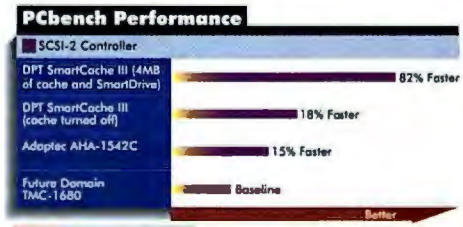

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OKI 400 - 2mb	93

MATH COs

83D8733	$29
83D8740	49
83S8733	45

CPUs

I486DX2-66	$389
I486DX33	239
CX486DLC-40	89
CX486DLC-33	79

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Promise DC4030VL-VLB, IDE Caching Controller	$139
Adaptec 1542CK-ISA, SCSI Controller	249
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IDE/IO-VLB,2s/1p/1g	35

SPECIALS

CYRIX

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Maxtor

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586 P66	1259
Pentium Board W/O CPU	275

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M486-DX266	599
M486-DX W/O CPU	139

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SpeedStar24x	ISA, max. 1024x768 NI, 72MHz, 24-bit, 16.7 mi. colors	$119
SpeedStarVL	VL-Bus, 16 mil. WinMark, 1MB, 16.7 Mil. Colors, 72MHz	119
ViperVLB	VL-Bus, 74MHz, 2MG VRAM, Weiteck P9000, 60 Million WinMark	359
Cirrus Logic	SVGA VLB 1-2, 1MB Upgradable to 2	95
ATI Graphics Ultra Pro	2MG V-RAM MOCK 32 Graphics Chip, 256 Colors, 1280 X 1024	285

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CFA420A	420MB	12MS	IDE	279
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ST3550A	452MB	12MS	IDE 3.5"	290
ST3655A	545MB	12MS	IDE 3.5"	379

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2340	340MB	12MS	3.5" IDE	265
2420	425MB	12MS	3.5" IDE	279
2540	540MB	12MS	3.5" IDE	359

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MAXTOR	MXT540SL	540mg	9MS	$419
CONNER	CFA340S	340mg	12MS	339
CONNER	CFP1060S	1.06gb	9MS	779
SEAGATE	ST3390N	340mg	12MS	349
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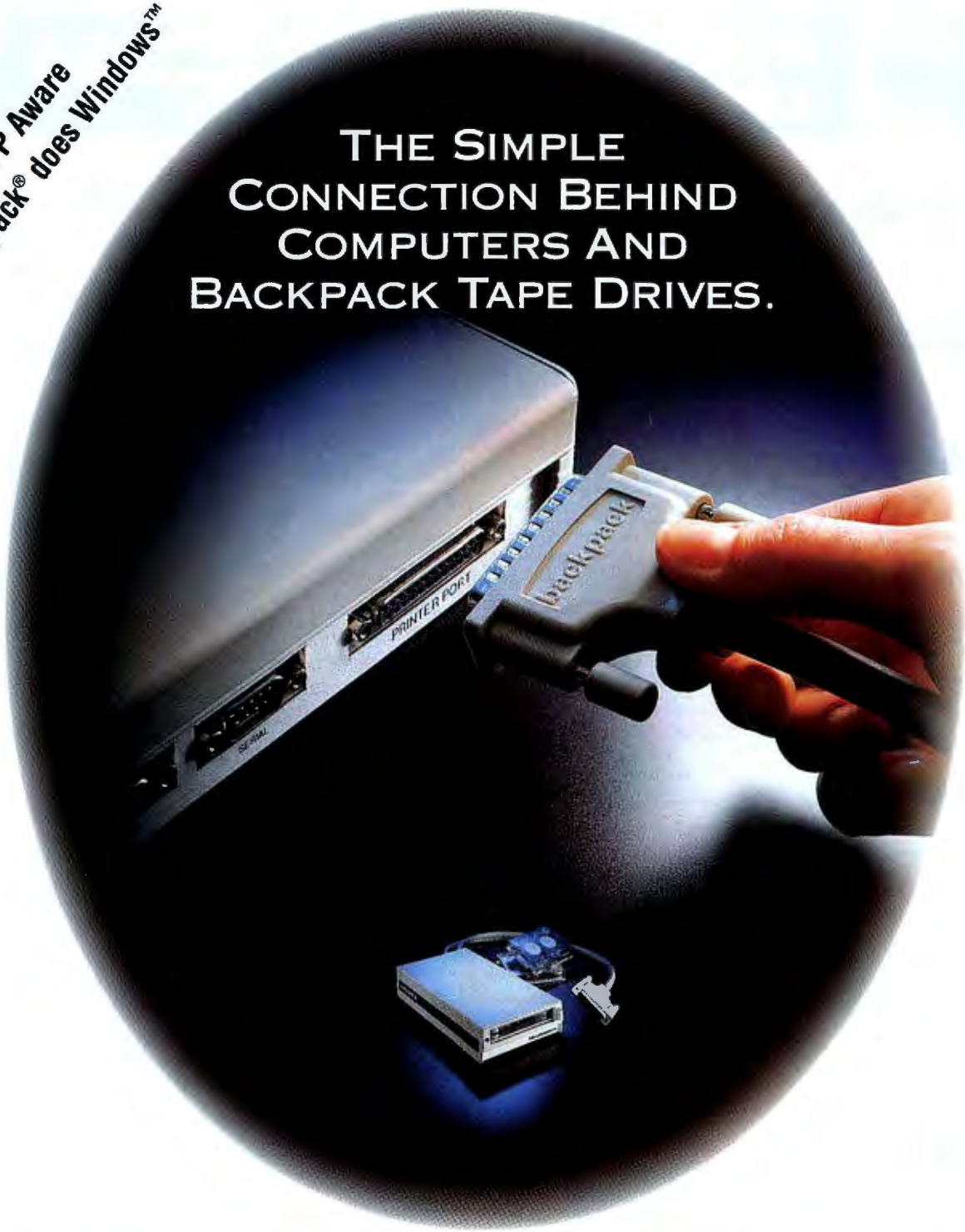

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ST3655A	545MB	12MS	IDE 3.5"	$478
ST12550N	2100MB	9MS	SCSI	$1999
ST31200N	1050MB	10MS	SCSI	$1598

CONNER

MODEL	SIZE	SPEED	TYPE	PRICE
CFA210A	210MB	15MS	IDE	$214
CFA340A	340MB	12MS	IDE	$264
CFA420A	420MB	12MS	IDE	$288
CFA540A	540MB	12MS	IDE	$378
CFA1060S	1060MB	10MS	SCSI	$788

