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PAGE 90

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* Not in native mode.
OS/2 Gets Lean and Mean ..........26
IBM has released the first beta of a new version of OS/2 for Windows: a 32-bit operating system that will run well on 4-MB PCs. But support for APIs for future versions of Windows is uncertain.

IBM Plans Ambitious Network ......34
This fall, IBM will introduce Intelligent Communications, a set of communications services that span the gulf between different access providers, mail systems, delivery media, and user devices.

Help for Patent Fever ..............44
New products and services are out that can help a developer file a patent application or search for prior patents.

Fine-Tune LANastic ..............55
BY AMIN R. ISMAIL AND RHONDA COPLEY The LANastic API gives you an unprecedented degree of control over your network configuration.

Silicon in Reverse ............67
BY PETER WAYNER Reversible logic circuits promise to radically decrease the power requirements of future VLSI chips.

Cache Advantage ............78
BY DAVID F. BACON CPUs get the glory, but cache type and organization are just as critical in determining system performance.

Back of the Bus 108
BY RUSSELL KAY Connecting add-on devices to your computer can be an exercise in frustration. New buses promise to simplify the process.

SCSI and Beyond 111
BY DINAH MCNUTT New standards clarify the future direction and higher-speed capabilities of this long-established workhorse interface for PC, Macintosh, and Unix platforms.

Seriously Serial 117
BY MARK CLARKSON Two new serial buses contend for desktop acceptance—the low-speed Access.bus and the high-speed P1394/FireWire. Each has special strengths.

Pumping Up the Parallel Port—118
Software Roundup: SPARC Workstations to Go

Virus-Prevention NLMs

As the computing world becomes increasingly interconnected through LANs, wide-area links, the Internet, and on-line services, corporations are more vulnerable to the threat of computer viruses. BYTE evaluates a convenient and effective solution: antivirus software that works as NetWare NLMs. We're reconfiguring between different network situations.

Antivirus Software Systems

ANTVIRUS SOFTWARE SYSTEMS

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Flatbed Color Professionals

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Systems

Apple Redefines the Notebook

BY TOM THOMPSON The latest PowerBooks set a new standard for notebook computers: built-in Ethernet, an innovative trackpad, optional PCMCIA expansion, 16-bit color, stereo sound, and a fast 68040 processor upgradable to PowerPC. Tom Thompson tests the new PowerBooks.

Groupware

Blazing the Path

BY BEN SMITH DEC's LinkWorks delivers 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 can provide an effective set of tools for automating your most complex work-flow tasks.

Lab Report:

“The” Debugger Is Aptly Named

BY TOM THOMPSON This program is an essential tool for developing native PowerPC programs.

Pentium Systems

21 Pyrotechnic Pentiums

BY K. R. PARTON Our application tests identify the best Pentium systems for general business and high-performance computing.

Best Pentiums for General-Purpose Windows—166

486DX4: A 100-MHz Alternative to Pentiums?—166

Best Pentiums for High-Performance Windows—169

Best Pentiums for Unix Applications—171

How We Tested—174

Beating the Heat—176

Honorable Mention—176

Operating Systems

System 7.5: A Step Toward the Future

BY TOM THOMPSON System 7.5 is a significant evolutionary step toward a new Mac OS.

Supercomputer Processor

A Different Kind of RISC

BY DICK POUNTAIN Hewlett-Packard's PA-RISC 7200 superscalar processor is not typical, and neither is its performance: It's likely to hold the title of "fastest RISC in town" for the immediate future.

Operating Systems

SNMP Version 2

BY WILLIAM STALLINGS AND BEN SMITH SNMP is maturing, as evidenced by the added functionality of SNMP 2.
OS/2 Gets Lean and Mean ........ 26
The first beta of IBM's new version of OS/2 for Windows is out. It targets users who need the benefits of a 32-bit operating system and the ability to run native OS/2, DOS, and Windows 3.11 applications on a modestly configured PC.

MACINTOSH

SPARC Workstations to Go .... 153
If you use Sun Unix, you now have more options for making it portable. BYTE tests three SPARC portables from RDI, Sun Microsystems, and Tadpole.

Lab Report: 21 Pyrotechnic Pentiums ........ 164
New Pentium systems have enough muscle to run Unix, but many don't yet provide software support to do so, particularly when it comes to graphics card adapters.

NETWORKS

Hubs Branch Out of the Wiring Closet .... 30
Network managers are moving toward integrating WAN access into their hubs. Advantages of this approach include simplified network management, improved reliability, and enhanced management functions.

IBM Plans Ambitious Network .... 34
A set of new communications services due out this fall from IBM targets mobile business users who need access to legacy data. Collectively called Intelligent Communications, the service will support a range of devices and media types across the network, including public and private E-mail, voice and voice mail, fax, paging, and data.

Fine-Tune LANTastic .... 55
Tap into LANTastic's powerful API and create your own custom applications utilities to improve on the performance and security of your network.

Virus-Prevention NLMs .... 129
Network usage contributes to the computer virus problem by giving viruses a means of storage and transport. Virus-prevention NLMs provide network administrators with an effective tool for combating virus infections. We test and rate seven of these antivirus programs.

UNIX

Blazing the Path........ 147
DEC's new work-flow solution, LinkWorks, supports clients on the three most common corporate computing environments—Unix workstations, PCs running Windows, and Macs—and at the same time contains, controls, and routes data objects of any type.

Lab Report: 21 Pyrotechnic Pentiums .... 164
There are more choices than ever for Pentium-based desktop systems. We rank 21 Pentium PCs with various CPU speeds and price points to find the best for a variety of applications.

Index

Amiga .......... 252
Awards ........ 38
Books .... 49
Bus technology .... 108, 111, 117, 123
Cache technology .... 78
Communications .... 34, 40, 193
CPUs .... 67, 185
Document management .... 90, 147
File compression .... 44
486DX4 .... 166
Graphics .... 48
Groupware .... 90, 147
Low-power technology .... 67
Macintosh .... 129, 137, 143, 147, 159, 187
Networks .... 30, 34, 55, 90, 129, 147, 191
Objects .... 90, 147
OLE .... 90
OpenDoc .... 90
Operating systems .... 26, 187
OS/2 .... 26
Pentium .... 164
Portables .... 34, 143, 153, 193
PowerPC .... 159, 187
Programming .... 44, 55, 159, 183
RISC .... 40, 153
Scanners .... 137
SCSI .... 40, 108, 111, 193
SNMP .... 191
Software patents .... 44
SPARC .... 153
Storage .... 34, 79
Systems .... 143, 153, 164
RISC .... 40, 153, 185
Unix .... 147, 153, 164
Virus prevention .... 129
Voice recognition .... 48
WANs .... 30, 34
Word processors .... 193
Work flow .... 90, 147
Workstations .... 153
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You'll wonder how you ever managed without it.
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 Hanover, 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.
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full advantage of the PowerPC microprocessor's higher performance. (Interestingly, many haven't done the same for our competitor's microprocessor.)

One final note on software: PowerPC computers actually run more software than computers based on Pentium microprocessors. With PowerPC computers, you can run Macintosh*, OS/2®, MS-DOS®, Windows®, UNIX® and, soon, Windows NT® software.

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MOTOROLA
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 68x0 binaries into PowerPC binaries. Some Macintosh developers are using it to port all or parts of their 68x0-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 Introversions 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 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 Mathielsen’s review of Novell DOS 7 (“Novell’s Newest DOS,” continued in this issue). I then forwarded a copy to my group and asked their opinions.

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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 days out of the functionality advocates.

Carl H. Payne
Orem, UT

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

Executive Information Systems

I am the architect of the data-replication products for IBM’s DB2 family of database managers. These products are used to replicate data and support distributed database management among mainframe relational and non-relational 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 Golding
Architect, IBM Data Propagation Products
Santa Teresa, CA

• NETWORK CONNECTIONS
  Is ATM (Asynchronous Transfer Mode) ready for prime time? Are you ready for ATM? The State of the Art section focuses on WAN (wide-area networking) and internetworking issues with an emphasis on ATM, switching, and remote access.

• ACCESS 2.0
  This in-depth review focuses on the new high-end features of Microsoft’s greatly improved database, particularly on its expanded suite of applications development tools.

• FEATURE: ITTY-BITTY PROCESSORS
  These processors are so small they fit on a 16-pin DIP and so low-power they can run on only 2.0 V. You’ll find them in everything from cellular phones to IR remote controllers, but they’re far more powerful than you might guess.

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  New hard drives push IDE capacity beyond 528 MB and support the fast local bus for higher throughput. BYTE examines IDE drives ranging from 540 MB to 1 GB.

• HANDS-ON REVIEW: 24 CD-ROM DRIVES
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Once you've got this foundation, your business might just go right to the top of the food chain.

Microsoft
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)
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.'" 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 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 place 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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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 equipment, their network hub vendors.

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 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 integrated access devices 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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In Touch with Tomorrow

TOSHIBA

Circle 133 on Inquiry Card.
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 handing 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 Adventus 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 recharge. In fact, the tape unit detaches from the base, which houses two AA batteries. Datasonix claims a respectable 10MBps 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.

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
Want to get more bang for your box? Look for one that offers OS/2™ preloaded. It won't be hard to find. More than 50 major PC makers offer OS/2—companies like IBM, AST®, Dell® and HP®, to name a few.

Right out of the box, OS/2 takes advantage of your new PC in ways Windows™ simply can't. Now DOS and Windows programs can run more reliably—even faster in many cases. OS/2 multimedia delivers superior sound, faster digital video and better audio/video synch. And unlike Windows, OS/2's Workplace Shell™ interface gives you more flexibility to arrange your on-screen desktop to work (and play) the way you do.

