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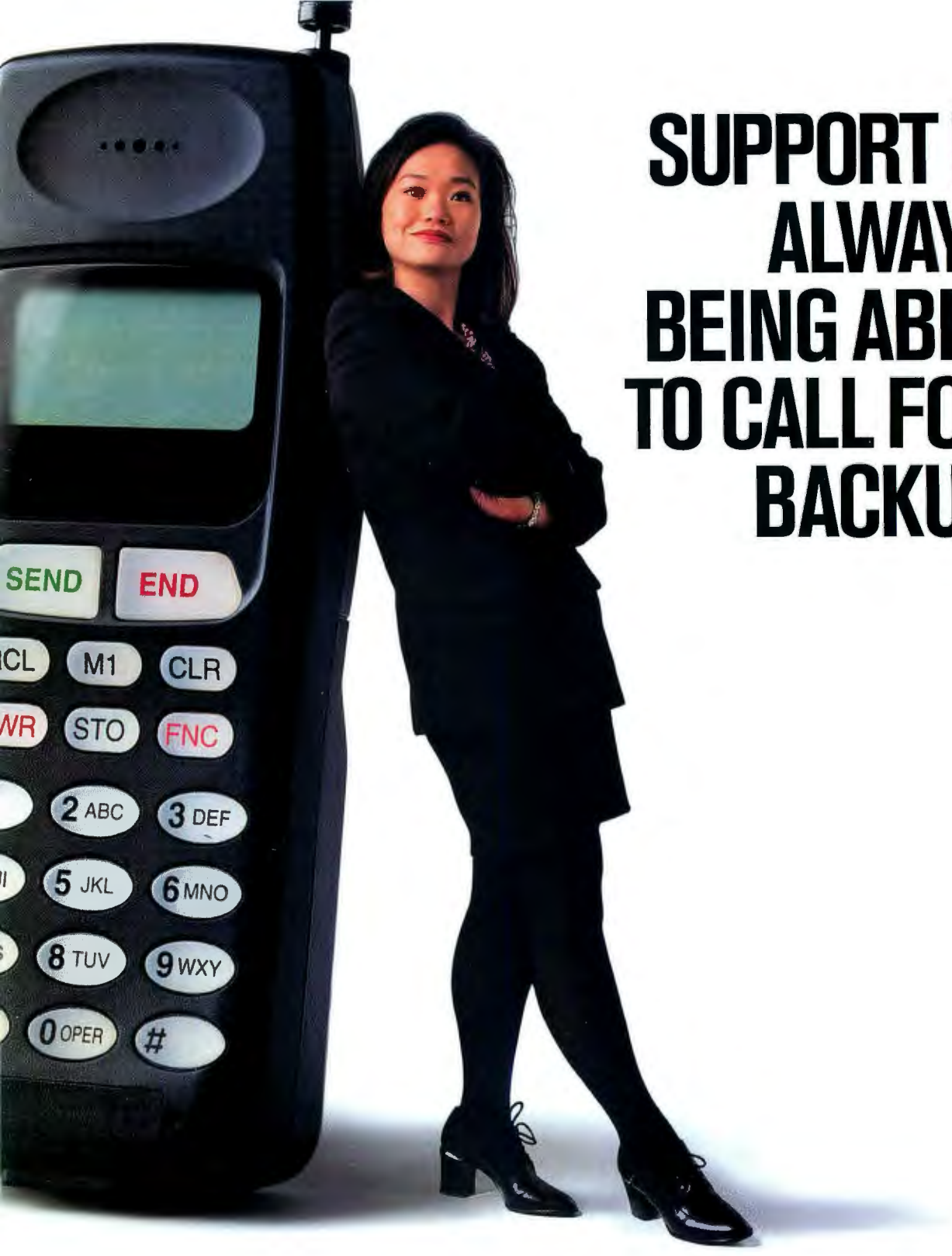

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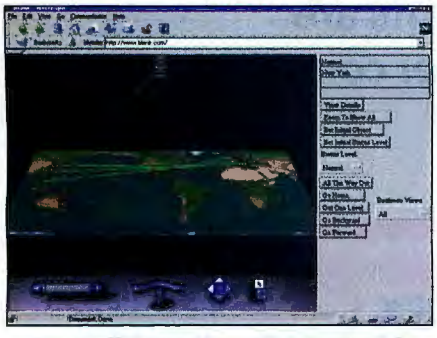

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Calendar Management	5	8	40	Available Now
Virus Detection	3	7	21	Available Now
Reporting	4	5	20	Available Now
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BYTE
COVER STORY
BUILDING NETWORK APPS
May 1998, vol. 23, no. 5

HOW TO SOUP UP JAVA

PART I

By Tom R. Halfhill

The rap on Java is that it's too slow. Proponents are inventing ways to speed it up, including better compilers.

PART II

NINE RECIPES FOR FAST, EASY JAVA

By Peter Wayner

Our tests will help you find the right development tools for your Java projects.

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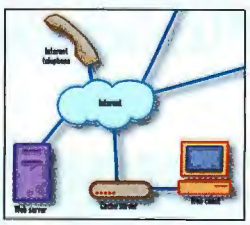

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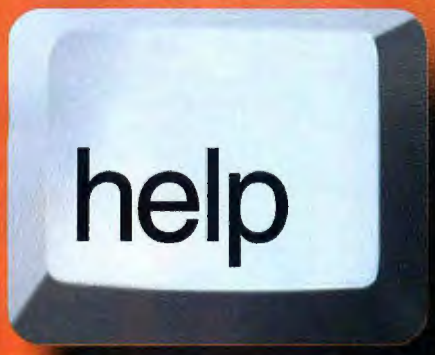

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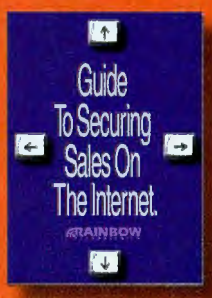

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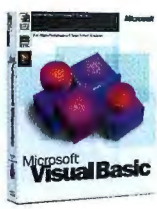

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editorial

Reliability Counts

Speed thrills, but crashes kill. Time to focus on quality code and never-say-die computing.

With last month's cover story, "Crash-Proof Computing," we put a stake in the ground for reliable computing. In the past, we've been as guilty as anyone of being dazzled by clock speeds and feature sets. These are important, but reliability has become a critical issue, and at BYTE we're not closing our eyes to it anymore.

In the aforementioned cover story, senior editor Tom Halfhill took a balanced look at the whys and wherefores of today's woefully crash-prone PCs. At the top of this page, it says "Editorial," so I don't have to be balanced. In my opinion, there's absolutely no excuse for computing that requires multiple reboots each day. The typical excuses sound awful whiney to me: Everything's so complex; people want so many features; it's a competitive market.

It's oft been pointed out that only in computing do we tolerate the shoddy work that passes for mainstream operating systems and apps. And I'm hard-pressed to think of any other piece of hardware you can buy for $3000 that's as failure-prone as a PC.

Sure, the culprits are often the cut corners that make PCs affordable: the cheap video card, the marginal memory chip, the inexpensive drive controller. But how often do PCs fail because of bad cooling, improper voltage regulation, or other fundamental design flaws? I'm betting pretty often. Preventing those failures with better components would not be that expensive. For example, while it's nice that disk drive capacities have been on a serious price/performance ramp-up, I'm sure we'd all take a slightly less steep ramp if it were combined with increasingly rugged and foolproof drives. Yet several years ago, some in the drive industry adopted the reverse tack. They said: Who needs MTBFs of hundreds of years when computers are obsolete in four? Yes, but that *M* stands for *mean*; that average is a combination of happy clams and less fortunate individuals whose hard drives fail in the first year of operation.

So, no more excuses. Time to get serious about quality. I'm mad as hell and I'm not going to take it anymore!

I have some definite ideas about where computing has to go to become more reliable. I'll be on-line May 11–15 *(http://www.byte.com/discuss/discuss.htm)* to talk about them with you. We'll put together a Manifesto for Reliable Computing and lobby for it in the industry. As a first step, we'll add to our awards at PC Expo and Comdex and our annual Editors' Choice Awards to recognize products that contribute to this cause, if and when they appear. So, let me throw down the gauntlet and get the dialog started:

PHOTOGRAPH: KELLIE WALSH © 1998

I'm hard-pressed to think of any other piece of hardware you can buy for $3000 that's as failure-prone as a PC.

1. All OS and application installs should have absolute rollback capabilities, for multiple generations. The PC will never live in as small a universe as the mainframe, where packaged software tends to be much better behaved. In such a diverse world, rollback at least preserves workability.

2. General-purpose computers need some real-time capabilities. Specifically, what good is network administration if a computer is so locked up that it can't communicate over the Net? All operating systems should keep a channel open to network admin traffic.

3. All OSes should be self-healing. If any component of the OS becomes corrupted or fails (due to version conflicts, for example), the OS should know that and take any appropriate actions.

4. All computers should monitor their own temperature and power consumption (for high and low voltage) and warn of out-of-limit operations.

5. All peripherals should run a POST-like diagnostic at start-up and have an invocable diagnostic routine that can be run when trouble occurs.

Beyond such a list of engineering principles, we should all exercise stern judgement in purchasing. Replace that smile with a frown when vendors say they produced their app on "Web time"—what they mean is that it's late alpha code and you're the beta tester. We all complain about buggy software and unreliable hardware—now let's put our money where our mouth is.

Mark Schlack

Mark Schlack, Editor in Chief
mark.schlack@byte.com

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* 1997 BSA/SPA Study

inbox

Kudos

Kudos to Scott Mace and his fellow authors. "Weaving a Better Web" (March cover story) is timely, comprehensive, and understandable. It has provided me with a clearer understanding of the interrelated concepts of Extensible Markup Language (XML), cascading style sheets, and Dynamic HTML than any other article or book that I have read. Keep up the excellent work.

Thomas P. Chester
Chief technology advisor
Securities and Exchange Commission

Limited Vocabulary

Sorry, but I didn't get the point of "Stored Procedures: Threat or Menace?" (March feature). Did the authors mean that we all should become SQL gurus? That would be a step backward. The real reason developers go back to the familiar way of doing things when they can't think of a simple way to solve a problem nonprocedurally is that SQL is limited, restrictive, and nonexpressive in comparison to C++, Delphi, Visual Basic, or even plain old C, BASIC, or Pascal. SQL development environments are about 20 years behind the times. Interactive debuggers, tracers, watches—all the things that allow developers to debug and validate today's complex applications—are virtually absent. I work with Delphi 3, and when I am forced to use SQL tools, I feel like I have entered a time warp and come out around 1975. I want to get back to my 1997 integrated development environment!

Michael Nachison
Horizon Real-Time Systems
MN@bbucutting.com

Wake-Up Call

I was lucky enough to use Sun workstations 8 years ago at university, and now my Pentium II system is probably equal in clock speed, if not in MIPS, to those machines. Yet, one thing is missing: power management. Those Sun monsters were *never* switched off; it was essential that they were ready to kick in at the touch of a spacebar. As a home user, without a network, you would think that I have no need of such a technology. It's just for laptops, you say? I am convinced it would be welcomed by millions of PC users. For a start, my Windows 95 machine is even slower to boot than my old 486DX. Secondly, I would like to leave it ready to check my e-mail account, receive fax messages, and possibly handle voice mail. I'd like to be able to do this without having to listen to a noisy fan, or have glowing LEDs watch over me at night. Please raise this issue with a wider audience.

Christopher G D Tipper
Athens, Greece
ctipper@iis.forthnet.gr

Intel, with input from others, provides a sleep capability similar to that in laptops. The problem with laptops is that not everything wakes up upon Resume; for example, you may have to reboot to get modems and network interface cards to work. PC 98 is supposed to fix that. It also is supposed to have "OnNow" capability, part of which deals with LAN wake-up events. A specific set of packets sent across the LAN will turn the machine on, enabling, for example, a network administrator to install software on desktops at night. A similar facility could allow you to contact your computer remotely and turn it on. We'll see how well it works. For an overview, see http://www.microsoft.com/hwdev/pc98.htm. —Mark Schlack, editor in chief

VBA Bashing

In "VBA and COM" (March feature), Mr. Gates repeated his tired mantra: Buy Visual Basic for Applications and use it to bludgeon other Microsoft products into an application stew. After all, with the declining purchase cost of hardware, who cares about such archaic concepts as speed, parsimony, and efficiency? I do. Besides wanting to avoid bankrupting my clients with perpetual equipment upgrades, I want to avoid bankrupting myself with the time-consuming exercise of trying to make incompatible off-the-shelf components do something productive together. Before Microsoft talks about bashing modules, it should get the infrastructure of its programming languages in working order.

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Three Systems
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One Disk to Another

Russell Kay's report on disk drives ("15 Disks Cover More Data Than Ever," February Hardware Lab Report) was good, but not as technically detailed as previous reports. In particular, the last time around you discussed the issue of dynamic recalibration interrupting streaming data transfers from magnetic disks to optical drives. This is mentioned only in passing in this review. Do all the drives now handle it transparently? Or do the optical drives all have big enough buffers?

Stephen Leake
leakstan@erols.com

We didn't touch on this because there wasn't much new to say. In general, the newer magnetic drives seem to handle asperities better than older models, partly because they are using somewhat bigger buffers. That said, if you want to deliver streaming, uninterrupted data, you're still advised to use an AV-rated drive designed specifically for that requirement. Some of the newer 18- to 20-GB AV drives we've looked at use 2-MB buffers, and their firmware is optimized for streaming data. —Russell Kay, technical editor

Infinite Space, Fallible History

With regard to Edmund DeJesus's otherwise excellent "Infinite Space" (February feature), I should like to point out that he is mistaken when he says "holography itself was discovered shortly after the invention of the laser." In fact, if memory serves, holography was invented by Dennis Gabor in 1954. The laser was first proposed by Charles Townes in 1958, and the first laser was built, by Theodore Maiman, in 1960. Therefore, holography is four years older than the laser.

John F Schlesinger
New York, NY

Gabor worked out the theory of the hologram in 1947, but in connection with electron microscopy. I was thinking of laser holograms when I wrote the sentence. You make a good point that the theory of holograms was worked out for another technology before lasers came along. —Ed DeJesus, senior technical editor

To Be or Not to Be (A System Component)

I just got the latest Microsoft Developer Network universal CD and it includes the ActiveX Redistributable Installation Kit, which seems to have an installer for WININET.DLL and friends. Perhaps using this installer will solve some of the registry setup problems you described in "In Search of SSL Spidering" (February Web Project).

Spencer Low
spencer@lowtek.com

Thanks for the pointer. However, it's unclear whether it would solve the basic problem I referred to, which is that Microsoft Internet Explorer, an application, shares state information with WININET.DLL, a shared system component. Microsoft may now wish to argue that WININET is not a shared system component, but rather an application-specific component particular to MSIE. However, I remember the pitch that was made at the Microsoft Professional Developers Conference in 1995: WININET was described as a system component, not an application-specific component. I think it should be a system component, but unfortunately, it isn't. —Jon Udell, executive editor, New Media

Any ORB Will Do

In "Making Components Portable with JavaBeans" (February feature), author David S. Renshaw states "The basic model for the Enterprise Bean is one of a client and server, where communication between the client application and the Enterprise Beans executing in the server is via remote method invocation (RMI), the CORBA Internet Inter-ORB Protocol (IIOP), or the forthcoming RMI over IIOP." You also stress platform-independence. Different servers using IIOP and using different ORBs can communicate, but the API for them has not been standardized. This results in writing code for a particular ORB and might limit the platforms available. Also, I would be concerned about the financial health of any of the software houses providing ORBs, given who they are up against. I like the use of RMI over IIOP the most, but it's not available yet.

John Menarek
Lombard, IL

If I use CORBA IIOP to communicate between the client and my server, the ORB in the client (or merely IIOP support classes) will happily talk to a variety of ORBs in the server(s), as the protocol is specified, but the client application is built for a specific client-side ORB and is dependent on that ORB's API definitions. I agree with you entirely in cases where the client is something other than Java. I would expect a Java client to communicate via RMI, or RMI over IIOP in the future. In this case, the APIs will be standard, i.e., part of the Java definition, core, or extension. In the case of non-Java CORBA objects in the client, there is a dependency on the ORB environment. On the server side, Enterprise JavaBeans (EJBs) are insulated by their use of Java-defined APIs to access server functions. They do not access ORB APIs directly. In fact, there may be no ORB as such; the EJB server environment may be provided by a procedural TP monitor such as CICS. For the latest on EJBs, see the JavaSoft Web pages at http://java.sun.com/products/ejb/index.html. —David S. Renshaw

Correction

In "Three Vendors Make an Alpha Bet" (February Eval), we erred in including the Aspen Durango II, which is based on a 21164A processor and 164LX motherboard. To make amends, we asked the vendors—Aspen Systems, Polywell Computer, and Tri-Star Computer—to send in their systems for a retest. To create a truly level playing field, we asked for 533-MHz systems based on the 21164PC processor, 164SX motherboard, with a street price of $2500 or less. Aspen sent us the $2383 (minitower) Montrose system with a 4.5-GB Wide/Fast Ultra SCSI hard disk, 16x EIDE CD-ROM, and 4-MB Matrox Millennium II PCI graphics adapter. Polywell turned in a $2499 PolyAlpha

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164SX, which housed a 4.5-GB, 10,000-rpm, Ultra Wide SCSI hard disk and an 8-MB Diamond FireGL 1000a AGP graphics card. Tri-Star sent a $2383 StarStation SXS, with a 4.3-GB, 7200-rpm, SCSI-3 Ultra Wide hard drive, 14/32x IDE CD-ROM, and 4-MB Matrox Millennium II PCI graphics adapter. We measured performance with our low-level processor test, BYTEmark, and BAPCo's SYSmark 4.0 application test. Not surprisingly, the three systems had similar performance numbers. Though all are solid machines, we give our nod to the $2383 Tri-Star, which had the right mix of configuration and price for performance. We also liked its large cabinet with easily replaceable cover, roomy inside for accessing RAM, extra fan, and space to support three high-speed drives.

COMING UP IN JUNE

COVER STORY

The Truth About Windows

Should you upgrade your company desktops to Windows 98, or wait for Windows NT 5.0? We look at the real differences—as they now exist—between Windows 95, Windows 98, NT 4.0, NT 5.0, and Windows CE.

FEATURES

What's New with IA-64

BYTE reports on developments that have come to light since our December '97 in-depth analysis of Intel's next-generation microprocessor architecture.

Scripting Languages

So you wouldn't trust your business to free software? You may already, if you rely on Perl, Tcl, Tk, or other free scripting languages to tie together the applications you deploy over the Web. Here's what you need to know.

HARDWARE LAB REPORT

Multiprocessing Servers

The BYTE Lab looks at multiprocessor servers for Windows NT 4 Enterprise Edition and Unix. We test servers that can scale up to 10 CPUs, with a special focus on transaction processing.

REVIEWS

Lotus Notes 5.0

The groupware leader completes its transition to a Webbed world. Our reviewer tests the redesigned GUI, with its browser-like features and support for major messaging standards, among other new capabilities.

LAB NOTES

The Real Deschutes

The BYTE Lab tests second-generation Deschutes PCs with the new 100-MHz system bus, designed to take full advantage of 350- and 400-MHz. processor speeds.

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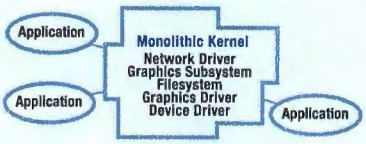
Joe reboots his PC every day.



That's a fact.

Conventional OS Architecture
The monolithic OS on Joe's machine clumps all OS components into a single address space. One subtle programming error in just one driver, and ***whoomp!****, Joe has to reboot – again.*

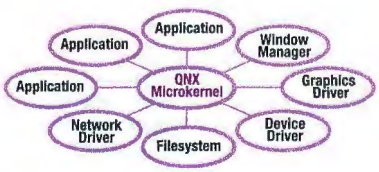
Dave hasn't since 1994.

That's a fact too.

Four years ago, Dave Cawlfield at Olin Chemicals replaced expensive PLCs with OMNX Open Control Software and the QNX Realtime OS. "Since then," says Dave, "we've upgraded the control system regularly with new hardware and software – including parts of the OS itself. But not once have we had to reboot."

For a handy 12-point checklist on OS reliability, download Dave's paper, Which OS for PC-based Control?, *at www.omnx.com/productinfo/technical_papers.htm.*

white paper



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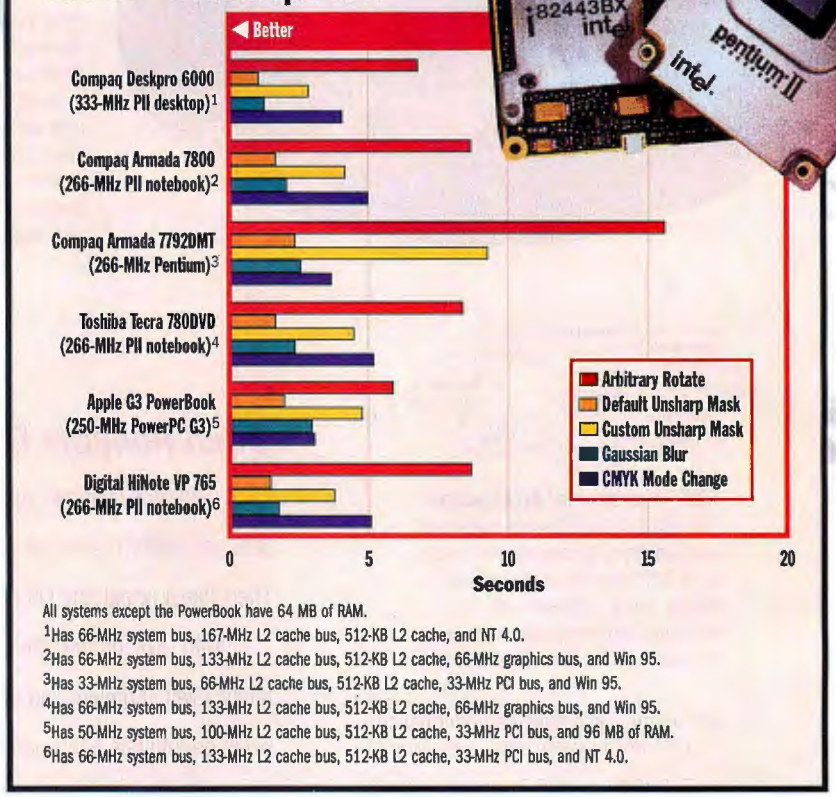
More PC Power to Go

Intel's new mobile processor brings Pentium II power to portable PCs.

Notebook Performance on Five Photoshop Tests



All systems except the PowerBook have 64 MB of RAM.
[1]Has 66-MHz system bus, 167-MHz L2 cache bus, 512-KB L2 cache, and NT 4.0.
[2]Has 66-MHz system bus, 133-MHz L2 cache bus, 512-KB L2 cache, 66-MHz graphics bus, and Win 95.
[3]Has 33-MHz system bus, 66-MHz L2 cache bus, 512-KB L2 cache, 33-MHz PCI bus, and Win 95.
[4]Has 66-MHz system bus, 133-MHz L2 cache bus, 512-KB L2 cache, 66-MHz graphics bus, and Win 95.
[5]Has 50-MHz system bus, 100-MHz L2 cache bus, 512-KB L2 cache, 33-MHz PCI bus, and 96 MB of RAM.
[6]Has 66-MHz system bus, 133-MHz L2 cache bus, 512-KB L2 cache, 33-MHz PCI bus, and NT 4.0.

Intel has mobilized its Pentium II processor, and the new CPU gives portable PCs a significant boost in performance. Available initially at 233 and 266 MHz, the Mobile Pentium II is built on a 0.25-micron process and shares the dual independent bus (DIB) architecture of the desktop versions of the Pentium II.

Previous Intel notebook processors ran both system and L2 cache traffic over the same bus. The Pentium II's DIB architecture gives the L2 cache its own private path to the CPU running at speeds of 117 MHz in the 233-MHz version and 133 MHz in the 266-MHz version. That, plus other advantages of the Pentium II architecture, such as dynamic execution (first used in the Pentium Pro), allows for notebooks with performance that approaches that of the fastest x86-compatible desktop PCs.

BYTE's tests of several new notebooks with the 266-MHz version of the CPU show about a 25 percent improvement in BYTEmark integer performance over Intel's previous fastest notebook CPU, the Mobile Pentium with MMX, running at 266 MHz. In addition, we found almost a 40 percent improvement in BYTEmark floating-point performance.

All three Pentium II notebooks we tested turned in very similar results on the BYTEmark tests; there was no significant difference in their scores. We also tested Apple's current-generation 250-MHz PowerPC G3–based PowerBook, and it beat Intel's desktop and notebook processors in the BYTEmark tests.

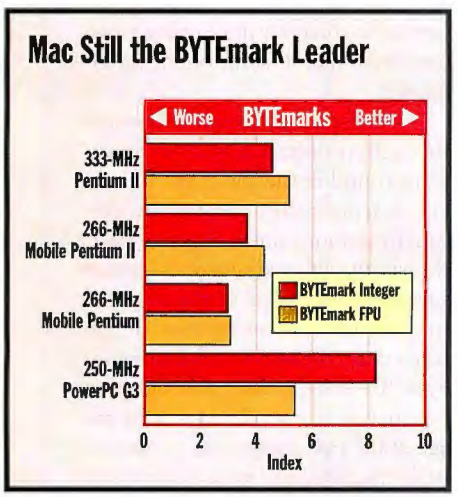
The PowerBook's performance advantage was not nearly as decisive when we tested the notebooks using Photoshop, which is available in 32-bit Windows and Mac OS versions. Here the results were more mixed, for a variety of reasons. One is that the PC notebooks benefit from certain operations in Photoshop that take advantage of Intel's MMX instructions, such as the Default Unsharp Mask and the Gaussian Blur tests. Furthermore, three of the PC-compatible notebooks, Compaq's Armadas and Toshiba's Tecra, were running Windows 95. Digital Equipment's HiNote, however, ran NT 4.0. In previous tests BYTE has performed, the exact same desktop system turns in slightly faster Photoshop performance in the Unsharp Mask and Gaussian Blur operations when running NT instead of Win 95. We found similar results when comparing the Photoshop performance of the HiNote running NT and the other Pentium II notebooks running Win 95.

One thing is clear: The Pentium II offers significant performance improvements over the previous-generation Intel mobile processor, whether you run Win 95 or NT on your notebook. And prices for notebooks are coming down. The price you pay for one of these new Pentium II notebooks may be less than what you would have paid for the first Tillamook notebooks. (Tillamook was the

code name for Intel's first Pentium processor to be built on a 0.25-micron process.) "Many of the first Tillamook machines were in the $5000 price range, and some cost even more," says Stephen O'Brien, product manager for Digital's VP line of value notebooks. (Digital's Hi-Note VP 765 will start at $3999; at press time, Toshiba and Compaq hadn't finalized their prices.)

Donnie Oliphant, product marketing manager for Dell's Portable Development Group, agrees that prices for notebook components are declining, but you can still pay a lot for a high-end system. "Prices on all key components are trending down, especially for hard drives, but most significantly for LCDs," he explains. "Processor modules are not significantly cheaper today [than Tillamook], but I expect prices will drop as the year progresses and speed that downward trend."

For example, last year Dell's Latitude CP laptop with a 233-MHz Pentium with MMX, 32 MB of RAM, a 2.1-GB hard drive, a 13.3-inch screen, and a 20X CD-ROM cost $4700. But a Dell Latitude with a 266-MHz Pentium II and a 3.2-GB hard drive, a 13.3-inch screen, 64 MB of RAM, and a 20X CD-ROM starts at $3300.



But Tillamook won't go away quickly. For one thing, vendors estimate that the battery life of a Pentium II–based notebook is about 10 percent to 15 percent less than that of an equivalent Tillamook (your mileage may vary). And heat dissipation is always a concern in notebook and hand-held designs. Pentium II designs that require a fan might be too bulky for a mini-notebook, for example. But if performance is what you want, these notebooks deliver.

–Dave Andrews and Jason Krause

Geek Mystique

CyberCommerce? No On-Line Research? Yes

Although many on-line users are still reluctant to buy products and services over the Internet, cyberspace has an important role in determining what customers buy. According to a recent survey by Ernst & Young's Retail and Consumer Products Group (212-773-5299; http://www.eyi.com), few of the 850 people surveyed make 10 or more on-line purchases annually (see the chart at right). But almost one-third have purchased a product or service on the Internet at least once, and 64 percent of users research product purchases on-line and then later buy through traditional channels.

The ability to comparison-shop was liked by 56 percent of the respondents who had on-line access, and 50 percent enjoyed the ease of navigation and speed of the Web. The major problem is still security: 70 percent said it was the major reason why they were uncomfortable sending credit-card numbers over the Internet.

Internet Buyers: Still Just Browsing

Number of respondents to phone survey: 850
Source: Ernst & Young (http://www.eyi.com)

OS Vendors Race After Merced

The race to port Unix OSes to Intel's next-generation 64-bit IA-64 (aka Merced) chip has reached full stride. While jockeying for position by Unix vendors—who will compete with each other and Microsoft on IA-64—is far from over, already some dark horses and surprise contenders have emerged. IT managers who have tied their fortunes to the wrong OS may be out in the cold when the chip emerges.

SCO, the Unix market-share leader, has almost two years' worth of work invested in a 64-bit port to Merced, while Hewlett-Packard has been at it for three years. Sun and Digital Equipment announced their porting projects more recently—in December and January, respectively. IBM remains committed to its own architectures and has not announced a port to IA-64. Meanwhile, Novell, at the Brainshare conference in March, announced that after NetWare 5, its next release will be a new OS for the IA-64 chip.

Perhaps the most surprising statement to date regarding IA-64 was Digital and Sequent's joint announcement that they are collaborating to port Digital Unix to Merced. Today these companies occupy a niche position, jointly laying claim to a mere 5 percent of the market. But Digital, which is now owned by Compaq, already has a high-end 64-bit Unix OS. With Sequent's large transaction-processing and data-warehousing capabilities, analysts say, these partners could be well positioned for Merced's launch, which is scheduled for late 1999.

Observers were somewhat surprised that Sequent chose Digital Unix, which will be renamed when it's introduced on Merced. Sequent worked with Sun

Contents

Merced OS Scorecard

Digital
Pros:
- Already has 64-bit Unix
- Possible benefit from Sequent relationship

Cons:
- Late start on porting efforts
- Weak Unix market share

Hewlett-Packard
Pros:
- Already has 64-bit Unix
- Close ties with Intel
- Three-year head start

Cons:
- Only big-endian OS on Merced
- Has not signed key ISVs

Microsoft
Pros:
- Increasing popularity of NT

Cons:
- Currently lacks 64-bit OS
- NT needs improved scalability and reliability for enterprise

The Santa Cruz Operation (SCO)
Pros:
- Leader in Unix-server licenses
- Two-year head start
- Recent support from Compaq, Data General, ICL, and Unisys
- 64-bit capabilities

Cons:
- Current OSes need improved scalability, reliability, and performance
- UnixWare 7 has limited 64-bit capabilities

Sun
Pros:
- Now working more closely with Intel

Cons:
- No 64-bit OS
- Solaris for Intel currently not equal to SPARC version

for 12 months and nearly signed on to collaborate on a similar effort for Solaris, but it backed off at the last minute.

Solaris is a leading contender on Merced, with a strong market share, independent software vendor (ISV) partnerships, and a reputation for reliability. But, according to Jeff Pancottine, vice president of marketing for Sequent, "Sun's focus is on SPARC, and while Solaris on Intel and Solaris on SPARC share a common source base, Solaris on Intel is not equal to Solaris on SPARC." Today, Solaris on x86 lacks the scalability, partitioning, and hot-swap capabilities of Solaris on SPARC.

Sun officials respond that Solaris on Merced will have advantages that Solaris on x86 never had. "Sun has reached a level of cooperation with Intel for Solaris on Merced that we never had on x86," says Brian Croll, director of product marketing for Solaris. Unlike previous x86-based development efforts, Sun has early access to Merced's inner workings, thanks to a nondisclosure agreement. Sun has also opened a porting center for ISVs, application developers, and OEM partners, such as NCR, to tune Solaris applications on Merced simulators.

SCO had initially planned to develop a single binary specification for Merced with HP, but the company eventually settled for a technology-sharing agreement, which has since ended. Analysts point out that SCO's UnixWare is a general-purpose enterprise platform and must be upgraded in order to compete on IA-64. UnixWare 7, announced in March, already includes 64-bit capabilities, and Compaq, Data General, ICL, and Unisys are today committed to UnixWare.

HP is Intel's partner in developing Merced, and it will phase out its PA-RISC architecture in favor of IA-64. This relationship bodes well for HP-UX on Intel, but HP is challenged by the fact that HP-UX will be the only big-endian OS on Merced (Merced will be bi-endian, supporting big- and little-endian OSes). This might scare off some ISVs.

Of course, Windows NT will also be competing with the various flavors of Unix on Merced. Microsoft believes it will release a 64-bit NT almost concurrently with Merced's introduction and says it will provide SDKs by the end of this year. NT continues to evolve, and Microsoft believes it will be competitive with more high-end Unix OSes. "SMP [symmetric multiprocessing] scaling, graphics performance, I/O subsystems, memory support, ATM [asynchronous transfer mode] support, and all the necessary pointers are ready for a 64-bit implementation of NT," says Ed Muth, group product manager for Personal Business Systems with Microsoft.

OS vendors might be eager to port to a chip that doesn't exist yet, but analysts and IS directors are more blasé. "We have a few applications that could benefit from Merced, but probably not anytime soon," says Todd Wright, a system architect with Wells Fargo in San Francisco. "First we've got to take care of Year 2000–compliance issues. Maybe in 2001 we can look at Merced."

"IA-64 is not a compelling reason to lose sleep right now," admits Tom Henkel of GartnerGroup. "But I would be uneasy if I were an IT manager committed to a second-tier vendor and I had to migrate to a new OS in order to implement Merced." For example, Henkel points out that Sequent customers will have to migrate to Digital Unix if they plan to use Sequent's IA-64 servers, and NCR users will be faced with a migration to Solaris.

When Merced arrives, it will likely be supported by more software platforms than previous Intel architectures, which would mean more choices for customers. That means every OS vendor will need to provide a smooth migration path to Merced or risk losing customers. **–J. K.**

Security for Your Eyes Only

A new method that identifies people by analyzing their eyes might soon be coming to a bank, store, or building near you. Iriscan (Mt. Laurel, NJ, 609-234-7977; *http://www.iriscan.com*), whose identification technology can recognize the unique pattern in the iris of the human eye, is partnering with technology and financial organizations to market products for applications that require nonintrusive, noncontact, and extremely accurate electronic identification. Iriscan is also currently developing a low-cost version of its solution for the PC market.

Iris technology identifies people through an electronic analysis of patterns found in the iris of the human eye. Scientifically accepted as a personally unique human characteristic, the iris, the colored ring of tissue that surrounds the pupil of the eye, features a complex combination of patterns that can be recorded as a 256-byte "Iriscode." An iris-recognition product captures a photographic image of the iris, analyzes its unique visual structure, and then compares it to previously stored Iriscodes for authentication of identity. The technology can be used for access control, point-of-sale (POS) solutions, and data protection.

Sensar, of Moorestown, New Jersey, is now using Iriscan technology in a test pilot program for the banking industry. Pilot programs using iris-recognition products in bank ATMs are under way with Citicorp in the U.S. and NCR and NationWide Bank in the U.K., and in cooperation with Oki Industry Co. and other financial institutions in Japan. Although Sensar's cur-

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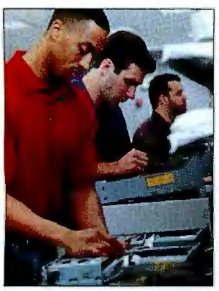

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rent pilot program requires end users to carry an access card (but doesn't require them to remember a personal identification number [PIN]), Iriscan can also be deployed in an application that doesn't use such a card (see the figure "Banks Eye New Security" at right).

Current Iriscan solutions can be a bit pricey. For example, the company's System 2100, which includes a computer, a frame grabber, and other components needed for access control, costs about $5000. "The costs associated with iris recognition are high compared to other forms of authentication," explains Erik Bowman, biometrics analyst with CardTech/SecurTech, an industry watcher based in Bethesda, Maryland. "In addition, there are issues with social acceptance. The general public will need to become more comfortable with it."

Despite those drawbacks, Bowman says Iriscan has advantages over other access solutions that are based on smartcards and fingerprint analysis. "Iris recognition represents the least intrusive form of biometrics available today," he says. The nonintrusive, noncontact nature of iris recognition, coupled with an extremely low error rate, makes the technology attractive. According to IEEE studies on the technology, the probability of two irises producing the same iriscode is approximately 1 in 10^{78}.

In addition, a project under development between Iriscan and GTE, known as Iris Certificate Security (ICS), adds a security element that might increase the technology's appeal. ICS binds the iris-recognition process to digital certificates. In essence, encrypted electronic-commerce transactions are also biometrically secured, requiring the sender and recipient to possess the digital-certificate keys and a personal iris-recognition Iriscode to access data.

Iriscan technology can be used for a variety of security applications, including digital certification.

Targets for this initiative range from business-to-business e-commerce and stock and commodity trading to credit-card purchases and securing information contained in e-mail. According to Iriscan, ICS prototypes are expected to be operational in the third quarter of this year.

Another advantage is that iris recognition isn't burdened with the negative stigmas associated with other forms of biometrics, such as fingerprinting. "Iris recognition has never been associated with the criminal-justice system, the way fingerprinting has," says Iriscan spokeswoman Kelly Gates. "We feel this will make social acceptance of the technology easier to attain."

The company is also addressing the issue of price. A prototype of an inexpensive hand-held imaging device is expected this fall. The device will be bundled with software for PCs and could be priced as low as $200. If the company succeeds in getting its products widely available in low-cost solutions, the possibilities are endless. Some day, instead of fumbling for your keys outside your front door, you might gain access by simply looking into a camera and smiling. **–Dan Coyle**

Bug of the Month

Not Clear As a Bell

Because of a problem with authentication, approximately 10,000 Bell Atlantic customers recently had to go for days without any e-mail or Web access. The problem, which first hit customers in the Pittsburgh area in late February, took several days to solve.

According to a Bell Atlantic spokesperson, the source of the problem was difficult to pinpoint because several different programs were involved. Even more frustrating was the fact that some users were occasionally able to get access, often during periods of limited network use.

Eventually technicians found the source: A software bug resulted in the slow authentication of passwords, causing the system to "time out" and disconnect dial-up users when they attempted to log on. Users with dedicated access were not affected, according to a Bell Atlantic spokesperson.

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How to Build an Electronic Store Fast

You don't have to host your own Web site on the Internet to have an online store. Many ISPs are becoming commerce solution providers (CSPs), which provide electronic store-hosting services for businesses that would like to use the Internet as a new sales channel but don't have the time or resources to build and maintain their own Web site.

The tasks involved in hosting such a Web site can be daunting, especially to small businesses: You must buy and maintain numerous hardware and communications equipment, including a computer, a fractional T1 line from an ISP, and a router; you also have to install the Web server and electronic-commerce software. Only then can you start developing and hosting your Web store. The approximate costs for such a project include $11,500 for hardware, software, and connectivity, plus about $2000 in monthly connectivity charges.

Instead of doing all that yourself, you can have a CSP do it for you. If you choose to partner with a CSP, a key criterion in choosing where to host your e-commerce Web site is the store software provided to you. The functionality that a merchant can provide is limited by the software that's used.

For example, PSI Net and MindSpring offer Web-store-creation software from Mercantec (*http://www.mercantec.com*) that might appeal more to bigger

E-Commerce Solutions at a Glance

CSP	PSI Net	MindSpring	NetCom	GoSite
Web-store software	SoftCart	SoftCart	ShopSite	ShopSite
Storage space (MB)	100	100	200	75
E-mail addresses included	50 virtual	None	75 (POP3)	Unlimited
Monthly data transfer limit	1.25 GB	4.5 GB	4 GB	3 GB
Cost per MB transfer over limit	20¢	10¢	8¢	3¢
Dial-up account included?	Yes	No	Yes	No
Setup fee	$640	$225	$350	$349
Monthly fee	$125	$350	$250	$189

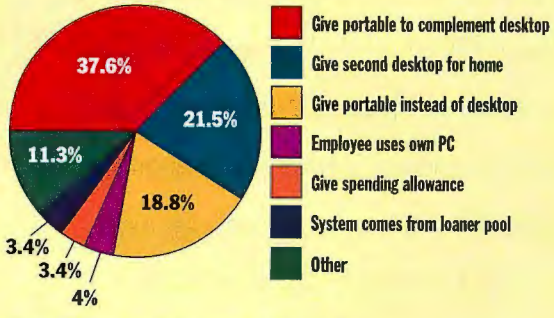
Survey

What Users Dislike About Notebooks

Screens and price tags. Those are the top two things users found not to like with PC notebooks when comparing them to their desktop counterparts, according to a recent survey by BYTE Research. Although Intel's new mobile Pentium II processor adds a performance boost to the latest notebooks (see "More PC Power to Go" on page 24), respondents to the survey seemed satisfied with their CPU performance overall. Instead, they are dissatisfied with inferior displays (compared to those on desktops); high prices; small keyboards; lack of durability, reliability, and expandability; and their unfortunate tendency to "walk away" (i.e., get lost or stolen) when users aren't looking. Prices are currently dropping for PC notebooks, but the systems are still more expensive than equivalent desktops.

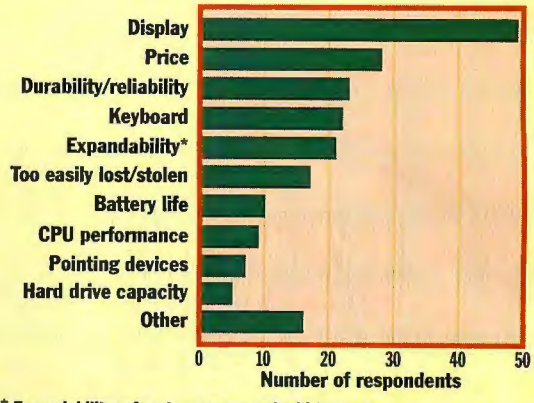
Perhaps users will always have to pay a price in exchange for the most-liked aspect of notebooks, their portability. But users have spoken, and there's a lot they still don't like about notebooks—which would explain why, in a situation where they need to give an employee a second PC to work on at home, many respondents buy another desktop PC instead of a notebook.

Strategies for Employees' Work-at-Home PC



Source: BYTE Research, telephone survey, 149 responses

Disadvantages of Portables Compared to Desktops



*** Expandability refers to memory and add-in cards.**

Source: BYTE Research, 150 respondents (multiple answers accepted)

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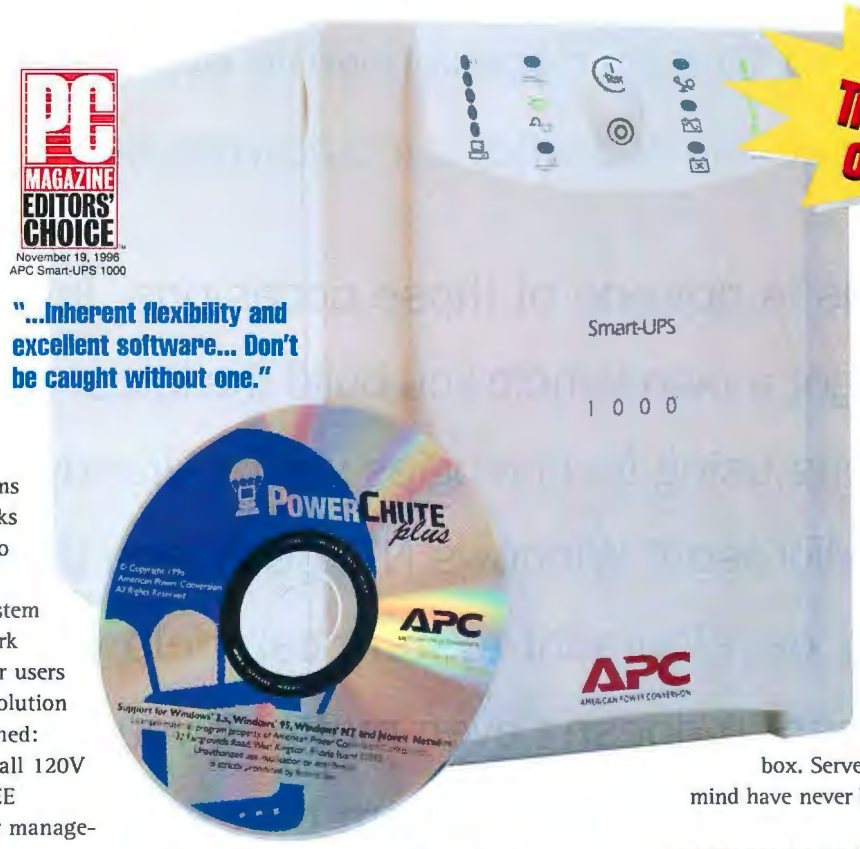

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companies, while NetCom's and GoSite's partnership with iCentral, the publisher of ShopSite Express (*http://www.shopsite.com*), might appeal to smaller companies. Both Mercantec's SoftCart and iCentral's ShopSite Express provide basic store functionality, including a virtual shopping cart, a collection of credit-card information, extremely flexible calculation of taxes and shipping charges, and notification of orders via e-mail to both buyer and merchant.

But ShopSite Express is designed for merchants with a small selection of items (25 or less) and a limited knowledge of HTML. (iCentral also offers programs, such as ShopSite Pro, for managing bigger e-commerce projects.) You can easily set up a ShopSite store using just a Web browser, but this approach offers only limited flexibility regarding Web-page layout; you'll probably want to use ShopSite with an HTML editor, such as Adobe PageMill. ShopSite Express supports on-line ordering, including purchase orders, but it doesn't support real-time credit-card authorizations.

One of ShopSite's negatives is that it uses cookies to store a user's shopping cart during shopping. Many users elect to turn off the cookies option on their computer because of their concern for privacy. This is somewhat problematic to the software.

Mercantec's SoftCart is designed for more sophisticated vendors with up to 10,000 products and an understanding of HTML. The package supports on-line ordering and real-time credit-card authorizations through CyberCash. It also lets shoppers print and fax or mail their order. SoftCart can generate a transaction log file that can be directly imported into Intuit's QuickBooks. SoftCart does not use cookies for storing shopping-cart information. Instead, it stores this data on the merchant's host server.

Limited space prevents us from covering all the CSP options and e-store software available. Each CSP offers a variety of hosting plans to suit your needs, so you should shop around and compare. And if you can't find exactly what you're looking for, ask the CSP if it can customize a plan for you.

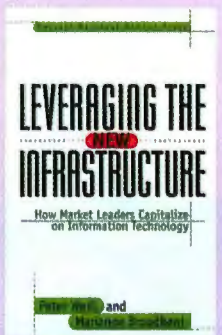
Hosting your own e-commerce solution might be a better idea for your organization in the long term, especially if your e-commerce business grows. But getting in front of your customers quickly might be even more important, at least in the short term. By using a CSP, you can get started quickly, even if you're operating on a budget.

Eugene Mondrus is a senior product analyst for Progressive Strategies (http://www.progstrat.com), a technology-assessment and research firm.

Book Reviews

How to Invest in the New Infrastructure

Enterprises everywhere are scrambling to build an internal infrastructure to support the new business reality: virtual storefronts, Web-based customer services, integrated call centers, electronic supply channels, and shared data across business units. Three new books can help IT managers create and implement technology strategies that best suit their organization.



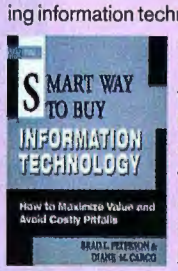
According to *Leveraging the New Infrastructure*, 50 percent of all capital spending in the U.S. goes into IT investments. The authors, Peter Weill and Marianne Broadbent, offer a strategy for devising a successful IT investment portfolio.

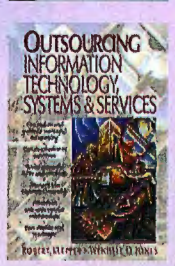
The key to successful investments is avoiding a hair-trigger technological response and instead following a focused plan that matches infrastructure to the firm's strategic objectives, according to the authors. Using research results and case studies, they analyze different types of IT investments and develop methods for assessing risk and return.

Their conclusions suggest going with the right type of investment to meet company goals. For instance, companies seeking "revenue growth and fast response to market shifts are better served by more infrastructure," while a successful strategy "to maximize short-term profit is to minimize infrastructure investments and focus on transactional uses of information technology." The book details a framework for balancing the IT portfolio for risk/return and appraising the investment on a balance sheet.

In today's evolving business environment, the enterprise infrastructure is directly tied to a firm's strategic direction. It dictates the way in which a company does business and how quickly the company can respond to competitive challenges and customer demands. Given the essential role of infrastructure, the final investment decision belongs not to IT managers but to executives at the very top of the enterprise. *Leveraging the New Infrastructure* will acclimate these executives to the strategic issues and help articulate a blueprint for a successful IT investment portfolio.

Two other books provide a practical, "how-to" approach to buying and outsourcing information technology. *The Smart Way to Buy Information Technology* makes extensive use of numbered lists and bulleted points to illuminate vendor negotiating, contracting, consulting, and strategic alliances. The book delivers a rich set of guidelines for making IT purchases and developing vendor relationships. *Outsourcing Information Technology, Systems and Services* covers several issues: whether or not to outsource, what to outsource, outsourcing trends, writing requests for proposals, negotiating contracts, and managing the transition to an outsourced IT infrastructure.





Stanford Diehl *is a freqent contributor to BYTE and former director of BYTE reviews. You can reach him at Sdiehl@nebs.com.*

Leveraging the New Infrastructure by Peter Weill and Marianne Broadbent; Harvard Business School Press, 1998; ISBN 0-87584-830-3; $29.95

The Smart Way to Buy Information Technology by Brad L. Peterson and Diane M. Carco; AMACOM, 1998; ISBN 0-8144-0387-5; $35

Outsourcing Information Technology, Systems and Services by Robert Klepper and Wendell O. Jones; Prentice Hall PTR, 1998; ISBN 0-13-281578-8; $39.95

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GartnerGroup Report

Win 98 or NT for the PC Desktop? It Depends

This year will mark the peak of the hype cycle for the next iterations of Windows 95 and NT. Although Windows 3.x was adopted by many companies as a single enterprise-wide standard, Windows 98 and NT 5.0 will coexist in most enterprises through 2001. GartnerGroup believes that NT 5.0 will become generally available in the second quarter of 1999. In addition, we recommend that you shouldn't deploy NT 5.0 Workstation until the first service pack is released and proven to be stable, which GartnerGroup believes will be six to nine months after NT 5.0's initial release.

Win 98 will become generally available in the second quarter of 1998. However, because Win 98 is very similar to Win 95, OSR 2, and Internet Explorer 4.0, we believe that organizations will be able to deploy Win 98 upon its release, without having to wait for a service pack.

With these time frames in mind, how does an organization break through all this noise and decide which OS is appropriate for its particular needs? Defying the conventional wisdom, GartnerGroup believes that both Win 98 and NT 5.0 will be applicable to business and consumer markets alike. Organizations should consider the following considerations before deploying Windows 98 or NT 5.0:

- The importance of legacy (16-bit) Windows and DOS business applications that are running on the desktop.
- The diversity of PC hardware that must be supported.
- The organization's desktop-management strategy.

Although Win 98 and NT 5.0 share a common 32-bit applications architecture, Win 98 retains a significant amount of legacy 16-bit code that helps it achieve better reliability running 16-bit legacy applications. Organizations that continue to rely on these older applications will be better served by Win 98 than by NT. This backward compatibility, however, is expected to be short lived. GartnerGroup expects Win 98 to be the last Windows release to be based on non-NT code. Organizations deploying Win 98 for better applications compatibility need to begin their 16-bit applications migration. Enterprises that have limited dependency on legacy applications will be much better candidates for NT 5.0 when it ships.

Issues of PC hardware diversity and mobile computing also play an important role in choosing among the different versions of Windows. NT 5.0 and Win 98 offer robust support for a wide variety of new hardware, but many systems purchased prior to mid-1998 will be unable to take advantage of at least some of the new features planned for Win 98 and NT 5.0, such as Advanced Configuration and Power Interface (ACPI) support. Although the new Windows Device Driver Model will alleviate some of the issues associated with hardware working on both Win 98 and NT 5.0, it will apply only to new classes of devices, such as universal serial bus (USB) or IEEE-1394 (also known as FireWire). Drivers for older devices will still need to be created individually for both Win 98 and NT 5.0.

PC laptop users in particular will face a greater hurdle in deploying NT 5.0. Although NT 5.0 will finally support such mobile features as advanced power management, it will do so only on systems that are purchased after the second half of 1998. GartnerGroup believes that existing mobile systems running NT 4.0 will not migrate smoothly to NT 5.0 and will be hampered by compatibility and performance issues. As a result, those older mobile PCs should continue to run NT 4.0.

One of the key features of NT 5.0 will be support for a wide variety of management technologies aimed at lowering the total cost of ownership (TCO) through better centralized control. Known as the Zero Administration Initiative (ZAW), its features will exist on both NT 5.0 and, to a lesser degree, Win 98. Features available only on NT 5.0 that enable the best manageability and TCO reduction include true server-based roaming profiles; side-by-side machine replacement, which provides simplified moves and installations; and better system stability. This stability is due to the use of ZAW-enabled and branded applications that will have a much more restricted installation process and no access to the system directory.

Despite the attractiveness of the ZAW features set, NT 5.0 will incorporate a host of unproven technologies. As a result, GartnerGroup recommends that you should wait at least six to nine months until the first NT 5.0 service pack is released and proven stable before deploying.

Windows NT Workstation and Win 9.x are both powerful 32-bit OSes that can meet a variety of business-computing needs. Organizations should not be swayed by marketing hype; instead, they should choose the OS that best fits their computing requirements based on the three major areas outlined above.

Although NT technology will eventually become the standard for all Windows users, this change will not happen for at least three years, with the major impediments being legacy hardware, software, and mobile-computing needs. Organizations should not withhold deployment of a 32-bit OS waiting for NT 5.0 but should instead proceed with migration efforts to Win 98 or NT 4.0 as appropriate. This will help them reap the benefits that 32-bit OSes bring to the desktop and avoid the death throes of 16-bit Windows and DOS.

Michael Gartenberg *is a research director for GartnerGroup, where he focuses on end-user computing, particularly the implications of personal computer technologies on end users and enterprises alike.*

Which Windows?

Stay with Windows 95
- if your PCs use older (e.g., 486) CPUs
- if your PCs have modest (e.g., 16-MB) RAM
- if you don't want to upgrade your older hardware
- for mobile-computing support
- if you still rely on 16-bit legacy Windows and DOS applications

Upgrade to Windows 98
- if you need support for new features, such as ACPI, USB, multiple displays, and FAT32
- for improved mobile computing with new notebooks that support ACPI, USB, or CardBus
- if you rely on legacy 16-bit Windows and/or DOS apps

Migrate/stay with NT 4.0
- if you're running 32-bit applications exclusively
- if you need better security and stability than Win 95's

Upgrade to NT 5.0
- if you need improved security, performance, and reliability
- if you're running 32-bit Windows applications exclusively

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Blasts from the Past

5 Years ago in BYTE

Intel's new Pentium was initially found mostly in PCs and servers starting at prices of $5000 and up, but many systems sold at prices closer to $8000. Today you can easily get that much PC computing for about one-tenth the price.

10 Years ago in BYTE

The DisplayWrite 4, MASS-11, MultiMate, OfficeWriter, Samna, WordPerfect, WordStar, and XyWrite word processors were reviewed (which was *your* favorite 10 years ago?), along with Microsoft Word, which back in those days required only 256 KB of RAM.

15 Years ago in BYTE

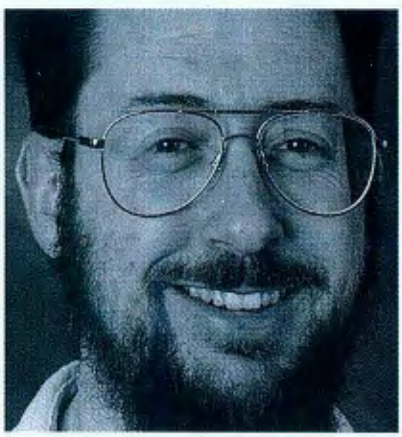
Tandy's amazing TRS-80 Model 100 portable computer (prices started at $799 for an 8-KB system), which weighed 4 pounds and included built-in text-editing and communications software, was to prove popular for years to come.

20 Years ago in BYTE

The majority of this issue was devoted to color and 3-D graphics. Editor in chief Carl Helmers wrote that he spent a day during the infamous Blizzard of 1978 (which hit in February) updating his documentation, creating a new 1-KB EROM with low-level disk drivers for interrupt-driven block transfers between memory and disk, implementing a "primitive" physical I/O OS, and working on other projects in the basement laboratory in his home.

Double Trouble for E-Mail Security

Paul Hoffman, director of the Internet Mail Consortium, discusses e-mail security-standards problems, the prospects for merging, and what to do when merging doesn't happen.



BYTE: *It doesn't look like we're going to see one single standard anytime soon for e-mail security.*

Hoffman: Everyone has known all along that we need secure e-mail. E-mail is easy to intercept over the Internet, which is why we need private e-mail. And the need for authentication is also strong because it's easy for someone to spoof your e-mail address.

Two protocols have been submitted to the IETF for consideration as standards for adding authentication and privacy to messages: S/MIME v.3 and OpenPGP. The problem is, these two protocols don't interact at all. You can't read messages from one to the other.

BYTE: *What is the status in the IETF for the two?*

Hoffman: Both working groups had their first official meetings in December. Neither of them is yet a standard, and they both have a fair amount of work to be done, although S/MIME is well ahead of OpenPGP. OpenPGP has been going very slowly; they've only put out one draft, whereas S/MIME has revised the draft a couple times. So, it's very likely that S/MIME v. 3 will be out much sooner than OpenPGP. S/MIME v. 3 should be ready by this summer. OpenPGP will probably be ready by the end of the year.

BYTE: *So, if I'm managing a network of trusted individuals or companies, I have two options—get people to convert to one standard, or somehow juggle both?*

Hoffman: Yes, and this is the big dilemma. Unfortunately, there are actually a very small number of signed and/or encrypted messages traversing the Internet today, because there's more than one standard. If we had picked a standard a few years ago and if you were an IT manager, you would buy certain products that you knew to be interoperable.

Instead, you're looking at a huge hassle. The current versions of S/MIME and PGP/MIME, which are also not interoperable, are being used within organizations in which a manager has been able to specify one or the other. PGP/MIME has a fair number of people using it because you get it free with Qualcomm's Eudora, which is a popular mail program. However, S/MIME has a lot more people using it because you get it free from both Netscape and Microsoft. You can buy plug-ins for Eudora that also do S/MIME, but when you have to deal with someone who's outside your organization, the answer is you shrug a lot in these situations.

The simple fact is that there's often nothing you can do. If one of the standards becomes dominant—and it appears that standard will be S/MIME—it's most likely that people who really want to use PGP (because of some of the features it has that S/MIME doesn't have) would get clients that do both PGP and S/MIME at the same time. I'm not aware of any clients that do that yet, but there will be products that do. Some vendors have announced that their clients that do PGP today will also do S/MIME in the future.

For more on these standards, see http://www.imc.org/smime-pgpmime.html.

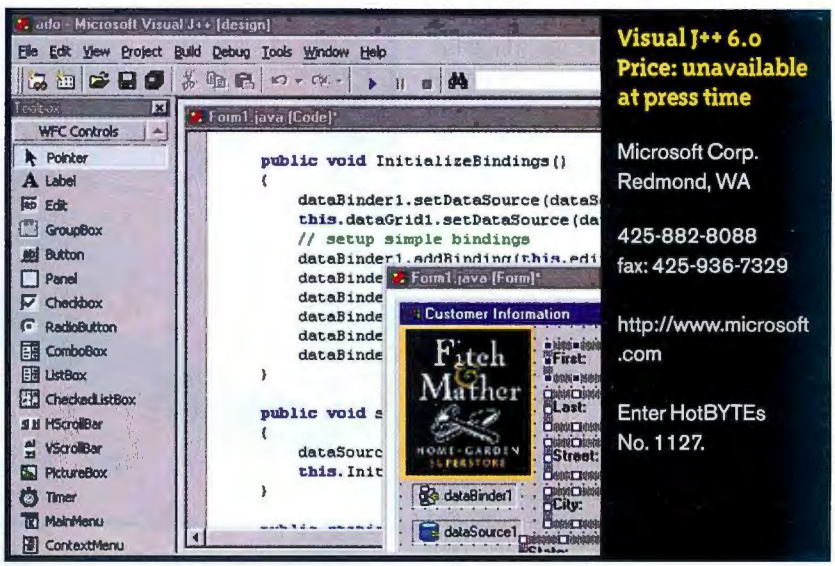
Microsoft Visual J++ 6.0 ties Java ever more tightly into the Windows platform. ***By Steve Gillmor***

Java for Windows

What happens when an irresistible force meets an immovable object? With Microsoft's Visual J++ 6.0, the result is fireworks. Technology Preview 1 of VJ6 makes Java into a potent Windows tool, blending an enhanced Visual Basic integrated development environment (IDE) with Java's rich object-oriented programming toolset.

At VJ6's core is the new Windows Foundation Classes (WFC) application framework, which builds on Microsoft's J/Direct technology to access the core Win32 API via Java. Visual Basic (VB) programmers will feel right at home dragging and dropping list boxes, tabbed panels, and other GUI elements from the Toolbox to the WFC form designer.

VB's familiar Properties Window has been extended with custom property editors that I used to apply layout effects such as anchored and docked objects. Gone, too, is the laborious menu editor, replaced with a MainMenu control (written in VB5) that let me visually design menus, submenus, and keyboard accelerators in seconds. Similarly, visual data controls can open multiple data sources and bind WFC, HTML, ActiveX, and Component Object Model (COM) controls via Microsoft's new ActiveX Data Objects (ADO) 2.0 framework.



VJ6's IDE lets you drag and drop objects and code between the Toolbox, Code, and Form Designer windows.

To test VJ6's packaging and deployment tools, I configured an NT server with BackOffice 4.0 and associated a deployment target at its URL address. You can package any combination of Java class files, Windows EXEs and DLLs, and HTML pages into COM DLL, cabinets (CABs), self-extracting EXEs, and ZIP files. CABs generated by VJ6 contain an Open Software Distribution (OSD) description that lets Java applets be installed and updated on a local machine, much like ActiveX components.

If you are deploying to Internet Information Server, you can push server-side components, including Active Server Pages (ASP), COM servers, and Java classes. With my server as the active deployment target, I was able to set up breakpoints and step through HTML, script, and Java code on both browser and remote server.

VJ6 does not overtly support JavaBeans, though you can use its extensibility features to add JAR packaging as a menu item. With wizards like the Class Builder, which automates COM, Distributed COM, and Microsoft Transaction Server component creation, Windows developers may not miss Beans support.

An easy migration path for VB programmers, an attractive alternative to C++, encapsulated server-side DHTML for the thin-client world—VJ6 is hard to put down. B

*Steve Gillmor (**sgillmor@southerndigital.com**) is a consultant in South Carolina.*

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

TECH FOCUS

WFC and DHTML

Besides allowing direct Java manipulation of Windows APIs, the Windows Foundation Classes (WFC) framework provides a Dynamic HTML class library to create applications that support the W3C DHTML standard. Java developers can use the wfc.html classes to generate DHTML code that can either be hosted in the browser via the <OBJECT> tag or on the server via ASP code. In an Internet Explorer 4.0–only environment, you can intermingle DHTML and Windows GUI calls line-for-line, staying in one place and writing all UI logic across the disparate boundaries of HTML, scripting, and graphics routines.

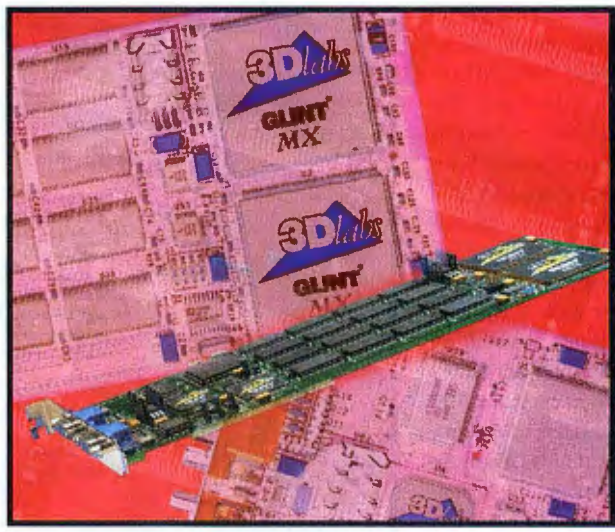
The first single-chip geometry and lighting processor, 3D Labs' Glint GMX 2000 screams on Windows NT. ***By David Em***

3D Labs Puts a Glint in Graphic World's Eye

The latest graphics accelerator from 3D Labs, the Glint GMX 2000, features a single-chip OpenGL geometry and lighting processor called Gamma. Containing more than 5 million transistors and a million gates, Gamma dramatically improves the real-time performance of such computation-intensive graphics tasks as lighting and vertex transformation.

I tested a 3D Labs' GMX reference board on a 300-MHz Pentium II with 96 MB of RAM. The board contained two Glint MX graphics processors, each of which can have up to 40 MB of nonlocal, extended data out (EDO) DRAM frame buffer, one Glint Gamma chip, and a VGA boot chip. The GMX reference board took up a single PCI slot, had a 16-MB frame buffer, and a 250-MHz RAMDAC.

Three-D Labs claims the GMX will support up to 2000 by 2000 pixels in true color. But our reference board displayed wavy lines at 1600 by 1200 pixels, a driver problem that should be resolved in the shipping version.



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Processing duties from the CPU are off-loaded to the Gamma's dedicated silicon, through either an AGP or a 33- or 66-MHz PCI bus.

The GMX 2000 achieved impressive scores on the OPC ViewPerf 5 benchmarks, which measure 3-D rendering performance under OpenGL. The CDRS-03 test returned a geometric mean average of 76.5, more than 50 percent faster than a Silicon Graphics 195-MHz Octane R10000. Also, the DRV walk-through test returned a mean of 9.6, compared to the Octane's 8.2. Given that NT-based GMX systems will likely cost less than $10,000, and that Unix-based systems with similar capabilities cost three to five times as much, these are compelling numbers.

I ran a number of 3-D modeling tests using Kinetix 3D Studio MAX R2, which was stable in its performance. I loaded very complex models made up of thousands of polygons, displayed them as shaded surfaces, lit them with 16 lights, applied textures to them, and performed a variety of transformations on them with excellent results. The 2-D performance on the reference board was adequate but sluggish. Previous 3D Labs chip sets have excelled at 2-D, so it's likely this one will ship with more refined 2-D drivers.

