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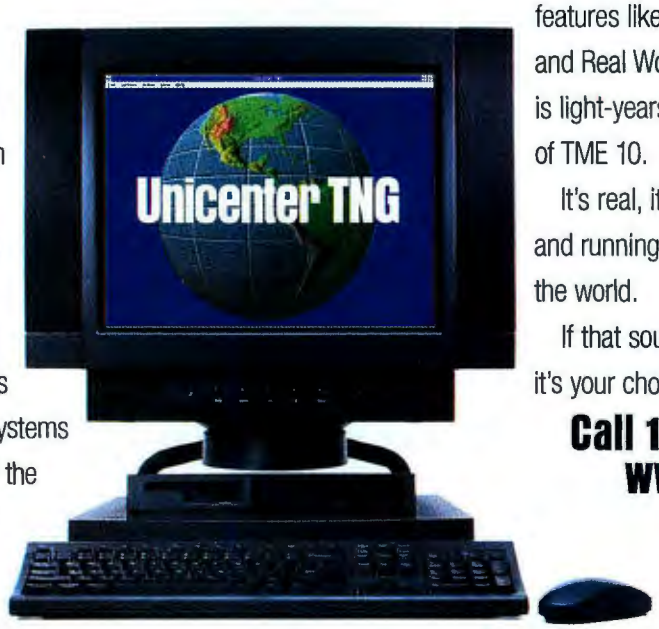

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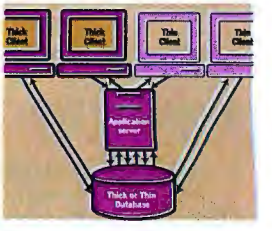

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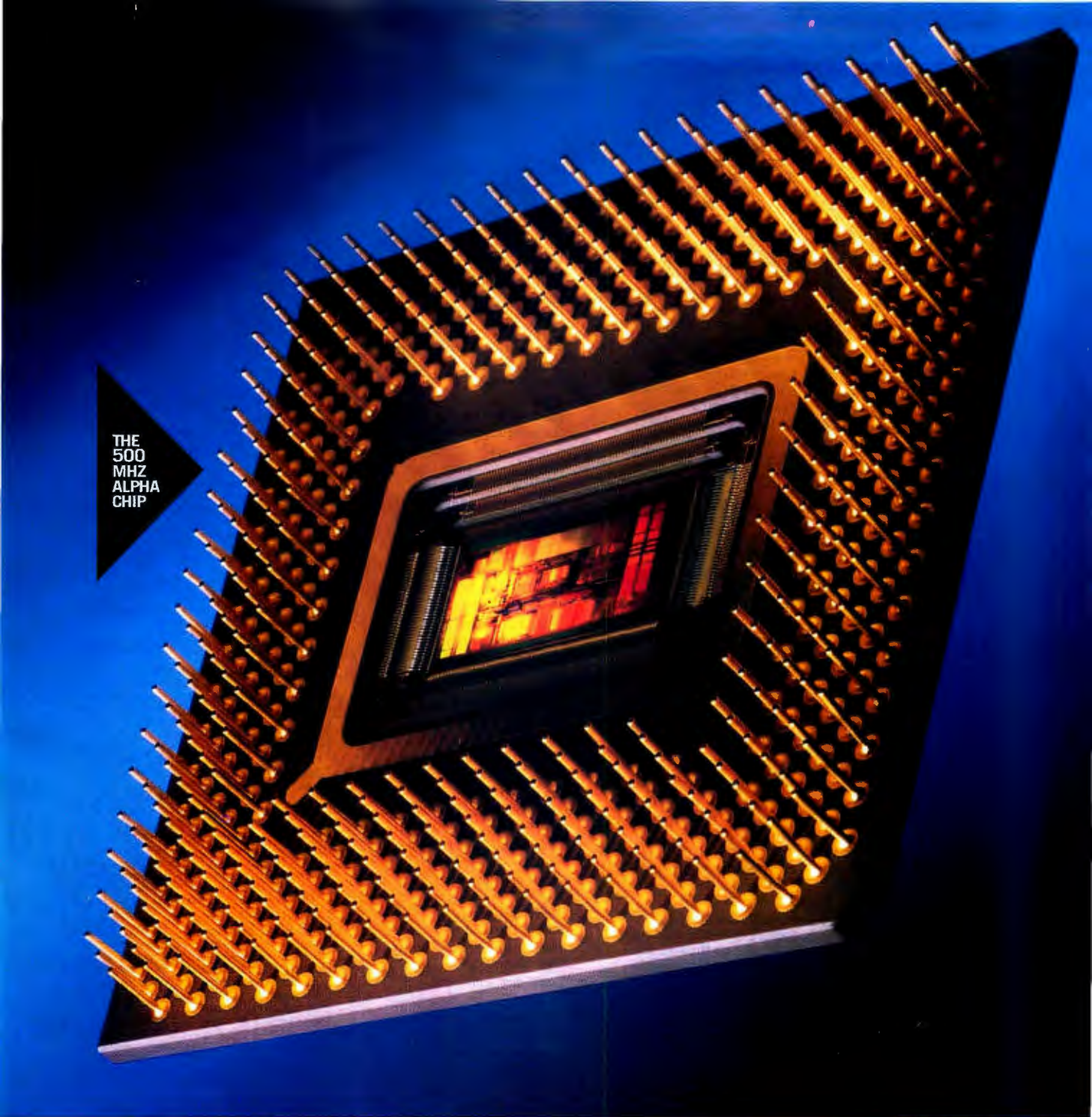

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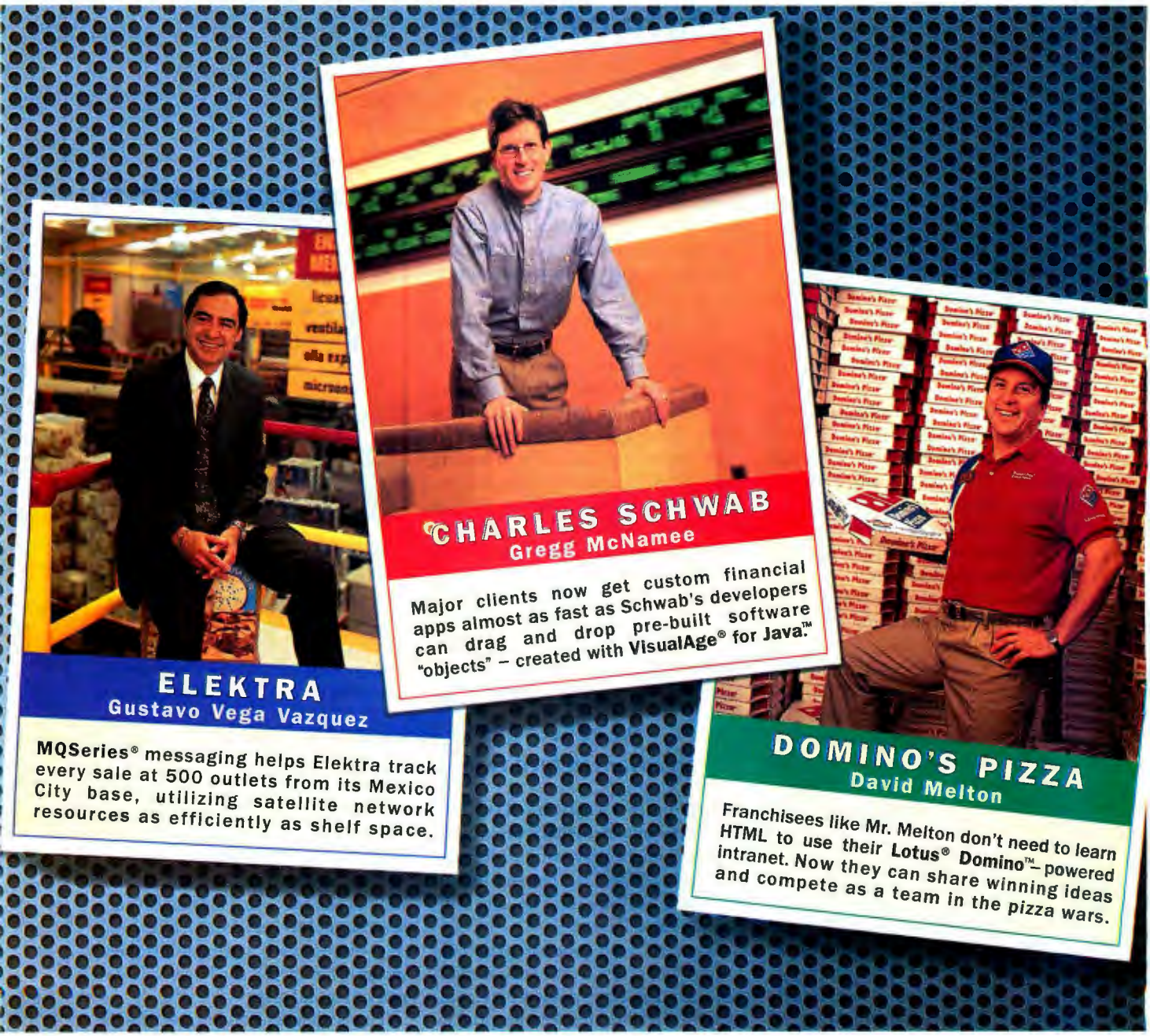

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editorial

State of BYTE

Here's how we plan to bring you the future of information technology today.

Readers have requested something like a State of BYTE column from me. The timing seems right, following on the heels of President Clinton's State of the Union address.

Some of our international readers may need a little explanation. If BYTE were run by the president, present or past, he'd promise subscribers that magazine prices would go down, advertisers that we'd write about their products only, the editorial staff that hours would be shorter and parties more frequent, and corporate bosses that expenses would decrease.

How many lies can I pack into 650 words? On second thought, maybe I should concentrate on the real business of BYTE, bringing you the future of information technology today.

This last year has seen a gradual increase in the readership of BYTE, as well as continued high renewals from subscribers. Apparently, most of you are finding the magazine more interesting and useful. This has not led us to complacency, however; we have aggressive plans to improve BYTE.

Chief among them is a reinvigoration of BYTE's test lab. In the recent past, we've had modest facilities buttressed by partnerships with other labs. Since moving our headquarters from Peterborough, New Hampshire, to Lexington, Massachusetts, a year ago, we've been quietly preparing the BYTE Lab, an advanced testing facility.

First and foremost, we want to give you more sophisticated and in-depth product testing. Other publications do a good job testing a few aspects of a large number of products. We aim to go deeper into a more manageable group of products, including important product categories that are not widely tested. We'll test different kinds of servers, DBMSes, and some of the other complex technologies at the heart of modern networked systems with the thoroughness and platform independence you expect from us.

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As part of our dedication to finding answers to hard questions about computer technology, we'll be using our Lab as an investigative arm. In the past year, we've discovered interesting flaws in the major compilers and (since fixed) incompatibilities between Windows NT 4.0 and certain microprocessors.

As the leaders of this effort, reviews director David Essex and technical manager Al Gallant have been hard at work putting together a networked environment that simulates what a progressive company might have: multiprocessing servers, 100-Mbps Ethernet, and a mix of NT, Unix, NetWare, Mac OS, and Windows 95 capabilities.

We've been quietly preparing the BYTE Lab, an advanced facility for the kinds of testing you need.

As readers, you can be part of the Lab. On our Web site, you can read our editorial calendar at http://www.byte.com/admin/edit98.htm and see what product categories future Lab Reports will cover. Longtime readers are familiar with our willingness to publish source code and methodologies for tests, so that you can use them in your environment.

This also gives you a chance to critique our methods and suggest improvements. Our Web site now has a lively conference section (found at http://www.byte.com/discuss/discuss.htm), where readers and BYTE editors can carry on long before and after an article has been published.

Last year, we added a special magazine section aimed at North American subscribers who are resellers. I'm pleased to announce that we will again be adding to BYTE with a section called "E-business Technology," beginning in June. This magazine within a magazine—available to BYTE readers around the world—will look at the specific issues involved in leveraging Internet and Web technology—issues such as global intranets, secure e-commerce, and large-scale Web marketing and sales.

That's what I can tell you about for the moment.

Now, about that land deal....

Mark Schlack

Mark Schlack, Editor in Chief
mschlack@bix.com

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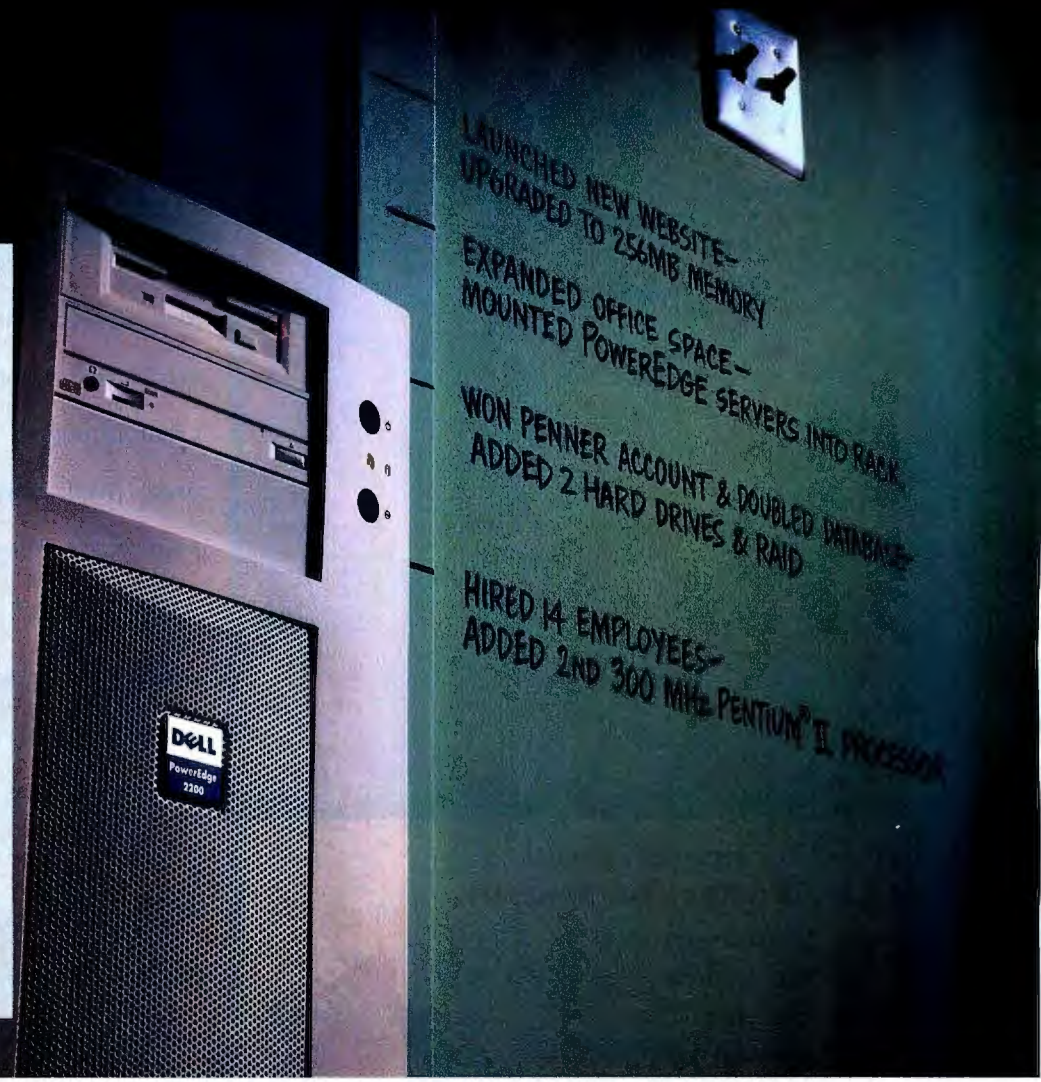

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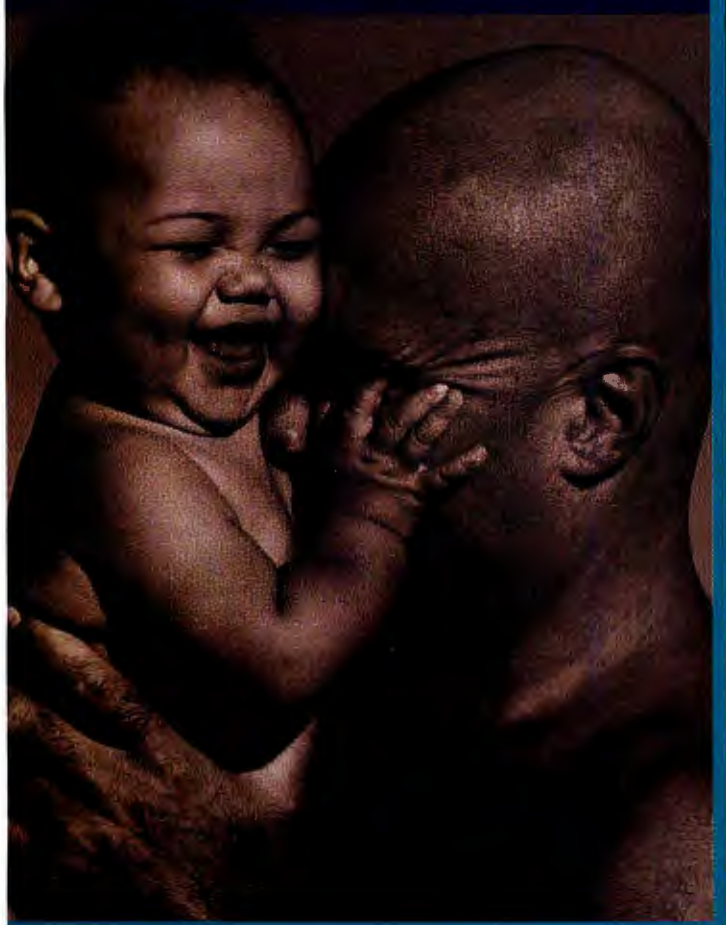

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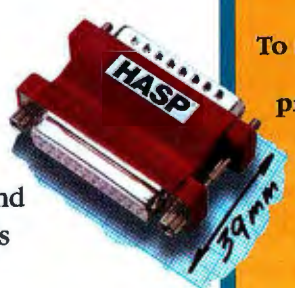

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inbox

Pssst, Wanna Buy a PC?

Thanks for "Disposable PCs" (February), your timely article on the segmentation of the PC market. Can we expect a report on sub-$1000 PCs soon? I'm quite interested in seeing how Cyrix MediaGX systems score on the benchmarks that BYTE uses, plus how well Java performs on the MediaGX compared to a Pentium of the same speed.