<table>
<thead>
<tr>
<th>A Preload to Greatness</th>
<th>OS/2</th>
<th>Windows 3.1</th>
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<tbody>
<tr>
<td>Intuitive, object-oriented interface.</td>
<td>The Workplace Shell.</td>
<td>They're working on it.</td>
</tr>
<tr>
<td>Reliably runs more than one program at a time*</td>
<td>Like a dream.</td>
<td>Keep dreaming.</td>
</tr>
<tr>
<td>Lets you print in one program while you work in another.</td>
<td>No problem.</td>
<td>Good luck.</td>
</tr>
<tr>
<td>Comes with Adobe Type Manager™, memory manager, print spooler and disk cache program.</td>
<td>Built-ins.</td>
<td>Add-on$.</td>
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Missions don’t get much more critical than this. Motorola is currently developing the IRIDIUM™ System, a massive cellular communications system involving a constellation of 66 satellites orbiting the earth. Equally critical is the massive amount of documentation required to get the IRIDIUM System off the ground. And naturally, Motorola selected the best tool for the job: FrameMaker. FrameMaker delivers exactly what Motorola needs for all their hardware and software documentation. The ability to easily integrate text,
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Circle 252 on Inquiry Card.
**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.

**BEST OF COMDEX FINALISTS**

**Most Significant Technology:** DEC's Alpha microprocessor blazing at 333 MHz and Kurzwell Applied Intelligence's Voice for Windows (see "Kurzwell 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 InSync ((301) 831-5008).

**Multimedia Hardware:** MediaPlayback PC and Macintosh lets a CD-ROM-equipped computer play full-screen CD (CD Interactive) programs, Phillips Digital Video movies, and VideoCD CDs from International Interactive Media (617) 890-6656; and Matrox Graphics MGA Impression Plus 64-bit graphics and video accelerator board (514) 685-2630.

**Portable:** Zenith Data Systems' ((708) 808-5000) modular ZNotebook 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-passive-matrix) with its portable multimedia expansion unit ((800) 425-2988).

**System:** ALR's Revolution QSP Symmetrical Multiprocessor server that supports up to four Pentium processors ((714) 581-6770) and NekoTech's low-cost Mach 1:66 workstation ((714) 580-0055) based on the Alpha AXP 21066 processor.

**Printer:** HP's LaserJet 4 Plus and LaserJet 4M Plus 12-page printers and ((800) 762-0900) and the PrimeraPro Color Printer from Fargo Electronics with 600-to-300-dpi dye-sublimation and wax thermal printing ((612) 941-9470).

**Software:** ARES, 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) 869-7796) 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) Smart-Raid self-contained RAID storage subsystem.

**System/Development Software:** Microsoft's Windows NT Workstation operating system (code-named Daytono) 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 landline and voice capabilities from Open Sky ((508) 442-4367), and Connection Pro, a multifunction 1.92-Mbps data/fax/voice modem from DigilCom ((408) 262-5017).

**Networking:** SkyLAN, a LocalTalk wireless network from Amax S&T ((215) 692-3290), and the Ben1016 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 to use faster controller chips to help reduce the I/O subsystems to keep up. As a result, a fast processor must often wait until instructions and data are available from peripheral devices.

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.

Advansys is also selling two SCSI host adapters based on its controller chips. AdvansCSI Gold ($399) 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 supports 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 "stop-gaps until ISDN."

—Andy Reinhardt
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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
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Audience attention spans are short. And if they snooze, you lose. So what you need is a way to connect with them, a way to make your presentations really worth watching. The versatile, new Z·NOTEFLEX system, from Zenith Data Systems, is sure to keep them wide-eyed and endlessly entertained.

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And, of course, no multimedia-ready system is complete without a CD-ROM drive. Video, however, is only part of the picture. Because with built-in, 16-bit audio, a microphone and stereo speakers, the Z·NOTEFLEX system is truly (pardon the expression) a sound investment.

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CorelDraw 5.0 Adds Better Image-Editing Tools

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.”

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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.

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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InfoWorld, April 4, 1994
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It's ideal for those who travel the fast track. Driven by a fast Intel DX4 100MHz processor, the N100 is a blur. The screen, however, is sharp and vivid—thanks to a 9.5-inch active matrix (TFT) display. Combined with the integrated audio playback and record functions, your multimedia presentations will be very sharp indeed. The N100 may be small, but it packs an impressive list of features. Such as a 450MB hard drive. An 85-key, full-size keyboard. And an integrated, easy-to-use 16mm trackball. All at a flyweight price. And all to help you fly through your workload.

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- 3.5" 1.44MB Diskette Drive
- Type III PCMCIA Slot (1 Type III/2 Type II)
- 85-Key Keyboard
- Centered 16mm Trackball
- Integrated Audio (Speaker and Microphone)
- System Status Panel
- 6.7 Pounds, Including NiMH Battery
- MS-DOS 6.2
- Windows for Workgroups 3.11
- Includes AC Adapter and Case

**N100T-450 $5299**

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- 450MB Hard Disk Drive, Upgradable
- 9.5" Active Matrix TFT Color Display with Local Bus Video and 1MB Video RAM
- 4MB RAM, Max: 20MB
- 3.5" 1.44MB Diskette Drive
- Type III PCMCIA Slot (1 Type III/2 Type II)
- 85-Key Keyboard
- Centered 16mm Trackball
- Integrated Audio (Speaker and Microphone)
- System Status Panel
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<td>D466DXA</td>
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**MOBILE SYSTEMS**

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<td>9.5&quot; Dual Scan Color Display</td>
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<td>D600EVL</td>
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<td>$103/Month</td>
<td>540MB SCSI Hard Disk Drive</td>
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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 8051 s 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...
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 Grehaw is technical director of the BYTE Lab. He can be reached on the Internet or BIX at rick_g@bix.com.

## Publishing in the Information Age:

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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.

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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.

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
```
Feature

NET CLOCK \server\ 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 BIOS-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 SCh 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 SCh, only they will be discussed.

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 user name, password information using register ES:DI.

Notice that the log-in string actually contains two ASCllZ 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-

<table>
<thead>
<tr>
<th>LANtastic API FUNCTIONS</th>
<th>FUNCTION NUMBER</th>
<th>DESCRIPTION</th>
<th>NET EQUIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DOS-compatible calls</strong></td>
<td><strong>5E00h</strong></td>
<td>Get Machine Name</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5E02h</strong></td>
<td>Get Printer Setup*</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>5E05h</strong></td>
<td>Get Printer Setup*</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>5F02h</strong></td>
<td>Get Redirected Device Entry</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5E09h</strong></td>
<td>Redirect Device</td>
<td>NET USE</td>
</tr>
<tr>
<td></td>
<td><strong>5F04h</strong></td>
<td>Cancel Device Redirection</td>
<td>NET UNUSE</td>
</tr>
<tr>
<td><strong>LANtastic NOS extend calls</strong></td>
<td><strong>5F08h</strong></td>
<td>Get Log-In Entry</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F01h</strong></td>
<td>Log In To A Server</td>
<td>NET LOG IN</td>
</tr>
<tr>
<td></td>
<td><strong>5F03h</strong></td>
<td>Get User Name Entry</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F04h</strong></td>
<td>Get Alternate Server Entry</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F05h</strong></td>
<td>Change Password</td>
<td>NET CHANGEPW</td>
</tr>
<tr>
<td></td>
<td><strong>5F06h</strong></td>
<td>Disable Account</td>
<td>NET DISABLED</td>
</tr>
<tr>
<td></td>
<td><strong>5F07h</strong></td>
<td>Get Account</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>5F08h</strong></td>
<td>Get Out From All Servers</td>
<td>NET LOG OUT</td>
</tr>
<tr>
<td></td>
<td><strong>5F09h</strong></td>
<td>Copy File</td>
<td>NET COPY</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Send Unspecified Message</td>
<td>NET SEND</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Bh</strong></td>
<td>Get Last Received Unspecified Message</td>
<td>NET RECEIVE</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Message-Processing Flag</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Bh</strong></td>
<td>Set Message-Processing Flag</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ch</strong></td>
<td>Pop Up Last Received Message</td>
<td>NET MESSAGE</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Dh</strong></td>
<td>Get LPT Notification Flag</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Set LPT Notification Flag</td>
<td>NET LPT NOTFY</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Queue Entry</td>
<td>NET QUEUE STATUS</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Set Queue Entry</td>
<td>NET QUEUE</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Control Queue</td>
<td>NET QUEUE</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Printer Status</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Set Stream Information</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Create User Audit Entry</td>
<td>NET AUDIT</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Active User Information</td>
<td>NET EXPAND</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Shared Directory Information</td>
<td>NET INDIRECT</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get User Name From Account File</td>
<td>NET INDIRECT</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Translate Path</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Create Indirect File</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Indirect File Contents</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Server’s Time</td>
<td>NET CLOCK</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Schedule Server Shutdown</td>
<td>NET SHUTDOWN</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Cancel Server Shutdown</td>
<td>NET SHUTDOWN</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Stuff Server Keyboard Buffer</td>
<td>NET RUN</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Redirected Printer Time-Out</td>
<td>NET SHOW</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Set Redirected Printer Time-Out</td>
<td>NET LPT TIME-OUT</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get DOS Service Vector</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Set DOS Service Vector</td>
<td>NET STREAM</td>
</tr>
<tr>
<td></td>
<td><strong>5F0Ah</strong></td>
<td>Get Message Service Vector</td>
<td>NET STREAM</td>
</tr>
</tbody>
</table>

* 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.
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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 4An).
- 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.

Feature

Log-in with C