The GMX 2000 encompasses 100 percent of all key 3-D API functionality, including Gouraud shading, texture mapping, trilinear texture filtering, antialiasing, and destination Alpha blending under OpenGL 1.1, Direct3D, Heidi, and QuickDraw3D. Along with competitive products such as HP's Kayak and Intergraph's RealiZm II VX 113-GT, the GMX is redefining desktop 3-D. The GMX chip set is a price/performance breakthrough. The company expects production boards with the chip set to ship for $2000 to $3000, depending on configuration. B

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

David Em (Sierra Madre, CA) is a digital artist and writer. You can contact him at **davidem@earthlink.net.**

TECH FOCUS

OpenGL Visualization Under Windows NT

True real-time photo-realism is still a few years away, but with the latest implementations of OpenGL coupled with boards such as the GMX 2000, the gap between previsualization and high-quality output rendering is rapidly narrowing. To test this, I used the GMX 2000 with Evans & Sutherland's Glaze program. Using a model of a turtle, the GMX 2000 maintained frame rates that varied between 10 and 100 frames per second while using various combinations of bilinear and trilinear texture mapping, antialiasing, multiple light sources, fog, transparency, and reflection.

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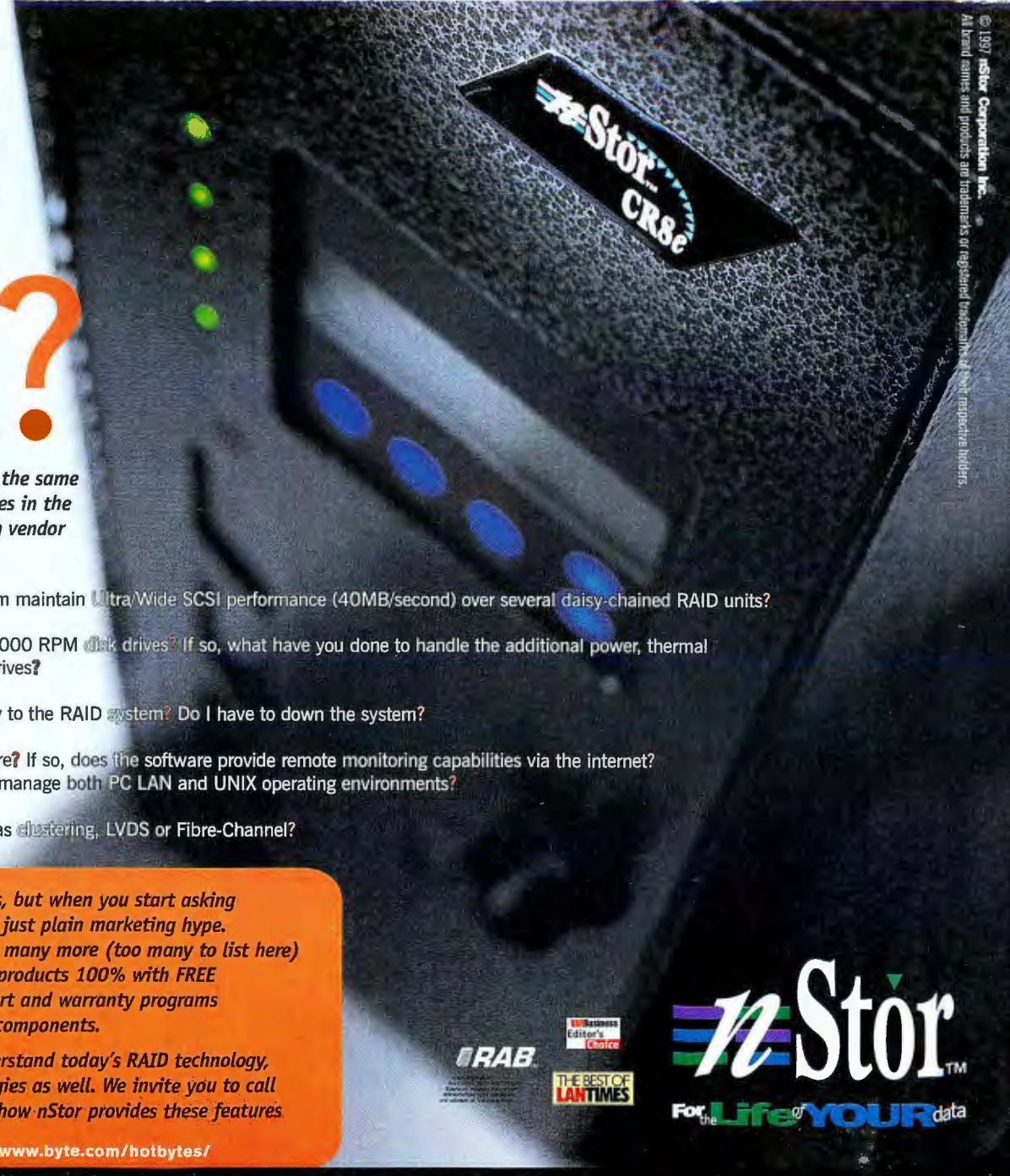

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- Does the system support the new higher performance 10,000 RPM disk drives? If so, what have you done to handle the additional power, thermal and vibration requirements of these higher performance drives?
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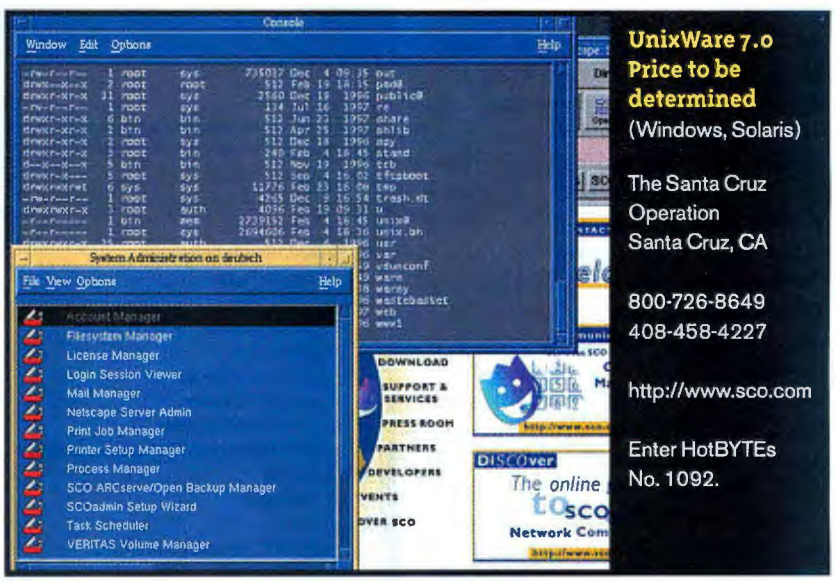
SVR5-based UnixWare 7.0 offers faster networking, better reliability, and 64-bit features for Intel boxes. ***By Barry Nance***

Unix Gears Up for Merced

With UnixWare 7.0, SCO has taken an important step on the road to 64-bit Unix for Intel CPUs, specifically the upcoming Merced. Whether Sun Microsystems and Digital Equipment can catch up remains to be seen, but the race is on.

Because this isn't designed as a desktop OS, I tested it on a Gateway NS-8000 with two 333-MHz Pentium II processors, 512 MB of RAM, and two 9-GB SCSI hard drives. The OS exhibited eye-blinking performance and rock-solid reliability. I tried SCO's Java virtual machine (JVM) and just-in-time (JIT) interpreter with Pendragon's CaffeineMark Java benchmark. The interpreter had about 20 percent better performance on CaffeineMarks than the previous release.

The new kernel has a rewritten networking subsystem that handles LAN traffic quickly and efficiently. It integrates nonuniform memory access (NUMA) and supports up to 16 GB of RAM, 2-TB file systems, and 512 disks. The maximum process size is 3.75 GB; file size, 1 TB. SCO includes limited support for I_2O (see the Tech Focus), Compaq's PCI Hot Plug for hot-swapping controller cards, and multipath I/O technology, which lets a system automatically fail over to alternate I/O cards and mirrored disks in case of failure. Topping off this impressive hardware support, UnixWare 7.0 can distribute work loads across up to 32 processors.



UnixWare's Common Desktop Environment is just as easy to use as Windows.

TECH FOCUS

Off-Loading I/O

I_2O improves I/O bandwidth by letting systems off-load device drivers and their work load to intelligent I/O processors on the motherboard. SCO says UnixWare will eventually support the entire I_2O standard, including the Block Storage Operating System Service Module, SCSI Operating System Service Module, Message Module, and Transport Module. UnixWare 7.0 has I_2O Host Bus Adapter (HBA) support but not I_2O network-driver technology.

Just 64 Bits More

SCO owns the AT&T Unix source code, including System V release 5 (SVR5), which introduces a 64-bit file system, libraries, commands, and APIs. SCO says you can simply flip a compiler switch to invoke the 64-bit extensions. They use the LP64 standard to represent pointers and give even 32-bit CPUs access to a 64-bit long data type. The new APIs also have code libraries for Secure Sockets Layer (SSL), Posix-based threads, and LDAP.

Older versions of UnixWare had few graphical tools. Here, we get a beefed-up Common Desktop Environment (CDE) and heavy reliance on a Web-browser interface. There's still no tool for administering network addresses for configured IP interfaces, but SCO's SkunkWorks CD contains an ipalias utility along with many other useful administrative aids.

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

SCO's DOS emulator, Merge 4.0, lets Windows 95 or 3.x applications run on a Unix system, but SCO didn't have a compatible version ready for my tests.

UnixWare 7.0 is SCO's best effort to date to unify and consolidate its Unix products. With its improved performance and reliability, UnixWare 7.0 should help SCO retain its dominance in the Intel-based Unix market. B

Barry Nance, a computer analyst and consultant, is a BYTE consulting editor. You can reach him at **barryn@erols.com**.

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

Microsoft SMS 2.0 has better inventorying and distribution, but upgrading might be tricky. ***By Gary Monti and John Clay***

SMS: Ready for NT 5.0

Microsoft's Systems Management Server 2.0 beta 1 took us back to the days when vendors released upgrades with new features requested by customers, instead of bug fixes and marketing ploys. SMS 2.0 delivers enhanced capabilities for software distribution, complementing the intelligent mirroring technology expected in the upcoming Windows NT 5.0 (see the Tech Focus).

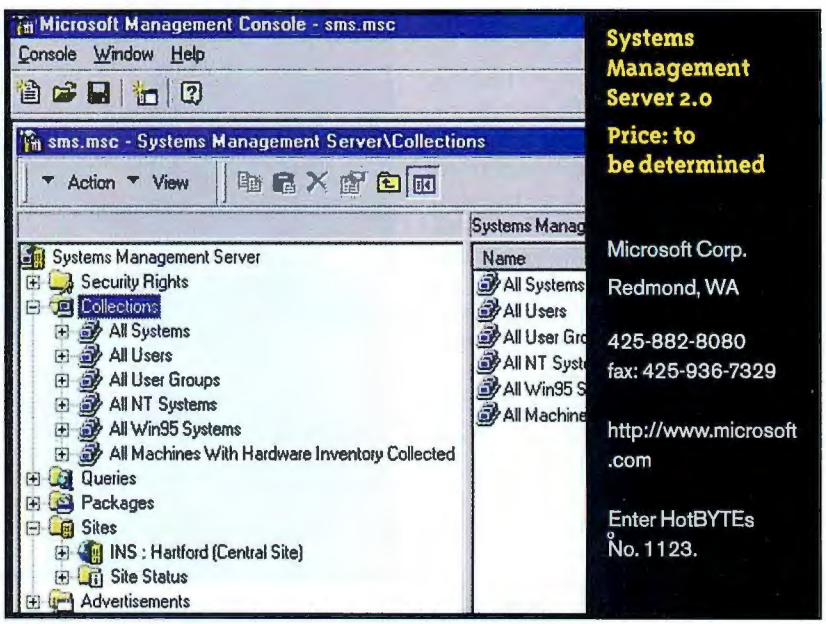
The hardware-inventory function now uses data from more sources, such as Win32, SNMP, and DMI. The software-inventory function has shed its package-based approach, instead searching every executable on a client machine for version information. Software distribution is now based on NT group affiliation, TCP/IP network segments, and user name. Also new is rule-based distribution.

SMS's software-metering function now monitors shared servers and local workstation applications, and network-attached and mobile clients must check out a license for each metered application. Microsoft says a later beta will also offer native support for managing Windows clients that authenticate through Novell Directory Services (NDS).

Installation now supports secondary site setup, which you previously could deploy only as a system job from a primary site. In our tests, we encountered SQL Server setup, which detected an invalid machine name, aborted, and returned control to SMS installation—which also aborted. Neither of the resulting partial SMS and SQL installations uninstalled properly, so we had to manually clean up the file system and registry.

SMS upgrade installations went off without a hitch, courtesy of the upgrade wizard, but we recommend carefully planning upgrades of existing sites. The setup program migrates SMS 1.x machine groups into SMS 2.0 collections, and a new client agent replaces Package Command Manager and the Program Group Control, so client program group controls are lost. You must create a target collection that advertises the same programs and assigns them to run when the client's code is being upgraded to SMS 2.0.

We like this rearchitected SMS, which enhances its classic services while adding nice new features. Companies with big investments in SMS 1.2 may pay a price, but Microsoft promises migration wizards and support for interoperability between 1.2 and 2.0 in the second beta. B



SMS 2.0 administrative tools snap right into the new Microsoft Management Console architecture.

TECH FOCUS

Intelligent Mirroring

With intelligent mirroring, Windows NT 5.0 will mirror information about a client's system files, applications, data, and administrative settings onto NT 5.0 servers. If a user's machine becomes unstable or nonfunctional, administrators will be able to use the stored image and NT 5.0's IntelliMirror to compare and repair the offending components, or to redeploy on another platform. Administrators can deploy client configurations for mobile users, or execute mass changes brought about by reorganizations. IntelliMirror complements SMS software distribution by stabilizing and standardizing the client environment.

RATINGS	
TECHNOLOGY	★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

*Gary Monti (**gary_monti@ins.com**) is managing consultant and John Clay (**john_clay@ins.com**) is network systems engineer for International Network Services.*

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

QNX offers a small resource footprint and real-time processing power, all while using familiar Unix APIs. ***By Robert Krten***

A Tiny OS That Scales Up

QNX Software Systems, Ltd. (QSSL) created the QNX OS in the early 1980s. QNX started life as an embedded real-time OS. You accessed its services through standard Unix APIs instead of a set of proprietary APIs. A decade later, QNX 4 was introduced, which built upon the capabilities of the earlier versions. Notably, it supplied many Posix features, had a Posix API, and was Posix-certified.

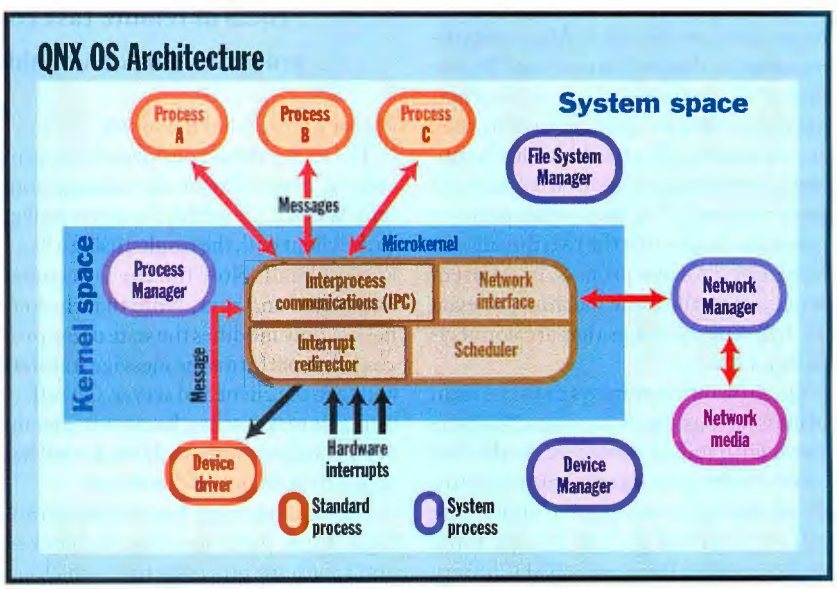
Last year saw the introduction of QNX/Neutrino, which offers a Posix-based microkernel; Posix support, such as Posix threads and real-time processing; and better scalability. This third capability makes QNX/Neutrino readily adaptable—through the addition of extensible service-providing modules—from a small kernel suitable for embedded systems up to a full-blown OS with networking, a file system, and a GUI that handles jobs on large, high-end systems.

The key to QNX/Neutrino's ability to offer both real-time performance and scalability is its design. What follows is a look at the OS's architecture that will reveal how its designers managed to accomplish this feat. (It's important to note that the OS reuses existing code wherever possible for reliability.)

A Quick Tour

QNX/Neutrino is a preemptive scheduling, multitasking OS with configurable memory protection. Its microkernel occupies only 32 KB of memory. The kernel was written from the ground up around Posix real-time standards, including ANSI and the Posix 1003.1, 1003.1a, 1003.1b (real-time), 1003.1c (threads), and 1003.1d (draft) real-time extensions. It manages two fundamental operations: message-passing and scheduling.

The kernel's interprocess communications (IPC) and optional network services handle message passing, while the interrupt redirector and scheduler oversee thread-level scheduling, interrupt handling, and timing, as illustrated in the figure "QNX OS Architecture" below. The kernel itself is never scheduled for execution; it's only entered through kernel calls that are invoked by a process or from a hardware interrupt.



The microkernel handles all message-passing and process states, which permits it to coordinate and synchronize processes.

The kernel orchestrates the operations of cooperating processes. Some of these processes implement other QNX system services, such as process creation (the Process Manager), file-system support (the File System Manager), networking (the Network Manager), and device I/O (the Device Manager).

These four managers are system processes, as opposed to standard processes. The only difference between the two types is that system processes manage services that are traditionally associated with the OS, while standard processes don't. Because both process types use the same interfaces and calls (there are no hidden system APIs), QNX/Neutrino is easy to extend: Just write a service-providing module, which is a process that implements a new service.

Furthermore, device drivers are themselves processes and can be either system or standard processes. A driver's interrupt handlers are part of a driver's process, but they execute asynchronously from it.

The Process Manager is the only process that operates inside the microkernel's address space. The Process Manager adds only 32 KB to the OS's memory footprint while adding memory allocation, process contexts (i.e., memory protection), resource-manager namespaces, and other extensions to the kernel. This dispels the myth that any useful Posix-compliant system must be big.

While QNX 4 had rudimentary thread support, QNX/Neutrino's thread sup-

port was conscientiously added to the design as the minimal unit of schedulable execution. This greatly simplifies the kernel design because the kernel has to concern itself only with the scheduling of threads.

This threaded design pervades the QNX/Neutrino architecture and so provides the fast response times necessary for a real-time OS. For example, the Process Manager uses a loader thread that copies a process image into memory. This allows the Process Manager to service other requests while programs load. QNX/Neutrino also uses priority levels when scheduling time-critical processes, so when the Process Manager creates a new process, it inherits the priority of its parent.

The Message Is the Medium

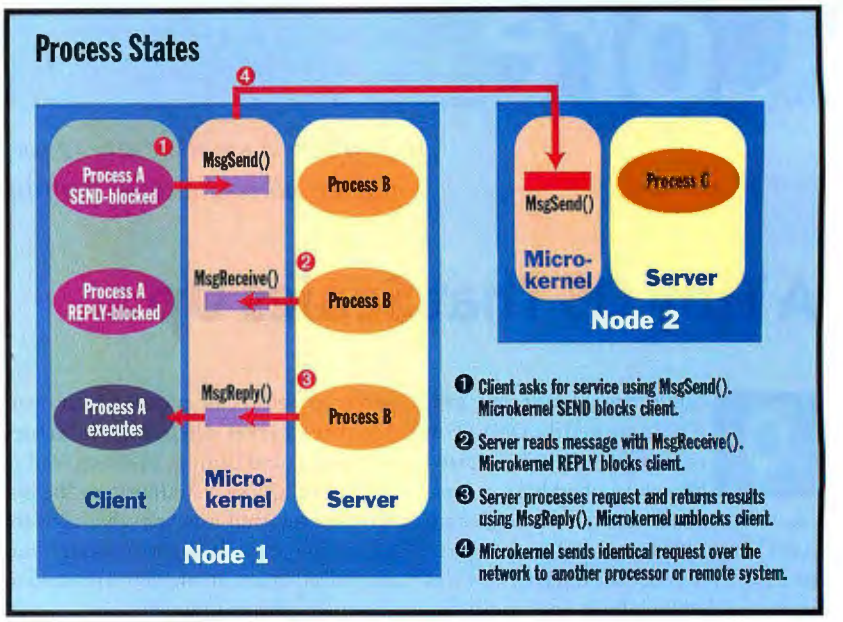
All QNX OSes employ message-passing for process coordination. *Message-passing* refers to the mechanism used by one thread to communicate with another. Messages have no special format; they are just packets of bytes. A message's content is determined solely by the client and server threads. The important point to remember here is that the two threads can be part of the same process, in different processes on the same machine, or even on different machines that are connected by a LAN.

QNX/Neutrino employs the same form of message-passing as previous QNX versions, with minor revisions. As the elements of the microkernel architecture show, message-passing is the underlying infrastructure of the OS. In fact, some of the supplied Posix and ANSI C library functions, such as `fopen()`, `lseek()`, `write()`, and others, transparently use message passing on your behalf.

Different States

Threads send messages synchronously between each other. It's easy to implement process synchronization because threads change states during such transfers. As shown in the figure "Process States" above, a client thread constructs a message and sends it to a server thread via the kernel call `MsgSend()`.

At this point, the client thread becomes SEND-blocked: It's waiting for the server thread to receive the message. The server thread fetches the message using a `MsgReceive()` call, and now the client becomes REPLY-blocked, since it's waiting for a reply from the server.



Local or remote task coordination is possible when processes block and unblock in response to messages.

The server thread performs some processing, depending on the message content. When it's finished, the server replies to the client with the results, using a `MsgReply()` call. Now the client becomes unblocked and runs. Note that the kernel not only modifies the state of the processes but performs the message transfers between the client and server. On reflection, this makes sense, because in a memory-protected model only the kernel has access to both threads' memory.

This arrangement has several advantages. First, processes that are blocked don't consume processor time, which enables the kernel to load-balance the needs of high-priority processes in a more effective manner.

Second, the message-passing and process states allow you to design your target application as a set of cooperating processes. Each individual process has a fixed area of responsibility and can provide and/or request services to or from other processes. This lets you design a system where programs are decoupled from each other, resulting in easier integration and unit testing, as well as distributed processing support.

Finally, message-passing works consistently, regardless of the location of the two threads that wish to perform a message-passing operation.

The advantage to this approach is that clients use the same server interface whether they're on the same system or on different nodes. For example, when writing data to either a local or remote hard drive, QNX/Neutrino uses the same open and write messages. These messages can be transferred to a thread located on the same or another CPU, or to another node on the network. QNX/Neutrino thus permits you to easily construct symmetric multiprocessing (SMP) or distributed applications.

The QNX/Neutrino OS is easily adaptable to a variety of uses. Because it supports execute-in-place (XIP) code, the OS and its applications can execute out of ROM or flash memory. Unneeded system processes can be trimmed from the OS for embedded applications. Conversely, you can write service-providing modules that extend the OS for specialized applications or devices.

QSSL has created a demo disk that you can download for evaluation from the company's Web site (at *http://www.qnx.com*). The entire OS, GUI, TCP/IP package, and Web browser all fit on a single 1.44-MB floppy disk. B

Robert Krten is an independent software/systems consultant with Parse Software Devices, Ltd. (Kanata, Ontario, Canada). You can contact him by sending e-mail to **rk@parse.com** *or to the Parse Web site, at* **http://www.parse.com**.

A new protocol enables computers to automatically locate a network's resources. ***By James Kempf and Charles Perkins***

What's Your Service?

The Service Location Protocol (SLP) is a new, broadly applicable protocol for connecting service providers to service clients. It's a TCP/IP-based protocol designed for advertising and locating network services on corporate intranets. In this context, *advertising* means that a network device describes its functions and capabilities to other clients.

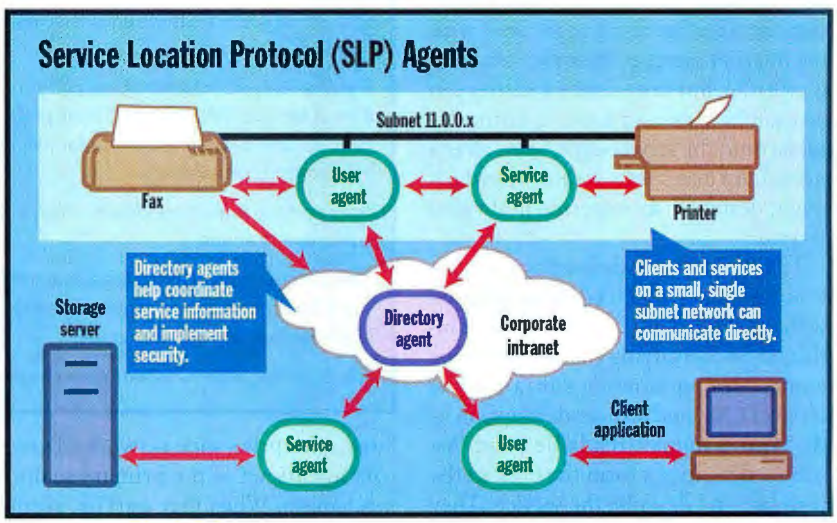
Using SLP, a computer can automatically discover and use network resources, such as printers and e-mail servers. In addition, SLP supports the attribute-based description of services, so clients can browse through services and select exactly the one they want. Existing services that might be advertised through SLP include Web servers, fax machines, printers, and mail servers, among others.

SLP is well suited to low-cost administration designs because the setup and administration of an SLP-enabled network requires a fraction of the effort necessary for solutions based on directory services. SLP's simplicity allows it to be built into firmware, so network-enabled devices can advertise themselves as soon as they are plugged into the network.

SLP is complementary to Hewlett-Packard's JetSend protocol (see "HP JetSend: Off-the-Cuff Communication," April BYTE). While JetSend allows clients to use network devices without requiring a special driver, it offers no support for locating services, except on a peer-to-peer level. SLP can handle device locations spanning a corporate intranet, and it offers some security and management features that JetSend lacks.

A Trio of Agents

As described in RFC 2165, an SLP-enabled network contains three different active entities, or *agents*. Service agents advertise services. User agents seek service agents based on attribute queries describing the service they need. Directory agents function as intermediaries between user agents and service agents, aggregating advertisements so that user agents can find services without searching all the networks where services might be located.



Several processes, or agents, help clients discover and query devices about the services they offer.

The figure above illustrates the various roles played by agents in an SLP-enabled network. The fax machine is connected directly to the network; it functions as its own service agent through the SLP in its firmware. The printer and the storage system advertise their functions through proxy service agents running on servers. SLP is very flexible in that the user agent and the service agents in the 11.0.0.x subnet can directly exchange data. Through the intervention of a directory agent, agents outside the subnet can more efficiently locate services within it.

As an enterprise grows, it might no longer be convenient to let user agents search the entire network for services. When this happens, services that are under common administrative control can be logically grouped together into a scope. *Scopes* enable you to organize services into separate administrative domains that allow a single directory agent to advertise these services. An example of a scope is the collection of services available to a marketing department. User agents can be configured to include a scope name in their SLP requests, so directory agents reply only to requests that include the scopes that they support. To continue with the company example, the marketing department's directory agent won't respond to requests for color-printer services issued by a user agent in the accounting department.

It's in the URL

SLP uses text to specify service information, which allows it to be both readable and sent via e-mail. (Note that not all the data in SLP packets is text; some of it is binary.) Because the URL has become a standardized way of describing resources on

the Internet, SLP uses a particular URL scheme, called a *service: URL*, for service advertisements. It consists of the string `service:`, followed by a string describing the kind of service, followed by information indicating how to contact the service. An example of a service: URL is

```
service:printer:lpr://printserver
  .fiction.org/colorprint
```

This service: URL designates a print service that uses the Internet LPR protocol. The service is contacted through the DNS-resolvable name `printserver.fiction.org`, and the particular printer queue is `colorprint`.

The string following `service:` designates the kind of service and is called a *service type name*. Service type names are standardized by being registered with the Internet Assigned Numbers Authority (IANA), but unregistered names can be used by tacking a naming-authority token onto the service-type name after a period. An example is video.exp, which might designate an experimental video service.

The service type is defined by a service-type template, which is also registered with the IANA. The template contains information identifying the service's type name, version number, syntax of the service: URL, and a short description of the type in human-readable form. Attribute definitions form the bulk of the template and describe the service. They can describe a service's dynamic characteristics, such as a printer's current work load and queue length, as well as static characteristics, such as its resolution and color support.

The SLP protocol is based on messages where user agents query available service types and attributes and then request services based on the values of the attributes. A client searching for a service formulates a query based on the attributes of a service and the desired values. The query is sent to SLP, and matching service: URLs are returned.

For example, suppose one of the printer-service type attributes is `control_language`. A client searching for a PostScript printer could formulate a query with `control_language=postscript` to find printers that support PostScript. To support changes in an intranet's services, SLP has additional messages that let service agents add (register) and remove (deregister) service advertisements. See the table below for a brief description of these messages.

Inter-Agent Communication

Inter-agent communication in SLP is designed to efficiently scale from networks containing very few nodes up to large, enterprise-wide networks. Directory agents act as the primary scaling mechanism. When they start up, agents discover directory agents on a network through three mechanisms: static configuration, DHCP option 78, or a multicast service request.

User and service agents must either try DHCP or multicast a service request to the directory-agent discovery-multicast address, 224.0.1.35. Periodically during operation, they can multicast a request for directory agents to the directory-agent discovery-multicast address and passively listen for directory-agent advertisements on the service-location general-multicast address, 224.0.1.22, to detect any directory agents that have appeared in the interim.

The only security mechanism specified by SLP is the protected scope. An example of a protected scope is a manager who wants to print out workers' salaries. To prevent tampering, the manager needs to make sure the printer is available from a protected scope. A protected scope is implemented by service agents, directory agents, and user agents that share a public-key cryptographic algorithm and a public key. Every service advertisement in a protected scope is validated twice—once when it registers itself with a directory agent and once when the user agent validates the URL received in a service reply. This protects the user against malicious directory agents as well as malicious service agents. Other security needs, such as access control, user authentication, and privacy, can be provided by the IP Encapsulating Security Payload (ESP) protocol, as described in RFC 1837.

SLP Messages

Every message is prefixed with a header that identifies the protocol version, message type, packet length, natural language, transaction identifier, and flags.

Service request—Contains a query in which the service type, scope, and a predicate describe what kinds of service advertisements the client is interested in.

Service reply—Contains a status code and a list of service: URLs that match the predicate, along with authentication information if the scope is protected.

Service-type request—Contains a naming authority and scope.

Service-type reply—Contains a status code and a list of service-type names registered in the naming authority and scope.

Attribute request—Contains either a service: URL or a service-type name and a list of attribute tags that identify the attributes of interest.

Attribute reply—Contains a status code and a list of attribute tags with their values, along with authentication information if the scope is protected.

Registration request—Contains a service: URL and a list of attributes for advertisement, along with authentication information if the scope is protected.

Deregistration request—Contains a service: URL and an optional list of attribute tags to remove. If the tags are missing, the entire service: URL is removed. Authentication information is also required if the scope is protected.

Service acknowledgment—Acknowledges registration or deregistration with a status code.

Valuable Uses

SLP offers companies the ability to construct intranets that can dynamically change as the business's needs change. Clients can automatically query the network for services, which minimizes network-configuration and management problems. Directory agents can act as intermediaries, which reduces multicast traffic. Authentication is possible by configuring the agents for protected scopes.

SLP is well suited for today's businesses that have a mobile workforce and ad hoc workgroups. B

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This third-generation embedded processor offers better performance and peripheral support. ***By Susan Shimshock***

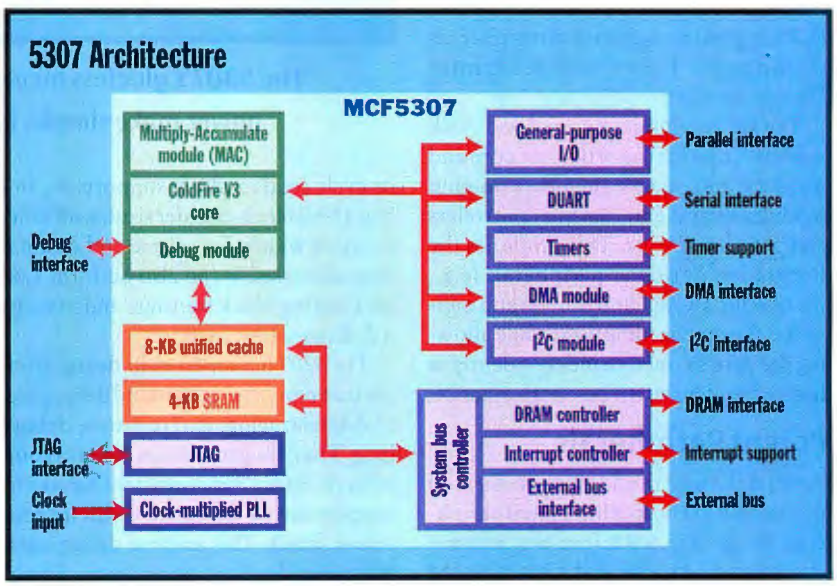
ColdFire Revisited

The microprocessor has made its mark on the world since its introduction three decades ago. It has changed not just the electronics industry, but how we work, communicate, and play. While desktop processors routinely get the lion's share of ink, the market for embedded processors (often called microcontrollers) has grown to titanic proportions: It literally dwarfs the desktop computer market. Hundreds of millions of embedded processors are used each year in a wide variety of applications ranging from communications devices, business machines, and automobiles to toys, home appliances, and consumer electronics.

Lasting Legacy

System designers today look at the whole picture regarding an embedded product's life cycle. Issues such as price, system development environment (i.e., development tools, debugging tools, OS support, and modeling support), reuse of existing software, ease of integrating custom logic, and the ability to migrate to newer processors in the future are important factors when selecting a CPU. Motorola's 32-bit RISC ColdFire architecture readily addresses these issues, because its instruction set is founded on the venerable 68000 architecture. Since many 32-bit embedded applications today use the 68000 processor or its descendants, ColdFire lets designers preserve their investment in time-tested, solid code. The latest progeny of this family, the MCF5307, combines a third version (V3) of the ColdFire core, along with an integrated package of communications peripherals.

The previous-generation ColdFire core (V2) was designed to address two complementary goals. First, it enabled the rapid, low-cost deployment of new embedded systems. Second, it allowed customers to leverage the 19-year legacy of code, tool sets, and engineering know-how from 68000-based designs. Representing a major upgrade, the MCF5307's V3 ColdFire core continues its predecessors' goals while boosting processing throughput. This was accomplished through architectural improvements, better mathematical performance, and the addition of DSP-like functions. These enhancements, along with sufficient built-in peripherals (as shown in "5307 Architecture" above), enable the 5307 to implement a single-chip system capable of handling a wide range of consumer and business electronics. It is a 3.3-V part fabricated using a 0.35-micron TLM CMOS process, and it is available as a 208-pin quad flat pack.



The processor features an optimized core and a wide variety of peripheral interfaces.

At the Core

Fundamental to the 5307's design is its compact and modular ColdFire core. It employs a variable-length RISC instruction set that maximizes code density (the "packing efficiency" of instructions and operands held within registers, buffers, and on-chip memory). The core's frugal use of system memory greatly minimizes the need for off-chip memory, which in turn lowers a product's cost because memory is one of the most expensive elements of a design.

The 5307's primary performance increase comes from the clock-multiplied V3 core, which boosts data throughput to 70 MIPS at 90 MHz. When using the same external memory subsystem, this represents nearly a twofold improvement over the 68040 processor, and a 2.5 to 3 times increase over the MCF5202 (which uses the ColdFire V2 architecture).

Besides a faster CPU clock, the 5307 also sports other V3 core performance-related upgrades. A four-stage instruction fetch pipeline and a two-stage execution

pipeline combine to create a more balanced instruction load in the 5307, thus enabling high-frequency operation. Branch-prediction hardware reduces the penalty of change-of-flow operations (such as branches or jumps).

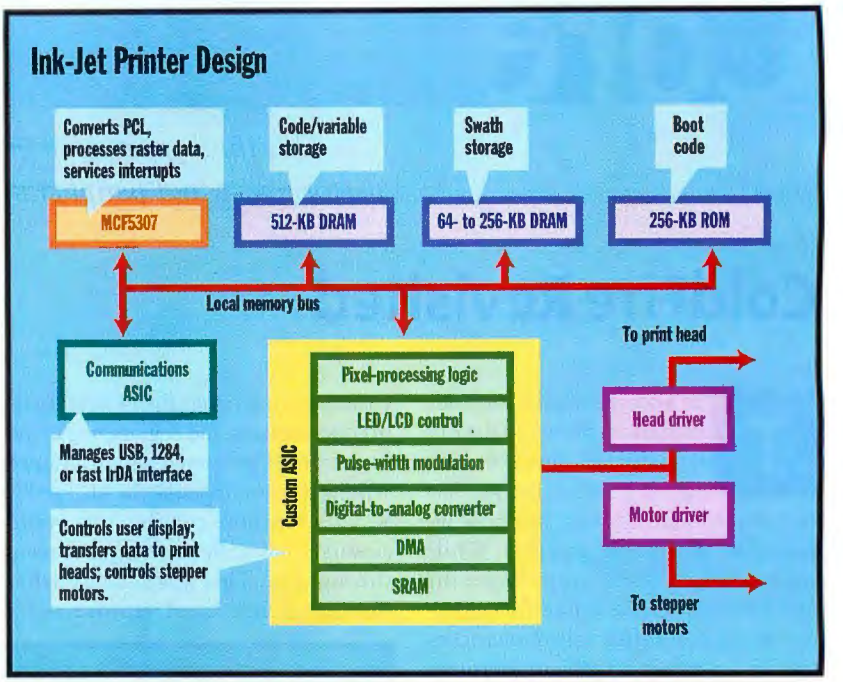
The 5307 also embodies specialized execution engines in the form of a dedicated multiply-accumulate (MAC) unit and a hardware divider. These modules significantly augment the processor's performance in target systems such as printers and mass-storage devices. Depending on the specific code that's implemented, the signal-processing algorithms for a servomotor control can be accelerated by as much as 70 percent using the MAC unit, while the hardware divider can accelerate raster-image processing in printers by as much as 15 percent. The 5307's glueless memory interface and specialized processing power make it ideal as a printer controller, as shown in the figure "Ink-Jet Printer Design" at right.

The 5307 maintains two isolated clock domains: one for the processor core and memory, and one for the other on-chip modules such as external bus controllers and peripheral logic. This simplifies the integration of slower peripherals (e.g., the on-chip DUART and timers) and minimizes power consumption, while allowing the core to operate independently at higher frequencies for best performance.

Potent Peripherals

Supplementing the 5307's accelerated throughput is a host of integrated peripherals. An on-chip, 8-KB, four-way set associative unified cache and 4 KB of SRAM help reduce external memory accesses for tight code loops. The 5307's external bus provides a direct interface to external 8-, 16-, and 32-bit memory and I/O devices. A DRAM controller provides *glueless* support for up to 256 MB of synchronous, extended data out (EDO), or page-mode DRAMs. The integrated 5307 also includes two 16-bit general-purpose multimode timers, serial and parallel communications interfaces, and an I^2C-compatible bus.

The 5307's programmable DMA controller supports four fully independent DMA channels, including two that can be invoked by external request pins to initiate transfers internally or externally. The DMA controller handles single- and dual-address transfer operations in burst or cycle steal mode. It supports 8-, 16-, and 32-bit block-transfer sizes, with independent widths for source and destination addresses. It can also perform 128-bit bursting block transfers and manage a dedicated UART service.



The 5307's glueless memory interface and processing power make simple, low-cost designs possible.

The 5307 has an on-chip debug module that supports background debugging, real-time tracing, and real-time debugging. The debug module provides a common interface for consistent emulator support across the entire ColdFire processor family. This internal debug capability provides direct observation of internal registers at any point during code execution, simplifying and speeding up software/hardware integration, as well as final testing and verification.

Where the debug module really shines is that it facilitates the debugging and testing of embedded devices. Static debug monitors are limited because they must halt an application's execution to read internal kernel resources or change a task's state. Unfortunately, servomotor controllers, or other time-critical mechanical parts, can be damaged if their operations are suspended. While real-time systems may not withstand complete stops, they can tolerate small interrupt routines inserted into their execution streams that allow register values and other memory variables to be saved externally—the approach taken by the ColdFire debug module. In addition, this debug unit enables system designers to perform real-time traces during the dynamic execution of instructions, allowing them to observe and identify code bugs.

Compatibility and Upgradability

The 5307 is code-compatible with previous ColdFire cores, which makes it an ideal upgrade for existing designs based on the MCF5206 (an earlier member of the ColdFire family). Because ColdFire is based on the 68000 instruction set, the MCF5307 is suitable for upgrading legacy embedded designs based on Motorola's 68340 or 68EC040 parts.

Embedded applications will continue to multiply and evolve, and system designers must examine their choices closely. The features of ColdFire cores have found them homes in applications such as set-top boxes, printers, network hubs, video games, GPS units, cellular base stations, and storage devices. B

Susan Shimshock is a technical marketer in Motorola's Consumer Systems Group. She is working with the design team for the Version 4 ColdFire core. She can be reached at **editors@byte.com.**

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These server-oriented Java classes offer system independence and better performance over CGI programs. ***By Paul Clip***

Servlets: CGI the Java Way

When Web servers made their appearance on the Internet, they were built to serve Web pages and nothing more. Now, server-oriented Java classes, known as servlets, give Web servers the ability to exchange information with applications without sacrificing speed or reliability.

Early Web servers had no way to access a database and return the results of a query as HTML. This was soon remedied with the introduction of the CGI, a rather unwieldy specification that defines how Web servers exchange information with external software.

Using CGI programs (or CGIs), it then became possible for Web servers to spawn these programs (i.e., start running a new copy), communicate with them via the CGI, and perform arbitrary yet useful functions, including accessing databases.

While CGIs represented a major breakthrough in extending the Web's capabilities, many problems are associated with them. The chief one is performance. Every time a request is made to a Web server that requires running a CGI, the server must spawn it and suffer the performance impact of having the CGI load, initialize, execute, and finally return HTML. Fielding many simultaneous CGI requests can quickly bring a high-traffic server to its knees.

Improvements to CGIs have since appeared. Both Microsoft and Netscape released APIs to enable Webmasters to write CGIs as libraries that load as part of the Web server itself. This greatly improves performance because the libraries don't require a spawning operation. But it places more responsibility on the programmer. A badly written library can easily crash the whole server.

Meet a Servlet

Servlets are an attempt to address the problems of speed and reliability. Servlets are Java classes loaded into and invoked by a Web server. They're the server equivalent of applets on the browser side. Once loaded, they become part Web server. This provides improved performance because they load only once, instead of being spawned at every request.

Given Java's pointerless nature, a Java-based servlet is less likely than a C++ plug-in to misbehave sufficiently to crash the entire Web server. Also, most servlet-capable servers allow running servlets in a "black box" isolated from the rest of the server to enhance stability and security.

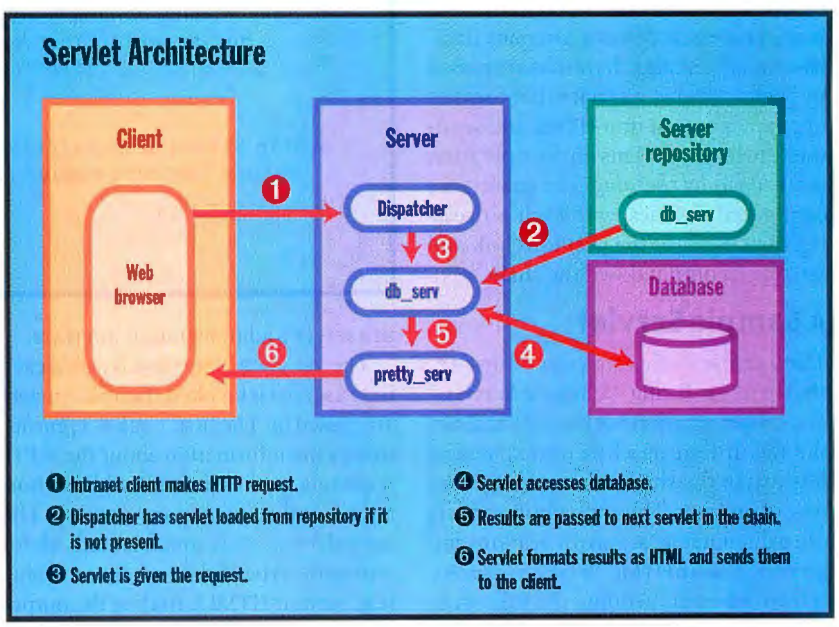
Because they effectively become part of the Web server, servlets can save state between invocations. In the stateless nature of HTTP, this is an important advantage. For example, a servlet could track a surfer's actions for statistical purposes and/or generate custom HTML based on the behavior that it witnesses.

Finally, servlets inherit the advantages of the Java language, such as cross-platform portability, garbage collection, multithreading, and synchronization.

Servlet Architecture

Although this article mostly discusses servlets from the point of view of replacements for CGIs, they play other roles in the enterprise Java world. Servlets are considered a general mechanism for extending the capabilities of services, a generic name for Web servers, mail servers, and so forth.

Thus, a servlet is not only cross-platform thanks to Java, it also provides a measure of independence from proprietary servers and protocols. In other words, assuming that you are willing to write your custom logic as servlets, you will be able to "plug" them into different vendors' products, whether they are



You can load servlets on demand and pipe their results to other servlets for more processing.

Web servers (HTTP), file servers (NFS), mail servers (SMTP), and so on.

The figure "Servlet Architecture" illustrates some of the more important features and concepts. In this hypothetical example, an intranet client (e.g., a Web browser) makes an HTTP request to a servlet-capable Web server.

The dispatcher, the part of the server that assigns threads to incoming requests and dispatches them to various servlets, discovers that the required servlet (`db_serv`) to invoke is not on the server. In this case, it is loaded from a central servlet repository (potentially another Web server) and given the request. This shows another strength of servlet environments: the ability to load servlets from a remote site as well as from local storage. Presumably, various company systems use `db_serv` extensively, and therefore it is worth centralizing.

`Db_serv` carries out the request and, in the process, accesses a company database for information. Its results are passed to `pretty_serv`, a servlet that formats `db_serv`'s output into HTML and sends it to the browser. This entire operation is called *servlet chaining*. The servlets are configured in series, with each processing the output of the previous link and sending its output down the chain.

A Simple Servlet

```
public class BrowserCounter extends HttpServlet {

   Hashtable browserHash = new Hashtable();

   public synchronized void service
    (HttpServletRequest request, HttpServletResponse
     response)
       throws ServletException, IOException
   {
      String browser = request.getHeader("User-agent");
          Integer hits;

          if (browserHash.containsKey(browser)) {
                hits = (Integer) browserHash.get(browser);
                hits = new Integer(hits.intValue() + 1);
          } else {
                hits = new Integer(1);
          }
          browserHash.put(browser, hits);

          response.setContentType("text/plain");
       ServletOutputStream out = response.getOutputStream();
          out.println("Your type of browser has accessed this
                       site "+ hits + " times");
   }

   public String getServletInfo() {
      return "Returns number of hits by type of browser";
   }

}
```

A Sample Servlet

The sample code `BrowserCounter`, shown in the listing "A Simple Servlet," determines what kind of browser accesses the site. It returns a line of text stating how often the site has been hit by that type of browser. This shows how servlets can maintain state across invocations and generate custom HTML. `BrowserCounter` is invoked by embedding the following servlet tag in an HTML file: `<servlet class=''BrowserCounter''> </servlet>`. You can also invoke servlets as CGIs via URLs or as part of a chain.

`BrowserCounter` is a subclass of `HttpServlet`, which adds HTTP-specific methods to the generic servlet interface. In this example, only two methods are shown: `service()` and `getServletInfo()`. Others (e.g., `init()` and `destroy()`) are provided by superclasses and can be overridden as necessary. For instance, `db_serv` might connect to a database in `init()` and release the connection in `destroy()`. And `getServletInfo()` enables a servlet to return a short description that's displayed in a server's administration interface.

The `service()` method is called each time a servlet is invoked. Two parameters are passed in. The first, `request`, encapsulates the information about the HTTP request (e.g., the client's IP address, host name, and request parameters). The second, `response`, contains methods for setting the type of data we are returning (e.g., text or HTML), finding the output stream we should write to, and—in our case—sending HTTP-specific headers. Notice that because servlets are inherently multithreaded, I made the `service()` method synchronized to prevent the data in `BrowserCounter`'s hashtable variable from being corrupted.

The `service()` method works as follows. I determine the client's browser type, or `User-agent` in HTTP parlance. Next, I check whether this type has an entry in the hashtable. If it does, I increment its counter (a simple `Integer` object). If it doesn't, I create a new entry in the hashtable, with the new type's counter set to 1. Finally, I print the message to `response`'s output stream. In my case, this is a socket back to the client, but had this servlet been part of a chain, I would have written to the next servlet's input stream transparently.

Future Services

Servlets are set for a bright future. The servlet classes are now part of the Java Development Kit (JDK) 1.2 distribution as the first of JavaSoft's Standard Extensions. Servlets are also being combined with JavaBeans to form Servlet Beans.

These servlets have the added advantages of serializing their state and enabling their instance variables to be modified via configuration interfaces. This would have let `BrowserCounter`'s hashtable be saved to disk when the server is shut down, preserving any statistics gathered. Servlets' simple interface, performance, and the independence they provide are likely to prove attractive to many developers. B

Paul Clip (**paul@clip.org**) *is a Java-certified consultant working at Sapient's San Francisco office.*

Getting a database connected to the Web need not be an expensive and time-consuming task. By Tony Cox

Using Perl with Databases

Scientific environments have always generated large numbers of databases, and office software such as Microsoft Access has fueled an explosion in smaller data repositories. I'm often asked by colleagues if it is possible to make these databases available on the Internet. Until recently, my answer has been "not easily," for the simple reason that we don't have an NT server. For organizations wedded to Unix, installing and maintaining an NT system to host an Access database makes poor economic sense.

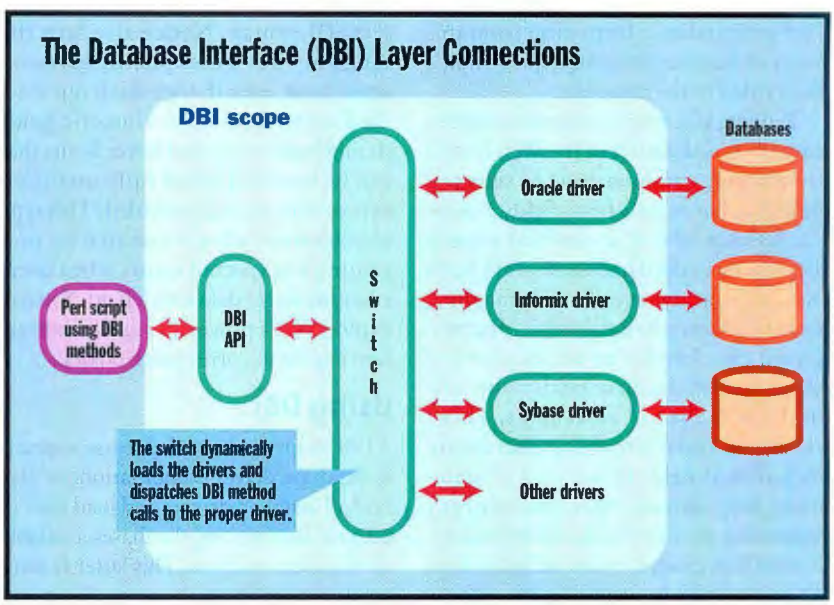
However, I decided to investigate further. How difficult (and therefore expensive) might it be to publish Access data on the Internet, using a Unix-only server environment? I would need to transfer Access data to a relational DBMS running under Unix, use a Web CGI to pass SQL queries, and format the query results for an HTML browser. Since the project had zero budget, any software would have to be free, and ideally I'd want to exploit my modest Perl programming skills.

As I believe in starting simply and adding complexity later, I chose a small Access database for my prototype system. It consists of two tables with about 4000 rows of data detailing the amount of DNA ("4C") stored in the nucleus of different plant species. My aim was to duplicate Access functions as far as reasonably possible and be able to select and sort DNA data by combinations of various fields and numeric ranges on an HTML form.

Assembling the Tools

First, I had to find what tools were available for accessing databases via CGI. All roads led to the Perl Database Interface (DBI), written by Tim Bunce. The DBI furnishes a constant Perl API with which to manipulate databases. Source for DBI is available at *http://www.hermetica.com/technologia/DBI/*. Versions of DBI exist for different sorts of database systems.

Equally important, DBI lets you write database-independent scripts. The DBI layer uses database drivers (DBD) to translate DBI API calls to database-specific commands. If your Perl script conforms to the DBI specifications, it can manipulate any database for which a Perl DBD module exists. A single script lets you perform the same operation on major RDBMSes such as Oracle, Informix, and Sybase, plus a host of smaller ones. DBI also allows you to manipulate multiple databases at the same time, as shown above in "The Database Interface (DBI) Layer Connections."



A single Database Interface–conforming script can access any database that has a DBI driver module.

The most attractive packages fitting my project criteria were inexpensive Unix RDBMSes for which a DBD module was available. A little research focused my attention on the freely available MySQL package (*http://www.tcx.se/*), written by Monty Widenius. Not only does it have a Perl DBI, but ODBC (Unix/Win32) and Java Database Connectivity (JDBC) drivers are also available.

MySQL is available as source code and as prebuilt binaries for most flavors of Unix. Don't assume it's not a serious RDBMS just because it's free—MySQL can administer databases containing millions of entries. It's very fast, supports all standard data types, including *binary* large objects (BLOBS), and implements practically all the ANSI SQL92 specification (plus a number of useful extensions). MySQL has a sophisticated privilege system that allows managers to control access to database functions according to database, user, and location. I set my DBI scripts to run as the user "webclient," for which I gave read-only access to my test database.

Compiling and installing the MySQL

database application was straightforward. Installing DBI and the MySQL DBD (in that order) was similarly uneventful; all come with helpful installation instructions and test scripts that check that everything works correctly. MySQL provides a simple command-line utility program for creating databases, setting permissions, defining tables, and constructing fields. I duplicated the Access table structures in mySQL, and transferred data from Access into MySQL by importing files saved in either tab-delimited or CSV format.

Building the User Interface

So that Web browsers could query the database, I needed to construct an interface that passes queries to the database via the DBI/DBD layer. I created a Web form, shown in the screenshot at right, that acts as the main query interface. A Perl script takes information from this form and constructs a SQL query that's forwarded to the database.

Building SQL queries properly requires careful consideration of the Web form's field types, combinations of selected fields, and how data from fields may be validated or otherwise sanitized prior to submission to the database. I found Perl's associative arrays excellent for mapping form field names to database field names. I used checkboxes to allow users to choose which database fields to include in the SQL `SELECT` statement. These checkboxes set internal flags that ensure inclusion of fields in the `SELECT` statement; they also cause the contents of any associated modifier fields to be checked. If modifiers exist, they are added to a list of items to be included in the subsequent `WHERE` clause.

To preserve SQL syntax, a field must "know" if it is the first modifier to a `SELECT` statement, which requires a *`WHERE`* keyword, while subsequent clauses require `AND` keywords. For example, the processed form in the screenshot will yield the following SQL statement:

```
SELECT genus, species, family,
fourc FROM main
WHERE genus = 'Tulipa'
AND fourc <= '10' AND fourc >=
'600'
ORDER BY species;
```

SQL syntax must be maintained, however, if `genus` is not selected and `species` is the first modifier field. Scripts must therefore react dynamically to the fields found selected and always produce correct SQL syntax. Notice also how the range of `fourc` is explicitly given an upper limit, even though this is not specified in the form field. Numeric fields should have upper and lower limits that can be inserted when fully qualified expressions are not provided. This type of defensive coding is essential for preventing unexpected errors when users enter incorrect data into a field. You can exploit Perl's powerful regular expression engine to correct such errors.

☑	Genus	Tulipa		Default = all
☑	Species			Default = all
☑	Family			Default = all
☐	Authority			Default = all
☑	4C DNA range (pg)	From: 10	To:	Default = all
☐	Chromosome number	From:	To:	Default = all
☐	Ploidy level	From:	To:	Default = all
☐	Subclass	○ Monocot ○ Dicot ◉ Both		Default = both
☐	Voucher available?	○ Yes ○ No ◉ Both		Default = both
☐	Life cycle type	○ Annual ○ Perennial ◉ All		Default = all
☐	Estimation method	○ Feulgen ○ Flow cytometry ◉ All methods		Default = all

An HTML form serves as the front end to a SQL database, so users can make queries from a browser.

Using DBI

A DBI script can be coded to use a specific database/driver combination, or else find all installed drivers and load each in turn to discover any databases available on the local machine. This latter feature can be used to great advantage: By cycling through installed drivers, the first one capable of accessing a requested database can be used. Should the database crash or need to go off-line, and a copy is available via another driver, then the DBI script automatically selects the next driver that can service the request. This capability helps implement fault tolerance and improve database availability. This is possible only because DBI-compliant scripts are database-independent.

Once a suitable SQL query string has been constructed, DBI passes it to the database. DBI database operations are encapsulated in objects that are manipulated via handles. A successful DBI `connect()` function loads the appropriate driver, establishes a connection, and returns a database handle. Once a handle object has been obtained, its member functions may be called. The `execute()` function passes a string containing a SQL query to the database. A successful query returns a handle to a statement object. This handle provides convenient access not only to query results but also to metadata such as column names. Multiple `fetchrow_array()` function calls retrieve references to query results, a single row at a time, and can be used to place them in an array. This makes it simple to present the returned data in an HTML table.

WHERE TO FIND

MySQL
T.c. X DataKonsultAB
http://www.tcx.se/

The Cost Advantage

Making information in desktop PC databases available on the Internet in the absence of an NT server proves to be far from an insurmountable task. Many excellent tools are available to help you achieve this goal. While you might need to spend some money on writing Perl scripts and building an HTML form for the front end of the database, most of the process can be done for free. A sample Perl script is available for downloading from the BYTE site at *http://www.byte.com/art/download/download.htm.* B

Dr. Tony Cox works at the Jordell Laboratory, Royal Botanic Gardens, Kew, U.K. He can be contacted via e-mail at **a.cox@rbgkew.org.uk.**

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HOW TO SOUP UP JAVA

PART I

Will Java always be noticeably slower than C++? It's a matter of debate, but many experts say no. They're working on nine ways to boost Java's performance.

By Tom R. Halfhill
BYTE Lab Testing By Al Gallant

Software tends to get slower over time, not faster. Otherwise, our applications could still be cruising on a 4.77-MHz IBM PC. But Java is bucking the slothware trend, at least for now. Thanks to the brute force of global research and development, Java is experiencing a growth spurt that will bring it very close to the performance of languages such as C++.

Competitive performance is crucial to Java's success. Java tool vendors and developers agree that sluggish execution is their customers' biggest complaint—both the customers who are using Java and those who are still evaluating it. Indeed, poor performance is second only to the problem of inconsistent cross-platform compatibility, another annoyance of Java's youth.

"There's been a lot of buzz in the marketplace about Java performance, and the fact that it's not as fast as C++, which is the benchmark," says Colette Coad, a partner at Ernst & Young who leads its Java development in the U.S. "It's holding some people back from building enterprise-level, server-based Java applications."

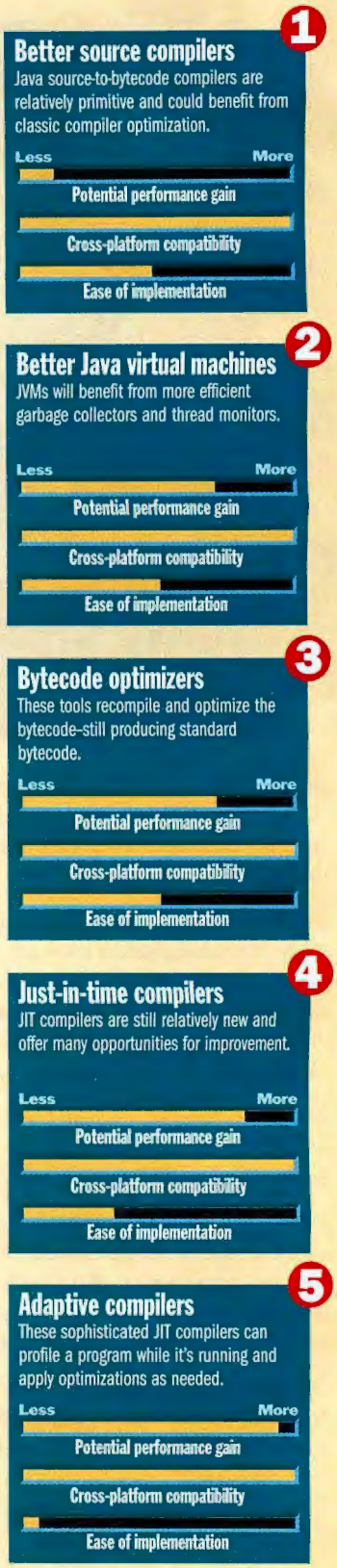
Despite those misgivings, Coad adds, Java continues to score major design wins, especially at large organizations whose need for cross-platform solutions overrides other factors. (See "Java Gets Down to Business," October 1997 BYTE.)

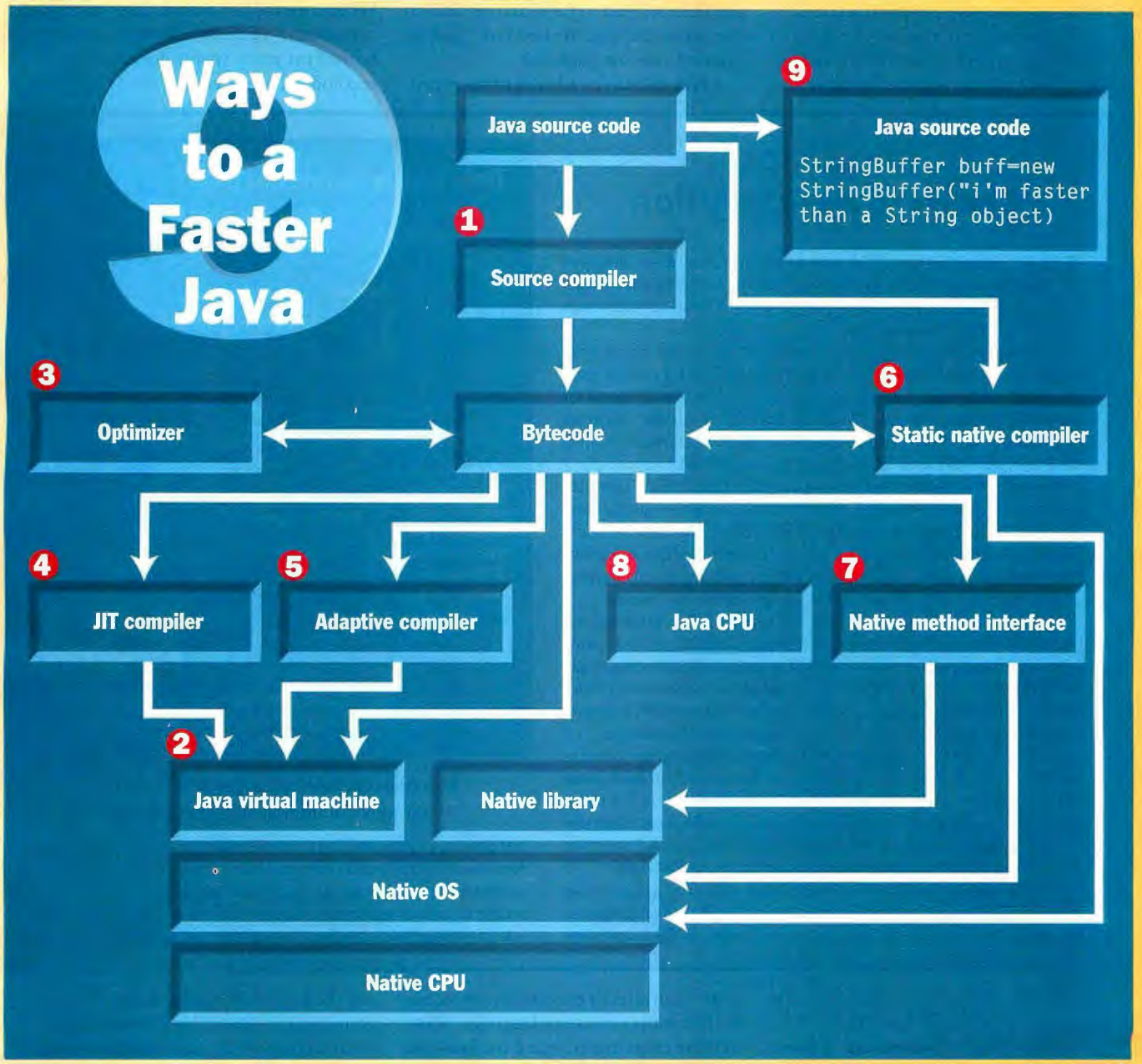
It's happening because Java is already fast enough for many purposes. Often, Java applets are merely the front end for a centralized process, such as a database manager, that's running on a server. It's the database's stored procedures, the server, or the network that's the bottleneck, not the applet. However, it's more often the case that Java is simply too slow for applications that could benefit from its advantages: multiplatform compatibility, developer productivity, and run-time safety.

The same barriers stunted the popularity of earlier object-oriented, dynamic languages, such as Smalltalk and Eiffel. Even more successful languages, such as Visual Basic and PowerBuilder, have been limited by their less-than-C performance. But the tremendous hype over Java is generating an unprecedented amount of R&D at companies and universities all over the world.

In general, researchers are exploring nine approaches to higher performance:

- **Better Java compilers.** These are the compilers that translate Java source code





6 Static native compilers

Compiling directly to native object code could yield near-native performance, but early compilers aren't that good yet.

	Less	More
Potential performance gain		
Cross-platform compatibility		
Ease of implementation		

7 Native method calls

Calling native code from a Java program seems like cheating but isn't, especially if it's done right.

	Less	More
Potential performance gain		
Cross-platform compatibility		
Ease of implementation		

8 Java chips

Java CPUs execute bytecode as their native machine language. Most will end up in low-cost devices, not PCs.