Kristopher Bixler
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The first available sub-$1000 systems are aimed at home- and small-office users. Next month, we'll look at this fast-growing segment of the PC market, as we evaluate Cyrix MediaGX- and AMD K6-based systems from IBM, Compaq, and others. We'll tell you how much you get for the money, and whether companies really can expect to reduce IS costs when the corporate cousins of these systems appear in the months ahead.—Eds.

The Road to XML

Jon Udell's "Extensible Markup Language" (Tech Outlook '98, January, page 80) was very timely. I hope that the attention it provokes will also move the focus onto some critical "noncomputing" information management questions, sadly ignored by a large part of the computing fraternity in recent years. Most Web-design strategies seem to have broken the link between the public site and the back-office document, and data repositories and work flows. XML, and a more thorough understanding of the role played by Standard Generalized Markup Language (SGML), will, I hope, help us in the fight against organizational laziness and application bloat.

I'm convinced that 95 percent of full-text search engines' work load would disappear if a bit more—OK, a lot more—thought were given to document and data structure and entities.

One point I did miss in the article was any reference to Unicode, which together with XML and HTML 4.0 will truly contribute to making the Web worldwide.

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Party of European Socialists
Parliamentary Group
Brussels, Belgium
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Two Digits Too Clever

While I agree with most of Ed DeJesus's comments in "Solving for the Year 2000" (Tech Outlook '98, January), I think it is his analysis of the cause of the problem that is too clever, and not—as he claims—the programmers who created the noncompliant code. The roots of the problem go deeper than mere attempts to save some storage. One primary cause

of the dilemma is programmers' tendency to thoughtlessly mimic manual procedures. Most of us have been writing two-digit years longer than programmers have been coding for them. Another cause is unexpected longevity. Few believed, when these "clever" programmers produced much of this code, that it would survive to execute in the next millennium. Finally, there is the software market's current tendency to value flash over fundamental accuracy and stability. I predict that the fallout from the Y2K problem will be so severe as to cause a major shift in market values. Users will flock to vendors whose code keeps on ticking, and it will be a very long time, if ever, before they will place more orders with any companies whose products fail miserably at the turn of the millennium.

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You raise some interesting points, but criticizing programmers for mimicking manual procedures doesn't seem valid. Usually, that is their mandate. I think you are right on the money when you predict that users will move to hardware and software guaranteed to be millennium-proof; it will be difficult for competitors to pry them loose again.—Ed DeJesus, senior technical editor

Spoofing Revisited

Several approaches have been suggested to ameliorate the latency issues of transmitting over nonstandard, high-latency networks such as geostationary satellites. All these approaches have their limitations and/or

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incompatibilities. The TCP spoofing suggested by John Montgomery in "Stop at Gateway, Pay Toll" (January Inbox), for instance, is incompatible with the new Secure IP (IPSEC) architecture, including the IPSEC authentication mandated by IPv6.

Additionally, TCP is an end-to-end protocol, so it would require modifications to all computers using the link, not just to the satellite gateway. A white paper on this issue is available (http://www.teledesic.com/tech/latency.html). Teledesic's approach is to conform its network to the market requirements—by offering fiber-like quality—rather than require that the market conform to the limitations of a geostationary satellite.

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Although TCP is an end-to-end protocol, systems can act as gateways between systems without necessarily modifying the clients. This is basically how proxy servers work, for example.

That said, you raise an excellent point about IPSEC, and any sites considering the use of IPSEC should note that spoofing TCP acknowledgments (ACKs) will not work in an IPSEC environment. Roy Pereira of TimeStep, a maker of IPSEC-based virtual private network (VPN) systems, puts it this way: "Let's say I have a security association from A to B and that connection is over a satellite. If A FTPs to B, the TCP FTP data will be encrypted and/or authenticated. Thus, TCP will not be the next protocol in the IP header, and the intermediate satellite system will not send any spoofed ACKs. (The intermediate system looks at the next protocol field in the IP header to see if it is TCP; if is not, then it can't spoof it.) Even if it understood IPSEC's Authentication Header (AH), its spoofed TCP ACKs would not contain AH—the intermediate satellite system does not have the keys—and thus A would reject the spoofs."

Thanks for clarifying the point, and thanks to Roy Pereira for his help with the explanation.
—John Montgomery, West Coast bureau chief

No Wrong Guess

I've followed the slow road to Merced with interest. I note, however, the comment in "Beyond Pentium II" (December Cover Story): "Compilers can't predicate every branch: Dynamic method calls... are one obvious exception.... Compilers will have to be clever about this."

This flaw has always seemed to me the Achilles' heel of very long instruction word (VLIW) processors. As we move to a run-time world of dynamic, independently compiled objects, the notion that compilers can optimize code for an unknown run-time environment seems to mandate, not cleverness, but rather paranormal powers of prediction akin to telepathy.

Even calling a DLL function exposes the flaw. How could you know whether the function will return TRUE or FALSE, and therefore optimize your branch prediction, when the code for the DLL was compiled independently? Are we back to static linking again? Still, you do say that "developers will... see their programs grow larger."

I loved *Lord of the Rings*, but I never knew Hewlett-Packard and Intel had secured Gandalf's services. When he's done with Merced, can I book him for my Y2K projects?

Andrew Mayo
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We don't know everything about IA-64 yet. Intel and HP are keeping a great deal

under wraps. However, we do know that IA-64 isn't betting as much on branch prediction as other CPUs. By executing both paths beyond a branch—both the TRUE and FALSE outcomes—it doesn't need to predict the branch. All it has to do is flip a bit in one predicate register to validate all the instructions along the correct path. There is no such thing as a wrong guess.

Of course, this doesn't apply if the compiler can't predicate the branch at compile time. Perhaps IA-64 will fall back on some dynamic optimization to cover those cases. This could even be an implementation question; some IA-64 processors may do some optimizing at run time, and some may not. Or, if the percentage of branches the compiler can't predicate is low enough, maybe it won't be significant.
—Tom Halfhill, senior editor

It's Not Lonely at the Top

Belated kudos on your mammoth "Fiber in the Sky" story in November. It was great. One minor note: The altitude for the Teledesic network in the chart "Broadband Satellites, Broadly" on page 61 reads 435 miles, which is the old altitude for the 840-satellite constellation. The altitude for the 288-satellite constellation is 850 miles (1375 kilometers).

Roger Nyhus
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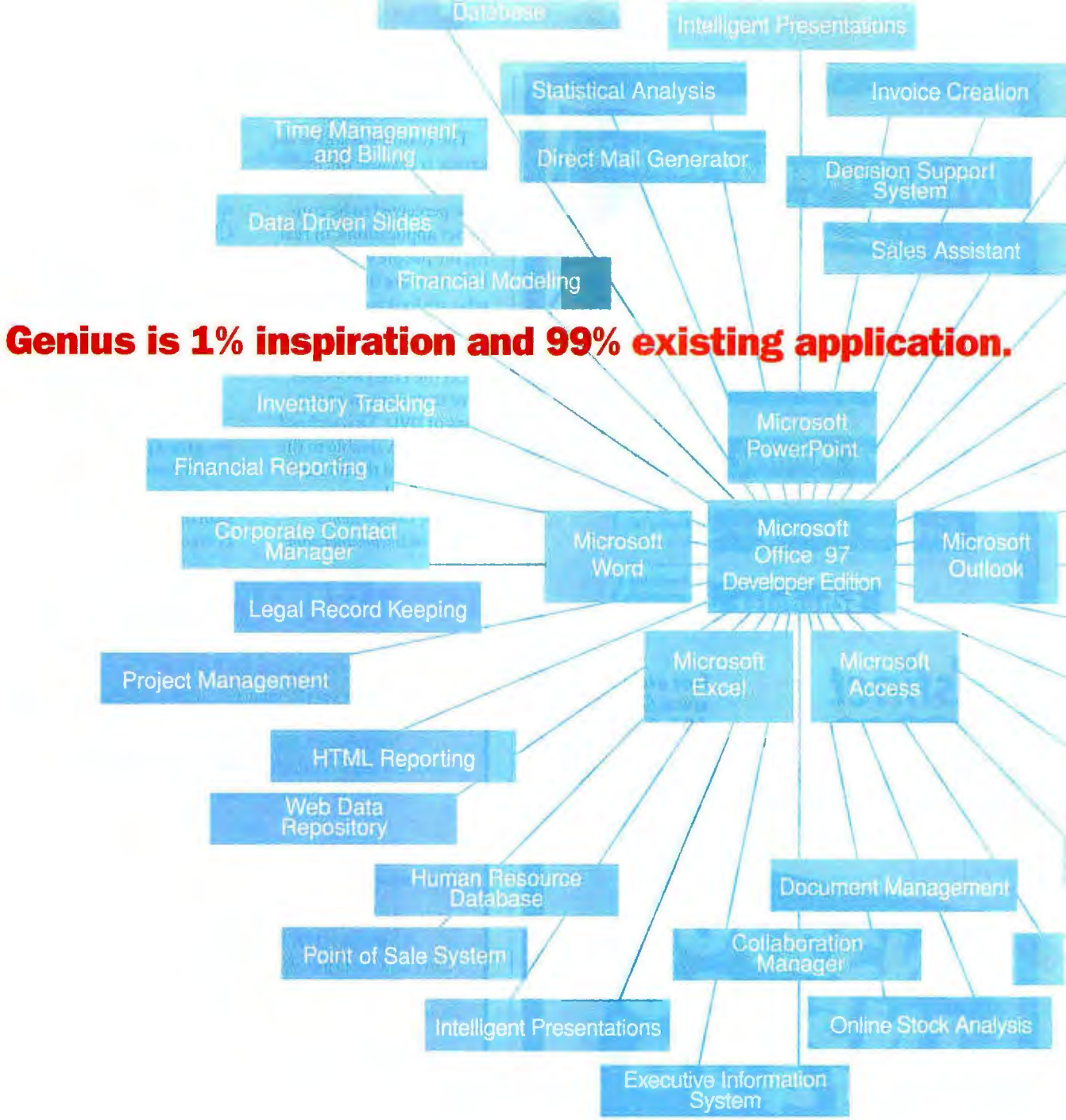
Will the Real DVD Please Stand Up?

I was a little irritated to read the cover headline "Step aside, x86" (December) in the same issue that you suggest "DVD Remains a Moving Target" (Bits). Let's get with the program and fight the proper battles. DVD is a strategic battleground for computer users, who are ceding control of this critical technology to those not of the digital faith—good old analog Hollywood.

Intel has provided us with a blueprint for the future of processing (386, 486, Pentium, etc.), and we have been very comfortable living with all the variations on the theme (SX, DX, Tillamook, Deschutes). How is it we are suddenly "confused" in the DVD world as variants customized for specific tasks proliferate?

The overwhelming point is that DVD is a lower-cost medium for data storage and transfer. Forget about how sexy the medium is for movies—compared to magneto-optical (MO), CD Recordable (CD-R), and even tape, DVD offers compelling price advantages while maintaining the ease of use of random-access media. I don't think that the PC media have grasped just how important the control of this technology is for our



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The reason it is still in the garage is because the high-volume-demand segment is now perceived to be consumer applications. In reality, the people who need DVD now are those of us who are looking for a way to reduce software and image-transfer costs.

Let the Hollywoodites have their consumer versions of DVD. This technology is more valuable to the digital side of the house.

Bob Whitcombe
President, CompuTrends
computrends@hevanet.com

Fixes

In "Enabling the Real-Time Enterprise" (January Core), we indicated that JoMei Chang and Nick Maxemchuk invented a reliable multicast protocol to solve the ACK/NACK implosion problem in the early 1990s; in fact, it was the early 1980s.

On page 158 of February's "What's New: Software," we gave a price of $495 for SPSS's AnswerTree. That was a limited offer that expired shortly after press time; the correct price is $995.

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Deschutes on the Desktop

The BYTE Lab benchmarks a fleet of 333-MHz Pentium II–based professional workstations. Should you buy now or wait to catch the 100-MHz system bus?

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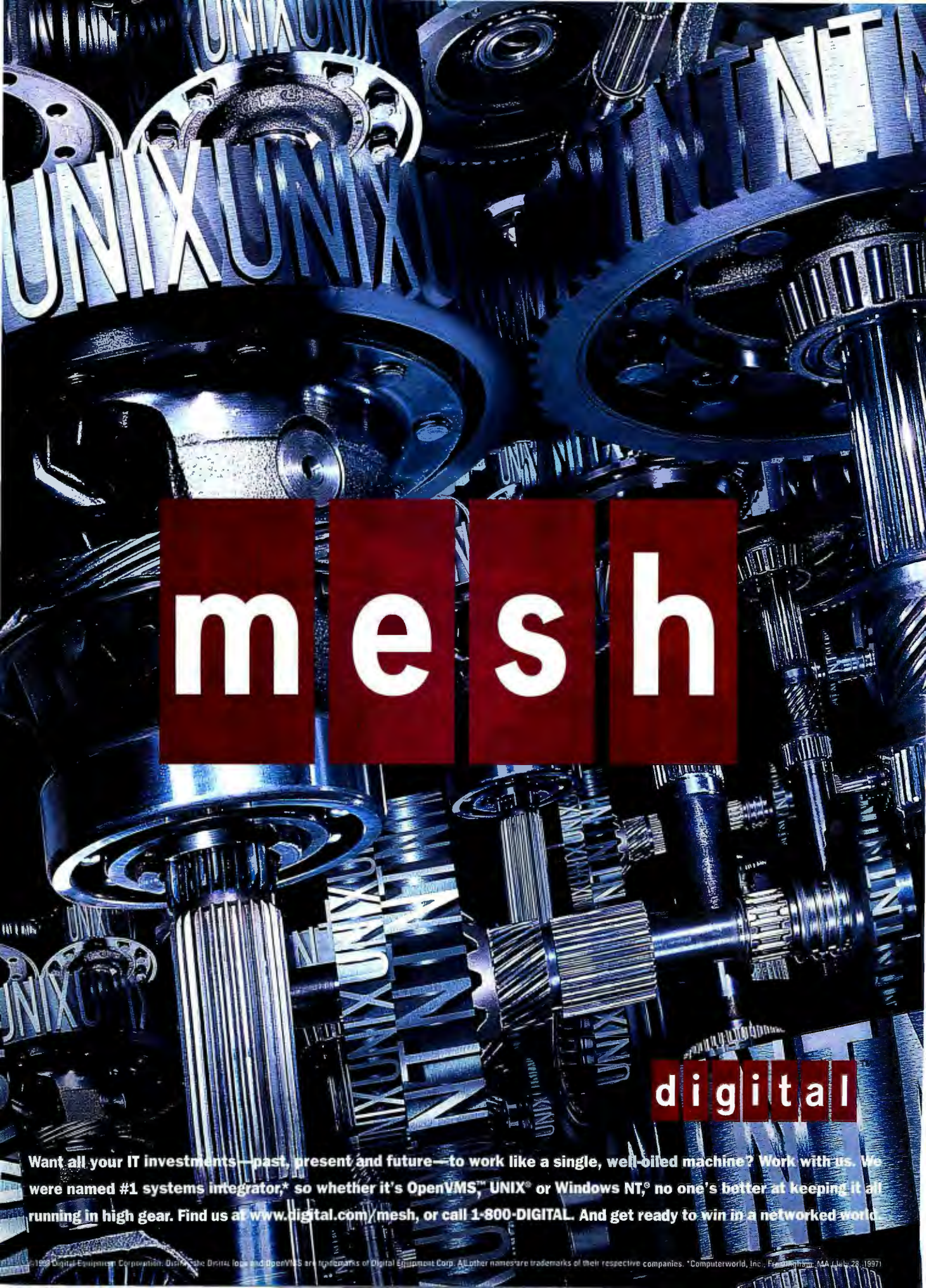
BYTE sits in on a real-world rollout and brings you the scoop on the performance advantages and the setup issues.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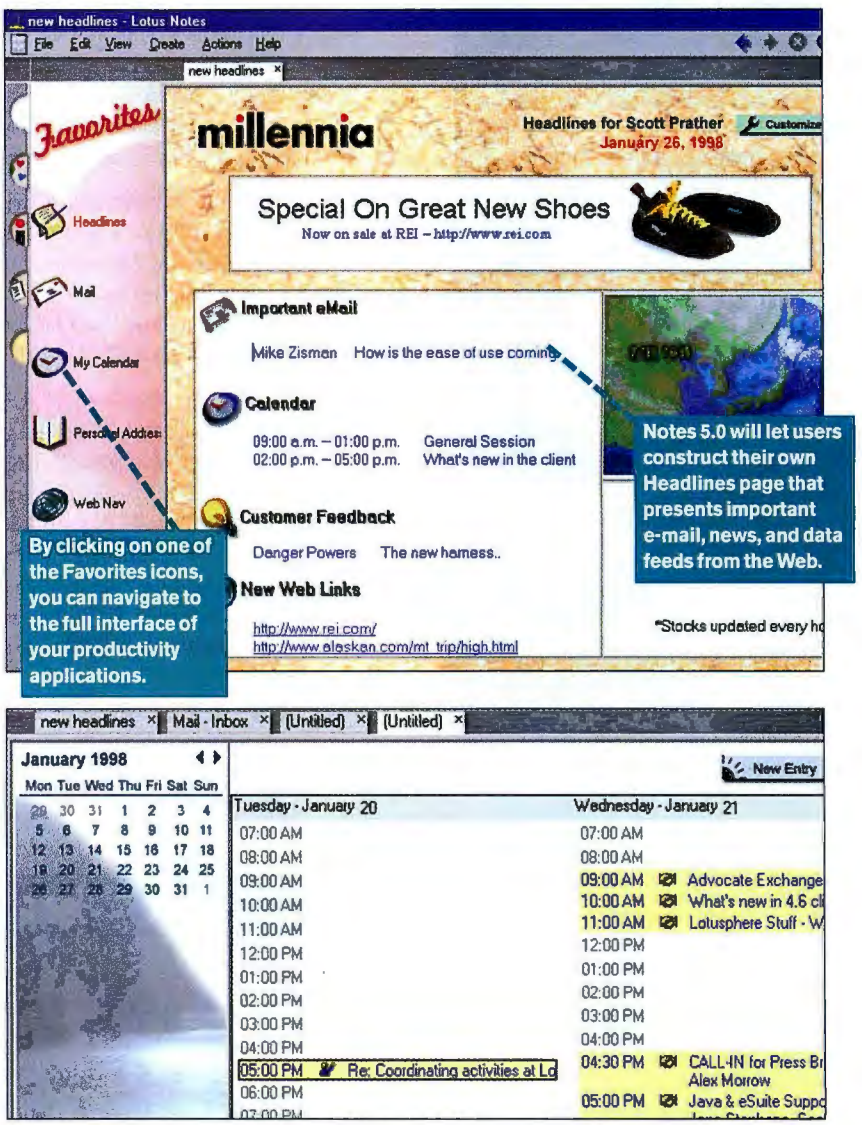
Lotus Consolidates on Notes

With new versions of Notes and Domino and other initiatives, Lotus aims to unify its groupware/messaging platform.