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MODEL	SIZE	SPEED	TYPE	PRICE
7245A	245MB	15MS	IDE	$228
7345A	345MB	14MS	IDE	$274
7546A	540MB	12MS	IDE	$388
75465	540S	12MS	SCSI	$538

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2217 (3.5")	1750MB	10MS	SCSI/IDE	$1189
1548 (FH)	1748MB	14MS	SCSI	$1199
1926 (FH)	2100MB	11MS	SCSI	$1488
1936 (FH)	3300MB	11MS	SCSI	$1895

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2270	270MB	12MS	3.5" IDE	$238
2340	340MB	12MS	3.5" IDE	$274
2420	425MB	12MS	3.5" IDE	$298
2540	540MB	12MS	3.5"IDE	$398

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LPS270	270MB	12MS	IDE/SCSI	$233
LPS540A/S	340MB	12MS	IDE/SCSI	$298
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CPU'S

intel

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80486 DX/33	$264	80486 DX-2/50	$294
80486 DX4/100	$748	80486 DX-2/66	$448
		80486 SX/25	$78
		80486 SX/33	$100
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80387DX	$74
80387-SX16	$48
80387-SX20	$54
80387-SX33	$84
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8087-2 8MHz	$48
8087-1 10MHz	$78
80286 MACHINES:	
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80287-8MHz	$39
80287-10MHz	$49
80287-XL	$54
80287-XLT	$78

Cyrix

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83D87-40MHZ	$48
83S87-25MHZ (SX)	$44
83S87-33MHZ (SX)	$49

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256X9 (30PIN)	$9	$12	$15	$17		
1MEGX3 (30PIN)		$39	$39	$42	$49	$64
1MEG X 9 (30PIN)	$37	$42	$44	$49	$64	$78
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1X36 4MEG (72 Pin)	$169	$174	$248	
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4X36 16MEG (72 Pin)	$648	$664	$738	
8X36 32MEG (72 PIN)		$1475	$1575	
16X36 64MEG 72 PIN		$2950		

CPU DOUBLERS

Cyrix

Cx486DRx²-33/66	$338
Cx486DRx²-16/32	$238
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MODEL	MEMORY	PART#	PRICE
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	8MB	N/A	$328
AMBRA Enterprise 486, Hurdla 486, Sprinta 486 (all models)	4MB	N/A	$178
	16MB	N/A	$648
PS/1 and 386/SX (2121)	2MB	P2F9025	$80
	2MB	P2F9694	$168
PS/2 30/286;25/286; Adpt Brd 1497259 ...	512K	30F5348	$35
	2MB	30F5360	$80
PS/2 35SX, LS, 40SX,70-E61; 061; 121, Adpt Brd 6450609; 34F3011; 34F3077, 502, 55SX, 6555X, P70, 55LS, 65LS X Station 120 & 130	1MB	6450603	$39
	2MB	6450604	$84
PS2 50, 50Z, 55SX, 60, 65SX	2-8MB	1497259	$198
	2-16MB	6450609	$368
PS/1 Consultant, Essentials & Expert models x43, x44 & PS/Valuepoint all models except Cxx series	4MB	96F9290	$194
	16MB	96F9291	$638
PS/2 70-A21; A61; 821, B61; PS/1 Consultant, Essential & Expert models x11, x13 & x14, PS/Valuepoint Cxx series	1MB	6450603	$39
	2MB	6450608	$89
PS/2 55SX, LS, 40SX, 555X; LS, 65SX;	4MB	34F2933	$178
PS/2 90 XP, 95 XP, P75 (Point), 56 57 (all) 76, 77, PS/1 Pro 2123	2MB	6450902	$75
PS2 90, 95 XP, P75 (Pairs) 56, 57, (all) PS/1 Consultant, Essential, Expert x11, x13 & x14, PS/1 Pro 2123, RS/6000	4MB	6450128	$174
	8MB	6450130	$338
PS2/2 35SX; LS; 40SX	8MB	6450129	$338
PS2 70's and 80's	2-8MB	6450605	$297
	32 BIT BOARDS	2-14MB	34F3077	$225
	32 BIT BOARDS	4-16MB	34F3011	$318
PS/2 80-A21; A31; A61	4MB	6451060	$188
PS/2 80-041	1MB	6450375	$78
PS/2 80-111; 311; 121; 321; 081; 161	2MB	6450379	$94
4010 RISC/6000(16MB) $768, 4033(32MB) $1598, 4036(64MB) $3298			

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	8MB	33G9289	$368
Thinkpad 350, 350C	8MB	6060378	$358
	16MB	6060379	$668
Thinkpad 500	4MB	53G6959	$228
	8MB	53G6960	$449
CL57SX	4MB	07G1420	$208
Thinkpad 700, 700C, 720, 720C	8MB	07G1421	$378
	16MB		$998
Thinkpad 710T, 750, 750C	4MB	N/A	$188
	8MB	N/A	$318
PS/Note N45SL	2MB	92F8804	$108
PS/2 Model N51, Notebook SIC, SX	2MB	07G1826	$98
	4MB	07G1827	$188
	8MB	07G1828	$418
Laptop N33SX, L40SX & PSNOTE 182	2MB	79F0999	$98
	4MB	79F1000	$184
L40SX, PSNOTE 182 ONLY	8MB	79F1001	$348