```c
#include <dos.h>
#include <stdio.h>
char strg[100] = "\\server\\\ Jones\secret":
union REGS Inregs, outregs;
struct SREGS segregs;

int result;

int main()

{

    Inregs.ax = 05F81h;
    Inregs.h.b1 = 0;
    Inregs.d1 = FP_OFF(strg);
    segregs.ah = FP_SEG(Lstreg);
    result = int86x(0x21), Inregs, &outregs, &segregs);
    if (outregs.x.cflag)
        printf("Network error \xdin", result);
    else
        printf("Login Okay");
}
```

Log-in with BASIC

```basic
'INCLUDE "QB.BI"

COMMON SHARED InRegs AS RegTypeX, OutRegs AS RegTypeX

DIM Lstrg AS STRING * 50

Lstrg = "\\server\\Jones" + CHR$ (0) + "SECRET" + CHR$ (0)

InRegs.ax = 05F81h
InRegs.bx = 0
InRegs.es = VARSEG(Lstrg)

INT0 82H, 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 *strg to it. You set register AX to the function number by assigning the value 05F81h to the union variable inregs.x.ax. Similarly, you assign the adapter number to register BL (inregs.h.b1). Register DI (inregs.x.d1) 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 INTERRUPT 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 (segment address). The INTERRUPT 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 ASCII 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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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 TMEBLK. Register SI points to the data structure while register DI points to the ASCIIZ server name on input. On return, the TMEBLK data structure is filled in with the server's date and time. The code then extracts the date information from TMEBLK 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 TMEBLK 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 (5FAOh), 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 ODEST 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 tasks:

- 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.

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The players around the industry poker table have changed some, but the game hasn’t. Gateway’s strategy is to deal you a royal flush of value: high-performance, high-quality PCs at the very best prices with old-fashioned, good service. Same as always. And although Gateway has become a Fortune 500 firm, we still think like a small, maverick company from the South Dakota frontier.

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<thead>
<tr>
<th><strong>4DX2-66</strong></th>
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<td><strong>- 3.5&quot; Diskette Drive</strong></td>
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<td><strong>- 15&quot; Color CrystalScan Monitor</strong></td>
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<td><strong>- 17&quot; Color CrystalScan 1776LE</strong></td>
<td><strong>- Tower Case</strong></td>
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<td><strong>- 5.7 Lbs., 11.7&quot; x 8.5&quot; x 1.77&quot;</strong></td>
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<td><strong>- 10.3&quot; or 9.4&quot; VGA Dual-Scan STN Color Display</strong></td>
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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

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 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.
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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 doubtless 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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The Logic of Reversible Logic

Transistor switching: Today Tomorrow

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 speed.

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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.

**Recovering 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.

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 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.

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For Further Reading


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

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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 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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<td>i486DX2/66MHz</td>
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<tr>
<td>Pentium chip upgradable</td>
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<tr>
<td>270MB² HD, 4MB RAM</td>
<td>270MB² HD, 4MB RAM</td>
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<td>Desktop with 5 slots, 5 bays</td>
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<td>VESA local bus</td>
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<td>128K L2 cache</td>
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<thead>
<tr>
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<th>ThinkPad 755Cs</th>
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<tr>
<td><strong>$2599</strong> IBM Credit Lease $96/month¹</td>
<td><strong>$3599</strong> IBM Credit Lease $133/month¹</td>
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<td>486SX/33MHz</td>
<td>486DX2/50MHz</td>
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<tr>
<td>170MB³ HD, 4MB RAM</td>
<td>170MB³ HD, 4MB RAM</td>
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<tr>
<td>One Type III or two Type II PCMCIA slots</td>
<td>One Type III or two Type II PCMCIA slots</td>
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<tr>
<td>Over $800 worth of preloaded business software</td>
<td>Over $800 worth of preloaded business software</td>
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<tr>
<td>1-year International Traveler’s Warranty</td>
<td>3-year International Traveler’s Warranty</td>
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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.

**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.

**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
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 equptott 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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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 at[3,0] and at[3,1] are adjacent in memory, while at[3,0] and at[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 effects 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.

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 table 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 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.

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<thead>
<tr>
<th>Security Continuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Button Type</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>DS1420 ID Button</td>
</tr>
<tr>
<td>DS1427 Time Button</td>
</tr>
<tr>
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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 dbf@cs.berkeley.edu or on BIX c/o “editors.”

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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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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 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
"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

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**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 Document Management API (ODMA) 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).

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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 MAP! 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.

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 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.

Upcoming 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.

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 Tadjamulia, executive vice president of technology at SoftSolutions Technology (Orem, UT), "is to know that an original is an original, and who touched 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
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.

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 multifaceted 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.

Another company embracing a client/
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- Four 486 models ranging from a 25MHz to a racy IntelDX4™/75MHz
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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 (e.g., 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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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 spoil 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 check-in/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, 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
In the real world of project management, the only constant is change. Managers are faced with coordinating more activities in less time, with tighter budgets, and workgroups spread out across the building and around the world. So what can managers at all levels of experience count on to keep them up to date and in control—Project Scheduler 6 for Windows!

Unlike many software programs that claim to be easy to use, Project Scheduler 6 for Windows really is, and the experts agree. According to a recent InfoWorld review: "Project Scheduler's interface is a joy to use...Scitor understands how people use project management software."¹

But Project Scheduler 6 offers managers more than just relief from occasional project stress. "Project Scheduler 6 surpasses Microsoft Project and CA SuperProject — in addition to challenging many high end packages." wrote InfoWorld.²

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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. PC DOCS can concentrate on 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 entire “volumes,” 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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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 re-visited 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, researchers 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 theaurus-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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Image Retrieval for Compound Documents

TOM R. HALFHILL

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 retooling 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 keyup 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 UltraMedia 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 toolkits 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.

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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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.

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.
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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...
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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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 anderasable 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.periph.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.periph.scsi.


ACKNOWLEDGMENTS
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Dinah McNutt is a systems administration consultant and founder of Zilker Internet Park in Austin, Texas. You can contact her on the Internet at dinah@zilker.net or on BIX cfi "editors."
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's 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 backbone—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/Sigmetrik 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 32-bit-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,
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**State of the Art** 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

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. Why, 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 certain 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 hopping 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**
There Are Two Times When Modem Reliability Is Critical.

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State of the Art Seriously Serial

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 SCS1-3? Access.bus is basically a replacement for aging RS-232 technology, while FireWire has its sights set on 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

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 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 DataComm 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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State of the Art  Fibre Channel Speeds Up

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, Elderc, 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 online 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 online. 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 mix and match cards according to their requirements.”
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 multipport I/O, something Fibre Channel provides. With Fibre Channel, you can have an Internet Protocol connection, multi-channel 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 re-calculate 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-
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

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

TokenRing. A line of Token Ring network adapters and multi-station access units that feature on-site support by IBM's own Customer Engineers. The adapter cards feature 100% IBM driver compatibility, the IBM designed TROPIC chip and a retail price of less than $200.

Ethernet.

Our EtherRx family of ISA and EISA Ethernet network interface cards, dual interface pocket adapters, concentrators and transceivers provide solutions for a wide range of Ethernet connectivity needs. With uncompromised reliability and compatibility plus value pricing, EtherRx is the ideal Ethernet choice.

PCMCIA Ethernet Cards.

Combining industry performance with a retail price of less than $200, EtherRx PCMCIA cards are setting new standards for portable connectivity. They are available in both 10Base-T and 10Base2 versions, support the widest range of Type II compliant notebook, laptop and desktop systems and are compatible with all popular network operating systems.

Certified Compatibility.

Kingston networking products are certified compatible with Novell Netware, Microsoft Windows for Workgroups and LANManager, Arisoft LANTastic and support every other popular network operating system including IBM OS/2 Extended Edition and Banyan VINES.

Kingston Reliability.

Network users enjoy the same reliability customers have come to expect from Kingston memory and processor upgrades. Every product is individually tested prior to shipping, supported by free comprehensive technical assistance and is backed by a five-year warranty.

More Information.

For more information on the Kingston line of networking products, contact your nearby Kingston dealer or call (800) 435-2620, (714) 435-2600 or fax (714) 435-2699.
In Canada: Dynatech, Ltd. (416) 636-3000 or in Mexico MPS Majorista 325-09-93 or Ingram Dicom 328-11-11.