The battle for dominance of messaging/groupware appears to be settling into a two-company contest, with Microsoft and Lotus now holding a commanding lead in total messaging seats. With forthcoming versions of its Domino groupware/messaging server and new Notes 5.0 client interface, IBM's Lotus division hopes to gain momentum as it completes Notes' transition from a proprietary environment to one that natively supports Web standards from client to server. Lotus is also moving on several fronts to migrate its customers to the Notes 5.0 interface and Domino 5.0 server platform, which are expected to be released in the second half of 1998. The new Notes interface incorporates the functionality of Lotus Mail, cc:Mail, Notes Mail, Notes Desktop, Organizer GS, and Weblicator into an integrated, standards-based Notes R5 client. And Lotus's server platforms will consolidate around the Domino server.

To entice the large installed base of cc:Mail users, the new Notes Mail environment adopts many familiar features, such as separate address headers, English-like mail rules, deferred delivery, signature files, and a compressed lightweight names and address book with faster type-ahead addressing. At press time, sources said Lotus was considering an offer of free Notes client upgrades to customers with cc:Mail maintenance contracts. Lotus has demonstrated a technology code-named R6D that lets cc:Mail 6.x clients connect to Domino 4.x and 5.0 servers. Lotus's SoftSwitch messaging unit will now focus on products that migrate host-based mail environments to Domino.

The new client interface takes advantage of HTML 4.0 support. You can import Web pages, animated GIFs, and Java applets, and then render them directly in Notes without conversion. Back, forward, search, and other operations that browser users are familiar with let you navigate among mail, tasks, newsgroups, Web sites, and calendar items. Tabs along the top of the screen let you switch be-



Top screen: Lotus's new Notes 5.0 consolidates multiple messaging programs in one interface.

Bottom screen: The Notes Calendar is built with ActiveX, JavaBean applets, and HTML style attributes.

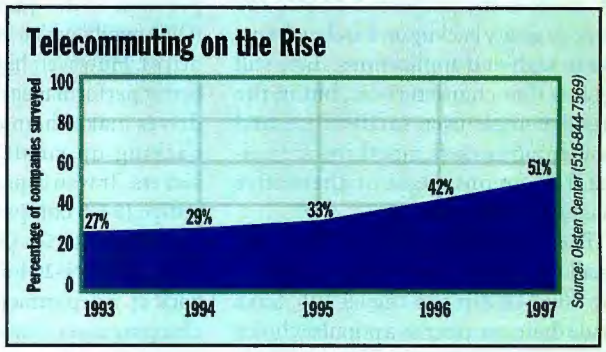
Geek Mystique

Business Acceptance of Telecommuting Increases

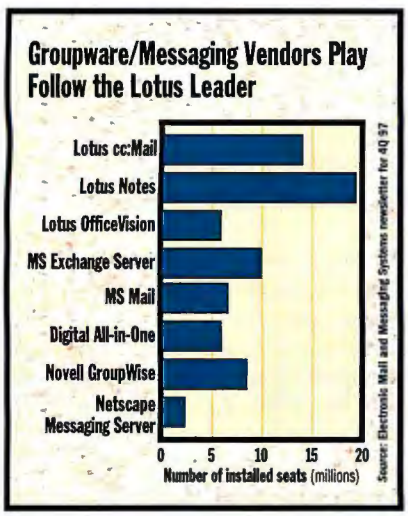
Workers in the U.S. are increasingly using their modems, instead of their cars, to get to work. Fifty-one percent of North American companies say they now permit employees to telecommute through ongoing or pilot programs, according to a survey of nearly 300 executives. That latest figure represents an increase of nine percent compared to 1996.

The survey, conducted by the William Olsten Center for Workforce Strategies late last year, indicates that many companies (about one-third of those surveyed) use their telecommuting programs as a tool to recruit employees. Nearly three-quarters (74 percent) say they expect their company's use of telecommuting to increase.

Implementing a telecommuting program requires planning. Companies must consider a wide range of managerial and technical issues ranging from employee accountability to off-site ergonomics to security, yet such programs can be advantageous to the company.



Benefits of telecommuting cited by respondents include improved productivity (45 percent), economics (35 percent), traffic patterns (11 percent), and environmental issues (6 percent).



tween multiple screens, or you can bring up additional top-level windows. Gone is the Notes workspace; the Portfolio interface that was introduced in Release 4.6 has been enhanced to support drag-and-drop organization in multilayered folders.

The Notes Designer development client retains familiar Notes constructs, adding Web-friendly elements such as synopses, outlines, pages, recursive tables, and a frameset editor. The client's Calendar interface is built with a combination of ActiveX controls, JavaBean applets, and HTML 4.0 style attributes. Notes developers can now author one application for display in Notes clients as well as in browsers.

Lotus is limiting the native OS implementations of its Notes 5.0 client to 32-bit Windows and PowerPC Macs. That leaves OS/2 and Unix users with what Lotus president and CEO Jeff Papows calls "the ultimate browser experience." By that, Lotus means it intends to provide a Web client whose applications will be similar, feature for feature, to those of the native clients. Lotus plans to accomplish that via JavaBeans that emulate the Notes design elements, including views, navigators, and rich-text editing.

The Domino 5.0 server remains a cross-platform solution, with versions for AIX, NT, Unix, S/390, OS/2, and most recently, AS/400. Release 5.0 will add support for Secure Multipurpose Mail Extension (S/MIME), Lightweight Directory Access Protocol (LDAP) V3 with authenticated read/write, clustering for Web browsers and POP3 clients, on-line indexing and in-place database compaction, and a renovated Administration user interface that will let you perform global tasks such as modifying access control lists for multiple databases. The Domino server on NT will run as an Internet Services API (ISAPI) application that can run in tandem with Microsoft's Internet Information Server (IIS). At press time, Domino's Microsoft Back Office certification was pending.

Microsoft has released Exchange Server 5.5 and in March was readying release of Outlook 98. That combination will offer server programmability and user-friendly features that begin to rival Domino/Notes. And with Microsoft offering Outlook upgrades for free to Office 97 owners, and bundling IIS with NT, Lotus will face strong competition.

According to Papows, Notes captured 10.5 million new seats in 1997. And as it continues to improve Notes, Lotus is also developing for newer platforms, such as Java. The company's eSuite Workplace, and accompanying DevPack toolkit for building networked applications, will let developers roll out work-flow applications that run inside or outside the Notes client. "We've done a lot of work to make certain that eSuite works extremely well with Notes," said Lotus executive vice president Mike Zisman at the firm's Lotusphere 98 conference. "Can we make it faster? Of course. Can we make it smaller? Of course. It's an execution issue now."

Lotus appears to be headed in the right direction with its groupware strategy. Now it just has to execute.

–Steve Gillmor

Contents

What's Up with Tape Storage?

Tape's low cost-per-megabyte has made it the preferred choice for large-capacity backup and archival storage in high-end applications. Tape still retains that characteristic, but in the broader single-user, small-office, and workgroup markets, tape drives are reeling from an onslaught of alternative mass-storage devices.

The affordability and versatility of small removable-media drives, such as the 100-MB Zip and the LS-120, have made these peripherals a popular choice for consumers for data storage, data exchange, and incremental backups. For larger capacities, users can choose a CD-Recordable or CD-Rewritable drive at 680 MB, or a Jaz or a SyJet drive holding 1 GB. Other options include optical, magneto-optical, and the various flavors of writable DVDs.

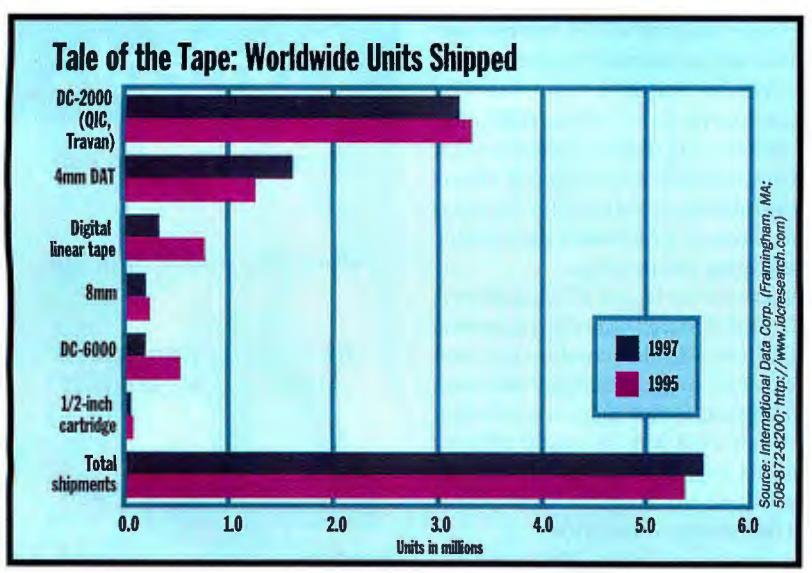
This withering assault from other media is partially to blame for the flat sales of tape drives over the past three years. Couple this with the cannibalistic infighting that's taking place between different tape technologies, and it's easy to see why the tape drive market appears fragmented. About a dozen tape formats, some of which are proprietary, hold at least 1 GB (compressed). Drive manufacturers, eager to stake out a segment of the market as their own, aren't making much progress toward common standards, notes Bob Amatruda, an analyst with International Data Corp. (IDC; Framingham, MA).

Tape backup for the desktop is the province of the quarter-inch cartridge (QIC) family, which includes Travan tape drives. However, higher capacities and better performance of the latest Travan drives make them more suitable for backing up small to medium-size servers. Travan capacities of up to 4 GB native (8 GB compressed) for the NS8 format and 10 GB (20 GB compressed) for the new NS20 format enable you to back up a departmental server without changing tapes. NS8 and NS20 both support read-while-write backup and hardware data compression for improved performance. Backup speeds of 7 GB per hour for NS20 drives should be typical.

NS20 drives, from vendors such as Aiwa, Seagate, Tecmar, and others, are just now reaching the market, at prices of about $500. But pressure from 4mm DAT drives will continue to compress this market.

The 4mm DAT format (12-GB native capacity for the DDS-3 format) is a cost-effective backup solution for network or multiuser systems or high-end workstations. Its higher initial drive cost can be offset by lower media costs when a large number of tapes is used in a backup regimen. DAT is under pressure from Travan at the low end, 8mm in the midrange, and digital linear tape (DLT) at the high end, though there is some overlap.

Another helical scan technology, 8mm competed with 4mm DAT at first, but with native capacity of 20 GB, this



Future Watch

Coming Soon: An Easier to Use, Graphical Linux

Thanks to the efforts of developers working on the GNU Network Object Model Environment (GNOME) project, the Linux operating system may soon have a consistent graphical user interface that's easy for even computing novices to use. As you'd expect from

GNOME: a standard way to graphically configure desktops.

the Linux community, the GNOME team is basing this project entirely on free software.

It's not that graphical versions of Linux and Linux apps don't already exist. They do. But there are problems with these various environments, according to Marc Ewing, director of development at Red Hat Software, which is devoting programmers and resources from its advanced development labs division to the GNOME project. Current Linux graphical environments are not standardized, can be arcane for novices, and don't always integrate well with other programs. GNOME will provide an environment with standard widgets and facilities that programs can use, and will let novice users configure their desktop environment graphically. GNOME's goals include a graphical file manager, customizable taskbar, and support for dragging-and-dropping files.

It's not clear when version 1.0 of GNOME will ship, though Ewing estimates it could be available within nine to 12 months. For more info, see http://www.gnome.org.

– Dave Andrews

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format now competes with DLT in the enterprise backup market. Another format competing in this space is the Advanced Intelligent Tape (AIT), which is not interchangeable with other formats but offers 25-GB native capacity and memory and cassette technology for faster access to data.

No single tape technology has distinguished itself as the best solution for all cases. But the market has selected QIC/Travan, DAT, and DLT to serve the low-, middle-, and high-end markets, respectively, with some overlap. In the low-end, PC server segment, choice is driven by sensitivity to cost and features. Both QIC/Travan and DAT offer similar capacities and performance, but QIC/Travan drives are generally less expensive because the tracking control is contained within the cartridge. This makes the cartridges more expensive to manufacture than DAT but represents a good trade-off if your plans include using few tapes. Conversely, if you will use a lot of tapes or store archival backups over long periods, the lower cost of DAT cartridges may save money, despite the higher cost of the drive.

In the battle between DAT and DLT, it's not clear that either format is winning. The DLT2000 internal DLT drive from Quantum (408-894-4000; http://www.quantum.com), for example, can back up 15 GB (native capacity) at 1.25 MBps and has a street price of about $2499. The SDT-9000 internal DAT drive from Sony (800-352-7669; http://www.sony.com/storagebysony) can back up 12 GB (native capacity) at the same 1.25 MBps but has a street price of only $1030. Quantum also offers the DLT7000, which boasts a native capacity of 35 GB and a transfer rate of 5 MBps. But you'll pay a premium for this performance—$6400 for the internal version. **–Robert L. Hummel**

Bug of the Month

Deregulation No Light Task for Integrators

Computer glitches have delayed the deregulation of California's power utilities, causing companies that had hoped to become new providers of electricity to wait until at least March 1. The problems stemmed as much from unrealistic deadlines as from the complex nature of integrating disparate software.

Legislators took four years to write the road map for restructuring the California electric power industry, leaving less than a year to get hardware, software, and regulatory approval finished. The independent system operator (ISO), the company that operates and controls the statewide transmission grid, does so with five applications. All this software is proprietary and created by different independent contractors.

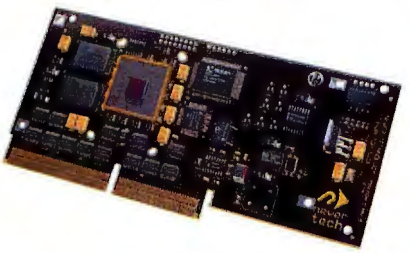
With practically no staff until the second half of 1997, and no IT staff until the third quarter, the ISO found it difficult to coordinate with the California Power Exchange, a company charged with auctioning electricity to independent service providers. "We were doing development, testing, and production on the same machines simultaneously," says Dennis Fishback, CIO for the ISO. "Everyone knew going in that this would require a Herculean effort, and we came damn close to pulling it off." However, despite its best efforts, the ISO missed its January 1 deadline.

Send yours to jason.krause@byte.com

PowerPC G3 Aims for 400+ MHz in '98

Intel and Digital have both crossed the 300-MHz threshold with their Pentium II and Alpha 21164PC processors, and now the PowerPC alliance is pushing past that barrier, too. This year, the PowerPC partners will introduce new technologies and manufacturing processes that will improve the speed and performance of its third-generation (code-named G3) PowerPC 740 and 750 processors. And then the next-generation PowerPC chip, the G4, should arrive sometime in early 1999.

The G3 750 series of PowerPC CPUs that shipped last year introduced faster system and L2 cache buses for performance that in some cases beat a PowerPC 604e running at 350 MHz (see January BYTE, page 28). Motorola and IBM plan on releasing new G3 processors with even faster core speeds and buses in 1998. Sources at Apple say the company might release new G3-based Mac OS machines with a 100-MHz system (CPU to main memory) bus by the end of 1998. Motorola already has 300-MHz 750s ready to ship. Sources say the 750 will hit 366 MHz by the second quarter of 1998 and 450 MHz by the end of 1998.



Newer Technologies' MAXpowr G3 upgrades a Mac's CPU to a 275-MHz PowerPC 750.

Currently, the only desktop systems that use the G3 series are Mac OS-based, so the market for embedded devices will inevitably assume a more prominent role in the PowerPC camp. In 1997, the desktop computer market provided the majority of sales for the PowerPC consortium but, according to Motorola, even if Apple's sales increase in 1998, embedded PowerPC chips will outsell desktop chips this year.

Embedded PowerPC chips based on the G3 design will appear in hand-helds, network computers, and networking devices. With the embedded line of G3 parts, IBM and Motorola will take a similar approach as they did with the PowerPC 603e: They removed the floating-point instructions from the processor (they are rarely needed for embedded applications) to make an embedded 603e-based CPU.

The G3 PowerPC 740 began life at a peak speed of 233 MHz; the 750 started at 266 MHz. Exactly how much faster beyond 300 MHz the new G3 PowerPCs will run remains to be seen. "Right now

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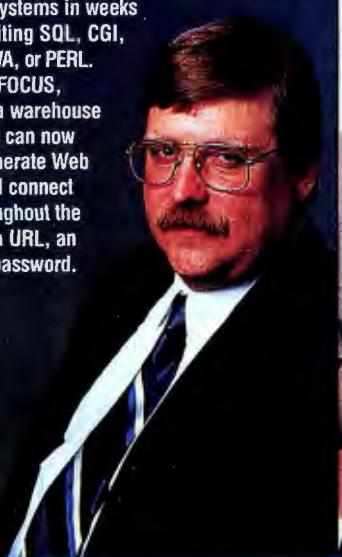
Gary Fisher, Manager Strategic Systems, Sony Electronics Inc.

Sony Electronics Inc. decided to build a data warehouse to help manage and control its inventory. To make the information easily available to users in over 20 states throughout the U.S., the company wanted to build Web front ends for reporting and analysis. The company needed software that had report writing features, supported drill down, graphics and complex, multi-pass database queries. Sony looked at a variety of Web-based tools ranging from the very complex and expensive to the simplistic and inexpensive. The company installed WebFOCUS and had reports on their Intranet in days and drill down reporting systems in weeks without writing SQL, CGI, HTML, JAVA, or PERL. Using WebFOCUS, Sony's data warehouse developers can now quickly generate Web reports and connect users throughout the U.S. with a URL, an ID, and a password.