	Less	More
Potential performance gain		
Cross-platform compatibility		
Ease of implementation		

9 Better source code

Programmers can do a lot to boost performance merely by writing better code.

	Less	More
Potential performance gain		
Cross-platform compatibility		
Ease of implementation		

(.java files) into Java bytecode (.class files) for execution on Java virtual machines (JVMs).

• **Faster JVMs.** The JVM is the software layer in a Web browser or OS that interprets Java bytecode and handles run-time operations such as garbage collection.

• **Bytecode optimizers.** These tools apply additional optimizations by recompiling the bytecode produced by other Java compilers, yielding faster class files that still consist of standard bytecode.

• **Just-in-time (JIT) compilers.** When a JVM loads a program's classes, a JIT compiler quickly translates the bytecode into native machine code and then caches it in memory. JIT compilers are common in Web browsers.

• **Dynamic or adaptive compilers.** These high-tech compilers intelligently translate Java bytecode into native machine code at run time based on profiles of how the program is running. An example is Sun's upcoming HotSpot technology.

• **Static native compilers.** These tools translate Java source code or bytecode into native object code at design time, just like compilers for C/C++.

• **Native method calls.** Java applications can invoke native executable files, including DLLs written in C++ and services in the native OS. (See the text box "Calling Native Code" on page 68.)

• **Java chips.** A new breed of microprocessors can directly execute Java bytecode as their native machine language. Most of these chips are designed for low-cost devices. (See the text box "Java Chips: The Hardware Solution.")

• **Writing better code.** (Last but not least!) Developers can follow good programming practices and exploit Java's idiosyncrasies. (See the text box "Speed Tips for Java Coders" on page 72.)

Why Java Is Slow

To grasp how these techniques work, it's crucial to understand why Java is slow in the first place. One reason is that Java is a dynamically bound object-oriented language. Java programs don't bind their classes until run time; only then can they resolve polymorphic method calls inside their deep hierarchies of inherited objects. When a method in a child class overrides a method in a parent class, a dynamically bound program won't discover which method takes precedence until run time, and the precedence can change if the program loads another class. (A method is the Java counterpart to a function, procedure, or subroutine in other languages.)

C compilers statically bind a program during compilation by inserting pointers to the function calls, so the program does not have to resolve those references at run time. But C++ allows virtual methods that are late-bound and polymorphic like Java methods, and C++ also suffers from the hierarchical nesting of objects. That's why C++ is generally slower than C, a classic procedural language.

Java Chips: The Hardware Solution

The Java virtual machine (JVM) isn't virtual anymore—it's real. New Java chips can execute Java bytecode as their native machine language, making it unnecessary to interpret or compile the bytecode into some other CPU's machine language.

In theory, this could allow Java to run as fast as native code on other CPUs—if Java chips were as powerful as other CPUs. In practice, most Java chips will be sub-$50 processors, because they're designed for network computers (NCs), TV set-top boxes, smartcards, and other embedded devices. Only one company, Sun Microelectronics, is known to be developing a high-end Java processor (ultraJava).

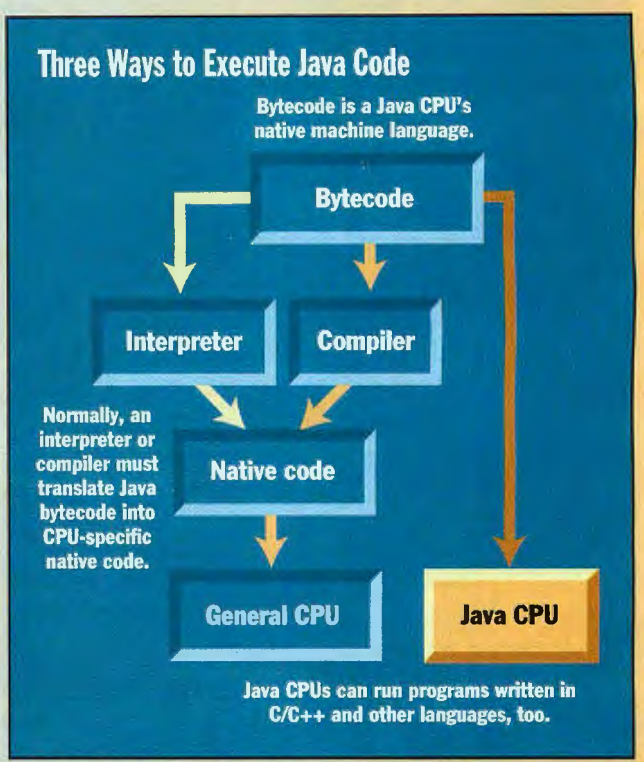
Nine companies are working on Java chips: Sun, NEC, IBM, Fujitsu, LG Semicon, Rockwell, Siemens, Patriot Scientific, and International Meta Systems (IMS). Seven of them (Sun, NEC, IBM, Fujitsu, LG Semicon, Rockwell, and Siemens) are designing their chips around Sun's picoJava core, which is available for licensing. Patriot modified an existing processor to run Java, and IMS is working on an independent design.

Sun plans to ship its first Java chip, the microJava 701, in the second half of this year. Later, Sun plans to introduce additional 700-series microJava chips, plus some lower-end 500-series and 300-series chips. For the high end, Sun is designing the ultraJava for 1999 or later. It's for graphics workstations and will compete against high-end CPUs of other architectures, says Harlan McGhan, technical marketing manager.

So far, nobody has shipped actual products with Java chips. Sun has announced the JavaBlaster, a $99 ISA card that turns old PCs into Java-based computers, but it won't appear until after the microJava 701 ships. Siemens is designing a picoJava-based smartcard. Rockwell might use its JEM1 chip in navigation and communications systems. Patriot has shipped more than two dozen development kits for its PSC1000.

Java chips aren't limited to running software written in Java, any more than other CPUs are. Programmers can use any high-level language that has a bytecode compiler. In fact, Sun is introducing C/C++ compilers that generate bytecode. The picoJava architecture defines about half a dozen extended bytecode instructions to support C/C++ and low-level hardware functions, such as memory writes, on-board cache control, access to control registers, and power-up/power-down diagnostics.

Is this heresy? No, says Sun. Java chips must support those functions



Java chips execute bytecodes directly, without the need for interpreting or compiling.

To recover some of the efficiency of static binding, Java defines a bytecode instruction called INVOKE_VIRTUAL_QUICK that a smart JVM can substitute at run time for the more common INVOKE_VIRTUAL instruction. The quick version bypasses a few table lookups after the JVM has already resolved a method call. In general, though, dynamic binding and object hierarchies play a relatively minor role in Java's poor performance. A much larger factor is Java's almost unprecedented degree of hardware abstraction.

so developers can write OSes, device drivers, and other low-level programs. Regular Java can't do it because Java source compilers don't generate the extended bytecodes. Even if they did, the bytecode verifiers built into JVMs would reject the extended bytecodes as illegal. This preserves the safety of Java applications while permitting developers to write low-level system software for Java chips.

Patriot was the first company to demonstrate a working Java chip (November 1997). Instead of licensing Sun's picoJava core, Patriot took an existing Forth chip and reprogrammed the microcode to recognize bytecodes. The PSC1000 already had a stack architecture, because Forth, like Java, is a stack-oriented language. Patriot's PSC1000 costs less than $10 in volume.

Marc Tremblay, a chip architect at Sun, predicts that low-end Java chips based on the picoJava core will run Java about 20 times faster than interpreters running on a Pentium at the same clock frequency. Tremblay thinks the chips will deliver about five times as much performance as a just-in-time (JIT) compiler running on a Pentium.

Is that fast enough? By the time the chips come out, the best JIT compilers might deliver more performance on fast CPUs than low-end Java chips. However, that won't threaten the two most important markets for the chips: inexpensive devices that can't afford a Pentium-class CPU but still need to run Java at acceptable speeds and low-memory devices that lack the resources for a full-size JVM and a JIT compiler.

Higher levels of abstraction have been a trend in software development for half a century. Starting from the hard-wired logic of ENIAC, computer programming has advanced to machine language assemblers, high-level-language compilers, high-level-language interpreters, OS-level APIs, and object-oriented class libraries. Each step up the ladder makes it less necessary for application programmers to bother with hardware details. But each step also consumes more CPU cycles. Fortunately, that penalty is largely hidden by a parallel trend in hardware: Moore's law. The circuit density (and thus the performance) of CPUs roughly doubles every 18 months.

Java carries abstraction to a new height. It's a programming language that's also a platform. The JVM contains a software representation of a CPU, complete with its own instruction set. (Java chips turn that virtual CPU into real hardware.) The bytecodes in Java class files contain instructions for the virtual CPU, and the classes will run on any native platform with a compatible JVM. By writing to the Java APIs and compiling to bytecode, developers don't have to worry about the native CPU or OS.

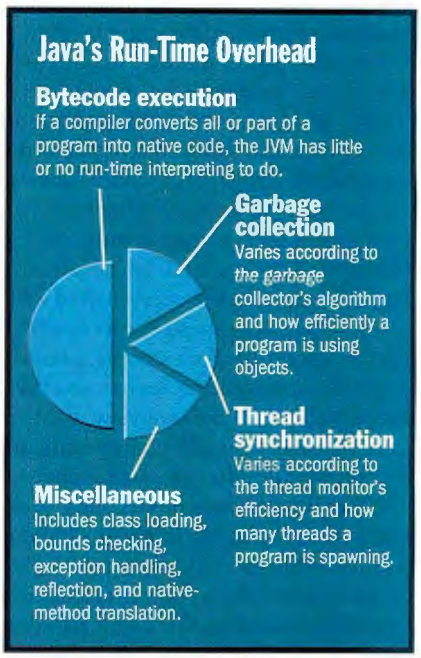
To make this work, the JVM has an interpreter that translates bytecode instructions into native CPU instructions at run time. Interpreted programs always run slower than natively compiled programs, because a compiler has already turned a native program into a binary executable file at design time. No run-time translation is necessary.

Run-time interpreting alone would put Java at a disadvantage, but there's much more. Java removes another burden from programmers by automatically handling memory management. In C/C++, programmers are responsible for allocating memory, using the memory properly, and releasing the memory when they're done with it. Memory leaks and pointer bugs are the most common reasons why C/C++ programs crash. Java avoids those headaches by using a garbage collector—an automatic background process that frees up memory when a program no longer needs it. But garbage collection adds more overhead to execution.

The JVM eliminates another common hazard of C/C++ by automatically checking for array-bounds exceptions—attempts to reference array elements that don't exist. The JVM also checks for null pointers, division-by-zero errors, illegal string-to-number conversions, invalid type casting, and a host of other exceptions that threaten to crash a program.

Java's powerful multithreading adds significant overhead. Threading is easy in Java, and programmers can prevent thread conflicts by using a built-in keyword (synchronized) that ensures only one thread at a time is executing a particular method. However, calling a synchronized method takes longer, because the JVM's thread monitor must check to see if any other threads are using the method. This penalty applies even to single-threaded programs that call synchronized methods—and hundreds of methods in Java's standard classes are synchronized.

Don't forget Java's dynamic loading. The JVM can load new classes at any time while a program is running, which means it needs resources to load, verify, and initialize the new class. Most native platforms can dynamically load and link, too—that's how Windows DLLs work—but programmers have to explicitly write a program that way. In Java, dynamic class loading demands no extra effort, because a program can automatically load any class file whenever it's needed. Therefore, dynamic loading happens more often.



JVMs spend only about half of their time executing program instructions.

Finally, there are Java's restrictive but effective security measures. Web browsers implement a Java security manager that normally stops applets from reading or writing to local disk drives, calling native executable files, connecting to servers other than the host, and doing some other potentially dangerous things. Checking for those violations soaks up more CPU cycles. But Java *applications* don't suffer as much in this regard. Unlike applets, they're stand-alone programs that can do virtually anything a native program can do.

It's a trade-off. In return for multiplatform compatibility, greater safety, the flexibility of dynamic loading, and higher programmer productivity, users pay the

price of slower execution. Of course, like all software, Java will ride the coattails of Moore's law. But even if CPUs never get any faster, Java's performance would still get better.

The Garbageman

To begin with, JVMs are getting faster. JVMs based on Sun's Java Development Kit (JDK) 1.1 are about twice as fast as those based on JDK 1.0.2. One reason is that Sun streamlined the event model.

The old model would "broadcast" events (e.g., mouse-clicks, mouse movements, and keystrokes) throughout an entire program until an object trapped the event with event-handling code. That was very inefficient, especially for high-volume events such as mouse movements. Under the new event model, objects can register with another object called a *listener* to hear only those events in which they're interested. For example, a button might want to listen only for mouse-clicks. From the button's point of view, all other events are like trees falling in an uninhabited forest: They don't make a sound.

Changing the event model might seem like a small thing, but it makes a big difference at run time. JVMs spend roughly 50 percent of their time interpreting bytecode (assuming there's no JIT compiler), so anything that speeds up that process yields big gains in performance.

JVMs may spend another 15 percent to 25 percent of their time on garbage collection. Why so much? Because object-oriented languages such as Java make heavy use of memory.

Classes are templates that define objects. A program can create any number of objects from a class, and each instance of an object stays in a memory heap until the program no longer needs it. The garbage collector in Sun's current JVM uses a simple mark-and-sweep algorithm that periodically marks all unreferenced objects and sweeps them away in a single pass.

If you chart the memory usage of a JVM with this kind of garbage collector, you'll see a jagged sawtooth pattern (see the screen on page 66). The memory consumption goes way up, then way down, then way up again. The JVM could smooth out those jaggies by scavenging the heap more often, but it would steal CPU cycles away from other processes, including the program's execution threads.

Luckily, JVM vendors can draw on two decades of research into garbage collectors, thanks to pioneers who faced the same problem with Lisp, Smalltalk, and other languages. Later this year, the JVM that includes Sun's HotSpot technology will introduce a new collector based on an advanced generational algorithm.

Generational collectors are more efficient because they sweep smaller parts of the heap more often. They're called generational because they base their sweeps on the "age" of objects. "Most objects die young," explains Tim Lindholm, a senior staff engineer at JavaSoft. In other words, a program tends to use an object briefly before discarding it. Sun's new JVM keeps the references to newly created objects in a special part of the heap called the "nursery." The garbage collector sweeps the nursery often to make room for more infant objects.

Objects that outlive a few sweeps in the nursery move on to another part of the heap reserved for middle-aged objects. The garbage collector doesn't visit them as often. Longer-lived objects eventually graduate to a third area of the heap that the collector sweeps the least often of all. And to optimize the technique still further, Sun uses different collection algorithms for each region of the heap. For example, the collector sweeps the oldest region with a "train" algorithm that divides memory into chunks called "cars." If the collector is pressed for time, it can sweep individual cars instead of the whole train.

The garbage collector in Microsoft's JVM uses similar techniques, according to Joe Herman, Microsoft product manager for Internet platforms. It keeps a dynamically ordered table of objects and collects only part of the list at a time. As with Sun's new garbage collector, it tends to level out the jagged peaks and valleys of memory consumption. Because most Java vendors license their JVMs from either Sun or Microsoft, these advances will ripple through the entire Java community.

Thread synchronization is another runtime task that's ripe for improvement. Like garbage collection, it might account for 15 percent to 25 percent of a JVM's work load. Symantec licensed Sun's JVM and extensively modified the thread monitor—and, according to Al Bannon, Symantec's director of developer relations, thread synchronization is now 80 percent to 150 percent faster. Symantec licenses those modifications to other companies.

Sun improved the performance of its own JVM for Solaris by rewriting it to map individual Java threads onto native OS threads. The earlier version piggybacked all Java threads on a single Solaris thread, which meant the OS couldn't dispatch Java threads to different CPUs on multiprocessor systems. Microsoft's JVM for Windows NT also maps Java threads directly to native threads. But it isn't feasible with an OS such as Windows 3.1, which has little or no native support for multithreading.

This is one area where application programmers can make a difference, too. Sun's HotJava browser used to require the JVM to spend 25 percent of its time monitoring thread synchronization in the program, says Peter Kessler, a senior staff engineer at JavaSoft. By rewriting the browser to optimize threading, Kessler says Sun reduced that work load to 10 percent to 15 percent.

Better Compilers

Despite the ongoing improvements in JVMs, that's not where Java will realize the greatest gains in performance. Interpreted execution simply isn't fast enough for most

A Java Glossary

Bytecode: Java's object code or machine language. A compiler turns Java source code into bytecode and stores it in a class file. Java chips can execute bytecode directly, but all other CPUs require an interpreter or a compiler to translate the bytecode into the CPU's native object code.

Inlining: Copying the body of a method into the body of another method. Example: If method A calls method B, a programmer or compiler can copy the code of method B into method A. This makes it unnecessary for A to call B at run time, thereby speeding up execution—at the expense of code size.

Polymorphism: The ability of methods in object-oriented programs to override methods of the same name in other classes. If a child class has a method whose name is identical to a method in a parent class, the child method takes precedence.

Thread: A process within a program. A multithreaded program can execute two or more threads by distributing time slices from the CPU, so the program appears to be executing multiple operations simultaneously.

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purposes. That's why computer science graduates who are pondering their uncertain futures should consider compilers.

There are five types of compilers relevant to Java: source code compilers, bytecode optimizers, JIT compilers, dynamic/adaptive compilers, and static native compilers. It's possible for a single Java program to undergo as many as three different levels of compilation with these tools. And because today's Java compilers are relatively primitive, the potential gains are enormous.

Source code compilers turn Java source files into class files of bytecode, ready to run on any compatible JVM. By modern standards, Java source compilers don't do much optimization. The JAVAC compiler in Sun's JDK—the benchmark Java source compiler—has only one command-line optimization switch (-O), and it applies only a few simple optimizations, such as method inlining. (See "Better Java Programming," September 1996 BYTE.)

Other Java tool vendors have their own source compilers. Most vendors concentrate on making their compilers work faster, rather than making the compilers produce faster code. Fast compilers shorten the edit-compile-test cycle for programmers but do nothing for users. Tool vendors are just starting to add the optimizations found in mature compilers for other languages.

There's nothing especially new about those optimizations—most of them are straight out of computer science textbooks. It's just a matter of bringing Java compilers up to date. For those who can't wait, one alternative is a bytecode optimizer. This tool recompiles bytecode (you don't need the source code) into optimized bytecode that's still platform-independent. Some examples are DashO and DashO Pro, from Preemptive Solutions.

DashO is the brainchild of Paul Tyma, president and chief scientist of Preemptive, who's writing his doctoral dissertation on Java performance at the University of Syracuse. Tyma says DashO can speed up typical logic code by about 30 percent, with loops and matrix multiplication showing even greater improvement. DashO applies several classic compiler optimizations to Java bytecode, and Tyma says future versions will introduce some of his own Java-specific optimizations. Here are some examples:

• **Transient variable caching.** This technique (for which a patent is pending) recognizes that Java's virtual CPU has a stack instead of registers. When a program swaps the values of two variables, an ordinary Java compiler generates three pairs of stack load and store instructions. DashO uses the stack in a smarter way to generate only two pairs of stack loads and stores.

• **Loop unrolling.** This is a classic optimization that replaces short loops with a series of instructions that duplicate the function of the loop. It's faster because it eliminates a compare instruction and a branch instruction for every iteration through the loop.

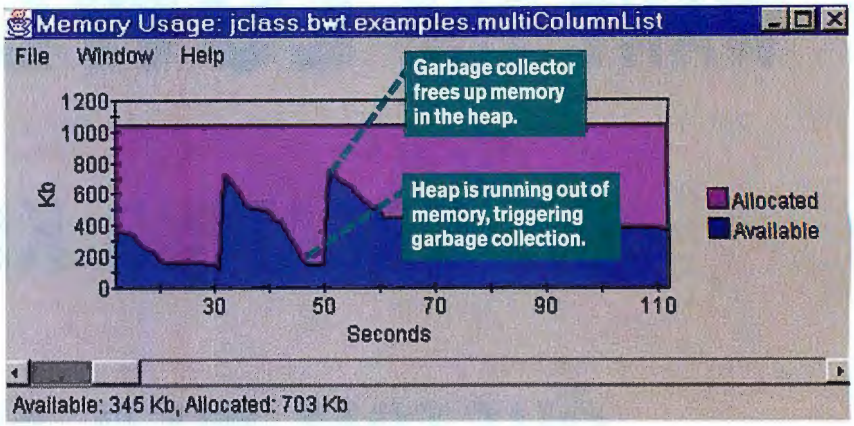
• **Loop-invariant code motion.** Some loops contain statements that execute during every iteration but always yield the same results. (Example: a+1=b, where neither variable is a loop variable.) Good compilers move this code outside the loop so it executes only once.

• **Common subexpression elimination.** Given a statement such as x=(y+5)+(y+5), a smart compiler will reuse the result of the first expression rather than evaluate the second expression.

• **Tail-recursion elimination.** In some recursive algorithms, only the tail portion is recursive. Often, it's more efficient for the compiler to transform the recursive algorithm into an iterative algorithm.

• **Statically analyzed polymorphic inlining.** This lets an optimizer inline public methods. (Java compilers can inline private, final, and static methods, but they can't inline a public method, because a polymorphic method might override it.) First, the optimizer analyzes the bytecode to find public methods that aren't overridden. Then it inlines those methods, eliminating the JVM's overhead of checking for child methods. Drawback: There will be a problem if the program dynamically loads a class that tries to override the inlined public methods.

• **Method desynchronization.** Tyma says a future version of DashO will use this Java-specific technique to fix the thread-synchronization problem described earlier. DashO will analyze the bytecode to see if a synchronized method really needs to be synchronized; if not, it removes the lock. For example, if method A is the only method that calls method B, and if method A is synchronized, there's no need to synchronize B. Removing the lock on B reduces the overhead of calling the method without compromising the thread safety of the program.



This sawtooth pattern is typical of memory usage when Java's garbage collector disposes of objects en masse.

It's possible that these optimizations and more will eventually find their way into Java source compilers, reducing the need for a recompiler such as DashO. But tool vendors seem to be focusing on three other types of compilers: JIT compilers, dynamic/adaptive compilers, and static native compilers.

Going Native

At some point, bytecode must become native machine code so it can execute on a real CPU (unless the real CPU is a Java chip). The slowest way is to let the JVM's interpreter translate the bytecodes one by one, over and over again. A much faster way is to bypass the interpreter by compiling the bytecode into machine code and then to cache the machine code in memory. The main difference between JIT compilers, adaptive compilers, and static native compilers is when they do that translation. The first two types do it dynamically, at run

time; static compilers do it at design time.

There's a fine line, or perhaps no line, between JIT compilers and adaptive compilers. Both are really dynamic compilers. The simplest JIT compilers translate bytecode into machine code immediately after the JVM loads each class into memory. Then the JIT compiler steps out of the way and lets the program run. If the JVM dynamically loads another class at a later time, the JIT compiler may compile the new class as well.

However, a JIT compiler may decide not to compile every class, especially if a class is so large that compiling it would seriously delay execution. That's the weakness of a JIT compiler—it has to be quick and dirty. "A lot of optimizations take a lot of time," notes Tyma. "JITs can't take too much time or the user will say, 'Whoa, when is this program going to start?'"

The solution: smarter JIT compilers. Borland's JIT compiler can compile individual methods without compiling a whole class. It doesn't bother to compile static initializers (which a program calls only once per class), and it won't compile an object constructor method unless the program calls it more than once.

The JIT compilers from Microsoft and Symantec are similarly intelligent, and they're making rapid progress. Symantec's first JIT compiler appeared in March 1996; six months later, version 2.0 was 50 percent faster, according to several benchmarks. Symantec says version 3.0, introduced last December, beats that by another 50 percent. Depending on the nature of the code, today's JIT compilers can run a program from five times to 20 times faster than an interpreter. (See the text box "Benchmarking Java" on page 70.)

Java programs that are compiled with Microsoft's JIT compiler can achieve 30 percent to 40 percent of the performance

Calling Native Code

Some say it's cheating. Others say it breaks the promise of write once, run anywhere. Could it even be a Communist conspiracy?

Nope, it's a native method call—a controversial technique for squeezing more performance out of Java. Java applets normally can't do it, because Web browsers have a security manager that prevents hostile applets from doing evil things to your system. But stand-alone Java applications can do virtually anything native applications can do, and that includes calling native executable files such as DLLs and OS services.

Critics say it threatens Java's integrity. Perhaps they don't realize Java has always allowed it. Java has a built-in keyword (`native`) that declares a Java method as the gateway to a native binary. Java Development Kit (JDK) 1.1 defines a native interface called native method invocations (NMIs), and JDK 1.2 will introduce a better one called the Java native interface (JNI).

NMIs neatly partition a Java program into platform-dependent and platform-independent modules. As Java gets faster, developers can rewrite the native modules until eventually the whole application is pure Java. That's the vision.

Native methods are also a good way to integrate Java programs with existing systems—a big point for businesses that have lots of legacy software. And they can tap the richer veins of native APIs.

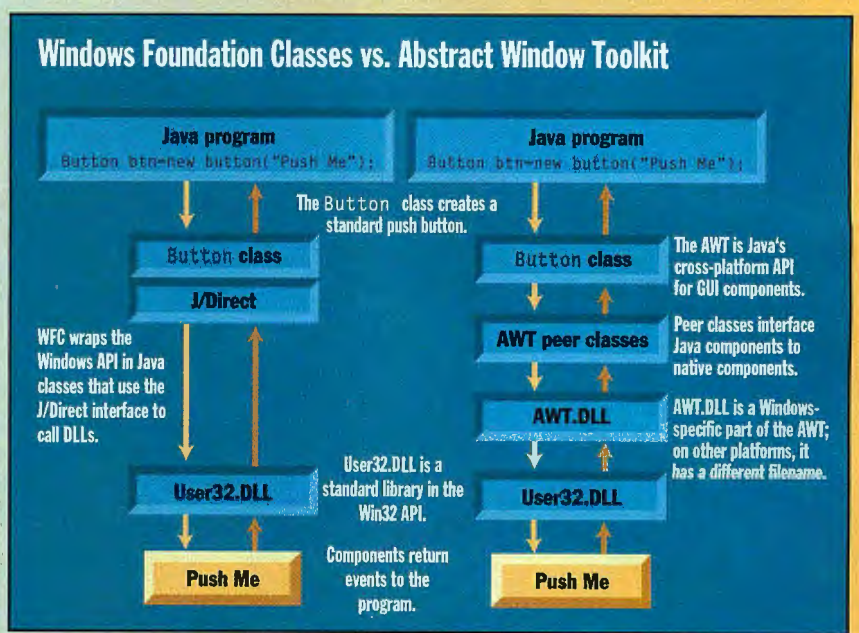
Microsoft's Visual J++ supports a Windows-specific interface called J/Direct. With J/Direct, a programmer merely precedes a Java native method declaration with a compiler directive that identifies a DLL by its filename. The Java native method passes any parameters that the DLL function requires, and it receives any results the function returns.

J/Direct is easy, but Microsoft isn't finished. In March, it planned to introduce the Windows Foundation Classes (WFC) for Java. This is a library of Java classes that wrap major parts of the Windows API in Java code that handles native method calls automatically.

Let's say you want to create a push button. Normally, you'd call the Button class in Java's Abstract Window Toolkit (AWT), a class library that maps cross-platform GUI components to native components.

Microsoft's WFC bypasses the AWT. WFC's Button class has a constructor that uses J/Direct to invoke the button function in USER32.DLL, a standard Windows library that has basic GUI components.

According to Microsoft's informal tests, a WFC window with 12 miscellaneous components opens and closes about 600 percent faster than an identical AWT window. Line drawing is about 50 percent faster. Filling a list box with 2000 strings is about 12 times faster.



Microsoft's Windows Foundation Classes are faster than Sun's Abstract Window Toolkit, but they run only on Windows.

What's equally important is that the WFC gives Visual J++ programmers access to almost the entire Windows API. They can call functions that Java APIs don't duplicate: Multiple Document Interface (MDI) windows, graphics, animation, rich text objects—the works.

"We're always going to be able to give the developer full functionality," says Bill Dunlap, Visual J++ product manager.

Of course, the resulting programs run only on Windows. That fits Microsoft's business strategy of promoting Java as a language, not as a virtual platform. But J/Direct and the WFC do offer a way to get higher performance and richer functionality.

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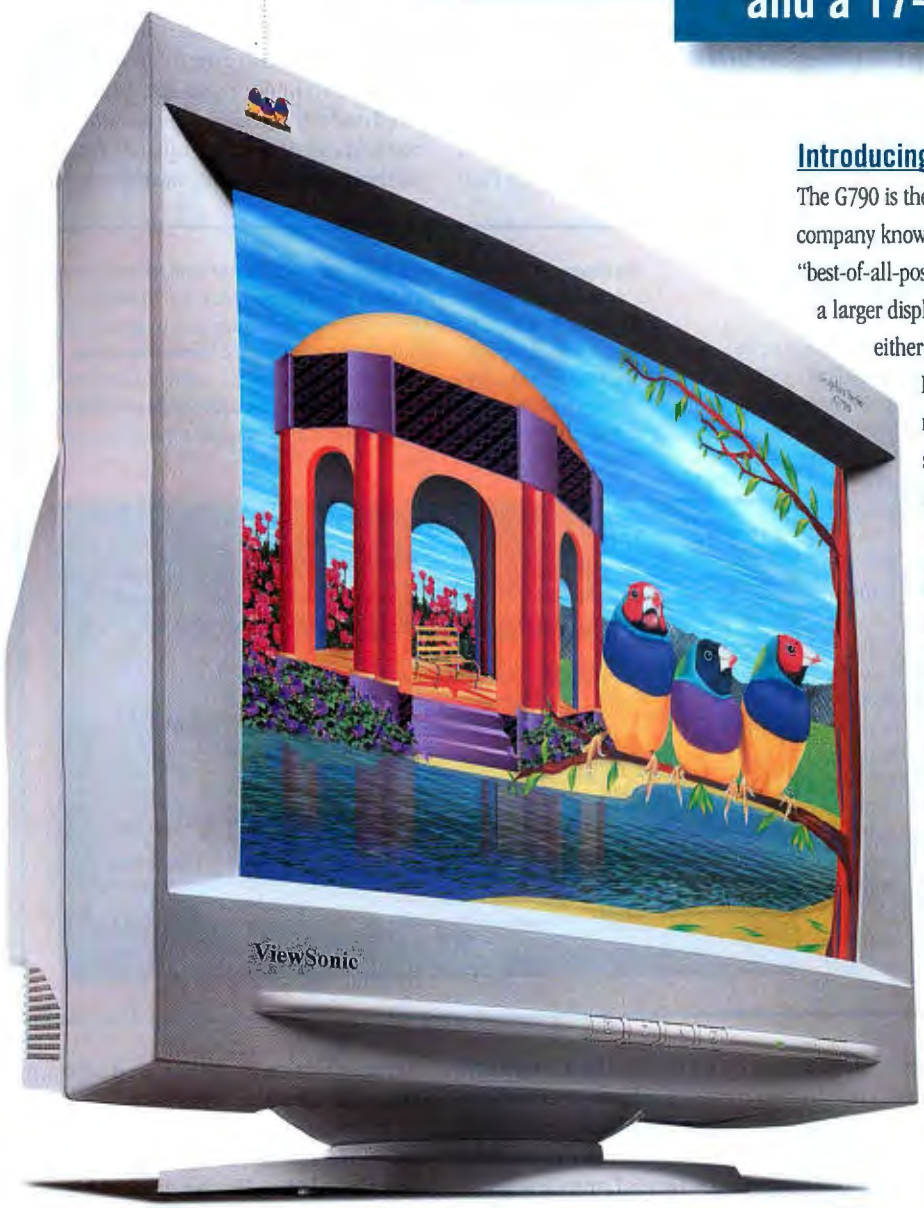

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of native C++ programs, says Bill Dunlap, product manager of Visual J++. He estimates that JIT-compiled Java could eventually attain 60 percent to 70 percent of the speed of native C++. Symantec is more optimistic, predicting that fast JVMs and JIT compilers could eventually match C++.

To reach those goals, JIT compilers are doing some amazing things. Borland's JIT compiler doesn't stand on the sidelines execution, identify the performance bottlenecks, and then compile or recompile parts of the program to relieve the bottlenecks. This is the cornerstone of Sun's HotSpot technology, which will probably appear later this year in JDK 1.2.

HotSpot (a code name) isn't new technology. It grew from research that began at Stanford University in 1987, based on earlier work on Smalltalk at Xerox Palo Alto Research Center (PARC). Stanford researchers created an object-oriented language called Self to explore dynamic compilation. Several of them later founded a small company known as LongView Technologies (or Animorphic Systems). Sun acquired the company to make HotSpot.

Sun is using HotSpot as an umbrella term for several acceleration techniques, including the generational garbage collector described earlier and a new thread monitor. But the most interesting part is adaptive compilation.

HotSpot is like a hyperactive JIT compiler—it profiles, it compiles, it recompiles. It can start compiling when the program launches or wait to see how the program runs. It can make decisions about which parts of a program to compile according to how often the code executes or how much time the code takes to execute. It balances the time required for compilation against the time saved by faster execution.

It can apply additional optimizations by recompiling code that's already been compiled. It can flush compiled code from memory to make room for newly compiled code. It can inline the parameters of method calls if the program always calls a method with the same parameters. It can after compiling part of a class—sometimes it compiles additional methods later. Microsoft's JIT compiler performs a quick data flow analysis during the initial compile and then continues to analyze and compile parts of the program during execution (except for small applets, which *aren't worth the trouble*).

"I think we've only seen the tip of the iceberg for JVMs and JITs," says John Robbins, engineering product manager for performance tools at NuMega. "There are a lot of smart companies working on this, and I think the real breakthrough is going to happen two or three years from now."

The Great Hype Hope?

The best JIT compilers are really adaptive compilers. Adaptive compilers create a profile of a program before and during even turn bytecode into buttered popcorn. (OK, that last claim was a joke.)

Or maybe it's not a joke. Critics accuse Sun of overselling HotSpot. Last year, Sun speculated that HotSpot could boost Java even beyond the performance of C++. Lately, Sun has been more conservative. "We think it's going to be a horse race," says JavaSoft's Peter Kessler. "But it would be irresponsible to say at this point that a Java program will be faster than the same program written in C++."

One of the foremost authorities on dynamic compilers is Dr. Craig Chambers, an associate professor in the University of Washington's department of computer science and engineering. Chambers worked on the Self project at Stanford in the 1980s and continues to develop experimental languages (such as Cecil) and adaptive compilers (such as Vortex). "There will be

Benchmarking Java

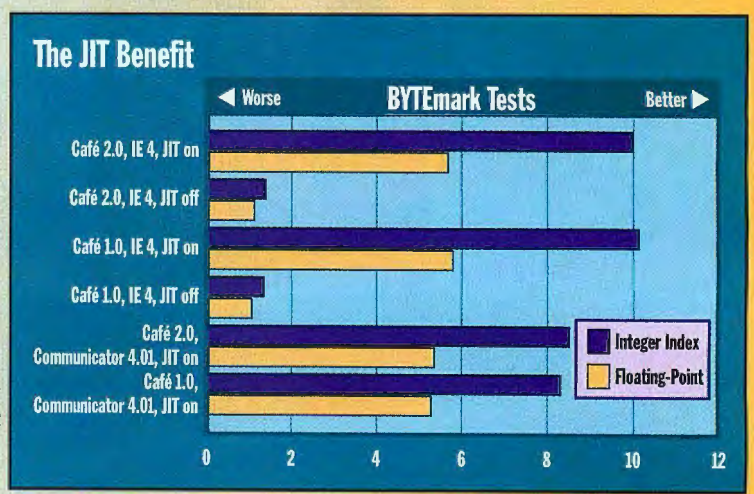
To demonstrate the dramatic difference a just-in-time (JIT) compiler makes, the BYTE Lab ran the Java version of our BYTEmark program (jBYTEmark) on a Dell 90-MHz Pentium system with Windows 95 and the two most popular Web browsers. We also compiled the jBYTEmark source code with two releases of the same Java development tool (Symantec's Visual Café). The results show that interpreters are no match for a good JIT compiler.

Netscape Communicator 4.01 doesn't let you turn off the JIT compiler, but Microsoft Internet Explorer 4.0 does. With the JIT compiler off, Explorer's performance was close to the jBYTEmark reference baseline of 1.0. (We established the baseline in 1996 by running jBYTEmark on the same Dell Pentium-90 system with Symantec Café 1.0.) The results were almost identical after recompiling jBYTEmark with Visual Café 2.0, the latest release.

With the JIT compiler turned on, Explorer roared through the benchmarks. It ran the integer routines 10 times faster and the floating-point routines nearly six times faster. Again, recompiling the program with Visual Café 2.0 made virtually no difference.

Communicator lagged behind Explorer, but it ran the integer tests more than eight times faster and the floating-point tests more than five times faster than the baseline.

Note that jBYTEmark is a fairly straight port from the C version of BYTEmark. It's a CPU-intensive synthetic benchmark program that uses a mix of algorithms found in modern applications. However, it does not include any Java-specific tests to measure such critical performance factors as object creation/destruction, garbage collection, or thread synchronization. Actual performance could vary widely from these results.



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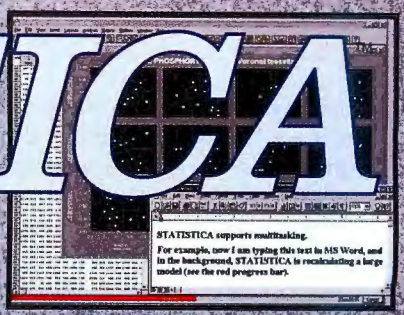

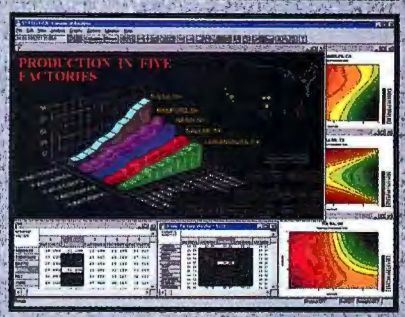

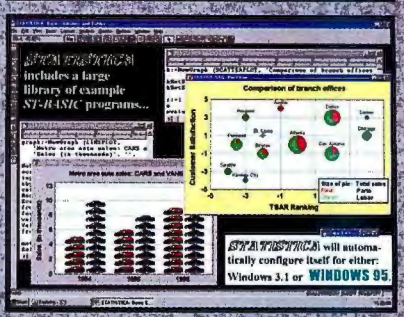

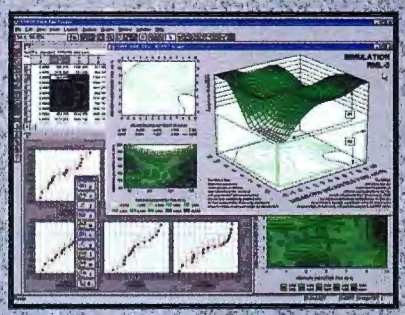

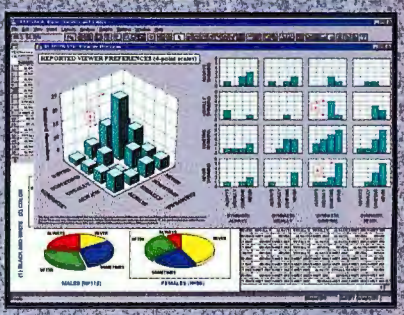

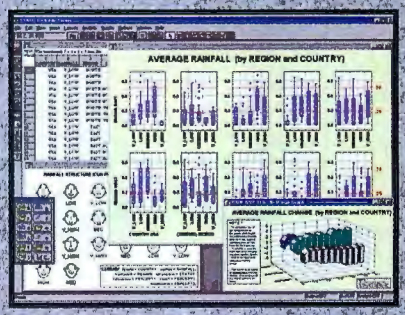

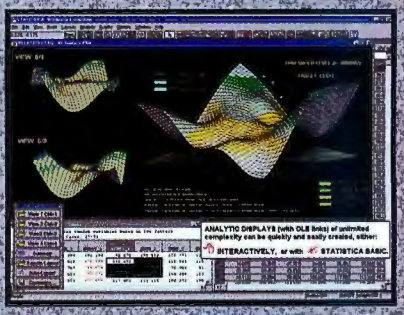

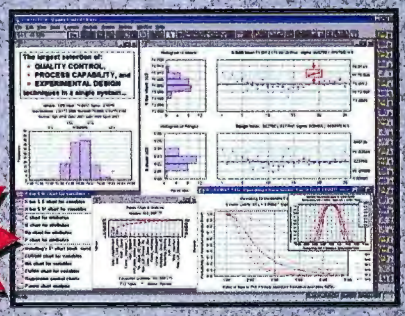

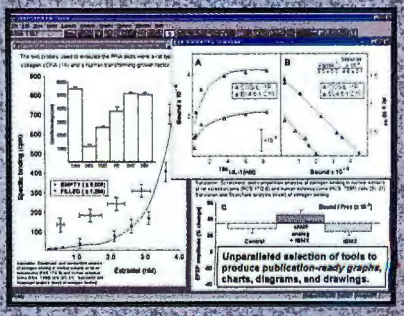

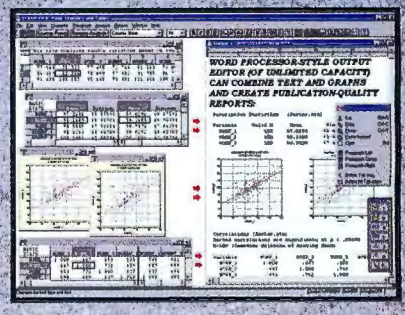

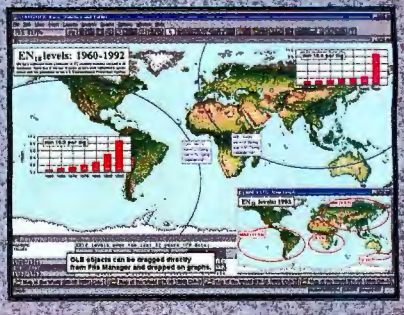

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Java systems that match the performance of C++," he says. But he adds that some programs—perhaps 5 percent—will always be faster in C++, because of Java's run-time overhead and dynamic nature.

Others, however, denounce HotSpot as an overhyped JIT compiler. "Dynamic processes like garbage collection are one of the things that will keep Java from ever achieving the performance of native compiled languages like C++," declares Microsoft's Herman.

Dynamic vs. Static

Static compilers would seem to enjoy an enormous advantage over dynamic compilers: virtually unlimited time to analyze and optimize a program. Programmers are accustomed to lengthy builds, while users are not. Besides that, static compilers usually work from source code, not bytecode, so it should be easier for them to deduce the semantics of a program before optimizing it. And static compilers can globally analyze a whole program, so they can apply more aggressive optimizations. Dynamic compilers are limited to peephole (local code) optimizations.

But dynamic compilers have a big advantage, too: They profile a program while it's running, so they don't have to guess where the actual bottlenecks are. They know which way branches are forking, how many objects the program is creating, and the actual size of arrays. Indeed, they can adapt to the different ways that different people use the same program. Working from bytecode instead of source code isn't a huge problem, because bytecode isn't nearly as obscure as native object code. In fact, bytecode is similar to the intermediate code generated by the front ends of some compilers, says Jim Russell, manager of Java technology for IBM Research.

Static native compilers for Java are available from SuperCede, Symantec, Cosmo Software (a Silicon Graphics spin-off),

Speed Tips for Java Coders

Java developers don't have to wait for fancy new compilers and other whizbang technologies to make their programs run faster. It's possible to achieve major gains in performance simply by writing (surprise!) better code.

Strangely enough, Sun engineers discourage programmers from using too many clever tricks. As Java evolves, some tricks won't work anymore, they point out. "In effect, you're writing to a specific VM implementation, and that doesn't make sense. You're doing damage to your code," says Tim Lindholm, a senior staff engineer at JavaSoft and coauthor of *The Java Virtual Machine Specification* (Addison-Wesley, 1997).

This is especially true when the tricks compromise good object-oriented program (OOP) design. For example, liberal use of Java's `final` keyword does make programs run a little faster, because the JVM knows a program can't subclass final classes, override final methods, or alter final data members. But `final` makes code reuse more difficult—and code reuse is what OOP is all about.

"There's a lot of pretty rotten code being written out there," says Collette Coad, the U.S. leader for Java-based computing at Ernst & Young. "People attend a few Java courses and then revert back to old habits. They're writing scripted Java programs or procedural Java programs. They're not embracing the concepts of OO."

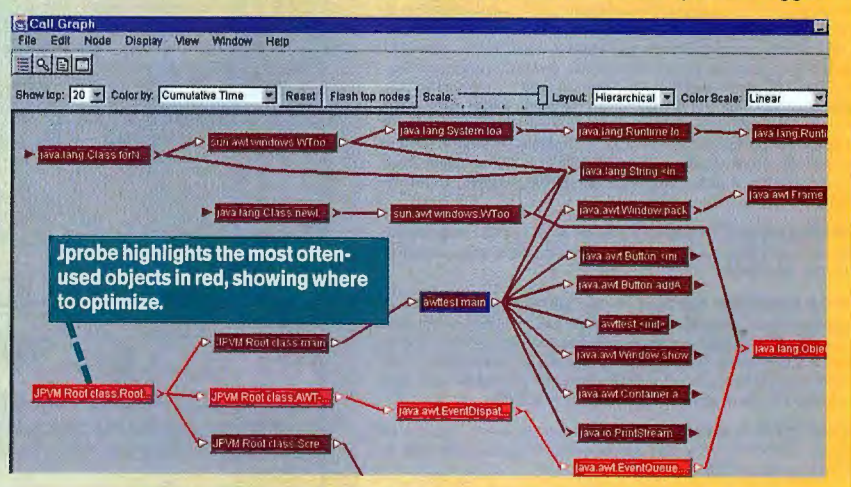
You're better off studying good design and algorithms—classic computer science. However, if you absolutely must squeeze the last drop of performance out of Java, here are some tips from experts:

→ Strings are slow. Use StringBuffers or `char` arrays instead. String concatenation is particularly costly, because the JVM must convert the String constants into StringBuffer objects, join them together, and convert them back into Strings. *–Doug Stein, an engineer at Active Software, who created the GridBag Layout manager while at Sun*

→ You have control over dynamic class loading. If you'd rather take the hit when a program first launches, initialize all objects immediately, even before you need them. Or delay class loading by not creating objects until later. *–Stein*

→ It's possible to write better class loaders. Borland JBuilder, which is 80 percent Java, starts up faster because Borland improved Sun's class loader. *–Jayson Minard, JBuilder product architect*

→ The new Java Foundation Classes (JFC) are faster than the Abstract Window Toolkit (AWT) because they're not bogged down by as much thread synchronization. Also, JFC components are pure Java—easier to compile. *–Minard and Tim Freehill, engineering manager for Metrowerks CodeWarrior*



A profiling tool such as KL Group's JProbe can show which classes and methods a Java program calls most often.

→ Don't create a lot of temporary objects; they make more work for the garbage collector. Avoid creating objects locally within loops or frequently executed methods. *–Paul Tyma, president and chief scientist of Preemptive Solutions*

→ If all objects of a class require some identical initialization code, put that code in a static initializer, not a constructor method. It will execute only once. *–Richard M. Fogel, technical product manager for KL Group's JProbe*

→ Find bottlenecks with a profiling tool. Examples are JavaScope (SunTest), JProbe (KL Group), OptimizeIt (Intuitive Systems), TrueTime (NuMega), Visual Quantify (Rational Software), and VTune (Intel).

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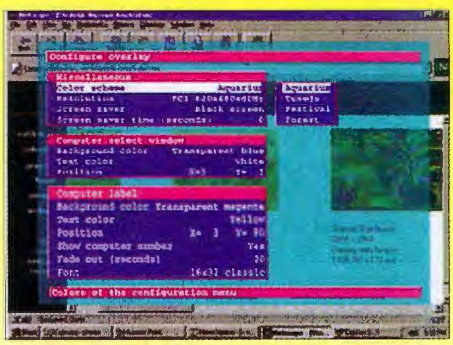

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IBM, Tower Technology, and the Open Group, with more on the way from Microsoft, Borland, Instantiations, and others. They target platforms as varied as Windows (x86), IBM OS/2, AS/400, AIX, Mips Rx000, HP-UX, and Linux (x86).

Most of these compilers work from bytecode, not source code, so developers can compile third-party JavaBeans and class libraries that don't include source code. The compilers produce native-code executable files—which are, of course, limited to a single platform.

That doesn't necessarily violate the write-once, run-anywhere religion. A compiled Java program still exists in its original cross-platform source code and bytecode, unless the programmers lose their disks. More important, static compilation makes sense when developers are deploying a Java application on a known platform, especially a server. This wouldn't make sense for an applet, which downloads at run time to an unknown client. Dynamic compilers are better for applets.

Just because a Java program is statically compiled doesn't mean it escapes Java's run-time overhead. The program still needs a run-time system to handle garbage collection, thread synchronization, bounds checking, exception handling, and—ideally—dynamic class loading. That's why a statically compiled Java program often isn't faster than the same program running on a good JVM with a smart JIT compiler.

That may change as the compilers get better. Most of them don't do much optimizing, and some are rather crude. One of them converts Java bytecode into C source code, which then feeds through a regular C compiler to produce native object code. Another compiler chokes on finalize() methods, and few of them can handle dynamic class loading.

Several sources told BYTE that static compilers for Java could eventually outperform the best JIT compilers and deliver near-native performance. Those sources include Tim Freehill, the engineering manager for Metrowerks' CodeWarrior; Robert "Rock" Howard, chief technology officer at Tower Technology; Jayson Minard, the product architect for Borland's JBuilder; Jim Russell, manager of Java technology and applications at IBM Research; and Allen Wirfs-Brock, chief technology officer at Instantiations.

On the other hand, Sun, Sybase, Symantec, and Microsoft are leaning toward dynamic compilers or doubt that any technology can make Java as fast as C++. But that isn't necessarily stopping them from developing static compilers. "The move is toward native compilation," says Microsoft's Herman. "We have to get to the point where we have performance comparable to native code, and we're going to need native compilers to get there."

Fast Enough

Does Java really need to be as fast as C++ to succeed? History says no.

Keep in mind the 50-year trend toward higher levels of hardware abstraction. Although Java needs *competitive* performance to succeed, it doesn't need *superlative* performance. When there's a trade-off between raw performance on one side and code productivity and portability on the other, developers rarely choose performance.

The C language replaced assembly language for the vast majority of development, because it's an easier, more portable language than assembly language. C++ has been replacing C for the same reasons. Likewise, Java will replace C++. Sure, some programmers still resort to C or assembly language when they need to write low-level code, device drivers, or critical loops. Java programmers can do that, too.

Besides high productivity and portability, Java offers two additional advantages that help make up for its slow performance: run-time safety and code longevity. Both will become more important in the future.

The PC industry gets away with buggy code on client systems today, but customers won't tolerate it on their mission-critical servers, and they're growing more aware of what it's costing them on clients. That's why mainframes are still popular: They really work. To build reliable systems, PC developers must trade the guns and knives of C++ for the seat belts and air bags of a modern language.

Meanwhile, users are learning the hard way that mission-critical code often lives for decades. Consider the year 2000 problem or the U.S. government's troubles with the air-traffic-control system.

Millions of lines of code written today will still be running 30 years from now. Nobody can predict what platforms will be popular at that time. A virtual platform such as Java is cross-platform not only in the horizontal dimension, but also in the temporal dimension. No matter what new platforms appear, only the JVM and native compilers will have to be ported—not the applications.

All those factors will outweigh Java's laggard performance, as long as Java can achieve at least 50 percent of C++ native performance. That's a much smaller gap than the difference between C++ and assembly language. Even Microsoft thinks Java can reach 60 percent to 70 percent of native performance, and most experts are more optimistic. The enormous amount of effort invested toward that goal and the numerous ways of getting there virtually guarantee that if Java fails, it won't be because it isn't fast enough. B

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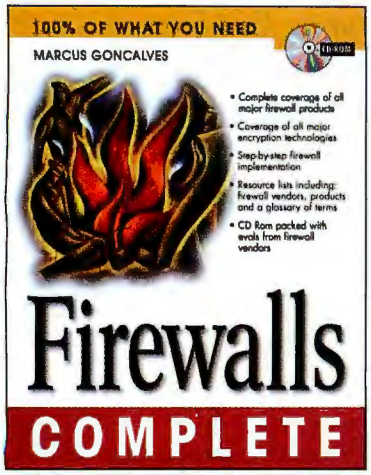

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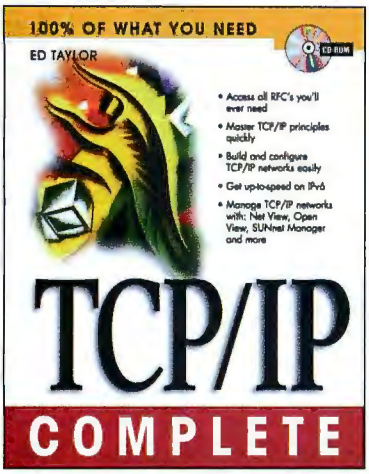

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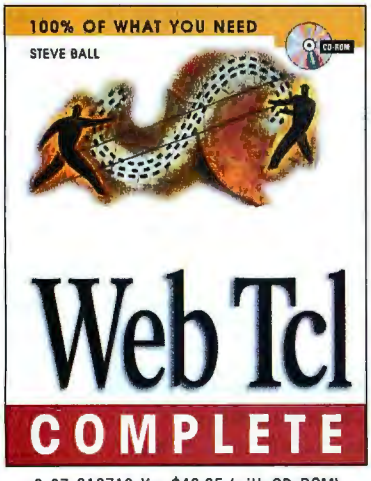

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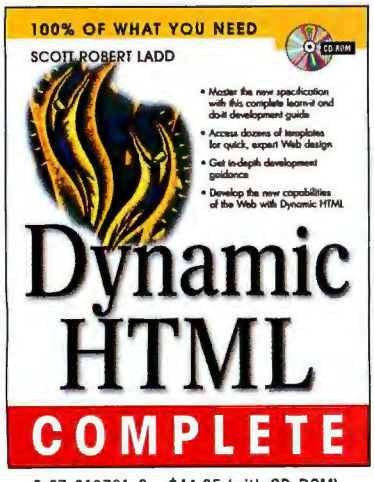

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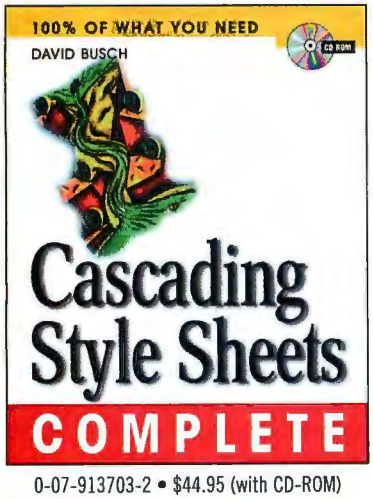

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A maturing Java brings a wide variety of programming solutions to developers.
By Peter Wayner

How to Soup Up Java: PART II

Nine Recipes for Fast, Easy Java

Java has come a long way from Sun's old javac compiler. Today, all the major development-tool manufacturers are putting out serious Java efforts. All this vendor activity is good news for anyone preparing to use Java. The available options have never been better.

We tested nine such products for this report. At one extreme, Lotus BeanMachine might provide the easiest way for someone with no programming skills to produce sophisticated applets for Web pages without writing any source code. It shows how powerful the JavaBeans model can be for making programming accessible to a wide range of people.

At the other extreme lie Symantec's Visual Café for Java, Borland's JBuilder, CosmoCode, and Microsoft's Visual J++, which all have a look and feel similar to that of those companies' C++ products. Traditional programmers will feel right at home with these tools, which have a familiar look, focus squarely on source code, and have debuggers that are much improved over earlier versions.

We also tested IBM's VisualAge for Java and Sybase's PowerJ, both of which offer more elaborate tools that incorporate the source code into their own internal format. Java is a highly structured language, and ASCII source files are far from the best way to store data internally, so these sophisticated tools might be indicative of Java programming's future.

SuperCede's SuperCede Java Edition 2.0 blends Java and C++ development into one package, making it easy to produce applications that use both languages—although the resulting x86 native code doesn't run everywhere, as good Java code should. While Internet-based and cross-platform programming will continue to drive Java development, SuperCede is too good for people building native applications to ignore.

Filling out the list is Sun's Java Studio, a high-level Bean-editing tool meant for connecting compiled Beans rather than hacking Java source code.

Each of these tools focuses, more or less, on simplifying the process of remotely accessing databases. Java looks like a great answer for custom programmers looking to solve database-access problems in a heterogeneous world with a single piece of code.

That said, there are also big differences. Lotus's BeanMachine is a low-cost tool offering rudimentary database access. Aimed at large-scale enterprise developers, Sybase's high-priced PowerJ comes with a wide range of more sophisticated server and client tools. The others all fall in between. Most of the low-end versions come complete with compilers and often with debuggers, ready for building Web-based applets, while the high-end tools include the client and server software necessary to build complete enterprise applications. These usually include middleware that sits on the server and accesses the databases through more traditional C++ interfaces.

We tested all these products on a low-cost Cyrix Media GX system running at 150 MHz with 64 MB of RAM and a 1.6-GB disk. They all ran well on this system, although loading more than two or three of these disk-intensive applications at a time proved impossible.

BYTE BEST
JAVA DEVELOPMENT TOOLS

Borland's JBuilder

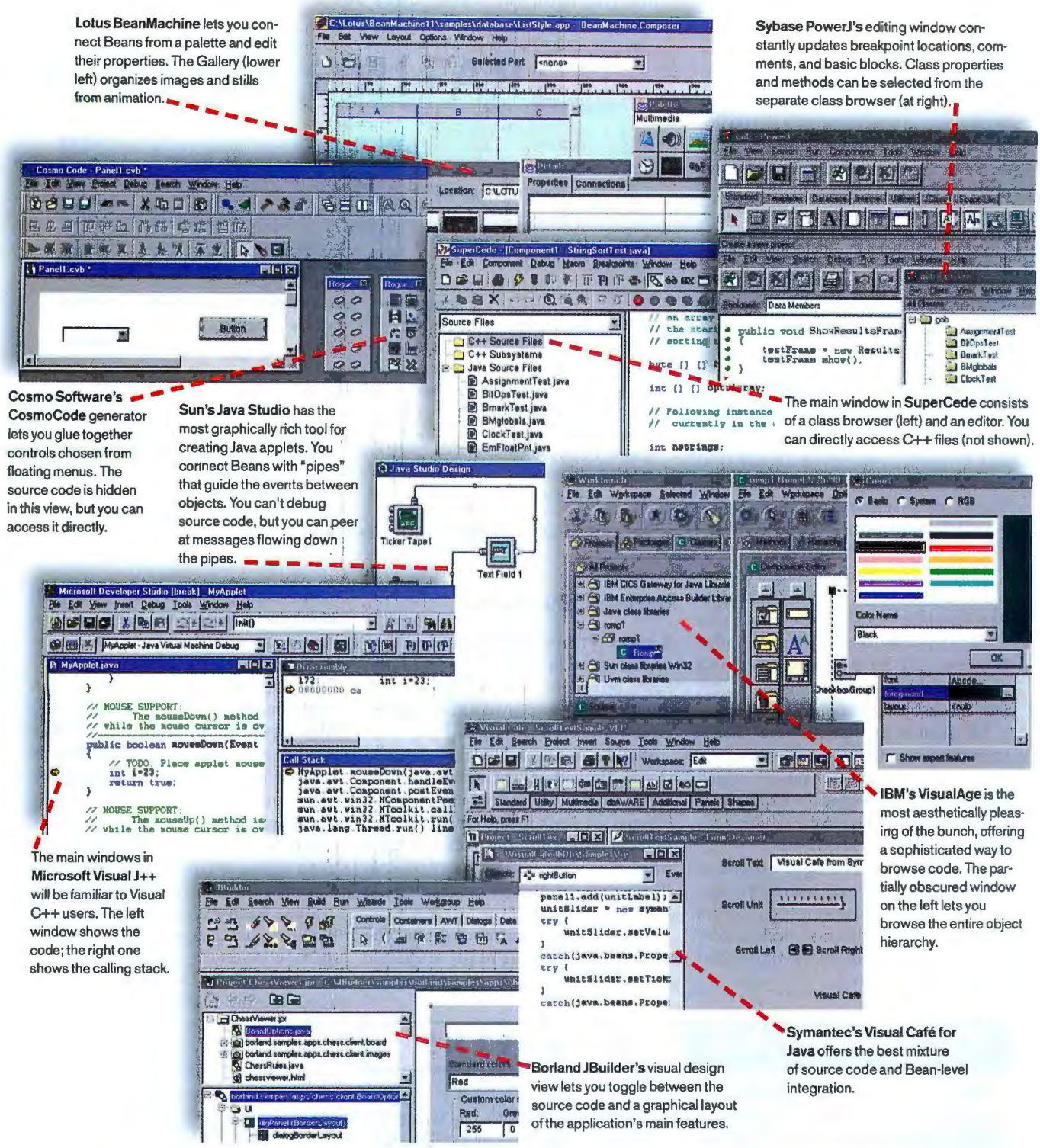
JBuilder stands out because it's fast, crisp, and built around ASCII text. These are the hallmarks that made Borland's Turbo Pascal so popular, and they should serve Java programmers well. JBuilder's compiler is very fast and well integrated with the debugger. This makes it easy to compile, tweak, test, and repeat again and again.

Lotus BeanMachine 1.1

Lotus BeanMachine, deceptively simple yet surprisingly powerful, at first glance seems to be an idiot-proof design tool that lets you string together basic Beans to create slick Web sites. With tools for basic input and output and slick multimedia effects such as animations, ticker tapes, and headlines, BeanMachine lets you join these widgets together and compile them into applets for Web sites without touching source code. Lazy coders, neophyte programmers, and even nonprogrammers will find it useful.

BeanMachine surprised us with its power, letting us inject source code and invoke methods when an event was generated. This simplifies generating forms that animate and do useful analysis. You can go a long way gluing in methods that link into the event hierarchy.

Still, there are limitations: BeanMachine lacks a debugger, so you must resort to the usual black-box debugging tricks



Java tools differ mostly in the degree to which they expose source code to direct manipulation.

to catch errors. Also, there's no easy way to subclass a Bean or wrap substantial functionality around it. We couldn't find where it hides the source code for the applets, and it would be great if you could develop an applet here and extend it in a full programming environment. But even with its limitations, BeanMachine can help you get plenty done.

Cosmo Code 2.5

Silicon Graphics started its Cosmo Software unit to make it easier for people to develop Java code for their SGI workstations. The main product, a Java development tool named Cosmo Code, turned out to be good enough to port to the Windows platform. The latest version, 2.5, includes all the major features of its competitors and provides them all in a richly detailed visual-design environment. *continued*

The software incorporates all the information in a standard integrated editor/debugger environment that lets you see the ASCII text and step through it as you debug. There's also a fairly sophisticated window that sorts the classes, methods, and other elements.

The best feature might be a rich collection of widgets, controls, charts, graphs, and other devices that make it easier to thread together an application. The most frustrating feature is the tiling windows, which make it difficult to open up a text window to fill the whole screen.

Symantec Visual Café 2.1

Visual Café has become one of the dominant Java tools, and it's easy to understand why. It provides a strong visual design field and well-integrated database-access tools. The JavaBeans standard is completely supported, and the wizards that help you lay out new source code are great.

Entry-level programmers might want to start with Visual Café instead of a program like BeanMachine, because its wizards make it quite easy to spin up a good applet. But the wizards leave the complete source code available, providing a growth path into full-fledged programming.

The greatest strength of Visual Café is its ample database support. We tested the complete enterprise-level version, which comes with the tools and the middleware that make it fairly easy to create client applets that access a central server.

Visual Café is one of the few products to offer both a Macintosh and a PC version. The Windows version also provides a native-code compiler that produces x86 native executables for those who demand the best performance.

LAB RATING RESULTS

BEST OVERALL

Borland JBuilder

This well-designed environment offers the best combination of code-level control and high-level visual programming assistance.

	TECHNOLOGY	IMPLEMENTATION	USABILITY	OVERALL
Borland JBuilder 1.2	★★★★	★★★★★	★★★★★	★★★★★
IBM VisualAge 1.0	★★★★★	★★★★★	★★★★	★★★★★
Lotus BeanMachine 1.1	★★★★	★★★	★★★★	★★★★
Symantec Visual Café 2.1	★★★★	★★★★★	★★★★★	★★★★★
Microsoft Visual J++ 1.1	★★★	★★★★	★★★★	★★★★
Sybase PowerJ 2.0	★★★★	★★★★★	★★★★	★★★★
Cosmo Code 2.5	★★★★	★★★★	★★★★	★★★★
SuperCede 2.0	★★★★★	★★★★	★★★★	★★★★
Sun Java Studio 1.0	★★★★★	★★★	★★★★★	★★★★

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

Borland JBuilder 1.2

Borland's Philippe Kahn created an identifiable style when he built the first Turbo Pascal compilers, and this style lives on in JBuilder. This tool provides a fast and efficient way to produce Java code.

JBuilder's approach might be termed classic. The code is kept in ASCII text files that you can edit with another editor. The binaries are stuck in separate directories that correspond to the packages from which they come. It's easy to write code in JBuilder the way that you might in an old Unix environment.

Still, there are nice innovations. The visual design tools are neatly integrated with the source code. If you add a button in the visual part of JBuilder, the ASCII source for initializing and positioning that button appears in the source file. This also works in the reverse direction.

JBuilder comes with a number of different Beans that Borland developed to work together and integrate with its visual design environment. Some are plain Abstract Window Toolkit (AWT) objects; others are more intricate, including a number of Beans for building business charts, spreadsheets, and outliners. It's a nice collection, but it could use some glitzier components, such as animators or ticker tapes.

Some Bean devotees might not like JBuilder's visual approach because it's so source-code-centric. Some of them believe that Beans should be manipulated at a higher level by sending commands to real objects, not changing the source code that produces the Beans. So be it. If that's your feeling, then a tool like BeanMachine is a better choice for you.

Microsoft Visual J++ 1.1

Microsoft is one of the big players in the C++ development world, so it's no surprise that it leveraged its marketplace strength by extending Visual Studio to embrace Java. The result is Visual J++, a tool with many familiar-looking features.

The biggest problem with Visual J++ is it doesn't embrace the full JavaBeans component model, which is now fairly standard. This might change if Beans become dominant, but for the time being

TECH FOCUS | JAVABEANS

Invasion of the JavaBeans

The most striking element of the tools in this roundup is their adherence to the JavaBeans model. Sun's decision to push everyone to write to JavaBeans was risky because it changed the entire event model that was part of the early AWT. But tools like Lotus's BeanMachine illustrate why this is such a good idea.

A JavaBean is a lightweight Java object written to conform to a rigorous model that allows meta-programming tools, such as BeanMachine, to analyze the workings of the Bean. For instance, the names for functions to access variables are created by adding the suffixes "set" and "get" to the variable name. Therefore, the method getAverage should return the value of the variable "Average."