Circle 100 on Inquiry Card (RESELLERS: 101).
## Reviews: Software Roundup

### Protection Parameters

<table>
<thead>
<tr>
<th></th>
<th>CENTRAL POINT ANTI-VIRUS</th>
<th>DR. SALOMON’S ANTI-VIRUS TOOLKIT</th>
<th>INOCULAN VIRUS PROTECT</th>
<th>LANDesk NET-PROTO</th>
<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check DOS files</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Check Macintosh files</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Check for unknown viruses</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Supply a TSR monitor for workstations</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Password-protect NLM configuration</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
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</table>

### Scanning Options

<table>
<thead>
<tr>
<th></th>
<th>CENTRAL POINT ANTI-VIRUS</th>
<th>DR. SALOMON’S ANTI-VIRUS TOOLKIT</th>
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<th>LANDesk NET-PROTO</th>
<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine executable file types</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan drives, directories, or files</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan specific volumes</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan by domain</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Include subdirectories</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Exclude subdirectories</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Automatically run periodic scans</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Set priority for CPU usage for scan</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Real-time scanning</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan using wild cards</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Encrypt signature</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>User must create a list of files to check for unknown viruses</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Automatically run periodic scans</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan compressed files</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan migrated files</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Scan by domain</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Exclude subdirectories</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>List detectable viruses</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

### Integrity Checking

<table>
<thead>
<tr>
<th></th>
<th>CENTRAL POINT ANTI-VIRUS</th>
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<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculate CRC or checksum codes</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Seed CRC with password</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Copying files maintains validation codes</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Remove validation codes</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Maintain validation-exception list</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Encrypt validation-code database</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Check for validation before executing file</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Specify groups of files to validate</td>
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<td>✗</td>
<td>✗</td>
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<td>List files that have been validated</td>
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### Repair

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<th>CENTRAL POINT ANTI-VIRUS</th>
<th>DR. SALOMON’S ANTI-VIRUS TOOLKIT</th>
<th>INOCULAN VIRUS PROTECT</th>
<th>LANDesk NET-PROTO</th>
<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
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<tr>
<td>Remove known viruses</td>
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<td>Remove corrupted files</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<td>Restore corrupted files</td>
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<td>✗</td>
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<td>Restore overwritten files</td>
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<tr>
<td>Clear infected file upon detection</td>
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<td>✗</td>
<td>✗</td>
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<tr>
<td>Purge or overwrite file</td>
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<td>✗</td>
<td>✗</td>
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<td>Move infected file to a specific directory</td>
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### Network Capability

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<tr>
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<th>DR. SALOMON’S ANTI-VIRUS TOOLKIT</th>
<th>INOCULAN VIRUS PROTECT</th>
<th>LANDesk NET-PROTO</th>
<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
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<tbody>
<tr>
<td>Automatically update nodes</td>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Automatically update other servers</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Automatically configure nodes</td>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Update configurations from server to server</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Configure NLM from workstation</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Specify NLM to load after scanning</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<td>✗</td>
</tr>
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</table>

### Alerting/Reporting

<table>
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<tr>
<th></th>
<th>CENTRAL POINT ANTI-VIRUS</th>
<th>DR. SALOMON’S ANTI-VIRUS TOOLKIT</th>
<th>INOCULAN VIRUS PROTECT</th>
<th>LANDesk NET-PROTO</th>
<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert administrator even if infection occurs while off-line</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Notify administrator upon log-in</td>
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<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Send message to administrator via computer</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Send message to administrator via fax</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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<tr>
<td>Display customizable alert to workstation</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Server-to-server communication of alerts</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Store virus activity to audit file</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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</tr>
<tr>
<td>Create custom reports</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
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</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Resource allocation</th>
<th>CENTRAL POINT ANTI-VIRUS</th>
<th>DR. SOLOMON’S ANTI-VIRUS TOOLKIT</th>
<th>INOCULAN</th>
<th>LANDesk</th>
<th>VENTRY</th>
<th>NET-PROT</th>
<th>NETSHIELD</th>
<th>NORTON ANTIVIRUS</th>
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</thead>
<tbody>
<tr>
<td>System modules</td>
<td>232,287</td>
<td>65,211</td>
<td>328,983</td>
<td>94,143</td>
<td>46,112</td>
<td>186,537</td>
<td>137,238</td>
<td>196,340</td>
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<tr>
<td>Small memory allocations</td>
<td>41,356</td>
<td>19,924</td>
<td>26,348</td>
<td>12,594</td>
<td>1124</td>
<td>86,736</td>
<td>181,760</td>
<td>196,340</td>
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<tr>
<td>Large memory allocations</td>
<td>467,200</td>
<td>156,140</td>
<td>628,780</td>
<td>215,220</td>
<td>12,880</td>
<td>730,060</td>
<td>196,340</td>
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<tr>
<td>Total memory resources</td>
<td>740,963</td>
<td>230,275</td>
<td>984,111</td>
<td>321,947</td>
<td>59,896</td>
<td>1,005,333</td>
<td>497,858</td>
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<td>Number of threads</td>
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<td>15</td>
<td>8</td>
<td>2</td>
<td>5</td>
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<tr>
<td>Number of modules loaded</td>
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<td>1</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>5</td>
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Default file extensions scanned

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<th>CENTRAL POINT ANTI-VIRUS</th>
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<th>INOCULAN</th>
<th>LANDesk</th>
<th>VENTRY</th>
<th>NET-PROT</th>
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<td>.COM</td>
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</tr>
</tbody>
</table>

© No real-time scanning. 0 = yes; O = no.

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

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 NLM 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.

NLM Performance

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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 beep 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-
This DOS is Boss.

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.
Review Software Roundup

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. NetProt, 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 NetProt 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.

NetProt 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 531, Hightstown, NJ 08520, (609) 426-7070; fax (609) 426-5434). BYTE magazine and NSTL are both operating units of McGraw-Hill, Inc.
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 Scanetx 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 gray values 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...
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 remarkably short 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 newswEEKIES. 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 Whidney Island, northwest of Seattle. You can reach him on the Internet or BIX at va horn@bix.com."
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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.

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 lowercost 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.
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 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 when portions of an application’s code reside in the processor caches. Since the 68LC040 lacks an FPU, floating-point math performance suffers. Those 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.

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.
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 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 knockaround desktop systems and superbe 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**

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PowerBook 520</td>
<td>(with 50-/25-MHz 68LC040, 4 MB RAM, 160-MB hard drive, and FSTN gray-scale display)</td>
<td>$2269</td>
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<tr>
<td>PowerBook 520c</td>
<td>(with 50-/25-MHz 68LC040, 4 MB RAM, 160-MB hard drive, and dualscan color display)</td>
<td>$2899</td>
</tr>
<tr>
<td>PowerBook 540</td>
<td>(with 66-/33-MHz 68LC040, 4 MB RAM, 240-MB hard drive, and active-matrix grey-scale display)</td>
<td>$3159</td>
</tr>
<tr>
<td>PowerBook 540c</td>
<td>(with 66-/33-MHz 68LC040, 4 MB RAM, 320-MB hard drive, and active-matrix color display)</td>
<td>$4839</td>
</tr>
<tr>
<td>PowerBook Duo 280</td>
<td>(with 66-/33-MHz 68LC040, 4 MB RAM, 240-MB hard drive, and active-matrix grey-scale display)</td>
<td>$2639</td>
</tr>
<tr>
<td>PowerBook Duo 280c</td>
<td>(with 66-/33-MHz 68LC040, 4 MB RAM, 320-MB hard drive, and active-matrix color display)</td>
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</table>

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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 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 rout-

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. The administration and configuration menus are poorly designed.
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
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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 does not 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 DECSation 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, MSDOS/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 Macintoshs—and at the same time contains, controls, and routes data objects (and collections) of any type.

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 potential 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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<table>
<thead>
<tr>
<th>COMPARE</th>
<th>BEST</th>
<th>APC</th>
</tr>
</thead>
<tbody>
<tr>
<td>250VA list price</td>
<td>$133</td>
<td>$139</td>
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<tr>
<td>250VA full-load runtime</td>
<td>8.5 min.</td>
<td>5 min.</td>
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<tr>
<td>250VA runtime after 2 blackouts*</td>
<td>8 min.</td>
<td>3 min. 10 sec.</td>
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<tr>
<td>400VA list price</td>
<td>$219</td>
<td>$229</td>
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<tr>
<td>600VA list price</td>
<td>$379</td>
<td>$399</td>
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<tr>
<td>UL-Certified surge suppression? (All models up to 850VA)*</td>
<td>YES</td>
<td>No</td>
</tr>
</tbody>
</table>

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SPARC Workstations to Go

SPARC portables from RDI, Sun, and Tadpole make workstation computing more or less mobile

STEVE APIKI

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 portable 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 not 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...
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 whatever 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 multiplenet

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 configur-

ing 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 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 portable 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 $600 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-
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.

<table>
<thead>
<tr>
<th>RDI POWERLITE</th>
<th>SUN SPARCSTATION VOYAGER</th>
<th>TADPOLE SPARCBK 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base price</strong></td>
<td>$9995</td>
<td>$14,995</td>
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<tr>
<td><strong>Price at tested</strong></td>
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<td><strong>Clock speed</strong></td>
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<tr>
<td><strong>RAM (tested/MB)</strong></td>
<td>45/45</td>
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<tr>
<td><strong>Maximum RAM supported (MB)</strong></td>
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<td>80</td>
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<tr>
<td><strong>Internal video</strong></td>
<td>10.4-inch 640- x 480-pixel color/TFT</td>
<td>12-inch 1024- x 768-pixel color/TFT</td>
</tr>
<tr>
<td><strong>Max. external resolution (pixels)</strong></td>
<td>1152 x 900</td>
<td>1152 x 900</td>
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<tr>
<td><strong>Storage (as tested)</strong></td>
<td>Two 340-MB SCSI hard drives, 3½-inch floppy drive</td>
<td>340-MB SCSI hard drive, 3½-inch floppy drive</td>
</tr>
<tr>
<td><strong>Networking connections</strong></td>
<td>10Base-T Ethernet, AUI Ethernet</td>
<td>10Base-T Ethernet</td>
</tr>
<tr>
<td><strong>Other ports</strong></td>
<td>SCsi-2, serial (2), parallel, 8-bit audio</td>
<td>SCsi-2, serial (2), parallel, 16-bit audio, ISDN, infrared interface</td>
</tr>
<tr>
<td><strong>Other devices</strong></td>
<td>Internal speaker and microphone, internal fax modem, integrated trackball</td>
<td>2 Type II PCMCIA slots, microphone, mouse</td>
</tr>
<tr>
<td><strong>Licensed software</strong></td>
<td>Solaris 1.1, 1.2, VWA</td>
<td>Solaris 2.3</td>
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<tr>
<td><strong>Dimensions (H x W x L, in.)</strong></td>
<td>2.2 x 12.75 x 11.18</td>
<td>13 x 14 x 5</td>
</tr>
<tr>
<td><strong>Weight with battery (lbs)</strong></td>
<td>8.5</td>
<td>15.8</td>
</tr>
</tbody>
</table>

1 Base price configuration: 16 MB of RAM, 340-MB SCSI, internal graphics as noted

* Includes power supply, keyboard, and mouse

About the Companies

**RDI Computer Corp.** (PowerLite)
6696 Mesa Ridge Rd., Building A
San Diego, CA 92121
(619) 589-6985
fax: (619) 589-7061
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.