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Dan Bond, Data Warehouse Manager, Paradyne Corporation

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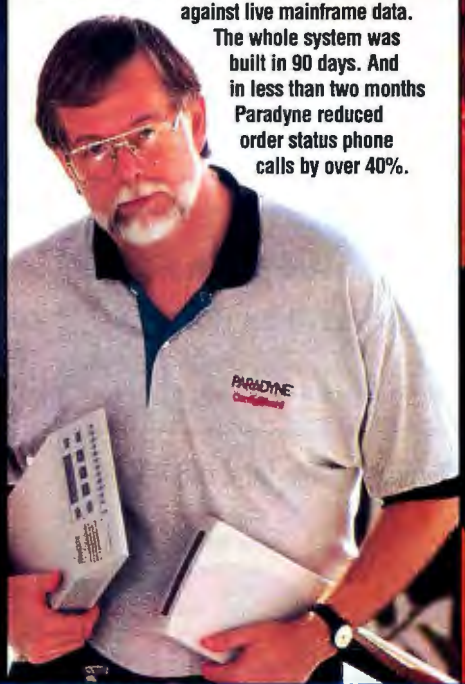

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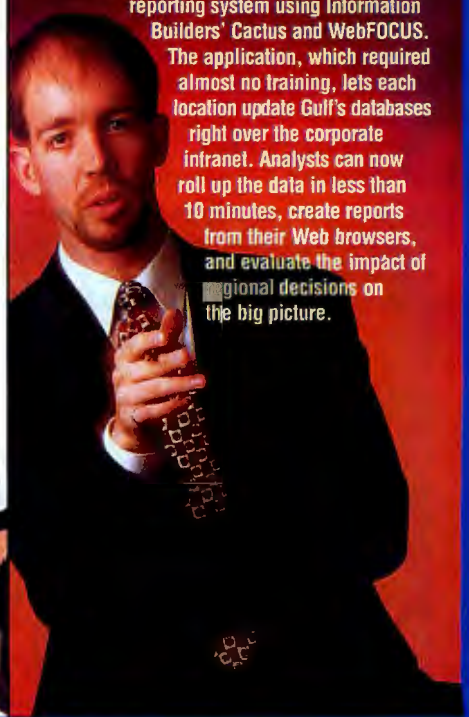
Kevin Rasmussen, Expert Application Coordinator, Gulf Canada

In the oil and gas business, proactive monitoring of production and costs versus operating budgets is a mission-critical function. That's why Gulf decided it needed a faster way to collect and analyze this information from its field locations around the world. The solution... a Web-enabled data entry and reporting system using Information Builders' Cactus and WebFOCUS. The application, which required almost no training, lets each location update Gulf's databases right over the corporate infranet. Analysts can now roll up the data in less than 10 minutes, create reports from their Web browsers, and evaluate the impact of regional decisions on the big picture.



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G3 Today and Tomorrow

CPU (Time frame)	CMOS Process	Core Speeds	On-Chip Cache ?	Maximum L2 Cache Controller	Power Consumption	Maximum Bus Ratios	Backside L2 Cache[1]
604e (Q3 1997)	.25-micron	Up to 350 MHz	No	1 MB	8/14.5 W at 350 MHz	7:1	N/A
PowerPC 750 (Q3 1997)	.29-micron	Up to 266 MHz	Yes	1 MB	5.7/7.9 W at 266 MHz	8:1	133-MHz
603e (Q3 1997)	.29-micron	300 MHz	No	1 MB	3.7/5.8 W at 250 MHz	6:1	N/A
PPC 750 (2Q 1998)	.25-micron	300 MHz	Yes	1 MB	5.9/8.2W at 275 MHz	8:1	150-MHz
PPC 750 (4Q 1998)	.20-micron	Up to 450 MHz[2]	Yes	1 MB	N/A	8:1	To be determined

[1] Certain Apple systems use the 604e with an inline cache, but that does not reflect the chip's design. [2] BYTE Magazine estimate.

we can easily increase speeds over 20 percent," says Will Swearingen, manager of PowerPC marketing for Motorola, which would peg the PowerPC 750 core at 330 MHz. In January, IBM announced the first speed bump of the year for the PowerPC 750, a 275-MHz part that's now available in processor upgrade cards from Newer Technologies (Wichita, KS) and Interware Co., Ltd. (Tokyo). New desktop systems will almost undoubtedly follow, but at press time, Apple hadn't announced any 275-MHz or faster PowerPC 750-based systems.

In February, IBM announced a PowerPC 750 microprocessor in a .20-micron process (the 750 currently uses a .25-micron process) with a .12 effective channel length and copper interconnects. Use of copper interconnects allows smaller, faster processors that consume less power. IBM says the chip can achieve 480 MHz at 2V. IBM's announcement was only a technology demonstration, and the company isn't currently saying when such a chip will be available commercially.

IBM and Motorola are implementing copper processes separately; IBM will be the first to use copper in the G3, and then both IBM and Motorola will use copper in the G4 series. Copper processes will reduce the chip's 5W dissipation (at 266 MHz) to even lower levels.

Certain products, such as Newer Technologies' MAXpowr G3, provide a PowerPC upgrade card with the L2 cache running at the same speed (up to 275 MHz) as the CPU itself. But to run the L2 cache at the same speed as the CPU in that case requires expensive RAM, which is why Newer's 275-MHz version with 1:1 L2 cache ratio costs about $2000.

Apple officials say that releasing Mac desktop machines with 1:1 ratio is possible but would result in systems that cost too much. Don't expect Macs with faster L2 cache buses until prices for late-write RAM drop.

Because the G3's bus implements only the MEI (modified, exclusive, invalid) protocol, it can't be used in a design that includes more than two processors. When Apple's Rhapsody OS appears with support for multiprocessor systems, the previous-generation 604e will need to be deployed. Both IBM and Motorola plan speed increases for the 604e, while the 603e will not be pushed beyond its current 300 MHz.

This year is important for the PowerPC group. An expansion of the Somerset facility (a shared semiconductor-design center in Austin, Texas) for building new embedded chips is planned, and the alliance will disclose details on the G4, successor to the G3. Meanwhile, look for more megahertz, higher memory bus speeds, and new copper processes from the G3.

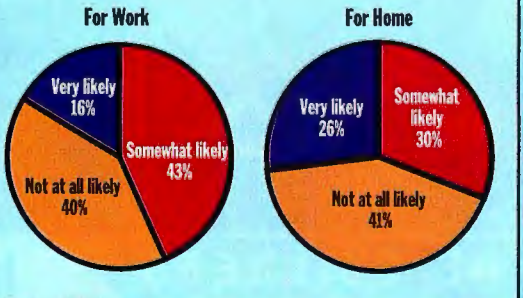
– Jason Krause

Survey

Intel More Likely Inside Business Than Home

Home PC users are more likely than business users to buy non-Intel computers. In a recent telephone survey by BYTE Research of 102 BYTE subscribers who recommend PC purchases, more respondents said they would be "Very Likely" to purchase a PC without Intel Inside if the computers were for use at home, not at work. Intel alternatives were more likely to get a lukewarm appraisal from business: More respondents were "Somewhat Likely" to purchase non-Intel PCs for business than for home. The "Not at All Likely" responses were about even for both.

Likelihood of Purchasing Non-Intel x86 PC



Source: BYTE Research.
n=102 BYTE subscribers involved in PC purchasing.

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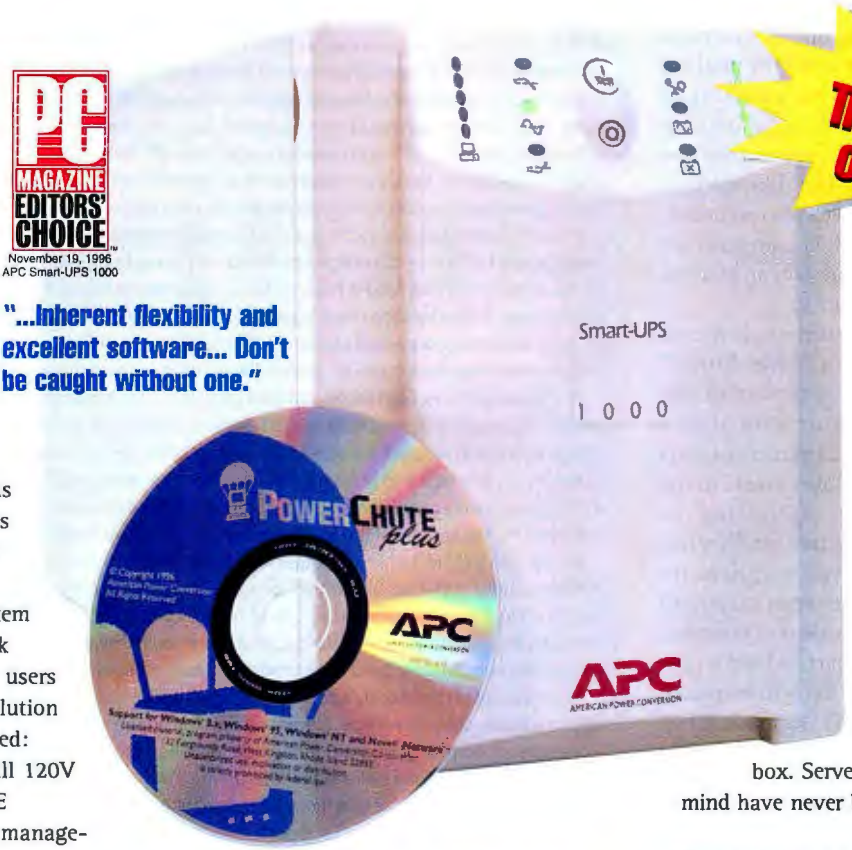

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Low-Cost PCs Go to Work

Low-cost PCs are the latest rage in the consumer world, but for the most part they haven't yet made the grade in the business world. That's starting to change, however, thanks to falling chip prices and Intel's new focus on the low end of the PC market. And although they still worry that these PCs are too underpowered to be useful, IS managers are reevaluating what roles cheap PCs can play in the business world.

In the world of business, low cost doesn't yet translate to "under $1000." As of last November, 32 percent of unit sales in the retail sector were of sub-$1000 PCs, while just 2.8 percent of units sold by corporate resellers were in the same price range, according to researchers at Computer Intelligence (CI; La Jolla, CA). Even so, prices are falling. PCs costing between $1500 and $1999 used to be prevalent in business. But thanks in large part to Intel's processor price cuts, desktop systems priced between $1000 and $1499 made up 61 percent of sales by corporate resellers in November, up from 35 percent in November '96, CI reports. Intel's release later this year of "Covington," its first Pentium II CPU that specifically targets sub-$1000 PCs (see "Deschutes: Pentium II Breakout," March Bits), will be an important milestone for many businesses. Although AMD, Cyrix, and others already have low-cost chips, many corporate buyers do not embrace them. A recent survey by BYTE Research indicates that prospective PC buyers who are "very likely" to buy an alternative to Intel are more likely to do so for their home rather than for work (see page 32).

IS managers are intrigued by less expensive PCs, but not without skepti-

GartnerGroup Report

Remote Access and the Internet

As remote access becomes an ever-greater priority for businesses, outsourced services are becoming more attractive to them. Since 1995, GartnerGroup's total cost of ownership (TCO) models for remote access have shown that enterprises can save money by using external managed service providers (MSPs) to deliver remote connections, network management, user support, security, and application hosting. MSPs include postal, telegraph, and telephone agencies (PTTs); value-added networks (VANs) and their providers; local exchange carriers; and Internet service providers (ISPs). They can all provide access from multiple locations over managed backbones.

In 1997, GartnerGroup's 250-user TCO model forecasted that MSP operations costs are typically half those of services built with in-house equipment and staff. In addition, by the end of 1997, all MSPs had made competitive changes to further reduce enterprise costs. These include more aggressive usage discounts, expanded international access, internetwork packet exchange (IPX) support, a willingness to renegotiate contracts, more help-desk support, better dial-up utilities, and more security services.

For these reasons, GartnerGroup contends there is an 80 percent probability that all enterprises planning more than 5000 hours of cumulative remote-access connection usage per month will be best served by contracted MSP services in 1998 and through 2000, as an alternative to building their own access services. All enterprises in need of the highest quality of service for global or transnational remote access should also consider MSPs, regardless of the total number of cumulative remote-access hours.

Along with WANs, LANs, and other network systems, the Internet can be a vehicle for remote-access systems. The Net will become a viable, but degraded, conduit for remote workers. During 1998, using first-generation VPN products, enterprises that are generally among the first to implement new technologies, as well as those that are somewhat risk-averse, will successfully build back-office remote access workforces with ISP networks.

The majority of these early adopters will later renegotiate business-class offerings to obtain a better class of service. Regional ISPs that lease rather than own backbone services cannot control or guarantee the quality of services they offer to their customers. While many enterprises believe the Internet and the use of multiple, regional ISPs will save them money, they fail to anticipate the reduced quality of service (e.g., variable response, busy lines, and limited support) that accompanies inexpensive connections.

In 1998, GartnerGroup states, there is a 90 percent probability that carriers will use low-cost ISP packages to attract cost-conscious enterprises, then urge contract upgrades to business-class (or premium) services after customers are frustrated by poor performance. Larger ISPs that can offer private IP service on extensive backbones will adopt the MSP service model, offering access from multiple locations along with security, network management, help desk, and usage accounting.

Despite the hype about the potential of remote access over the Internet, we do not advise it this year– even if VPN technologies are used. Other, more mature network-based solutions are more viable at present. We also expect that ISP remote-access services will appeal only to occasional, informal, and nonmission-critical enterprises in 1998.

John Girard *is GartnerGroup's vice president and research director, telecommuting and remote access. For more information on the GartnerGroup conference, Remote Access: Building and Managing the Workplace of the Future (Lake Buena Vista, FL, April 28–30), call 800-778-1997 or go to http://www.gartner.com.*

Cheap Biz PC Road Map*

$1000 Business PC	CPU	Hard Drive	Network Interface Card	Graphics	Cache	CD-ROM	Memory	Monitor	Modem
Today	166-MHz Pentium w/MMX	2-GB	No	64-bit, 2-MB memory	256-KB	No	16 MB	No	Yes
In six months	266-MHz Pentium II	2-GB–4-GB	Optional	128-bit AGP graphics, 2-MB	No	Not for under $1000	16-32 MB	No	Yes

*Based on estimates by Compaq and AST.

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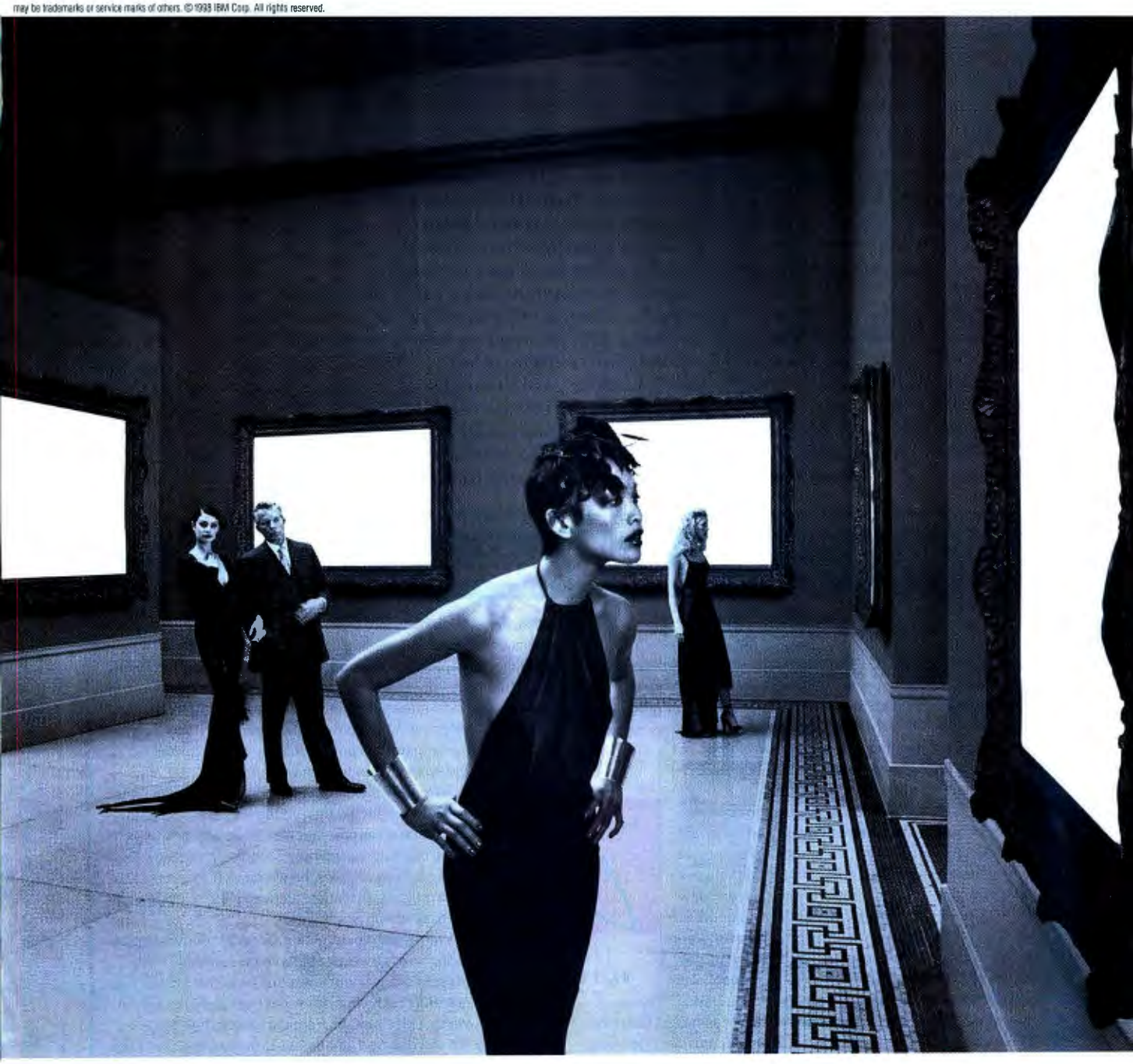

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cism. Lee Hill, VP of information systems at GT Capital Management (San Francisco), says one possible role for cheap PCs is running intranet applications that don't tax the computer. Says Lee, "I can only see a good number of users moving in that direction [toward low-cost PCs] with more Web-enabled database applications and a browser interface." Bruce Yates, systems administrator at The Computer Learning Center (San Jose, CA), a training center, is ready to use cheap PCs, but for limited tasks. "Our mentality is to buy nothing less than the best that's on the market," says Yates. "But you have to recognize that for the average business professional doing word processing and spreadsheets, a lesser priced system will probably work."