This makes it possible for tools like BeanMachine to use introspection and automatically determine which variables are manipulated by which methods. This also makes it possible for a visual tool to link up Beans without requiring the programmer to write source code.

JAVA DEVELOPMENT TOOLS FEATURES

	Visual Café 2.1	Sybase PowerJ 2.0	Borland JBuilder 1.2 ★B	Lotus Bean-Machine 1.1	Visual J++ 1.1	IBM VisualAge for Java 1.0	Cosmo Code 2.5	SuperCede 2.0	Java Studio 1.0
Price	$99; $299 (Prof. Dev. version); $499 (Data Dev. version); $1495 (25-user database version)	$1995	$2495 (Database Server version)	$159	$1995	$1995	$329	$99	$99
Typical hard disk required (MB)	35	225	70	16	31	100	70	200	40
Bean-compatible	✔	✔	✔	✔		✔	✔	✔	✔
Wizards for development	✔	✔	✔	✔	✔	✔	✔		✔
Built-in components	100+	300+	150+	22+	100+	120+	120+	70+	50+
Code obfuscator			✔						
Native database gateway	With top	✔	✔			w/Enterprise		✔	✔
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Open access to different VMs	✔	✔			✔				
Easy transitions between 1.02 and 1.1	✔	✔		✔			✔		
ActiveX components		✔			✔	w/Web Runner			
C++ integration						✔		✔	
Generates EXE and DLL files	✔							✔	
Debugger	✔	✔	✔		✔	✔	✔	✔	
Debug in application (like Netscape)	✔	✔			✔				
Macintosh version	✔								

★B = BYTE Best ✔ = yes

J++ users will feel a bit behind the times.

There are still plenty of other reasons to recommend J++. Its Java virtual machine (JVM) is one of the best in the industry, and its tools come with extensive documentation. And the Visual Studio is a great environment that provides a good breakdown of methods and code.

IBM VisualAge for Java 1.0

IBM's VisualAge takes a sophisticated approach to Java development. All the source code is sucked into a central file, and the bytecode is kept attached to it. When you want to publish the code on a Web site, you push a button and it emerges as a JAR file or the class files.

The advantages of this approach are speed and flexibility. ASCII source code is a pretty inefficient way to represent object-oriented software with many methods and variables. The source code must be continually parsed and reparsed as it's edited. If the methods, classes, variables, and so on are kept in custom-designed data structures, then searching, compiling, and execution can be more controlled.

There are downsides to this approach. It's more complicated for developers to use the best compiler or tools for advancing a project. And you must export the Java source to use it with other tools.

SuperCede 2.0

SuperCede might be the most advanced tool in this roundup because it integrates Java projects with C++ so that you can mix and match code. This approach might be the most attractive for developers who want to produce native code for machines like the x86 while leveraging the capabilities of the Java language. It will likely be less attractive to developers who want to produce cross-platform Java applets.

In either case, the rapid application development (RAD) tool incorporated with SuperCede is excellent. It provides a sophisticated graphical development environment and an excellent visual editor. The compiler is fast and produces code that can be hot-patched. If you find a small error and want to fix it, you can compile the new code and drop it into place without restarting the entire program. This is a great feature. We also like the fact that SuperCede registers its own special sounds for alerting you to breakpoints and errors.

Tools like SuperCede will certainly be part of Java's future. The language is too good to be relegated to developing bytecode for cross-platform use. SuperCede is a great tool for leveraging these advantages and using them for serious development for native Win32 platforms.

Sun Java Studio 1.0

Java Studio is not a complete development package like the others. It's more a visual development tool than a compiler and source-code-editing environment. You drop components into a window, where they appear as boxes with pipelike fittings for routing the events. You then design an applet's behavior by linking these boxes with pipes.

This might seem like taking the saying "a picture is worth a thousand words" to the extreme. But we found Java Studio ele-

gant and easy to use, though a bit awkward when the number of boxes and pipes grows large. Also, we wish you didn't have to create another box to insert a line or two of source code to tweak an event before it reaches its destination.

Also, programmers will probably disagree about the way applets are generated. In Java Studio, you push a button and answer a few questions, and the class files appear somewhere. You can produce fairly neat applets without ever typing a curly bracket. Beginners and object-oriented-programming (OOP) aficionados will like this approach, but code-heads who have spent hours learning the idiosyncrasies of a compiler might feel disconnected.

In all, Java Studio is a close cousin to BeanMachine in approach. But it comes with substantially more components and many more options for more-advanced users to manipulate.

Sybase PowerJ 2.0

Sybase's PowerJ, like IBM's VisualAge for Java, takes a sophisticated approach to Java development. Like VisualAge, it sucks all the code into its internal data structure and manipulates it. The resulting marked-up data structure allows more in-depth analysis than you typically get from tools that store programs in ASCII text format.

PowerJ comes from Sybase, so it's no surprise that it's a full-featured, enterprise-level package with a wide range of solutions for building databases and providing client-level access to them. It comes with a full toolkit and plenty of examples.

PowerJ is also one of the more Microsoft-friendly products in the group, providing an easy way to integrate ActiveX controls with Java. This might not be what Sun intends, but it might be the fastest way to pull together an x86 application if you have some prewritten ActiveX controls.

PowerJ will appeal most to corporate developers who already use other Powersoft database tools, such as PowerBuilder.

The Microsoft Story: Chapter Two

Microsoft's next version of Visual J++ will provide Java developers with a teasing trade-off by promising increased performance in return for obeisance to the Windows platform. Bill Dunlap, product manager for Visual J++, says that's because Microsoft's customer surveys have shown that a large number of users love Java the language but are frustrated by its performance.

Microsoft's solution is to make it simple for people to code in Java and mix together more functional versions of controls and ActiveX components. The company is working on Windows Foundation Classes that, like the Java AWT, will enable users to write directly to the native Win32 API. Microsoft's version, however, will provide more robust interaction. You won't be limited to the five major Java fonts, for instance, and you will be able to invoke whatever TrueType fonts are installed. Many of the highly tuned details of the Windows API will be open to your commands.

The downside to taking this route is the loss of compatibility. Applets that call the new classes will work only on computers with a Microsoft OS, and cross-platform development will be a memory. Says Dunlap: "We're not going to go out and call ourselves 'the best pure Java tool' out there. We'll leave that to Café and JBuilder. We're going to be the best tool for developing Java programs for Windows."

There will be incentives. The RAD tool built into the new version will spit out only Windows-capable code. You can still develop cross-platform pure Java, but you'll need to type the ASCII text yourself.

The new version of Visual J++ is expected to be available as a "Technology Preview" by the time you read this. See "Java for Windows" on page 41 for a hands-on report.

Final Thoughts

The top product of the bunch, Borland's JBuilder, gave us the best feel of the raw code, which might seem antiquarian to moderns who hope that OOP and instantiation will take us beyond all that.

It may be that this source-code-centric view of programming is reaching its end. BeanMachine is surprisingly powerful for a product that doesn't allow you to touch the source code that's fed to the compiler. BeanMachine might be the best argument for the Bean creation-and-linking model imagined by the creators of JavaBeans because it shows that the Bean model can be used to create a low-cost but powerful tool for nonprogrammers.

Finally, while our bias may be toward the lower-end developer, there's no reason why programmers with bigger projects and a bigger budget shouldn't use the relatively more expensive IBM VisualAge for Java or Microsoft Visual J++. To a large extent, you get what you pay for. B

Peter Wayner is a BYTE consulting editor and writer based in Baltimore. You can contact him at his Web page: **http://www.access.digex.net/~pcw/pcwpage.html.**

PRODUCT INFORMATION

Borland JBuilder 1.2
$2495 (client/server suite)
(for Windows 95, NT)
Borland International, Inc.
Scotts Valley, CA
800-233-2444
408-431-1000
http://www.borland.com
Enter HotBYTEs No. 1076.

Cosmo Code 2.5
$329
(for Windows 95, NT, SGI)
Cosmo Software
Mountain View, CA
650-933-6088
http://cosmo.sgi.com/
Enter HotBYTEs No. 1078.

IBM VisualAge for Java 1.0
$1995 (Enterprise Edition)
(for Windows 95, NT, OS/2)
IBM Corp.
Somers, NY
770-863-1234
http://www.software.ibm.com/ad/

Lotus BeanMachine 1.1
$159 (estimated retail price)
(for Windows 95, NT)
Lotus Development Corp.
Cambridge, MA
800-343-5414
617-577-8500
fax: 617-693-0968
http://www.lotus.com/beanmachine
Enter HotBYTEs No. 1079.

Microsoft Visual J++ 1.1
$1995
(for Windows 95, NT, OS/2)
Microsoft Corp.
Redmond, WA
206-882-8088
http://www.microsoft.com/
Enter HotBYTEs No. 1080.

Sun Java Studio 1.0
$99
(for Windows 95, NT, Solaris)
SunSoft, Inc.
Palo Alto, CA
800-786-7638
650-960-1300
http://www.sun.com/studio
Enter HotBYTEs No. 1081.

SuperCede Java Edition 2.0
$99 (for Windows 95, NT)
SuperCede, Inc.
Bellevue, WA
800-365-8553
425-462-7242
http://www.supercede.com
Enter HotBYTEs No. 1075.

Sybase PowerJ 2.0
$1995 (for Windows 95, NT)
Sybase, Inc.
Emeryville, CA
800-879-2273
510-922-3555
http://www.sybase.com/
Enter HotBYTEs No. 1082.

Visual Café for Java 2.1
$99–$1495
(for Windows 95, NT, Macintosh)
Symantec Corp.
Cupertino, CA
408-253-9600
http://www.symantec.com/
Enter HotBYTEs No. 1083.

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http://www.byte.com/hotbytes/

Computers to Go

What kind of portable will best suit your needs? And what improvements can you expect in the next couple of years?

By Russell Kay

1 Mitsubishi Amity CN
2 WinBook K6-233
3 HP 620LX
4 PageWriter 2000
5 TI Avigo
6 HP Sojourn

PHOTOGRAPHY: STEVEN GREENBERG © 1998

Just a couple of years ago, if you said, "mobile computing," everyone knew what you were talking about: laptops. These densely packaged, battery-powered little PCs were popping up everywhere. But the rapid increase in processing speeds and chip densities, coupled with the advancement of display technology, has lowered the cost of computing power, sparking the development of whole new classes of computing and communications devices.

Today we have notebooks, subnotebooks, mini-notebooks, hand-held PCs, personal digital assistants, smart phones, and two-way pagers. But we don't need to tell you that; you probably already have two or more of these little devices. And we don't need to tell you which kind of device is good for particular kinds of computing and communications; you've probably got that down, too. Instead, this article looks at how these devices are going to evolve into their next stages—what technologies need to change and what kinds of devices you can expect to be able to purchase during the coming year.

Balancing Act

Designing a portable computer is one of the ultimate expressions of the phrase "engineering trade-offs"; when you change *x*, you must also change *y*. If you want a larger monitor, you're going to add weight and power consumption. Conversely, if you want a 2-pound computer, you're going to sacrifice things like battery life, monitor size, and keyboard size. Everything must balance.

Here are the 15 areas where most of the trade-offs happen:

1. Case design, size, and weight
2. Processing power
3. Memory
4. Keyboard
5. Navigation devices
6. Display
7. Video circuitry
8. Video input
9. Storage
10. Communications and networking
11. Battery life
12. Heat dissipation
13. Connectors
14. Additional I/O devices
15. Expandability

We can examine some portable-computing issues, including how these machines interact and where they might be headed, by designing what at least one BYTE editor considers an ideal portable computer, looking at what is (and isn't) possible with today's technology (see the text box "Proposing the Perfect Portable" on page 80NA 2).

As for what we can expect during the next few years, let's look at it while performing a modified version of that hoary old party dance, the hokey-pokey.

You Put Your Data In...

Getting data into a computer is a necessary first step. Right now, for most purposes, that means a keyboard. Some of the ultra-thin systems coming out this year have keyboards with a very short throw: a millimeter or two. This makes a keyboard feel stiff. The ultra-narrow systems have narrow keyboards—in many cases, too narrow for touch-typing (witness Toshiba's Libretto and most of the Windows CE hand-held PCs). IBM has experimented

Proposing the Perfect Portable

To get a clear view of what's possible with mobile computing, let's indulge in a little fantasy. I'm going to design the perfect portable computer, one that fulfills all my needs and wants, with a little regard (but not too much) for what's doable with the current technology.

Case Design, Size, and Weight
Clearly, I want a computer that's small and light, but I need to be able to type on it and read its display. So, let's say I want the final package size to be a bit smaller than the current subnotebooks—roughly 8 inches wide, 6 inches front to back, and under 1 inch thick. Weight, under 2 pounds.

I want a good-size, built-in, retractable handle for easier, more secure carrying. Any little doors used to cover connectors should retract into the case, not be removable (and thus prone to loss). And can I please get this in some color that's not gray or black?

Processing Power
Of course, I'll want the fastest CPU I can get—say, a 400-MHz Pentium II, with as much L2 cache as the CPU can support.

Memory
I'll need at least 64 MB of synchronous DRAM (SDRAM), expandable to 1 GB.

Keyboard
A small package means a too-small keyboard. Here's the perfect place for a newer, more rigid version of IBM's "butterfly" unfolding keyboard, one that grows at least 2 inches wider when the case is opened. Good key switches with tactile feedback are a must, and the key tops must be thick enough to provide decent separation between adjacent keys so that your fingers can find their proper places.

Pointing Devices
This is such a personal and nonrational choice that I'd like to see several options available: a trackpoint-type stick in the middle of the keyboard, plus a touchpad below that's replaceable with a trackball, as in the original Compaq Armada 4100. Hewlett-Packard's mouse-on-a-stick might be an option, but what I'd most like to see is a retractable platform on the side to be used with a real mouse (with a wheel, of course). And when I'm not using the mouse, can I please dock it inside the portable unit's case? No, not attached outside with Velcro, but firmly located inside the case's volume.

Display
Given the case size that I've defined, it's possible to fit about a 9½-inch display (active-matrix, of course). However, that's simply not big enough for a lot of users, who need to run at SVGA or XGA resolution without squinting. Let's face it, I really want a 14- or 15-inch screen.

I've seen a keyboard that gets bigger; how about an expanding or unfolding display? But the standard display panel, whatever its size, must be bright and clear, with the image clearly visible from at least 60 degrees off-axis horizontally and vertically.

Video Circuitry
I want 8 MB of high-speed video memory, MPEG-2 and zoom-video support in hardware, fast 2-D and 3-D acceleration, and support for an external display at a different resolution than what's simultaneously being used on-screen. If this were a desktop, not a laptop, I'd specify at least two monitors side by side.

Video Input
While we're getting ready for the twenty-first century, let's also fit in a small, aimable video camera to be used for conferencing—perhaps similar to the unit Toshiba uses, but built into the case. And let's put it on a pull-out cable or arm so that one can also use this video-input device for limited document scanning or capture.

Storage
I'll accept no less than a 4-GB hard drive (and might as well go for today's laptop limit of 8.4 GB), plus a built-in combo DVD/floppy drive that occupies only one bay. I'd like this to be a rewritable DVD, but that will have to wait out a standards battle. Users should be able to hot-swap in an additional module for an extra hard drive, a CD writer, or a high-capacity removable drive.

Communications and Networking
The very minimum is a built-in 56K modem meeting the new international standard, plus a 10-/100-Mbps Ethernet connection, both with no need for any add-in cards. Third, let's include a normal digital cellular phone for both voice

with its "butterfly" collapsing keyboard. All these examples have drawbacks, and no "savior keyboard" is on the horizon.

But speech recognition, already surprisingly effective, is developing fast, and some full-size laptops now come with built-in software. Micron, for example, bundles Dragon Systems' Naturally Speaking with its notebooks. Speech will likely become much more widespread in the future, but it's unlikely to replace the keyboard completely in the foreseeable near term—either on the road with portables or in our open-door, open-top office cubicles.

What about graphics-based input? Toshiba's Tecra 750CDT laptop was the first to include a video camera for conferencing and scanning. This should also be a boon for those who do library research.

Smaller machines (i.e., PDAs) can get by with stylus-based input, either through tappable on-screen keyboard grids, like the T9 keyboard in Texas Instruments' Avigo, or handwriting recognition, like the Graffiti alphabet in the 3Com PalmPilot. But this works simply because you don't enter much data that way. According to several vendors, a stylus will be around for some time in small-screen devices, simply because fingers are too big and regular pens damage display screens. For serious data entry, such as getting 1000 addresses into a PDA, you download the information from your PC over a cable or IR link; there's no practical alternative.

You Get Your Data Out...

With a portable, output is normally the display screen; printing is rarely an issue. Displays represent a problem in terms of future development, for several reasons. First, today's flat-panel LCD screens are already good enough, big enough, and bright enough for most users; they don't need significant improvement. "The 14-inch TFT [thin-film transistor] display is actually significantly better than most 17-inch CRT monitors," says Greg Munster, product marketing manager for Hewlett-Packard's mobile-computer division, "and thus it's all most users really need or want." But the big screens don't cut it in terms of price and power consumption. Ironically, the worst problem of all might be size. We all want a bigger screen, but we want the total package to be as small and light as possible.

How do you shrink a display screen without shrinking the image? There are three likely possibilities: a display whose physical size can be reduced for transport and enlarged for use (e.g., some kind of foldable LCD or mirror-based system), an

and data communications.

Why carry around a separate device that you have to hook up to your computer? Nokia is already building computer functions into its high-end GSM phone; it would seem far simpler (and more marketable) to instead build a phone into our portable PC.

Battery Life

All these features should consume minimal electrical power so that we can reduce the number of batteries and increase their working life. The battery pack should be no bigger than, say, four AA cells. It should be good for 6 hours before needing recharging, and, in a pinch, it should be able to run on real AA cells, which you can obtain almost anywhere.

Heat

As CPUs and disk drives get smaller, they consume less power and thus generate less heat, which in turn allows tighter packaging. That's good, because I can still remember the first 5-V Pentium laptop that BYTE tested: The magnesium case reached 118°F—and no, you didn't want to put that on your lap!

Connectors

Current laptops are seriously limited in the number of add-on connectors they can fit around the edges of the case, primarily because each is different from the others. Let's see: two PC Card slots, two infrared ports, one DB-25 parallel port, one DB-9 serial port, one mini-DIN mouse jack, one mini-DIN keyboard jack (and no, I don't want to have to choose between mouse and keyboard), one RJ-11 telephone jack, one RJ-45 Ethernet connection, one earphone/speaker jack, one microphone jack, one DB-15 video port, one RCA video-out-to-TV jack, one external power adapter (preferably just a cord, without a wall wart), a SCSI connector, and one or two universal serial bus (USB) jacks.

Oh, yes, let's not forget the docking connector, the Kensington security slot, and the on/off switch. And we really ought to include an IEEE-1394 connector.

And even with all this multiplicity, some of these connections are doing double-duty, especially the parallel port. Let's hope that widespread adoption of USB can eliminate the need for so many different connectors.

Additional I/O Devices

With the experience of numerous PDAs behind me, I'd like to see a few additional input devices built into my perfect portable. First, a voice recorder with a microphone and controls that are accessible when the case is closed. Second, I want a panel for pen/stylus input of graphics and text, together with excellent handwriting recognition. Requiring users to write in the specially modified Graffiti alphabet, as with the PalmPilot, would be an acceptable compromise.

Expandability

I've already talked about memory, swappable disk drive modules, and interchangeable pointing devices. Everything should be hot-swappable, without interruption of processing. I'm going to assume the availability of an effective, lockable docking station with extra drive bays, PCI slots, a network connection, a printer, and other attached peripherals for those instant office situations.

image projector with a folding screen, or a tiny image that's magnified by a lens. The first would be useful, but so far no one seems to have invented one. The second is really just speculation, because it raises even more severe power and brightness questions than the current technology.

But the third might soon be possible. A number of companies, including DisplayTech, Kopin, and Siliscape, are developing small LCD displays that you can hold up to your eye behind a lens (think one-eyed View-Master slides, and you get the idea) to see a decent color image.

At the present time, the resolution is at VGA levels and the number of colors is limited, but the potential is there (see "Mini Displays Get Sharper Focus," September 1997 BYTE, page 24). Indeed, Rockwell incorporated such a display into its body-mounted computer, the Trekker (see "Wearable Pentium," September 1996 BYTE). Kopin has demonstrated a display small enough to be built into a Motorola Startac, the smallest cellular phone on the market, so getting faxes on the run might someday be truly easy.

You Store It on Your Hard Drive

Disk drive technology is, for the moment, advancing faster than Microsoft's attempts to occupy it all for Office 9x, so storage capacity isn't much of a problem. IBM is currently supplying 8.4-GB hard drives in some ThinkPads, and more will come. Solid-state or other nonmagnetic technologies might eventually replace magnetic disks, but not soon. And high-capacity removable drives—those of the Zip/Sparq/Shark/SuperDisk/Jaz/Quest ilk—will take care of the need for moving data physically.

Digital versatile disc (DVD) drives are starting to appear as options on some full-size laptops. Apple's Greg Joswiak says that "the availability of DVD will be important for our newest generation of PowerBook laptops, which are heavily used for graphics presentations and video-intensive applications."

And You Bake It All About

Heat has been a constant concern of designers of full-function laptops and associated peripherals. The first 5-V Pentiums and older DRAM chips ran at shockingly high temperatures and required fans for cooling. Earlier hard disks were also serious heat producers, and we've had more than one PC Card modem that ran hot enough to fry itself. However, the modern versions of all these components run

Which Portable for You?

Class of device	Pluses	Minuses	Best applications	Available machines
Smart pagers	Easy paging and e-mail; real OS; graphical display for future application development	Difficult keyboard; tiny display; no expandability; limited storage	Paging	Motorola PageWriter; Airtouch; Research In Motion Inter@ctive Pager
PDAs	Fits in shirt pocket; easy synchronization with PC apps	Text entry awkward; screens dim; add-on applications limited	Address books, calendars	Apple MessagePad; TI Avigo; 3Com PalmPilot; IBM WorkPad; Zaurus SE-500; Psion Siena
Hand-held PCs	Color displays bright and sharp; dedicated application buttons	Mono displays dim; touch-typing impossible	Light-duty computing, e-mail	Win CE PCs from Casio, Compaq, Hewlett-Packard, LG, NEC, Philips, and Sharp; Psion Series 3 and 5
Subnotebooks	Small; under 3 pounds; serious power; runs full Windows 95 apps	Limited expandability and battery life	Real work in tight quarters (although keyboards and displays are marginal)	Hitachi Traveler; Mitsubishi Amity; IBM Nimantics Persona; Toshiba Libretto; ThinkPad 735 (Japan only)
Superthin laptops	Sleek; attractive; attention-getting; 233 MHz; 64 MB; TFT display; under 3 pounds	Expensive; needs add-ons for I/O	Instances where a floppy or a CD is not needed	HP Sojourn; Mitsubishi Pedion
Full-size, full-function laptops	Everything in one package; easy desktop replacement	2 inches thick; weighs 8 pounds or more; expensive; limited battery life	Anything	Too numerous to list

much cooler, and heat-control methods have also improved through the use of conductive fluids, heat pipes, innovative heat sinks, and, yes, fans.

Increases in clock speeds that would otherwise present a serious thermal challenge to laptops have been largely offset by accompanying decreases in physical sizes and operating voltages. The highest-speed mobile Pentium CPUs made with 0.25-micron technology today run at only 1.8 V internally, while memory and I/O run at 3.3 V. Intel's *Mobile Power Guidelines* for 1999 target the core at 1.6 V, and memory and I/O at 2.5 V. According to Intel, average laptop power consumption (excluding displays) has doubled (from 10 to 20 W) from 1994 to 1997, and if heat dissipation isn't addressed, it's projected to nearly double again by 1999.

With proper management, however, the thermal load can be restricted to 23 to 25 W. For smaller portable devices, lower-powered, non-Intel CPUs, such as Hitachi's S3 and Digital Equipment's StrongARM, simplify heat-control issues.

Closely allied with heat is battery power, since excessive heat means wasted electricity. Therefore, heat reduction contributes to longer operating time between recharges, as well as increased battery longevity through reduced thermal stress.

Battery life (i.e., time of operation) has always been a point of contention, with users needing more than portables can deliver, and with manufacturers quoting highly optimistic specs. Today's lithium-ion cells represent the third generation of laptop battery technology, and at the moment there's no near-term replacement in sight that offers greater energy density in a compact package. (Zinc-air and starved-electrolyte cells have been shown for laptops, but they're currently too bulky to build in and are suitable only for add-on battery packs.) For the business sky warrior, airliners with the new generation of computer-friendly power plugs are a welcome development that will take some of the pressure off laptop and battery designers alike.

You Do the Clickey Pokey...

With GUI screens and most modern software usable on portables, you absolutely need to have a pointing/navigation device. Yes, you can certainly perform a lot of operations in Windows 95 or NT or the Mac OS using keyboard shortcuts, but you can't do everything.

So, you need a (choose one): mouse, mouse-on-a-stick, touchpad, trackpoint, joystick, trackball, digitizing pad/pen, or touchscreen. The mouse was there first, and most desktop systems still have one, with trackballs coming in a very distant second place. The other pointing devices were all designed to concentrate fingertip screen navigation into a small, fixed space. They all work—some better than others—and we will likely see even more ingenious systems in the future.

If it were any smaller, and if the case were tan, you might mistake this Inter@ctive Pager for a big walnut.

And You Connect Yourself Around

One problem facing portable designers is the number of different connectors they must incorporate into their machines for communications and peripheral hookups. A typical full-size laptop these days can have almost two dozen I/O connectors and switches on the outside of its case. And there still have to be bays for removable drives and batteries, plus upgrade

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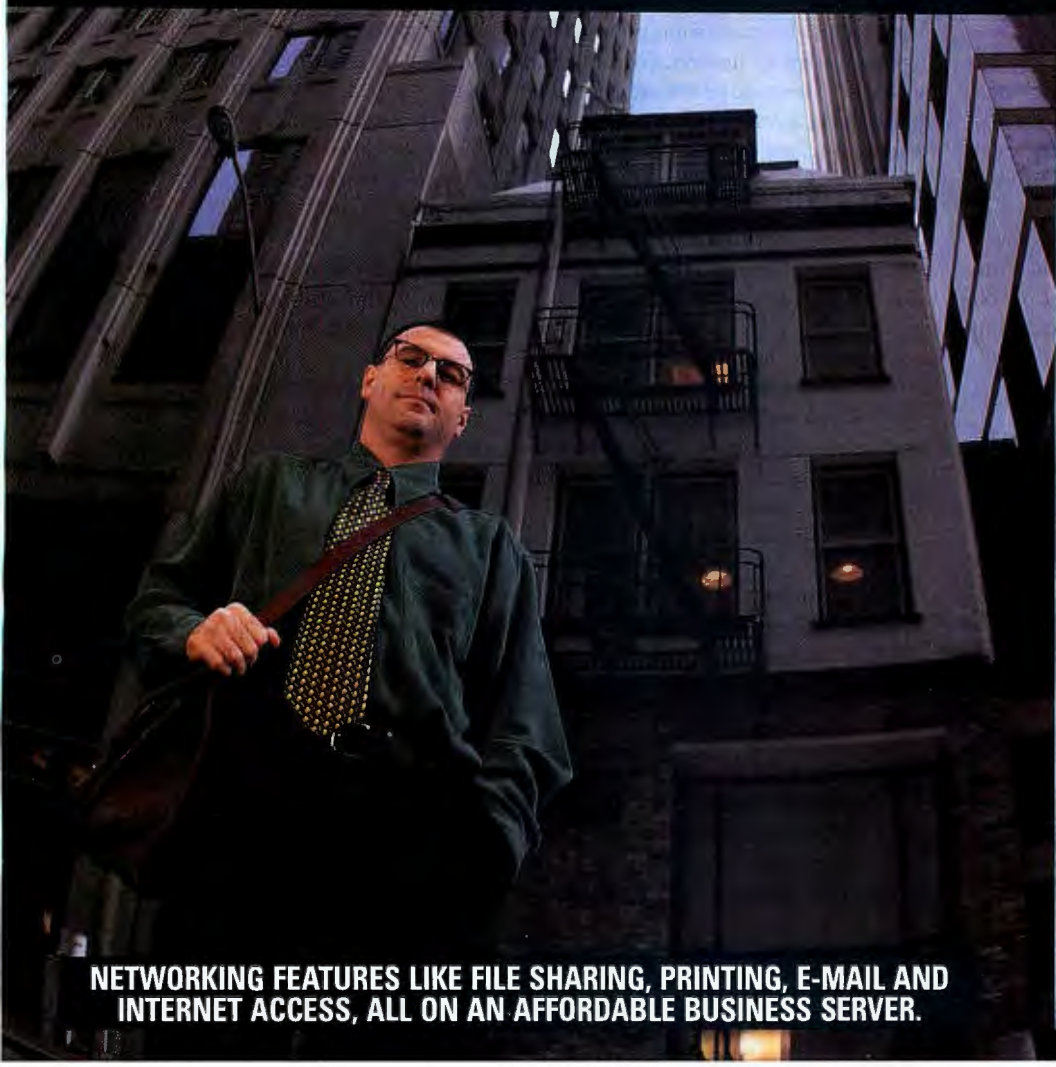

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access to the memory and hard drive.

The universal serial bus (USB) standard, which can hook up to 127 different devices, is one good possibility for replacing many, though not all, of those varied connectors. Also, eliminating the number of different components would noticeably reduce the manufacturing cost of the system for both parts and labor.

For all its potential, however, USB has been slow to catch on, and it's not clear when it will reach the critical mass of acceptance. There's still only a trickle of USB peripherals available, and most of the things people want to plug into their portables need some other connector.

A pure USB machine is an interesting idea, but it seems to be science fiction. No portable maker we talked to, including Compaq, HP, and Toshiba, seems to be even considering such a machine. Mark Hanson, a product manager for Compaq's Armada laptops, thinks the great number of legacy peripherals will limit USB's acceptance. "IEEE-1394 will be more likely to replace some other connectors and will also be implemented in drive bays, although it raises some power-management issues," he says. For better or worse, USB seems to be not a replacement but just one more connector standard—aggravating, not solving, the problem.

PDAs such as TI's Avigo organizer let you carry an extensive amount of data in your pocket.

That's What It's All About!

Finally, we come to the matter of software, without which none of these machines is more than a paperweight. The larger machines use full-function desktop OSes and applications, so you need make no compromise when selecting them. Certainly Windows 95 (and soon 98?) and NT are widely available on laptops and subnotebooks, and Macintosh fans have the PowerBook laptops.

For hand-helds and PDAs, though, you must consider your needs and choose carefully. Do you go with Windows CE, now in version 2.0, or a proprietary but more efficient (and perhaps more limited) OS, such as Psion's EPOC, Apple's Newton, or the 3Com PalmPilot's Palm OS?

There's been significant application development for the PalmPilot (*http://www.pilotgear.com/index.html* lists over 1100 Pilot applications) and Psion machines; the current crop of CE applications is limited by comparison but likely to grow rapidly. Still, all the smaller machines are adequate for taking notes and doing minor data entry in the field, they're a lot easier to carry around, and you can easily upload your work and information to your desktop or full-laptop PC.

What's Next?

As we approach the twenty-first century, we're more likely than ever to have some type of portable computer with us. Today's mainstream laptops are too big and heavy for general carry, and they're suited only for sit-down, tabletop or desktop operation. Thus, the smaller portables we've discussed—PDAs, hand-helds, mini-notebooks—are where the real action and innovation are called for.

We could use one more development: standardization. Today's portables have just too many limiting incompatibilities among their hardware, accessories, and system software. You can interchange PC Card modems, but you don't get much beyond that. Docking stations? A painful subject. Is it too much to ask for hardware that's usable with several different brands instead of being specific to a single vendor's line? Desktop architectures have failed precisely because of such incompatibilities—remember Micro Channel?

The mass (and mess) of device-driver software is another place where unnecessary individualism rears its head and makes interoperability difficult. Standardizing on fewer connectors, as discussed earlier, would simplify life for everyone.

Will we ever see such standardization? Somehow, we don't think so. The industry will muddle along for the next few years on an incremental path. But until (or unless) someone develops a *really* new approach to computing, we'll carry evermore-powerful (and, hopefully, smaller) computers with us to complement our digital address/schedule books, cellular phones, pagers, GPS receivers, and who knows what else.

Today's laptops have gotten big and heavy enough to require travel cases on wheels. Maybe, with all these computing devices hung on our belts, inside our pockets, and locked up in our shoulder bags, we should just admit that *we're* the ultimate portable-computing device, strap on rollerblades, and be on our merry way. B

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WHEN PARALLEL LINES MEET

Only parallel databases wring the best performance out of parallel-processing systems.

By Ken Rudin

Databases today start out as gigabyte babies and rapidly grow to terabyte toddlers. Feeding their growth are trends including: the rush to build data warehouses that consolidate all your corporate data, the desire to put ever more information on-line for access by Internet or intranet, data mining solutions that require access to detailed transaction-level data, and the corporate longing to track every interaction with customers. And the data itself is expanding to include documents, pictures, video, and anything else that exists in digital form.

Large and rapidly growing databases strain the abilities of traditional hardware platforms. Just storing all this data will stress most existing platforms. But an even more serious problem is the ability to query these mountains of data in a reasonable amount of time. Traditional single-processor machines don't have the raw number-crunching power to sift through these large and growing databases efficiently.

In response to these needs, hardware vendors have created multiprocessor machines (historically referred to as "parallel" platforms, and now more frequently referred to as "scalable" platforms). These systems can hold from two to hundreds of processors. The resulting computers give you enough aggregate processing power to handle all your data more quickly.

However, these scalable hardware platforms are only one part of the solution. Their strength in numbers won't help if the database software is not able to take advantage of the hard-

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Partitioning Data

Due to the large size of modern databases, you might find it beneficial to divide an entire database into smaller partitions. Each partition then resides on a different disk or another data store. In a multiprocessor system, especially a shared-nothing hardware architecture, the CPUs in each node are responsible for their own data stores. Since these CPUs must respond to requests for either data or results from their owned data stores, it is important to create the partitions judiciously for optimum processing.

For example, each partition should have approximately the same number of records. Why? Because if some partitions are larger than others—a condition called *data skew*—tasks performed on those partitions will take longer. This will mess up the parallel processing because one processor has to do more work than the others. Because of this unequal distribution of labor, the query takes longer than it should.

Unfortunately, it's easy to choose a partition scheme that results in data skew. An example would be partitioning a sales table by month when most of your sales are during the Christmas season. As a result, nearly all the data would end up in the December partition, and very little data would be in any other partition. Partitioning by customer name would also result in data skew, since more names begin with some letters (like M and S, in English) than with others (like X and Z). Partitioning by year is probably the worst choice, since most queries will probably be looking for the most recent data, and the CPUs that own that partition will get run into the ground. (This is known as the problem of access frequency.)

There are three basic forms of partitioning: round robin, hash-based, and range (see the figure "How to Partition Data" at right). You can create hybrid methods, based on these three, for specific purposes.

Round robin is the simplest way to partition. With *n* data stores, the first record goes in the first data store, the second in the second store, and so on until the *n*th record goes in the *n*th data store. Then the next record goes in the first again, the next in the second, and so on. Round robin thus guarantees nearly equal partition size. The major drawback of round-robin partitioning is that it does not help expedite searches for specific queries, unless indexes are available. For on-line transaction processing (OLTP), an index is likely to be available. If so, round robin balances the OLTP workload over the processors.

On the other hand, range partitioning does help with some kinds of queries. With range partitioning, a certain defined range of a record value goes into the first data store, another range in the second, and so forth. If you do a lot of searching by customer name, for example, you should place part of the alphabet in one data store, another part in the next, and so on. Then when you perform your search, you know which data store to go to immediately, saving considerable time. You would do similar partitioning if you do a lot of searching by date, product, or other specific field in the record.

The disadvantage here is the danger of data skewing. If you're storing things alphabetically, it may take a lot of effort to ensure that the partitions have comparable numbers of records. This can be easier if you have a large database already. You can determine the percentage that each part of the range occupies in the database, then combine ranges into roughly equal partitions. You can be confident that future additions to the database will be in similar proportions, thus maintaining the same relative sizes. Naturally this won't work if the percentages change—for example, if you partition by year and your sales keep growing.

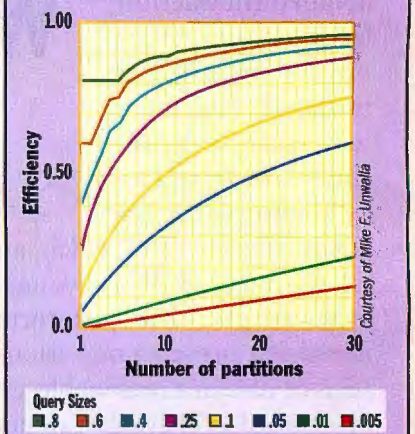
Hash-based partitioning is a more abstract version of range partitioning. With this approach, you compute a hash value modulo *n* from one or more fields in every record, then store the record by its hash value. A sufficiently randomizing hash function will ensure that each partition is about the same size. Hash-based partitioning can also help in searching for records with specific values, since you know where the records with the hash of that value are.

One major disadvantage of hash-based partitioning is that it doesn't help with range searches. Since a range of values does not correspond to a range of hash values, you must do many separate searches instead.

Obviously, no one method does everything. That is why people invent hybrids. Knowing the type of data your database contains, and especially knowing the most common types of queries run against that data, you can probably

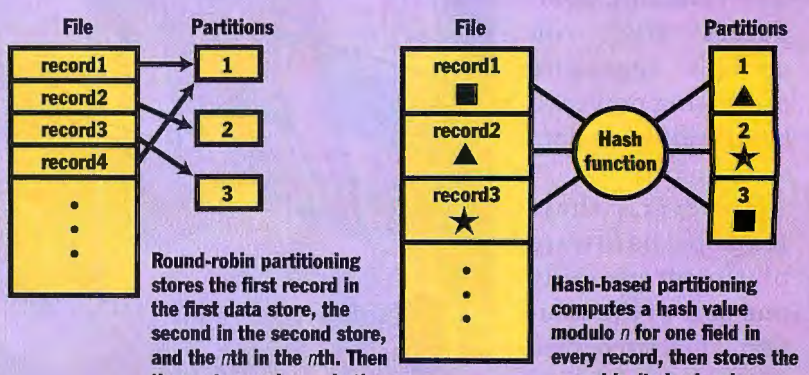
Efficient Data Queries

Graph shows efficiency of query vs. number of partitions for several sizes of queries. Usually, the more partitions, the better.



How to Partition Data

The basic methods of partitioning data are round robin, hash-based, and range. Hybrid methods use combinations of these three.

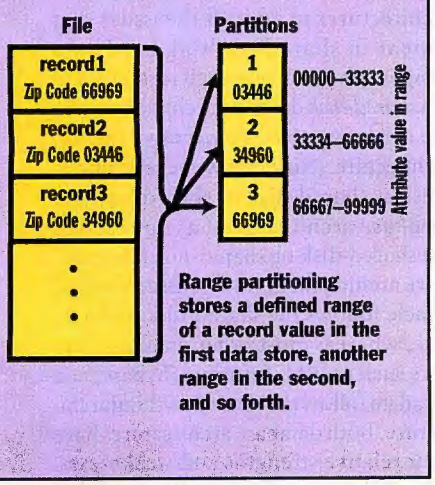


determine a custom partitioning scheme. The ideal would be one that speeds the typical type of query while avoiding multiprocessor bottlenecks by ensuring no data skew.

Finally, how many partitions is ideal? This depends upon the "size" of the query, namely, how much of the database the query involves. The figure "Efficient Data Queries" shows the results of one study of partitioning in one dimension (that is, partitioning based on the value of a single column). Each curve shows the average efficiency of a set of range queries all the same size. As you can see, for small queries (size .01 and .005), the efficiency is nearly linear with the number of partitions. The more, the better. However, even with 30 partitions, the efficiency never gets much above .20. (This graph ignores the *cost* of partitioning, when records have to move to another partition; for example, when a customer moves to a different address.)

For larger queries (size .05 to .8), the efficiency is not linear, but rises rapidly with more partitions. Again, the more, the better. Notice also, though, that for very large queries (size .6 and .8), the efficiency begins to flatten out. This means that above a certain number of partitions there is no added benefit to having more partitions. Research on sets of similar queries (*http://www.syol.com/~munw/*) shows that if partitioning is done on the basis of multiple dimensions, a low number of partitions in each dimension can yield savings that are close to the theoretical maximum.

–Edmund X. DeJesus *and Mike F. Unwalla (mike.unwalla@syol.com)*



ware's multiprocessing capabilities. In other words, the database management system must be able to put the multiple processors to good use when handling large queries. This means that relational DBMSes must be able to process queries in parallel in order to achieve the required performance levels.

Queries Without Parallel

Though the optimization details can become extremely complex, the general concept of performing a query in parallel is fairly straightforward. You must first understand the two basic types of parallelism used in parallel queries: partitioning and pipelining. To become familiar with these techniques, let's first look at a sample query to see how it executes without parallel queries (that is, as a sequential query). Then we'll add in partitioning and pipelining to see how they both increase database performance.

For our sample sequential query, I'll choose a query that first scans two tables, then performs a join of the results of the scan, then sorts the results, and finally returns the sorted set to the user. Let's assume that each of the two tables contains 20 million rows, and that when we run this query sequentially on a uniprocessor, each of the three stages (scan, join, and sort) takes 4 minutes to execute. (See the figure "Sequential Query Execution vs. Query Partitioning" on page 84.)

We're using fictional results here for simplicity. The actual times for executing each stage would likely be very different from each other. Also, to keep the example simple, let's assume that all queries submitted against this database have this same general format of scan, join, and sort. In our example, each stage of the query takes 4 minutes, so the entire sequential query takes 12 minutes.

Cut to the Quick

However, by executing this query on a multiprocessor platform and then using the concept of query partitioning, we can improve this result dramatically. Query partitioning is simply the notion of taking the overall query workload and cutting it up into smaller tasks that can run simultaneously.

For example, the scanning stage, as described above, requires scanning 40 million rows (two tables of 20 million rows each). Rather than having a single task running on a single CPU be responsible for scanning all 40 million rows, the DBMS can instead logically divide the tables into smaller pieces (say, 10 million rows in each piece). Then the DBMS can assign four different tasks running on four different CPUs to each scan their 10-million-row "partition" at the same time (see "Partitioning Data" at left). In this case, each processor has only one-fourth of the task as the single-processor example. Therefore, the scanning stage will be roughly four times faster, completing in about 1 minute instead of 4.

If we had a hardware platform with 12 CPUs (instead of four or one, as in the previous examples), we can repeat this process for the join and the sort stages. (See the figure "Sequential Query Execution vs. Query Partitioning" on page 84.) The join stage and the sort stage show similar time savings.

There is certainly some overhead involved in all this—to partition the workload for each stage and to merge the four sorted subsets of data into a single sorted set before returning it to the user—but if the query is large enough, this overhead is negligible. Given that, our entire query should now take only one-fourth the time as with a single processor. The query will complete in about 3 minutes instead of 12.

In the Pipeline

Query partitioning provides an impressive improvement. Or does it? Yes, our entire query now runs four times faster, but remember that we went from a uniprocessor machine to a 12-processor machine. We used 12 times the computing power, but achieved only a fourfold improvement. Why is this the case?

Because we have not yet leveraged the second part of parallel queries, which is the concept of *query pipelining*. With query pipelining, the consecutive stages in processing a query (in our example, scanning, then joining, then sorting) form a "pipeline," and separate processors can work on separate stages of the pipeline.

The concept is similar to an assembly line in an automotive plant, where individual workers focus on one stage of a car's construction. And, similar to there being multiple cars in the assembly line at any point in time (each one at a different stage of completion), there will also be multiple queries in the pipeline at any point in time, each one at a different stage of completion. In the assembly line, much of the performance gain comes from there

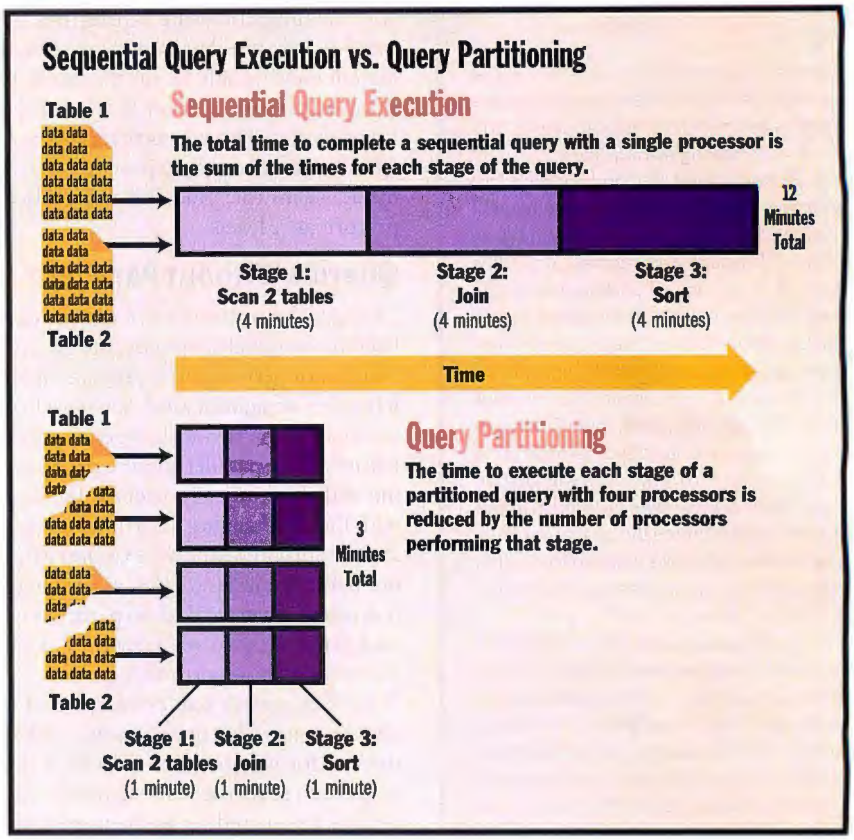
being multiple cars in the line, because even though it still may take hours to build an individual car, a newly completed car will roll off the assembly line every few minutes.

The same holds true for queries. Pipelining may not speed up the execution time of any single query, but more queries can be completed in the same amount of time.

After pipelining is introduced into our example, as soon as the four processors that are assigned to the scan stage finish the scan for a query, they hand off their results to the processors executing the join stage, and then they immediately begin scanning the tables for the next query. They don't just sit there idle until the entire query finishes. The same holds true for the join-stage processors. As soon as they finish joining the rows for the first query, they hand off their results to the sort-stage processors and immediately begin joining the next set of rows sent to them by the scan processors. As in the automobile assembly line, all workers on the line are always busy, working on their stage of the cars progressing through the pipeline.

So, each minute, the sort stage receives a new set of rows to sort, and at the end of each minute it completes the sort and hands the query results back to the user. (See the figure "Query Pipelining" on page 86.) After an initial ramp-up period to fill the pipeline (which lasts 3 minutes in our example), 12 queries complete in 12 minutes.

Because of parallel queries—including query partitioning and query pipelining—we are therefore now able to achieve 12 times the throughput that we obtained with our sequential query. Our 12-processor system increases overall system throughput by a factor of 12.



Parallel Kinds

There are several different types of multiprocessor architectures. The preceding description of the use of parallel queries applies directly to multiprocessor designs known as *shared-everything* hardware architectures, in which all the processors physically share all the hardware components (such as memory and disks). This sharing makes it easy to divide the workload of a parallel query among multiple processors, because each processor can directly query the data residing on any disk drive. Symmetric multiprocessing (SMP) platforms fall into this category.

Shared-everything is not the only type of hardware architecture. Another type of multiprocessor hardware design is known as a *shared-disk* hardware architecture. Even though different groups of processors have their own physically separate pools of memory, all the processors can still access all the disks. Some vendors' clusters, massively parallel processing (MPP), and nonuniform memory access (NUMA) platforms fall into this category. Since any CPU on the platform can still access any piece of data residing on any disk by issuing an I/O request to that disk, the preceding description of parallel queries also directly applies to these shared-disk hardware architectures.

However, most clusters and MPP platforms fall into the category of *shared-nothing* hardware architectures, in which different groups (nodes) of processors each have their own pool of memory and their own set of nonshared disks. Since processors on one node cannot issue I/O requests against data that resides on disks connected to another node, my earlier description of parallel queries needs some clarification.

The main concepts of parallel queries do not change in a shared-nothing hardware architecture: Partitioning and pipelining are still alive and well. However, there are new performance considerations to take into account because accessing data on a remote node involves more overhead in the form of additional message passing.

Drawing a Parallel

Just as there are different parallel multiprocessor architectures, there are different parallel database architectures. Database vendors have created two different architectures to address the issues that appear in shared-nothing hardware designs. The first approach is referred to as a *shared-disk* database architecture, and the other is a *shared-nothing* database architecture. (Note that we're referring to these as shared-disk or shared-nothing *database* architectures, as opposed to the shared-disk or shared-nothing hardware architectures we discussed earlier.) Oracle follows the shared-disk architecture, whereas most other database vendors such as IBM, Informix, Sybase, and Teradata follow the shared-nothing architecture. Both database architectures have their relative strengths and weaknesses, in both theory and reality. It is crucial to understand which issues are important

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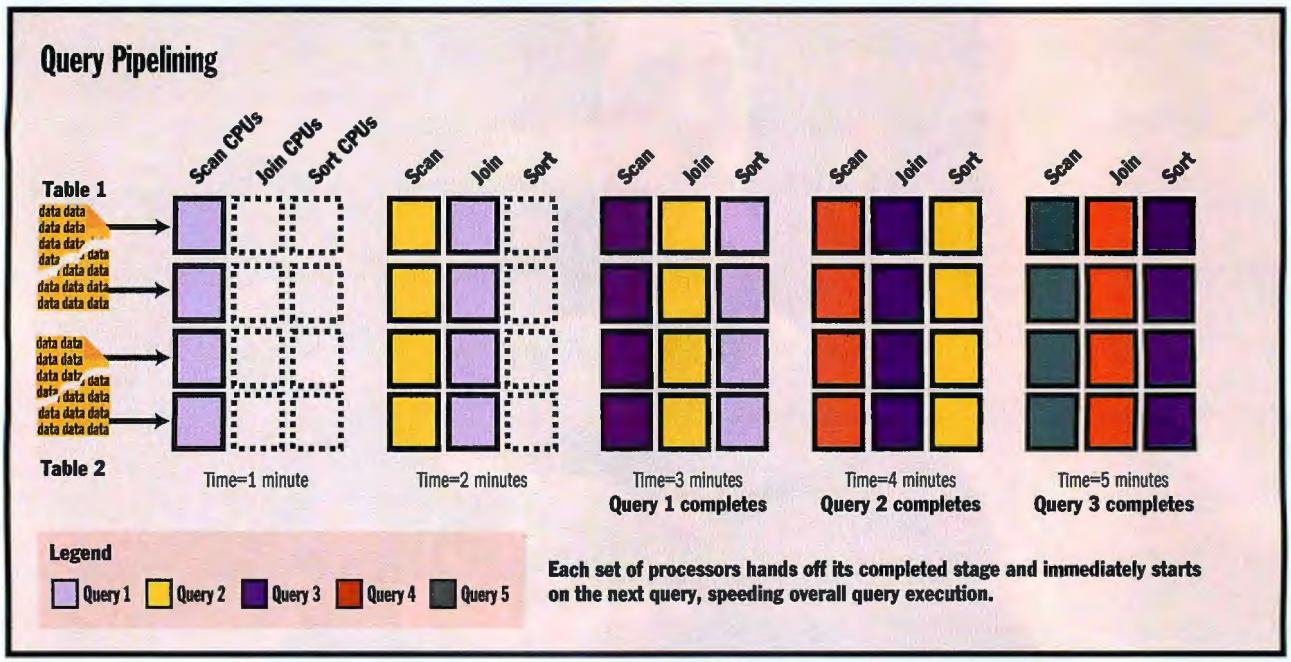

and which are not. Also, we must keep in mind that we're now talking about the architecture of the database server software, not the hardware. As we'll see, despite their names, both the shared-disk and shared-nothing database architectures can (and do) run on shared-nothing hardware.

Share and Share Alike

Briefly, a shared-disk database architecture means that at a conceptual level, when the DBMS is executing a parallel query, any processor is allowed to query data residing anywhere in the entire database.

The situation is obviously different on a shared-nothing hardware architecture, since a processor can't directly issue an I/O request to a disk residing on a remote node. So, if a set of rows that a processor needs happens to be on remote disks, then the appropriate message passing will automatically occur behind the scenes. The processors that "own" the disks in question will issue the I/Os and will then send all the data read from the disks back to the original requesting processor for local query processing. This technique of sending all the rows back to the requesting processor is called *data shipping*.

With this architecture, the DBMS has no notion of a certain node "owning" a certain set of disks—it views all the disks as logically shared, even though they are not physically shared. The "behind the scenes" message passing is responsible for allowing the database to treat all the disks as accessible to all processors.

The theoretical advantage of this database architecture is increased flexibility regarding how your system's resources are used during a parallel query. The database management system can dynamically choose not only how many processors and how many nodes to involve in executing a query, it can also choose which processors and which nodes to use. This improves your ability to perform load balancing.

The theoretical drawback, however, is that this flexibility incurs additional communication overhead between nodes due to data shipping (that is, because many rows may need to be sent across the interconnect as messages). This additional overhead can have a detrimental effect on performance.

Does Not Share Well

In contrast, a shared-nothing database architecture focuses on minimizing the message-passing overhead required to process a parallel query. It does so by dividing each table into "partitions," based on some partition scheme that you choose, and assigning each partition to a different node. For example, if you have four nodes, a trivial partitioning scheme for your customer table could use the customer's last name as the partitioning key and assign names in the range A-F to node 1, G-L to node 2, M-S to node 3, and T-Z to node 4.

In essence, each node exclusively "owns" a partition of each table. If a processor needs to query rows that reside on a remote node, the database does not send the rows back to the original processor for local processing. Rather, by employing *function shipping*, the database sends the query to the remote node, processes it there, and then returns only the query results back to the original processor. (See the figure "Data Shipping vs. Function Shipping" on page 88.)

The theoretical advantage is reduced internode-communications overhead during parallel query execution (and therefore more efficient use of interconnect bandwidth). Rather than sending all the rows across the interconnect network, you just send the query itself, and you get back only the results of the query (rather than each row that was queried).

However, there are a few theoretical drawbacks as well. The first drawback is simply reduced flexibility, because a query that involves a particular database partition can execute only on the CPUs of the node that owns that partition.

The second drawback is that response times for these parallel queries are very sensitive to data skew. Data skew occurs when a poor partition scheme is chosen, leading to one partition having a disproportionate amount of data.

Parallel Realities

I very carefully used the word "theoretical" when referring to the advantages and drawbacks of the shared-disk and shared-

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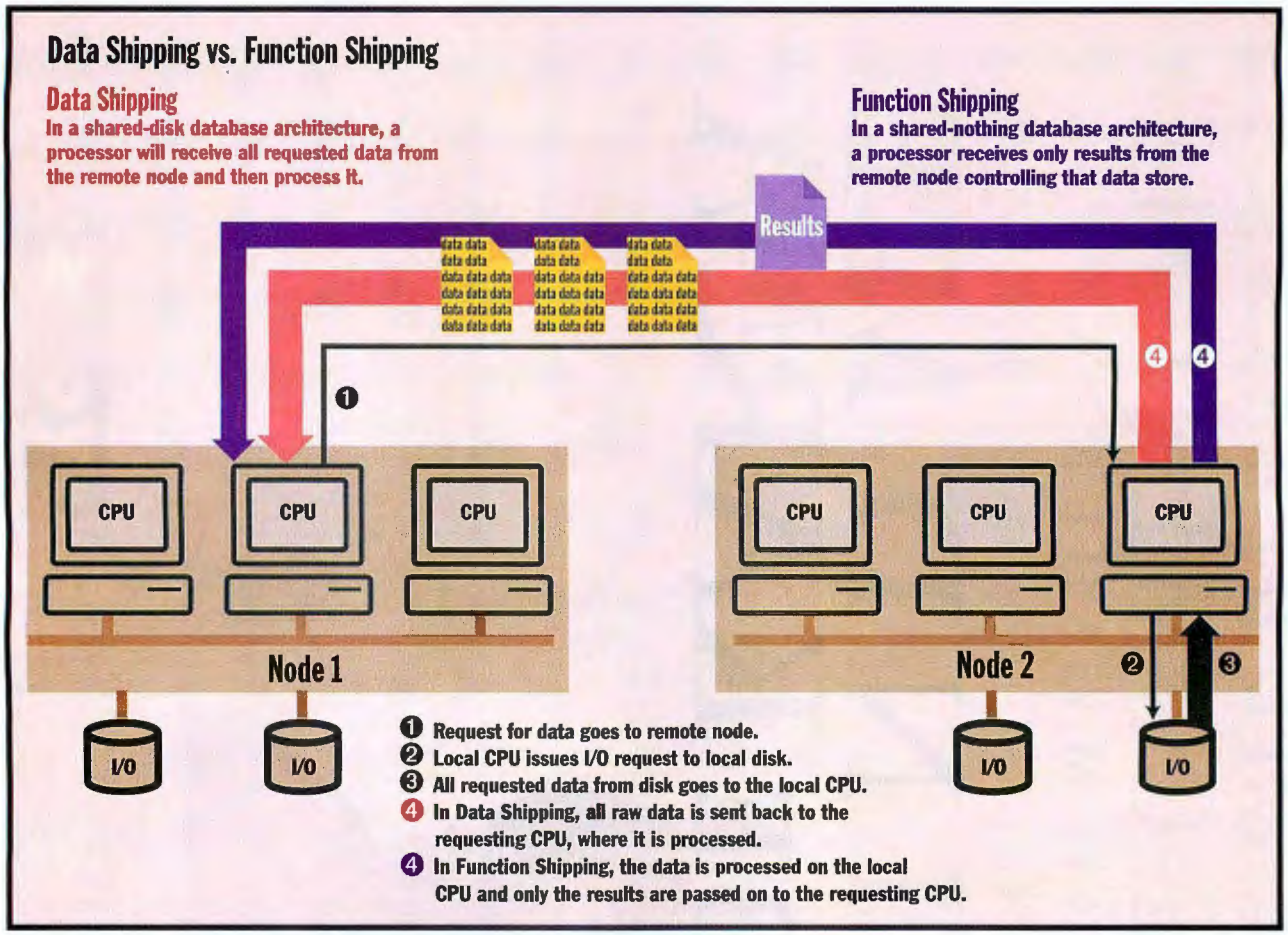

nothing database architectures. How much should you believe the theories about these architectures and how well they will run data warehousing applications? Can you make your technology and product choices based solely on these theories?

No—it would be a mistake to do so. Although understanding the theoretical pros and cons of these two architectures is critical to understanding whatever technology you choose, in reality the actual quality of a database vendor's implementation is much more important than the architecture. This will likely be true for years to come, until the products are fully mature.

For example, the quality of a vendor's query optimizer often has a far greater effect on performance than any of the pros and cons I've mentioned. In another example, one database vendor's code path to perform a certain operation might be 50 percent the length of a competitor's. For this operation, the first vendor has an enormous advantage over the competitor, regardless of the architecture. In these and many other cases, the differences in how well the vendor's developers wrote various parts of the products are the true determining factors of performance. This is the issue on which you should focus. Although this might sound like heresy, architecture is currently only a secondary consideration.

So, how can you determine which database products are built better in the areas where it matters most to you? Industry standard benchmarks are of only limited use, since they are highly specified and highly controlled. The only way to really know is to test your own database queries. The larger the test, the more you will learn, because larger tests will put more stress on a system, highlighting its strengths and exposing its weaknesses.

The Most Effective Approach

If your database is strategic, sooner or later it will scale up to a size that only multiprocessor platforms—such as SMP, clustering, MPP, and NUMA architectures—can handle. To use these platforms to effectively improve query-processing performance, you will have to employ parallel queries. Though parallel queries are not magic, and will require you to learn new approaches to query tuning, they are the most effective technology available today for quickly processing large amounts of data. B

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Breaking Bandwidth Bottlenecks

Technology can rush key applications through a congested network or create the illusion of more bandwidth. By Scott Mace

If you've been adding T1 lines to your WAN but not seeing any improvement in your network application performance, you're not alone. Adding WAN links is the most costly yet fastest-growing aspect of today's intranets and extranets. Meanwhile, the use of these long-distance links is exploding. New high-bandwidth applications, including push sites and multimedia, must run across an entire enterprise.

By simply throwing more bandwidth at the problem, corporations are wasting millions of dollars each year in misused or unused network bandwidth. This is because it isn't a real solution; it results in demand always outpacing supply. TCP/IP was primarily designed to support FTP and telnet applications, but today's higher-speed networks are placing greater demands on bandwidth, exaggerating delays and bottlenecks. The result: lost productivity and lost business.

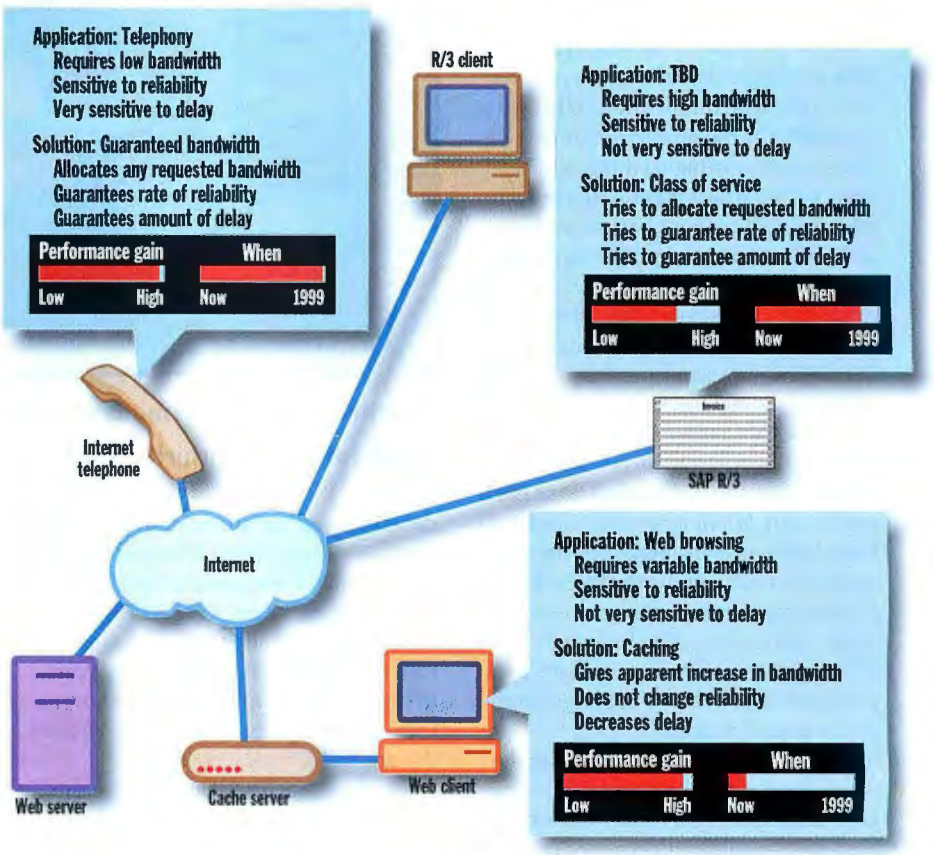
Currently there are few good available alternatives for managing TCP/IP traffic. That's because such traffic wasn't designed to be managed. This situation is beginning to change, however. Low-priority applications can now be controlled, given lower priority, and otherwise made to go to the back of the line waiting to pass through a bottlenecked portion of a network. Because so much data is redundant, caching and multicasting can reduce network traffic problems by keeping packet-copying to a minimum.

The bad news is that some bandwidth-control techniques, such as class of service (CoS), still don't guarantee a given amount of bandwidth, although they offer "better than best effort" service to priority traffic. Other techniques can guarantee bandwidth, but only in networks that are under your control.

Finally, caching technologies are getting sophisticated enough to deliver Web pages in a snap, so even if your particular bottleneck situation persists, or if the Internet backbones or your ISP offers substandard performance, you or your users might not notice as much as before.

These caching technologies will become critical in a situation where ISPs provide differentiated services and you pay more to obtain a higher quality of service (QoS). This situation is still a rare offering on the Internet today.

Building Tomorrow's Internet



Clearing Up Congestion

Wherever there's traffic, there's bound to be congestion. Many systems that process large amounts of traffic—human or otherwise—have specific ways of dealing with it. The California Department of Transportation throttles traffic with metering ramps. Macy's increases its sales capacity by adding more staff members. The U.S. Postal Service decreases delivery time with Priority Mail. United Airlines maintains capacity with reservations. The Internet uses (or will use) techniques that are roughly analogous to all these techniques, which are outlined below.

Metering ramps. Metering ramps are at the heart of the Internet, but they're a little different from traffic ramps, which, instead of throttling cars at an on-ramp, tell drivers to stay away. When congestion occurs, devices running TCP/IP begin dropping packets and send messages back to the originators of the

traffic, telling them to slow down. At the point of the traffic originators, TCP/IP's slow-start mode throttles transmission back and then ramps it up until it reaches a relatively stable state.

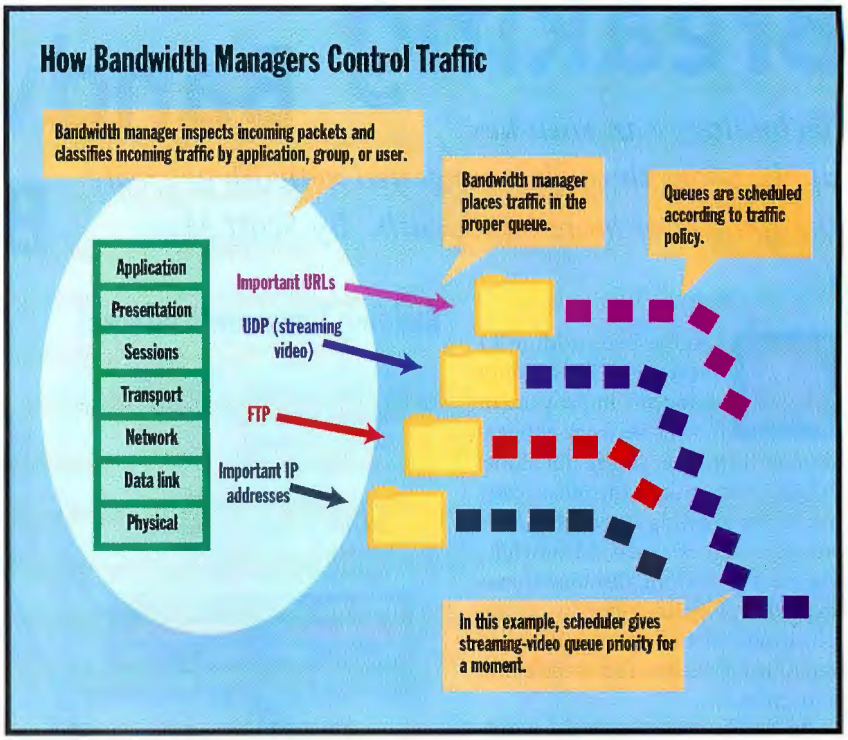
Until recently, this technique has worked admirably. But even though they are efficient and fair, metering ramps cause wild swings in network utilization, leading to the burstiness of the Internet. This makes the Internet's metering ramps as much a part of the problem of delivering consistent QoS as they are a part of the solution.