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T2000 / T2000SX	2MB	PA8317U	$93
T2000SX/T1000 LE	4MB	PA8314U	$188
	8MB	PA8315U	$368
T1200 XE	2MB	PA8306U	$98
T1600	2MB	PA8302U	$98
T2000 SXE/T2200SX/T1800 T1850, C	2MB	PA2000U	$94
	4MB	PA2001U	$188
	8MB	PA2002U	$358
T3100	2MB	PA7125E	$138
T3100 E	2MB	PA8341U	$108
T3100 SX	2MB	PA8308U	$108
	4MB	PA8310U	$198
T3200 SX	2MB	PA8307U	$118
	4MB	PA8309U	$214
T3200 SXC	2MB	PA8318U	$198
	4MB	PA8319U	$198
T3200	3MB	PA7137U	$184
T3300SL	2MB	PA2006U	$118
	4MB	PA2007U	$238
	6MB	PA2008U	$258
	16MB	PA2009U	$698
T3400CT	4MB	PA2019V	$198
	8MB	PA2020V	$398
	16MB	PA2021V	$818
T4400 SX, SXC, T6400 SXC, DXC	2MB	PA2003U	$125
	4MB	PA2004U	$198
	8MB	PA2005U	$378
	16MB	PA2010U	$698
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T4500, T4600, T1900C 3.3VOLTS	4MB	PA2012U	$208
	8MB	PA2013U	$408
	16MB	PA2014U	$798
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	8MB	501159-002	$348
	16MB	501159-003	$734
ADVANTAGE 386SX/20 25, PRO SX/25 BRAVO 3/33'S	2MB	500962-001	$88
	8MB	500962-002	$348
BRAVO NB486	4MB		$198
	16MB		$798
ADVANTAGE PRO 486DX/33,SX/25, BRAVO LC 4/255, 33, 33S, 500, 4'660	2MB	500987-001	$88
	4MB	500987-002	$178
	5MB	500987-003	$418
PREMIUM 386/25; 33, 33T II 386SX/16 20,25	1MB	500780-003	$48
	1MB	500780-002	$48
ADVANTAGE 486/25, 33,33P,SX20, BRAVO 4/33, 486/25; PREMIUM 4/25, 33TE, SE 4/33	2MB	500718-004	$84
	2MB	500780-005	$84
ADVANTAGE 486/25,33,33P,SX20,POWER PREMIUM 3/33,4 33; 33S; 50D;66D, PREMIUM 386/33TE, 486/25,E, 25TE; 33, 33TE; PREMIUM II 386/ 25, 33, 486/33, 486SX/20 PREMIUM SERVER SE 4/33	4MB	500780-004	$178
	8MB	500780-001	$330
AST LAPTOP			
POWER-EXEC 3/25SL, 3/25SL-C,EL	4MB		$178
	16MB		$768
POWER-EXEC 4/25SL	4MB		$178
	16MB		$768
PREMIUM EXEC 286,386SX/20,25,25C	4MB	500814-003	$168
BRAVO NB486	4MB		$198
	16MB		$848

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MODEL	MEMORY	PART#	PRICE
Deskpro 386/16	1-2MB	108069-001	$238
	2MB	108069W71	$448
	4-8MB	108070-001	$398
Deskpro 286E; 386-20; 20E; 25; 25E	1MB	113131-001	$59
	4MB	113132-001	$208
Deskpro 386S	4MB Board	113634-001	$278
	4MB Module	112534-001	$208
Deskpro 386-20E; 25E	4MB	113645-001	$278
Deskpro 386/33/33I; 486/25; 33L;50L; Systempro	2MB	115144-001	$104
	8MB	116561-001	$428
	32MB	116568-001	$1458
Systempro; Deskpro 6 SKT EXP BRD W/2MB		116569-001	$279
Compaq "M4"	2-64MB	129160-001	$188
Deskpro 286M; 386M, 386SX/20; 20M, Portable 486c, Deskpro M			
Systempro LT Series 129160-001, Pro Signia	1MB	118688-001	$49
	2MB	118689-001	$84
	4MB	118690-001	$178
	8MB	128877-001	$348
Prolina 3/25 & 25Z	2MB	141738-001	$98
	8MB	141742-001	$318
Prolina 4/25si, 4/33, 4/50	2MB Module	141683-001	$94
	4MB Module	141684-001	$178
	8MB Module	141685-001	$338
Compaq Pro Signia	16MB	149320-001	$684
	32MB	149147-001	$1524
DeskPro 5/60, 5/66M	8MB	149911-001	$388
Prasignia PC Server, 486/33/66	8MB	141685-001	$348
	16MB	149320-001	$698
	32MB	149147-001	$1498
Prasignia 5/60	16MB	149949-001	$738
Proliant 100 5/60	32MB	149912-001	$1398
Proliant 2000 4/30, 5/66	64MB	149913-001	$2698
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Concerto 486	4MB $198	8MB $388	16MB $798
Contura 320, 325	2MB	139497-001	$98
	4MB	139498-001	$178
	8MB	139499-001	$348
Contura 4/25CX	4MB	146520-001	$178
	8MB	146521-001	$338
	16MB	146532-001	$748
SLT/286	1MB	110235-001	$75
	4MB	110237-001	$218
SLT386	1MB	118303-001	$79
	2MB	118304-001	$108
	4MB	118305-001	$218
Lte 286	1MB	117081-001	$79
	2MB	117081-002	$99
	4MB	117081-004	$178
Lte 3865/20	1MB	121125-001	$98
	4MB	121125-002	$208
Lte Lte/20, 25, 25C	4MB	129769-001	$138
	4MB	129769-002	$208
	8MB	129769-003	$388
	16MB	129769-004	$808
LTE Lte 486/25C	4MB	142337-002	$178
	8MB	142337-003	$348
	16MB	142337-004	$768
Aero 3.3-volt	4MB	190532-001	$218
	8MB	190597-001	$398