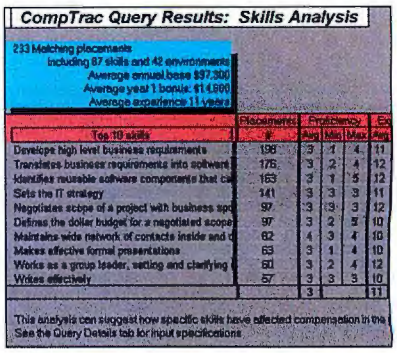
Intel's disdain for the low-cost market stymied vendors who wanted to build inexpensive business PCs. But Intel is now competing in this market. This means the less costly PCs with "Intel inside" will no longer be built to unload end-of-life parts but to meet your low-end computing needs. **–Jason Krause**

Service to Cure IT HR Headache

As news of talent shortages and rising salaries grips the North American IT industry, businesses are sharing salary information with each other to help retain valuable employees.

A new service from Toronto-based Compensation Tracking Systems (http://www.comptrac.com) could make it easier for Canadian IT organizations to track pay levels. Developed in cooperation with backers including Xerox Canada, Ontario Hydro, Atlantis Aerospace, Star Data Systems, and Aetna Canada, CompTrac is an on-line service where subscribers share comparative, up-to-date data on the value of high tech skills, rather than just static salaries for job titles. (A U.S. pilot program is also planned.) For a setup fee of approximately $2500 U.S., and an annual fee averaging about $7500 U.S., companies can exchange compensation/skills data.

At Aetna Canada, the investment in the CompTrac pilot program is already demonstrating its effectiveness. "The more we know about the market, the easier it will be for us to retain and attract talent," says Shannon Reilly, organization development consultant at Aetna Canada. "Our participation in the CompTrac pilot program has validated a direction we had already taken." **– Dan Coyle**


CompTrac Query Results: Skills Analysis

233 Matching placements
including 87 skills and 42 environments
Average annual base $97,300
Average year 1 bonus: $14,600
Average experience 11 years

Top 10 skills	Placements #	Proficiency Avg	Min	Max	Ex Avg
Develops high level business requirements	196	3	1	4	11
Translates business requirements into software	176	3	2	4	12
Identifies reusable software components that ca	163	3	1	5	12
Sets the IT strategy	141	3	3	3	11
Negotiates scope of a project with business spo	97	3	3	3	12
Defines the dollar budget for a negotiated scope	97	3	2	5	10
Maintains wide network of contacts inside and o	82	4	3	4	10
Makes effective formal presentations	63	3	1	4	10
Works as a group leader, setting and clarifying t	60	3	2	4	12
Writes effectively	57	3	3	3	10
		3	1		11

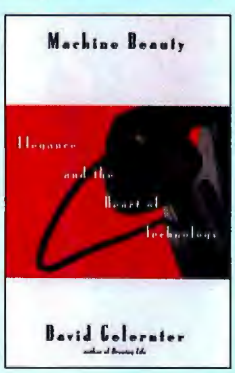
This analysis can suggest how specific skills have affected compensation in the
See the Query Details tab for input specifications

CompTrac provides salary information based on skills and experience.

Book Reviews

In Search of Elegance

In his memoirs, David Gelernter reflects on the irony of being letter-bombed by Ted Kaczynski. After all, Gelernter is clearly no wide-eyed fan of unrestrained technology. In his latest technology treatise, *Machine Beauty: Elegance and the Heart of Technology*, the inescapable impression emerges of the author as renaissance man, artist, philosopher, and–at best–reluctant technologist.



In concise and accessible prose, Gelernter mourns the lack of beauty in modern software and hardware. By recounting the history of computer technology, he convincingly establishes a key theme of the book: machine beauty, an elegant blend of simplicity and power, "has been at the core of nearly every major breakthrough in the field." But creating beauty in software *and* hardware is a vanishing art, replaced by the new holy trinity of systems design: maximum functionality, rampant featuritis, and a lucrative market for upgrades.

As an example of software design driven by aesthetics, Gelernter introduces the Lifestreams interface. In Lifestreams, your personal data–documents, e-mail, Internet content, chat sessions–stretch out into the past and extend into the future, creating the concept of a "single, all-encompassing, receding stream." Your personal stream flows across the Internet (perhaps on your service provider's disk), where you can access it from virtually any location. The model handles different media architectures with ease and grace, without contorting its basic design. For example, a TV station might deliver content streams. New shows join the stream at the original air date while old shows stretch back into time. You access shows just as you access documents, by scrolling back in the stream or by launching a search; you capture upcoming shows just as you might add new appointments to your schedule, by placing them onto the future of your own personal stream. The interface clearly fits the criteria of elegance as power couched in simplicity. Whether you agree or not, the point is that the design guidelines for the system were "exclusively aesthetic."

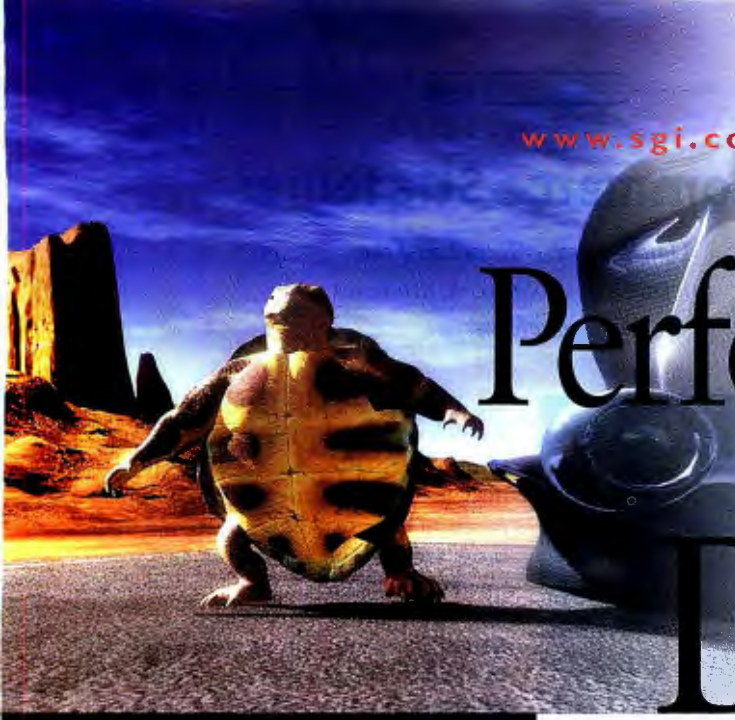
To restore the dream of machine beauty, Gelernter believes we should train young engineers in aesthetics. Teach an appreciation of art as well as the technique of artists, he advises. Technical adequacy is not enough. Programmers, he writes, should submit software projects, as student architects do, "to juries capable of aesthetic judgments."

With a fresh voice, Gelernter addresses vital issues facing us all as we grapple with the inevitable intrusion of technology in our everyday lives. We should feel grateful that he has emerged from a shattering personal tragedy with his ideals intact. Perhaps his best revenge is that the cowardly act of a deluded lunatic has brought his ideas to the broadest possible audience. If Kaczynski is cogent enough to grasp this irony, he might be reaching again for his underwear.

–Stanford Diehl

Machine Beauty: Elegance and the Heart of Technology, ©1998 by David Gelernter. Published by BasicBooks, a subsidiary of Perseus Books, L.L.C., ISBN 0-465-04516-2, $20.00.

www.sgi.com/go/workstations



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Blasts from the Past

5 Years ago in BYTE

More RAM, more hard disk space, more CPU speed... That's what applications wanted five years ago, and more often than not, it's what they want today, too. Meanwhile, sources were reporting a new version of Windows, code-named Chicago, that would bring Microsoft's OS into the 32-bit world. Chicago eventually became Windows 95.

10 Years ago in BYTE

Wyse's 386 PC with a 16-MHz CPU, 1 MB of RAM, 40-MB hard drive, and EGA monitor cost $6247. Our initial look at an early version of dBase IV indicated Ashton-Tate's new database showed promise, but bugs would eventually cause the company to stumble.

15 Years ago in BYTE

Steve Ciarcia's article on how to use RS-232C diagnostic tools to test and debug serial port connections was a popular article among readers 15 years ago. Also in this issue: how new processors will allow software with new features like context-sensitive help and graphical dialog boxes.

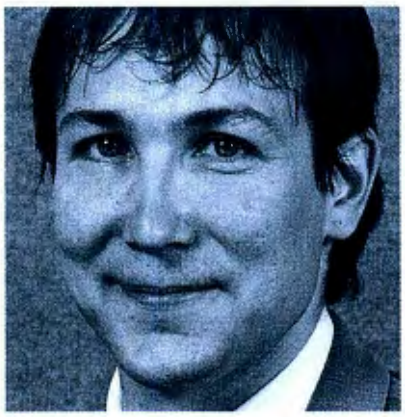
20 Years ago in BYTE

Radio Shack's new TRS-80 (about $700 with 16-KB RAM and monitor), announced in August 1977, was reviewed in this issue. Our conclusion: it was a good contender in the emerging category of "appliance" computers.

INTERVIEW

E-Commerce Strategies

Dan Whaley, cofounder of the Internet Travel Network, discusses e-commerce issues.



BYTE: *What are the top technology issues you expect to deal with in the next six months or so?*
Whaley: The first is an infrastructure issue. Our site is growing very quickly. We are doubling our capacity to serve and process transactions approximately every two or three months. That means every two to three months we are doubling the number of servers and the accompanying infrastructure to process transactions, which includes Web servers, data process engines, bandwidth to the airline reservations systems, and so forth. As a high-speed transaction facility, we need to make sure that there is always a server supporting the customer. So, we would reroute during periods of particularly high volume or during something as simple as a power outage. Right now we are focused on developing mirror sites or redundancy centers, each having the same architecture as we have here at ITN—the idea being that we can quickly redistribute our customer volume. That means we have to have distributed database systems that replicate across long distances in real time, that we have to use BGP-4 [Border Gateway Protocol] routing. BGP-4 routing is a fairly powerful concept in networking that allows a site to provide access through multiple pathways. Say one of my ISPs goes down and I have two lines. Through BGP-4 routing, customers that are using my site might never know that my site went down, as they would be instantly routed over to the other ISP because the fabric of the Internet understands that that route is no longer available and would reroute through the alternative method. Implementing that distributed system with those technological requirements is a tremendous challenge.

BYTE: *To what extent do you build for the lowest common Web denominator?*
Whaley: If a new technology is supported by 95 percent of the browsing population, we are comfortable making that technology part of a core requirement of completing a reservation. If that technology is not supported by 95 percent of the browser population, then we may add that capability to our system, but it won't be a fundamental requirement that you have that technology to complete a reservation on our system. The Number 1 requirement for our system for users is that it be easy to use, simple, fast, and that it gets them what they want with minimum hassles. Believe it or not, people are not that interested in having the latest technology—for example, Dynamic HTML—in the reservation process, because the additional facility that it gives people in attaining a reservation is not necessarily that perceptible. Our focus is on simplicity and ease of use, and not necessarily on incorporating the latest and greatest technologies.

BYTE: *What's your strategy for handling sudden spikes in traffic?*
Whaley: The travel industry definitely has those spikes, and those are called fare wars. [About four years ago] there was an extended period of about two weeks where the fares were just incredibly low. In times like those, purchasing volume will jump about three to five times over what it is normally. So our system has to have built-in headroom to handle those sorts of cases. We typically scale our site to be between 3X and 4X. We give ourselves about that much headroom.
(You can check out the ITN at http://www.itn.com.)

Intel Tech Buzz

Delivering flexibility for the future.

The pace of change continues to accelerate. Yesterday, companies were networking their PCs and putting groupware solutions in place. Today, connectivity is moving beyond the corporate walls. Tomorrow, businesses may rise or fall on the strength of their computer linkages to key suppliers and customers.

To survive in a world of rapid change—or, better yet, to exploit it for competitive advantage—the key is flexibility. Even if no one can predict precisely what tomorrow's business computing solutions will look like, companies know they'll need to adapt and deploy them quickly, without obsoleting their current infrastructure or impacting their current ability to solve problems.

To maintain that flexibility as they expand into uncharted territory, many businesses are basing their computing infrastructure on the Intel Architecture (IA).

By choosing clients and servers based on Intel's Pentium® II, Pentium® Pro, and Pentium® processors with MMX™ technology, companies can build a robust, cohesive environment that provides power and consistency from the desktop to the data center. This common infrastructure, coupled with new Wired for Management technologies and a scalable network architecture, enables companies to deploy new capabilities quickly, yet preserve current solutions. Performance can be added where and when it's needed, easily and cost effectively.

An Intel-based environment also offers the flexibility to match the computing model to the task at hand. Whether the business challenges

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"Intel-based servers deliver power and scalability to SAP R/3 customers at unprecedented price/performance levels. Because Intel servers are the platform of choice for so many of our customers, we optimize our products for top performance on the Intel architecture."

Dr. Hasso Plattner,
Co-Founder/Vice Chairman,
SAP

"Working closely with Intel to take advantage of its platform and processor expertise allows us to deliver Oracle products on an architecture optimized for network computing. Oracle8, the Database for Network Computing, and Intel's Pentium processor family will provide an outstanding computing platform for business solutions."

Gary Bloom,
Senior Vice President,
System Products,
Oracle Corporation

"We are enthusiastic about the introduction of Intel's new IA-64 processor family. We expect the combination of PeopleSoft and the IA-64 architecture to bring our customers additional power and scalability."

Stan Swete,
Vice President,
PeopleTools
Product Strategy,
PeopleSoft

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demand three-tiered client/server solutions, network-centric Java*-based applications, or Internet-enabled line-of-business programs, the Intel Architecture lets companies give each user or department the solutions they need.

Adding further flexibility, Intel-based platforms are supported by the industry's widest selection of software tools, applications, and add-ons. The economics of the volume marketplace ensure that emerging solutions will likely be available first and with the greatest range of choices on the Intel Architecture.

In times of rapid change, one of the biggest mistakes is to choose a strategy today that limits flexibility tomorrow. By relying on the Intel Architecture as they build their computing infrastructure, businesses can pave a smooth path to the future—wherever the future takes them.

Today's servers: flexibility in action.

The power and versatility of Intel's processor family allows companies to create a cohesive environment that spans lean clients to departmental, application, and database servers. That environment can evolve to meet tomorrow's business requirements without disrupting what works today.

Case in point: Intel-based servers are already running 24x7, business-critical, transaction-oriented applications around the globe. Not only are the majority of file/print and workgroup servers based on the Intel Architecture, but scalable Intel-based servers are delivering reliable, cost-effective computing to the glass house as well. According to SAP, for example, 42% of all new SAP R/3* installations are on Intel-based systems.

Intel's industry-leading commitment to developing next-generation platforms will provide a smooth transition to higher performance while maintaining existing infrastructural investments. Advances in high-performance scalable server clusters and I/O will push performance even higher, as will Intel's forthcoming 64-bit microprocessor architecture. The IA-64™ architecture maintains its compatibility with Intel's 32-bit processors, and dozens of software companies are already tuning their tools and applications for top performance on the next-generation processors.

For clients, servers, and networking solutions, such as Fast Ethernet and Gigabit Ethernet technologies, Intel delivers the performance and flexibility to keep companies on the leading edge, today and tomorrow.

For more information, visit our Web site at: www.intel.com/techbuzz

Gateway's Solo 5100 offers most of what you want in a $6000 notebook for half the price. ***By Mark Schlack***

Pretty Thin, Very Wide

I write articles and memos and give presentations for a living, so I want the best keyboard and display available. I'm on the road constantly, so I leave those 9-pound boat anchors at home. I trade off external drives and mediocre video for less height and weight.

Gateway's new Solo 5100 series gives me a 14.1-inch active-matrix XGA display that's better than the first color monitor I owned. And it's only 6½ pounds (5.9 if you remove the 8X-to-20X CD-ROM or floppy drive). The extra weight compared to, say, the IBM ThinkPad 560 is barely noticeable; it's still only 1½ inches thick and 12.4 by 9.6 inches in footprint.

Thin doesn't mean weak, though. The 5100's 266-MHz Intel Tillamook processor, 80 MB of RAM, and 4-GB hard disk make it outstanding for business use and even occasional graphics and database applications. The Tillamook is the first chip made by Intel on a smaller 0.25-micron process, which keeps power consumption and heat to a minimum (see "26 No-Compromise Power Portables," November 1997 BYTE).

Gateway Solo 5100
$2999
166 MHz; 16 MB; 2-GB disk; 2 MB of video memory; 8X–20X CD-ROM; Win/Works 95. Tested: 266 MHz; 80 MB; 4-GB disk; X2 cellular modem; mini-dock; Office 97 ($4499)

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Enter HotBYTEs No. 976.

Gateway's Solo 5100 has a 14-inch XGA display, an EZ Pad pointing device with a three-button IntelliMouse, and a lithium ion battery.

TECH FOCUS

Dieting for Laptops

How do you shrink a notebook without using exotic, expensive components? Most systems in this screen-size range weigh a pound or two more or are much costlier.

Much of the Solo 5100's weight loss is due to the replacement of the metal shielding with a nickel coating on the inside of the thin-walled plastic housing. In addition, the system's big, thin lid uses an LCD panel chosen for being the lightest in its size range, with specially designed brackets and hinges for rigidity. The latch is in the keyboard half of the computer. The 7-mm-thick keyboard has full 3-mm travel.

The Solo 5100 is the first 266-MHz notebook I've seen. My gut impression: It's a screamer. The BYTEmark clocks the Tillamook at 2.82 integer and 2.76 floating-point (for comparison, a 90-MHz Pentium = 1.0). Its 2-MB Chips & Technologies 65555 PCI video chip might be a bit light for high-performance graphics, but overall this machine performs.

What you gain over a ThinkPad 560–style system is an internal floppy or CD-ROM drive (with the machine on, you can swap the CD-ROM drive for the floppy, but not vice versa—disappointing in a 1998 laptop), universal serial bus (USB) ports, NTSC or PAL video out, and better sound. The display captivates; you don't need an external monitor for prolonged desktop use. That's also the bad news; the screen is oversized for some plane seats.

We'll surely see other vendors try a 266-MHz system in this form factor. It's said that such extreme thin-and-wide systems appeal mostly to journalists; real people, it seems, want that CD-ROM built in. I expect the 5100 will attract business users.

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

The 5100's keyboard is responsive but flexes disconcertingly. And its mini-dock lets you down: It has two slots, but it does not accept CardBus cards. The computer does, though—odd, because the number-one candidate for a docked PC card would be a 10/100 CardBus network card.

On balance, I found the 5100 to be an excellent, highly usable notebook computer that satisfied most of my desktop and travel needs. B

Mark Schlack is BYTE's editor in chief. You can reach him at **mark.schlack@byte.com**.