Increased capacity. Why not just make the pipes bigger? For a long time, we were able to live with the idea of just throwing bandwidth at the problem. But two circumstances are bringing things to a head. First, WAN traffic is way up: It's growing more quickly than we can throw bandwidth at it. In a LAN, it might be possible to over-provision bandwidth enough that congestion never occurs. But this is hardly ever possible with a WAN, due to the economics of transmitting data over long distances. Companies simply can't afford to keep WAN links up all the time.

Second, services such as voice, video, and mission-critical applications need predictable *latencies*—the round-trip times between transmissions—to avoid the phenomenon known as jitter. But increasing capacity just exaggerates the Internet's burstiness. The Internet's best-effort system might cause packets from push sites and Web-surfing to get in the way of critical packets.

Priority. The aforementioned services require packets to be prioritized somehow. Like opening several windows at a bank to serve different types of customers, one line must become three (or even more) so that each packet can get an appropriate level of attention. Customers are willing (and even begging) to pay for that kind of attention. But until recently, there haven't been any standards for setting priority, and the new standards still aren't widely used. On top of that, service providers haven't yet figured out how to maintain and charge for priority services, especially if they cross from one provider to another.

Reservations. Internet customers are even willing to reserve a place in line ahead of time, like airline customers. But so far, the Internet and WANs haven't been able to fulfill these desires. One possible solution to this problem, asynchronous transfer mode (ATM), failed to make it to the desktop. And the shortcomings of the Resource Reservation Protocol (RSVP) have been well documented (see "Faster, Smarter Nets," April 1997 BYTE), so its appearance in Windows 98 will have minimal impact for the next couple of years. In short, ISPs are still figuring out how to provide and bill for QoS (see "A Virtual Private Affair," July 1997 BYTE).



When a bandwidth manager can control traffic flow, important applications get priority and bandwidth is more efficiently utilized.

So where does that leave you? The good news is that there are ways to manage any network bottleneck or the bandwidth in a leased line, provided you control the network and can establish the network's policies. The three main techniques (in increasing order of the apparent performance improvement they create) are CoS; QoS, also known as guaranteed bandwidth or prioritization; and caching.

Setting Some Priorities

The Internet guarantees "best effort" delivery of packets—it tries its best to get the packets to their destinations. CoS tries for "better than best effort"; like Avis, it tries harder, typically by setting some bandwidth aside for high-priority traffic. Don't confuse CoS with QoS, however. Unlike QoS, CoS doesn't guarantee bandwidth or latency. Instead, CoS enables network managers to request priority for traffic based on its importance.

3Com is one of the heavyweights behind CoS. Early this year, 3Com announced CoS prioritization support on its TranscendWare SuperStack Layer 2 and CoreBuilder Layer 3 switches, as well as on a new line of desktop network interface cards (NICs), some routers, and some WAN concentrators. "This strategy scales across the WAN and works with packets as well as [ATM] cells," says Frank Fuller, director of systems marketing at 3Com.

3Com claims to be the first vendor to implement CoS broadly and adhere to the new IEEE 802.1p and 802.1q standards for CoS, as well as IP Type of Service (ToS). IP ToS is a proposed Internet Engineering Task Force (IETF) standard dating back to 1992 that allows for up to eight classes of service over WANs. "By spending 1 hour setting up policies, you'll be able to reduce staff time by an hour a day," Fuller says.

ToS is equivalent to a carpool lane: You reserve bandwidth ahead of time and then assign traffic that needs priority, such as voice or a priority CoS, so that it can use that reserved bandwidth. IP ToS's history shows that, just like carpooling, traffic isn't congested in enough places for many people to use it. But, just as the awareness of carpooling zooms up when highway

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conditions worsen, so too is attention turning to IP ToS. And the newly achieved capability of Layer 3 devices, such as 3Com's CoreBuilder, to prioritize packets at wire speeds adds to the increase in interest in IP ToS.

Skeptics doubt that the 802.1p and 802.1q standards promoted by 3Com will be widely adopted. Both standards were unanimously approved by the IEEE in late 1997, with participation by all major networking vendors. Ratification of the final standards is due by July.

3Com also pledges to provide drivers for non-3Com Ethernet NICs by June. By prioritizing packets at the desktop, network administrators can lessen the load on core network devices. And later this year, 3Com will deliver an LDAP-compatible Policy Server to store policies and push them out to switches, routers, and desktops, instead of requiring individual configuration of each device.

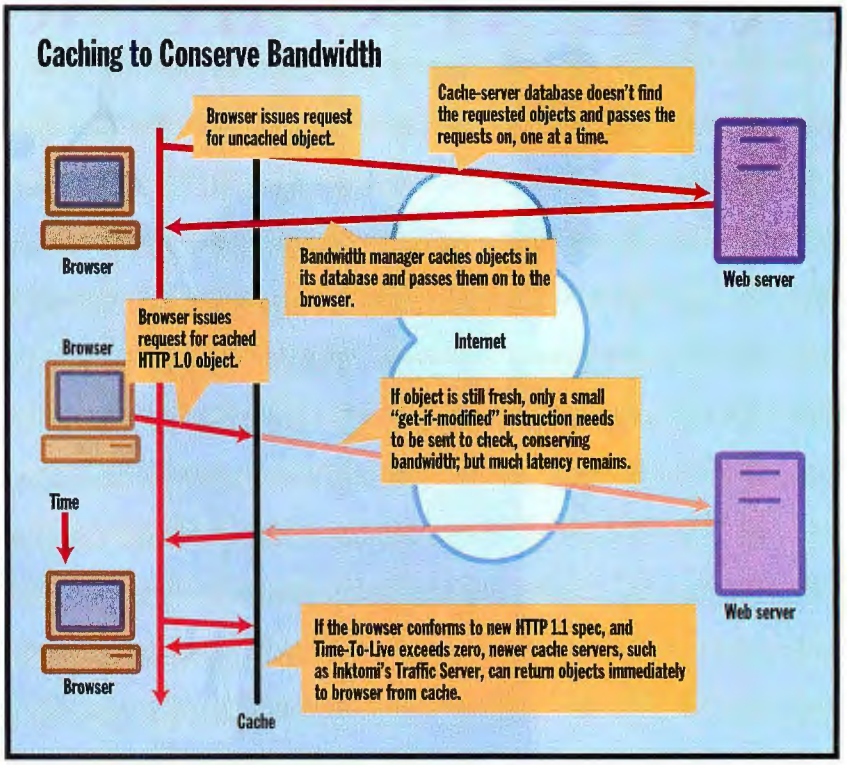
Private Bandwidth

Sometimes CoS's "better than best effort" isn't good enough. This is particularly true if an application requires a guarantee of bandwidth and latency. To get this kind of control, you need to manage all the network devices in your network end-to-end. Then bandwidth-management products can dole out dollops of bandwidth by application, group, or user.

Using leaky-bucket algorithms, bandwidth-management products queue up or drop packets that don't fit bandwidth policies. (In a leaky-bucket algorithm, the queue allows a limited stream of packets out at any time but has a maximum depth, so packets exceeding the bucket's drainage rate are discarded.) The latest generation of these products, which typically sit at the threshold of the narrow pipe being managed, also provide separate queues for each class of traffic.

That's the high-level view. Once you examine these products, at least three different approaches emerge.

Xedia's Access Point devices offer basic Layer 3 traffic management, giving administrators the capability to allocate a committed bandwidth rate to each application and guaranteeing that the bandwidth allocated will never drop below that committed rate. Xedia's Class-Based Queuing also lets applications borrow spare bandwidth from other applications. Xedia is targeting not only corporations but also ISPs and office buildings seeking to offer guaranteed bandwidth to tenants.



Typical cache servers conserve bandwidth but might not eliminate the World Wide Wait and similar latency problems.

Check Point Software, best known as the leading maker of firewalls, offers Floodgate-1, server-based software that allocates bandwidth by a committed rate, but Floodgate adds the ability to allocate by an abstract number. The advantage of this ratio method: If a network adds bandwidth, the individual bandwidth allocations don't all have to be readjusted to reflect the increased available pipe.

Packeteer's Packet Shaper devices use TCP Rate Control (see the table on page 94) to tell devices they should not burst traffic into the network due to congestion. Although it works with Web traffic, TCP Rate Control is not universally admired because it lacks support for UDP packets, such as voice and video. Packeteer acknowledges this but denies allegations that TCP Rate Control is risky stuff.

You might think that at least one of these three approaches could solve bandwidth problems. But even TCP Rate Control can't cure all congestion woes in a network. "There are implementations of TCP/IP, such as some versions of Solaris, with bad default values going to dial-up users," says Bob Packer, chief technical officer at Packeteer. "These values create TCP window sizes that are too large, causing a huge amount of unnecessary packet retransmission." Packet Shaper detects these redundant premature transmissions and drops them, which can help reduce and smooth out traffic more quickly. But every dropped packet requires a TCP slow-start, with its accompanying drop in performance.

By contrast, traffic managers, such as Access Point and Floodgate-1, attempt to eliminate dropped packets entirely with queuing. However, the larger the queue, the bigger the potential for latency during congestion.

So, for now, bandwidth managers are doing the best they can with a protocol which, poor implementations aside, will continue to rule the Internet.

Cache in Hand

CoS and guaranteed bandwidth have their problems. So, if you can't keep the information where it is and get at it faster, then why not bring the information closer? That's exactly what caching does. Already, the leading Web browsers maintain small caches of viewed pages on local hard drives. Many of the caching techniques being deployed today on servers

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1 Do you currently have a private web site? *(Choose one.)*

- ☐ Yes
- ☐ No

2 Does your company have a web site? *(Choose one.)*

- ☐ Yes
- ☐ Not currently but plan to have one soon
- ☐ Not currently and have no plans

3 Does your company have an intranet? *(Choose one.)*

- ☐ Yes
- ☐ Not currently but plan to have one soon
- ☐ Not currently and have no plans

4 Do you currently use web hosting services? *(Choose one.)*

- ☐ Yes
- ☐ No

5 How satisfied are you with the web hosting service you are currently using? *(Choose one.)*

- ☐ Very satisfied
- ☐ Somewhat satisfied
- ☐ Somewhat dissatisfied
- ☐ Very dissatisfied

6 How proficient would you say you are with web technologies? *(Choose one.)*

- ☐ Expert
- ☐ Advanced
- ☐ Novice

7 Rate on a scale of 1 to 5 (1=no experience, 5=expert) your knowledge of the following technologies:

	1	2	3	4	5
Security	☐	☐	☐	☐	☐
Certificate servers	☐	☐	☐	☐	☐
Virtual private networks	☐	☐	☐	☐	☐
Electronic commerce	☐	☐	☐	☐	☐
Firewalls	☐	☐	☐	☐	☐
Remote access	☐	☐	☐	☐	☐
Extranet	☐	☐	☐	☐	☐
Java	☐	☐	☐	☐	☐
Dynamic HTML	☐	☐	☐	☐	☐
XML	☐	☐	☐	☐	☐
HTML	☐	☐	☐	☐	☐

8 In which technologies do you hope to improve your understanding over the next six months?

- ☐ Security
- ☐ Certificate servers
- ☐ Virtual private networks
- ☐ Electronic commerce
- ☐ Firewalls
- ☐ Remote access
- ☐ Extranet
- ☐ Java
- ☐ Dynamic HTML
- ☐ XML
- ☐ HTML

9 If you have a web site/intranet/extranet today, what do you use it for?

- ☐ E-mail
- ☐ Groupware
- ☐ Displaying product/company information
- ☐ Remote access
- ☐ Electronic commerce
- ☐ Business to business commerce
- ☐ Other _____

10 What new capabilities do you plan to add to your web site/intranet/extranet?

- ☐ E-mail
- ☐ Groupware
- ☐ Dynamic HTML
- ☐ XML
- ☐ Java
- ☐ ActiveX
- ☐ Virtual private networking
- ☐ Electronic commerce
- ☐ Remote access
- ☐ Other _____

11 How many employees does your organization have?

- ☐ Under 100
- ☐ 100 - 499
- ☐ 500 - 999
- ☐ 1000 or more

12 If you win the free web site, what will you do with it?

_____

_____

_____

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are similar, though much more sophisticated and effective.

A prominent example of such a technique is Inktomi's Traffic Server, software that runs on Solaris-based systems. Piggybacking off the recent work done in the parallel-computing and cluster-technology fields, Inktomi first made a splash in the search-engine arena with its HotBot technology. Traffic Server soon followed.

"Caching lets you store information much closer to the user, and it gives that user a better quality of experience than going through a congested net with multiple hops," explains Peter Galvin, director of marketing for Traffic Server. Inktomi estimates that 60 percent of the traffic on the backbone of one ISP it works with is redundant.

But caching is not as simple as storing HTML pages. The trick, of course, is figuring out how often to refresh each object in the cache. Each page is actually made up of many objects—sometimes dozens. Each of those objects changes over time, but not at a constant rate. Making matters worse, the original HTTP 1.0 protocol did not let page publishers dictate the typical time interval before a cache must fetch a refreshed object.

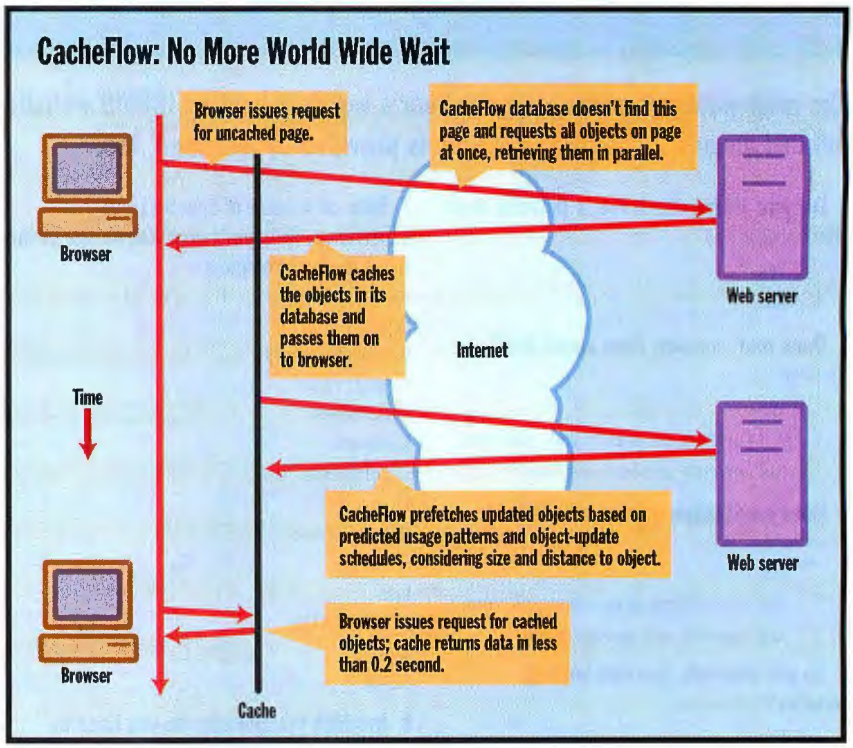
How does Traffic Server approach the problem? After a user requests a page for the first time, Traffic Server keeps all the objects on that page in its cache. Since pages don't change quickly, future users of that same page consume only a fraction of the first user's bandwidth. A simple `get-if-modified` HTTP request is the only thing that travels across the Internet and back if a page is unchanged.

In addition, Traffic Server is mildly proactive in updating the cache. By default, the cache refreshes each object hourly. That default can be changed.

Traffic Server can also take advantage of HTTP 1.1's Time-to-Live (TTL) HTML tag. To reduce latency, HTTP 1.1 lets Web publishers attach a TTL tag to each object, which gives them more granular control over when the cache requests a new copy of the object. Banner ads might have to be excluded from such treatment because Traffic Server doesn't return hit information to servers for the all-important Web-ad click-through information. But the bandwidth savings derived from caching every object on a page except the banner ad is still substantial.

CacheFlow, from the company of the same name, takes caching a step further. The company started with the observation that the typical browser fetches only four objects at once. A page containing many objects might take many fetches to pull down everything. CacheFlow gets around this problem by fetching all objects on a page at once.

Web pages are starting to contain more objects, so the savings can be substantial. For instance, http://www.cnn.com has so many objects that, in the best case, electrons have to travel something like 600,000 network miles to deliver the home page coast to coast. Given the limitation



CacheFlow eliminates latency problems, even for pre-HTTP-1.1 objects, by prefetching objects based on usage and update schedules.

Beyond Queuing

TCP Rate Control is achieving new prominence through technology such as Packeteer's Packet Shaper.

	Queuing	TCP Rate Control
Efficiency	Tosses packets. Induces packet loss; generates retransmissions.	More efficient; no queues form. Reduces packet loss and retransmissions.
Precision	Limited traffic classification. No bit-per-second control. No flow-by-flow QoS.	Rich traffic classification. Bit-per-second control. Rate-based QoS for individual flows.
Inbound/outbound	No inbound control.	Both inbound and outbound control.
Ability to react	Reactive. Congestion has already occurred.	Proactive. Prevents congestion before it occurs.

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of the speed of light, that's nontrivial.

The CacheFlow engine is also constantly prefetching Web pages based on a complex formula of a page's popularity and the cost in time and bandwidth of fetching the page. According to the company, this prefetching is so much more efficient than the fetching done by products such as Traffic Server that CacheFlow doesn't need to send a `get-if-modified` statement when a second user requests a page and its objects. This saves not bandwidth, but latency: When demonstrated, CacheFlow easily fetches pages faster than the eye can blink.

Traffic Server might approach that kind of low latency, but only if the entire Web adopts HTTP 1.1. Just how fast that's happening is a matter of controversy. For various reasons, CacheFlow claims that the latency reduction with HTTP 1.1 will approach only 20 percent, and then only because HTTP 1.1 also supports persistent connections.

One thing is for sure: Nothing will force Web publishers to cache ads unless hit-rate information can be returned from the cache to the Web server. CacheFlow's cache can do this; Traffic Server's cannot. Inktomi officials point out that Web publishers are using sophisticated banner-ad-rotation schemes, so they still won't be thrilled about caching.

Different Packets Coming

As if all the tricks employed to decongest and apparently speed up Internet traffic weren't enough, within the next year multicast traffic will proliferate. The bandwidth-management wizards all agree that multicast will change the Internet again and help hasten the systemwide CoS standards that companies such as 3Com are evangelizing. Time will tell if multicast is a killer application, but its introduction hastens the day when no network device can be indifferent about where a packet came from, where it's going, or what it's carrying.

Meanwhile, the more control you have over your network, the more possible it is to guarantee bandwidth to critical applications and to begin to shape bandwidth priorities for other applications. Even if you don't control your network, caching might offer a quick way out of the World Wide Wait. Either way, the old solution—getting out the checkbook and ordering up more expensive bandwidth—isn't the only game in town. B

WHERE TO FIND

CacheFlow, Inc.
Palo Alto, CA
650-849-1400
http://www.cacheflow.com

Check Point Software Technologies, Inc.
Redwood City, CA
650-628-2000
http://www.checkpoint.com

Inktomi Corp.
San Mateo, CA
650-653-2800
http://www.inktomi.com

Packeteer, Inc.
Cupertino, CA
408-873-4400
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THE CRYPTO BOMB IS TICKING

Today's faster, less expensive computers can crack current encryption algorithms easier than ever before. So what's next?

By Bruce Schneier

Cryptographic algorithms have a way of degrading over time. It's a situation that most techies aren't used to: Compression algorithms don't compress less as the years go by, and sorting algorithms don't sort slower. But encryption algorithms get easier to break; something that sufficed three years ago might not today.

Several things are going on. First, there's Moore's law. Computers are getting faster, better networked, and more plentiful. The table "Cracking for Dollars" on page 98 illustrates the vulnerability of encryption to computer power. Cryptographic algorithms are all vulnerable to brute force—trying every possible encryption key, systematically searching for hash-function collisions, factoring the large composite number, and so forth—and brute force gets easier with time. A 56-bit key was long enough in the mid-1970s; today that can be pitifully small. In 1977, Martin Gardner wrote that 129-digit numbers would never be factored; in 1994, one was.

continued

ILLUSTRATION: DOUGLAS FRASER © 1998

Aside from brute force, cryptographic algorithms can be attacked with more subtle (and more powerful) techniques. In the early 1990s, the academic community discovered differential and linear cryptanalysis, and many symmetric encryption algorithms were broken. Similarly, the factoring community discovered the number-field sieve, which affected the security of public-key cryptosystems.

There are many encryption algorithms currently available; see the table "Encryption Algorithms: Suitability to Task" on page 100 for classes of algorithms and their characteristics. What algorithms are considered secure today? What about the future? Predictions are dicey at best, but they are essential in the business of cryptography.

For instance, if I design a cryptographic system today, it may spend two years in development and be fielded for another dozen. The information it carries might have to remain secure for six years after transmission. This means I'm forced to make a decision today about what the state of cryptography will be 20 years from now. Like it or not, cryptographers have to be futurists.

Cracking for Dollars

An expenditure of twice the dollars makes your adversary's attack twice as fast. By Moore's law, these attacks will be 10 times less expensive (and 10 times faster) every five years.

Type of attacker	Budget	Tool	40 bits: Time and cost per key recovered	56 bits: Time and cost per key recovered	Key length for protection in late 1996
Pedestrian hacker	Tiny	Scavenged computer	1 week (No cost)	Unfeasible (No cost)	45
	$400	FPGA	5 hours ($0.08)	38 years ($5000)	50
Small business	$10,000	FPGA	12 minutes ($0.08)	556 days ($5000)	55
Corporate department	$300K	FPGA	24 seconds ($0.08)	19 days ($5000)	60
		ASIC	0.18 second ($0.001)	3 hours ($38)	60
Big company	$10M	FPGA	0.7 second ($0.08)	13 hours ($5000)	70
		ASIC	0.005 second ($0.001)	6 minutes ($38)	70
Intelligence agency	$300M	ASIC	0.0002 second ($0.001)	12 seconds ($38)	75

FPGA = field-programmable gate array

From the paper "Minimal Key Lengths for Symmetric Ciphers to Provide Adequate Commercial Security," available at http://www.counterpane.com/keylength.html.

Fearful Symmetry

Symmetric algorithms use the same key for both encryption and decryption. These algorithms are the workhorses of cryptography. They encrypt anything digital, including e-mail, telnet connections, audio, and video. You can divide symmetric algorithms into two piles: stream ciphers and block ciphers. *Stream ciphers* encrypt data in streams—a bit, byte, or word at a time. *Block ciphers* encrypt data in fixed chunks, generally 64 bits. Since you can use block ciphers to build stream ciphers, most ciphers are block ciphers.

And there are a lot of them. The table "Symmetric Algorithms and One-Way Hash Functions" on page 102 lists the major ones, comparing speed, block size, key size, and patent and licensing terms.

A few points are worth noting here. Triple-DES is the conservative choice, although it's the slowest. Everything else has received far less cryptanalytic attention. Blowfish is the fastest algorithm, but it has a long key-setup time and isn't suitable for encrypting small blocks. And its large tables make it completely unsuitable for smartcards. The International Data Encryption Algorithm (IDEA) got its fame as the encryption algorithm in PGP, and it would probably be used more if it weren't impossible to get any reasonable licensing terms out of Ascom-Systec. CAST, the new algorithm in PGP, is similar to Blowfish. RC2 has been largely abandoned in favor of RC5.

If I had to choose an encryption algorithm to use today, I'd select Triple-DES (it's much harder to break via exhaustive searching than DES), IDEA (it has survived since 1991 without any serious cryptanalysis), or Blowfish (it's fast, compact, and simple; allows variable key lengths; and has been the victim of no known successful cryptanalysis). A couple of years ago, I and a group of other cryptographers recommended a 90-bit key as the bare minimum for security today (see why in the table above); all three of these algorithms exceed that key length.

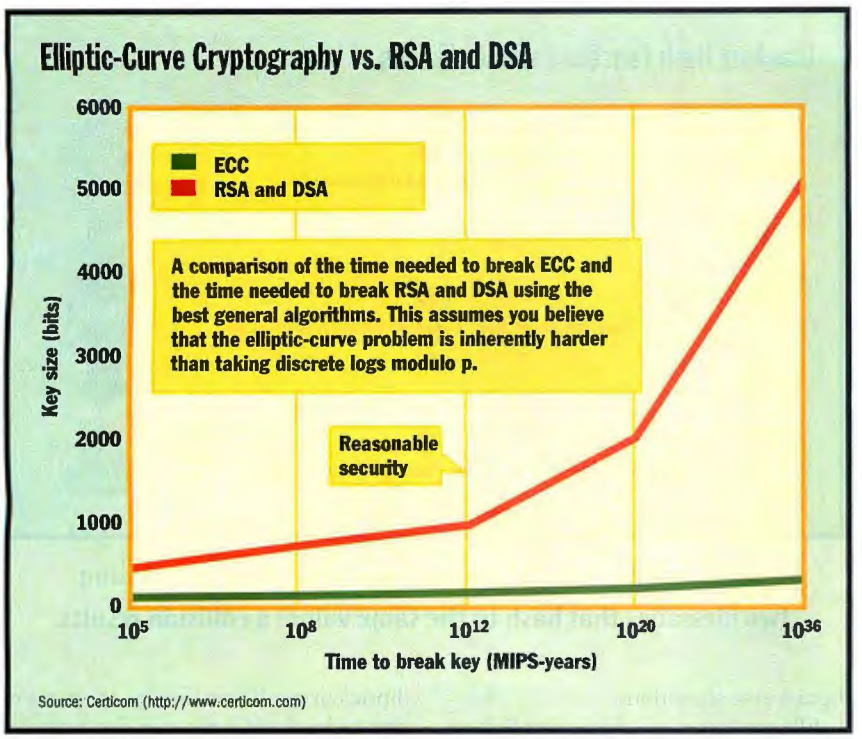
The block-cipher landscape will change soon. The National Institute of Standards and Technology (NIST) is soliciting candidate algorithms for an Advanced Encryption Standard (AES), which will replace DES. None of the aforementioned algorithms is suitable because AES must have a 128-bit block size and key lengths of 128, 192, and 256 bits.

Candidates are due in June of this year, and NIST will select an algorithm sometime in 1999 or 2000. Thus far, about 15 people have indicated that they will submit an algorithm. Most will likely be pretty awful attempts by crypto wannabes, but expect to see an RC5 variant from RSA Data Security, a CAST variant from Entrust Technologies, a variant of Square, and Blowfish II (based on Blowfish).

Those who need a stream cipher have two choices. One option is to use a block cipher in stream mode. This isn't difficult; any block cipher will work, and you can consult any cryptography text to find out how to do it.

The other option is to use a dedicated stream cipher. There are a few of these, some optimized for custom hardware and others for 32-bit microprocessors. RC4 is one common choice. Once a trade secret of RSA Data Security, it was "outed" to the Internet in 1994 and has since become public-domain. There's even an Internet Draft for something called ARCFOUR, which is actually RC4: The draft's authors didn't want to use the real name.

No one has succeeded in breaking RC4, but cryptographers have found some sta-



The Speed of RSA

Task	512 bits	768 bits	1024 bits
Encrypt	0.03	0.05	0.08
Decrypt	0.16	0.48	0.93
Sign	0.16	0.52	0.97
Verify	0.02	0.07	0.08

RSA speeds in seconds (on a SparcStation 2) for different modulus lengths with an 8-bit public key.

tistical anomalies in it, including weak keys. When I recommend RC4, I advise the use of a more complicated key schedule, namely spinning the key schedule twice. A *key schedule* is an algorithm that expands a relatively short master key to a relatively large expanded key for use in encryption and decryption. RC4 uses a key schedule to initialize the state of the stream cipher prior to generating the keystream. Due to weak mixing in its key schedule, RC4 has a class of detectable keys. The more complicated key schedule strengthens that.

Making a Hash of It

A *hash function* is a fingerprint function that takes an arbitrary-length input (i.e., a pre-image) and produces a fixed-length output (i.e., a hash value). Given a digital blob (a file, a message, or whatever), it's easy to calculate the hash of that file. But given a hash value, it's hard to create a file that hashes to that value. It's much easier (by a factor of $2^n/2$ for an n-bit hash function) to find collisions for a hash function than to reverse the function. This means that the function is "one-way," unlike something like a cyclic redundancy check (CRC), where it's easy to create a file with a given CRC value.

Hash functions also have to be "collision-free": It must be hard to find two files that hash to the same value (see the figure "Cracking Hash Functions with Collisions" on page 100). This means that if I give you a hash value and then later show you a file that hashes to that value, you can be sure (to the extent of the security of the hash function) that I had that file at the time I created the hash value.

Most hash functions in use a few years ago produced 128-bit hashes, although for any long-term security a 160-bit hash is de rigeur. I wouldn't use a 128-bit hash for anything unless I had a really good reason for doing so.

There are only a few suitable algorithm choices here. I recommend SHA-1, from the National Security Agency (NSA). SHA, the Secure Hash Algorithm, is a NIST standard. It produces a 160-bit hash. Another choice is RIPE-MD-160, from the European Community. MD5 produces only 128-bit hashes, and cryptographers have found weaknesses in the algorithm. Don't toss your MD5-based applications immediately, but you should switch them over to SHA as soon as possible.

Not much is forthcoming in this category. A lot of work has been done on creating hash functions from block ciphers, but no single proposal has emerged as a front-runner. People are likely to stick with SHA-1 or RIPE-MD-160, although some ultra-high-end applications use a combination of MD5 and SHA-1.

Big MACs

Message-authentication codes, or MACs, are hash functions with a key: Only someone who knows the key can create or verify a MAC value. For instance, I can use MACs for integrity checking. After creating a file, I calculate its MAC (using a key you and I share) and append it to the file. Anyone can read the file, but only someone who knows the key can create a new MAC. When you get the file, you can calculate the MAC and verify that it's the same as the MAC I sent you. If it is, you know that no one has tampered with the file during transit.

There are several MAC algorithms, but the most promising ones are HMAC and NMAC. They're based on hash functions, generally SHA-1; HMAC is an Internet Draft (RFC 2104). There are other MAC constructions based on hash functions, but they're not nearly as good. And I haven't seen any MACs based on block ciphers that I've liked very much.

Playing the Public Keys

Public-key algorithms are the surprise of the 1970s. Encryption and decryption use different keys and, more important, you cannot calculate these keys from each other. Thus, you can generate a key pair and publish just the encryption key (see the table "Pick Your Enemy, Then Your Key" on page 102 for recommended key

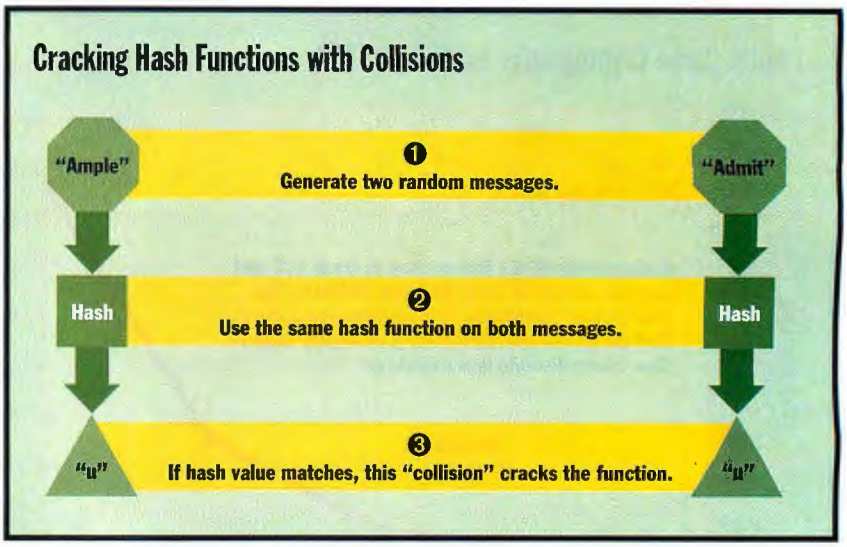
lengths). Anyone can get that key and send you a message that only you can decrypt (using the decryption key). You can use the same math for digital signatures (more on this later). The actual implementation is complicated, with certificates, certificate authorities, trust management, and lots of odds and ends, but that's the general idea (see "Picking the Crypto Locks," October 1995 BYTE).

Public-key algorithms are based on one of two problems: the factoring problem and the discrete-logarithm problem. Both are more or less equally hard, so I'll discuss the factoring problem with the understanding that what I say applies to both. Factoring the kind of numbers used in public-key cryptography—1024 bits or more—is hard. It would take all the computers in the world years to accomplish.

Patents are another issue to deal with when choosing a public-key algorithm. RSA is patented, for example, and will remain so until 2000. Diffie-Hellman and ElGamal are both in the public domain: Any patents that might have applied expired last year. I usually use ElGamal, unless I have a strong reason to use RSA.

Legible Signatures

Digital-signature algorithms are simply public-key-encryption algorithms turned on their ears—the private key is used for signing, the public key for verification—and all the key-length discussion in the previous section applies. RSA digital signatures are just as secure (or as vulnerable) as RSA encryption. The same is true for ElGamal. There are other alternatives: NIST has endorsed something called the Digital Signature Algorithm (DSA) as a federal standard. And there are several elliptic-curve algorithms.



The "birthday attack" cracks a hash function by guessing two messages that hash to the same value; a collision results.

Elliptic curves are the newest kids on the block. Points on an elliptic curve form a mathematical group: Given any two points, there are operations that always produce another point on the curve. Further, you can use a number and a point on the curve to give another point on the curve—but it's hard to figure out what number you used, even if you know the original point and the resulting point. This one-wayness leads to cryptographic applications. And because cracking this is much harder than cracking other systems, it requires much smaller keys to obtain comparable encryption.

This normally wouldn't be interesting, but the fast algorithms used for finding discrete logarithms don't work with elliptic curves. Therefore, proponents of this technology argue, you don't need as long a key. For applications where bits are very dear, like smartcard applications, these are enticing words.

The question is not whether elliptic-curve cryptosystems are secure, but whether they offer the same security with shorter key lengths than comparable systems. Today, the discrete-logarithm problem for elliptic curves is harder than the discrete-logarithm problem modulo prime numbers p: There is no subexponential algorithm for doing the calculation. (The discrete-logarithm problem involves finding the exponent to which you must raise a given number to generate a value modulo some large prime number.) Thus, people use elliptic-curve cryptosystems with significantly shorter key lengths. The figure "Elliptic-Curve Cryptography vs. RSA and DSA" on page 99 illustrates the difference between key sizes required for comparable security.

It's unknown whether the discrete-logarithm problem is harder because of the fundamental mathematical nature of elliptic curves or because of our limited knowledge of their mathematical properties. This is a very new area of research, and recent discoveries indicate that there is still much theoretical work to be done. I do not recommend assuming that they can provide the same security over the long term with shorter key lengths than cryptosystems using discrete logs modulo prime numbers p. *continued*

Encryption Algorithms: Suitability to Task

Algorithm	Confidentiality	Authentication management	Integrity	Key
Symmetric encryption	Yes	No	No	Yes
Public-key encryption	Yes	No	No	Yes
Digital signature	No	Yes	Yes	No
Key agreement	Yes	Optional	No	Yes
One-way hash	No	No	Yes	No
Message-authentication code	No	Yes	Yes	No

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Security? What Security?

Popular magazines like to describe cryptography products in terms of algorithms and key lengths. Algorithms make good sound bites; they can be explained in a few words and are easy to compare with one another: "128-bit keys are good security." "Triple-DES means good security; 40-bit RC4 means weak security." "2048-bit RSA is better than 1024-bit RSA." Unfortunately, reality isn't that simple.

Longer keys don't always mean more security. Compare the cryptographic algorithm to the lock on your front door. A door lock might have four metal pins, each in one of 10 positions. Thus, there are only 10,000 possible keys, and a burglar willing to try all 10,000 is guaranteed to break into your house.

But an improved lock with 10 pins, making 10 billion possible keys, probably won't make your house any more secure. Burglars don't try every possible key (a brute-force attack); most aren't even clever enough to pick the lock (a cryptographic attack against the algorithm). Instead they smash windows, kick in doors, disguise themselves as police officers, or rob keyholders at gunpoint. Better locks don't help against these attacks.

I've spent years designing, analyzing, and breaking cryptographic systems. I do research on published algorithms and protocols, but most of my work consists of examining actual products. I've designed and analyzed systems that protect privacy, ensure confidentiality, provide fairness, and facilitate commerce.

I can almost always find attacks that bypass the algorithms altogether. I don't have to try every possible key, or even discover flaws in the algorithms. Instead, I exploit errors in design, implementation, and installation. And most of the time I exploit the same old mistakes that implementers make over and over again.

Symmetric Algorithms and One-Way Hash Functions

Algorithm	Type	Clocks per byte processed (Pentium)	Block size (bytes)	Key size (bytes)	Patents
RC4	Stream	7	N/A	Variable	No
Blowfish	Block	18	8	4–56	No
CAST	Block	20	8	16	Yes, but free
RC5-32/16	Block	23	8	Variable	Pending
DES	Block	45	8	7	No
IDEA	Block	50	8	16	Yes
SAFER (S)K-128	Block	52	8	16	No
Triple-DES	Block	108	8	14	No
MD5	Hash	5	64	N/A	No
SHA-1	Hash	13	64	N/A	No
RIPE-MD-160	Hash	16	64	N/A	No

N/A = not applicable.

The moral here is not that cryptography is useless, but that cryptography is not enough. Strong cryptography is not a panacea. Focusing on crypto algorithms while ignoring the other aspects of security is like defending your house not by building a fence around it but by putting a single immense stake into the ground and hoping that your adversary runs right into it.

Security designers occupy what Prussian general Carl von Clausewitz called "the position of the interior." A good security product must defend against every possible attack—even attacks that haven't been invented yet. Attackers, on the other hand, need to find only one security flaw in order to defeat the system. Moreover, they can cheat: They can collude, conspire, and wait for technology to provide them with additional tools. They can attack a system in ways the system's designer never thought of. They can ignore the algorithms.

Building a secure cryptographic system is easy to do badly and very difficult to do well. Unfortunately, most people can't tell the difference.

In other areas of computer science, functionality serves to differentiate the good from the bad. For instance, a good compression algorithm will work better than a bad one; a bad compression program will look worse in feature-comparison charts.

Cryptography is different. Just because an encryption program functions doesn't mean it's secure. What happens with most products is that someone reads *Applied Cryptography*, chooses an algorithm and a protocol to use, performs tests on it to make sure everything works, and thinks the job is done. It's not. Functionality does not equal quality, and no amount of beta testing will ever reveal a security flaw. Too many products are merely "buzzword compliant": They use secure cryptography, but they are not secure. B

Pick Your Enemy, Then Your Key

Year	vs. Individual	vs. Corporation	vs. Government
1995	768	1280	1536
2000	1024	1280	1536
2005	1280	1536	2048
2010	1280	1536	2048
2015	1536	2048	2048

Recommended public-key lengths (in bits).

Bruce Schneier (Minneapolis, MN) is president of Counterpane Systems and author of Applied Cryptography *(John Wiley & Sons, 1994 and 1996). You can reach him by sending e-mail to* **schneier@counterpane.com** *or to his Web page, at* **http://www.counterpane.com.**

Jon Udell

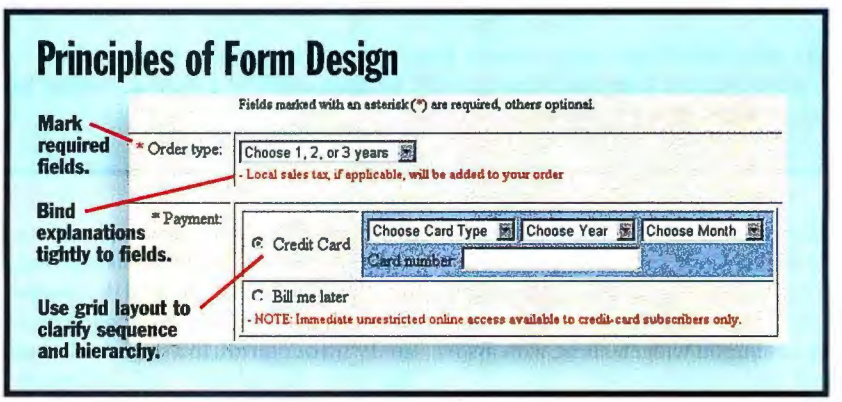
Web Project

Effective HTML Forms

An overhaul of The BYTE Site prompts us to rethink our methods of creating and processing forms.

Web applications nowadays can use all sorts of fancy user-interface gadgetry, including JavaScript, Java, and Dynamic HTML. Is there still a place for plain old HTML-based forms? You bet. HTML forms tied to server-side processing still work just fine. And, as I'll discuss this month, there are lots of ways to extend and refine the HTML/CGI technique.

A recent overhaul of our Web site gave me the opportunity to review and upgrade our forms and related scripts. This effort led me to articulate 10 principles for effective use of HTML forms.



1 Mark required elements. Many sites do this, but many more don't. Remember that people are always in a hurry and will bail out of your application in a heartbeat if it starts to feel like a waste of time.

2 Attach explanations directly to form elements. Put field-level documentation right on the form, next to or below the widget it explains. A separate help file is fine, and a hyperlink that jumps context-sensitively from the form to the relevant part of the help file is even better. But where practical, it's best to put the explanation right on the form. Remember: People are in a hurry. If you require six-character alphanumeric passwords, say so. Don't make users click on Submit to find out the hard way.

3 Solicit feedback. Add a `<textarea>` widget that invites users to ask questions and make comments. Then accumulate that information into a Web, mail, or news archive that you can review periodically. A `mailto:` link is fine, too, but it's one click removed from the form. People are in a hurry, and the Web relentlessly encourages context-switching.

Over time, patterns emerge from these responses. Pay attention to them, and refine your feedback mechanism accordingly. To improve a business process, you have to be able to measure it. If you instrument them properly, Web-based customer-service forms can provide the raw data.

4 Use layout and visual cues to organize elements. Two years ago, I avoided using HTML tables because a lot of browsers handled them poorly or not at all. This time around, I formatted all our forms using tables. The new batch look nicer than the old ASCII-formatted forms, but my motivation was only partly aesthetic. Built on a grid, forms can best express the sequences and hierarchies implicit in the data they capture.

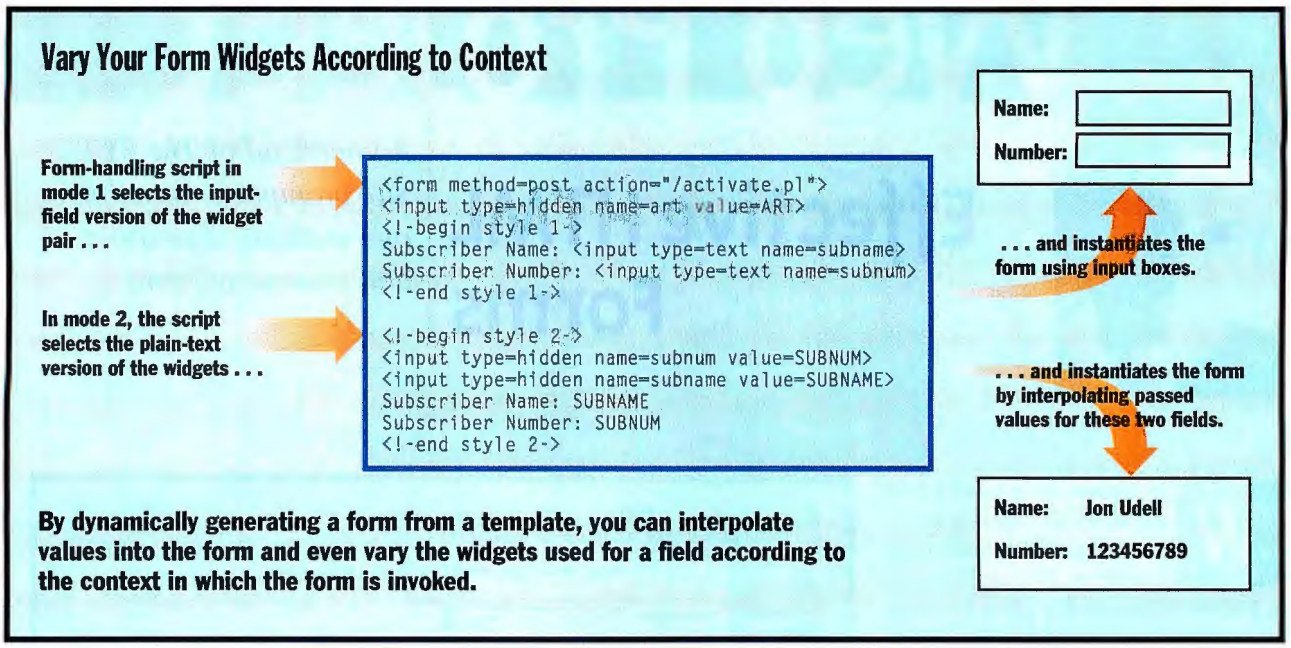
The structure that emerged from several rewrites of our current batch of forms is a two-column grid of name-value pairs. This design flexibly accommodates not only simple elements but also more complex clusters of elements.

Table formatting works in several ways here. The horizontal alignment of the radio buttons, located in successive rows of the nested table, binds them into a unit. The adjacency of the cells containing the credit-card radio button and its four associated widgets binds all these into another unit. Finally, a background color groups the credit-card widgets. This design (I hope) wordlessly conveys the following instructions: 1) Choose credit-card or bill-me-later; 2) if you choose credit-card, you must fill in the associated fields; and 3) if you fill in any of these fields, complete them all.

5 Develop a consistent style. The BYTE Site is a cluster of servers that delivers a suite of applications. We took pains to standardize the look of the HTML pages dished out by the various applications, such as archive articles, search results, and conference messages. But we failed to standardize the look and feel of the forms presented by these applications.

It makes sense to do so, and we will, for reasons that are as much functional as aesthetic. One instance of the design illustrated in the screen above might work well enough, but it works better when users encounter consistent variations on the theme.

Given such standardization, you can create and leverage a data dictionary of



form elements, along with associated error-handling code and messages. For example, we collect e-mail addresses on four different forms. Clearly, each ought to inherit a common widget, along with associated error-handling code.

6 Parse forms completely and report all errors and omissions. In order to download the JDK 1.2 beta from JavaSoft's site, I had to register. On my first try, the server rejected my form with the "Username cannot match password" message. So I backed up, corrected that, and resent the form. It rejected my form again, this time with "Required address field is blank."

This all-too-common behavior irks me. The application saw all the fields I sent, and didn't send, on the first try. Why not do all the necessary griping immediately? I'd rather take care of everything at once. Finding multiple errors one at a time, by bouncing repeatedly off a server, rapidly erodes my patience.

To spare users this headache, I've settled on an error-handling technique based on the assumption that it's better to deliver all the form-processing results all the time. I've implemented the technique in Perl, but you could just as easily do it in any other Web scripting language.

It's nothing fancy. I just accumulate the complete list of errors each time I process the form. If the list isn't empty at the conclusion of the script's error-checking phase, the script passes the list to a common library routine that displays all the errors, along with associated explanations.

An unexpected benefit of this approach was that it greatly accelerated the process of testing the error-checking code associated with our forms. In a single cycle, you can verify that a form's handler correctly reports an incorrectly confirmed password, an empty address field, and an ill-formed account number.

7 Accept all unambiguous inputs. When I last renewed a digital certificate on the VeriSign site, the server rejected my order form with an "Invalid credit card number" message. Why? I'd typed the number with hyphens, but the application was looking for unhyphenated input. That's just silly. Here's the line of Perl that will reduce a mixture of 16 digits, hyphens, spaces, or other junk to just 16 digits:

```
$num=~ s/\D*//g;
```

C'mon, VeriSign. You said that better service was the reason you raised your rates on digital certificates. Doesn't my extra hundred bucks buy me one line of Perl?

8 Use short error messages linked to longer explanations. As I worked through the new batch of forms, I consolidated the error messages into a dictionary of keyword/value pairs. The keywords are short phrases, such as "AccountNotActive." The values are longer explanations, such as "please activate your account first, using the activate link on any protected page." In my case, the dictionary is implemented as a Perl hash table, but you can easily achieve the same effect in any scripting language.

This method works in conjunction with a standard error-message routine shared by all form-handling scripts. When a script checks the input sent from a form, it does not report any errors directly. Instead, it builds a list containing the keywords associated with all errors found. For example:

```
if (length($username) < 4)
  {push(@errs,"Name Too Short");}
if ($pw1 ne $pw2)
  {push(@errs,"Bad Password");}
```

Then, if the error list is nonempty, the script sends the list to the error-message routine, which reports errors along with their associated explanations:

```
if ($#errs > 0) {
 {errorMsg(@errs)}; exit; }
```

I like this approach for two reasons. In the source code, the error keywords bind closely to the tests that trigger them, so the code becomes self-documenting. The same keywords, appearing on the page generated by the error-message routine, are more explanatory than numeric codes would be, yet they are more easily communicated than the accompanying long explanations. And, of course, since the error-message routine is always prepared to handle a list of keywords, the system

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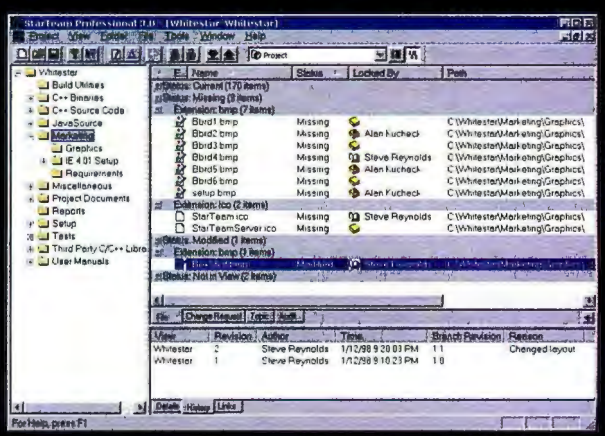

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obeys principle 6: It always reports all errors and omissions.

9 Use forms as components. The design of the new subscriber-access part of BYTE's Web site required the capability to vary the outcome of a given interaction with a form according to the context in which the form is invoked. For example, as a subscriber to BYTE magazine, you're entitled to activate your on-line account and view complete current articles that are otherwise shown only as abstracts. A link to the activation form appears on every abstract. Completion of the form leads back to the full version of the article that was first displayed as an abstract.

How can you achieve this effect? It's straightforward if you dynamically generate the form from a template. In this case, the link that invokes the form self-referentially encodes the URL of the article containing the link. Here's an example:

```
<a href="http://www.byte.com/
  perl/activate.pl?mode=form&art
  =9802/sec1/art1.htm">
  activate</a>.
```

The signal `mode=form` tells `activate.pl` to read and emit the file activate.htm, which contains the form's HTML. That file contains a placeholder for a URL to be interpolated into this form:

```
<input type="hidden" name="art"
  value=ART>
```

Here's how `activate.pl` renders the form:

```
if ($mode eq 'form') {
  open(F,'activate.htm');
  while (<F>) {
  s/value=ART/value=$art/;
  print $_; } close F; exit; }
```

The form's action attribute again names the script `activate.pl`. But the form itself contains no element named MODE. So when `activate.pl` regains control, it skips the form-generation phase and proceeds to the form-parsing phase. If there are no errors, it calls a database routine to activate your account and then issues a confirmation page. A link on that page invites you to continue reading the article that originally prompted this sequence of events. The address embedded in that link is the URL passed on the first call to `activate.pl`, which was embedded in the form as a hidden variable during the form-generation phase.

BOOKNOTE

Understanding Digital Signatures

$34.95
by Gail L. Grant
McGraw-Hill
http://www.computing.mcgraw-hill.com
ISBN 0-07-012554-6

A useful survey of the business, legal, and technical issues surrounding public-key cryptography. It also catalogs vendors of toolkits and applications.

TOOLWATCH

JHLZip

John Leach
http://www.easynet.it/~jhl/apps/zip/zip.html

This handy, free Java application builds an uncompressed zip archive from a list of class files. Since the JDK's jar utility works only on entire subtrees, you need something like JHLZip to build a distributable package from a list of specifically enumerated classes.

10 Vary widget types according to context. As soon as this problem was solved, another requirement emerged. BYTE's circulation department decided to run a circulation drive hosted on another site, *http://www.bytesub.com*. We wanted to refer new subscribers from bytesub.com to the same activation form used by existing magazine subscribers on The BYTE Site. But the circumstances were different. An existing BYTE magazine subscriber has to enter a subscriber name and number on the activation form in order to authenticate. A bytesub.com subscriber shouldn't have to, because the ordering process on that site already has this data.

We could tell bytesub.com subscribers to write down their credentials. Then we could refer them to a byte.com activation form that would require them to enter that data. But that would be silly. Using a Web-style remote procedure call (RPC), bytesub.com need only construct the URL that transmits this data to `activate.pl`. It took only a few tweaks to the template and the script to empower bytesub.com to make a call like this:

```
/activate.pl?mode=form&name=
  jon&num=123
```

This causes byte.com to display an activation form with prefilled subscriber-name and subscriber-number fields.

This was an improvement, but it still wasn't quite right. The name and number appeared in editable input fields, yet in this context the data should only be displayed, never changed. Although most users wouldn't touch this data, it seemed wrong to invite them to do so.

The final iteration resolved this problem by varying the types of the widgets according to context. As shown in the figure on page 104, the template contains placeholders for two versions of the widget pair. The `mode=` signal tells the form generator which pair to include. In a byte.com context, the form presents empty input boxes. Called from bytesub.com, it prints the passed values in these same locations.

Future Directions

We've made a lot of progress this time around, but there's still plenty of room for improvement. The data dictionary remains just a good idea; we haven't rigorously decomposed all our forms to create an inventory of reusable widgets.

Another tantalizing possibility is namespace completion. Using the replaceable-widget technique shown in the figure on page 104, I've prototyped a mechanism that accepts partial input in a text box and then returns a version of the form that swaps in a listbox containing matches resulting from a database lookup. This magical effect is the holy grail of Web-based data-collection applications. Many commercial toolkits can deliver this capability, but homegrown (and, thus, maximally customizable) implementations are well within the reach of competent scripters.

There's nothing Perl-specific about the techniques discussed here; they'll work in any scripting environment. You just need to know how HTML forms work and be willing to fluidly adjust the relationship between scripts and forms. B

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Rick Grehan

Javatalk

TopLink Bridges Two Worlds

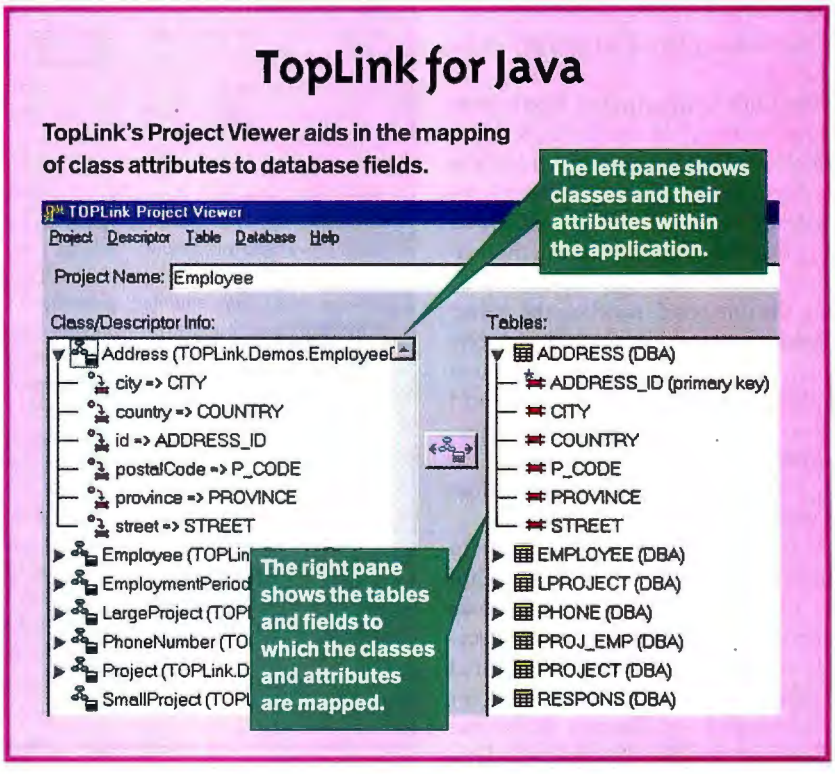
A new version of TopLink maps Java objects to relational databases.

Sometimes you can't get from one place to another without crossing a bridge. The same is true if you want to reap the benefits of Java object programming but need to work with data that's stored in a relational database. TopLink for Java provides that bridge. A 100 percent pure Java object-relational database system, the program is the third in a line of object-relational database products from Object People. Previous versions of TopLink supported Smalltalk and Gemstone.

TopLink (prices start at $4000 per developer for a four-developer license, and volume discounts are available) works with databases equipped with a Java Database Connectivity (JDBC) driver. The documentation gives examples for DB2, Oracle, Sybase, dBase, and Access. Object People has also built custom back ends for mainframe systems.

The linchpin of the TopLink system is a *descriptor*, which is a data structure that serves to map the details of the object structure (and object relationships) to the relational database. In other words, a descriptor tells the TopLink system how an object's data is to be stored in the relational database.

A descriptor includes the name of the Java class it describes, as well as the associated tables that the Java class will be mapped to (e.g., the table in the database where objects of the class will be stored). Information in a descriptor describes the attributes and object-object relationships that exist for objects in the class. Necessarily, a descriptor must also carry information describing the structure of the table. This information includes the primary key of all records in the table, the field names, and so on.



A descriptor holds other information that's necessary for successful storage and retrieval of database objects. For example, the Java object may contain a data type that is not supported in the relational database. A descriptor contains information necessary to transform data of one type to the other.

A descriptor's information is actually stored in a file. The application imports this file prior to the application's accessing the database. As you might guess, building a descriptor is a complex undertaking, because it involves assigning classes to tables, attributes to fields, application data types to database data types, and more.

To help in this task, TopLink provides the Builder tool. The Builder reads in the database schema (via JDBC) and the class structure (Builder reads Java class files directly). With the schema and class structure fed into the Builder, you then have a visual view into both the database and the application's classes (see the screen). Using the Builder's Descriptor Editor, you can easily go through the process of mapping attributes to table columns. The Builder will construct a descriptor for you automatically and emit a file ready for import into the application.

At run time, a descriptor is imported into a session object (TopLink defines a session class). A session object is an

abstraction of an application's access to a database. The session object includes connection information (e.g., log-in name and password). Once an application has registered a descriptor with a session object, the application can begin reading and writing objects from and to the database.

TopLink builds into an application an object cache—called an identity map. When an object is read from the database, it's placed in the cache. At a later time, if the application requests the object again, TopLink can read the object from the cache rather than from the database.

This cache is a customizable one. That is, the developer can control how long objects live in the cache and thereby control the memory footprint that the cache consumes.

I couldn't help noticing a one-page "design strategy" in the TopLink documentation. The question it tackled was this: As you begin designing an object-relational database system, which part do you design first: the object structure or the relational database schema?

On the one hand, tackling the object structure first appears advisable. It's certainly the tack I would take, because it would permit me to construct what I would consider to be an optimal object structure. Optimal, in this case, refers to how easy it would be to program and does not necessarily refer to performance.

Furthermore, it does *seem* to be best to design the object structures with no regard for artifacts from the relational database system underneath. Designing your structure with the relational database in mind would mean adding features that don't really benefit the application. You're just adding them to make the relational database happy.

However, the documentation points out that the object structure and the underlying database schema are intertwined—the structure of one influences the structure of the other. Also, the relational database imposes restrictions on the object model "above." Keeping these limitations in mind while the object structure is being built can keep you from painting yourself into a corner.

WHERE TO FIND

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So, Help Me, Java

JavaSoft continues to roll out APIs about as fast as you can hiccup. The new Java Help API, currently in beta testing, is an all-Java "über alles" help system for JavaBean components, applications, desktops, and HTML pages. (That's a big target.) The Java Help documentation envisions a Java help system written purely in Java. That means you can embed a help system within an application or compress it into a Jar file for transport to another destination.

The primary component of a Java help system seen by a user is the help viewer, which comprises a toolbar, content pane, and navigation pane. (Java Help relies heavily on swing user-interface components.) The contents of the help viewer ought to be familiar to anyone who has interacted with a help system. The content pane displays help topics. The navigation pane is a tabbed pane that lets a user select from among the table of contents, index, and text search options.

Java Help permits a single help system to support varying "navigational views" of help content. The navigational view is a description of how a particular kind of content is to be viewed. In that sense, it is metadata—data about data. For example, a navigational view is defined by (among other things) its format (how it is to be shown) and data that identifies the format and location of the view. A navigational view is implemented by a Help Navigator, which is a subclass of the JHelpNavigator class (a swing component).

The Java help system already understands several navigational views. The table of contents, index, and search information (displayed in the help viewer) already have navigational views defined. Java Help provides mechanisms for registering new navigational views. Consequently, the diversity of data permitted, and the means by which the data is viewed, is limited only by developers' imaginations.

The data structure that carries all the information needed to provide a view into a help system is bundled into a HelpSet file. Note that there are two "loose" terms at use here. First, a HelpSet file isn't necessarily a file, in the same sense as files that you store on your hard disk. A HelpSet file could be bound into an application, for example. Second, it's probably more accurate to say that the information is rooted in the HelpSet file. The structure of a HelpSet is XML-encoded (Extensible Markup Language) data. The data points to the URLs from which you can find the info necessary to build the help system.

Here's an example. One portion of the HelpSet file points to yet another structure called the Map file. A Map file is a series of "key = value" pairs. Each key is a help topic (i.e., an entry from the table of contents), and the value is the URL of another file that stores the actual content that the system will display when the user selects a table-of-contents item.

The upshot is that the data structures used by a Java help system are flexible enough to permit a wide variety of delivery scenarios: Help can be bundled into a JavaBean, help can be inside an application, help can be a separate (but local) file outside the application, help can be pulled in from across the network, and so on. The architecture is initially daunting, but it looks as if it will serve the broad (and ever-broadening) needs of Java applications and applets.

Still, this raises the "impedance mismatch" question. That the relational database need be considered at all is something that likely causes cheering in the camps of purveyors of pure object databases. They can rightly point out that—their systems being object-based through and through—they needn't worry about the underlying characteristics of a relational system adversely affecting the objects above. However, the fact is that many organizations have vital corporate data stored in legacy relational databases.

TopLink also contains the classes necessary to create three-tiered applications. For example, TopLink defines ServerSession and ClientSession session subclasses. The former lets an application construct the server side of a session with a database (the server being the middle layer of the three-tiered application); the latter handles the client side.

ServerSession objects are session managers to the client tier. ClientSession objects give the application the "appearance" of being a "typical" (i.e., two-tiered) application.

Compared to other object-relational systems I've tried, I liked the visual approach taken by TopLink's Builder. It makes a difficult process of mapping objects to tables relatively easy. B

Rick Grehan (Hancock, NH) works for Metrowerks' Discover Products division. You can reach him at **rgrehan@austin.metrowerks.com.**

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Udo Flohr

FutureVision

The Smallest Components

Advanced physics meets computer design at the atomic level in IBM's laboratories.

Walking the corridors of an R&D lab at the world's largest computer company, you naturally expect to see all manner of things electronic. Yet I was struck on my visit to IBM's Zurich Lab, in Rüschlikon, by the prominence of nanomechanical and optical technologies. As we near the limits of today's semiconductor fab technology, will the new millennium be a post-electronic world? Will BYTE in 2010 be filled with new technologies layered on top of electronics in the same way that electronic marvels like the integrated circuit now work side by side with antique electrical devices like switches and coils?

Probably, if Gerd Binnig is right. Getting beyond the biases of electronic engineering has been a career for Binnig. In 1978, when he and Heinrich Rohrer first started their quest to map and manipulate matter at the atomic level, they had a "beginner's innocence," Binnig recounts. They ignored the conventional wisdom that their goal could be achieved only with ephemeral ion or electron beams. They turned to mechanics. The result was the scanning tunneling microscope (STM) in 1981 and a subsequent Nobel Prize in 1986.

The STM offered the first view ever of the world from an atomic perspective. Scanning a sample's surface line by line, it measures the tunnel current—a quantum mechanical effect exhibited by the electrons surrounding an atom—between a microscopic tip and the surface and translates it into an atom-by-atom image.

The STM was refined into the atomic force microscope (AFM) in 1986. It also scans with a microtip, but without the current the STM requires, which limited the STM to imaging conductive materials. Instead, the AFM measures attracting and repelling forces between atoms. A cantilever suspending the tip acts like a spring. The forces of interaction deflect the cantilever; gauging the amount of deflection yields an atom-level picture.

Using the STM to move single atoms around, scientists have achieved a theoretical density of a million gigabits per square inch, but these experiments require temperatures near absolute zero. In a more practical approach, IBM's Almaden (California) and Zurich research labs are experimenting with probe-based storage using AFM technology. With a rotating, penny-size plastic disk, Dan Rugar's group at Almaden constructed a kind of high-tech phonograph with a 0.008-micron tip. At a reliable density of 64 gigabits per square inch, the electrically heated stylus writes dents into the disk; it later dips into those dents for reading (see "Infinite Space," February BYTE, page 121).

The Zurich team has taken that AFM work a step further, trying to overcome single-tip data rates that are limited to between 1 and 10 megabits per second. Their answer is Project Millipede. In January, they reported the construction of a 5 by 5 set of tips; by year's end, they hope to have a 1000-cantilever array working, which would yield a terabit on a 1.4-inch-square area at a rate of 1 gigabit per second. For rewriting, they heat parts of the polymer substrate to erase blocks of data.

3-D Chips

Binnig's vision extends further. He wants to put the new technology to work creating a generation of microprocessors that will be mechanical. If this evokes clattering wheels and sprockets, you've got the wrong picture. Binnig is talking about components so tiny they are invisible to the naked eye.

He predicts that nanoprocessors will be more tightly integrated and less energy-hungry than today's transistor-based chips. Several orders of magnitude less, in fact, which is why "the VLSI age of micromechanics" could make three-dimensional processor architectures a reality. Today's chips crowd all their elements into a single plane, Binnig says, "because nobody has a clue how to cool a 3-D package."