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.

**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.
Dear Angus,
Now the TV series is into reruns, I calculate it safe to defy the Prime Directive by communicating with you. I believe this is what Humans call a Fan Letter. I have used my Positronic brain to access your columns in the Enterprise’s computer and have analyzed your advice and its impact on late 20th-Century Information Technology. It would be unwise to further breach the Prime Directive by revealing the results, but I am compelled to thank you, Great-great-great-grandfather.

Lt. Cndr. Data  
Starship Enterprise

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I’m honored. Could you bend the Prime Directive just once more? Fax, download, beam down, or whatever it is you do, a copy of your letter to my bosses at ANGOSS Software. If this doesn’t get me a big raise come contract renewal time, nothing will.

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Circile 162 on Inquiry Card.

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 re-configuring at each location.

Editor’s note: As we went to press, RDI announced a new base price of $7995 for the PowerLite.

Steve Apiti 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 apiti@bix.com.
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Circle 125 on Inquiry Card.
“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 Macbug 6.5, a debugger written in 680x0 code that relies on the Power Mac’s 68LC040 emulator to operate. This version of Macbug still only interprets 680x0 processor instructions and registers. There are special resources called cmdms (shorthand for debugger commands) that can enhance Macbug’s capabilities, much as a Photoshop plug-in adds new features to Photoshop. Apple provided early Power Mac developers with cmdms that enabled Macbug to interpret PowerPC instructions and display the processor registers. However, at this writing, Apple has not decided whether to offer these cmdms 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. 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. Macbug 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 leverages 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 Metroworks' 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 Jesik 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 Macbug, 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; MacNoy, 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.

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 any Extension conflicts, but if you're using Think C or Metroworks 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 seize 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—a 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 Metroworks 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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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 ToggleSet 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, MacNoisy 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.

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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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HANDS-ON TESTING

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

ower 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 1.4GB or larger hard drive, a 15-inch color monitor (unless otherwise noted), and a CD-ROM drive.

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.

Features scores rate systems for expandability and flexibility.

Ease-of-use scores indicate how easy it is to configure and upgrade a system; they include the quality of the documentation.
Pentium Components

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 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 (80 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). 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).

<table>
<thead>
<tr>
<th>VENDOR/PRODUCT</th>
<th>CASE</th>
<th>UNUX</th>
<th>RAM (MB)</th>
<th>HARD DRIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro Express MicroFlex-PC100</td>
<td>$3174</td>
<td>EISA, VL</td>
<td>16/128</td>
<td>500, SCSI, ATI Mach64</td>
</tr>
<tr>
<td>Dell OmniFlex 4100</td>
<td>$3627</td>
<td>EISA, PCI</td>
<td>16/128</td>
<td>500, SCSI, ATI Mach286600AX</td>
</tr>
<tr>
<td>HP Vectra VL2</td>
<td>$3627</td>
<td>EISA, VL</td>
<td>16/64</td>
<td>340, IDE, Clums Logic 5428</td>
</tr>
<tr>
<td>Compaq ProLinea DX4/100</td>
<td>$3048</td>
<td>EISA, proprietary</td>
<td>16/100</td>
<td>525, IDE, Compaq QVision</td>
</tr>
</tbody>
</table>

* System could not run test.  * 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 Tungsten 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 system 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 half-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.

**Need the best all-around Windows performance?**

**BEST OVERALL** Cornell Pentium Power Pak

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.

---

### 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 MB of secondary cache on the motherboard. If fast Windows speed is essential but your budget is even more limited, consider the 66-MHz Tanger PCI 566, which places second among Low Cost winners for speed and costs $3795 (not including monitor) in our configuration.

---

### Rankings for This Category Considered

**Windows Performance 60%**

**Features 30%**

**Ease of Use 10%**

---

### Table: Windows Performance

<table>
<thead>
<tr>
<th>Category</th>
<th>Price</th>
<th>Case Type</th>
<th>PERFORMANCE WINDOWS</th>
<th>DOS</th>
<th>EASE OF USE</th>
<th>FEATURES SCORE</th>
<th>BUS</th>
<th>RAM (MB)</th>
<th>HARD DRIVE STD./MAX.</th>
<th>HARD DRIVE (MB, TYPE)</th>
<th>WARRANTY (MONTHS)</th>
<th>Video</th>
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<tbody>
<tr>
<td><strong>BEST</strong></td>
<td>Cornell Power Pak</td>
<td>$4295</td>
<td>7.30</td>
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<td>ATI Mach64</td>
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<td>Cornell EISA Power Pak</td>
<td>$4395</td>
<td>7.24</td>
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<td>36</td>
<td>Matrox MGA</td>
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<td><strong>RUNNER-UP</strong></td>
<td>ALR Evolution VQ 66</td>
<td>$8817</td>
<td>6.53</td>
<td>7.95</td>
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<td>AAAA</td>
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<td>1370, SCSI</td>
<td>15</td>
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<tr>
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<td>DECpc XL 566</td>
<td>$5948</td>
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<td>6.04</td>
<td>AAAA</td>
<td>AAAA</td>
<td>ISA, PCI</td>
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<td>1024, SCSI</td>
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<td>Diamond VIPer PCI</td>
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<tr>
<td><strong>RUNNER-UP</strong></td>
<td>Data Storage P5-60 PCI</td>
<td>$4495</td>
<td>6.31</td>
<td>6.48</td>
<td>AAAA</td>
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<td>ISA, PCI</td>
<td>32/192</td>
<td>1054, SCSI</td>
<td>36</td>
<td>Tseng W32P</td>
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</tr>
</tbody>
</table>

*Without monitor, *Vl-Bus

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### Table: Low Cost

<table>
<thead>
<tr>
<th>Category</th>
<th>Price</th>
<th>Case Type</th>
<th>PERFORMANCE WINDOWS</th>
<th>DOS</th>
<th>EASE OF USE</th>
<th>FEATURES SCORE</th>
<th>BUS</th>
<th>HARD DRIVE STD./MAX.</th>
<th>HARD DRIVE (MB, TYPE)</th>
<th>WARRANTY (MONTHS)</th>
<th>Video</th>
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<tbody>
<tr>
<td><strong>BEST</strong></td>
<td>Cornell Power Pak</td>
<td>$4295</td>
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<td><strong>RUNNER-UP</strong></td>
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<td>AAA</td>
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<td>1024, IDE</td>
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<td>Tseng ET4000X2P</td>
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<td>6.08</td>
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<td>1024, SCSI</td>
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<tr>
<td><strong>RUNNER-UP</strong></td>
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<td>6.04</td>
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<td>ISA, PCI</td>
<td>32/192</td>
<td>1052, SCSI</td>
<td>12</td>
<td>ATI Matrox MGA</td>
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<tr>
<td><strong>RUNNER-UP</strong></td>
<td>Cornell EISA Power Pak</td>
<td>$4395</td>
<td>7.24</td>
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<td>ISA, PCI</td>
<td>32/192</td>
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<td><strong>RUNNER-UP</strong></td>
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<td>ISA, PCI</td>
<td>32/192</td>
<td>1054, SCSI</td>
<td>36</td>
<td>Tseng W32P</td>
</tr>
</tbody>
</table>

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**Ease of Use:**

- Excellent: AAAA
- Good: AAA
- Fair: AA
- Poor: A

**Case:**

- Tower: T
- Desktop: D
- Mini-tower: M

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.
That's one reason we're the choice of the pros.

So, what's the big deal about just making monitors? It's called picking one thing and doing it right.

That singular focus helped CTX leap into color monitor leadership.

Remarkably, now every 15 seconds someone in the U.S. buys a CTX monitor. That's more monitors than sold under household names like NEC, IBM, Sony, Samsung, and Mitsubishi.

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CTX

We just make great monitors.
HIGH-PERFORMANCE WINDOWS

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.

**LOW COST** Gateway PS-90

Among systems priced under $6000, the $5014 PS-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.

### Rankings for This Category Considered

**WINDOWS PERFORMANCE 60%**

**FEATURES 30%**

**EASE OF USE 10%**

### Need economy at the high end?

**LOW COST**

Gateway PS-90

<table>
<thead>
<tr>
<th>PRICE</th>
<th>CASE</th>
<th>PERFORMANCE WINDOWS</th>
<th>EASE OF USE</th>
<th>FEATURES</th>
<th>RAM (MB)</th>
<th>HARD DRIVE</th>
<th>WARRANTY (MONTHS)</th>
<th>VIDEO</th>
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<tbody>
<tr>
<td>$5014</td>
<td>Gateway PS-90</td>
<td>$5014</td>
<td>7.45</td>
<td>9.14</td>
<td>Matrox MGA</td>
<td>$5014</td>
<td>1000, SCSI</td>
<td>36</td>
</tr>
</tbody>
</table>

### KEY

**Ease of Use:**

Excellent ▲▲▲▲ Good ▲▲▲

Fair ▲ Poor ▲

**Case:**

Tower ▲ Desktop =

Mini-tower ▲

**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.

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.
"KFC packs quite a lot into this $495 product. The 15-inch CA 1507 offers resolutions as high as 1280 by 1024 pixels at 60 Hz noninterlaced. The monitor provides a full set of image-adjustment controls, including pincushion, image rotation, and power management. It uses the VESA DPMS power management control signals to meet Energy Star requirements."