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AT&T Safari	2MB	37650	$148
	4MB	37651	$248
Bondwell B-310	1MB	23050-09100	$108
Dec pc 320 Notebook	2MB Mod	FR-PCIM-BA	$149
	4MB Mod	FR-PCIM-BB	$298
	8MB Mod	FR-PCIM-BD	$498
Dell Laptop 212, 320N; 320N+	2MB Mod	310-3204	$129
Dell 325N; NC	2MB Mod	310-3210	$139
Dell NL20 & NL25	2MB Mod	310-3213	$148
Epson NB-3 Notebook	4MB	A808511	$198
Epson NB-SL/	2MB Mod	A808771	$168
EPSON 25C Notebook	4MB Mod	A808781	$228
Everex Tempo LX, LX20	2MB	00160	$98
Everex Carrier	2MB	00263-00	$108
Grid 1500	4MB	25387	$228
Grid 1450SX	2MB	6200203	$148
Goldstar GS520, 386SX16	1MB	N/A	$98
	4MB	N/A	$298
NCR 3120 Notebook	4MB Mod	3120-K104	$299
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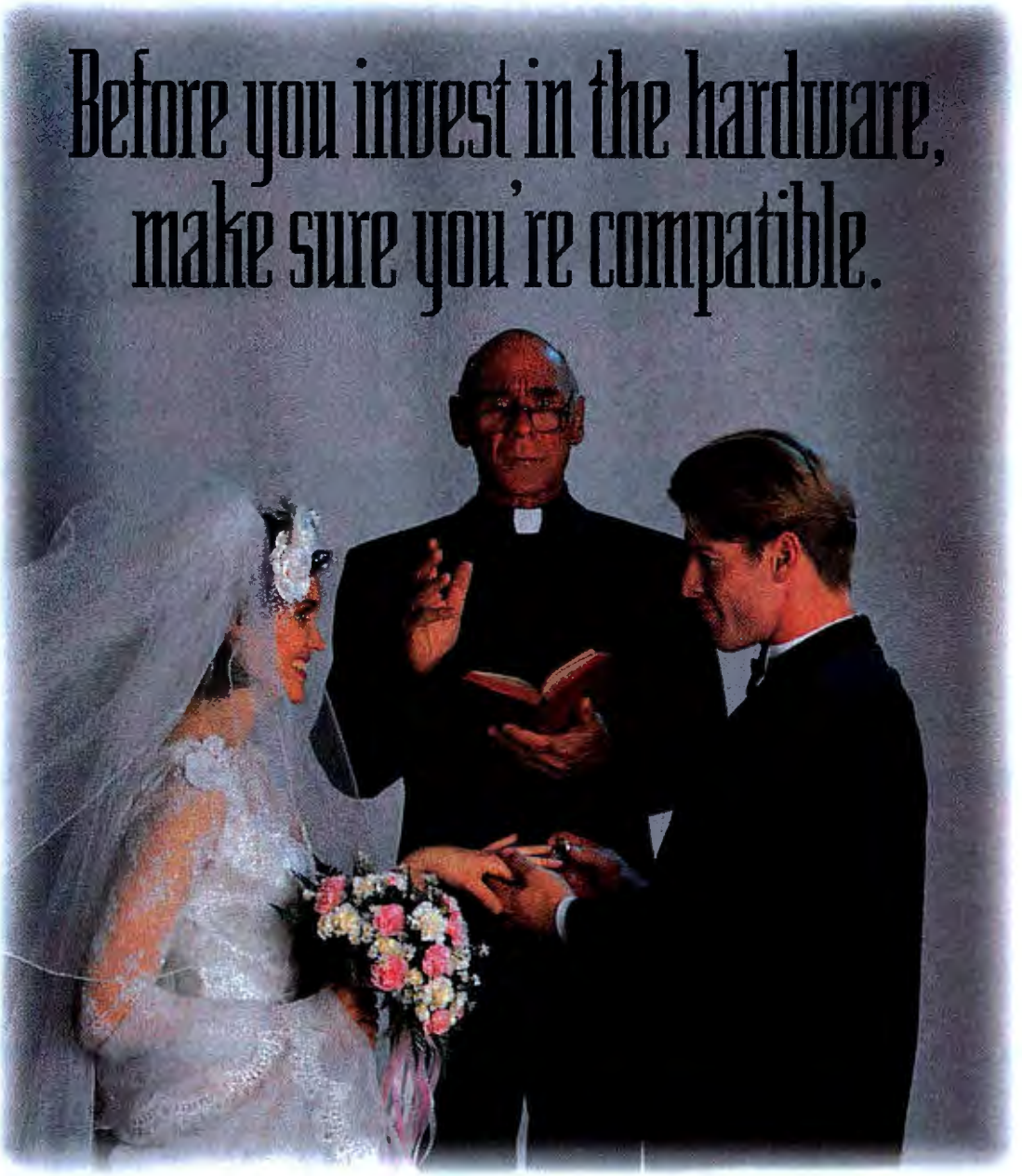

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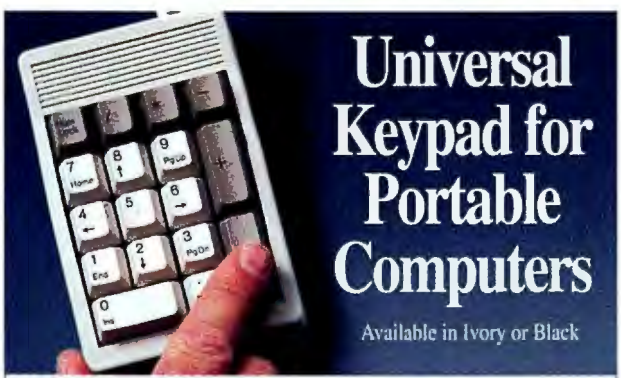

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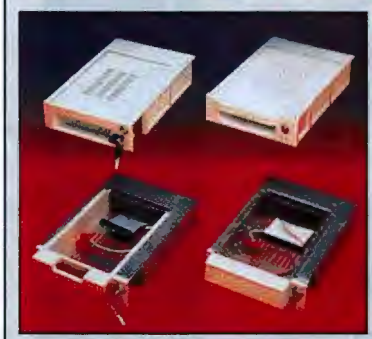

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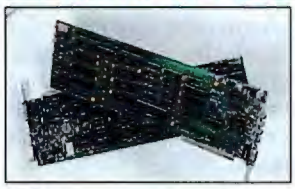

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THE BUYER'S MART is a unique classified section organized by product category to help readers locate suppliers. Each ad has Inquiry numbers to aid readers requesting information from advertisers.

AD FORMAT: Each ad will be designed and typeset by BYTE. Do NOT send logos or camera-ready artwork. Advertisers should furnish typewritten copy. **2"x1⅛"** ads can include headline (23 characters maximum), descriptive text (300 characters is the maximum recommended) plus company name, address, telephone and fax number. **2"x2⅛"** ad has more space for descriptive text (850 characters is the maximum recommended).

DEADLINE: Ad copy is due approximately 2 months prior to issue date. For example: November issue closes on September 8. Send your copy and payment to: THE BUYER'S MART, BYTE Magazine, 1 Phoenix Mill Lane, Peterborough, NH 03458. For more information call: Margot Swanson at 603-924-2656. FAX: 603-924-2683.

RATES (Jan. 1994)

	3-5 issues	6-11 issues	12 issues	13 issues
2"x1⅛"				
1 ad	$696	$668	$585	$557
2 ads/issue	–	–	557	529
3 ads/issue	–	–	529	501
2"x2⅛"				
1 ad	$1,392	$1,336	$1,170	$1,114
2 ads/issue	–	–	1,114	1,058
3 ads/issue	–	–	1,058	1,002

ACCESSORIES

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Plot it on PC (+Palmtops) with **RM-60 RAD. MONITOR + ALARM.** Uses com port. ALPHA • BETA • GAMMA • X-RAY. MicroR:1000 X resolution of survey gegers. Track **RADON,** find sources. Check food, water, ceramic coffee mugs **(EYE OPENING).** Plot background, plane ride, TV, bricks. PC MAG & BYTE rev. Visa/MC/EURO. 45 day $ back.