Zurich's Bruno Michel is working on less esoteric small-scale manufacturing techniques that will also have an impact on chip design and other processes. In

PROBABLE IMPACT

Storage

- **Atomic force microscope (AFM) technology** could produce devices that write a terabit of data on a 1.4-inch-square area at a rate of 1 gigabit per second.
- **Holographic storage** could instantaneously retrieve from large data sets the answers to complex queries.

Chip Manufacturing

- **AFM** could be used to overcome the limits of photolithography by using very tiny mechanical elements within multilayer chips.
- **New printing techniques** can't reduce the size of chips, but they can reduce the price of less size-sensitive components because they are only 10 percent of the cost of photolithography.

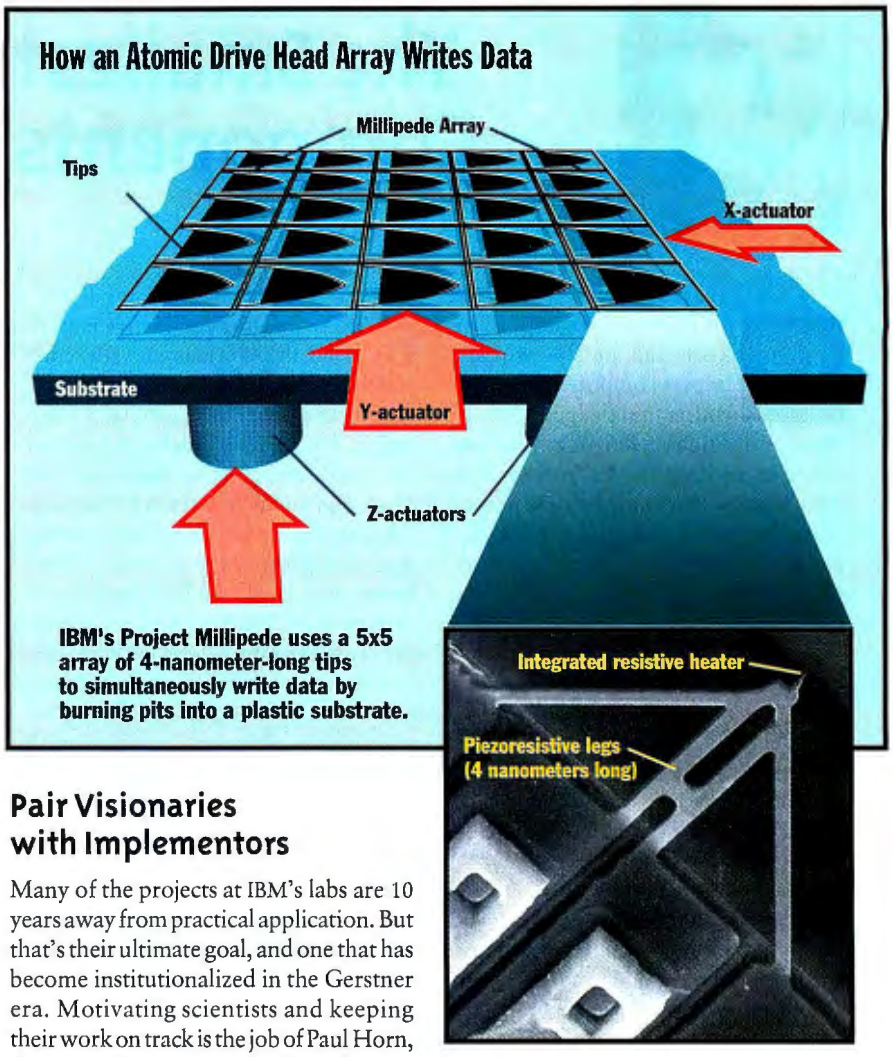
Michel's case, he's looking at a centuries-old technology to eliminate lithography altogether: printing. Using an elastomer-based "rubber stamp," the researchers transfer patterns of submicron resolution to solid surfaces. Using "self-assembling" molecules, they achieve "conformal contact" on a molecular scale across several square inches. The process, called *microcontact printing*, helps create medical tests for very small sample quantities by "printing" live protein molecules, but it could also be used to simplify chipmaking: Printing circuits with a rubber stamp costs only about a tenth of photolithography and is more environmentally compatible because it requires fewer chemicals, Michel says. But, he cautions, this technology will not scale down to the highest levels of integration achievable with lithography.

If Binnig deals with an arcane world too small to see, Hans Coufal's work is something you can hold in your hand. Looking at the sugar cube-size crystal in my palm, it was awe-inspiring that I was holding 10 gigabits, more than a gigabyte, of data. At Almaden, Coufal is pushing the envelope forward for holographic storage. Since BYTE first reported on it two years ago ("Creating Holographic Storage," April 1996, page 48), Coufal's group has pushed the capacity of the cube up from 48 megabytes, nearly two orders of magnitude.

The cube is based on holography. Holograms store a pattern of interference formed by a split laser beam, recording it on film or a light-sensitive crystal. (One part of the beam reflects off the original object; the other part is the reference beam.) Illuminating the pattern with the reference beam (or with ordinary light) recreates a 3-D image of the object when tilted for different viewing angles.

In Coufal's crystal cubes, however, each viewing angle holds a different page of information. By changing the angle in tiny increments, he has been able to store 10,000 pages of 1 megabit each (10 gigabits) in a crystal the size of a sugar cube.

A whole page is recorded and retrieved at once—yielding data rates up to 1 Gbps—which makes Coufal's approach ideal for associative memory: Illuminating the hologram with a search pattern immediately returns the target page's reference beam and angle. Thousands of fingerprints or satellite images, for example, can thus be searched in milliseconds. Finally, if a hologram is damaged or even breaks, each piece still contains all the information; only the image's light intensity suffers. Coufal, who is currently experimenting with less expensive and more reliable recording crystals, expects to have a prototype in about two years.



IBM's Project Millipede uses a 5x5 array of 4-nanometer-long tips to simultaneously write data by burning pits into a plastic substrate.

Pair Visionaries with Implementors

Many of the projects at IBM's labs are 10 years away from practical application. But that's their ultimate goal, and one that has become institutionalized in the Gerstner era. Motivating scientists and keeping their work on track is the job of Paul Horn, director of IBM Research. How does he manage all that creativity without reining it in? In a recent *Financial Times* article, he laid out his bag of tricks:

- Underdefine jobs, and people will rise to the titles and responsibilities bestowed upon them.
- Include customers and users in brainstorming sessions.
- Do not overmap the journey. It is impossible to anticipate all the risks. Just protect the core idea from being dismantled.
- Pair your visionaries with implementors.
- Encourage the flow of ideas outside work. Quite a few scientists can point to ideas that developed from conversations with their children. One suggestion: Research labs should be near universities.
- Evaluate the process, not the short-term result. While some breakthroughs may take decades of research, an experienced manager will be able to judge the dynamics of the project. In addition to Horn's guidelines, IBM labs have implemented another program to improve the applicability of research. Today, about a quarter of Research's employees work directly with customers. This is encouraged through the "First of a Kind" program, an effort to match research projects with customers to create solutions that might be applicable to others. One example is a digital library project with the Vatican. The goal is to make tens of thousands of priceless manuscript pages available on-line. B

Udo Flohr is a BYTE contributing editor who writes about advanced technologies. He is based in Hannover, Germany. You can reach him by sending e-mail to **flohr@dfn.de**.

BYTE Reseller

Cracker Tracker

Crackers are watching you. Get even: Watch them back.

Page 112C

JDBC's Growing Pains

Full of promise, JDBC is still too immature for many.

Page 112M

The Road to a Universal Repository

They aren't for most of us yet, but it's time to check out repositories.

Page 112S

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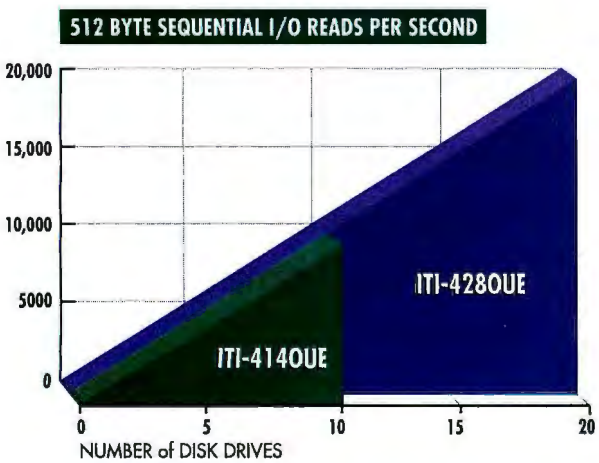

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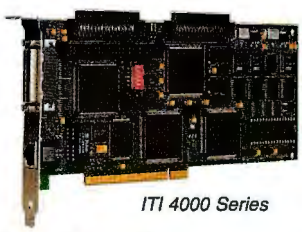

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You can't stop all security violations. Here's how to track the ones that get through. ***By Michael Hurwicz***

Cracker Tracking:

Tighter Security with Intrusion Detection

It's midnight. Do you know who's trying to hack your network? Probably not. According to a 1996 study by the Computer Emergency Response Team (CERT), an Internet security watchdog, network administrators fail to detect about 80 percent of network hacking.

That may change, though, with the advent of real-time intrusion-detection products. These electronic burglar alarms complement the locks (e.g., authentication, authorization, and encryption) designed to keep intruders out of your network and the inspections (security assessments and audits) that look for unlocked doors and windows. When intrusion-detection products detect something suspicious, they notify you, typically by pager, e-mail, or an SNMP trap. Intrusion-detection products may also have automated responses that can cut short a hacker's visit to your network within milliseconds.

"Intrusion detection is for the customer who has taken the steps to put together strong firewalling and an authentication process. It offers added security."

–John Freres, N2N Solutions

Complementary Technologies

There are two kinds of intrusion-detection products: host-based and network-based.

Host-based products have an agent running on each protected host. Examples include the Kane Security Monitor, from Intrusion Detection; OmniGuard/Intruder Alert, from Axent Technologies; and Stalker, WebStalker Pro, and ProxyStalker, from Trusted Information Systems. The agent sends a regular heartbeat, as well as alarms, to a management station. The heartbeat ensures that the management station can detect a denial of service aimed at overwhelming a host so that it's unable to respond or do normal work.

Network-based monitors sit on the network capturing packets and matching what they see with known attack patterns. Examples include Internet Security Systems' RealSecure, Network Associates' CyberCop, and NetRanger (introduced by WheelGroup but now a Cisco product). They, too, generate alarms when they see something suspicious and may also send a heartbeat to a central console.

Each approach has its strengths and weaknesses. Advantages of network-based detection include:

Faster detection: A network-based monitor will typically detect a problem in seconds or milliseconds. Most host-based

PHOTOGRAPH: ERIC HERZOG © 1998

Host-Based Intrusion Detection

For small networks, a host-based intrusion-detection system is probably the most cost-effective.

Pros: Cost-effective for small numbers of hosts, unlikely to miss activity due to high traffic loads, probably won't require dedicated hardware.

Cons: Requires agent for each host, vulnerable to attack, costs rise with number of hosts, requires resources on host.

Some Vendors:
Intrusion Detection
Axent Technologies
Trusted Information Systems

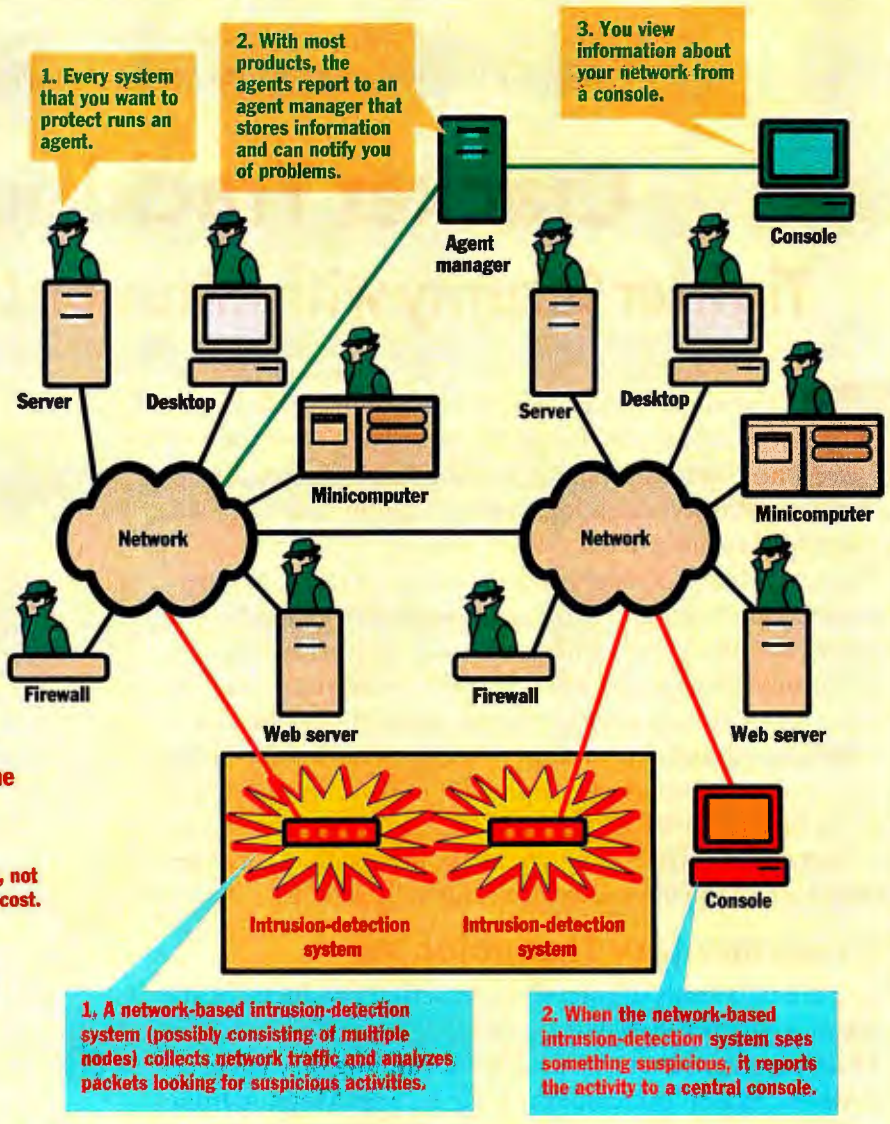
Network-Based Intrusion Detection

If you have to choose one kind of intrusion-detection system, a network-based one is probably better.

Pros: Protects every device on network, detects problems quickly, not very vulnerable to attack, one flat cost.

Cons: Expensive, can't watch individual files on a specific host, requires dedicated hardware, may miss traffic due to network load.

Some Vendors:
Internet Security Systems
Network Associates
Cisco Systems



approaches depend on auditing logs every few minutes.

Less visible: A monitor is less visible and accessible than a host, and thus less vulnerable to attack. Unlike a host, a network-based monitor doesn't have to respond to pings, allow access to its local storage, let users run programs on it, or allow access to multiple users.

Bigger perimeter: The network-based approach may be able to stop an attack at the perimeter of the network, before the perpetrator ever accesses a host.

Fewer monitors: You need fewer monitors because one monitor can protect a shared network segment. In contrast, you need an agent per host, which can be costly and hard to manage. On the other hand, in switched environments, you may need a monitor per host, too, because every host is on its own segment.

Fewer resources: It doesn't take up any resources on the protected device.

The host-based approach also has its advantages:

More cost-effective: It may be more cost-effective for small numbers of hosts.

More granular: It can easily monitor activities, such as access to sensitive files, directories, programs, or ports, that are difficult to deduce from protocol-based clues.

Tighter perimeter: Once a perpetrator has obtained a password and user name for a host, the host-based agent has the best chance of distinguishing harmful from normal activities.

More customizable: Per-host customization is easy with a separate agent for each host.

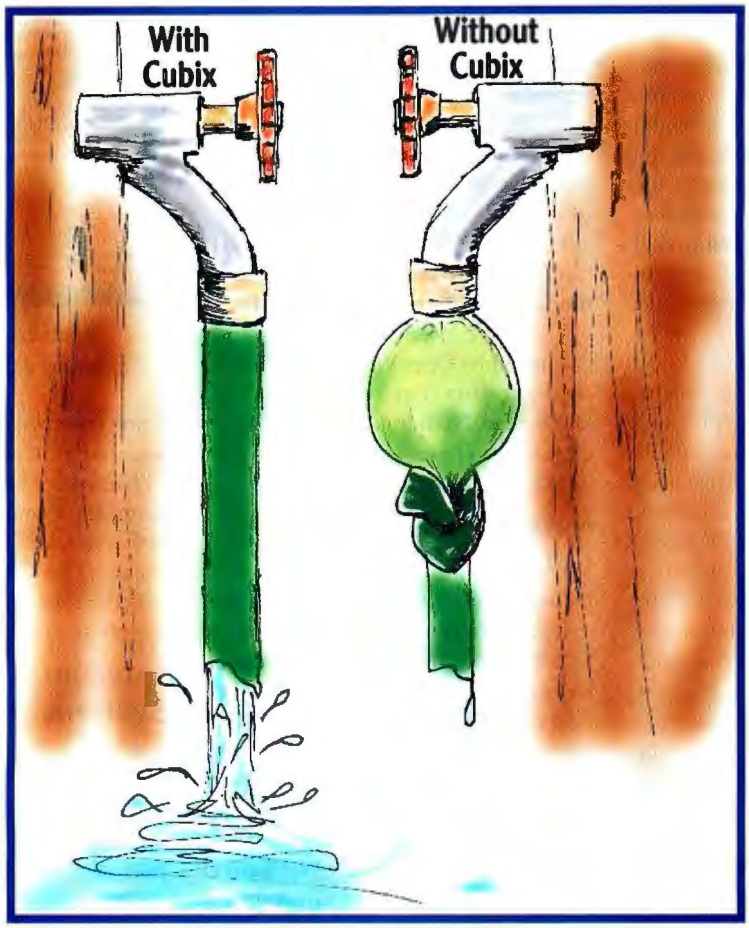
Fewer hosts: The host-based approach may not require a dedicated hardware platform.

Less traffic-sensitive: An agent is unlikely to miss any activity due to traffic loads.

These two approaches complement one another. One possible strategy is to implement network-based monitoring and add agents on particularly sensitive hosts.

Real-time intrusion detection also differs from programs such as TripWire, a freeware utility that creates checksums for critical files. Normally run once a day, TripWire notifies you if a file changes, possibly indicating corruption or virus

Apps run soooooooo slowwww.



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infection. While very useful, this is not real-time intrusion detection.

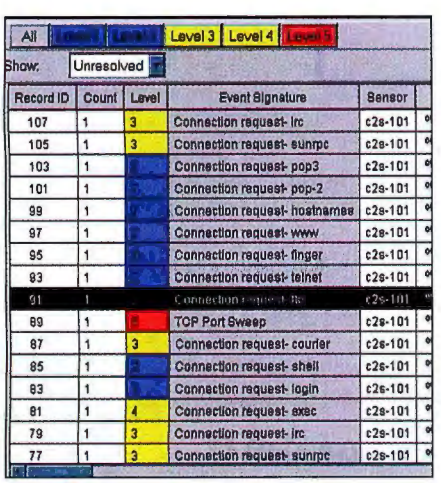
Cisco's NetRanger

NetRanger, introduced in March 1996 by WheelGroup, is based on years of field experience. The product has two components: the sensor ($9000), which monitors packets and generates alarms, and the director ($10,000), which receives and correlates alarms and initiates responses.

You'll also need at least a Pentium PC for the sensor and a Sun SparcStation running OpenView or NetView for the director. Both run Sun's Solaris. Your hardware and software costs will be $13,000 for a sensor and $25,000 for a director.

NetRanger has a reputation for high performance. It is also highly scalable. Directors can coordinate information from multiple sites and watch for attacks that span an enterprise. NetRanger's biggest claim to fame is its enterprise focus. One indication of this focus is the distribution channel, which includes companies such as EDS, Perot Systems, and IBM Global Services—all serving large clients with large global networks.

NetRanger works well across global WANs. For instance, it has a path-doubling feature. If one link goes down, information can flow along an alternate path. It is feasible to watch a global network from a single point or to outsource monitoring to a third party.



CyberCop is based on NetRanger but has a browser-based interface.

Another NetRanger strength is considering context (i.e., clues gained from multiple packets) as well as single-packet contents when looking for possible problems. This can be important, because a perpetrator may access a port in character mode and then send one character per packet. If a monitor thinks only in terms of single packets, it will never see the whole message.

NetRanger is one of the most sophisticated network-based intrusion-detection products on the market today, according to Jude O'Reilley, a research analyst with the GartnerGroup (Stamford, CT).

However, NetRanger's very strengths can turn out to be weaknesses for some users. It is designed for use in a network operations center (NOC) and for integration under OpenView or NetView. Its configuration requires detailed Unix knowledge. NetRanger is also relatively expensive. These won't suit the typical LAN administrator very well.

Network Associates' CyberCop

Network Associates is the result of a 1997 merger between Network General, of Sniffer fame, and McAfee Associates, known for its antivirus expertise. CyberCop uses NetRanger's engine and database of attack signatures, which Network Associates licensed from Cisco. Network Associates created its own browser-based graphical front end.

CyberCop is basically NetRanger packaged for the LAN administrator—Network Associates' main customer base. The software is more expensive than NetRanger: $9000 for a sensor and $15,000 for a server. However, the platform is a Dell PC running Solaris 2.5.1. (CyberCop is typically sold preinstalled.) The cost for the platform is about $3000 for a sensor and $5000 for a server.

In addition, CyberCop is designed as a network appliance. Network Associates says it should typically take 20 minutes to install. The company has created six standard configurations for the typical situations it expects to see: mixed Windows NT and Unix subnet, Unix subnet, NT subnet, remote access, perimeter (e.g., an Internet connection), and backbone. It lacks a NetWare configuration.

The browser front end is designed for ease of use and draws on Network General's experience in condensing packet data and making it easy for users to view and understand. Expert knowledge is built into help files, as it is with the Sniffer. CyberCop can also create trace files readable by a Sniffer. CyberCop lacks some enterprise features of NetRanger, such as path doubling.

RealSecure is inexpensive, simple, and runs under Linux.

Network Associates plans a number of acquisitions and partnerships in the security arena, says Katherine Stolz, product manager for CyberCop. "We will be setting the tone for large-scale security. We are going to be a holistic provider."

Internet Security Systems' RealSecure

RealSecure's strong points include simplicity and low cost, says the GartnerGroup's O'Reilley. Like NetRanger and CyberCop, RealSecure has a two-component architecture. Engines monitor packets and generate alarms. Consoles receive alarms and provide a central point for configuration and database reporting. Both run under NT, Solaris, SunOS, and Linux. You can mix and match OSes. They can run on commodity PCs.

For small installations, it is possible to run the console software on the same machine as the engine. That's not possible with NetRanger and CyberCop. The RealSecure engine costs about $10,000; console software is free. One engine can report to multiple consoles. One console can manage multiple engines.

RealSecure can reconfigure the FireWall-1 from Check Point Software. ISS has plans for reconfiguring Cisco routers, according to Mark Wood, manager of intrusion-detection technology. ISS is also working on an OpenView application for RealSecure, according to Wood.

Intrusion Detection's Kane Security Monitor for NT

Kane Security Monitor (KSM) for NT, a host-based monitor, was introduced in September 1997. It has three architectural

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components: an auditor, a console, and agents. The agents browse NT logs and forward statistics to the auditor. The security administrator uses the console GUI to receive alerts and look at historical reports and real-time activity. KSM costs $1495 per protected server (auditor and console included). Add workstation agents to this for $295 each.

KSM is particularly strong in TCP/IP monitoring, according to David Brussin, a senior consultant with Miora Systems Consulting, security specialist in Playa Del Rey, California. But he also adds that Intrusion Detection's products are not designed for speedy WAN performance.

Intrusion Detection will release an OpenView application for KSM in this quarter, according to Robert Kane, founder and CEO. Integration with the Tivoli Management Environment (TME) will follow toward the end of the year. In the future, Intrusion Detection plans to support Unix, Microsoft BackOffice, and Novell NetWare.

Axent Technologies' OmniGuard/Intruder Alert

The three architectural components of OmniGuard/Intruder Alert (ITA) are a manager ($1995), console (free), and agents ($995 per server, $95 per workstation). They correspond to KSM's auditor, console, and agents.

ITA offers much broader platform coverage than Intrusion Detection's KSM. It runs on Windows NT, 95, and 3.1; NetWare 3.x and 4.x (manager and agent only); and various versions of Unix, including Solaris, SunOS, IBM AIX, HP-UX, and Digital Equipment Unix.

You can customize ITA using solution packs for major OSes, firewall vendors, Web-server vendors, database applications, and router manufacturers. Axent acquired firewall vendor Raptor in February and will enhance ITA to reconfigure Raptor firewalls.

Trusted Information Systems' Stalkers

Stalker, introduced in 1993 by Haystack Labs, is a host-based monitor for NT and various versions of Unix, including Solaris, AIX, HP-UX, and The Santa Cruz Operation's UnixWare. Pricing for version 2.1 was $9995 for the manager and $695 for each agent. At press time, pricing had not been announced for version 3.0, which should be out now.

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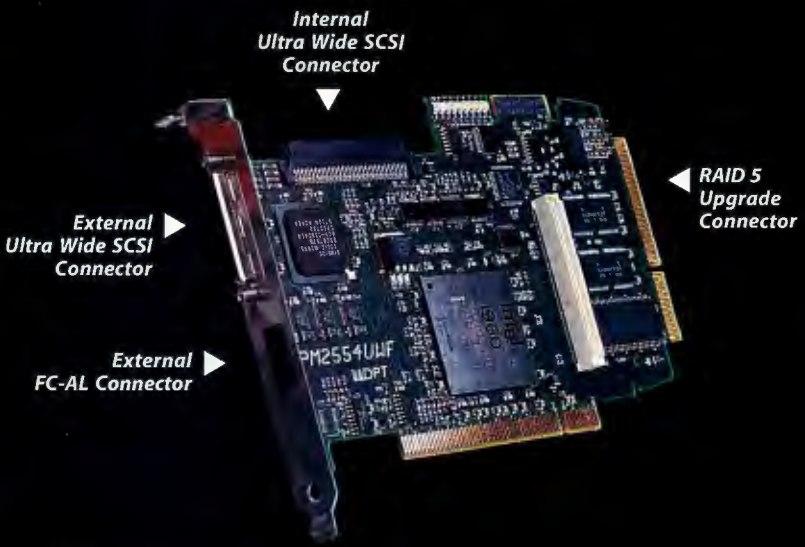

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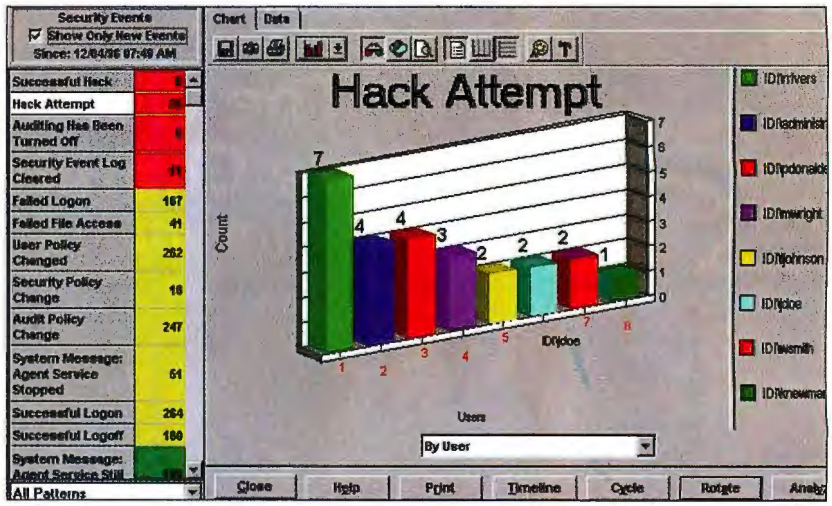

Intrusion Detection's Kane Security Monitor is a host-based monitor that scrutinizes logs for abuse patterns.

WebStalker Pro, which was introduced by Haystack Labs in June 1996, runs under the same OSes as Stalker. It specifically addresses Web servers. It costs $4995 for Unix and $2995 for NT. A version of WebStalker ships with Sun's Netra Web server. IBM Global Services also resells WebStalker.

Trusted Information Systems, maker of the NT-based Gauntlet firewall, bought Haystack in October 1997. In December 1997, it announced ProxyStalker, a monitor that runs only under NT and is designed for Microsoft Proxy Server 2.0. At press time, ProxyStalker was expected out in the first quarter. Pricing had not been announced, but it was expected to be commensurate with Proxy Server, which costs less than $1000.

All three Stalker products can reconfigure Gauntlet firewalls, and all three are able to terminate attacks as well as detect them. For instance, WebStalker Pro can terminate a log-in or a process, or restart the Web server. The Stalker family also integrates with TME.

An Alarming Conclusion

Intrusion detection is only one part of a complete security program. It's no use installing burglar alarms, for instance, if you don't lock the doors with proper authentication, authorization, and encryption.

"Intrusion detection is for the customer who has already taken the steps to put together good strong firewalling and an authentication process. Intrusion detection offers an added layer of security," says John Freres, president of N2N Solutions, a security integrator in Mount Prospect, Illinois.

In addition, many if not most security breaches are based on social engineering—which, in plain language, often means tricking users into revealing passwords. Therefore, education is fundamental to making security technology work. Users must understand what they're supposed to do and what they're not supposed to do—like ever give their passwords out over the phone.

In the context of a well-planned security program, intrusion-detection products can help a security manager sleep at night. B

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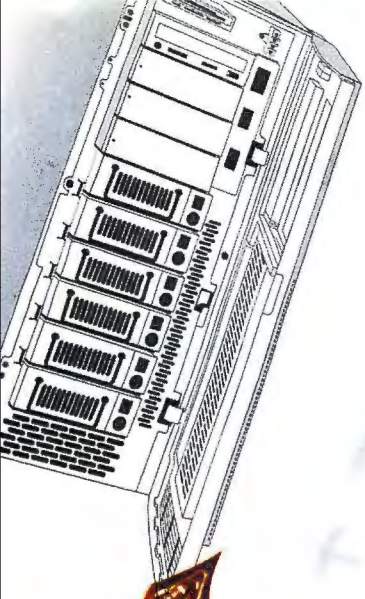

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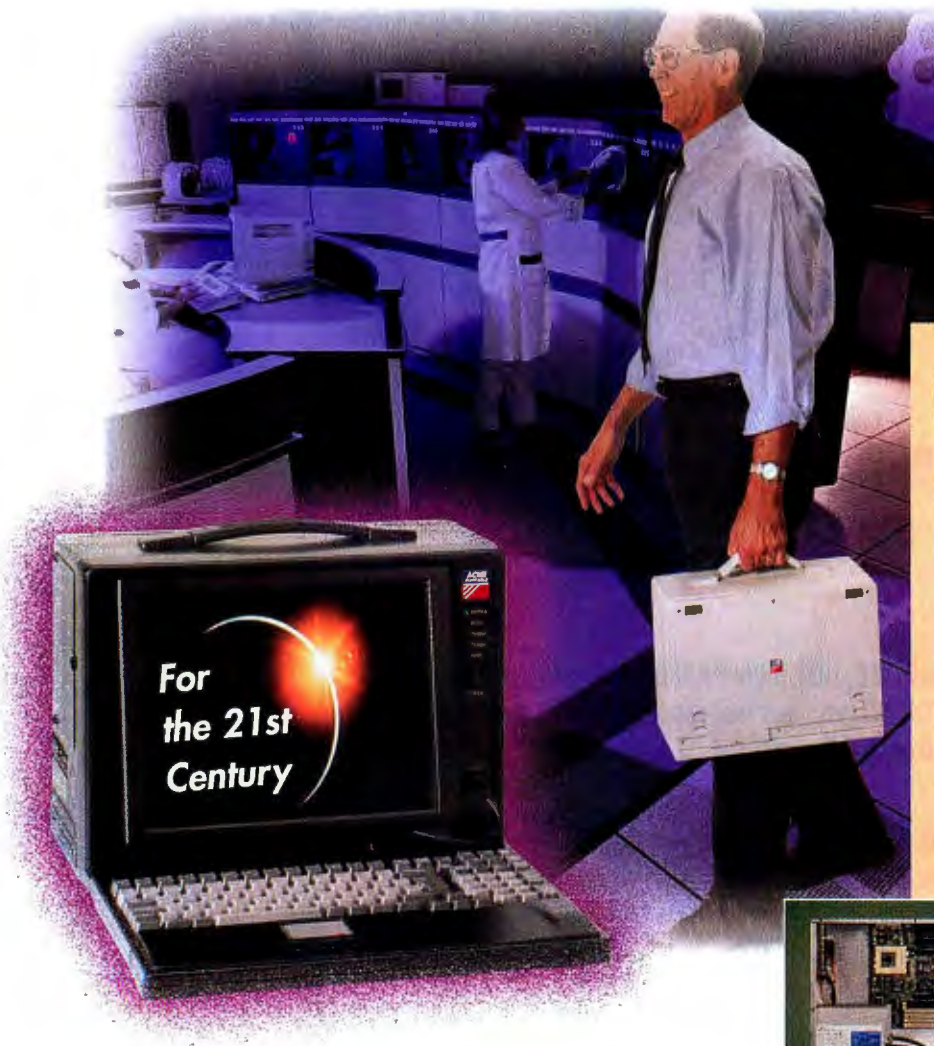

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Java Database Connectivity is a step in the right direction but still too immature for some Java developers. ***By Alan Joch***

JDBC's Growing Pains

Sun's JavaSoft division released the Java Database Connectivity (JDBC) specification, early in 1996, to define a collection of APIs for connecting Java applications to relational database management systems. Like its cousin ODBC ("O" is for "Open"), JDBC uses one common interface backed by DBMS-specific drivers and a driver manager that acts as traffic cop between applications and DBMSes.

To some degree, JavaSoft achieved its goal of providing an open-systems way for clients to access databases. But some developers have grown frustrated with JDBC's slow evolution.

One developer with a love/hate attitude toward JDBC is Ward Mullins, president and chief technology officer of Thought, Inc. (San Francisco), a Java consultancy and middleware developer. One minute, he credits JDBC for being "functional and useful" at its core. The next, he calls the specification "a beta spec" because of its authors' lack of attention to details. "Working consistently across JDBC drivers is like herding cats: You can make them all move, but you can't make them go where you want them to go," he complains.

Until a new version of JDBC comes out—maybe this spring—resellers and integrators who want to merge Java applications with RDBMSes must rely on somewhat immature JDBC drivers and their own finesse in making applications work. Success often comes down to choosing the right driver type from the four defined by JavaSoft (see "JDBC Driver Quartet," page 112N) and picking the right JDBC tools from DBMS vendors, third-party driver sources, and middleware developers.

"Working consistently across JDBC drivers is like herding cats: You can make them all move, but you can't make them go where you want."

—Ward Mullins, Thought, Inc.

Database Direct

Major RDBMS vendors, including IBM and Oracle, ship custom JDBC drivers with their database products. These drivers supply the cross-platform connectivity inherent in the generic spec along with the capability to use special characteristics within their individual RDBMSes. For example, a custom driver for Oracle 8 might extend JDBC to support Oracle sequences.

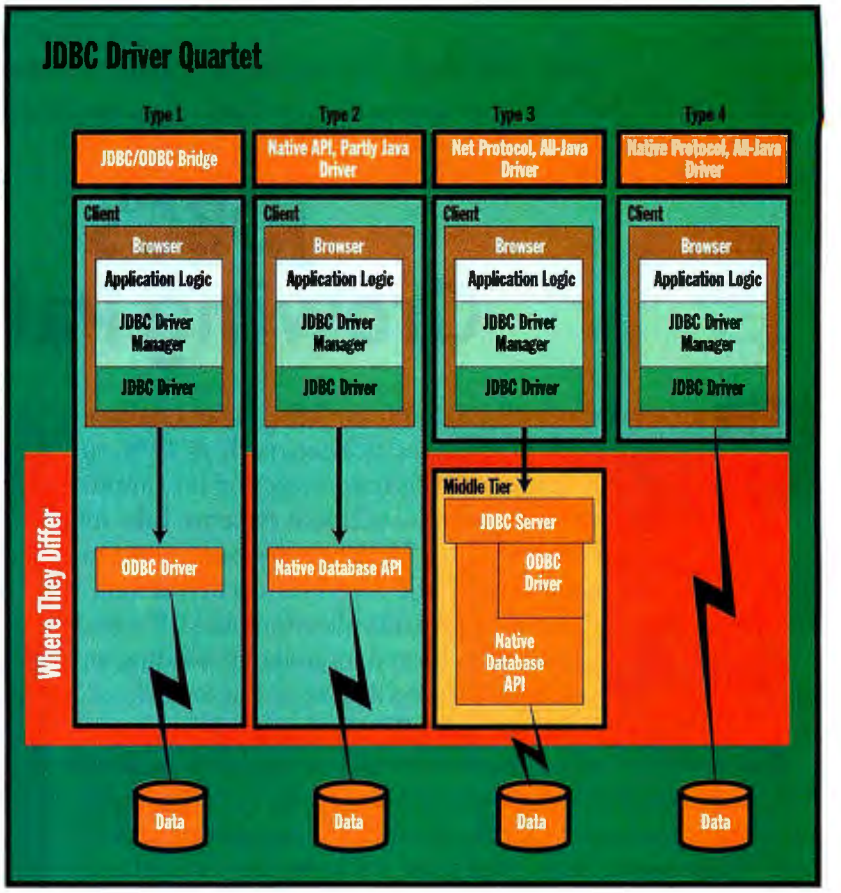
Oracle supplies driver Types 2 and 4. Moe Fardoost, senior product manager for Oracle's Data Server Marketing Division, characterizes this support as the initial step in bringing Java connectivity into the Oracle realm. Type 2 is for heavyweight, three-tier architectures. "Type 2 drivers map JDBC to native

APIs in C/C++," Fardoost explains. "This gives you access to more functionality that's Oracle-specific." Type 4 drivers provide downloadable applets and bypass any translation layers by going directly from Java calls to the RDBMS using Java sockets.

The Internet and New Media Division of systems integrator EDS (Plano, TX) uses Oracle as its primary RDBMS for its Web-hosting services. Prior to JDBC, the division used CGI as a kind of broker for communications between clients and C programs or Perl scripts on the database server, explains Darryl Thomas, consultant and systems engineer. "JDBC is smoother at the process level," he says. "With JDBC, because you talk to other entries directly, you don't have to worry about script violations."

The division currently uses only Oracle's Type 4 JDBC drivers. "We stay away from the Type 2 driver because Oracle's implementation is only for Solaris, NT, and 95," Thomas explains. "That may be enough for some companies that are perhaps running an intranet with only Solaris or Windows clients. But our customers have many more different types of clients that we need to support."

For its part, IBM provides two categories of JDBC drivers, based on driver Types 2 and 4, for DB2. The Type 2 relative, dubbed *application drivers*, translates JDBC calls from clients into call-level interface (CLI) calls, which then travel to the DB2 server via Client Application Enablement (CAE). CAE lets clients talk to DB2 servers, according to Judy Escott, IBM's manager of DB2 user-centered design and development. Application drivers differ from straight Type 2 drivers primarily in their support for DB2 CLI, the ODBC-like interface that takes advantage of DB2 capabilities such as object-relational support.



JavaSoft's four kinds of JDBC drivers differ mainly between the JDBC driver and the database.

The second category, *applet drivers*, contains a "client" and a "server" component. The applet client component runs on Java-enabled Web browsers, while the applet server resides on the Web server alongside CAE.

Deciding to use applets or applications depends on a number of issues. Applets require only a Web browser (not CAE) on the client. This makes for a smaller client footprint and simplifies installation and maintenance, especially for companies with a large number of clients. Because applets are Web-enabled, they're the best choice for Internet-based DB2 access, according to IBM's Escott. Applications fit the more traditional two-tier model: clients on a LAN accessing servers such as DB2. Performance is better because there is one less communication layer to deal with, she says. The DB2 CAE must be installed on each client.

JDBC drivers are "a natural way for Java

JDBC Driver Quartet

Here's how JavaSoft defines the four types of JDBC drivers.

Type 1: JDBC/ODBC bridge
Purpose: Provides JDBC access via most ODBC drivers. Note that some ODBC binary code, and in many cases database client code, must be loaded on each client machine that uses this driver.
Best for: Corporate networks or application server code, written in Java, in a three-tier architecture.

Type 2: Native API, partly Java driver
Purpose: Converts JDBC calls into calls on the client API for Oracle, Sybase, Informix, DB2, or other DBMS. Note that, like the bridge driver, this style of driver requires some binary code on each client machine.
Best for: Taking advantage of characteristics that are unique to a specific RDBMS.

Type 3: Net protocol, all-Java driver
Purpose: Translates JDBC calls into a DBMS-independent network protocol that is then translated into a DBMS protocol by a server. The specific protocol that's used depends on the vendor.
Best for: Connecting all-Java clients to many different databases.

Type 4: Native protocol, all-Java driver
Purpose: Converts JDBC calls into the network protocol used directly by DBMSes. Note that since many of these protocols are proprietary, DBMS vendors will be the primary source for this style of driver.
Best for: Direct calls from the client machine to the DBMS server; especially practical for intranet access.

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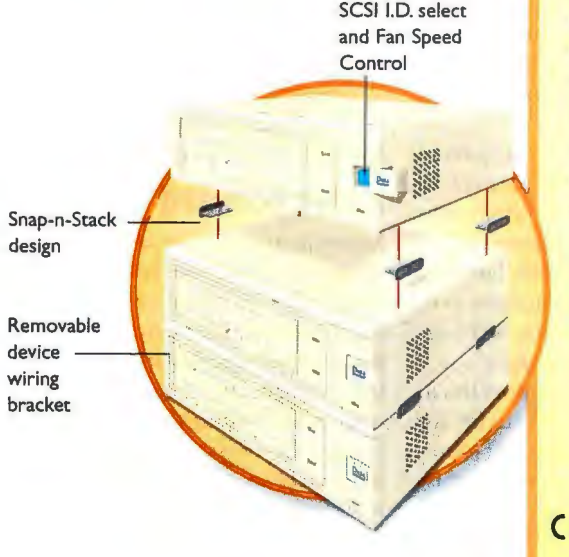

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What Do Java Developers Want?

Java developers aren't shy about pointing out JDBC's shortcomings. Here are some wishes on the top of their fix-it list.

1. *Write Better Documentation.* Consultant Jennifer McLean of Clarkston-Potomac gives high marks to the JavaSoft support staff for helping solve technical problems. But, she says, JDBC is plagued by Spartan tech manuals that could otherwise help developers avoid time-consuming tech-support calls.

2. *Specify Techniques for Mapping Data Types into Java.* According to Ward Mullins of Thought, Inc., the JDBC spec fails in not specifying how common databases and database types map to specific Java types. "Instead of saying 'For Oracle, a `DATE` type should map to a Java Timestamp object,' the JDBC spec leaves it up to JDBC driver vendors to decide if they even support specific types and how those types map into Java," Mullins says. The result: An application written for one driver vendor may get a different result-field object if you run it against the same tables using drivers from another vendor. "Because the spec is loose, so are the implementations," Mullins complains.

3. *Control the Use of "Undefined" Fields.* JDBC driver vendors may choose not to support a given database type and describe it as an "undefined" field when one or more of the JDBC types could readily be used to map the value into JDBC. "This is often done because it makes passing the JDBC driver compatibility tests easier," Mullins says. "Those tests allow database types to be listed as 'undefined', and doing so will skip any logic that might test their compatibility."

4. *Standardize Metadata Management.* To create a JDBC command as one line of code that works under a variety of JDBC drivers requires custom coding for developers to achieve consistent results.

Mullins offers a hypothetical example: To find all the columns for a given table, a call passes through the fields "catalog" (the database catalog name), "schemaPattern" (the user ID in Oracle and other DBMSes), "tablePattern" (a table or wildcard pattern used for tables), and "columnNamePattern" (the column name or wildcard).

"The values I enter for these for fields will vary wildly among JDBC drivers," Mullins says. "Some want the catalog parameter to be an empty string. Others want it to be a 'null' value. Others want it to be a wildcard (usually a % character as a Java string). Likewise the schema, table, and column patterns can vary in the same way."

Mullins says there are also problems with the return values of `getColumns` in many drivers. "Some throw in Java exceptions when you try to extract the results, which must be caught correctly or your whole program blows up," he says. "Others return faulty data, such as invalid column data-type information, while others simply don't return certain information that should be readily available."

5. *Handle Transactions Consistently.* Some JDBC drivers allow only one result set, rather than multiple results, open at once. With other drivers, there's a lack of reverse scrollability (i.e., an application can move either forward or backward from the current row).

Finally, some drivers display exceptions if you read the same column twice, and most don't fully support the JDBC matrix of casting. "The casting chart means, for example, I should be able to read an integer value from the database into a Java `LONG`," Mullins says.

programmers to get data through stored procedure calls that you can send over the network," says Jeff Jones, IBM's program manager for data management marketing. Nevertheless, it's not the only way, in IBM's view. Net.Data, which comes bundled with DB2, resides on a Web server and maps requests from Java apps to the database, using native RDBMS language.

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Third-Party Solutions

Third-party driver vendors build any of the four driver types and add nuances not spelled out in the spec (see *http://java.sun.com/products/jdbc/jdbc.drivers.html* for a list of driver vendors). In the short term, driver vendors like WebLogic work to distinguish themselves by writing drivers that can pass more of the modules in JavaSoft's JDBC compatibility tests and by adding features beyond what the generic spec requires. For example, WebLogic says jdbcKona supports extended SQL and multibyte characters.

But a competitive advantage gained with extensions won't last forever, as RDBMS vendors continue to roll out newer versions of their JDBC drivers. "Over time, most people will probably buy their Type 2 drivers from the database vendors," concedes Scott Dietzen, WebLogic's vice president of marketing.

The future for driver vendors lies in Types 3 and 4, which offer benefits for application developers who want to create better-performing and more sophisticated Java/RDBMS applications. Type 3 drivers, which reside on an application server and communicate with all-Java clients, give Java applications the ability to read and write to an RDBMS anywhere on the network. Because Type 3 drivers work with all-Java clients, there are no C libraries to download, making this type best for browser-based access to RDBMSes. When evaluating commercial Type 3 drivers, you should judge according to how they extend the generic spec. For example, some drivers support IIOP, query caching, and pooling of database connections.

Type 4 drivers provide essentially the same capabilities as Type 2 interfaces but have the advantage of being all-Java.

A Step Forward

Many programmers emphasize that despite its flaws, JDBC is a positive step forward, especially with the help of RDBMS and third-party products that flesh out the spec. Few are unhappy about leaving behind the time-consuming alternatives, like writing CGI scripts, to marry Java applications and RDBMSes. As Jennifer McLean, a consultant with systems integrator Clarkston-Potomac (Durham, NC), puts it: "The advantage of using JDBC is that it's all one Java program, it's all object-oriented." B

Alan Joch is a BYTE consulting editor. His e-mail address is **ajoch@monad.net**.


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More than databases, repositories should hold the corporate IS jewels. Why don't they? By Karen Watterson

The Road to a Universal Repository

The problem with repositories, notes Michael Barnes, an analyst with the Hurwitz Group consultancy, is that no one wants to deal with them directly. We might add that no one wants to pay for them, either. Their appeal is simply as an enabling technology, something that's supposed to make programmers' and information technology (IT) enterprise architects's lives easier.

At their simplest level, repositories are basically databases. More accurately, they're database applications for system information. System information? In the context of repositories, system information refers to information about an organization's IT assets—everything from C++ header files, component definitions, and COBOL copy books to information about on-line corporate knowledge-base assets. Repositories typically also contain database design information, business rules, and corporate naming standards, for example. In a sense, a repository's role is similar to that of a library's card catalog—an exhaustive and cross-indexed list of resources.

Chances are that most programmers will recognize the notion of a repository as the library or component manager associated with many of today's developer tools. Imagine that kind of library for an entire organization's resources. That's the vision of the repository, so it shouldn't be surprising that repositories have been called data dictionaries—even encyclopedias—and that their contents are often referred to collectively as metadata, or data about data.

Data repositories aren't new. For example, they have often been associated with CASE and data-modeling tools. CASE repositories have focused on storing design information, often about database schemata. Some repositories, usually from tool vendors, have been designed to store information related to the software-development process: source code, version history, project management information, and so on. But the need to share information across enterprises and government entities has led to a variety of domain-specific proposals for metadata repositories, including Federal Geographic Data Committee (FGDC) for geographic information systems, the Warwick Framework and Dublin Core for digital libraries, and industry standards such as Common Data Interchange Format (CDIF),

ILLUSTRATION: LYN BOYER-NELLES © 1998

a standard devised by CASE-tool vendors for modeling tools.

Repositories, then, are tools to help manage computer systems and networks. Metadata is extensively used in systems and applications to gain efficiency when accessing, transferring, sharing, or processing large amounts of data.

An ideal repository will be distributed, open, and extensible. It will also be largely self-managing and will interoperate with metadata sets coming from different sources and represented using different standards. It will let itself be interrogated through open, standard, and well-defined interfaces.

Repositories are back in the public eye. This has happened largely because of their role in the exploding field of data warehousing and on-line analytical processing (OLAP) applications. Repository technology makes sense in data warehousing, because you need to store information about a data warehouse's (or OLAP server's) source data and about the extraction, cleansing, and aggregation rules that are associated with building and maintaining it.

Historically, data-warehousing-tool vendors have created proprietary database applications to store and manage that data. Interestingly, some of these vendors make it easy to let traditional information-worker end users "browse" the repository data; others see IT staffers as their ultimate end users.

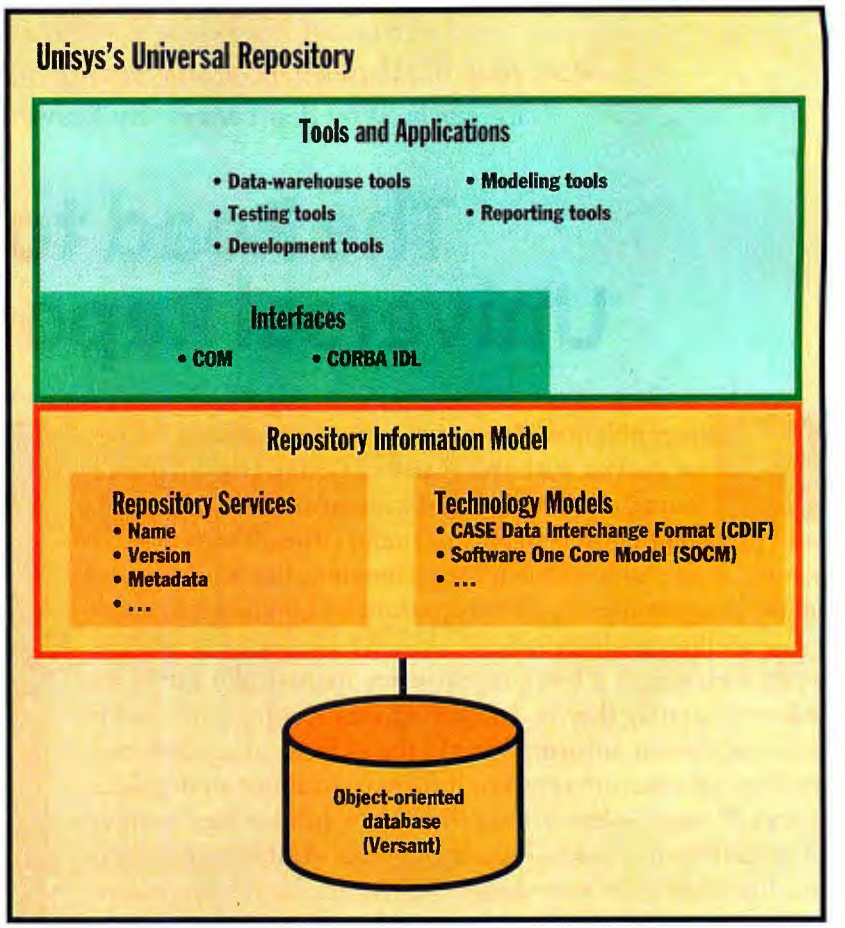
The Metadata Council was formed in July 1995 in an effort to help bridge the gap among proprietary stores of metadata, and the Metadata Interchange Specification (MDIS) is the result. Now in version 1.1, MDIS promises to be a valuable basis for interoperability. (See "The Quest to Standardize Metadata" by Stephen R. Gardner in the November 1997 BYTE for more on MDIS.)

OMG Repository Efforts

Meta Object Facility
Focuses on metadata and model management in distributed object environments.

Object Analysis and Design Facility
Focuses on object analysis and design methods, metamodel, and tool interoperability.

Source: The Object Management Group



The Universal Repository's architecture is in some ways typical of repositories.

Microsoft's Bottom-Up Strategy

Data warehousing isn't the only reason for the renewed interest in repositories. Another reason is Microsoft and its forthcoming Microsoft Repository 2.0. Unless you're a die-hard Visual Basic programmer, you probably don't even know that Microsoft shipped the first version of the Microsoft Repository in March 1997 as a Visual Basic add-in.

Although thousands of programmers have reportedly downloaded it from the Microsoft site, it hasn't set the world on fire. In fact, more than one programmer has complained that, not only did they have trouble installing the Microsoft Repository, they couldn't figure out what they were supposed to do with it.

That's been the problem with most repositories. They tend to be a hassle to set up and maintain, and, from a programmer's perspective, there's no perceived added value.

Some of you will remember IBM's AD/Cycle, a grandiose, but unsuccessful, attempt to centralize the management of mainframe application development. IBM's repository initiatives date back to the late 1980s, and its first host-based repository shipped in 1990 as part of AD/Cycle. Since then, IBM has switched to the client/server model, and its repository technology has evolved through Configuration Management Version Control (CMVC), from 1991, to the current VisualAge TeamConnection, which has been available since 1995.

The simple fact that IBM's top-down initiative was so far ahead of its time was undoubtedly the main reason AD/Cycle failed. However, it, too, was widely viewed by programmers as unnecessary overhead with no payoff. To be fair, Microsoft admitted that Microsoft Repository 1.0 was mainly for independent software vendors (ISVs), and not programmers.

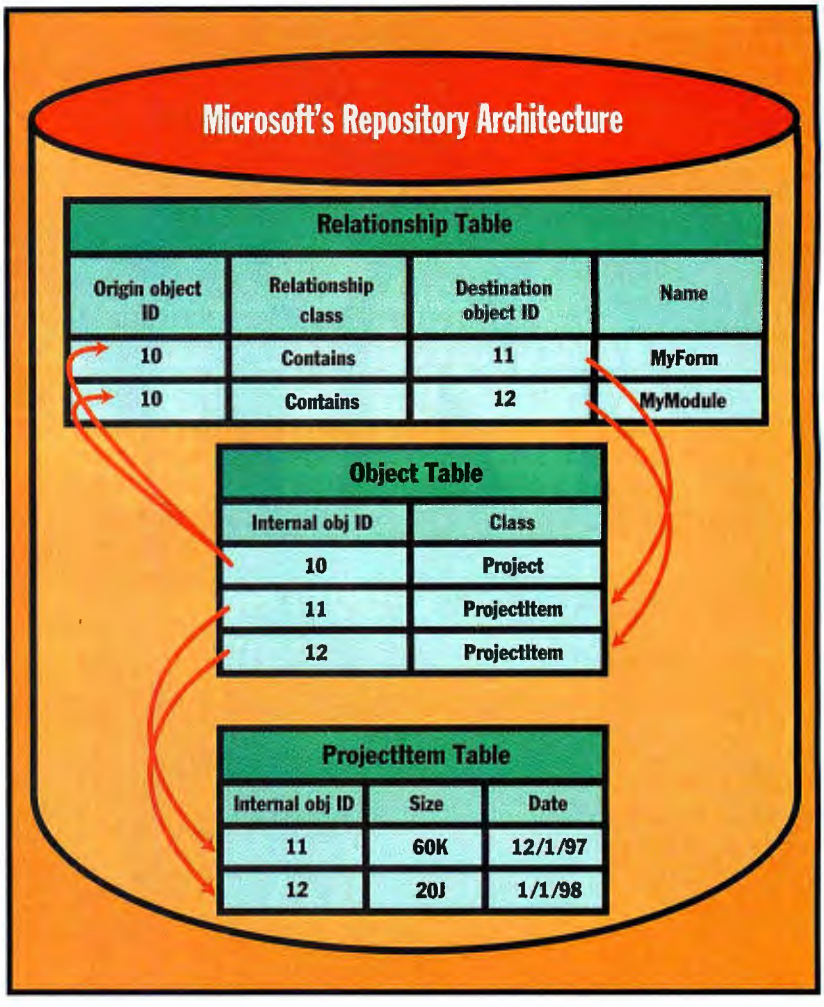
The Microsoft Repository dates back

to May 1994, when Microsoft and Texas Instruments announced collaboration on the design of an object-oriented repository that would store OLE components. (TI, with its Information Engineering Facility [IEF]/Composer product, was then a major CASE-tool vendor. TI's software division has subsequently been sold to Sterling Software, and Composer is now part of Sterling's Cool family of products.) TI may be out of the picture now, but the Microsoft Repository remains an ActiveX/COM-based (Component Object Model) vision.

Last summer, Microsoft and Platinum Technology announced an alliance whereby Platinum received the rights to port the Microsoft Repository to non-Windows platforms and to databases other than SQL Server for Windows NT—efforts that are both expected to bear fruit later this year. Platinum itself is a major high-end repository player (its prices start at $150,000), selling both Platinum Repository/MVS and Platinum Repository/OEE.

At the same time, Microsoft announced its Open Information Model (OIM), an extensible COM-based object model that defines the structure of objects shared by tools. Conceptually, it's probably useful to think of the Microsoft Repository in two parts.

The first part is the repository engine, a type-driven interpreter that is actually built on top of a SQL database (initially either Microsoft Access or SQL Server). The second part is the OIM part, a meta-meta model that can support a variety of information-model extensions such as database and OLAP.



This example of the Microsoft Repository's database design shows how it can hold COM objects.

Further Reading

Object-Oriented Strategies
http://www.cutter.com/itgroup

Ovum: http://www.ovum.com

Hurwitz Group
http://www.hurwitz.com

DAMA International
http://www.dama.org

The Data Administration Newsletter
http://www.tdan.com

Proceedings from the Second IEEE Metadata Conference
http://www.llnl.gov/liv_comp/metadata/md97.html

Implementing a Corporate Repository
Adrienne Tannebaum
ISBN 0471-585378
John Wiley & Sons, 1994

Paul Harmon, editor of the monthly newsletter *Object-Oriented Strategies* and author of several books on the Unified Modeling Language (UML), describes a four-layer metamodeling architecture in the January issue of his newsletter. Meta-meta models such as the Object Management Group's (OMG's) Meta Object Facility (MOF) or Microsoft's OIM, he says, define the fundamental infrastructure for a metamodeling architecture, while metamodels such as UML and Microsoft's database model (DBM) are simply instances of a meta-meta model. Models and User Objects round out the four layers.

Microsoft's OIM is derived from UML, which means that the behavior of UML is present inside the OIM. At each level of the OIM, you inherit behaviors of the previous level. For example, the SQL Server model inherits behavior from the DBM, which inherits behavior from the OIM. ISVs and developers can build their own custom models based on information that can be inherited from other portions of the OIM. Other organizations and standards groups, such as those associated with creating a document-exchange standard, could also extend the model to support their own repository efforts.

The Microsoft Repository's first information model basically offered support for UML, an analysis-and-design modeling language that has gained widespread industry support. That meant, for example, that you could create a Visual Basic program, use another optional download—Visual Modeler, which is a subset

of Rational Software's Rose product—to reverse-engineer your Visual Basic program, and then export the design into the repository. At that point, the UML version of your Visual Basic program would be available to other repository-aware tools (at the time, limited to products such as Visio's tools).

However, what if the list of repository-aware tools included other programming languages, testing tools, project management tools, revision management tools, and so forth? According to Mike Budd, an analyst who tracks the CASE-tools and repository markets for Ovum, the Microsoft Repository is a clever way of adding enterprise panache to its immensely popular programming tools that are actually geared toward single programmers.

Budd also thinks that Microsoft has recognized the incredible value of middleware in the largest sense of the word. He sees the company's Microsoft Repository as a means of owning the glue that integrates the application-development process.

What does all this mean for you? At this point, you have two choices. Either experiment with the pretty rudimentary Microsoft Repository 1.0 and associated Visual Modeler and Visual Component Manager (VCM) tools. (VCM is Microsoft's "interface" to the Repository.) Or wait until version 2.0 of all these tools, which are expected to ship some time this summer with version 6.0 of Microsoft's Visual Studio development environment.

Other Repositories

Not only isn't the Microsoft Repository the only repository, it isn't even the only meta-meta model out there. The OMG's CORBA-based (Common Object Request Broker Architecture) meta-meta model provides another alternative, one that is embraced by many of the traditional CORBA champions. Unisys's Urep repository (with prices starting at $1900) is the leading example of an OMG/MOF-compliant repository.

Unisys Fellow and Urep architect Sridhar Iyengar points out the advantages of Urep as a heterogeneous, multiplatform object repository that supports both COM and CORBA middleware on Unix, NT (client and server), and mainframe (client) platforms. He adds that, "Urep supports a rich set of core repository services, including object-level version control, nested transactions, and long transactions, which are not available in competing products." (According to Microsoft, Microsoft Repository 2.0 will support versioning.) Urep uses the Versant object database as its default storage engine.

IBM's VisualAge TeamConnection (prices start at $9995 per server) and associated DataAtlas represent another alternative that will be especially attractive to enterprises that use IBM's VisualAge tools. TeamConnection, which evolved from IBM's CMVC product, not AD/Cycle, is an open tool with a published API and is source code–compliant (i.e., interoperable with Microsoft's SourceSafe and other version-control products). Although TeamConnection currently uses Object Design's ObjectStore as its data store, the next version will reportedly be hosted on DB2 Universal DataBase (UDB).

Other repositories worthy of mention include LogicWorks' Universal Directory ($30,000), a data-warehouse-oriented repository; Viasoft's Rochade repository (formerly the R&O Repository with roots in the mainframe world, $35,000 and up); and Software Enabling Labs' Enabler, Visual Enabler, and Maestro suite (pricing starts at $3500 per developer).

Look Ahead

Repositories may not affect your life this month or even this year. However, it behooves you to start investigating this technology and thinking about how it's going to affect the way you design, develop, and manage applications, including data-warehousing applications. Platinum's Chris Justice, product manager for Platinum Repository/OEE, cited hockey's Wayne Gretzky ("I play where the puck's going to be, not where it is...") in his perspective on the repository market. Repositories should be on your radar screen. B

Karen Watterson (San Diego, CA) is a writer and consultant specializing in database and data-warehousing issues. She is the author of several books and is editor of Pinnacle Publishing's Visual Basic Developer *and* SQL Server Professional *newsletters. You can reach her at* **karen_watterson@msn.com.**

Selected Specifications

Metadata Council and MDIS specification
http://www.he.net/~metadata/

Federal Geographic Data Committee (FGDC) metadata standards
http://www.fgdc.gov/Metadata/metahome.html

Dublin Core
http://www.ukoln.ac.uk/metadata/resources/dc.html

Warwick Framework
http://www.dlib.org/dlib/july96/lagoze/o7lagoze.html

OMG (Object Management Group)
http://www.omg.org

CDIF specification
http://www.cdif.org

AIIM Document Management Alliance repository
http://www.aiim.org

Stanford Digital Libraries Project and Digital Library Interoperation Protocol
http://www-diglib.stanford.edu/diglib/pub

Stanford Digital Libraries Infobus Protocol
http://www-db.stanford.edu/~testbed

WHERE TO FIND

IBM
Armonk, NY
800-426-3333
914-765-1900
http://www.software.ibm.com/ad/teamcon

LogicWorks
Princeton, NJ
609-514-1177
http://www.logicworks.com

Microsoft
Redmond, WA
800-426-9400
425-882-8080
http://www.microsoft.com/repository

Platinum Technology
Oakbrook Terrace, IL
800-442-6861
http://www.platinum.com/products/dataw/repos_ps.htm

Rational Software
Cupertino, CA
800-728-1212
408-863-9900
http://www.rational.com

Softlab
Munich, Germany
+49 89 9936 1216
770-290-8800
http://www.softlab.com

Unisys
Blue Bell, PA
215-986-4011
http://www.urep.com

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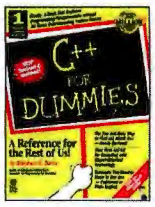

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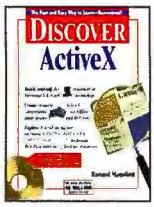

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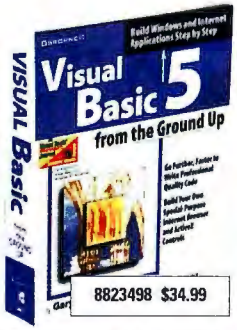

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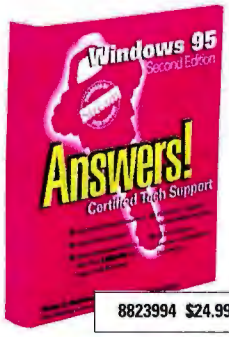

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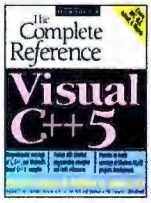

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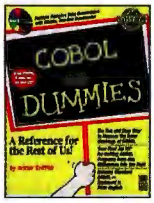

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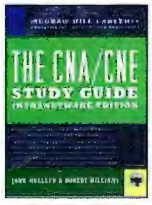

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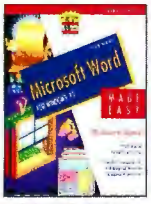

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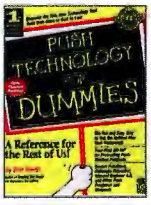

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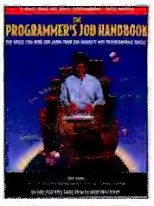

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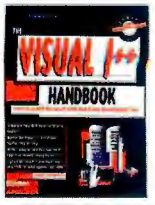

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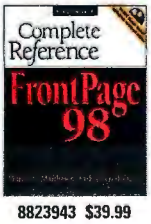

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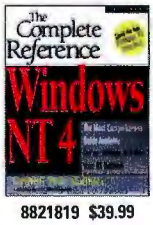

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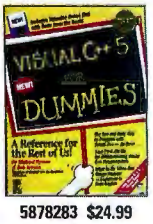


5878283 $24.99

Fast CPUs wring the ultimate in performance out of slow-bus NT systems.
By Dan Tanner

333-MHz Pentium IIs: Slow-Bus Swan Song

Deschutes is Intel's code name for the fast new Pentium II chips built using the 0.25-micron CMOS process. Ironically, these recently introduced 333-MHz processors are also the fastest Intel CPUs currently running on the soon-to-be-updated 66-MHz system bus motherboards. That makes these machines somewhat akin to dinosaurs, albeit extremely fast dinosaurs.