"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 "Best Value: General Business Color Monitor" award in the January 1994 BYTE/NSTL Lab Report, is highly recommended. It 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.

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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.
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 DECpce XL 566 and the Data Storage P5-60 can’t be used at the same time. The system’s hard drive is a 1-GB Seagate SCSI model. The DECpce and Data Storage systems also stand out from the leaders and from most of the pack with their relatively long (36 months) warranties.

Xinerton’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.
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 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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Even better, we now incorporate the latest award-winning Pantera technology (including PCI) to our 486 PCs. The expanded Pantera line includes more processors—from a 486 SX-25 to a DX4-100 all the way to a Pentium-90! The best news: The Pantera DX4-100 just earned PC Magazine's Editors' Choice (June 28, 1994).

These new, improved and even more affordable systems feature local bus IDE hard drives from 214MB to 1GB; memory from 4MB to 24MB; a new 64-bit video controller; 3 PCI slots (one contains our PCI local bus video card) in addition to 5 ISA slots; and on-board Fast SCSI-2 option. And all Pantera systems are 100% compatible with every major network operating system on the market.

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What's more, we give you all this at a marvelous price. There's no doubt about it. PC/Computing said: "We suggest you spend your money on this machine—it offers the best value of any system we tested."

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Call your ZEOS Systems Consultant now at 800-554-5226.
### FAVORITE OPTIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>528MB TO 1GB HDD UPGRADE</td>
<td>$395</td>
</tr>
<tr>
<td>1MB TO 2MB VIDEO RAM UPGRADE</td>
<td>$35</td>
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<tr>
<td>DIAMOND STEALTH 64/PCI VIDEO CARD WITH 2MB VRAM</td>
<td>$249</td>
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<tr>
<td>ZEOS 18&quot; MONITOR UPGRADE</td>
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<tr>
<td>SVGA NI, 1024 x 768, flat screen</td>
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<tr>
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<td>$495</td>
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<tr>
<td>SVGA NI, 1280 x 1024</td>
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<tr>
<td>ADAPTEC 6360 SCSI CONTROLLER CHIP</td>
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<td>For on-board SCSI. Includes drivers</td>
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<td>14.4 BPS V.32 BIS MODEM</td>
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<td>WITH 14.4 BPS SEND/RECEIVE FAX</td>
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<td>80 to 250MB (with compression), includes backup software</td>
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<td>10-BAY VERTICAL CASE</td>
<td>$95</td>
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<tr>
<td>MULTIMEDIA UPGRADE</td>
<td>$148</td>
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<td>16-bit sound card. Stereo speakers</td>
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<tr>
<td>LOTUS SMARTSUITE UPGRADE</td>
<td>$299</td>
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<tr>
<td>Five Windows applications in one box</td>
<td></td>
</tr>
<tr>
<td>Many other affordable upgrades and options available. Call for details!</td>
<td></td>
</tr>
</tbody>
</table>

**FAX ORDERS:** 800-362-1205 or 612-362-1205. **Phone Orders:** Government: 800-245-2449, Outside U.S. and Canada: 612-362-1212. Purchase Orders, MasterCard, Visa, AmEx, Discover, Z-Card, COD and affordable leasing programs. Open 24 Hours a Day, 365 Days a Year! Purchase orders are subject to approved. Business leasing programs available. Lease prices based on a 36-month lease. 10% purchase option. All prices, specifications and availability are subject to change without notice. Call to confirm these and warranty details. Prices do not include shipping. The Energy Star logo does not represent EPA endorsement of any product or service. All products and company names are trademarks or registered trademarks of their respective holders. Intel Inside and Pentium are trademarks of Intel Corporation. ZEOS is a registered trademark. Z-Card and CompuServe Now! are registered service marks. Panna is a trademark of ZEOS International Ltd. ©1994 ZEOS International Ltd., 500 Industrial Blvd., Minneapolis, MN 55426 USA. ZEOS is a publicly traded company (NASDAQ symbol: ZEOS).
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).

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?

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 or at NSTL, Inc., Plymouth Corporate Center, Plymouth Meeting, PA 19462; or at (610) 941-9600. Contact BYTE on the Internet or BIX at sjoe@ BYTE.com or at (603) 934-9281.
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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.

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.

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.

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.
Finally, a single system combining workstation power with PC personality — the personal workstation from Intergraph:

- Performance and power of a workstation
- Personality, compatibility, and affordability of a PC
- Productivity tools integrated with advanced technical applications
- Popular, easy-to-use Microsoft Windows operating environment
- Professional display technology and the industry's broadest monitor selection
- Packaged, ready-to-run systems with built-in networking and graphics
- Path for growth as your computing needs expand
- Perfectly designed for a safe and comfortable work environment

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## Roll Call of Pentiums Tested

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<th>Vendor</th>
<th>Model</th>
<th>Price as Tested</th>
<th>Windows</th>
<th>DOS</th>
<th>SPECint</th>
<th>SPECfp</th>
<th>BYTE Unix</th>
<th>Price Score</th>
<th>Ease-of-Use Score</th>
<th>Features Score</th>
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**NOTE**

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

**BYTEx/NSTL Lab Report August 1994**
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* Not including local-bus slots or shared PCI slots

Case type:
- Tower □
- Desktop ■
- Mini-tower ◆
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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 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.

Impure 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).

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.

A quicksort in the Miranda language

```haskell
quick_sort:: [num] -> [num] quick_sort[] = [] quick_sort(a:x) = quick_sort(b | b <- x; b <- a++) ++ quick_sort[b | b <- x; b > a]
```

Concurrent Clean, and Erlang, that combine efficient execution with referential transparency...
The Erlang Language

The Erlang language, named after Danish mathematician Agner Erlang, was developed by a team of employees at the giant Swedish telecommunications firm Ericsson, where it's used to write huge real-time control programs for telephone exchanges and network switches. Since its target was specifically at the write huge real-time control programs for teleQhone exchanges as asynchronous message-passing between processes. The lan­
ture 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 PPL 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 combinator.

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-re-writing 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 pow­
er 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 Fountain 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.