800-729-5397 or Tel/Fax: (302) 655-3800

Aware Electronics Corp.

P.O.Box 4299, Wilmington, DE 19807 ☆☆**$149.50**☆☆

KEYBOARD, VIDEO, MOUSE, AUDIO

Extend signals from PC with **EXTENDER**
Split signals with **COMPANION/PC EXPANDER**
Switch signals among PCs with **COMMANDER**

Boosts signals up to 600 feet. Control up to 96 PCs with one keyboard, monitor and mouse.

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Phone: 205-430-4000 Fax: 205-430-4030

Inquiry 651.

BAR CODE

Portable Reader

- ★ AA Battery Operated, 64K or 256K
- ★ Display messages and optional voice messages tell operator what to do. Messages are easily recorded (like answering machine) in any language. This unit is EASY!
- ★ Double duty as Non-portable Reader
- ★ 4x20 Supertwist LCD Display, 35 Rubber Keys
- ★ 2 Built-In Inventory Programs
- ★ Download tables and Pick Lists
- ★ Wand, CCD, or Laser Scanner Input
- ★ Serial Interface and Keyboard Interface
- ★ Reads 2of5, UPC/EAN, 128, Code 39, etc.
- ★ 2 year Warranty on Reader & Wand
- ★ 30 Day Money Back Guarantee
- ★ 64K Complete with Steel Wand – **$799**
- ★ **New Smaller Size – weighs only 12.5 oz.**

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408-458-9938 FAX 408-458-9964 **800-345-4220**

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BAR CODE READERS

For PC, XT, AT, PS/2, & Serial Terminals

- ➤ Emulates Keyboard: Works With Any Software
- ➤ Data Appears as Keyboard Input
- ➤ Uses Enhanced Decoding Algorithms
- ➤ Accepts Wand, Slot/Badge, CCD, Laser, Magnetic Stripe Reader, & RS232 Serial Input
- ➤ Reads All Popular Bar Codes (16 types)
- ➤ Reads HIGH, MEDIUM, & LOW density codes
- ➤ Auto-Discriminates Between Bar Code Types
- ➤ Easily Programmed with a Bar Code Menu
- ➤ Over 140 User Configurable Options
- ➤ Daisy Chain Up to 96 Readers
- ➤ Supports NOVELL Networks
- ➤ Supports US & INTERNATIONAL Keyboards
- ➤ Direct From Manufacturer
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- ➤ Complete Unit with LASER Scanner – $1095
- ➤ Complete Unit with WAND Scanner – $395

AMERICAN MICROSYSTEMS
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(800) 648-4452 (817) 571-9015 FAX (817) 685-6232

BAR CODE

Bar Code Readers

For PC, XT, AT, PS/2, Macintosh and Serial Terminals

- ★ Attaches as 2nd Keyboard or to any ADB port
- ★ Reads 2of5, 128, UPC/EAN, Code 39, etc.
- ★ External or Internal attachment on PC
- ★ Wand, CCD, Slot Badge, Magstripe or Laser
- ★ Two Scanners per Reader
- ★ 100+ Configurable Options
- ★ 2 Year Warranty, 30 Day $ Back Guarantee
- ★ Direct From Manufacturer
- ★ **Top Rated by Independent Review**
- ★ Complete with CCD Scanner – **$624**
- ★ Complete with Laser Scanner – **$1250**
- ★ Complete Wand only Reader– **$329**

Worthington Data Solutions
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Santa Cruz, CA 95060
408-458-9938
800-345-4220

Cordless RF Bar Code Wand

A cordless RF bar Code wand with a range of 100 feet. Plug-N-Play. No software needed. Attaches as 2nd keyboard. For IBM and Macintosh or any serial device. Real-time remote data collection for **$695.**Optional pocket beeper for long range -**$395.** It's an exclusive from the PC bar coding leader.

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Bar Code Printing Software LabelWorks for Windows

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- ➤ Desktop Publishing Features: WYSIWYG, Scalable Fonts, Rulers, Guides, Lines, Shapes, Page Zooms (25%-400%), Templates
- ➤ Rotates Text, Bar Codes, and Graphics
- ➤ Supports Windows Compatible Fonts
- ➤ Choose From Over One Hundred Popular Label Formats or Design Your Own
- ➤ Rich Text Support: Mix Styles, Types, & Sizes
- ➤ Automatically Prints Serial Numbers
- ➤ Imports & Exports Graphic Files: TIFF, GIFF, BMP, PCX, WPG, WMF, TARGA
- ➤ Supports Virtually all Windows Compatible Printers (PostScript, Laser, & Dot Matrix)
- ➤ 30-day Money-Back Guarantee, $295

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(800) 648-4452 (817) 571-9015 FAX (817) 685-6232

Portable Bar Code Reader

- ➤ Use as a PORTABLE, WEDGE, or SERIAL
- ➤ 9V Battery Operation with Lithium Backup
- ➤ 2x16 Supertwist LCD Display
- ➤ 54 Key Keyboard with Separate Numeric Keys
- ➤ Real-time Clock Supports Date & Time Stamps
- ➤ Reads all Popular Bar Codes (16 types)
- ➤ Wand, CCD, Laser, or Serial Input Devices
- ➤ Built-In Program Generator
- ➤ Create Your Own Custom Programs
- ➤ 6 Built-In Inventory Programs
- ➤ Up to 250 Programs Can Reside in Memory
- ➤ Create up to 250 Data Files per Program
- ➤ Up to 250 Look-Up Files in Memory
- ➤ Built-In Calculator
- ➤ Supports HAYES Compatible Modems
- ➤ 64K Memory with Data Compression
- ➤ 30-day $$ Back Guarantee – 1 Year Warranty
- ➤ Complete Unit with WAND Scanner – $795

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USA Made

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- **Mag Stripe Encoder/Reader** (2 or 3 trks) **$1099+**
- **Print Software** (DOS/WIN) **$149++ Software:** Inven. Assets, Tools.
- **POS Products • 30 Day $$ Back • SPANISH Dept. Avail.**

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(800)653-4252 US • (800) 219-5178 CAN • FAX (909) 270-0920

Inquiry 652.

BAR CODE

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- Readers w/RS-232, RS-485 and multidrop protocol.
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IBS-Intelligent Barcode systems, Inc.
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(800) 765-2271 (818) 968-6265 Fax: (818) 968-5527

Inquiry 653.