BYTE Lab evaluated 19 333-MHz Deschutes systems running NT 4.0 Workstation. All use the 66-MHz bus and 440LX chip set on the motherboard. The extra 33 MHz of clock speed might lead you to expect a roughly 11 percent increase in performance over the Deschutes' older 300-MHz cousins, and that's almost exactly what we found on these machines.

Yet that performance doesn't actually show the true worth of the Deschutes chip. Increasingly, it's slow components and the 66-MHz system bus, not the processor, that stifles overall system performance.

Fortunately, 66-MHz motherboards are about to become a thing of the past, at least for high-end systems. Deschutes PCs built around 100-MHz motherboards, clocked from 350 to 450 MHz, should make their debut about the time you read this.

Several manufacturers opted to wait out this 333-MHz round-up, choosing to submit PCs with 100-MHz motherboards and even faster Pentium II processors instead. All arrived far too late for comprehensive testing for this issue. But after April 15, you can check our Web site, at *http://www.byte.com*, for a first look at these machines.

AMD and VIA are already building chip sets to support systems with100-MHz motherboards; expect to see Deschutes competitors from AMD and Cyrix supporting this interface later this year.

Where Deschutes Fits

This first Deschutes chip, and those shipping in the next few months, will still fit the same proprietary Intel Slot 1 motherboard interface as today's Pentium II. Later on, Deschutes-series PIIs will likely migrate to the newer Slot 2 connector.

Like the Klamath series, Deschutes CPUs now come packaged in a single-edge contact (SEC) cartridge. Within the SEC, the processor core and industry-standard burst static RAM (BSRAM) Level 2 (L2) cache are enclosed in plastic and metal and are surface-mounted.

Later Deschutes-series PIIs, with full-speed backside buses, will require Intel to replace commodity BSRAMs with custom static RAMs (CSRAMs). BSRAMs require one clock cycle to read and another to rewrite data, so their top speed is half that of the CPU. The CSRAMs are limited-quantity proprietary Intel parts that can run at a full 450 MHz (i.e., with their 64-bit interface, at 3.6 GBps).

Deschutes and Klamath have the same P6 microarchitecture, including support for MMX, 32 KB of Level 1 (L1) cache, and (for the first Deschutes chip) a 66-MHz frontside bus. Both include an external 512-KB BSRAM L2 cache contained in the SEC cartridge. Both support Intel's 440FX/440LX chip sets and others from third parties. The current CPU interface and chip sets, however, limit them to a two-way multiprocessing implementation. Error-correction code (ECC) is available on the L2 cache of the Deschutes processor.

Pentium II's pipelined system bus allows multiple simultaneous transactions. Like the Pentium Pro, the PII speeds up performance at a given clock speed by using *dynamic execution*, Intel's term for branch prediction. The processor predicts which way branch instructions will fork (with a claimed 90 percent accuracy) and speculatively executes some instructions along the predicted path, rearranging them to take maximum advantage of the chip's resources.

Market Splash

Deschutes may have a bigger impact on the processor market than on overall system performance. Intel released the 333-MHz version at $721, $200 below the usual price for its top-line PC processor, and only two months later dropped that price almost 20 percent, to $583. As might be expected, the prices of previous-generation Pentium IIs tumbled.

Intel also cut prices on Pentiums for mobile computers from 15 to 51 percent, although desktop Pentium Pro prices remain unchanged.

The second half of 1998 will see a new Deschutes series, this time with 256 KB of on-die L2 cache.

BYTE BEST
333-MHz PENTIUM II PCs

DTK APRI-76M/P333

Although it didn't hit the top mark in any performance test, the offering from DTK Computer was fast enough to take first place in overall performance. It also took first place in Best Value/Low-Cost. The DTK costs 48 percent ($2750) less than the highest-priced entrant, but only 8 percent ($200) more than the lowest.

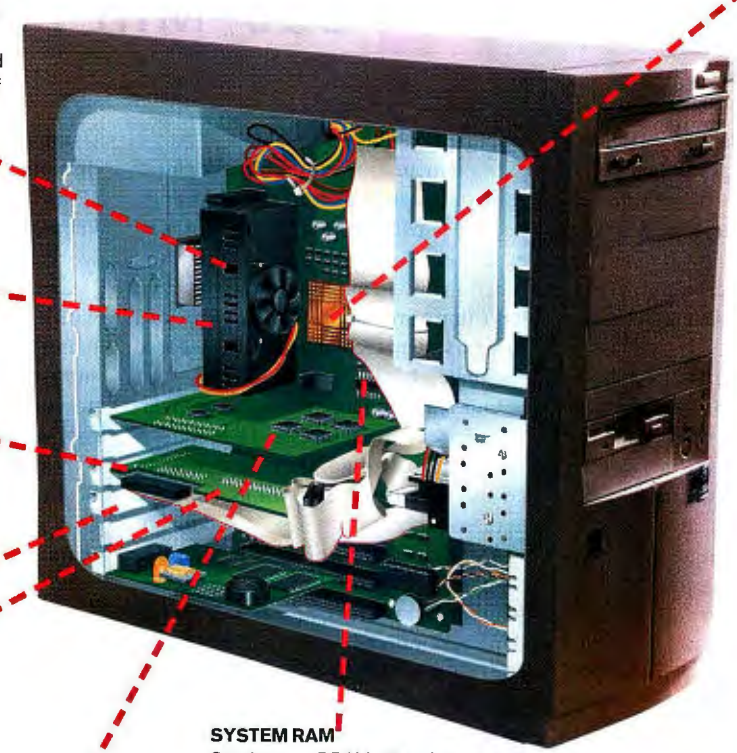
CACHE
Future Pentium IIs will boost L2 cache from these chips' 512 KB to 1 MB or more, which has prompted Intel to add ECC RAM to Deschutes. Turning it off (see "Trick of the Trade?" on page 116) can boost performance.

CPU
These first Deschutes chips continue Intel's proprietary Slot 1 design.

SCSI
Look for controllers supporting later SCSI standards; we prefer Ultra Wide SCSI.

ETHERNET
Integrated or add-in Ethernet ports are standard fare on these high-end PCs. Look for those that support Fast Ethernet (100 Mbps) as well as the older 10Base-T standard.

EXPANSION SLOTS
The best PCs in this roundup offer at least four PCI slots; a few systems include connections for 64-bit PCI devices as well.



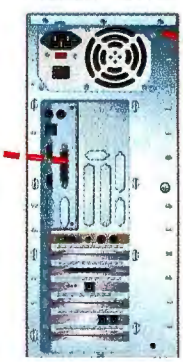
440LX CHIP SET
A 440LX chip set is virtually the minimum on these machines, since it adds support for Accelerated Graphics Port (AGP),error-correction code (ECC) RAM, SDRAM, and Ultra DMA hard drives. Watch for the new 440BX chips, however; these will support fast new 100-MHz system buses appearing about the time you read this.

SYSTEM RAM
Synchronous DRAM, offered on many of the machines tested here, is about three times faster than older fast page-mode (FPM) DRAM and twice as fast as extended data out (EDO) and burst EDO (BEDO) RAM.

GRAPHICS ACCELERATOR
You'll need a minimum of 4 MB of WRAM on any high-end graphics card to match the PII/333 performance. Even better, opt for those systems that offer 8 MB or more of SGRAM. For NT, choose an OpenGL-compatible video subsystem. While AGP offers faster connections than PCI for some applications, it lacks crucial software support in many areas, including native Windows 95 and NT.

Illustration is based on the DTK APRI-76M/P333.

Back View



POWER SUPPLY
At minimum, you'll want a power supply capable of sustaining loads of 235 W or more. Even better are units with a maximum capacity of 300 W.

INTEGRATED PORTS
USB has become standard fare on any high-end PC and these systems are no exception. Better machines also include integrated audio and Ultra Wide SCSI.

For high-end PCs, Slot 2 versions offering glueless support for up to four-way multiprocessing will arrive at 400 (mid-1998) and 450 MHz (year end), with L2 cache ranging from 512 KB to 2 MB.

Intel's road map for all market segments involves total, eventual migration to Pentium II:

- Slot 2 Pentium IIs will be used in high-performance servers and workstations, in single- to four-way multiprocessor designs.
- Slot 1 Pentium II machines will be used in desktops requiring midrange to high-level performance, using one or at most two processors.
- Celeron, Intel's latest Pentium II series, will become the chip of choice for low-cost desktop systems. Basically a Pentium II processor without L2 cache memory, Celeron is Intel's answer for under-$1000 PCs (for a look at new sub-$1000 PCs, please see page 125 in this issue).
- Mobile-cartridge Pentium II modules, with low power-consumption levels, will increasingly be seen in high-end notebook designs.

Pentium II Architecture

Deschutes uses the Dual Independent Bus (DIB) architecture, just like the Pentium Pro, to gain a performance advantage on single-bus systems. The superscalar processor can use the L2 cache bus and processor-to-main-memory buses simultaneously, for a possible peak capacity of five instructions per clock cycle.

The PII also includes 57 MMX instructions that it executes two at a time. Moreover, MMX instruction architecture is single instruction/multiple data (SIMD)—one instruction can perform identical operations on multiple pieces of data, reducing compute-intensive loops characteristic of video, audio, 2-D graphics, videoconferencing, printing, and animation processing.

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Dan Tanner, Technical Editor

Any of these 333-MHz PCs offers high performance at a good price. All include support for Accelerated Graphics Port (AGP) and SCSI hard disk connections, making them sure bets for speed gains under the forthcoming Windows NT 5.0.

We rated these PII workstations based on their quality of performance, implementation, technology, price, usability, and features, on a scale of one to five stars. You'll find a complete listing of features, along with overall ratings, in the chart on pages 122 and 123. We requested identical configurations from each manufacturer to achieve a level playing field; deviations from the standard configuration are noted in this chart.

Performance is an important consideration, especially for any PC sporting a topline processor. Our Best Overall scores recognize this by heavily weighting total performance ratings as 70 percent of the total score. Technology and implementation ratings share the remaining 30 percent.

Performance scores were obtained by averaging the results from multiple runs of our benchmark tests (see "Test Methodology" on page 121). The tests rate machine speed in integer, floating-point, and application operations.

We judge a system's usability based on the quality of documentation and other information provided to the user. We also look for ease of access to internal components; quick, well-designed setup and installation; and as much expandability and upgradability as possible.

Implementation scores rate the choices made by a manufacturer's design engineers. We come up with these scores by evaluating the overall system design and functionality. In our tests, these machines were uniformly excellent; on a scale of 1 to 5, no system included in this test scored less than a 4.

Our features score measures an overall rating of base features in the tested system. We look for good-quality integrated and nonintegrated options, supplied at reasonable costs.

Our technology scores reflect the quality of highly desirable options included with the test systems, in addition to standard options rated in our features score. For example, a high-scoring system may have included an additional processor slot on the motherboard for a second CPU, or a 10/100 Ethernet card in place of the standard 10Base-T. Systems providing integrated SCSI and sound, for example, were given higher technology ratings.

A combination of high technology ratings and low price put a system high on our list for Best Value. The Best Value scores are a weighted combination of our performance, usability, features and price ratings. Performance scores make up 50 percent of the final Best Value score; price receives a weighting of 30 percent; and features and usability scores contribute 10 percent each.

Best Overall

The DTK APRI-76M/P333 has no elaborate, expensive engineering features. Using a basic motherboard, standard options and memory, with an acceptable 17-inch monitor, the DTK has managed to keep a low price. At the same time, it scored top marks for performance.

Controls are conveniently located, with a primary power switch on the back panel to shut off the juice to the power supply as well as the more conventional power-on button in front. Inside, there's easy access and plenty of room for an extra CD-ROM, tape, or Zip drive. Besides the expected mouse, keyboard, USB, serial, and parallel ports, the back panel also holds connectors for the AGP video adapter, external SCSI, 10/100 Ethernet, and an x2 56K modem. The inside of this machine is simple and straightforward, offering easy access for repairs or upgrades.

Kingdom's Pinnacle 333 Power system came in second in our Best Overall scorings, largely due to an excellent technology implementation. Like the third-place Xi machine, this PC can support up to 1 GB of RAM on the motherboard.

Don't overlook NEC's nifty PowerMate Professional 9000 and SAG's fast STF 3300. Priced at less than $3200, both offer technology options you'd expect to see in higher-priced machines. They have a second processor slot for an additional CPU, for example, and free up an extra slot by integrating SCSI on the motherboard. The NEC's 64-bit PCI slot offers an upgrade path for the future, and its NEC 32X CD-ROM drive is one of the best on the market.

Best Value

The $2799 DTK system, with the third lowest price of all systems tested but lowest price of our top seven performers, also won honors as Best Value. It offers 10/100 Ethernet as standard equipment, a Toshiba 32X CD-ROM drive, a good-quality ELSA Gloria Synergy video card with 8 MB of SGRAM on-board instead of the more usual 4 MB, and a large 300W (its maximum output) power supply at a very reasonable price.

The $2599 Micron ClientPro 766Xi was fourth in Best Value. Its performance kept it out of the running for Best Overall system, but the machine managed to incorporate a good feature set—4.5-GB

Trick of the Trade?

Our time-tested BYTEmark benchmarks showed oddly variable scores on these systems, scores that became even more suspicious when our Van Horn Photoshop benchmarks returned virtually identical results for all systems. It turns out that the BYTEmarks had uncovered a little known trick of the PC maker's trade: Some manufacturers—Compaq, Everex, DTK, and Kingdom, in this case—disable the standard error-correction code (ECC) on the L2 cache and improve performance, apparently with Intel's blessing.

Unfortunately, most buyers can't perform the large-scale comparative testing that allowed us to discover this ECC performance tweak. And users will find it virtually impossible to disable (or enable) ECC themselves. While there's probably little likelihood that turning off ECC will cause problems, we believe that buyers should be given a chance to decide if they want to opt for speed and ignore the possibility of unchecked error on the L2 cache.

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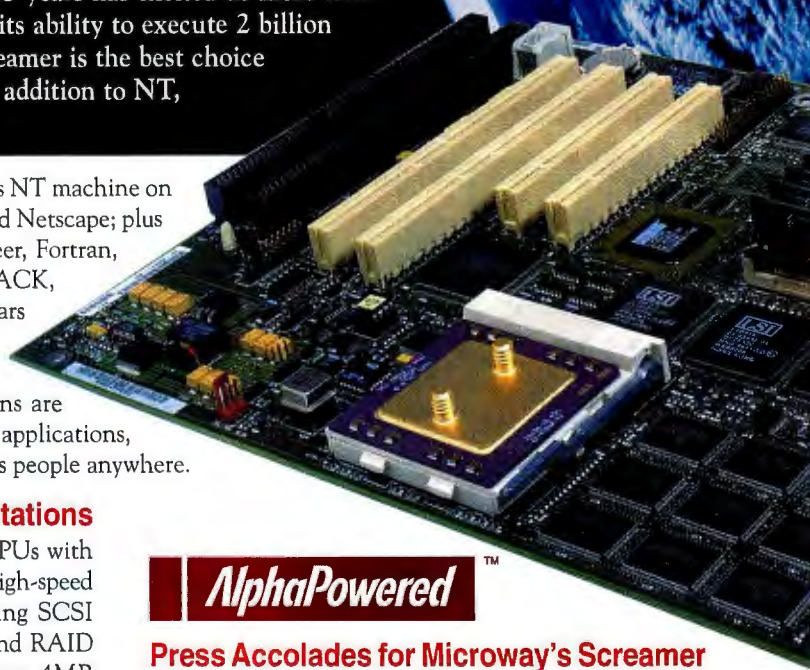

Your applications can now run on "the fastest Windows NT machine on the planet." These include Microsoft Office, Oracle and Netscape; plus engineering and graphics software such as Pro/Engineer, Fortran, C/C++, Visual Basic, Microstation, ANSYS, LAPACK, Gaussian, Softimage and Lightwave. Over the last 15 years we have designed systems for thousands of satisfied customers worldwide, including prestigious institutions like NASA and Fidelity Investments. Our technicians are expert at configuring all Alpha operating systems and applications, and you will not find more technically competent sales people anywhere.

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LINUX Journal - January, 1998
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PC Computing - July, 1997 ★★★★
Microway's Screamer . . . "is, quite simply, the fastest Windows NT machine on the planet. . . The performance leader."

Desktop Engineering - September, 1997 Product of the Month

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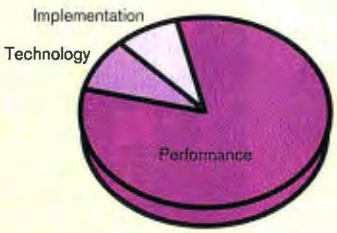
LAB RATING RESULTS

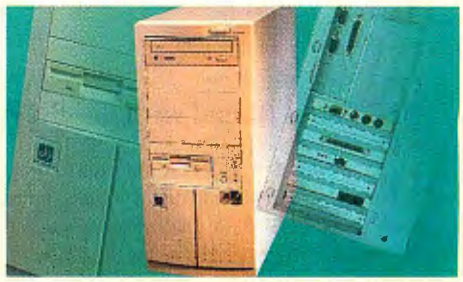
BEST OVERALL

DTK APRI-76M/P333

The DTK APRI-76M/P333 not only won Best Overall honors, it placed first in our price/value rankings (see below). Last September, the company's entry also garnered the Best Overall award in our testing of 17 233- and 266-MHz Pentium II systems.

WEIGHTING





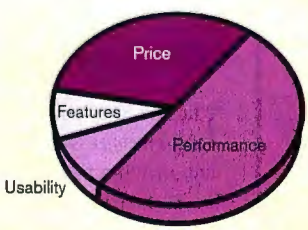
	PRICE	PERFORMANCE	TECHNOLOGY	IMPLEMENTATION	BEST OVERALL
DTK APRI-76M/P333	**$2799**	★★★★★	★★★★	★★★★★	★★★★★
Kingdom Pinnacle 333 Power	$2997	★★★★	★★★★	★★★★★	★★★★
Xi 666 Tower DP	$3199	★★★★	★★★★★	★★★★★	★★★★
NEC PowerMate Professional 9000	$3199	★★★★	★★★★★	★★★★★	★★★★
SAG STF 3300	$2945	★★★★	★★★★★	★★★★★	★★★★
SysTech Sys Performance Pro 333LS	$3724	★★★★	★★★★	★★★★	★★★★
Compaq Deskpro 6000 6333X/4300/CDS	$3750	★★★★	★★★★	★★★★	★★★★

BEST VALUE/LOW-COST

DTK APRI-76M/P333

DTK Computer's APRI-76M/P333, selling for $2799 in the configuration we tested, was one of the lowest-priced systems submitted to us for review. And although other systems were faster in individual tests, it came in as the top overall performer, easily making it our choice for Best Value.

WEIGHTING



	PRICE	PERFORMANCE	PRICE RATING	FEATURES	USABILITY	BEST VALUE
DTK APRI-76M/P333	**$2799**	★★★★★	★★★★★	★★★★★	★★★★	★★★★★
SysTech Sys Performance Pro 333LS	$3724	★★★★	★★★	★★★★★	★★★★	★★★★
Compaq Deskpro 6000 6333X/4300/CDS	$3750	★★★★	★★★	★★★★★	★★★	★★★★
Micron Electronics ClientPro 766Xi	$2599	★★★	★★★★★	★★★★★	★★★	★★★★
Everex StepStation 2	$2730	★★★	★★★★★	★★★★★	★★★★	★★★★
Kingdom Pinnacle 333 Power	$2997	★★★	★★★★★	★★★★★	★★★★	★★★★
Xi 666 Tower DP	$3199	★★★	★★★★	★★★★★	★★★★★	★★★★

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

Ultra Wide SCSI hard drive and 8-MB Number Nine video card—and still come in as the lowest-priced machine.

While the $3724 SysTech and $3750 Compaq PCs were among the more expensive machines tested, their combinations of great features and high usability made them our second and third choices, respectively, for Best Value.

The Bottom Line

With the 66-MHz system bus on the way out, at least for high-end PC workstations, does buying one of these machines make sense? If you're in the market for high-performance bargains, our response is an unqualified "You bet."

Prices for these 333-MHz units are, in many cases, less than half the price of the 300-MHz systems we reviewed in our January issue (see "Eight Heavy-Hitting NT Workstations," page 98).

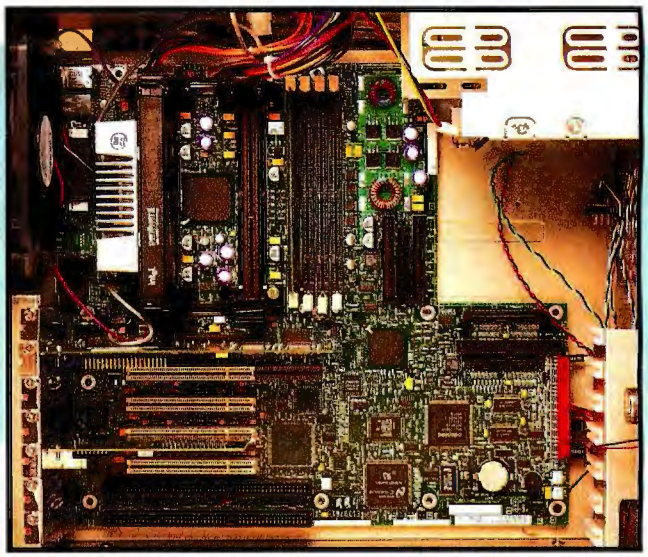
We expect that prices of Pentium PCs will continue to fall, possibly precipitously, as the 100-MHz system bus makes its debut and new sub-$1000 PCs utilizing Intel's Celeron and other low-cost chips become popular.

If performance and upgradability are your chief concerns, however, you may want to wait out this round for even faster machines emerging in the next couple of months. Next-generation 350- and 400-MHz machines, supported by the faster system bus and faster components, likely will add to the overall cost of the PC, but the improvements in speed and compatibility with future upgrade paths might be worth the extra cost.

DETAILS

NEC Looks Ahead with 64-Bit PCI Slot

Up close and personal is the best way to know your system. Here's something that you'd miss unless you opened up the NEC PowerMate Professional and removed the internal drive bays. Just below the AGP card is the first of four PCI slots, a 64-bit connector that we'd normally expect to find only in higher-priced NT workstations. Even though 64-bit devices are still relatively rare, these slots will be increasingly valuable as performance demands increase. NEC engineers showed foresight by including it in a reasonably priced, and strong-performing, system.



SAG Makes Upgrading Easy

The SAG Electronics STF 3300 shows value in engineering and design. It's extremely easy to add a second processor, without moving or dismantling anything, by simply sliding the PII processor into its Slot1 connector. The machine has four memory slots that hold up to 512 MB, and plenty of drive bays and PCI/ISA slots for adding components. You don't need to remove components to install PCI options, add memory, or put in drives. As in the NEC system, this machine's integrated, on-board Adaptec 2940UW SCSI adapter, along with the second processor option, are usually found on systems priced much higher.

TECH FOCUS

SHRINKING THE CHIP

0.25-Micron and Smaller

More efficient process technology means Deschutes runs faster, cooler, and uses less power than its predecessors. The first Deschutes attained a core frequency of 333 MHz—11 percent faster than the fastest Klamath-series PII (300 MHz). It has a 131-square-millimeter die, compared to Klamath's 202 square millimeters, and consumes almost half the power, 23.7 W as opposed to the older chip's 43 W.

Silicon etch resolution has been sharpened 29 percent with the Deschutes chip, from 0.35- to 0.25-micron. Shrinking linear dimensions on a chip to 71 percent reduces the chip's area by half. Reduced chip area translates to shorter distances for signals to travel, enabling ever-higher clock speeds. And, as chip geometry shrinks, "parasitics"—largely the signal-degrading effects of stray capacitance—are naturally reduced.

Nowadays we can process information faster than we can move it. Ultimately board, bus, and machine geometry will have to shrink, too, and that may be even more difficult to accomplish (see "Amending Moore's Law," March BYTE).

At 333 MHz, a clock period consumes only 3 nanoseconds. But it's during the rise/fall times of the clock that signals are gated or triggered. Such times are an order of magnitude less, well into the picosecond range. In 300 picoseconds, light can travel merely 9 centimeters. Small wonder that processor cores and cache memory are migrating to a single die.

Question: When is 333/90 greater than 3.7?
Answer: When you're comparing Pentium II performance to original Pentium performance, back in the days when 90MHz reigned supreme.

BYTEmark evaluates processor and memory performance. We base our results on an index system, in this case a Dell 90-MHz Pentium PC. If the clock speed of the processor under test is 333 MHz, one might expect performance scores of 3.7.

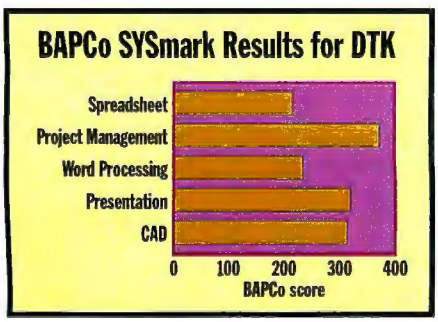
The enhanced architectures of new Pentium systems can achieve much higher scores. Our top-rated DTK machine scored an integer index over 4.75; floating-point was nearly 5.33.

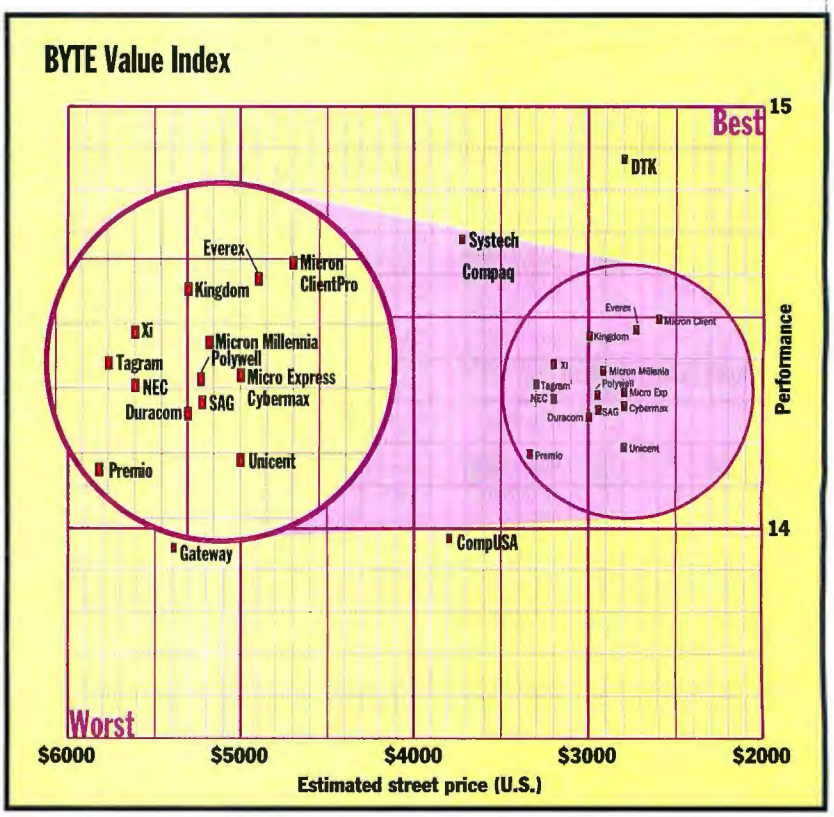
Changes in Pentium II architecture can take the credit for this feat; many PII instructions are simply more efficient. Integer Multiply (IMUL), for example, has been trimmed from 10 clock cycles on a Pentium to three cycles on a PII (see "Which Compiler Is Fastest?," January BYTE). In addition, the Pentium II employs such speed-up methods as dynamic execution.

BAPCo SYSmark Results

BAPCo SYSmark tests exercise real-world applications running native-mode code under Windows NT 4.0. BAPCo chose Microsoft Excel and Word for typical office operations, Texim for project management jobs, and Layout Plus for CAD work.

BAPCo's test applications provide intense system exercise, including file I/O that works a hard drive heavily. The spreadsheet and word processing applications are integer-intensive; BAPCo's CAD application generally emphasizes floating-point operations.





Our Photoshop Test

The BYTE/Van Horn Photoshop benchmark is an integer-intensive test using the functions that graphic artists with Adobe Photoshop 4.0 would employ. The file used for the test is large, over 8 MB, to ensure that memory calls go far beyond the range of the processor's cache.

Photoshop interpolation was set to Bicubic. We eliminated video-card performance differences from these scores. The following tests were performed:

- Rotate Canvas. Arbitrary rotation at 7 degrees clockwise.
- Unsharp Mask at two settings, first with the default values (50 percent, radius of 1 pixel, no threshold) and again with more demanding values (50 percent, radius of 10 pixels, threshold of 5).
- Gaussian blur with 3-pixel radius.
- RGB-to-CMYK Mode Change.

Methodology

Every configuration we examined met the following specifications:
Processor: Intel Pentium II/333-MHz (Deschutes)
Chip set: Intel 440LX
Operating system: Microsoft Windows NT 4.0 Workstation, with a separate installation of Service Pack 3
Memory: 64 MB
Hard drive: Minimum 4-GB SCSI, controller on motherboard or PCI card
File structure: NTFS
Graphics adapter: AGP adapter, minimum of 4 MB of video memory
Monitor: 17-inch color, 1024 × 768 resolution, true color (24-bit), 75-Hz refresh rate

No other applications, including virus shields, TSRs, or applets, were running during the tests. Nonessential start-up applications or placeholders that could be using memory were removed before testing.

Evaluations in this report represent the judgement of BYTE editors based on tests conducted in BYTE's laboratory. For full documentation of the benchmarks, visit the BYTE Web site at http://www.byte.com; see http://www.byte.com for the BYTEmark, http://www.bapco.com for BAPCo data, and for the Van Horn Photoshop tests, see "MMX: Better in Fits and Starts," February BYTE (magazine or CD-ROM), or visit the BYTE Web site.

333-MHz PENTIUM II PCs FEATURES

	Compaq Deskpro 6000 6333X/4300/ CDS	CompUSA PC American Pro AP333L-SE	CyberMax Computer PowerMax 1	DTK Computer APRI-76M/ P333 ★	Duracom Computer ProForma 6201	Everex Systems StepStation 2 P2-333	Gateway 2000 E-5000 333 Technical Workstation	Kingdom Computers Pinnacle 333 Power
Price as tested (MSRP, unless noted)	$3750	$3800	$2799	$2799	$2999 street price	$2730	$5369 direct only	$2997
Overall rating	★★★★	★★★	★★★	★★★★★	★★★	★★★★	★★★	★★★★
MICROPROCESSOR								
BIOS vendor and version	Compaq	Phoenix 4.0 rel 6.0	Phoenix 4.0 rel 6.0	AMI v 1.19	Phoenix 4.0 rel 6.0	AMI 6271C11	Phoenix 4.0 rel 6.0	Award 4.51PG
Supports second CPU							✔	
ECC on L2 cache	Off	On	On	Off	On	Off	On	Off
DMI-compliant	✔	✔	✔		✔, 2.0	✔	✔, 2.0	✔
Setup (ROM or disk)	ROM	ROM	Both	ROM	ROM	Both	ROM	ROM
BIOS shadowing (ROM or video)	Both	ROM	Both	Both	ROM	Both	Both	Both
EQUIPMENT INFORMATION								
Sound adapter/chip	Embedded ESS 1869	Yamaha OPL-3 on board	Ensoniq AudioPCI	None	None	ES1868 w/Wavetable	None	Ensoniq PCI/16-bit
CD-ROM/speed	Hitachi/24X	Pioneer/32X	Toshiba/32X	Toshiba/32X	Sony/24X	Toshiba/32X	Plextor 13/32X	Matsushita/24X SCSI
10/100 Ethernet LAN	Integrated	Optional	✔	✔	Optional	✔	✔	Optional
Fax/modem	56K	Rockwell/56K		USR/56K				
Motherboard (design/ manufacturer)	Compaq	ATX/Intel	AL440LX/ Intel	ATX/DTK	AL440LX/ Intel	FIC/FIC	Burbank/ Intel	ECS - Elite Group, with on-board SCSI
Power supply	260W	200W	235W	300W	235W	235W	300W	235W
HARD DISK								
Bays (3½-/5¼-inch)	3/2	2/3	5/4	3/4	5/3	4/3	7/4	3/5
Internal/external	2/3	1/4	5/4	2/6	4/4	2/5	6/5	8/5
Bays with front access	(1) 3½, (2) 5¼	(1) 3½, (3) 5¼	(1) 3½, (4) 5¼	(2) 3½, (4) 5¼	(2) 3½, (3) 5¼	(2) 3½, (3) 5¼	(1) 3½, (4) 5¼	(2) 3½, (3) 5¼
Hard drive (vendor and model)	Compaq WDE 4360	Seagate ST34572W	Seagate ST34371UW	Seagate ST34501W	Seagate ST34572W	Seagate ST34572W	Seagate ST34572W	IBM DCAS 34330
Hard drive controller (vendor and model)	Compaq Ultra SCSI	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AIC-7895	IBM
Hard drive interface type	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI
Hard drive capacity	4.3 GB	4.5 GB	4.3 GB	4.5 GB	4.5 GB	4.5 GB	4.5 GB	4.3 GB
Primary system architecture (PCI/ISA)	3 PCI, 4 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	4 PCI,. 3 ISA, 1 AGP	3 PCI, 2 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	4 PCI, 3 ISA, 1 AGP
Shared slots	1	1	1	1	1	1	1	1
Remove cover without tools	✔	✔	✔	✔				
VIDEO								
Video accelerator (maker/model)	Matrox Millennium II	STB Velocity 128 AGP	Number Nine Revolution	ELSA Gloria Synergy	STB Velocity 128	Nvidia Model RIVA128	AccelGraphics AccelEclipse II	ATI Rage Pro
Video memory and type	4-MB SGRAM	4-MB SGRAM	4-MB WRAM	8-MB SGRAM	4-MB SGRAM	4-MB SGRAM	32-MB mixed	4-MB SGRAM
Maximum resolution without upgrade	1280 x 1024	1280 x 1024	1920 x 1060	1280 x 1024	1280 x 1024	1280 x 1024	1280 x 1024	1060 x 1024
I/O PORTS								
Serial/USB	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2
Parallel ports	1	1	1	1	1	1	1	1
SCSI-2 ports	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin	1 50-pin, 1 68-pin
EIDE ports	1	2	2	2	2	2	2	2
MEMORY								
Maximum RAM on motherboard	384 MB	384 MB	384 MB	512 MB	384 MB	384 MB	512 MB	1 GB
Type and architecture	SDRAM/ECC	SDRAM	SDRAM/ECC	SDRAM/ECC	SDRAM	SDRAM	SDRAM/ECC	SDRAM/ECC
ECC RAM on motherboard?	✔	Option					✔	
VENDOR INFORMATION*								
Phone number	281-370-0670	888-226-6772	800-218-4881	626-810-0098	972-416-7600	510-498-4411	800-779-2000 (Sales)	
Toll-free phone number	800-345-1518	888-226-6772	800-218-4881	800-289-2385	800-551-9000	800-262-3312	800-846-2303 (Supp.)	800-385-3436
On-line address	http://www .compaq.com	http://www .compusa.com	http://www .cybmax.com	http://www .dtkcomputer .com	http://www .duracom.com	http://www .everex.com	http://www .gateway.com	http://www .kingdomcomputers .com
Inquiry Number	**1101**	**1102**	**1103**	**1104**	**1105**	**1106**	**1107**	**1108**

★ = BYTE Best ✔=yes ★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

* Access vendor Web site for latest price, warranty, service, support, terms and conditions, and telephone number (if not in toll-free area).

Micro Express MicroFlex-PII/333	Micron Electronics ClientPro 766Xi	Micron Electronics Millennia XKU 333	NEC PowerMate Professional P9000	Polywell Computers Poly 7333LS1	Premio Computer Premio LX Series	SAG Electronics STF 3300	Sys Technology Sys Performance Pro 333LS	Tagram System Corp. Thunderbolt	Unicent Technologies Avanta L333	Xi Computer Corp. Xi 666 MTower DP
$2799	$2599	$2918	$3199	$2950	$3335	$2945 direct	$3724 direct	$3299	$2799	$3199
★★★	★★★	★★★	★★★★	★★★	★★★	★★★★	★★★★	★★★	★★★	★★★★
Award 4.51PG	Phoenix 4.0-rel 6.0	Phoenix 4.0 rel 6.0	Phoenix 4.0 rel 6.0	Award 4.51PG	AMI v 1.1	AMI v 2.5	Award 4.51PGM	AMI Hiflex v 1.19	AMI v 1.19	AMI rel 1.33A
			✔			✔				✔
On	On	On	On	On	On	On	On	On	On	On
✔	✔	✔	✔, 2.0	✔	✔	✔	✔	✔	✔	✔, 2.0
ROM	ROM	ROM	Disk or CD-ROM	ROM	ROM	ROM	Disk	None	ROM	ROM
ROM	Both	Both	Video	Both	Both	Both	Video	ROM	Both	Both
Sound Blaster AWE64	Sound Blaster AWE 64	Sound Blaster AWE 64	Crystal CS 4236B audio integrated	Yamaha/ 719 chip set	Sound Blaster AWE64	Sound Blaster AWE64	Sound Blaster AWE64	Ensoniq Audio PCI	Ensoniq	PCI Ensoniq/DCS Sound Image
Toshiba/100X	Plextor/20X	Plextor 14/32X	NEC/32X	Toshiba/24X	Mitsumi/24X	Sony/32X	TEAC/32X	Toshiba/32X	Toshiba/32X	Teac/32X
Optional	✔	Optional	✔	✔	✔	Optional	Optional	✔	Optional	Optional
Rockwell/56K		USR/56K					USR/56K	Powercom/56K		
Micro Express 235W	Augusta/ Intel 235W	Atlanta/ Intel 235W	DK440LX with AGP/Intel 260W	P6SLS/ Super 230W	REMIO 212B 200W	DLS Dual PII Supermicro 230W	ATX/Giga-Byte GA-686SLX 235W	GVC/BCM KR632 250W	AL440LX/ Intel 235W	P6DLS/ Supermicro 250W
3/3	3/2	3/2	1/5	4/3	3/3	3/3	5/3	3/4	5/2	5/3
1/5	2/5	2/5	2/4	2/3	1/5	1/5	3/5	1/2	2/5	3/5
(2) 3½, (3) 5¼	(2) 3½, (3) 5¼	(2) 3½, (3) 5¼	(1) 3½, (3) 5¼	(2) 3½, (3) 5¼	(2) 3½, (3) 5¼	(2) 3½, (3) 5¼	(2) 3½, (3) 5¼	(2) 3½, (4) 5¼	(3) 3½, (2) 5¼	(2) 3½, (3) 5¼
Seagate ST34501W	Seagate ST34501W	Western Digital Enterprise	Seagate ST34572UW	Seagate ST34501W	Seagate ST34501W	Seagate ST34501	Seagate ST34501W	Seagate ST34501W	Seagate ST34371W	Seagate ST34501W
Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AIC-7895 PCI SCSI	Adaptec AHA2940UW on-board	Adaptec AHA2940UW	Adaptec AHA2940UW on-board	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AHA2940UW	Adaptec AHA2940UW
Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI	Ultra Wide SCSI
4.5 GB	4.5 GB	4.3 GB	4.5 GB	4.5 GB	4.5 GB	4.5 GB	4.5 GB	4.5 GB	4.3 GB	4.5 GB
4 PCI, 3 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	3 PCI, 2 ISA, 1 AGP	4 PCI, 3 ISA, 1 AGP	3 PCI, 4 ISA, 1 AGP	4 PCI, 3 ISA, 1 AGP	4 PCI, 3 ISA, 1 AGP	4 PCI, 2 ISA, 1 AGP	4 PCI, 3 ISA, 1 AGP	4 PCI, 3 ISA, 1 AGP
1	1	1	1	1	1	1	1	1	1	1
	✔	✔						✔	✔	
Diamond Fire GL 1000 Pro	Number Nine Revolution	Diamond Viper V330	AccelStar II 3D	Diamond FireGL	ATI 3D Rage	ATI Rage Pro 3D	Matrox Millennium II	ATI Rage Pro Turbo	STB Velocity 128	AccelStar II 3D
4-MB VRAM	8-MB SGRAM	4-MB SGRAM	8-MB SGRAM	8-MB SGRAM	8-MB SGRAM	8-MB SGRAM	8-MB WRAM	8-MB SGRAM	4-MB SGRAM	8-MB SGRAM
1280×1024	1280×1024	1280×1024	1600×1200	1280×1024	1280×1024	1600×1200	1600×1200	1280×1024	1600×1280	1280×1024
2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2
1	1	1	1	1	1	1	1	1	1	1
1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 2 68-pin	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin, 1 ext.	1 50-pin, 1 68-pin
2	2	2	2	2	2	2	2	2	2	2
512 MB SDRAM/ECC	384 MB SDRAM	384 MB SDRAM	512 MB SDRAM/ECC	1 GB SDRAM	768 MB SDRAM/ECC	512 MB SDRAM,	1 GB SDRAM,	384 MB SDRAM	384 MB SDRAM	1 GB SDRAM/ECC
✔				Option						✔
714-852-1400	208-893-3343	208-893-3343	978-264-8000	650-583-7222	800-677-6477	508-683-0339	714-821-3900	714-979-8900	216-344-2649	714-498-0858
800-989-9900	888-209-8039	888-209-8039	888-863-2669	800-789-8027	800-677-6477	800-989-3475	800-367-7794	800-824-7267	800-628-4888	800-432-0486
http://www .microexpress .net	http://www .micronpc.com	http://www .micronpc.com	http://www .necnow.com	http://www .polywell.com	http://www .premiopc.com	http://www .sagelec.com	http://www .systechnology .com	http://www .tagram.com	http://www .unicent.com	http://www .xicomputer.com
1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119

HotBot is #1

The experts agree: HotBot is the Web's best search engine. Not only is HotBot the fastest, freshest, and easiest to use, it's also the biggest – indexing an astonishing 110 million documents every three weeks.

Find out for yourself why the critics choose HotBot.

"The top search engine is clearly HotBot."	– PC Computing
"HotBot is superior to all Internet search engines."	– Internet World
"Editors' Choice for power searches."	– PC Magazine
"★ ★ ★ ★ ★"	– Computer Life
"HotBot could easily replace all its competitors."	– Database
"The best search engine in the world."	– Network World
"The top engine, the search site we'd head to first."	– CNET

HOTBOT

Wired's HotBot.
The ultimate search machine.
www.hotbot.com

Does a low price tag always equal a value? We put five sub-$1000 PCs—all Pentium alternatives—to the test. ***By Robert L. Hummel***

Cheap PCs: Bargain or Blunder?

For over a decade, PC manufacturers have tried to find the exact combination of features, applications, and price required to woo new home and business users. Early attempts at bargain PCs have produced anemic, underpowered machines that were soundly rejected by the market. Are the latest crop of sub-$1000 systems viable PCs or just expensive toys?

Specifying Systems

To qualify for this review, a PC had to provide adequate processing power for business and multimedia applications. We demanded a Pentium-class processor with support for the MMX instruction set, 32 MB of RAM, and Windows 95 OSR2. To store all that software, we asked for a 2-GB hard drive.

These systems do not include a monitor, a necessary purchase that will add $150 to $350. To accurately reflect small office/home office (SOHO) usage, we used a video resolution of 800 by 600 pixels with a 16-bit color depth for all performance evaluations.

To accommodate on-line activity, each machine had to include a 56-Kbps modem. A 16×-or-faster CD-ROM drive, Sound Blaster audio-card compatibility, and powered external speakers were required to provide basic multimedia ability. Finally, the price of the system (excluding monitor) had to be under $1000. In response to our request, we received five systems, three based on the AMD-K6 processor with MMX (Compaq, IBM, and Polywell), one powered by the Cyrix 6x86MX, and one built around the Cyrix MediaGX (both from Pionex).

How We Tested

To measure each system's real-world performance when running typical SOHO applications, we chose Bapco's Sysmark 32 for Windows 95, version 1.0. This benchmark suite executes and times predetermined scripts of eight application programs. The overall performance score weights Bapco at 40 percent.

The BYTEmark benchmark most accurately determines pure processor power. Not surprisingly, we saw the best BYTEmark performance on the fastest chip with the largest L2 cache.

The Intel Media Benchmark release 1.0 measures video, image processing, 3-D graphics, and audio performance on systems running Windows 95. This benchmark uses DirectX and supports MMX-enabled processors.

Compaq Presario 4540

Although the Presario 4540 turned in good performance on our benchmark tests, its sleek, molded mini-tower chassis is an example of emphasizing form over function. Also, given Compaq's obvious goal of making the Presario an

PIONEX 6x86

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

COMPAQ PRESARIO 4540

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

IBM APTIVA E26

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

PHOTOGRAPH: STEVEN GREENBERG © 1998

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

appliance, we believe the documentation and software should have been better.

The default Presario screen is heavily customized with Internet Explorer (IE). Background music, a channel guide, shortcuts for a host of applications, and a huge invitation to take the IE tutorial all add to the overly busy desktop. Bundled software includes Microsoft's Encarta 98, Bookshelf 98, Money 98, and games.

Compaq Presario 4540

ADVANTAGES:
+ Best multimedia performance

DISADVANTAGES:
– Crowded case design
– Long boot time

Inside, the Presario 4540 is no less busy. Wedged between the CD-ROM drive and floppy drive cage is a 5¼-inch Quantum Bigfoot hard drive. Below the floppy drive, the power supply runs nearly the full depth of the tower, hiding the system board. One of the three available expansion slots is occupied by the modem.

The Presario 4540 contains 16 MB of RAM on the system board and provides only one dual in-line memory module (DIMM) slot for expansion, filled with another 16 MB in our review machine. Replacing this with a 32-MB DIMM brings the system up to its maximum 48 MB. Getting to the DIMM slot, however, requires removing all expansion cards, unplugging all external cables, and swinging the system board out from the back.

On the front panel, a hinged door covers both 5¼-inch bays, but it allows access to the CD-ROM drive through a window when closed. Install a device in the open 5¼-inch bay, however, and you may not be able to close the door.

The Presario 4540 is a solid performer, but its lack of expandability means you'll replace it before you upgrade it.

IBM Aptiva E26

IBM wants your first PC experience to be a good one. The Aptiva E26 is easy to set up, due in part to its color-coded cables and superb manual.

The Aptiva's case is stylized but still retains a classic computer look. The best feature of the case is its no-tools design that makes access a breeze. Release a latch at the rear of the unit, push a tab up front, and the entire case slides off toward the front of the unit.

PIONEX GX

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

POLYWELL POLY LPC5201

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

The inside of the Aptiva is roomy, the CPU fan is unobstructed, and the cables are neatly out of the way. Two 5¼-inch drive bays open to the front of the case and allow the addition of a tape drive or a digital versatile disc (DVD) drive. The modem takes up one of the six expansion slots in the unit.

The system board contains two DIMM slots. Our test system was equipped with a single 32-MB DIMM; you can add up to 32 MB more memory, for a total of 64 MB. At the heart of the E26 is an IBM-branded version of the AMD-K6 233. The chip can be a top Windows performer, but IBM has hindered its efficiency by eliminating the L2 cache.

The Aptiva consistently lags behind the other K6-based systems in our benchmark tests. Its on-board video is built around the ATI 3D Rage II+ chip set. But again, IBM has purposely limited the video memory to a nonexpandable maximum of 1 MB.

IBM rounds out the E26 package with a solid bundle of software, starting with the Lotus SmartSuite 97. Included are 1-2-3, WordPro, Freelance, Approach, Organizer, and ScreenCam. IBM includes both Netscape and IE, plus a CD full of utilities.

IBM Aptiva E26

ADVANTAGES:
+ Good documentation
+ No-tools case access

DISADVANTAGES:
– No L2 cache
– 1 MB of video memory

Pionex 6x86

The Pionex 6x86 stands out because of its simple, clean construction. Unencumbered with fancy molded cases or swinging doors, it is a straightforward PC that clearly doesn't pretend to be anything else.

The system is built around a generic motherboard that can accept a variety of CPUs, but this one has a Cyrix 6x86MX PR-233. Video and sound are provided on separate expansion cards. Although this uses two of the seven available expansion slots, it also lets you troubleshoot or upgrade easily.

Pionex 6x86

ADVANTAGES:
+ Very expandable
+ Nonproprietary components

DISADVANTAGES:
– Lacks a major software suite

The case is roomy inside. It's easy to add or remove expansion cards and memory. Additionally, the Pionex is the only PC in this review that provides a reset button.

The generic user's manual does a good job of explaining Windows. Also included is the manual for the system board, showing jumper settings, cable connections, and BIOS setup options. Granted, it's not what the first-time user needs, but something that a friend performing an upgrade or a

third-party service agency will be grateful to have at hand.

You won't notice any big names in the Pionex 6x86 software bundle. The Akrose Works CD provides a five-function collection of basic word processing, spreadsheet, database, draw, and paint programs. Reference works include Compton's Interactive Encyclopedia and Reference Collection as well as TLC Properties' BodyWorks medical-exploration program. Given the consumer slant of the under-$1000 market, it is odd that only Pionex bundled any software targeted at children, the Akrose Creativity Workshop for Kids.

Pionex GX

ADVANTAGES:
+ Lowest price

DISADVANTAGES:
– Lowest performance

Pionex GX

Cosmetically, the Pionex GX is identical to the Pionex 6x86 system and comes with the same software bundle. But on closer examination, several differences help keep its price $300 below its costlier sibling.

Powering the system is the Cyrix MediaGX processor and chip set. The GX and its companion Cx5510 chip provide a compact and inexpensive bundle of CPU, core logic, PCI, video, and sound support in one chip set. Video memory is carved out of normal system RAM, reducing costs further.

But all this economy comes at a price. Compared to the other review systems, the 200-MHz Pionex GX system was noticeably slower. System operation seemed sluggish, a problem exacerbated by slower video. As a result, the system has a trailing-edge feel to it, despite its recent vintage.

Nonetheless, given its $699 price and probable end use, it's not fair to expect the system to deliver the same performance as systems costing $300 more. Once Windows is up and running and you're connected to the Web or word processing, the real delays lie outside the PC.

When running office applications, the Pionex GX has about half the power of the AMD-K6 233 systems we tested, just enough to function as a network client or as an inexpensive office PC. Its lack of multimedia horsepower, however, limits its usefulness as a general home PC, where games and other video-intensive applications are the norm.

PRODUCT INFORMATION

Aptiva E26 $999
IBM Corp.
Research Triangle Park, NC
800-426-7235 ext. 4340
919-517-2430
http://www.pc.ibm.com/us/aptiva

Presario 4540 $999
Compaq Computer Corp.
Houston, TX
800-345-1518
281-370-0670
http://www.compaq.com
Enter HotBYTEs No. 1096.

Pionex GX $699
Pionex 6x86 $999
Pionex Technologies, Inc.
Orem, UT
http://www.pionex.com
Enter HotBYTEs No. 1097.

Polywell Poly LPC5201 $998
Polywell Computer, Inc.
San Francisco, CA
800-999-1278
650-583-7222
http://www.polywell.com
Enter HotBYTEs No. 1099.

Enter HotBYTEs No. at http://www.byte.com/hotbytes/

TECH FOCUS

Intel Takes the Low Road

Traditionally, Intel has focused on improving x86 processor technology, painting the low-cost end of the market as trailing-edge technology. However, the rising level of interest in the sub-$1000 PC market has not escaped Intel's attention. A new chip, Celeron, is expected to be shipping by the end of April.

Intel's Celeron uses the same 0.25-micron P6 core as the Pentium II, but it has reduced performance and a reduced cost. Clocked at 266 MHz, it comes without the Pentium II's L2 cache and runs with a 66-MHz bus.

Despite Intel's attempt to hobble the Celeron and market it under a different brand name than Pentium, the chip still has the possibility to turn the low-cost market on its ear. Sharing the Pentium's P6 core means that Intel can move its separate product lines forward simultaneously.

Polywell Poly LPC5201

The most striking feature of the Polywell Poly LPC5201 is its size, just 3 inches high and 12.5 inches wide. Despite its stature, the unit turned in the top overall performance score, fueled by its AMD-K6 233 processor and a 512-KB L2 cache.

The SiS chip set uses a type of universal memory architecture that assigns system memory to the video subsystem. Using the built-in BIOS setup, you can allocate between 0.5 and 4 MB of system RAM for use by the video display, depending on your required resolution. The lack of dedicated video memory doesn't hurt the LPC5201's performance at all.

Integrated Ethernet and universal serial bus (USB) ports are built onto the system board. It also has the largest hard drive of the bunch—a whopping 6.5 GB of storage. And the LPC5201 is the only system that configured its modem as COM3, leaving both serial ports active and available.

Although it has some impressive features, the LPC5201's small size translates to some compromises. There are no expansion possibilities for additional devices, such as a DVD or tape drive. A riser card provides one ISA slot (used by the modem) and one shared PCI/ISA slot, limiting your expansion choices.

Small also means cramped. The bottom of the floppy drive is less than one-quarter-inch away from the top of the CPU—blocking effective cooling of the chip by its CPU-mounted fan. The heat problem is aggravated by the tiny power-supply fan and obstruction of airflow in the unit by internal partitioning. Over the period of an hour's testing in a cool lab, the area of the case above the CPU got quite hot.

Equipping the LPC5201 with required software will drive up your total purchase price. Only Windows 95 and a few utilities are included. Despite its limitations, the LPC5201 is equipped to serve as a client for small networks, a second PC for SOHO use, or a first PC for home or school use.

Polywell Poly LPC5201

ADVANTAGES:
+ Small footprint
+ Large hard drive

DISADVANTAGES:
– Very limited expandability

Summary

Manufacturers are convinced that the key to getting more users to purchase their first computer is price, but we're not so sure. Although the PCs reviewed here cost less than $1000, they're no easier to use than their more expensive siblings. For those of us who are willing to configure our computers and don't mind downloading a new driver occasionally, these PCs are a cost-effective way to add another computer to our stables. B

Robert L. Hummel is an electrical engineer, programmer, and consultant. You can reach him at **rhummel@cheshire.net.**

KeyVision removes a lot of the hassle of managing Windows 95 and NT registries—even remotely. ***By William Wong***

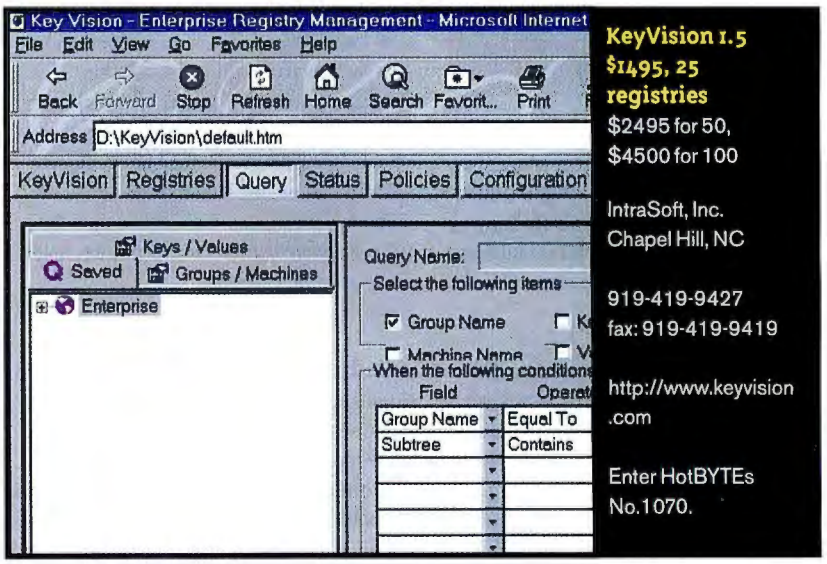
Remote-Control Registry

Windows 95 and NT applications live and die according to their registry settings, but managing them is a bear. Like many network administrators, I've spent countless hours tracking down registry-configuration problems on networked PCs. It's a difficult task involving cryptic, poorly documented variables.

But a marvelous new tool, KeyVision, brings order to the registry with searching, reporting, and updating features that allow me to monitor and alter registries across the network. I wouldn't be without it now.

KeyVision's client/server architecture has NT-based communications and management servers you administer with ActiveX controls via a Web browser. Agents run on Windows NT or 95. IntraSoft also provides agent installation for Microsoft Systems Management Services (SMS).

Heavy-duty requirements allow KeyVision to work in large networks. It needs Microsoft SQL Server 6.5 on a dual Pentium Pro machine that has 256 MB of RAM. Although IntraSoft recommends that KeyVision and SQL Server be on different machines for reliability and performance, I ran both KeyVision and SQL Server on the same dual-processor BackOffice server.



KeyVision uses ActiveX controls within Internet Explorer to provide remote batch management of Windows 95 and NT registries.

KeyVision agents run in the background and communicate securely between the registry and the KeyVision server. The Web-based management console provides access to users (query only), operators (change workstation groups and registries), and administrators (access policy and configuration options).

The management console was very easy to use. Workstations with agents installed showed up in the Unassigned group. Creating groups and moving workstations to them was a snap. KeyVision supports queries to find workstations whose registries meet specific criteria, monitors for real-time notification of registry changes, and filters to prevent unwanted updates.

KeyVision's Acrobat documentation was useful, though screens were unclear. I had minor SQL Server configuration hassles during installation. KeyVision's configuration support is poor, but maybe you won't need it. The installation program didn't put folders on the start menu, but all actions were available from the main form. Once installed, KeyVision was very stable.

KeyVision does only one thing—registry management—but does it so well that it should be easily justifiable by the management cost savings. Its use of SQL Server and SMS makes it a good fit for BackOffice environments. B

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

William Wong is a computer consultant and author. You can contact him at **bwong@voicenet.com.**

TECH FOCUS

Making Up a Batch

Microsoft provides remote registry management using the registry editor, but only for a single workstation. Batch operations are lacking, and Windows 95 and NT registries call for different management tools. Most software-distribution packages support registry manipulation when a package is installed. Limited batch operations can be performed using command-line arguments. But none of these tools can begin to match the capabilities of KeyVision, especially in searching and real-time monitoring.

With symmetric throughput of up to 1.1 MBps, Covad's TeleSpeed offers fast, though pricey, ADSL. By Michelle Campanale

Remote Access for Short Attention Spans

Sometimes it's easy to spot irony. I watched a home installation of Covad Communications' new high-speed, synchronous 1.1-MBps asymmetric digital subscriber line (ADSL) modem for one of Web TV's network engineers, Robert Gutierrez. With the resulting major speed increase over his previous Pacific Bell ISDN connection, Gutierrez can now more efficiently monitor the analog modem bank for the slower, dial-up connections of Web TV's customers.

In the future, Web TV and other companies that offer services to home users will likely benefit from ADSL technology. But that won't happen for at least a year, because newer ADSL technologies, such as splitterless discrete multitone (DMT), have yet to be standardized, and home implementation is tricky.

For the time being, Covad's TeleSpeed ADSL service uses carrierless amplitude and phase (CAP) modulation. Like the competing DMT, CAP is not "splitterless" and works at the single-user level for remote-access connections. Once splitterless DMT becomes standardized by the Universal ADSL Working Group (UAWG), the technology will be available as a much less expensive (yet slightly slower) solution for consumers.

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

Covad installs its remote-access device, a Diamond Lane ADSL router called SpeedLink Modem, into users' homes.

What's Involved

Currently, solutions like Covad's TeleSpeed 1.1—which functions as high-bit-rate DSL (HDSL) and requires the user to live less than 12,400 feet from the central office—remain costly. The service, which essentially turns a company into an ISP, requires an investment of expensive back-end ATM/DS3 or T1/frame-relay equipment and routers. Companies must also pay costly monthly surcharges. For example, Web TV's installation of the Covad ATM/DS3 device cost $7500; add to that a back-end recurring monthly rate of $4000 for the service. Companies also need to invest in a router if they don't already have one.

On Gutierrez's end, there are a series of installation charges, including $550, $325, and $80, for inside and outside wiring and customer premises equipment (CPE) installations, respectively. In addition, his employer must pay $195 per month for each TeleSpeed 1.1 user.

Unlike ISDN, Covad's service has a flat-rate fee, so there are no per-minute charges. Gutierrez says that in a competitive market like Silicon Valley, top engineers' demands for such perks as a T1 equivalent to their homes are often met. "I have headhunters calling me all the time for six-figure-salary jobs. This becomes an incentive on the [Web TV] employment package," he explains.

Setup issues are another impediment to the release anytime soon of a Covad package for individual home users. Currently, installation requires a visit from a service technician; the user's corporate network administrator must then tackle TCP/IP addressing and routing issues.

During Gutierrez's installation, I witnessed some thorny TCP/IP routing problems between Web TV's router and the newly installed ADSL modem. According to Lou Pelosi, director of marketing for Covad, the company's TeleSpeed service is an Ethernet interface, so the point of demarcation is on the side of the modem. "It's up to the company [i.e., Web TV] to ensure that the NIC [network interface card] software is configured properly,"

Pelosi says. He adds that Covad monitors and supports the service up to the modem, "but it's the [participating] corporation's responsibility to deal with the NICs and IP-addressing issues."

Advantage: Speed

Although it's costly and installation is tricky, Covad's service offers some compelling advantages. Before installation, Gutierrez transferred a series of files, through an ISDN connection, from his home computer (a Sun Ultra 1 Model 170E, running Solaris 2.6) to the Web TV server. After the Diamond Lane ADSL router and TeleSpeed 1.1 hookup, he transferred the same files, showing the differences in speed between ISDN and ADSL (see the text box below).

I later tested some of Covad's products at the company's executive briefing center in Mountain View, California (which is located 3000 feet from the central office), where I found the TeleSpeed 1.1 service capable of 1-Mbps throughput for FTP puts and sends to the server. In addition, I was able to ping the network in 11 milliseconds using a program that tests whether a network destination is on-line.

I did these tests using a Diamond Lane ADSL router connected to a Compaq 233-MHz Presario Pentium MMX with 32 MB of RAM and running Windows 95, MS-DOS 7.10, Chameleon FTP Server, and Netscape Communicator 4.01a. Using Covad's TeleSpeed 144, which uses existing ISDN infrastructure and is based on ISDN digital subscriber line (IDSL technology), I was able to transfer data at 6.6 KBps. (I did the tests using an Ascend Pipeline 50 terminal adapter connected to a Fujitsu LifeBook with 32 MB of RAM, running Win 95 and Netscape Communicator 4.01a.)

I also loaded a graphics-intensive Web page—the *Chicago Tribune* Web site (which reloaded in about 2.5 seconds)—that is often sluggish over a 56-Kbps modem connection. Unlike using a cable modem, Covad's end-user services are shared. These services have a dedicated line for each user, resulting in greater security without the need for encryption.

Because they use a switched, dedicated medium where no packets are shared, Covad's DSL services are fairly secure and do not require encryption or a firewall. Covad's architecture is a layer 2 network; Covad uses individual, dedicated permanent virtual circuits (PVCs) to encapsulate the transport data from the home to the corporation.

In addition to TeleSpeed 144 and 1.1, Covad offers two other services: TeleSpeed 1.5 (1.5-Kbps downstream and 384-Kbps upstream) and TeleSpeed 384 (symmetrical 384 Mbps). TeleSpeed 1.1 and 1.5 cost $195 per month per user and $4000 for back-end monthly service charges. The TeleSpeed 384 and 144 services cost $125 and $90, respectively, for the end-user fee, and $4000 and $975 for back-end monthly service charges. All these services except TeleSpeed 144 (which works over ISDN lines) work over 26-gauge, double-wired copper lines.

Who Benefits?

Currently, Covad is targeting businesses with as few as 40 telecommuters—the minimum that Covad believes is necessary for a company to get a return on its investment. But Web TV's Gutierrez estimates that his company will get a return on its investment with its five top producers, extremely productive employees who spend a lot of time on-line monitoring mission-critical services.

But even in Silicon Valley's competitive market, Covad's 1.1-MBps service is a luxury that most companies can't afford. Covad hopes economies of scale will allow it to grow this service quickly and that prices will drop enough so that nearly everyone can afford it. B

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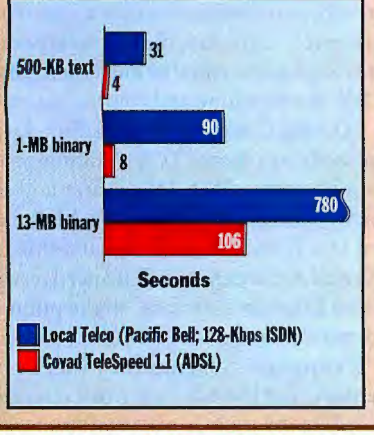
Speeds and Feeds

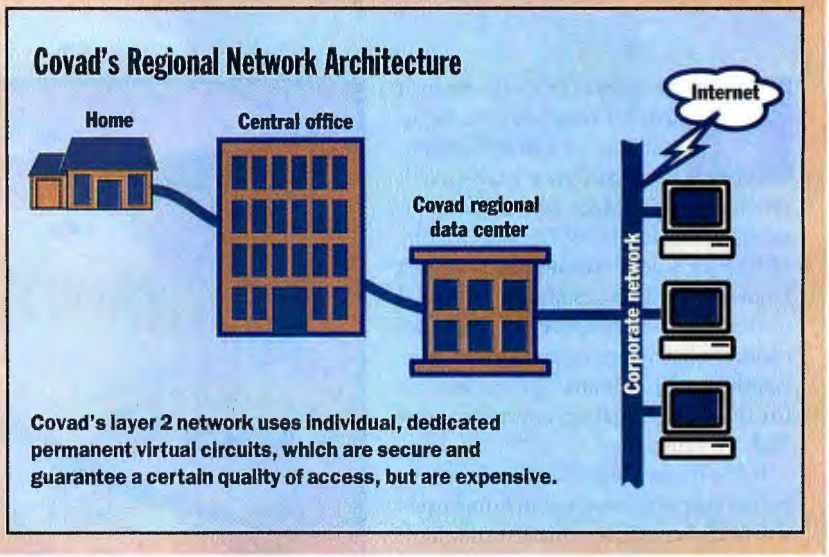
When transferring files to and from a company server, Covad's symmetrical 1.1-MBps service is seven to 11 times faster than ISDN.



TECH FOCUS DATA TRANSFER

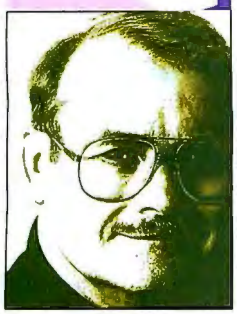
Going with the Data Flow

Data packets are transported from the home to the central office (CO) using DSL technology. The CO then delivers the traffic to the corporate network over one or more high-speed WAN circuits. Each WAN circuit terminates on a corporate router or switch, using either the T1/frame-relay protocol or the ATM/DS3 protocol, where one permanent virtual circuit (PVC) per telecommuter is supported. The resulting end-to-end connection is a secure, private, dedicated one between the telecommuter's PC and the corporate network.