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 ganttic. 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.
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
```

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 `LDW R2, R1(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.
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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.

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 workflow. 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, multitask 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 sorts 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 olympic 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.

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 a 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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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...
Pournelle

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 drive. I discovered to my horror that the OmniBook doesn't have EDIT.COM or even ELDIN, 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 statementinto 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 looos 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 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 of 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, 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 Windows/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 re-activated 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 them. I was totally upset. 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. Voila!, 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. Voila!, 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&00 to the modem.

It's easier to specify the cure than to explain why it works. The &0 commands set different communications modes; AT&05, 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 AT&36=n. If n=0, the modem disconnects if it fails to get an error-correcting connection. If you tell the modem AT&36=1, it stays on-line and falls back to basic asynchronous operation, which is what it starts with if you send AT&00. I've known about these things a long time, but since most modems default to &36=1, I tend to forget about them.

With the OmniBook, it doesn't matter. If you send it AT&05 and AT&36=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&00 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&00 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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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 the 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 it’s useful 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 mod 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 jerry@bix.com.
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.

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-compatible drive weighs 1 pound and can be used horizontally or vertically.
Phone: (408) 752-8500.
Circle 1278 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 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 1280 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 1281 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 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-exursion, low-resonance 3½-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 1284 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: (510) 623-8988.
Circle 1286 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.

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 upgradeability 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.

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.

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 Com- pex (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.
MULTITASKING ISA BOARD
The TeraDon ISA bus board (from $3995) has from four to 16 DSP3210 floating-point DSPs onboard. 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 MultiModemPCSC-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: (612) 785-3500.
Circle 1298 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 QuadMark (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 1299 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) 565-5030 or (905) 509-8752.
Circle 1300 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.
**SOLUTIONS FOCUS**

Please rate each possible Solutions Focus topic using the following scale:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting different E-mail systems to interoperate</td>
<td>1 2 3 4 5</td>
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<tr>
<td>Automatic configuration management</td>
<td></td>
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<tr>
<td>Coordinating information access using document management</td>
<td></td>
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<tr>
<td>Work flow in a manufacturing environment</td>
<td></td>
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<td>Migrating to object-oriented development technology</td>
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<tr>
<td>Connecting branch office networks</td>
<td></td>
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<tr>
<td>Coordinating on-line, CD-ROM, and paper-based information sources</td>
<td></td>
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<td>Implementing DCE</td>
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<td>Technologies for hands-free computing</td>
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<td>Network-based transaction processing</td>
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<td>Network-based conferencing systems</td>
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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
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 Magnifier2 ($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.
STOCK PHOTOGRAPHY
Image Vault 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 actions 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, Criterion 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 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.

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.

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.

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) 586-4144.
Circle 1334 on Inquiry Card.

Guide Professional Publisher 3.5, InfoAccess (Belleview, 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.
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.

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.

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.

MULTIPLExor PLUS 3.0

A powerful, easy-to-use productivity tool that offers 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) 889-8630.

Circle 1338 on Inquiry Card.

In Control 3.0

A tool for managing and tracking all your files. It supports multiplatform heterogeneously distributed networks and uses Distributed Computing Environment protocols. The software also includes an extensive set of powerful database tools.

Phone: (800) 925-5615 or (617) 776-1110.

Circle 1339 on Inquiry Card.

Swatch 3.0

A suite of tools for managing and tracking electronic mail and files. It includes a powerful search engine, an in-depth database, and a powerful database management system.

Phone: (800) 925-5615 or (617) 776-1110.

Circle 1339 on Inquiry Card.

Swatch Professional 3.0

A powerful, easy-to-use productivity tool that offers 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) 889-8630.

Circle 1338 on Inquiry Card.

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Phone: (800) 925-5615 or (617) 776-1110.

Circle 1339 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 CommServr (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 Computer Systems (Boston, MA) utility lets you monitor software used on stand-alone PCs, meter software suites, and interface with Frye's Network 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
Optiqueau's (Walnut, CA) Opti-Green 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: (415) 241-4555.
Circle 1071 on Inquiry Card.

OS/2 APPLICATION DEVELOPMENT
TechBridge Builder ($4995) lets you create advanced OS/2 applications that provide a GUI and object-oriented access to enterprise-wide data and processing. Iconic programming tools allow rapid development with little or no programming required—TechBridge Designers let developers paint applications into existence. The built-in methodology and framework automatically manage the class hierarchy. When you want to customize an application and thus must program, you use standard COBOL and SQL; a SQL visual programming tool is included.
Contact: TechBridge Technology, North York, Ontario, Canada, (416) 222-8998.
Circle 1304 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 1343 on Inquiry Card.

TurboCAD for Windows 2.0, International Microcomputer Software (San Rafael, CA), adds 20 more 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 (Miplitas, CA), monitors all errors reported to the LANstor 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.

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Phone: (408) 954-0710.
Circle 1343 on Inquiry Card.
The PCMCIA standard allows the information gathered via laptop, PDA, palmtop, or pen-based systems to be compatible with desktop PC's. Quatech manufactures a full line of products that conform to the PCMCIA standards including Type I card readers for memory cards, Type II and III interface adapters, and I/O cards for communications and data acquisition applications.

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Buyer's Mart
From Accessories to Laptops to Word Processors, you can easily find the dealers you are looking for in this directory of products and services.
### COMPUTERS

<table>
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### DOT MATRIX & LASER PRINTERS

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### HARD DRIVES & CONTROLLERS

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### MEMORY UPGRADES

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<td>HP 1GB DDR</td>
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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 28 x 16cm (11 x 6”), but the 100 keys have standard left-to-right spacing. Both models are XT/AT/PS2 compatible and are available in many languages.

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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 29 x 24 x 11cm (4.5 x 9.5 x 1”) and is rugged enough to survive as a touch system in harsh environments such as kitchens or factories.

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Dorking, Surrey, UK RH4 1EJ
Phone 306-876718
Fax 306-876742

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**MEMORY**

**CACHE MEMORY**

<table>
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**Individual DRAM Chips**

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**CYRIX Drx® 386 to 486 Upgrade**

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**SIMM MODULES (Add $5.00 for SIPP)**

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**ZENITH MEMORY MODULES**

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**MEMOY BOARDS**

**IBM Compatibles & PS/2**

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**BOCA AT PLUS**

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**BOCA XT 8 BIT BUS**

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**IBM P/52 2MBT EXPANSION BD.**

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**PS/2 MCA 0-8MEG EXPANSION BD.**

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**INTEL Math Chips**

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**IBM PS/1, PS/2 MEMORY MODULES**

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**TOSHIBA LAPTOP MEMORY**

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**NOTEBOOK, LAPTOP MEMORY**

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**IBM NOTEBOOK & LAPTOP MEMORY**

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**LASER PRINTER MEMORY UPGRADES**

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**H.P. COMPATIBLE FONT CARTRIDGE**

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**PRICE TRADE**

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<tr>
<td>IBM</td>
<td>$40.00</td>
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</table>

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- TRUE HARDWARE DIAGNOSTICS — Accurate testing of CPU, IRQ’s, DMA, memory, hard drives, floppy drives, video cards, etc.
- BATCH CONTROL — All tests, even destructive, may be selected for testing.
- ERROR LOGGING — Automatically inputs errors during testing to an error log.
- AUTOMAPPING — Automatically bad sector maps errors found on hard disks.
- IRQ DISPLAY — Show bits enabled in IRQ chip for finding cards that are software driven. (Network, Tape Backup, etc.)
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- Monitors ALE for proper CPU/DMA operation.
- Monitors Reset to determine if reset is occurring during POST, indicating short.
- Monitors progress of POST without POST codes.
- Reads POST codes from any IBM or compatible that emits POST codes. ISA/EISA/PCA.
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Fax Customer Service
(619) 581-0125 (619) 581-1439

Circle 399 on Inquiry Card.

MEMORY

IBM THINKPAD

<table>
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TOSHIBA

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NEC VERSA

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PCMCIA by New Media Corp

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</table>

CD ROMS

MITSUMI

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX001D Int., double speed, 250ms, 16 bit card</td>
<td>$169</td>
</tr>
</tbody>
</table>

TOSHIBA

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB3401 Int. double speed, 200MS, 300KB's, 256K buffer, multi-session, Kodak photo CD</td>
<td>$329</td>
</tr>
</tbody>
</table>

NEC

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC 3XCDR-510 195MS Triple Spin</td>