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A full line of **READERS • PRINTERS • PORTABLES • BAR CODE READERS FOR NOTEBOOKS • HEWLETT-PACKARD SCANNERS • MAGNETIC STRIPE READERS.** Our readers plug and play with your existing system without additional software. **CALL ABOUT OUR 30 DAY GUARANTEE • TECHNICAL SUPPORT • OEM/VAR DISCOUNTS.**
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Inquiry 654.

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Window Bar™

- Software that's easy to learn & install
- Ideal for compliance labeling
- **Rated as the "TOP RECOMMENDATION" by independent expert vs. 11 others**
- Full-featured, network ready; DDE compatible
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Inquiry 655.

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800-758-2001 206-451-8966 FAX 206-451-8982

DATA INPUT DEVICES
Bar Code, Magnetic Stripe Readers for microcomputers & terminals, including IBM PS/2 & others, DEC, Macintosh, AT&T, CT, Wyse, Wang. All readers connect on the keyboard cable & are transparent to all software. UPC & 39 print programs, magnetic encoders, & portable readers are also available.
TPS Electronics
4047 Transport, Palo Alto, CA 94303
415-856-6833 **AppleLink: BARCODE**
1-800-526-5920 **FAX: 415-856-3843**

Inquiry 656.

BAR CODE

VARIANT MICROSYSTEMS
BAR CODE READERS DELIVER
WAND/LASER/MAGNETIC CARD CONNECTIVITY

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SyPLUS & OraPLUS C++ Libraries for Sybase & Oracle	$189.00
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Inquiry 660.

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High-Performance Schematic Capture, Digital and Analog Circuit Simulation
Entire package only $269
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Phone 801-226-4470: Fax 801-226-6532

Inquiry 661.

ELECTRONICS CAD
Schematic Capture & PCB CAD
Analogue Simulation, Digital Simulation, etc.
Prices from $195. Credit cards welcome.
For brochure use Inquiry # or contact us at:
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CONTOURING MOTION CONTROL FROM A PRINTER PORT!
Indexer LPT™ software
NEW **VERSION 3** **$249** VISA/MC

- Controls up to six step motors simultaneously.
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Inquiry 663.

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The Newest Version of CADKEY – thousands previously sold at $3,495. Complete 3-D modeling and 2-D drafting tools: true splines and conics, surfaces shading, mass properties, and stereo/lithography support.
Complete symbols libraries, associative dimensioning and cross-hatching, dual dimensioning, geometric dimensioning/tolerancing Read/write AutoCAD, .DWG files, .DXF, and IGES 5.0. Graphical user interface. Programming tools (macros, CADL, and LISP).
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If you demand a simple, easy-to-use solution to create CDs, **GEAR** is everything you need. **GEAR** supports all major CD-Recorders;

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tel 31-(0) 40-515065 **fax 31-(0) 40-514920**
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Inquiry 667.

THE BUYER'S MART

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Inquiry 670.

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Inquiry 677.

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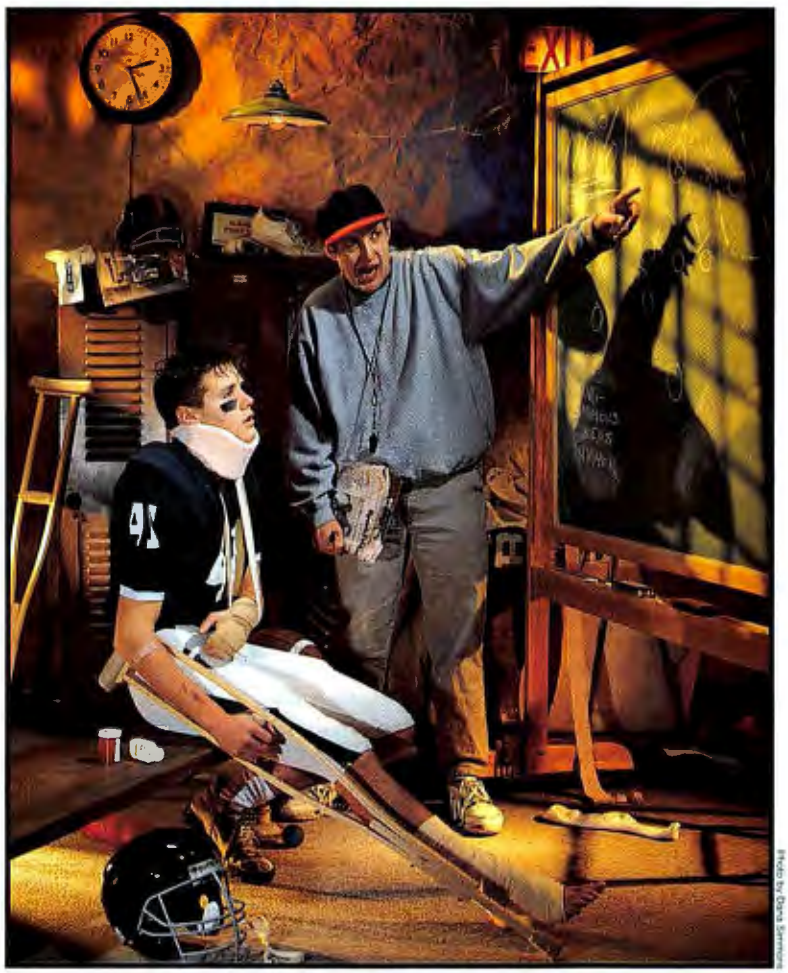

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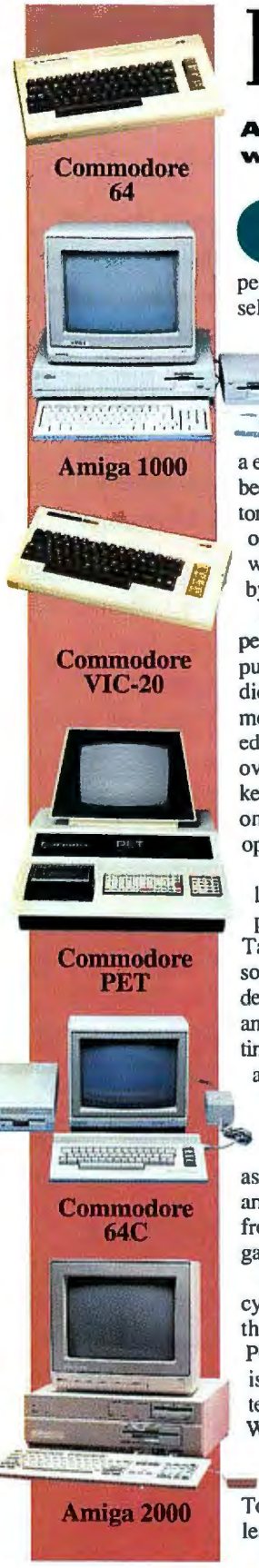
R.I.P. Commodore 1954-1994

A look at an innovative computer industry pioneer, whose achievements have been largely forgotten



Obituaries customarily focus on the deceased's accomplishments, not the unpleasant details of the demise. That's especially true when the demise hints strongly of self-neglect tantamount to suicide, and nobody can find a note that offers some final explanation.