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

With its new GMR head technology, IBM gets 14 and 16 GB into 1-inch-high desktop drives. By Stan Miastkowski

Giant Heads, Monster Drives

We expect disk drives to keep growing in capacity while staying the same physical size. But IBM's newest DeskStars are something else, packing amazing amounts of data into 1-inch-high 3½-inch UltraDMA (ATA-4) drives. The 5400-rpm DeskStar 16GP comes in seven different configurations, from 3.2 to 16.8 GB; the 7200-rpm DeskStar 14GXP can hold 10.1, 12.9, or 14.4 GB. I tested the 16.8-GB and 14.4-GB models, each of which have just five platters.

IBM, one of the oldest hard drive makers, continues to push the envelope. These new drives use giant magnetoresistive (GMR) heads. "Giant" here refers to areal storage densities—3 gigabits/square inch—not the heads' physical size. (In fact, 250,000 GMR sensors would make about an inch-high pile.)

Despite impressive specifications, accessing the DeskStars' speed and space can present problems. To reach the full 33-Mbps UltraDMA burst speed, your PC needs an Intel LX or TX chip set and associated BIOS. Lacking UltraDMA support, the drives run in PIO Mode 4 (ATA-2), albeit with seriously decreased throughput. But you can add UltraDMA controllers ($75 to $100) to an older PC.

Windows 95 (OSR 2) doesn't support drives this large, but the DeskStars come with a version of Ontrack Disk Manager that will serve until Windows 98 appears. Windows NT 4.0 is more complex; with SP3 installed, Disk Administrator sees the full drive capacities but won't let you partition or format them. For this you need a hot-fix version of ATAPI.SYS, available on Microsoft's Web site. IBM is working with Microsoft to include native NT support for such large drives in the future.

I benchmarked the DeskStars under NT using Adaptec's ThreadMark 2.0 (http://www.adaptec.com), which stress-tests a drive's ability to handle sustained I/O (see the chart). Both drives were solid performers. Other specs for the DeskStars include 9.5-ms average seek time, 512-KB buffers, and a five-year warranty.

The DeskStars offer enough storage for virtually any application. While SCSI remains the first choice for server, RAID, and audiovisual applications, these new DeskStars give it stiff competition in the workstation market. B

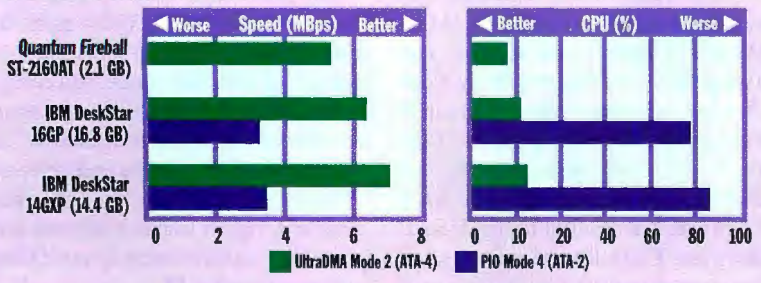
RATINGS	
TECHNOLOGY	★ ★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★
PERFORMANCE	★ ★ ★ ★

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

PRODUCT INFORMATION

DeskStar 14GXP, 16GP
est. street prices: 14GXP, $745; 16GP, $795
IBM Corp.
San Jose, CA, 800-426-7777
http://www.ibm.com/storage

Performance Test Results



Tested on a Dell OptiPlex GXa Pentium II/233 with 64 MB of RAM, Windows NT 4.0 Workstation SP3, Adaptec ThreadMark 2.0. The Quantum drive is included for reference. These numbers cannot be directly compared with those in our February Hardware Lab Report, which were obtained using a dual 300-MHz Pentium II with 160 MB of RAM.

Stan Miastkowski is a BYTE consulting editor. You can reach him at **stanm@bix.com.**

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

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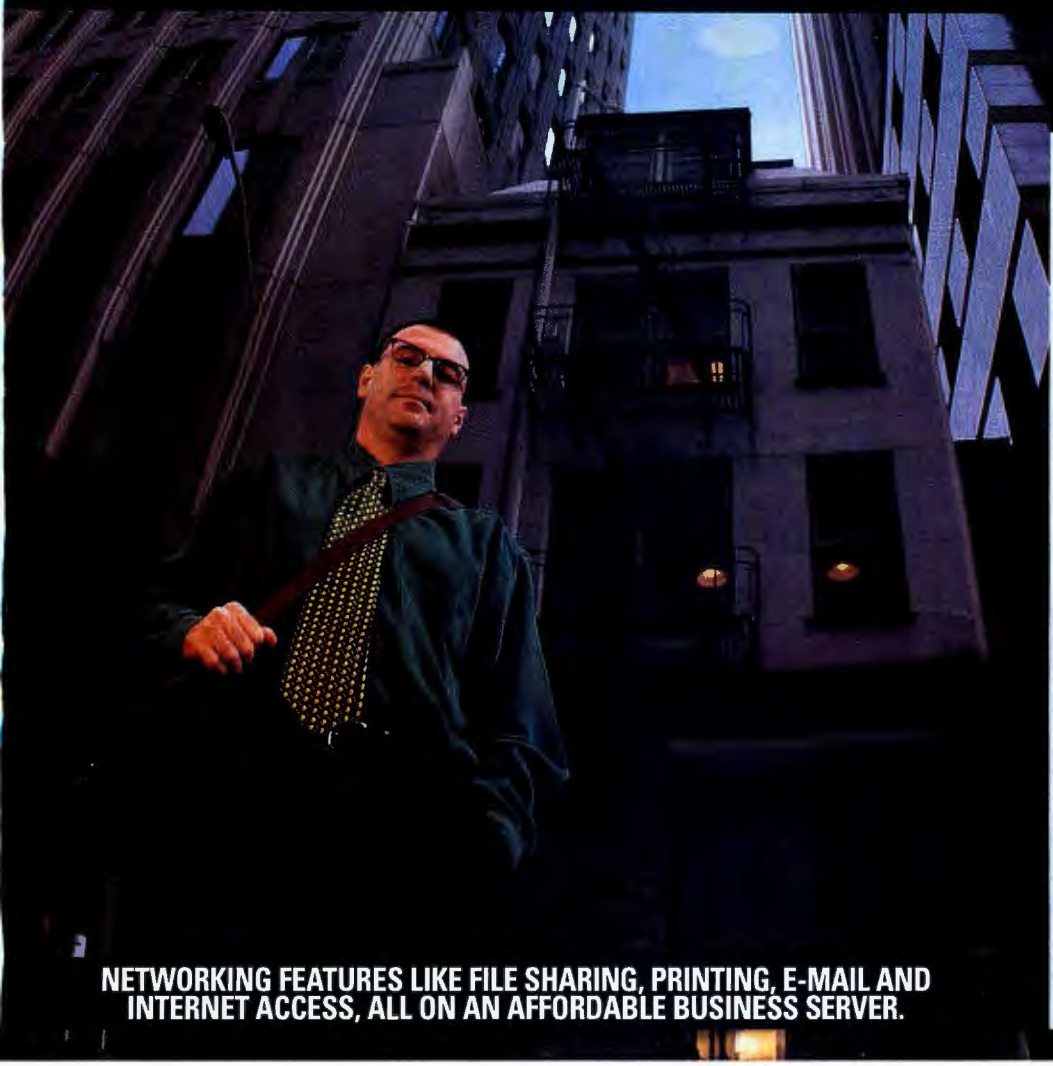

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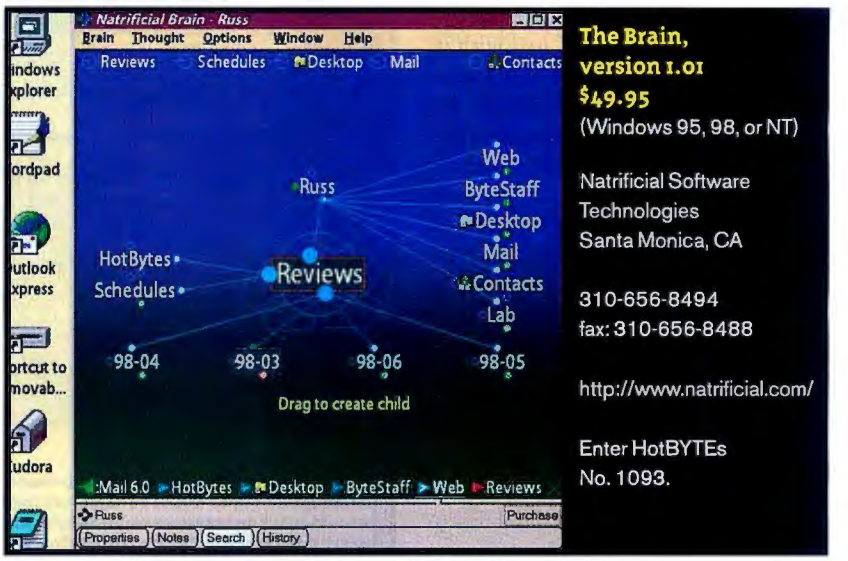
Natrificial's Brain helps you organize your work the way you think, regardless of file locations and application boundaries. ***By Russell Kay***

Your Brain in Software

Every new operating system brings a changed look and feel, interface, or desktop, often different but no better than its predecessors. Now, a truly interesting new product for Windows enhances but doesn't replace your desktop. The Brain lets you create a graphical, hierarchically linked representation of files and documents; you model your workspace the way your mind works.

The Brain starts with an on-screen box called the *active thought*, which you can link to other thoughts. To create a new thought, drag a link from one of the active thought's green circles (gates) and name it.

The display (called "the Plex") always shows the active thought in the center, with lines linking to one level of parents above, children below, siblings to the right, and distant ("jump") references on the left. The bottom of the Plex shows your most recent thoughts, and the top has "pins," thoughts you can jump to directly. Click on an outlying thought and the Brain moves it to the center and rearranges everything else.



Graphically linked thoughts are the heart of the Brain's organization model.

A thought can be almost anything—a document, application, placeholder, topic heading. You assign a file, a directory, an application, a URL, or nothing at all to a thought. Click on that thought to open or launch whatever is associated there. If this sounds confusing, let me assure you that it's far simpler in practice. For me, Brain was easier to use and more useful than any other organizing software.

Besides the Plex, another pane shows related information—properties, notes, or memos—and a search utility. If you import an existing folder, the Brain creates a separate thought for each file. When you click on a thought, its related document or application is opened. Move the cursor outside the Plex and it collapses into a small, unobtrusive icon.

Once you're done with a project, you can tell the Brain to forget that thought, and it goes away—but it isn't erased, it's just not displayed. You can recall a forgotten thought with a right click.

TECH FOCUS

How Do You Think?

Behind the Brain's razzle-dazzle focus-switching is a sophisticated, patent-pending technology and a proprietary API, all designed to allow any piece of information to be linked and accessed from multiple other pieces of information. You can use content from a wide variety of Windows applications and Web sources. Because the Brain is all you need to refer to, actual location becomes less important. In fact, files created with the Brain are stored in a single directory, but they can be associated with any other thought or file anywhere.

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

The Brain's most serious problem is that it's *so* different. I've worked so long with file-based hierarchies and applications that I often revert to my older work habits and forget to invoke the Brain.

I've tried many desktop replacements, taskbars and toolbars, application launchers, and menuing systems, and I've uninstalled every one as more trouble than it was worth. But I'm still using the Brain and I recommend it. Even if you decide not to keep using it, an encounter with the Brain will make you think a little differently about your work and how you access data or applications. B

Russell Kay (**russell.kay@byte.com**) *is a BYTE technical editor.*

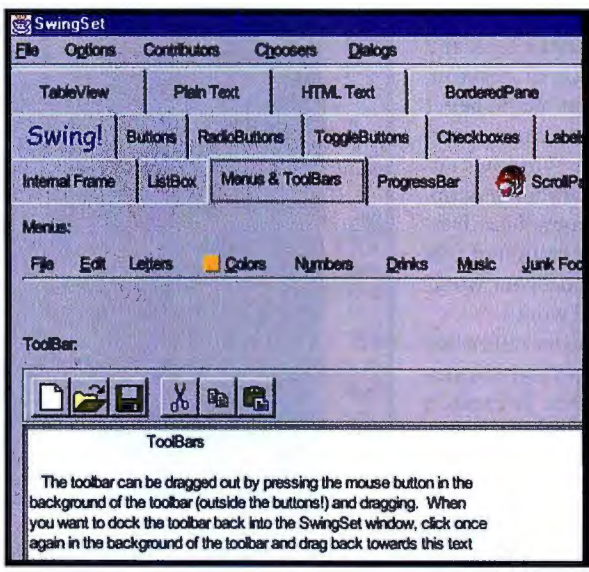
JavaSoft makes available an early release of JDK 1.2. Here's a peek at some of the highlights. ***By Rick Grehan***

JavaSoft Rides Again

This Java thing just keeps growing. Sun added fuel with its January release of beta 2 of the Java Development Kit version 1.2. (A full release is due this summer.) As with JDK 1.1, the big changes are not in the language but in the growing number of APIs comprising Java's "core platform" (see "Java Development Kit, Take Two," April 1997 BYTE).

With more Java Foundation Classes (JFC), Java now has the components developers need to build professional-looking UIs. Java2D API extends the Abstract Window Toolkit (AWT) and provides classes that do line drawing, text, and image manipulation. The new JFC drag-and-drop features add the ability to play with non-Java applications.

JavaSoft continues to add to the SwingSet—a collection of ready-made components that includes menus, buttons, checkboxes, and more. You can now select from sets of components to give your application the flavor of the underlying OS platform, such as Windows, Motif, or Macintosh. If you run the `SimpleExample.java` program included in the demo section, for example, you can execute a small program that switches between the "basic Java" and the Motif look and feel.



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JDK 1.2 significantly extends the JFC. Here, the SwingSet visual components portion of JFC is exhibited in an elaborate demo app.

Building on Java's original sandbox security model and JDK 1.1's signed applets, JDK 1.2 adds more granular permissions and policies. Each installation sets policies for external applets and for permissions allowed to all applets and applications. Permissions can be linked to a particular digital signature, or configured so that all "outside" applets have access to only a single subdirectory.

Developers can extend permissions to cover any system resource. Applets/applications can be given access to a printer and to disk files, and they can be allowed to perform serial I/O and more. You can also fine-tune what kind of access is permitted, choosing from file and directory creation, read, write, and delete.

JDK 1.2 has an accessibility API to the JFC, giving developers the ability to add alternative I/O devices for disabled or other users. The new collections API is eerily reminiscent of the C++ standard template library. Java archive (JAR) files and JavaBeans have also been improved.

JavaSoft is pushing hard to make Java an enterprise development environment. Improvements to JFC help GUI builders, while security enhancements should let developers safely deliver applets and applications over the Internet or intranet. Still, the development community has yet to enthusiastically embrace Java over C/C++, and JavaSoft engineers admit the Java environment is "incomplete." One wonders if it always will be. B

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

Rick Grehan works for Metrowerks and writes BYTE's Javatalk column. You can reach him at **rgrehan@austin.metrowerks.com.**

TECH FOCUS

Reference Objects

JDK 1.2 includes classes for implementing a new kind of object: a reference object. It's a sort of placeholder allowing one object (A) to refer to another object (B) without preventing the garbage collector from reclaiming B. Reference objects, ideal for building persistent storage systems, can track an object that is in the persistent store but not loaded in memory. A reference object can track a persistent object that was in memory but was "flushed" to make room for other objects, in which case the reference object becomes the cornerstone for an "object cache."

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

The OS for I_2O has undergone changes that make it easy to migrate the architecture to new processors. ***By David Wilner***

I_2O's OS Evolves

It's only recently that the PC graduated from being just a personal computer to being a high-powered machine capable of acting as an enterprise server, Web server, or robust desktop machine. The throughput demands of this new class of PC have mandated the creation of a standardized intelligent I/O architecture, better known as I_2O, which off-loads much of the interrupt processing and low-level hardware management from a system's main processor(s) to separate I/O processors (IOPs). I_2O also greatly simplifies the device driver model and provides a framework for running a new breed of application software on IOPs.

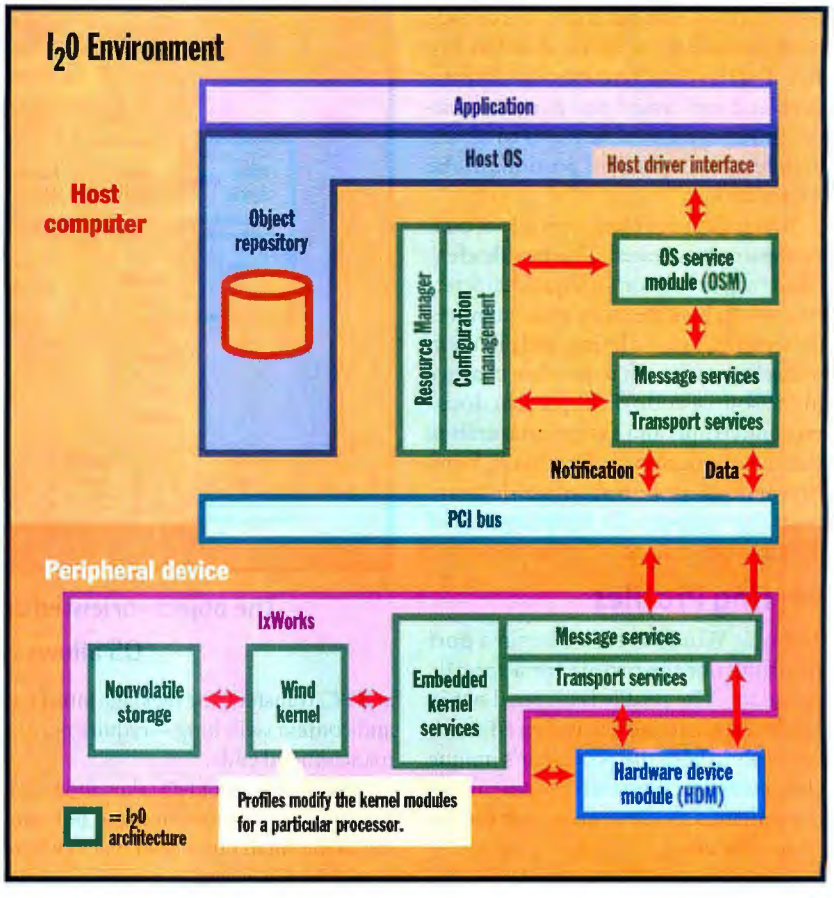
Overall, this approach improves the throughput and scalability of a system. It's similar to the function that cluster controllers performed in early mainframes to relieve system bottlenecks and slowdowns as large numbers of users logged on to a system. (For more on I_2O, see "Smarter and Faster I/O for Servers," May 1997 BYTE, and "I_2O Beats I/O Bottlenecks," August 1997 BYTE.)