Jerry Pournelle

Chaos Manor



Four Ways to More Storage

Jerry believes in backups, and Chaos Manor's multiple redundancy system has just entered a new age.

One of the neatest developments in the computer revolution is the plethora of cheap storage systems. We have a bunch of them at Chaos Manor.

The first solution is simple: add a larger hard drive. Except for portables, it's nearly impossible to buy a hard drive smaller than 2 GB, and larger ones are about 50 bucks a gigabyte. Put a new hard drive in your old system or install it in another system and network to it. Network costs have fallen to nearly trivial levels. Basic new machines are getting cheap enough that you can afford to use one as a "disk box" with the cheapest possible video card, no sound card or other accessories, a network card, and as much disk space as you want.

There are far more elegant solutions to your space problem—spending a bit more to get a good Windows NT server is one of them. However, if all you want is disk space in a hurry without configuration problems, networking to a box full of storage space certainly works.

Even Fast Ethernet is cheap. Last time I was at Fry's, the big discount electronics superstore, I saw a Netgear FA310TX Fast Ethernet PCI auto-sensing 100Base-TX/10Base-T adapter for $29, which is like they're giving it to me. Genuine 3Com boards work, but they were selling for nearly three times that price.

I already had two Garrett Ethernet hubs, one running at 10 Mbps and one at 100 Mbps. They're linked, so if I have 100-Mbps machines, I can simply plug into the 100-Mbps board. I figured that if this worked, I'd have 100-Mbps capability in my new machine on the cheap.

I installed the Netgear board at 10 Mbps without incident. The drivers they supplied worked just fine. After the system was stable, I unplugged the cable from the 10-Mbps hub and plugged it into the 100-Mbps hub to see if the auto-sensing really worked. It didn't: there was no green light. The Netgear board has a bunch of lights to signal what's wrong. In this case, it wasn't getting a signal.

The Netgear manual says you must have Level 5 cable to run at 100 Mbps. I wasn't sure what my old cable was, but I'd read that on the box when I bought the board, so in preparation I also bought a 25-foot cable certified as Level 5. I forget what it cost, but it was under 20 bucks.

I plugged that into the Netgear board and the other end into the 100-Mbps hub, and voilà! No change in software; literally plug in the right cable to the faster hub, and you have 100-Mbps communications. Now, three of my systems talk to each other at 100 Mbps (and to the rest of the network at 10 Mbps). I can sure notice the difference; enough so that I'll probably get a couple more of those boards and cables, and upgrade other PCI-bus systems.

Now, three of my systems talk to each other at 100 Mbps.

The installation was painless. Plug and Play worked just fine (in Windows 95; and once everything works in that, I install NT 4 and feed it the values that worked in Windows 95).

The moral of this story is that Pournelle's law holds: if you have a computer problem, check your cables first. The other lesson is more general: 100-Mbps equipment is now cheap enough that you ought to be using it, but it won't work without quality cables. Level 5 cable costs a little more, but once you have it, you can run at 10 Mbps until you get faster boards and then upgrade without pulling more wire. The odd thing is you may be better off paying attention to the brand of cable you buy than the brand of Ethernet board.

THE NETGEAR BOARD WENT into Fireball, which is my experimental dual 200-MHz Pentium Pro (the big ones with a 1-MB cache) system that I built from a Micronics W6-LI motherboard and a PC Power & Cooling case and cooling fans; see my December 1997 column for details.

Fireball also sports a Distributed Processing Technology (DPT) SmartCache IV SCSI controller and a DPT RAIDstation3 external RAID disk box. The RAID box contains a Quantum Fireball 3-GB SCSI drive and two Seagate Cheetah 4LP 4-GB drives. RAID is supposed to be a way to use inexpensive disk drives in an array without having to use identical drives. These were the cheapest large SCSI drives at Fry's; the Quantum was on sale, for I think under $100.

The RAID box supports three RAID modes. The first is RAID 0, which has no redundancy or safety at all. The RAID 0 array looks like one great big drive to the system. Files are written across the array in a manner to optimize performance. It's fast, and you get all the storage the drives are capable of.

Second, it supports RAID 1, which is mirrored data in pairs of drives. I could, for example, pair the two Seagate drives, and everything written to one of them

would then be written to the other. If either failed, the other would have everything on it. RAID 1 is fast on both reads and writes, and utterly safe unless both drives fail. It halves disk capacity, of course.

In the RAID box, I could have two drives in a RAID 1 array, and the third can be a hot-swappable spare. That is, if one of the drives fails, the third, which has been on standby, would swing in to substitute for the failed drive. The system would build up a copy of everything on the working drive, and within minutes, I'd be back to a fully backed up RAID 1 system. Alternatively, the third drive can just be a drive, not part of the RAID system at all.

The third alternative is RAID 5. A RAID 5 system requires at least three drives. All files are written across the three in such a way that if one of the drives fails, you can recover all the data through error-correction files stored on all three drives. This happens invisibly. RAID 5 is slower than RAID 0 or RAID 1, but most of the penalty is in writing files; reads in RAID 5 are fast.

RAID 5 also uses disk space. In my case, I have two 4-GB drives and one 3-GB drive, but the final formatted RAID drive (which looks to the OS like one big drive) is only 6.3 GB, which for Windows 95 formats into three 2-GB drives with some left over that I could partition into a special swap-file drive. It makes sense to set up the swap-file drive with the largest disk cluster size your system can handle. Never use that drive for anything but the swap file. You'll get significant performance improvements.

Setting up the RAID arrays is both easy and complex. The RAID box comes with three drive trays, into which you install your drives. Those then slide into the box and are turned on with a small key. They are hot-swappable. You can pull one out while the system is running, and, provided you have a redundant array (RAID 1 or RAID 5), you won't lose any data. You could then install a new hard drive into the drive tray, put the tray back in the box, and use the key to turn it on. The DPT software will take care of the rest.

The hard part of the installation is putting the drives into the drive trays. The array sets the SCSI ID number for the drive; to do that, you must connect cables from the drive tray onto the jumper pins that control the SCSI ID for the drive. It's explained reasonably well in the DPT RAIDstation3 documentation, but the ease varies from drive to drive.

On the Quantum Fireball, it was easy to connect to the SCSI ID jumper pins, but I never did find a connection to connect the "drive busy" light cable to. Consequently, I have no drive-activity indicator on that drive. The Seagate drives, on the other hand, have good documentation, making it easy to connect both the SCSI ID cables and the drive light cable. However, those connections are on the back of the drive in a position that makes it hard, mechanically, to get the drive into the drive tray once the cables are attached. It took me nearly half an hour to get it right. Once I did, though, there were no problems.

Setting up the RAID arrays is both easy and complex.

When the physical installations are done, invoke Windows 95 and install the DPT software. That's a breeze. Then run the software.

The DPT software is nearly self-explanatory, *but* it takes a long time (about an hour) to build an array, and there is absolutely no indication on your screen that anything is happening. Similarly, there's an option to format a disk in the array. It's not explained well in the DPT documents, but this is a low-level format.

If you start that format, it will take an hour or more. Once it has started, if you halt it before it is finished, the drive will be useless, unavailable, invisible to the OS, and shown as "impacted" by the DPT software. Fortunately, the remedy is simple: invoke the DPT Storage Manager program, select that drive, and hit the "format" button. Then go out to dinner. When you come back in an hour or so, the drive will work just fine and can be added to an array.

Alas, there is absolutely no indication that the format button *does* anything and no progress indicators. The drive light will blink furiously, but if you haven't connected the cable to the right place for the "drive busy" connection, you won't see a drive light. In the case of the Quantum Fireball drive, I simply must have faith; which works. Eventually the format is done, and the drive is in fine shape.

After that, Bob's your uncle. The DPT Storage Manager software is slow and thorough and quite self-explanatory, and you can create RAID 0, RAID 1, or RAID 5 at will. Each takes a while—about an hour—as does switching from one to another, and you must save your data before doing it; but it all works about as advertised. In theory, you can change RAID types without losing data, but I'd sure hate to try.

My first effort produced a RAID 5 setup that turns 11 GB of storage on three drives into a single 6+-GB drive (which I formatted into three 2-GB drives due to the limitations of Windows 95). When I saw that worked, I changed it into one 4-GB RAID 1 drive (mirroring the two Seagate drives) and one independent 3-GB drive. This gives me 7 GB, with 4 GB self-backing. That will become the safety cache for all-important storage.

I used PowerQuest's PartitionMagic to partition my RAID 5 array into three 2-GB drives, and again when I changed over to RAID 1 plus an independent drive. PartitionMagic sees a RAID array as one drive, which it partitions like any other. One note of caution: PartitionMagic works like magic until you hit 8 MB. It simply ignores any drive space beyond 8 MB, no matter how large your drive is. That's about its only problem, and PowerQuest claims they'll have it fixed Real Soon Now.

I have been partitioning my drives into 2-GB logical drives, because of Windows 95. When I change Fireball over to NT 4, I will repartition to 4-MB logical drives.

Interestingly, Windows 95 can network-access more than 2 GB of space although it can't see more. That is, Spirit, a Pentium Pro NT 4 server built from the husk of Big Cheetah (hence the name Spirit), has two 4-GB drives. One is a Micropolis AVI external drive, one of the best drives in the house. It *will* send audio and visual data in a continuous stream. Alas, Micropolis has ceased to exist, although I note that Fry's advertised some Micropolis drives this morning.

Anyway, if I look at Spirit's drives across the network with a Windows 95 machine, they appear to be 2 GB only. I see 1310 KB used space, 836,894 KB space available, and 2147 KB total. If I look at that same drive with Princess, my Compaq Professional Workstation 5000, running NT, I see 3448 KB used space, 836,894 KB space available, and 4285 KB total. None of this is a problem: I can always find files on Spirit through the network.

Anyway, the RAIDstation3 is a good choice for critical mass storage. RAID 5 is a bit costly in space, but it works, it's easy to set up, and while the write-time penalty is fairly high, the read-time cost is negligible. RAID 1 is utterly safe (for the mirrored drive) and as fast as the drive can be, and it leaves a drive for you to use as you like. It's all easy to set up, experiment with, and change around. It's a classy solution to your data-storage problems. I use DPT SmartCache SCSI controllers on many systems, and I've always been impressed with their capability and reliability. Recommended.

IF YOU ADD A HARD DRIVE TO AN existing system, chances are that the new drive will be larger than the old. Most of your program and system files are and may have to be on logical drive C, but changing your system around so that C resides on your new and larger drive is tricky, and it can be dangerous if you don't quite know what you're doing.

However, there's a simpler solution. BigDisk, from Syncronys Softcorp, will move files for you while tricking the OS into believing that they're still on the C drive. You use a simple slider control to indicate how much free space you want on your C drive, and the program does the rest. It won't move critical files, and the method used (they're all put into one big folder on your new disk) makes it relatively safe to use either BigDisk itself or a file manager of your own choosing to selectively restore files that shouldn't have been moved.

Alternatively, BigDisk will use redirectory trickery to make your system think all the disk space on your system is one big disk, so that you have a very large C drive. You can then forget about it.

Installation is simple, the manual is clear, the recovery paths seem reasonable, and the company includes people I've known for years—one was formerly associated with Quarterdeck's CleanSweep—so it all seems safe enough, and it's a simple solution to file-location nightmares.

My only doubts here involve using redirectors with memory-resident compression programs like Mijenix's FreeSpace. Either program is reliable acting alone, but one of the programs may not understand what the other is doing. Thus, I'd be cautious about using BigDisk with any on-the-fly compression program; but then I'm always cautious about compression programs to begin with.

If you're thinking of adding a new and large hard drive to an existing system, BigDisk can help you get things organized without your having to do much work.

I'm told that Syncronys will soon bring out a version of BigDisk that lets you map in network drives so they seem to be part of your C drive. I'm looking forward to that, and I'll let you know when I get it.

THE NEXT ADDITION TO STORage at Chaos Manor is CD, both CD-R (recordable, i.e., write only) and CD-RW (read and write). The cheapest and most useful is CD-R, but if you have the extra cash, it may be worth it to get a Ricoh MediaMaster MP-6200S Internal CD-RW drive. This will function as a (rather slow—6×) CD-ROM drive, write CD-R gold discs, and work with CD-RW if you need that.

It's a SCSI device that in my case operates off the DPT caching controller in Fireball, but it comes with a PE Logic SCSI board that has both internal and external SCSI connectors. If you don't have SCSI, this will work, because installation is a snap, and everyone ought to have SCSI.

You also get Adaptec's Easy CD Creator and DirectCD software, making it simple to copy CD-ROM discs or make new ones, as well as manage the CD-RW capability. The Adaptec software is easy to learn and has a mode for testing before you start burning a CD-R.

One caution about CD-RW: unless you have a fairly new system, your CD-ROM drive probably can't read CD-RW discs. The only drive I have that reads CD-RW discs (other than the Ricoh drive that created them) is a Panasonic 24× ATAPI CD-ROM drive that resides in Cyrus, my Cyrix 6x86 P-166 system. Most newer CD-ROM drives will read CD-RW discs, but newer means manufactured after the fall of 1997. The buzzword to look for is *multiread* with a silver sticker. Drives that have that will read CD-RW discs. Others probably won't.

In theory, you can change RAID types without losing data, but I'd sure hate to try.

continued

I don't use the Ricoh drive for CD-RW anywhere near as much as for CD-R. Fry's now has blank CD-R discs for under $2, so once a week, I use the Ricoh drive to burn a new "full Monty" backup of every word I have ever written (at least all of them I have in electronic readable form). I carry the latest of those on trips, so if the house burns down I'm still in business. I leave copies in safe-deposit boxes and at Larry Niven's house. I also make copies of the really critical system software on all my machines.

We currently recommend the Ricoh CD-R and CD-RW internal SCSI drives, and the Philips CDR-870 external drive. One caution: you can get two discs into a Philips drive. When you do, it scrapes off the laser. Not good. Don't do it. We managed to.

I'VE SAVED THE NEWEST BACKUP system for last. We have an Indigita iDT 2500 SCSI tape drive. It holds 6 GB on each tape.

The iDT 2500 can be an internal drive or an external drive; ours is internal in Fireball to back up the entire network. That does not make full use of the iDT 2500's capabilities, but it is something I need. One problem with installation. All my flat SCSI cables have three connectors, one for the controller and two for the devices; but both the Ricoh MediaMaster and Fireball's main hard drive are internal SCSI devices. Of course, I could go buy a four-connector flat SCSI cable, but it's storming outside.

Fortunately, the Micronics motherboard has an on-board Adaptec SCSI, but we were using the DPT SmartCache IV and never implemented it. Reset the machine, enter the BIOS setup, and enable the SCSI drive; install the Adaptec SCSI drivers that came with the board; and then connect the iDT 2500. It took longer to do it than to tell about it, but not much longer.

Now I have a new drive, T, and an icon of a tape drive. Put in a tape, format it, and there's 6 GB of data storage available. The interesting thing about the iDT 2500 is that the system can't really tell it from a disk: you copy files and such to it, and you can selectively add and delete and overwrite as you choose. Moreover, once it finds a file, it's *fast*: you can play audio and small-screen real-time video direct from the tape. It's great for saving Internet multimedia downloads.

Note I say once it finds the file. It can take up to a minute to find and open a new

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file, and even to get a directory takes many seconds. After all, it *is* tape. But once it has located the file, it reads multimedia files so fast you wouldn't know it wasn't a disk drive.

Because it looks like a disk drive, you can share the iDT 2500 across the network; having it available across the network means you can save to it from anywhere. As I write this, I'm using Canyon Software's Drag and File Gold to find and copy the latest versions of everything I ever wrote and store it on Fireball's RAID 1 drive. Once that's made up, I'll copy it to tape, as well as write it off to yet another CD-R disc. When I did my "full Monty" backup last time, I forgot to look into some magneto-optical (MO) discs, which may have some stuff that didn't get onto one of the networked drives. This time for sure.

I'll mostly use the iDT 2500 as backup storage, since the cost per gigabyte for storage media is very low while 6-GB chunks are more convenient than the 600 MB you get on a CD-R disc. However, since it's on the other end of a 100-Mbps Ethernet, I can also use it to store any multimedia files I download from the Internet. If you're looking into data storage, be sure to check out Indigita's iDT 2500. More as I use it more, but I like it already.

CREDENTIALISM HAS BECOME the curse of the age. It's no longer what you know, but what credentials you have that determine salary and promotion. Now much of this is due to Equal Opportunity legislation. If you can't prove that the person you promoted is somehow "superior," you could be sued by a legal bounty hunter just waiting for the opportunity; thus the emphasis on credentials like college degrees.

Credentialism has also created opportunities. One credential that's worth a lot of money is MCSE—Microsoft Certified Systems Engineer. There are a number of categories. None of them require college degrees. They do require you to pass a thorough and difficult exam, but the exam is based on practical knowledge, not on remembering who said what.

If I were young, had never made it to college, and wanted to get ahead, I'd go for one of the MCSE credentials; it's guaranteed employment at fairly decent wages. I'd be particularly interested if I were doing technical-support work but didn't have any credentials.

The usual way to get the MCSE credential is to enroll in a trade school, which doesn't so much teach you about engineering Microsoft products as how to pass the MCSE exam. These are tough exams, and having some coaching in a trade school certainly does no harm; but you don't have to enroll in classes to take and pass the MCSE exams. You can learn on your own.

If you want to try that, the best way is to get the appropriate New Riders MCSE book and CD-ROM. These books aren't cheap, but they contain everything you need to know to pass the exam, and the CD has sample tests.

Understand, while it would theoretically be possible to learn enough to pass the exam from one of these books, it's not likely anyone will do it; you need some practical knowledge and experience. The people who will find these books most useful are those who know a lot about the subject, but don't know it in a systematic way; who have holes in their knowledge base; and who are a bit nervous about exams anyway.

The New Riders MCSE books are the computer books of the month. Just be sure to notice the publication date; books of this kind become dated as quickly as Microsoft releases new versions of its products. Generally, the titles that say *MCSE Training Guide* are more recent than the ones that say *MCSE Study Guide*.

If you already know Windows NT, or Exchange Server, or one of the other major Microsoft product lines, but like the scarecrow in the *Wizard of Oz* you don't have a diploma, go to *http://www.newriders.com* and see if there's not an MCSE category and book for you. It could change your life.

THE BOOK OF THE MONTH IS BY George and Meredith Friedman, *The Future of War* (Crown, ISBN 0-517-70403-X). While I don't agree with all they say, it's a valuable contribution to the discussion of technology and warfare. Incidentally, I am doing a two-volume set on high-tech wars for St. Martin's Press, and I hope to turn in the manuscript of the first volume about the time you read this.

The game of the month is Cavedog Entertainment's Total Annihilation. I'd sworn off real-time strategy games, but this one has good enough speed control to be useful. It's fairly stylized war reminiscent of Warcraft set in the next millennium, and it has certainly eaten enough of my time. Warning, if you get this, you may find yourself playing at dawn, and not just once.

Be sure to see the Web Exclusive for another graphics report from David Em. There's a new era in color printing. Next month, waiting for the bus: what USB will do for us, plus the usual tales of hope and glory. B

PRODUCT INFORMATION

BigDisk about $39.95
Syncronys Softcorp
Culver City, CA
310-842-9203
fax: 310-842-9014
http://www.syncronys.com/
Enter HotBYTEs No. 1085.

DPT-RS3/UR RAIDstation Kit $1645
Distributed Processing Technology
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800-322-4378
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fax: 407-260-6690
http://www.dpt.com/
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MAY 1998, VOL. 23, NO.5

BYTE

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Essential Products and Services for Technology Experts

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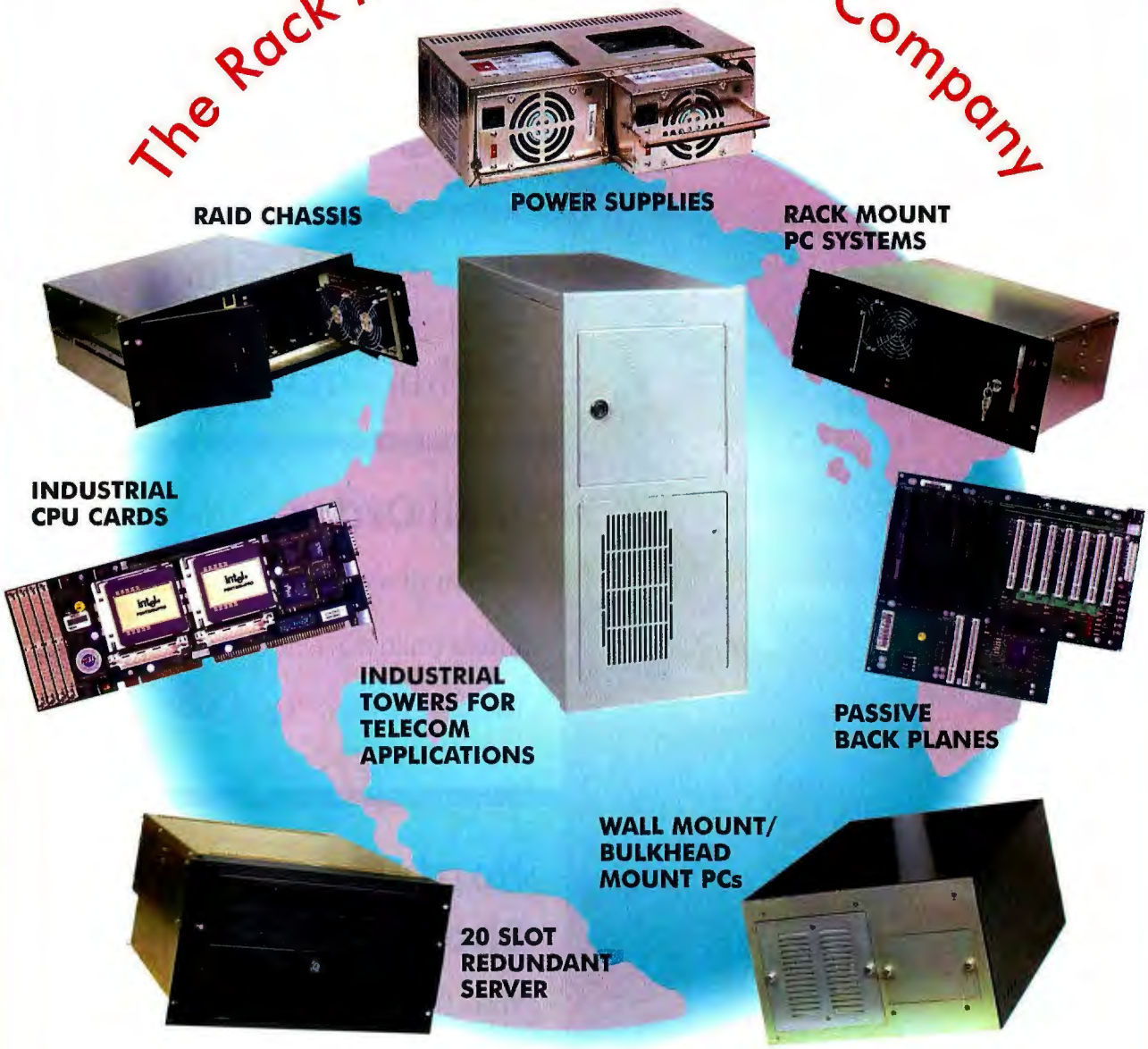

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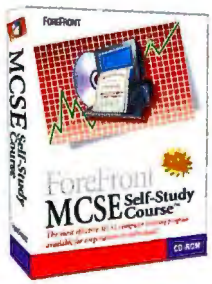

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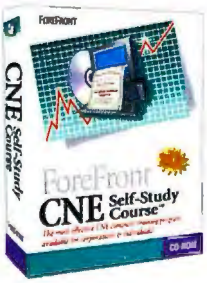

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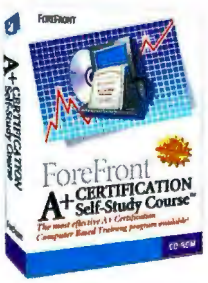

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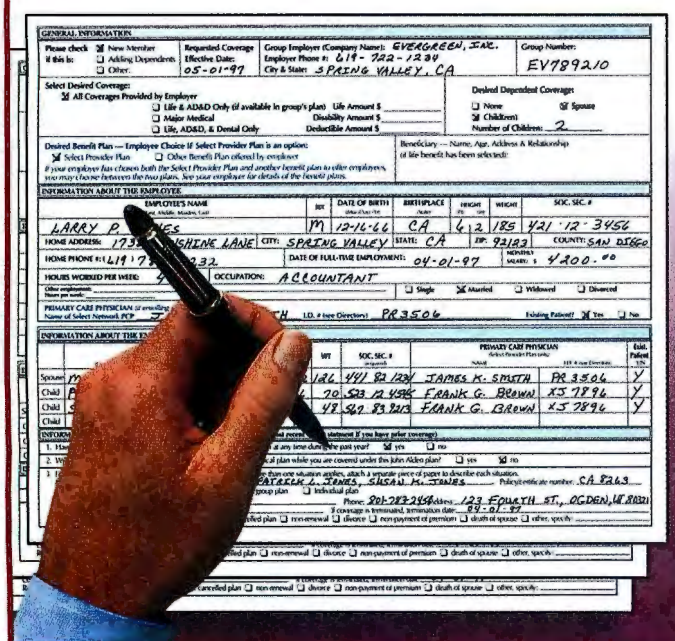

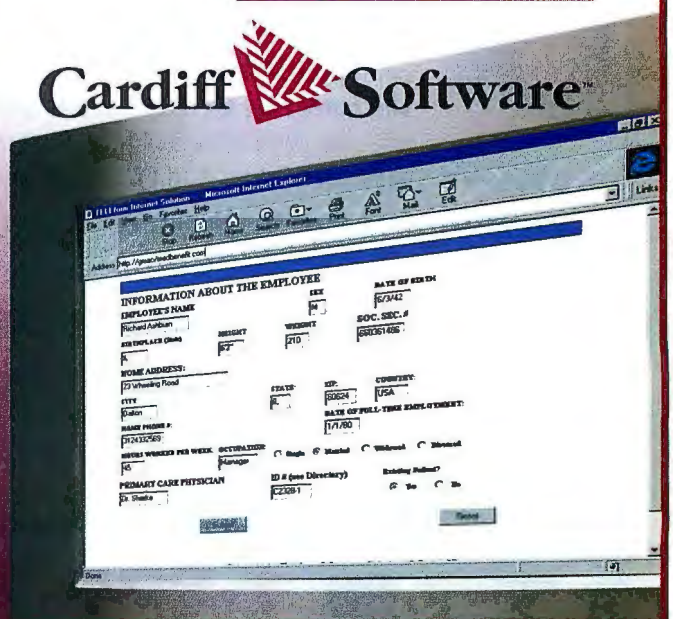

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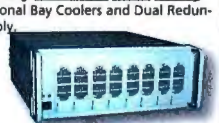

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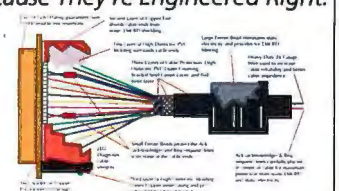

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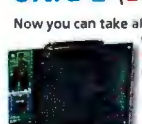

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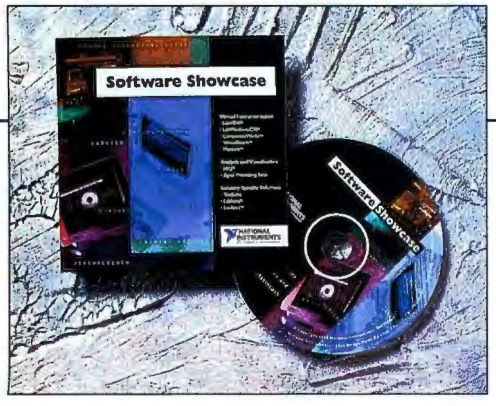

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EDITORIAL INDEX

For more information on companies covered in articles in this issue, enter the HotBYTEs number in the HotBYTEs form on the BYTE Web site at http://www.byte.com/hotbytes/. Page numbers refer to the first page of the article in which the company appears.

FREE Product Information Service: www.byte.com/hotbytes/

IS pages appear only in the International edition. C, M, and S pages appear only in the Reseller edition. NA pages appear only in the North America edition.

What's New

Hardware

This month, we look at a PC backup product, image-editing software for business, PA-RISC notebooks, and easy Web access.

PREVIEW

Ditto Max Professional External
$299 (street price)
(supports DOS and Windows, optional for NT)
Enter HotBYTEs No. 1069.

Iomega
Roy, UT
800-697-8833
801-778-1000
sales@iomega.com
http://www.iomega.com

Big Backup on a Budget

It may seem like a chore, but backing up your PC is a smart thing to do. So, when Iomega claimed that its latest tape drive, the Ditto Max Professional, offers cost-effective, easy, high-performance backup with room for growth, we decided to put it to the test. We came away impressed.

The distinguishing feature of this drive is its innovative OmniTray cartridge caddy, which can accept any of four 1.5-, 2.5-, 3.5-, or 5- GB native-capacity cartridges. The tapes have street prices of $20, $26, $30, and $35, respectively. The drive itself is available as an external parallel-port device or as a 5¼-inch internal unit (which we evaluated) that comes with its own 16-bit ISA accelerator card. A $199 version that supports only the 1.5-, 2.5-, and 3.5-GB cartridges is available for budget-conscious users.

Iomega claims a data transfer speed of about 2 GB per hour (at 2-to-1 data compression) for its internal unit and about half that for its external unit. Our real-world testing of a mix of both compressible and incompressible files (averaging 1.4-to-1 compression) produced a slower but respectable 1 GB per hour. At this speed, a full system backup is still an overnight task, though incremental daily backups could be performed over a lunch hour. With the bundled Ditto Tools backup software, single-button backup and restore or complete file-by-file control are possible. **–Robert L. Hummel**

PHOTOGRAPH: STEVEN GREENBERG © 1998

Workstations

Brawnier 3-D Workstations

INTERGRAPH HAS BEEFED UP ITS LINE OF graphics workstations with the StudioZ T-RAX 3-D system, powered by dual 300-MHz Pentium II processors. The StudioZ maintains the same serial digital (D1/SD1) video capabilities as previous-generation systems, but it adds the capabilities of Intergraph's RealiZm 3-D graphics subsystem, designed for 3-D animation creation. The machine costs $28,895 and comes with 128 MB of EDO memory and 40 GB of onboard storage.

Contact: Intergraph Computer Systems, Huntsville, AL, 800-763-0242; http://www.intergraph.com.
Enter HotBYTEs No. 1035.

Systems

Pentium II and More

WORRIED THAT LOW-COST SYSTEMS ARE just obsolete, low-powered machines sold at cut-rate costs? Toshiba's Equium 7000 Series corporate desktops attempt to dispel that perception by offering Pentium II–based systems with an NLX chassis, starting at $1229. You can slide the Intel industry-standard NLX motherboard in and out of the machine without unscrewing a single screw. This simplifies upgrades. You can mount the 7000S machine on a wall to make it less intrusive. The 7000S has a slim form factor with a 233-, 266-, or 300-MHz Pentium II processor. The 7000D machine supports up to a 333-MHz CPU and has expansion capabilities the 7000S lacks, with five drive bays and four

expansion slots. Both systems have an integrated 512-KB L2 cache, the Intel 40LX chip set, up to 256 MB of SDRAM, and ATI 3-D Rage Pro 64-bit PCI graphics with up to 6 MB of SGRAM.

Contact: Toshiba America Information Systems, Irvine, CA, 800-334-3445 or 714-583-3000; http://computers.toshiba.com.
Enter HotBYTEs No. 1036.

Notebooks

A Workstation in a Notebook

RDI'S PRECISIONBOOK IS THE EQUIVALENT of a Hewlett-Packard Visualize B-class desktop workstation in a 7.5-pound, 2.3-inch-thick notebook with a 14.1-inch active-matrix color screen. The PrecisionBook

includes a 160- or 132-MHz PA 7300LC processor, up to 12 GB of storage, 512 MB of memory, and Visualize-EG graphics. Prices start at $11,995.

Contact: RDI Computer, Carlsbad, CA, 760-929-0992; http://www.rdi.com.
Enter HotBYTEs No. 1037.

continued

A Skinnier Notebook

HEWLETT-PACKARD'S OMNIBOOK SOJOURN ($6599) is likely the thinnest, lightest full-size notebook on the market. At 3.2 pounds and 0.7 inch thick, this notebook is skinny but not malnourished. It packs a 233-MHz Pentium processor with MMX, a 128-bit graphics controller with 2 MB of video RAM, 64 MB of RAM, and a 12.1-inch TFT 800- by 600-pixel-resolution screen. The system is a result of a collaborative effort with Mitsubishi.
Contact: Hewlett-Packard Mobile Computing Division, Palo Alto, CA, 800-527-3753 or 650-857-1501; http://www.hp.com.
Enter HotBYTEs No. 1038.

Printers

Laser Technology in an Ink-Jet

LEXMARK'S 5700 COLOR INK-JET PRINTER generates high-quality output at an affordable price ($249). The Lexmark 5700's laser-crafted print heads deliver laser-like, sharp text and image copies. The printer's Accu-Feed paper-feed system helps avoid paper jams and can handle a

wide range of paper stock. The 5700 can create 1200- by 1200-dpi-resolution images at speeds that Lexmark rates up to 8 ppm for black text and 4 ppm for color. An optional photo ink cartridge and high-resolution paper are available.
Contact: Lexmark International, Lexington, KY, 800-539-6275 or 606-232-2000; http://www.lexmark.com.
Enter HotBYTEs No. 1039.

Servers

Flexible Pentium II Servers

DUAL PENTIUM II PROCESSORS POWER THE newest generation of enterprise servers from Tangent Computer. The Enterprise X-D is highly config-

urable, with up to two Pentium IIs running at 266 or 300 MHz, up to 512 MB of EDO RAM or SDRAM, redundant power and cooling options, hot-swap disks and power supplies, and nine expansion slots (six PCI, two ISA, and one shared). It is set for I_2O-ready system software and comes with built-in RAID support using on-board Ultra SCSI and an i960 processor. A machine with two 300-MHz Pentium II CPUs, 12 GB of storage, 128 MB of RAM, and Windows NT loaded will cost $6995.
Contact: Tangent Computer, Burlingame, CA, 888-826-4368 or 650-342-9388; http://www.tangent.com.
Enter HotBYTEs No. 1042.

Remote Access

New Modems for New Standards

THE HDSL, IDSL, AND SDSL STANDARDS are making possible remote-access speeds that today's modems and terminal adapters can't match. Adtran has the Express L128T integrated ISDN and IDSL modem ($795), Express L768 SDSL modem ($995), and Express L1.5 HDSL modem ($1495). These stand-alone remote-access products feature IP and IPX routing and bridging, and support an unlimited number of users over 10Base-T Ethernet ports.
Contact: Adtran, Huntsville, AL, 800-923-8726 or 205-963-8000; info@adtran.com; http://www.adtran.com.
Enter HotBYTEs No. 1047.

Storage

4.7 GB of Removable Storage

SYQUEST'S QUEST DRIVE HAS MORE THAN triple the capacity of previous generations of removable hard drives, offering 4.7 GB of storage. SyQuest estimates that the Quest drive can hold over 9 hours of digital audio, 1 hour of 16-track audio, or a full-length DVD-quality movie. It connects via Ultra Wide SCSI and uses IBM's new magnetoresistive heads. Pricing starts at $599 with one cartridge, while individual cartridges cost $199.
Contact: SyQuest Technology, Fremont, CA, 510-226-4000; http://www.syquest.com.
Enter HotBYTEs No. 1041.

Backup Tape Drives

TANDBERG'S MLR3 TAPE DRIVE ($2749) has 50 GB of compressed data capacity (25 GB native) and transfer rates of up to 240 MB per minute. MLR technology is similar to DLT and 8-mm technologies in the midrange segment of the server backup market. MLR3 is the second generation of Tandberg's multichannel linear recording technology, which is compatible with existing quarter-inch-tape technology, but uses magnetic rails to guide the heads into place to simplify the mechanisms of data recovery.
Contact: Tandberg Data, Simi Valley, CA, 800-826-3237 or 805-579-1000; http://www.tandberg.com.
Enter HotBYTEs No. 1045.

Cameras

A Digital Camera in a Camcorder

PANASONIC HAS INCORPORATED ITS VHS Palmcorder camcorder and a digital still camera in one unit, the PV-L858 ($1000). This combination system can capture either regular video or 640- by 480-pixel still images. A flip-out 3.2-inch color monitor serves as a viewer for both still-camera and camcorder functions. The camcorder can input still images from memory onto tape and can take still frames from tape and download them to a PC. The cam-

era has optical 23× zoom lenses and 1 MB of on-board memory for capturing 30 still photos.
Contact: Panasonic Consumer Electronics, Secaucus, NJ, 800-662-3537 or 201-348-7068; http://www.panasonic.com.
Enter HotBYTEs No. 1040.

Hard Drives

A Hard Drive with Head Room

THE LATEST MAXTOR DRIVE USING IBM'S magnetoresistive-head technology, the 11.5-GB DiamondMax 2880 should provide enough desktop storage space for all your hard-drive-hogging files and applications. The 3½-inch EIDE hard drive offers a 9-ms average seek time, 5400-rpm spindle speed, a 256-KB cache buffer, and on-the-fly error correction. It's priced at $479.
Contact: Maxtor, Longmont, CO, 800-262-9867

or 303-651-6000; http://www.maxtor.com.
Enter HotBYTEs No. 1043.

Hard Drives for Any System

IBM IS USING ITS GIANT MAGNETORESISTIVE hard drive technology to boost hard disk capacities in all form factors. Following its announcement last year of an 8.1-GB hard drive in a 17-mm form factor for high-end notebooks, IBM now introduces the Travelstar 6GT ($695), a 6.4-GB hard drive in a 12.5-mm form factor (about the size of a deck of playing cards) for slim notebooks. It has the highest areal density of any IBM disk drive with 4.1 Gb per square inch and has software power management to minimize power usage.
Contact: IBM Storage Systems Division, San Jose, CA, 800-426-7777; http://www.ibm.com/storage.

RAID

RAID Solutions

ADAPTEC'S FILEARRAY ACCELERATOR ($2995) product doesn't rely on the host CPU to handle I/O requests, but processes data itself. This PCI-to-SCSI accelerator card has 4 MB of ECC-protected, nonvolatile DRAM and support for a 16-MB parity-protected data cache.
Contact: Adaptec, Milpitas, CA, 408-945-8600; http://www.adaptec.com.
Enter HotBYTEs No. 1044.

CD-ROM

CD-ROM Today, DVD-ROM Tomorrow

JVC'S NEW CD-ROM LIBRARY SYSTEM offers up to 200-disc capacity for CD-ROM, CD-R, and DVD—when the latter is available. The MC-Printer Model 200 is a CD-ROM library with disc duplication and label printing built in, capable of burning 18 CDs an hour. Priced at $16,395, it can hold up to 130 GB of data, has a SCSI-2 connection, and has an average disc load time of 4 seconds and disc exchange time of 8 seconds.

Contact: JVC Professional Computer Products Division, Cypress, CA, 714-816-6500; http://www.jvc.net.
Enter HotBYTEs No. 1046.

Graphics

More RAM for Your Buck

DIAMOND MULTIMEDIA'S MONSTER 3D II graphics card ups the ante for graphics accelerators by including 12 MB of memory (previous generations had 8 MB) on a board priced at $299.95. It offers 4 MB of fast EDO DRAM for the Voodoo 2 pixel engine and 4 MB for each of two texture engines, generating 1024- by 768-pixel resolution.
Contact: Diamond Multimedia Systems, San Jose, CA, 408-325-7000; http://www.diamondmm.com.
Enter HotBYTEs No. 1124.

Upgrades

New Life for Your Mac

NEWER TECHNOLOGIES' G3 UPGRADE CARDS take advantage of the capabilities of the G3 processor to add power to your old Mac, Umax, or PowerPC system. The high-end MAXpowr 300 ($1999) 300-MHz upgrade with a 1-MB cache manages to run the L2 cache bus at the same speed as the CPU. The NUpowr 1400 ($999) will upgrade a PowerBook 1400 to 250 MHz with a 1-MB L2 cache.
Contact: Newer Technologies, Wichita, KS, 316-943-0222; info@newertech.com; http://www.newertech.com.
Enter HotBYTEs No. 1125.

SOFTWARE
Analysis

Java Reporting and Analysis

UNLIKE HTML-BASED REPORTING TOOLS that you access though a Web browser, PowerSqribe is an applet written entirely in Java for deploying OLAP tools on an individual user's desktop. The company claims that this desktop-based technology is faster than browser-based analysis tools, which claim to be faster than client/server applications. The company designed the tool for nontechnical users with no knowledge of SQL to process complex database queries. It costs $99 per user.
Contact: Sqribe Technologies, Menlo Park, CA, 650-326-5000; http://www.sqribe.com.
Enter HotBYTEs No. 1048.

Java Spreadsheet Component

INTEGER, A REAL-TIME SPREADSHEET COMPONENT for Java, lets you integrate spreadsheet functionality into distributed client/server applications. Integer ($3000 per server, $500 per developer seat) provides real-time data feeds, JDBC support, and compatibility with legacy spreadsheets and macros. Multiple users can collaborate on a single server-based spreadsheet in real time. The spreadsheet server is made up of the engine, which you can implement as a JavaBean or Enterprise JavaBean, and a JavaBean-based user interface. Integer was designed for distributed component systems.
Contact: Athena Design, San Francisco, CA, 415-512-3870; http://www.athena.com.
Enter HotBYTEs No. 1049.

E-mail

Coordinate Your E-Commerce Efforts

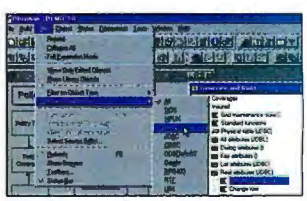
THE EXTRANET CREATOR IS A KIND OF ALL-purpose middleman for your e-commerce efforts. This enterprise software resides between your company's intranet firewall and Internet customers and business partners to control access to data, secure data sharing, manage accounts, and process data. It provides extensible data-processing

APIs, has user account management, controls accounts according to business policies, and tracks billing and order information. The package starts at $40,000, works with SSL-enabled browsers, and runs on Sun Solaris or HP-UX. The company plans to release a Windows NT version sometime this year, and future releases will support LDAP.
Contact: Differential, Cupertino, CA, 408-864-0600; info@differential.com; http://www.differential.com.
Enter HotBYTEs No. 1057.

Programming

Java for the Enterprise

SYNON HAS UPGRADED OBSYDIAN 3.0, ITS client/server application development environment, with TCP/IP

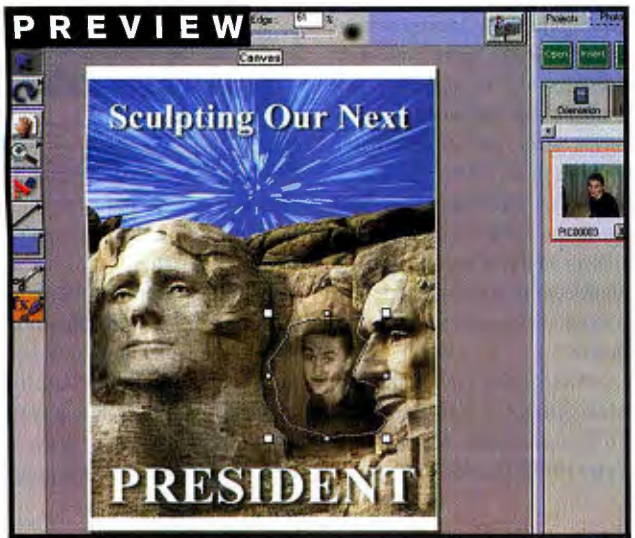


support for AS/400 systems and automatic import of database structures from ODBC databases. The company also introduced a new Java code generator for this release, called Obsydian for Java. Programmers using Obsydian for Java can automatically generate Java applications for multiplatform server environments and deploy Java applications from any platform that

is running a JVM. Obsydian 3.0 costs $23,000 with two code generators. Obsydian for Java is priced at $7800 as a stand-alone product.
Contact: Synon, Larkspur, CA, 415-461-5000; info@synon.com; http://www.synon.com.
Enter HotBYTEs No. 1059.

Java Troubleshooting

JPROBE PROFILER ($499) IDENTIFIES AND aids in the elimination of inefficient algorithms, I/O blockage, excessive method calling, excessive object and thread creation, inefficient memory usage, and other performance bottlenecks in your Java code. Its GUI displays the calling relationships between all your Java methods, letting you drill down and navigate through an individual method's source code to better understand and untangle the code.
Contact: KL Group, Toronto, Ontario, Canada, 800-663-4723 or 416-594-1026; http://www.klg.com/jprobe.
Enter HotBYTEs No. 1058.



LivePix Deluxe 2.0
$49

Enter HotBYTEs No. 1068.

LivePix
San Francisco, CA
800-727-1621
415-908-1067
fax: 415-908-1058
info@livepix.com
http://www.livepix.com

Business Gets the Picture

Photo-image editing has largely been the province of either home consumers or professional designers. But as the new LivePix Deluxe 2.0 shows, entry-level image-editing software can also satisfy the needs of business users.

Perhaps the essence of LivePix 2.0 is its collection of approximately 150 photo-based project templates. Many templates are for home and family use, but templates for stationery, Web pages, and business uses are included. LivePix templates are photo-based, so substituting your own photos into a template is easy, probably the easiest of any similar applications I've used. Infinite redo and undo make experimenting fairly painless.

A full range of photo-retouching tools are standard, along with a useful clone tool that lets you duplicate any object in a photo. There are nifty plug-in effects from XaosTools and connections to on-line photo services (e.g., Kodak Picture Network and Pictra Net). LivePix is also notable for its overall power and performance. Based on FlashPix technology, the program does an especially good job at making rapid edits to high-resolution images.

Perhaps the best news for the business user is the expected release of additional photo-based business templates for LivePix this year. At $49, LivePix is worth investigating. It provides an easy way to add photos to documents and other projects. **–Jon Pepper**

E-mail

Organize Your Inbox

IF YOUR E-MAIL INBOX IS A MESS OF UNUSED messages, Sharkmail 4.02 ($29) might be of help. You can set it to automatically update folders as you receive new mail or move and delete messages, keeping track of messages that are based on subject, sender, and/or content. It is MAPI-1- and SMTP/POP-compliant, and can access proprietary formats, including Microsoft Exchange and cc:Mail.
Contact: LANshark Systems, Columbus, OH, 614-751-1111; http://www.lanshark.com.
Enter HotBYTEs No. 1061.

The Web

Ramp Onto the Internet

RAMP NETWORKS' IP TUNNELING KIT ($249) makes VPN technology available at a price that small businesses can afford. For use with Ramp's WebRampM3 integrated router/hub devices, the IP kit supports Microsoft's Point-to-Point Tunneling Protocol, currently available for Windows-based PCs. The software and hardware combination lets you establish a secure VPN using analog phone lines and without having to invest in ISDN or frame relay.
Contact: Ramp Networks, Santa Clara, CA, 408-988-5353; http://www.rampnet.com.
Enter HotBYTEs No. 1052.

Put Your Intranet on a Hand-Held PC

WITH AVANTGO'S WEB CLIENT AND DESKtop programs, you can put your intranet in your pocket. The programs consolidate, compress, transfer, and render Web content onto PalmPilot and Windows CE handheld PCs. Graphics are automatically converted to gray-scale images, and Web pages are scaled to fit the smaller screens. The Desktop program lets you manage synchronization and Web replication, and the bundle costs $99 per seat.
Contact: AvantGo, San Mateo, CA, 650-638-3399; http://www.avantgo.com.
Enter HotBYTEs No. 1053.

Easier Web Surveys On-Line

VIRTUAL ARCHITECHS' SURVEYBUILDER .com is an automated, self-service system that lets you create and conduct customized e-mail and Web surveys. It eliminates the need for you to buy, program, and maintain survey software, as all operations, from survey creation to reporting, are done on the SurveyBuilder Web site. You manage the survey creation-and-analysis process yourself using a Web browser. Prices vary by sample size, but they start at $1500 for 100 respondents.
Contact: Virtual Architechs, Sausalito, CA, 800-809-9764 or 415-332-0992; info@vtechs.com; http://www.surveybuilder.com.
Enter HotBYTEs No. 1054.

Get on the Web for Less

QUICKSITE 3.0 DROPS THE PRICE BARRIER to getting on the Web. For $49, you get a WYSIWYG layout editor, templates, an HTML editor, and style wizards, as well as CSS, Java, and ActiveX support. It automatically builds product catalogs and order forms for running an on-line business, and has a built-in database engine to simplify updating your site.
Contact: Site Technologies,

Scotts Valley, CA, 408-461-3017; http://www.sitetech.com.
Enter HotBYTEs No. 1056.

Input

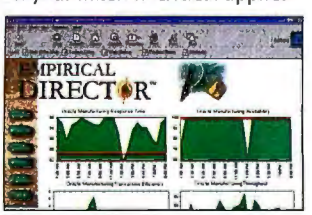
Your PDA Is a Notepad

WITH THE VIRTUAL NOTEPAD ($20), YOU can take notes or make sketches in your own handwriting. It works with a number of PDAs, including 3Com's PalmPilot, and a software viewer plug-in for Web browsers is available to download files to a desktop system.
Contact: NewCo Partners, Philadelphia, PA, 215-625-3950; newco@newcopartners.com; http://members.aol.com/newcoptnrs/index.html.
Enter HotBYTEs No. 1060.

Business

Report Card for Your Applications

EMPIRICAL SOFTWARE'S DIRECTOR 2.0 gives you a leg up for planning, measuring, and improving service on your mission-critical applica-



tions. You set and define service requirements, and the software notifies you of violations while providing a graphical representation of how an application is performing. The program includes new rules for relational database applications, analyzes I/O distribution, identifies and corrects poorly written SQL statements, and has a Web interface for remotely correcting any problems discovered.
Contact: Empirical Software, Richmond, VA, 804-794-0354; http://www.empiricalsoft.com.
Enter HotBYTEs No. 1050.

Keep Tabs on Your Data

MAGNIFI'S ENTERPRISE SERVER 2.0 SIMPLIfies keeping track of multimedia data on distributed platforms by locating and indexing information, including audio-video, text, and

images. Accessed through a Web browser, it presents any files it indexes, including HTML, GIF, JPEG, MIDI, and a number of video, animation, and 3-D file types, in a graphical format that tells you the file size and format, and gives you sample text, an image, or a video snippet. You can enter queries to search the samples it has extracted. Magnifi promises future versions that can index Oracle databases and Lotus Notes shared data. It will publish APIs so users can support proprietary formats. Pricing starts at $20,000 per server CPU.
Contact: Magnifi, Cupertino, CA, 408-863-3800; http://www.magnifi.com.
Enter HotBYTEs No. 1051.

Utilities

Learn to Share

ANNOYED WITH OTHERS MESSING UP YOUR computer? WinShield 2.1 ($69) can help anyone who shares a system with others, including computer lab administrators and MIS directors, to control desktop clutter and reduce the cost of computer maintenance. It prevents accidental and deliberate damage to your Windows NT/95 configuration and lets administrators configure options on all other networked computers.
Contact: Citadel Technology, Dallas, TX, 214-520-9292; http://www.citadel.com.
Enter HotBYTEs No. 1062.

Software Updates

Microsoft Office 97 Small Business Edition ($499) includes Word 97, Excel 97, Publisher 98, Outlook 98, financial-analysis tools, and the Expedia Streets 98 business and mapping program. The Outlook 98 e-mail/calendar/contact client lets you view all your appointments, tasks, e-mail, and Web alerts from a single Outlook Today view. You can drag and drop an e-mail message onto other Outlook modules to create a new task, contact, or calendar entry without typing. Publisher 98 adds numerous features for business and personal desktop publishing. The program now shares Word's look and feel. New color schemes help you add coordinated colors consistently to your publication, and an auto-convert lets you repurpose information. For example, you can design a brochure and convert it into HTML format for the Web. And Expedia Streets 98 now includes new restaurant listings, links to the Expedia hotel database, and enhanced maps.
Contact: Microsoft, Redmond, WA, 425-882-8080; info@microsoft.com; http://www.microsoft.com/office/info.
Enter HotBYTEs No. 1064.

Kane Security Analyst security suite has been upgraded with a new release for Novell NetWare and an enhanced version for Windows NT. The product for NT has the ability to cross trusted NT domains and supports the 32-bit Crystal Reports reporting-and-analysis software. Kane Security Analyst for NetWare includes customizable reports and has enhanced password-cracking capabilities, including more words and complete files from the password cracker's dictionary. Both releases start at $695 per server.
Contact: Intrusion Detection, New York, NY, 212-348-8900; info@intrusion.com; http://www.intrusion.com.
Enter HotBYTEs No. 1065.

Seagate's unified NT/Unix console for NerveCenter 3.0 ($2195 for a single-server license) correlates SNMP events, helping network administrators identify points of failure, and monitors network traffic, performance, security, and error conditions. Automated features include the ability to execute NT or Unix commands, execute Perl subroutines, page personnel, and generate an SNMP command across both platforms. This release has a fully distributed architecture, integrates Seagate's Crystal Reports analysis software, supports HP OpenView NNM 5.0 and IT/O 4, and has expanded action-routing capabilities.
Contact: Seagate Software, Heathrow, FL, 800-327-2232 or 407-531-7500; sales@img.seagatesoftware.com; http://www.seagatesoftware.com.
Enter HotBYTEs No. 1066.

VTune 3.0 ($279), from Intel, is not just a software optimization tool for Java, C, C++, Visual Basic, and FORTRAN. It has also been updated with more features to help programmers write better code. The ASM coach not only points out bottlenecks but offers suggestions on how to rewrite code and has been updated to include advice for C++. Intel claims it takes 30 seconds for the program to point out "performance hot spots," and it now watches for problematic events in the OS and processor when analyzing code.
Contact: Intel, Santa Clara, CA, 408-765-8080; http://www.intel.com.
Enter HotBYTEs No. 1067.

improbable

Advances and Retreats in Computing

Technology that might not exist, but probably should.

The Click of Doom

The remote-control TV clicker gives us control of many things, yet it still cannot filter out televised fluff. That's about to change, however.

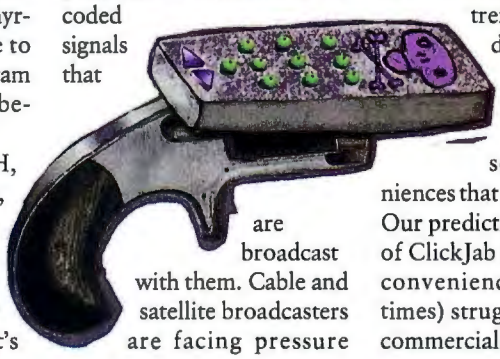
We're not talking V-chip here. We're not talking about the blunderbuss snuffing of entire channels. We're talking pinpoint personal control.

ClickJab (tm) is a simple, universal remote control that has one unique feature. Press its Delete key, and ClickJab will delete the program you're watching. That show will vanish from your TV viewing experience forever.

You don't like *Touched by an Angel*, for example? Next time you see it, press the Delete key. It will vanish from your screen, and whenever episodes of *Touched by an Angel* are broadcast, the channel is removed from the myriad of channels available to you. As soon as that program ends, its channel again becomes available.

Gefingerpoken GmbH, of Mannheim, Germany, manufactures ClickJab. It retails for $59.95 in the U.S. Those of us who have already used it would pay twice the price, or more. It's a very satisfying product.

It's also a product that's stirring up commercial resistance. ClickJab recognizes programs by deciphering the coded signals that are broadcast with them. Cable and satellite broadcasters are facing pressure from advertisers to modify these codes and defeat the ClickJab technology.



Take heart, though. Unless someone comes up with an extremely clever idea, disabling ClickJab would also disable most of the other channel-selection conveniences that consumers want. Our prediction on the future of ClickJab is: Score one for convenience in the (sometimes) struggle against crass commercialism.

Chance Gardener

Most of us love trees and flowers, yet few are the people who can name more than three of the species growing in their own backyards, if they have backyards. Yes, there are guidebooks, but this is 1998, and no one should have to read a book.

A device called the Chance Gardener (tm)–from Chance Devices, in Oakland, California–can identify any species of plant life. The Chance Gardener uses a small PCR (polymerase chain reaction) probe to sample, amplify, and pre-analyze the DNA from even a small piece of vegetable matter. A Pentium II (tm) chip–driven hand-held computer finishes the analysis and identifies the species by name in English, Latin, and 174 other languages. At $299, the device is pricey, but look for the cost to drop dramatically over the next year–along with that of other consumer-oriented botanical equipment.

Pet Project

Thanks to yet another new device from Chance Devices, there will no longer be any confusion about pets. The Chance Housepet Analyzer (tm) is a close cousin to the Chance Gardener (tm). The Housepet Analyzer can identify any dog, cat, hamster, Vietnamese potbellied pig, garter snake, guppy, emu, or other animal that you have as a pet. It can even identify mutts, thanks to a clever use of fuzzy logic.

The only drawback, aside from its extravagant price tag of $299, is that the Housepet Analyzer's sampling probe destroys approximately 5 percent of the samples presented to it. If the product's price drops low enough, however, this might prove to be a glitch that's worth overlooking.

Marc Abrahams is the editor of the Annals of Improbable Research. *You can contact him by sending e-mail to* marca@improb.com.

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- • Modular Bay accepts 24X Max^AA Variable CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery
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- • Zoom Video and USB Ports
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- ★ 6.9 Pounds*/Touchpad
- • Extendable 1-Year Limited Warranty†
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- ★ *56K Capable** x2 Modem, add $149.*
- ★ *2nd Smart Lithium Ion Battery, add $169.*

$2999

Business Lease^◊: $114/Mo., 36 Mos.
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INTRODUCING THE *NEW* DELL INSPIRON 3200 NOTEBOOK FEATURING THE MOBILE PENTIUM II PROCESSOR.

Shift into fifth gear with the latest mobile Pentium® II processor. It moves at top speed to better handle all your company's productivity needs. And because it's from Dell it's maxed-out on great new technology, not on price. Not only will you get the fastest mobile Pentium® II processor available, 266MHz, you will also get SDRAM, the fastest mainstream memory technology. To top that off, the Ultra ATA hard drive transfers data at twice the speed in burst mode of a normal ATA hard drive. And, if that doesn't blow you away, then maybe the 13.3" XGA active matrix display and 3D surround sound will. The new Dell® Inspiron™ 3200 notebook with a mobile Pentium II processor allows you to up the ante and hold on to your wallet. To take advantage give us a call or stop by our website. Feel free to loosen your grip now.

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Common features listed above plus:
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- ACS-295 Speakers with Subwoofer
- Iomega Zip 100MB Internal Drive

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- 8.4GB Ultra ATA Hard Drive (9.5ms)
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- 2X DVD-ROM Drive and Decoder Card
- *NEW* Turtle Beach Montego A3D 64 Voice PCI Sound Card
- Altec Lansing ACS-90 Speakers

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- 6.4GB Ultra ATA Hard Drive (9.5ms)
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- STB nVidia 4MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- Integrated Yamaha Wavetable Sound
- Altec Lansing ACS-90 Speakers
- Iomega Zip 100MB Internal Drive
- 3Com® 3C905 Fast EtherLink™ XL 10/100 PCI Card

$2199

Business Lease◊: $83/Mo., 36 Mos.
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DELL DIMENSION XPS D233
233MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 32MB SDRAM Memory
- 6.4GB Ultra ATA Hard Drive (9.5ms)
- 1000LS 17" (15.9" v.i.s.) Monitor
- STB nVidia 4MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive

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★ *Upgrade to an 8.4GB Ultra ATA Hard Drive, add $49.*

★ *3Com 3C905 Fast EtherLink XL 10/100 PCI Card, add $79.*

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DELL DIMENSION XPS D333
333MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 128MB SDRAM Memory
- *NEW* 16.8GB Ultra ATA Hard Drive (9.5ms)
- 1200HS 19" (17.9" v.i.s., .26dp) Monitor
- STB nVidia 4MB 3D AGP Video Card
- 2X DVD-ROM Drive and Decoder Card
- *NEW* Turtle Beach Montego A3D 64 Voice PCI Sound Card
- Altec ACS-495 Full Dolby Surround Sound Speakers with Subwoofer
- Iomega Zip 100MB Internal Drive
- Dell Comfort Key Keyboard

$3479

Personal Lease◊: $168/Mo., 24 Mos.ª
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DELL DIMENSION XPS D333
333MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 128MB SDRAM Memory
- 8.4GB Ultra ATA Hard Drive (9.5ms)
- 1200HS 19" (17.9" v.i.s., .26dp) Monitor
- *NEW* Diamond Permedia 2 8MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- *NEW* Turtle Beach Montego A3D 64 Voice PCI Sound Card
- Altec ACS-495 Full Dolby Surround Sound Speakers with Subwoofer
- Dell QuietKey Keyboard

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Personal Lease◊: $140/Mo., 24 Mos.
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DELL DIMENSION XPS D300
300MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 64MB SDRAM Memory
- 6.4GB Ultra ATA Hard Drive (9.5ms)
- 1000TX 17" (15.9" v.i.s., .26dp) Trinitron Monitor
- *NEW* Diamond Permedia 2 8MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- Integrated Yamaha Wavetable Sound
- Altec Lansing ACS-295 Speakers with Subwoofer
- Iomega Zip 100MB Internal Drive
- Dell QuietKey Keyboard

$2399

Personal Lease◊: $117/Mo. 24 Mos.
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DELL DIMENSION XPS D233
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FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 32MB SDRAM Memory
- 4.3GB Ultra ATA Hard Drive (9.5ms)
- 1000LS 17" (15.9" v.i.s.) Monitor
- STB nVidia 4MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- Integrated Yamaha Wavetable Sound
- Altec Lansing ACS-90 Speakers
- Dell Comfort Key Keyboard

★ *Upgrade to 64MB SDRAM, add $99.*

★ *Upgrade to Altec Lansing ACS-295 Speakers with Subwoofer, add $59.*

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Reference the appropriate order code t

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- 6 Expansion Slots: 3 PCI/3 EISA
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Common features listed above plus:

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- 144MB SDRAM Memory
- 4GB Ultra ATA Hard Drive
- 128-bit Graphics Accelerator with 65K Colors at 1024x768
- 56K Capable™ K-Flex Modem
- Leather Carrying Case
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Common features listed above plus:

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- 64MB SDRAM Memory
- 4GB Ultra ATA Hard Drive
- 128-bit Graphics Accelerator with 65K Colors at 1024x768
- 56K Capable™ K-Flex Modem
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- 32MB SDRAM Memory
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- 56K Capable™ K-Flex Modem
- Leather Carrying Case
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WITH MMX TECHNOLOGY

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- 3.2GB Ultra ATA Hard Drive
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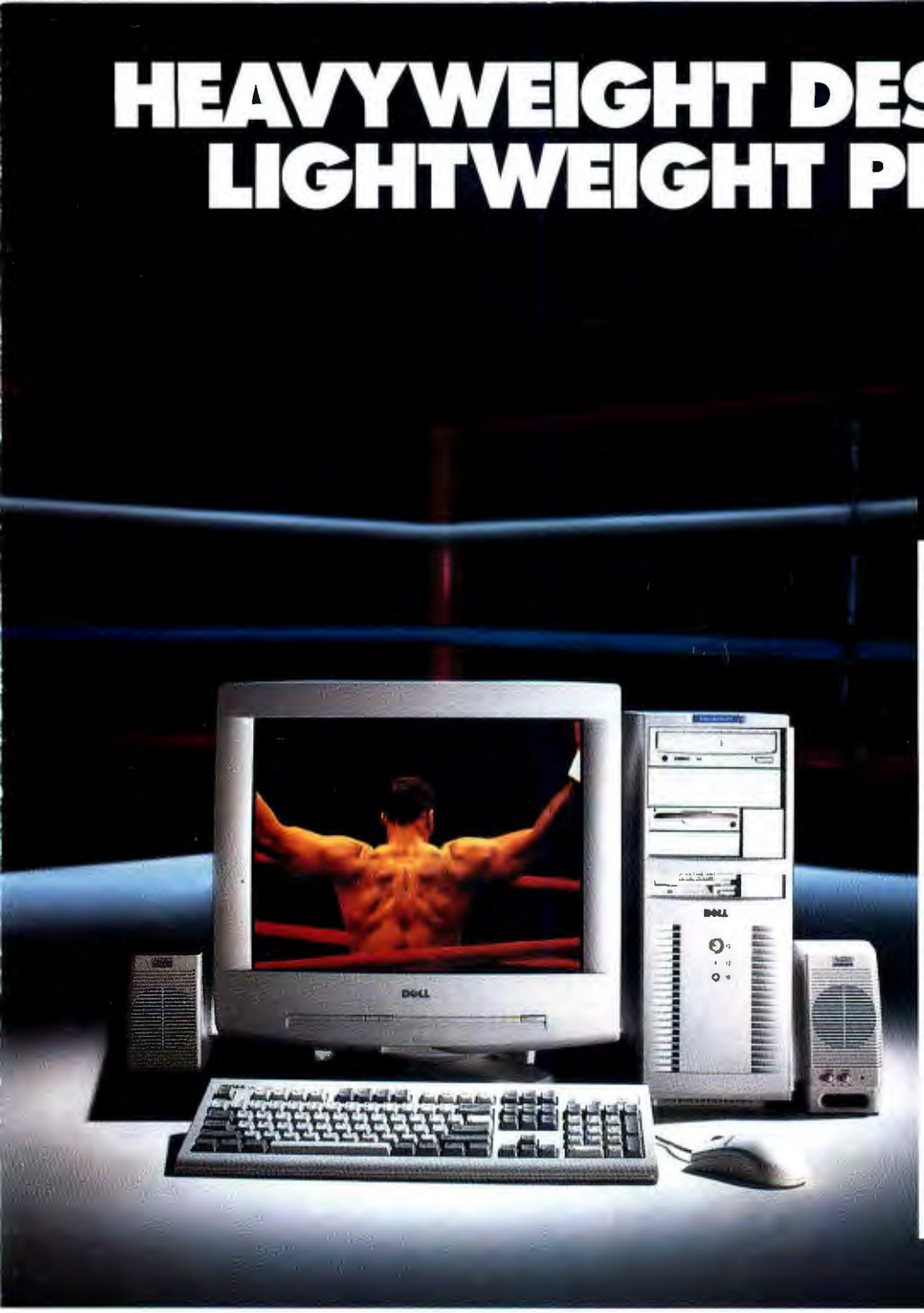

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