There will be no such note from Commodore, and it would take a book to explain why this once-great computer company lies cold on its deathbed. But Commodore deserves a eulogy, because its role as an industry pioneer has been largely forgotten or ignored by revisionist historians who claim that everything started with Apple or IBM. Commodore's passing also recalls an era when conformity to standards wasn't the yardstick by which all innovation was measured.

In the 1970s and early 1980s, when Commodore peaked as a billion-dollar company, the young computer industry wasn't dominated by standards that dictated design parameters. Engineers had much more latitude to explore new directions. Users tended to be hobbyists who prized the latest technology over backward compatibility. As a result, the market tolerated a wild proliferation of computers based on many different processors, architectures, and operating systems.

Commodore was at the forefront of this revolution. In 1977, the first three consumer-ready personal computers appeared: the Apple II, the Tandy TRS-80, and the Commodore PET (Personal Electronic Transactor). Chuck Peddle, who designed the PET, isn't as famous as Steve Wozniak and Steve Jobs, the founders of Apple. But his distinctive computer with a built-in monitor, tape drive, and trapezoidal case was a bargain at $795. It established Commodore as a major player.

The soul of Commodore was Jack Tramiel, an Auschwitz survivor who founded the company as a typewriter-repair service in 1954. Tramiel was an aggressive businessman who did not shy away from price wars with unwary competitors. His slogan was "computers for the masses, not the classes."

In what may be Commodore's most lasting legacy, Tramiel drove his engineers to make computers that anyone could afford. This was years before PC clones arrived. More than anyone else, Tramiel is responsible for our expectation that computer technology should keep getting cheaper and better. While shortsighted critics kept asking what these machines were good for, Commodore introduced millions of people to personal computing. Today, I keep running into those earliest adopters at leading technology companies.

Commodore's VIC-20, introduced in 1981, was the first color computer that cost under $300. VIC-20 production hit 9000 units *per day*—a run rate that's enviable now, and was phenomenal back then. Next came the Commodore 64 (1982), almost certainly the best-selling computer model of all time. Ex-Commodorian Andy Finkel estimates that sales totaled between 17 and 22 million units. That's more than all the Macs put together, and it dwarfs IBM's top-selling systems, the PC and the AT.

Commodore made significant technological contributions as well. The 64 was the first computer with a synthesizer chip (the Sound Interface Device, designed by Bob Yannes). The SX-64 (1983) was the first color portable, and the Plus/4 (1984) had integrated software in ROM.

But Commodore's high point was the Amiga 1000 (1985). The Amiga was so far ahead of its time that almost nobody—including Commodore's marketing department—could fully articulate what it was all about. Today, it's obvious the Amiga was the first multimedia computer, but in those days it was derided as a game machine because few people grasped the importance of advanced graphics, sound, and video. Nine years later, vendors are still struggling to make systems that work like 1985 Amigas.

At a time when PC users thought 16-color EGA was hot stuff, the Amiga could display 4096 colors and had custom chips for accelerated video. It had built-in video outputs for TVs and VCRs, still a pricey option on most of today's systems. It had four-voice, sampled stereo sound and was the first computer with built-in speech synthesis and text-to-speech conversion. And it's still the only system that can display multiple screens at different resolutions on a single monitor.

Even more amazing was the Amiga's operating system, which was designed by Carl Sassenrath. From the outset, it had preemptive multitasking, messaging, scripting, a GUI, and multitasking command-line consoles. Today's Windows and Mac users are still waiting for some of those features. On top of that, it ran on a $1200 machine with only 256 KB of RAM.

We may never see another breakthrough computer like the Amiga. I value my software investment as much as anyone, but I realize it comes at a price. Technology that breaks clean with the past is increasingly rare, and rogue companies like Commodore that thrived in the frontier days just don't seem to fit anymore. ■

Tom R. Halfhill is a BYTE senior news editor based in San Mateo, California. You can reach him on the Internet or BIX at thalfhill@bix.com.

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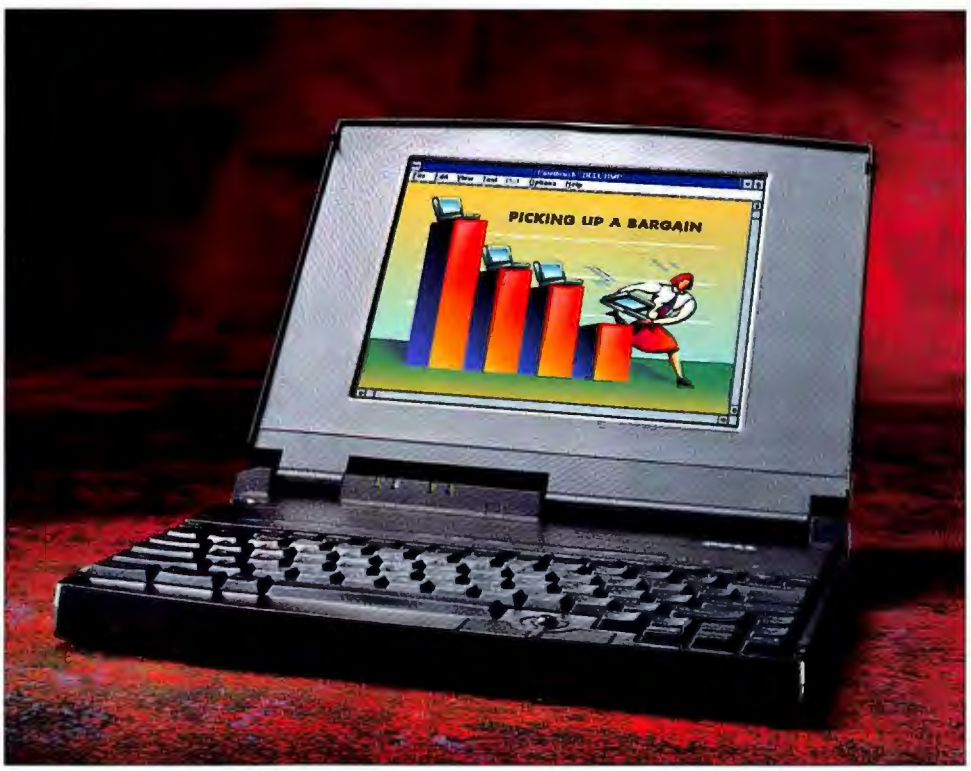

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Dell recently ranked highest in the 1993 J.D. Power and Associates Desktop PC Customer Satisfaction Study.‡ Otherwise known as the benchmark of desktop PC customer satisfaction. Almost 2,000 nose-to-the-grindstone, business PC users took part. So the next time you think about buying a cheap PC, think about this. Are you going to get ISO 9000 quality, plus outstanding service and support, all at a great price? Or are you going to get left holding the proverbial bag?