The OS for I/O

To effectively off-load and handle different I/O streams, each IOP—whether on the main logic board or on a peripheral card—runs its own copy of an OS, as shown in the figure at right. An embedded OS is ideally suited for this task, since it must be small, reliable, and fast. I_2O's embedded OS is Wind River's I_2O real-time OS (IRTOS). Sold under the commercial name IxWorks, it's a derivative of the company's VxWorks embedded OS that's optimized for the I_2O architecture.

Thus far, IxWorks has been ported to two I/O platforms: Intel's 960 Rx chips and Digital Equipment's StrongARM I/O platform.

IxWorks implements all the I_2O standard's features, such as an event-driven driver framework and host message protocols. Its microkernel provides a number of real-time capabilities, such as multitasking with priority levels and fast interrupt handling. Tasks can either be executed preemptively or use round-robin scheduling. To boost performance, portions of the driver APIs were written in assembly language. In addition, IxWorks employs an object-oriented architecture that allows the dynamic loading and unloading of device drivers. If a device is removed, its driver object and any corresponding child objects (e.g., memory buffers) are removed as well.



An embedded real-time OS, IxWorks manages a low-level device's operation.

The Perils of Porting

Knowledge of the Wind River kernel's underlying porting technology is essential for understanding how IxWorks was ported to the Intel and Digital processors. The kernel was designed from the beginning for modularity, with an eye toward portability. Until the actual ports were completed, however, it was difficult to comprehend what was involved.

continued

In years past, engineers took a "brute force" approach, where a copy of the code was modified where necessary to make it work on the target processor. Such brute-force ports created diverging copies of the source code, each with different modifications for different ports. Fixing a bug or adding an enhancement required changes that had to be duplicated throughout the many copies.

First, the source code from all the different ports was mashed together in a brute-force way, with many conditional compilations. This put all the source code back into one set of files and one source tree. But this didn't completely solve the problem; each time a new port was written, it required modifications to all the architecture-dependent portions of the source code.

To solve this problem, a profile of each processor was created. This profile identified each processor's unique characteristics—such as memory-alignment requirements, byte ordering, and direction of stack growth—that mandate changes in the source code. Profiles also document interrupts and exception handling that must be dealt with. Eventually, Wind River ended up with about six different ports that supported a fairly large set of different processors.

Porting Profiles

Today at Wind River, we begin a port by filling out the profile for a specific processor. The profile is mapped out in header files, and the text is then edited to correspond with the processor's unique characteristics. This profile automatically configures all the source code for the target processor.

Inevitably, a small amount of fine-tuning is required for certain architecture dependencies. To address this, we further refine the abstraction process by identifying those OS components that are inherently architecture-specific and extract them from the main body of code.

The combination of the basic source code control mechanisms with these procedures has made it possible for Wind River to provide support for a wide variety of different processors. The underlying technology in the Tornado development environment and VxWorks RTOS has been expanded to Tornado for I_2O and IxWorks. Assuming that a port to VxWorks is completed for a given processor, then the port to IxWorks simply becomes an extension of that effort.

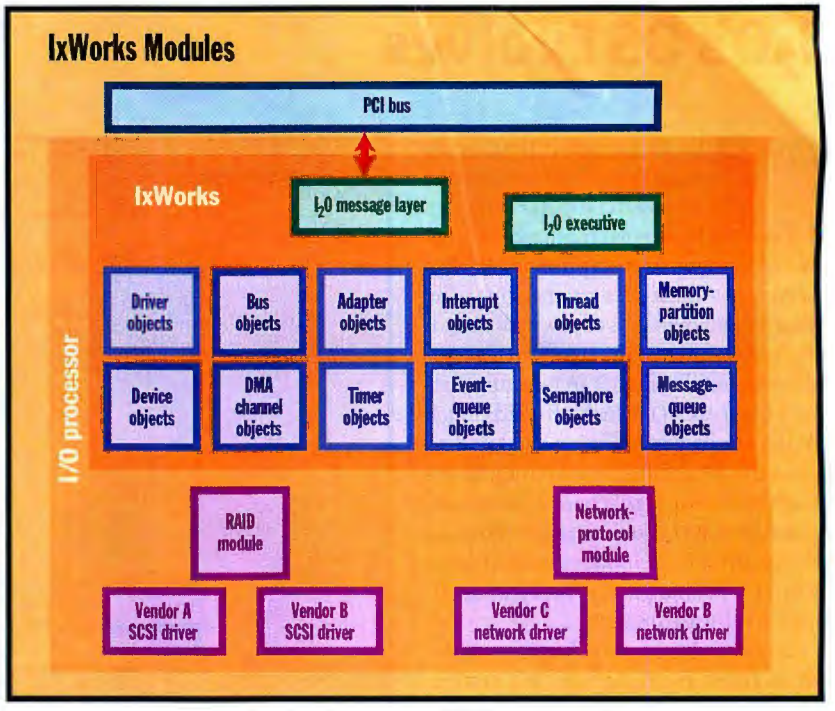
The lion's share of the work involved in porting I_2O lies in the peripherals. For porting I_2O to a particular processor technology, a subset of 50 peripheral functions must be customized for the various devices on the new platform. In addition, four time-critical OS components—DMA and PCI transfers, the message interface, and context switching—require performance-tuned code.

This basic port of I_2O takes about two months. The optimization and fine-tuning in the small number of places where performance is critical requires serious effort and is an ongoing process. The port of IxWorks to the i960, for example, is quite mature. But it was only recently that we found a few subtle settings that made a difference when initializing the processor and its caches. Other subtle changes, such as how memory wait states are handled, were also made. These setting changes improved performance by 20 percent to 25 percent.

The port to the StrongARM was started later, and we are just now beginning the optimization process. Undoubtedly, we will encounter instances similar to those involved in the i960 port: previously undiscovered subtle nuances that impact the performance of the OS.

A Tale of Two Processors

Because there's now a choice of I_2O-ready processors that support IxWorks, there's an inclination to compare them. The i960 is an integrated, single-chip, lower-price-point solution. It's well suited for use in adapter cards, such as RAID applications.



The object-oriented architecture of the IxWorks OS allows easy portability.

Because it's a one-chip solution that does not consume a lot of real estate, it can be placed on the motherboard.

The StrongARM platform, which is a two- or three-chip solution, has a slightly higher price point and is well suited for high-performance applications that could be implemented on an I/O card, such as Fibre Channel.

There will eventually be a broad spectrum of I_2O applications. The spectrum of I_2O solutions will range from high-end applications, where cost is not as much an issue as high performance, to dedicated applications, where a less powerful processor is sufficient. In the latter case, a higher level of integration will bring down the cost of making a premium, high-performance adapter card. B

David Wilner is cofounder and chief technical officer of Wind River Systems, Inc. (Alameda, CA). You can contact him by sending e-mail to **editors@byte.com**.

The HP JetSend protocol allows devices to negotiate the best possible information transfer. ***By Randy Sartin***

HP JetSend: Off-the-Cuff Communication

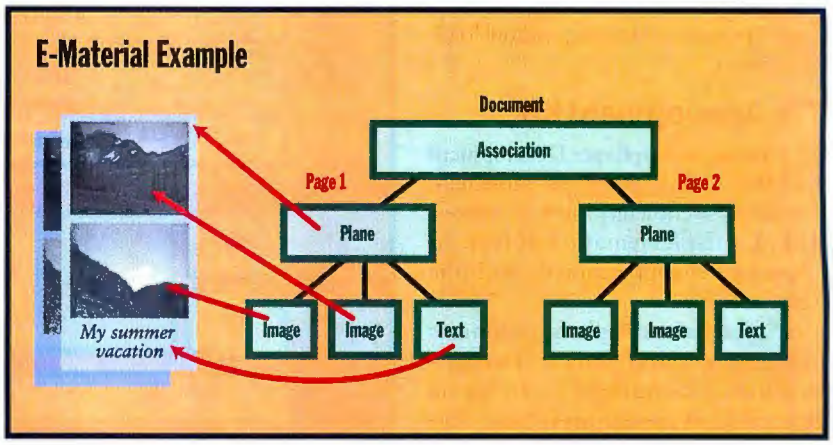
The HP JetSend communications protocol is a new architecture, developed by Hewlett-Packard, that allows two devices to talk to each other without the help of drivers or intermediary computing devices.

In HP's view, the next step in the evolution of computing, following the client/server model, is the "appliance model." The appliance model involves devices that can operate independently—communicating on a peer-to-peer or a device-to-device basis. The appliance model will not supercede the client/server model. Rather, it will complement and add value to the existing infrastructure.

Appliances can be thought of as devices that have the intelligence to communicate with one another. For example, a person takes a picture with a digital camera, then sends the picture to another camera, a printer (color or monochrome), a workstation, or even a fax machine. JetSend treats all transfers as being basically the same. All the user needs to do is identify the target device and send the data. Everything else is handled transparently through the JetSend protocol.

New Model, New Role

HP JetSend also implements a new interaction model. At the very core of JetSend are *surface interaction* and *e-material* (electronic material). Surface interaction defines how content moves between devices, while e-material describes that content. JetSend uses a content negotiation scheme for deciding what to communicate. JetSend appliances negotiate to determine the richest (or highest) common data encoding that the two devices understand. This guarantees that two JetSend devices exchange the best-quality data (i.e., color versus black-and-white images, where possible). The protocol defines a set of default content types to ensure that there will always be at least one data format the two devices can exchange. The actual e-material being exchanged is represented as a hierarchical tree of data encodings. Sample data encodings include image, text, file, association, and plane. "E-Material Example" shows a two-page document, with each page containing two image encodings and a text encoding.



An example document and its internal hierarchical tree representation.

All information is exchanged through surfaces. A surface is an information object comprised of three components: a header, a content description that provides information on what types of content are available for transmission, and the content itself. JetSend enables devices to share information with each other through surface interaction. The sending device impresses part of its surface onto a surface of the receiving device. The parts of the surface that get impressed are the header and the content description. The receiving device parses the impressed surface's content description to determine which of the available data types is best for it to receive. The receiver then requests that specific content from the sender. This is the content negotiation phase.

The Four Rules

There are four basic rules to the JetSend architecture:

RULE 1: Devices interact as peers. This means that devices cannot require intermediary computing devices for point-to-point interaction to occur; however, if intermediary computing devices exist, devices may take advantage of them. In many cases, intermediary computing devices could actually help with communications. For example, intermediary computing devices could aid in discovering suitable target devices, or they could perform data transformations.

RULE 2: The protocol is uniform and independent of device function. This means that JetSend devices do not model the devices with which they communicate; for example, a sending device, such as a scanner, should not be required to know whether it is communicating with a printer or a PDA. What should be communicated is information using negotiated data content, not device-specific

commands. In other words, devices should not require drivers for each other; they should simply be able to agree on what they can share.

RULE 3: Devices always interwork to the best of their abilities. A versatile JetSend device should be able to support a wide range of data encodings. Between the sender and the receiver, the highest level of encoding should be negotiated. The JetSend specification also mandates that all devices support the default encoding to guarantee that interaction occurs. The default encoding is defined in the JetSend protocol spec.

RULE 4: Control and data (including status information) use the same protocol. This means any type of interaction between JetSend devices is done through surface interaction and e-material. An example of control is the ability to configure a device's address list, or even take advantage of device features such as duplex printing or stapling, without loading a driver.

The Development Kit

HP provides an Appliance Development Kit (ADK) to help designers implement appliance functionality for their devices. The ADK implementation of JetSend takes a layered approach, as shown in the figure at right.

HP's first JetSend implementation uses Internet protocols (TCP/IP). In this implementation, JetSend uses User Datagram Protocol (UDP, also known as "unreliable datagram protocol") as its standard transport protocol; however, if a device supports streams (TCP), content may optionally be transmitted via TCP. JetSend also uses Reliable Message Transport Protocol (RMTP) to make UDP reliable. RMTP can be thought of as a lightweight TCP. This minimizes the burden of having to support multiple TCP connections on low-end devices. HP is also working on an infrared implementation of JetSend using the IrDA protocols.

The transport-independent communication layer maps between the different "network" transports. This layer abstracts the different transports to a common API for the JetSend session protocol, and it makes JetSend independent of network transports.

The JetSend session protocol manages multiple virtual device sessions (connections). A single virtual session contains one or more datagram channels and, optionally, zero or more stream channels. Channels are multiplexed through a session.

How to Interact

The JetSend interaction protocol manages surfaces and surface interaction between devices. E-material is passed through this layer as a surface.

JetSend contains a limited set of interaction policies, which define common behavior between devices. Think of these policies as rules for how devices should behave when talking to each other. These policies include:

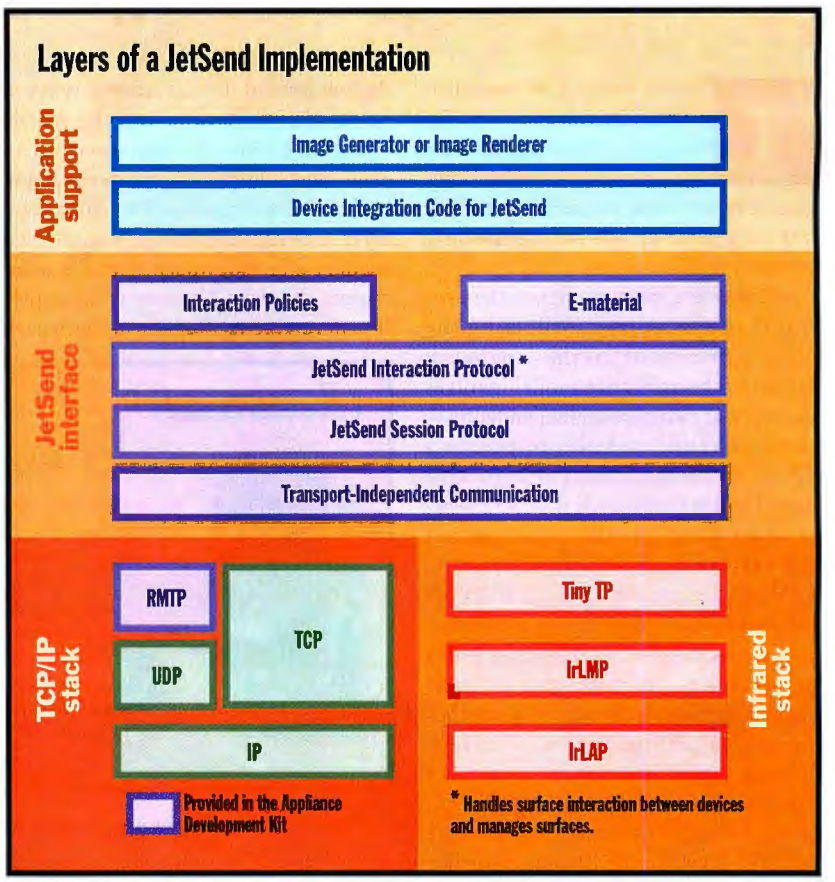
- Job policy: exchange of content
- Contact policy: exchange of device information
- Status policy: exchange of device and job status
- Address policy: exchange of address information between devices

In a sending device, the device integration code for JetSend takes data generated by the device and represents it as e-material. For a receiving device the transformation is the opposite: E-material is translated into data that the receiving device's image renderer can interpret.

The image generator would be in the sending device, and the image renderer would be in the receiving device. For example, in an HP LaserJet printer, the image renderer would be the PCL rendering engine.

With JetSend, information appliances communicate with each other simply and directly. HP's goal is that one day soon, people will not have to worry about communication between devices. In the same way that we can just pick up a telephone and call someone, we will be able to just pick up an information appliance and share data with someone. Regardless of who made the appliances, they will connect and share information.

More details, as well as a copy of the HP JetSend specification, is available at: http://www.jetsend.hp.com/. B



The JetSend Appliance Development Kit's layered protocol promotes device independence.

Randy Sartin is an HP JetSend system architect in Boise, Idaho. You can reach him at **randy_sartin@hp.com.**

With its eight-way superscalar core, the new Power3 raises the bar for high-performance CPUs. ***By Tom R. Halfhill***

IBM's Powerhouse Chip

IBM's current high-end microprocessor, the P2SC Super Chip, is a hard act to follow. After all, it's the microprocessor that IBM used in a supercomputer to beat world chess champion Garry Kasparov last year. But the new Power3 processor is even more awesome.

Imagine a 64-bit CPU with 15 million transistors, eight functional units, a 128-bit wide system I/O bus, a 256-bit wide secondary cache bus, nearly 8 GBps of aggregate bus bandwidth, 128-way caches, and built-in support for symmetric multiprocessing (SMP). You won't have to imagine it for long. IBM produced the first silicon samples in early 1997. The Power3 will first be made with a hybrid 0.25/0.35-micron process called CMOS 6S2, which uses aluminum for the five layers of metal interconnects. IBM plans to have Power3-based systems in production in the second half of 1998.

64-Bit Architecture

The Power3 is designed for high-end RS/6000 workstations, servers, and supercomputers. It adopts the 64-bit architecture and SMP features of the PowerPC 620. The Power3 stands to benefit more from a 64-bit architecture because it is aimed at an entirely different market than other PowerPC chips.