<td>$429</td>
</tr>
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</table>

TAPE DRIVES

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conner 250</td>
<td>$149</td>
</tr>
<tr>
<td>Colorado Jumbo 250</td>
<td>$169</td>
</tr>
<tr>
<td>Identity 250</td>
<td>$145</td>
</tr>
</tbody>
</table>

EISA & PCI MOTHERBOARDS AVAILABLE

SPECIALS

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYRIX CYRIX DX 4301/33 Matrocs Processor</td>
<td>$29</td>
</tr>
</tbody>
</table>

FAX MODEM

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>GVG 2244</td>
<td>$109</td>
</tr>
</tbody>
</table>

SCSI DRIVES

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXTOR MX050B</td>
<td>$419</td>
</tr>
<tr>
<td>CONNER CFP1005</td>
<td>$149</td>
</tr>
<tr>
<td>SEAGATE SEAGATE BARACUDA</td>
<td>$179</td>
</tr>
</tbody>
</table>

MOTHERBOARDS

INTEL 486 VLB

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>38V, 5 ISA Slots, Award BIOS, SIS Chip Set, Zifocket, 256 K-Cache</td>
<td>$345</td>
</tr>
<tr>
<td>486 DX-33</td>
<td>$345</td>
</tr>
<tr>
<td>486 DX-66</td>
<td>$495</td>
</tr>
<tr>
<td>486 DX W/O CPU</td>
<td>$109</td>
</tr>
</tbody>
</table>

MICRONICS 486 VLB

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 Bit IDE/10, 2 VL Slots, 5 ISA, 256 K-Cache</td>
<td>$399</td>
</tr>
<tr>
<td>M486-DX33</td>
<td>$399</td>
</tr>
<tr>
<td>M486-DX266</td>
<td>$599</td>
</tr>
<tr>
<td>M486-DX W/O CPU</td>
<td>$139</td>
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</tbody>
</table>

PENTIUM PCI

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 PCI-5 ISA Slots, Intel Mercuray Chip Set, Phoenix BIOS, Zifocket, 256 K-Cache</td>
<td>$1049</td>
</tr>
<tr>
<td>586 P6</td>
<td>$129</td>
</tr>
<tr>
<td>586 P6+/P6+</td>
<td>$275</td>
</tr>
<tr>
<td>Pentium Board W/O CPU</td>
<td>$275</td>
</tr>
</tbody>
</table>

CYRIX 486 VLB

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>38V, 5 ISA Slots, Ami BIOS, Optim Chip Set, 256 K-Cache, upgradeable to 686 DX CPU</td>
<td>$205</td>
</tr>
<tr>
<td>486 DDC 40 VLB</td>
<td>$205</td>
</tr>
</tbody>
</table>

VIDEO CARDS

<table>
<thead>
<tr>
<th>Model</th>
<th>Speed</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call for other Maxtor SCSl drives</td>
<td>$219</td>
<td></td>
</tr>
<tr>
<td>CONNER</td>
<td>13MS</td>
<td>$269</td>
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</table>

IDE HARD DRIVES

<table>
<thead>
<tr>
<th>Model</th>
<th>Size</th>
<th>Speed</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>725A</td>
<td>14MB</td>
<td>15MS</td>
<td>$219</td>
</tr>
<tr>
<td>745A</td>
<td>28MB</td>
<td>15MS</td>
<td>$219</td>
</tr>
<tr>
<td>746</td>
<td>56MB</td>
<td>15MS</td>
<td>$219</td>
</tr>
</tbody>
</table>

MATHEMATICAL COs

<table>
<thead>
<tr>
<th>Model</th>
<th>Speed</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call for other Maxtor SCSl drives</td>
<td>$219</td>
<td></td>
</tr>
</tbody>
</table>

CPUs

<table>
<thead>
<tr>
<th>Model</th>
<th>Speed</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>K66DX2-66</td>
<td>21MB</td>
<td>$399</td>
</tr>
<tr>
<td>K66DX2-44</td>
<td>17MB</td>
<td>$399</td>
</tr>
</tbody>
</table>

CONTROLLER BOARDS

<table>
<thead>
<tr>
<th>Model</th>
<th>Speed</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promise DC4030V1/1V, IDE Caching Controller</td>
<td>$199</td>
<td></td>
</tr>
<tr>
<td>Adaptec 1340CE-8 ISA, SCSI Controller</td>
<td>$249</td>
<td></td>
</tr>
<tr>
<td>Adaptec 2415-4 EISA, SCSI Controller</td>
<td>$389</td>
<td></td>
</tr>
<tr>
<td>IDE/10 card, 256K/1111</td>
<td>$19</td>
<td></td>
</tr>
</tbody>
</table>

CYRIX

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYRIX CYRIX DX 4301/33 Matrocs Processor</td>
<td>$29</td>
</tr>
</tbody>
</table>

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Circle 187 on Inquiry Card (RESELLERS: 188).
<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM</td>
<td></td>
</tr>
<tr>
<td>TOSHIBA</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Model #</th>
<th>Capacity</th>
<th>Speed</th>
<th>Cache</th>
<th>Interface</th>
<th>Form</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFS-210A</td>
<td>213MB</td>
<td>14ms</td>
<td>32KB</td>
<td>IDE</td>
<td>3-1/2&quot;</td>
<td>229.95</td>
</tr>
<tr>
<td>CFA-340A</td>
<td>343MB</td>
<td>13ms</td>
<td>64KB</td>
<td>IDE</td>
<td>3-1/2&quot;</td>
<td>299.95</td>
</tr>
<tr>
<td>CFS-420A</td>
<td>426MB</td>
<td>14ms</td>
<td>32KB</td>
<td>IDE</td>
<td>3-1/2&quot;</td>
<td>349.95</td>
</tr>
<tr>
<td>CFA-540A</td>
<td>540MB</td>
<td>10ms</td>
<td>256KB</td>
<td>IDE</td>
<td>3-1/2&quot;</td>
<td>419.95</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Category No.</th>
<th>Inquiry No.</th>
<th>HARDWARE</th>
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<td><strong>ACCESSORIES/SUPPLIES</strong></td>
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<td>235</td>
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<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td>MINCOM / CLASSNET VIDEO 127</td>
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</tr>
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<td>AMBRA COMPUTER CORP (N.A.) 48A-H</td>
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<td>APPROVAL INTERNATIONAL INC 239</td>
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<td>91</td>
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<td></td>
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<td></td>
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<td></td>
<td>DATA ELECTRONICS USA, INC 235</td>
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<td>103-104</td>
<td></td>
<td>MICROSTAR LABORATORIES 60</td>
</tr>
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<td></td>
<td>PC POWER &amp; COOLING 83</td>
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<td></td>
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<td></td>
<td>LA TRADE 218</td>
</tr>
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<td></td>
<td>MOTOROLA RISC DIVISION 16-17</td>
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<td><strong>MISCELLANEOUS HARDWARE</strong></td>
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<td>BILBO INNOVATIONS 236</td>
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<td>KUO FENG CORPORATION (INT'L) 59</td>
</tr>
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<td>516</td>
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<td>NANO USA CORP (NA) 97</td>
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<td>PHILIPS MONITORS (INT'L) 68-89</td>
</tr>
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<td>SMITH &amp; NEPHEW 48511</td>
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<td></td>
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<td>CONTROL VISION 237</td>
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<td></td>
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<td>PASSPORT DESIGNS INC 105</td>
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<td><strong>PRINTERS/PLOTTERS</strong></td>
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<td></td>
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<td></td>
<td><strong>PROGRAMMABLE HARDWARE</strong></td>
</tr>
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<td>174</td>
<td></td>
<td>BUFFALO PRODUCTS 230</td>
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<td></td>
<td>DATA ACCESS CORP 182</td>
</tr>
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<td></td>
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<tr>
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<td>ELASHIM MICROCOMPUTERS 162</td>
</tr>
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<td>510-511</td>
<td></td>
<td>FAST HARDLOCK 48517</td>
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<td>218-219</td>
<td></td>
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248 BYTE AUGUST 1994
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<td>173</td>
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<td>510-511</td>
<td>523-524</td>
<td>59</td>
</tr>
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<td>174</td>
<td>514</td>
<td>525-526</td>
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<td>61</td>
</tr>
<tr>
<td>49</td>
<td>175</td>
<td>515</td>
<td>529-530</td>
<td>531-532</td>
<td>62</td>
</tr>
</tbody>
</table>

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<table>
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<td>48IS-4</td>
<td>1576, DRIQ</td>
<td>26, 108, 147, 164</td>
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<td>1283</td>
<td>202</td>
<td>1113, 1121</td>
<td>48IS-18</td>
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<tr>
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<td>137</td>
<td>1117, 1121</td>
<td>48IS-18</td>
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<tr>
<td>1311</td>
<td>136</td>
<td>1145, Delcam International</td>
<td>48IS-18</td>
</tr>
<tr>
<td>1451</td>
<td>165</td>
<td>1147, Delena Software</td>
<td>48IS-18</td>
</tr>
<tr>
<td>1482</td>
<td>90</td>
<td>1149, Design Designtools</td>
<td>48IS-18</td>
</tr>
<tr>
<td>1432</td>
<td>48IS-4</td>
<td>1157, Distributed Processing</td>
<td>26, 193</td>
</tr>
<tr>
<td>1320</td>
<td>203</td>
<td>1158, D-Link</td>
<td>203</td>
</tr>
<tr>
<td>1271</td>
<td>26, 108</td>
<td>1159, Documentum</td>
<td>26, 193</td>
</tr>
<tr>
<td>1319</td>
<td>207</td>
<td>1161, Drag script</td>
<td>26, 193</td>
</tr>
<tr>
<td>1422</td>
<td>48IS-4</td>
<td>1164, Durcom Computer Systems</td>
<td>26, 193</td>
</tr>
<tr>
<td>1311</td>
<td>207</td>
<td>1165, EDS</td>
<td>26</td>
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<tr>
<td>1426</td>
<td>48IS-3</td>
<td>1166, Electronic Data Systems</td>
<td>26</td>
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<tr>
<td>1470</td>
<td>209</td>
<td>1167, ElimShrim microprocessors</td>
<td>26</td>
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<td>209</td>
<td>1168, Excitator Technologies</td>
<td>26</td>
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<td>209</td>
<td>1170, Express Star Systems</td>
<td>26</td>
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<td>1308</td>
<td>209</td>
<td>1171, Farno Electronics</td>
<td>26</td>
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<td>1173, Feinsoftware</td>
<td>26</td>
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<td>1317</td>
<td>164</td>
<td>1174, Forester Researcher</td>
<td>26</td>
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<td>1145</td>
<td>164</td>
<td>1175, Fraunhofer Institute</td>
<td>26</td>
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<td>1327</td>
<td>209</td>
<td>1176, Frye Computer Systems</td>
<td>26</td>
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<td>1177, Fuseware</td>
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<td>1179, General Magic</td>
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<td>48IS-16</td>
<td>1180, Genmark microprocessors</td>
<td>26</td>
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<td>48IS-16</td>
<td>1181, Gifford</td>
<td>26</td>
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<td>48IS-20</td>
<td>1182, Gimmic</td>
<td>26, 123</td>
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<td>1278</td>
<td>48IS-20</td>
<td>1183, Giant computer</td>
<td>26, 123</td>
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<td>48IS-20</td>
<td>1184, Harefult-Packer</td>
<td>26, 123</td>
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<td>48IS-23</td>
<td>1185, Haye Technologies</td>
<td>26, 123</td>
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<td>48IS-23</td>
<td>1186, Hughes Aircraft</td>
<td>26, 123</td>
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<td>48IS-8</td>
<td>1187, Hyperwerk</td>
<td>26, 123</td>
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<td>1305</td>
<td>206</td>
<td>1189, Iconovx</td>
<td>206</td>
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<td>1280</td>
<td>48IS-12</td>
<td>1190, Ide systems technology</td>
<td>48IS-23</td>
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<td>1346</td>
<td>207</td>
<td>1191, Infocenter</td>
<td>207</td>
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<td>1294</td>
<td>207</td>
<td>1192, Infoaccess</td>
<td>207</td>
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<td>207</td>
<td>1193, Inner Media</td>
<td>207</td>
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<tr>
<td>1439</td>
<td>26, 123</td>
<td>1194, Insight Direct</td>
<td>26, 123</td>
</tr>
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<td>1438</td>
<td>48IS-22</td>
<td>1195, Integr8ed solutions</td>
<td>26, 123</td>
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<tr>
<td>1467</td>
<td>48IS-22</td>
<td>1196, Intel</td>
<td>26, 123</td>
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<td>48IS-10</td>
<td>1197, Integrated instrumentation</td>
<td>48IS-10</td>
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<td>48IS-22</td>
<td>1198, International Interfacing</td>
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<td>1199, International Instrumentation</td>
<td>48IS-10</td>
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<td>48IS-18</td>
<td>1200, International microprocessor Software</td>
<td>48IS-18</td>
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<td>48IS-18</td>
<td>1201, Isocor</td>
<td>48IS-18</td>
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<td>1474</td>
<td>48IS-18</td>
<td>1202, Itigraph</td>
<td>48IS-18</td>
</tr>
<tr>
<td>1377</td>
<td>159</td>
<td>1203, Javel Designs</td>
<td>159</td>
</tr>
<tr>
<td>1499</td>
<td>193</td>
<td>1204, Kodak</td>
<td>193</td>
</tr>
<tr>
<td>1457</td>
<td>48IS-25</td>
<td>1205, Kuros software developments</td>
<td>48IS-25</td>
</tr>
</tbody>
</table>

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Commentary  Tom R. Halfhill

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 dom inated 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 1983 Amigas.

At a time when PC users thought 16-colorEGA 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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