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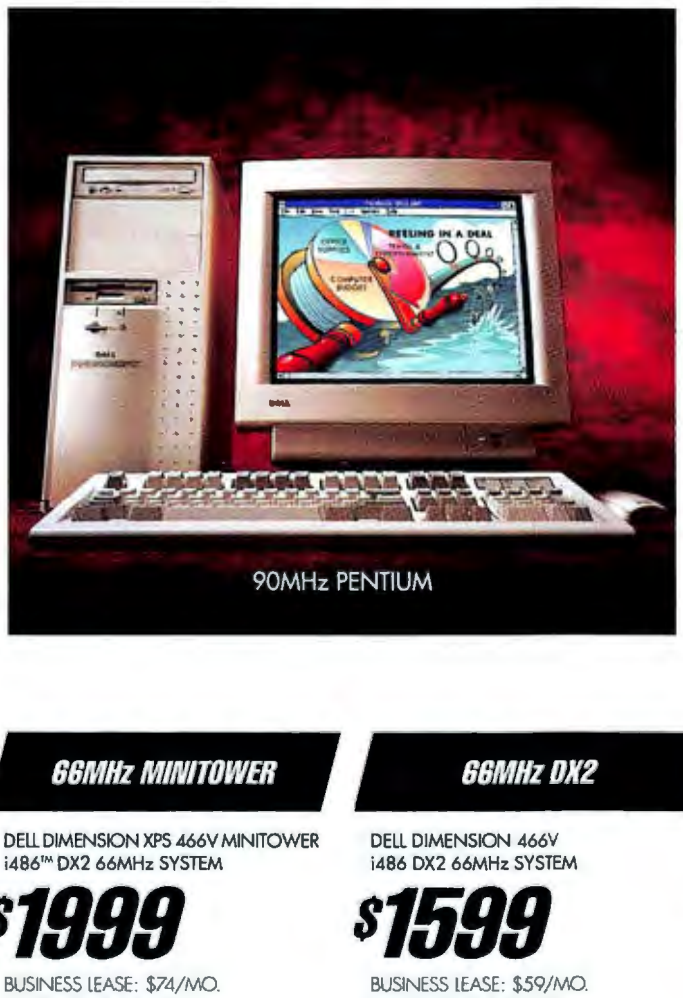

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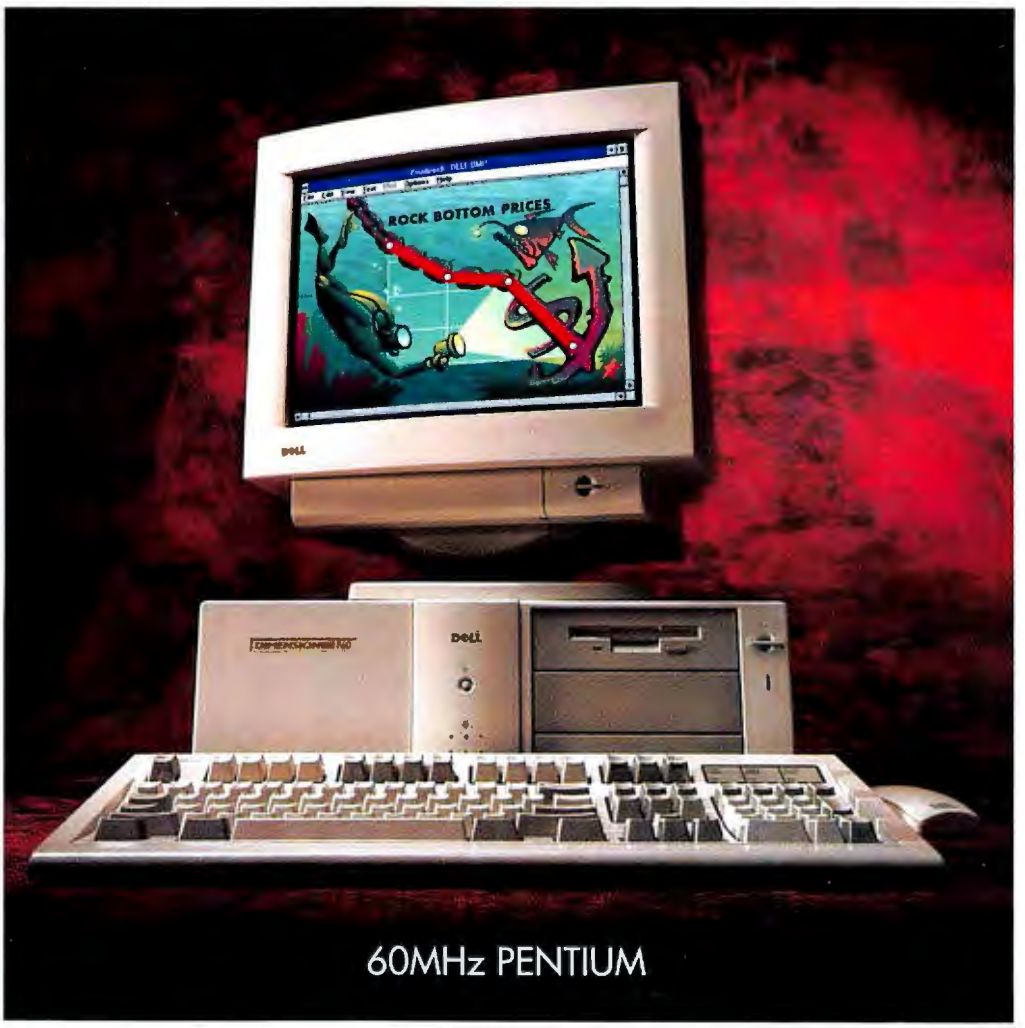

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