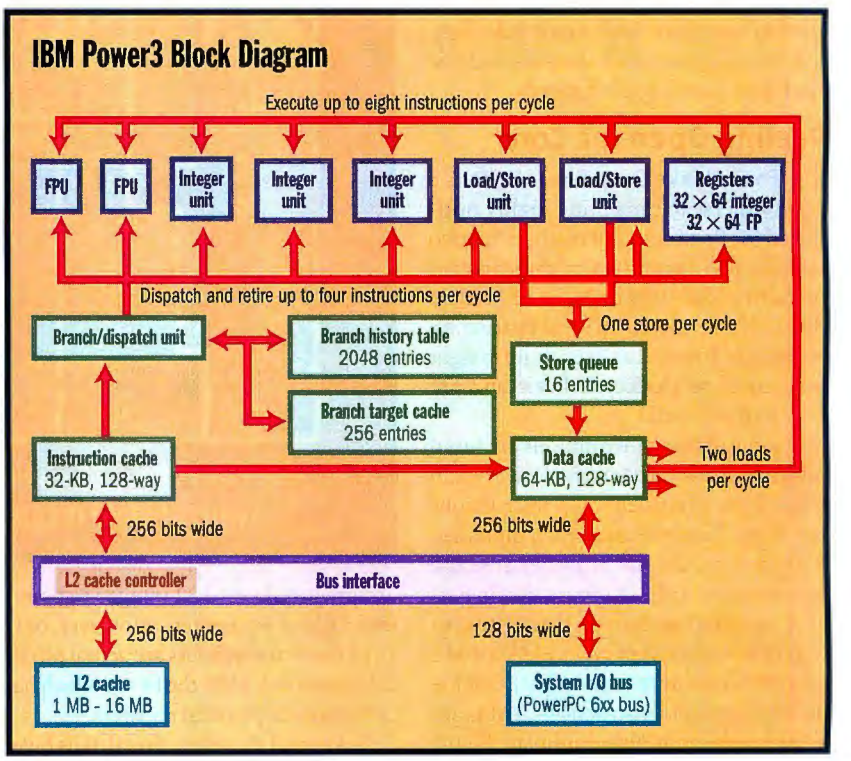
"It's a server and workstation part, not a desktop PC part," says Mark Papermaster, Power3 product manager. "It'll really cook on huge engineering, scientific, and on-line transaction processing applications."

The most dramatic measure of how IBM optimized the Power3 for large applications is the chip's phenomenal bus bandwidth. The system I/O bus is 128 bits wide—twice as wide as the bus on most of today's CPUs. At a clock frequency of 100 MHz, the Power3's system bus delivers 1.6 GBps of peak bandwidth.

Not stopping there, the Power3 also has a private bus for the Level 2 (L2) cache, similar to the L2 backside bus on a PowerPC 750, Pentium Pro, or Pentium II. But while Intel's backside bus is 64 bits wide, the Power3's bus is an incredible 256 bits wide. At 200 MHz, that's 6.4 GBps of peak bandwidth—or a grand total of 8 GBps of aggregate bandwidth when added to the capacity of the system I/O bus. Furthermore, all that bandwidth is available for data. Each bus uses separate address, data, and control lines instead of multiplexing the control signals and addresses with the data, as most other processors do.

Those extra lines, not to mention the superwide buses, boost the pin count far beyond the limit of what would be practical on a chip designed for mainstream PCs. The Power3 has 1088 pins, with 748 of them dedicated to signal I/O. Instead of cramming that many pads around the periphery of a die that's 270 square millimeters, IBM manufactures the Power3 with its patented C4 "solder-bump" technology, which distributes the pads all over the surface of the chip.

The Power3's system I/O bus can run at clock ratios of 1:2, 1:3, or 1:4 with the core. The private L2 bus can run at ratios of 1:1, 1:2, or 1:3. IBM says initial versions of the Power3 will run at a core frequency of more than 200 MHz. At that speed,



Eight execution units and wide buses give the Power3 processor phenomenal throughput.

it would make sense to clock the system I/O bus at 100 MHz and the L2 cache at 200 MHz. On more advanced fabrication processes, the Power3 core could run as fast as 400 MHz while maintaining the system I/O bus at 100 MHz and driving the L2 cache at 200 or even 400 MHz—if the static RAM (SRAM) chips in the cache could keep up.

Until now, IBM's Power chips have always been known as "brainiacs": They achieve high performance through complex parallelism, not raw clock speed. The P2SC, for example, runs at a relatively pokey 135 MHz. But when the Power3 moves to IBM's CMOS 7S process (it replaces the aluminum traces with copper), 500 MHz will be a realistic possibility. This places the Power3 squarely in the "speed demon" category. Such a part will probably need higher clock divisors to drive the buses at manageable speeds.

Peeling Open the Core

The Power3, like Deep Blue's P2SC, is a wide superscalar machine highly optimized for floating-point math. It has two floating-point units (FPUs), three integer units, two load/store units, and a branch/dispatch unit. Given an ideal instruction stream, the Power3 can execute up to eight instructions per clock cycle, but it can retire only four per cycle.

If some of those instructions are fused multiply-adds (FMAs), the Power3 can execute the equivalent of 10 instructions per cycle. That's because each pipelined FPU can execute the multiply and add operations of an FMA instruction in parallel, yielding a maximum throughput of four FP operations per cycle. FMA is IBM's term for single instructions that combine multiply and add instructions. FMAs are similar to the multiply-accumulate (MAC) or multiply-add (MADD) instructions found in digital signal processors (DSPs) and other CPUs optimized for data-intensive tasks.

Each FPU also has special subunits for executing divide and square-root operations in hardware. All FP data paths are 64 bits wide (IEEE-754 double precision). Most floating-point instructions have a three-cycle latency and a single-cycle pipelined throughput. The architectural set of 32 FP registers is supplemented with 24 additional physical registers plus eight virtual registers. So, from the CPU's point of view, there are 64 FP registers to play with—transparently mapped to the architectural set of 32 registers.

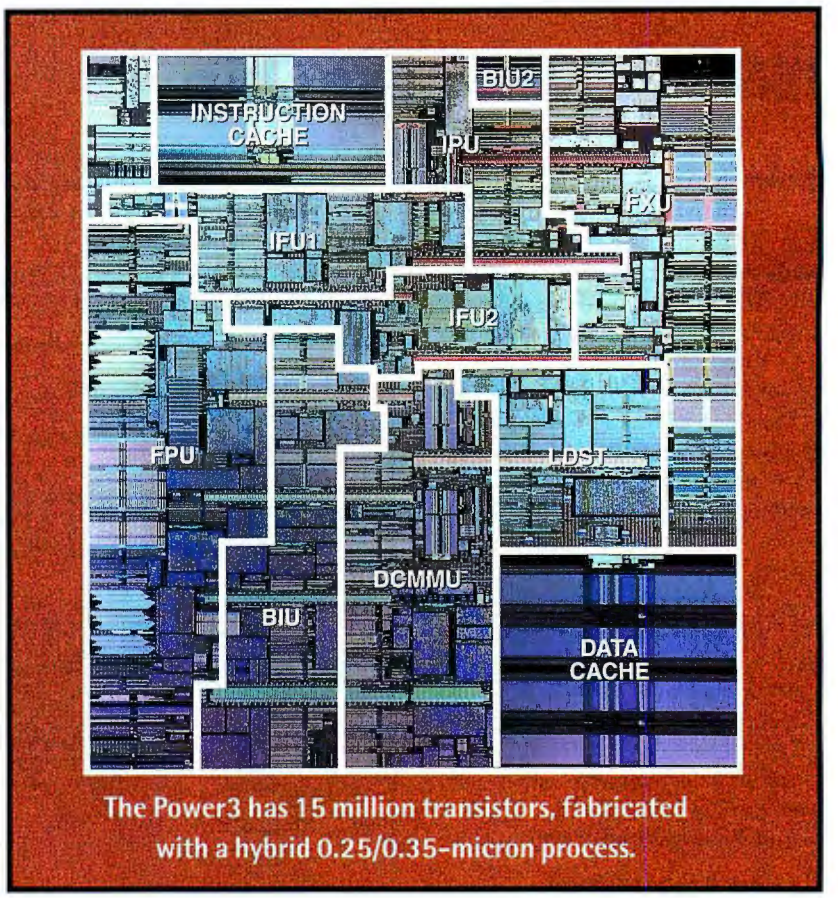
Two of the integer units execute single-cycle instructions (the majority), while the third integer unit handles more complex instructions. The nominal length of the integer pipeline is five stages. Here, too, register remapping expands the architectural set of 32 integer registers into a file of 64 registers. However, only 16 of the extra registers are actual physical registers—unlike the FP set, which has 24 additional physical registers.

To keep all those functional units busy, the Power3 has extraordinary Level 1 (L1) caches and load/store capabilities. The load/store units can perform two loads or one store per cycle, and they can load data speculatively. Four ports on the data cache can simultaneously handle two 8-byte loads, one 8-byte store, and a 128-byte cache-line update in a special reload buffer.

Although the caches are respectably large—32 KB for instructions and 64 KB for data—addressability is their standout feature. Each cache is 128-way set-associative and holds 128 bytes per line. Therefore, the instruction cache consists of only two sets, and the data cache has only four sets (128 lines per set × 128 bytes per line = 16 KB per set). Each set is fully associative, so cache access is very efficient indeed. In contrast, the P2SC's data cache was twice as large (128 KB) but only four-way set-associative.

What all this adds up to is superlative performance. IBM estimates that the Power3 will score 11-12 SPECint95 and 28 SPECfp95 at 200 MHz. Although the integer performance is about the same as a 300-MHz Pentium II (which scores 11.6 on this benchmark), the Power3's estimated FP performance is almost four times greater than the Pentium II's (7.2 SPECfp95). Of course, the Pentium II is shipping today and the Power3 isn't. But since IBM has actual silicon samples running in the lab above 200 MHz, you can bet those estimates are pretty accurate.

When this chip moves to the CMOS 7S process, it'll really come into its own. Assuming that its performance scales with the clock speed, a Power3 running at 500 MHz could achieve a stunning score of 30 SPECint95 and 70 SPECfp95. B



The Power3 has 15 million transistors, fabricated with a hybrid 0.25/0.35-micron process.

Tom R. Halfhill is a BYTE senior editor based in San Mateo, California. You can reach him at **thalfhill@byte.com**.

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These Web components let you package DHTML or HTML into reusable objects. ***By Rick Dobson***

Scriptlets Simplified

Dynamic HTML (DHTML) is Microsoft's non-Java solution for providing interactive, graphically rich Web pages. Scriptlets let you encapsulate DHTML, or even plain HTML, into components for reuse. For more information on scriptlets, see the feature in this issue, "Scriptlets to Energize Your Site," on page 96NA 1 (only in the North America edition).

In this article, I will describe the scriptlets architecture and present two sample scriptlets to help get you started.

Scriptlet Architecture

The screen illustrates how a scriptlet appears in Microsoft Internet Explorer 4. First, it shows as a control (the green area in the window). Second, it does or shows something. In this case, clicking anywhere in either sentence highlights the entire sentence. Third, it can expose methods or properties to the host application. The two buttons in this example use JScript to invoke methods within the scriptlet.

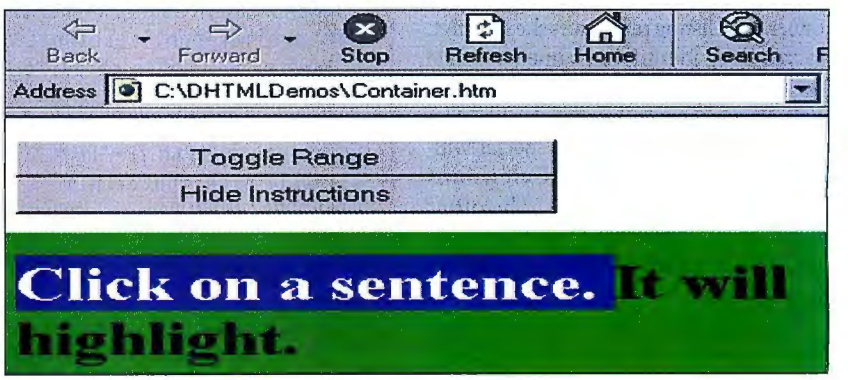
When building a scriptlet, you need to work with at least two files. One file contains the scriptlet itself. This is an .html file. The second file acts as a host for the scriptlet. Usually, the host is simply another Web page. However, it can also be a document from an application (e.g., Visual Basic or Word) that supports Component Object Model (COM) objects.

When downloading scriptlets to Internet Explorer 4, make sure security for their originating zone is either medium or low. If custom security is in effect for a scriptlet's originating zone, set both script ActiveX controls marked safe for scripting and initialize, and script ActiveX controls not marked as safe to either prompt or enable.

The same security restrictions apply to nested scriptlets and other controls in scriptlets. When you distribute scriptlets, Internet Explorer 4 browsers on other machines must not have a high security setting. Scriptlets will download only to browsers with a lower setting.

Designing Scriptlets

There are two ways to design a scriptlet. One technique, known as the prefix method, works for both JScript and VBScript. I call it the prefix method because of the way you mark functions and variables that you want to expose. The second approach creates a `Public_Description` object that offers access to exposed methods and properties. This technique works exclusively with JScript.



A sample scriptlet showing itself as a control (green region).

VBScript currently cannot create objects, so the `Public_Description` object option is not available to it. The next release of VBScript is supposed to overcome this restriction. My examples will use the prefix method.

You need to create a function for each method you intend to expose for external manipulation. When a scriptlet exposes a property, it can use either a variable or two functions. The variable stores the value of the property.

If a property represents a color, and you want the object's color to switch when a browser revises the color property, then you would use one of two functions. A `put_` function can change a color. A `get_` function can capture a color's current value. This is similar to how Borland's Delphi implements component properties.

When you use the prefix method to identify exposed methods, simply insert `public_` before the function name. For example, if your object has a function called `setUnit`, calling it `public_setUnit` exposes the function for use as a method outside the scriptlet.

When a variable represents a property value, the same basic rule holds—add the `public_` prefix before the variable's name in its declaration. Or, if you are using the get/put approach, simply add the `public_` prefix to the function names (e.g., `public_get_myProperty` and `public_put_myProperty`).

A Sample Scriptlet

Simple.html in the Code Gallery on page 56 describes a simple Web page. The portion between `<BODY>` and `</BODY>` is fairly standard HTML. The text in the `<SCRIPT> </SCRIPT>` block defines the DHTML scriptlet.

Clicking anywhere in the Paragraph

<P> block invokes the setUnit method, which toggles the contents of the SPAN element between word and sentence. Clicking anywhere in the Header <H1> block invokes the selectMe method, which highlights a word or a sentence.

Simple.html has three functions. Function setUnit toggles the SPAN contents. Function selectMe selects either a word or a sentence, depending on the SPAN element's setting. Function hideMe hides the Paragraph <P> block. Because only the setUnit function has a public_ prefix, it is the only exposed method.

Another Scriptlet

To be useful, the scriptlet must be loaded into a container page. The second listing that's found in the Code Gallery, Container.html, is a Web page that acts as a host for Simple.html.

The OBJECT tag at the end of the Container.html listing references the scriptlet. It creates an identifying name (TestS1) for this invocation of the scriptlet. The PARAM tag points at the scriptlet file. The TYPE attribute designates the special Multipurpose Internet Mail Extensions (MIME) type for scriptlets. The other OBJECT tag attributes size and position to the scriptlet window that's within the host's display.

In general, the OBJECT tag in the host file will have a minimum of three attributes set at design time. It is essential to include a TYPE attribute. Make it equal text/x-scriptlet. You must also specify a source for the scriptlet file. You can do this with the DATA attribute for the OBJECT tag or with a PARAM tag that has a NAME equal to url and a VALUE referencing the scriptlet's URL. Whenever you need to reference either an exposed scriptlet property or method, you must also assign a VALUE to the OBJECT tag's ID attribute. The ID setting represents the object in the host.

You can set a variety of other attributes at design or run time as the host loads the scriptlet file. For example, all scriptlets that provide user feedback should have HEIGHT and WIDTH settings. These expose a fixed area from the top-left corner of the scriptlet page. You can also specify a scroll-bar property. With a scroll bar, users can move the scriptlet window around to see different parts of the scriptlet page from the host.

An INPUT button in Container.html invokes TestS1.setUnit. This function activates the exposed method that toggles the SPAN's value. By changing the SPAN element's value, the button outside the scriptlet changes how the Header <H1> block responds to a click.

Code Gallery

Simple.html

```
<HTML><HEAD>
<TITLE>Scriptlet Example</TITLE>
<SCRIPT>
function public_setUnit() {
  if (document.all.Unit.innerText=="word"){
    document.all.Unit.innerText ="sentence";}
  else
    document.all.Unit.innerText ="word";}
function selectMe() {
  var r=document.body.createTextRange();
  r.moveToPoint(window.event.x, window.event.y);
  if (document.all.Unit.innerText=="sentence"){
    r.expand("sentence");}
  else
    r.expand("word");
    r.select();}
</SCRIPT>
</HEAD><BODY BGCOLOR=chartreuse>
<P  onclick=public_setUnit() STYLE="font-size:35">
Click me to toggle selection below between word
and sentence.</P>
<H1  onclick=selectMe() id=myH1>
Click on a <SPAN ID="Unit">word</SPAN>.
It will highlight.</H1>
</BODY></HTML>
```

Container.html

```
<HTML><HEAD>
<TITLE>Scriptlet Example</TITLE>
<SCRIPT LANGUAGE="JScript">
function rangeChange(){
TestS1.setUnit();}
</SCRIPT></HEAD>
<INPUT onclick="rangeChange()" TYPE=button
ID=Range VALUE="Toggle Range" STYLE="width:250">
<OBJECT ID="TestS1" TYPE="text/x-scriptlet" WIDTH=400
  HEIGHT=250 STYLE="position:absolute;top=75;left=0">
  <PARAM NAME=url value="Simple.htm">
</OBJECT></HTML>
```

Benefits

The most significant scriptlet benefit is that it lets DHTML developers encapsulate their code for reuse. Because scriptlets work in Internet Explorer 4 as well as native Windows applications, corporate developers can build and deploy components across a wide range of desktops

Because DHTML is proprietary, using it limits you to Microsoft browsers on Windows or the Mac. Thus, DHTML is not suitable for Web pages that cater to a wide range of customers. Instead, use it for Internet Explorer 4–specific sites and sites that auto-sense the browser. B

*Rick Dobson, Ph.D., (**RickD@cabinc.win.net**), is president of CAB, Inc., a database and Internet development consultancy. He is a contributing editor for Microsoft Interactive Developer. Visit his firm's Web site at* **http://www.cabinc.win.net.**

Relaying changes to data throughout a corporation's different systems poses a challenge. Here's help. ***By Bob Breton***

Reliable Data Replication

The average client/server site today runs 12 operating systems, nine databases, and 17 development tools. Add to that the trend toward decentralized organizations, the growth of data warehousing, plus new Web-centric applications, and it's easy to see why data replication has become a strategic part of corporate operations.

Business users expect full and easy access to corporate data when they need it; they want to be able to slice, dice, and examine it to their hearts' content. MIS is charged with protecting the integrity of this invaluable corporate asset, while also ensuring the peak performance of operational systems. What's needed to satisfy both audiences is a replication solution that enables current data to be placed where it's needed, when it's needed.

One clear indication that you need to replicate data is the hue and cry from your end users. If that is not enough to convince you, there are several tell-tale business requirements and situations that indicate the need; these are summarized on the next page in the text box "You Need to Replicate Data When..."

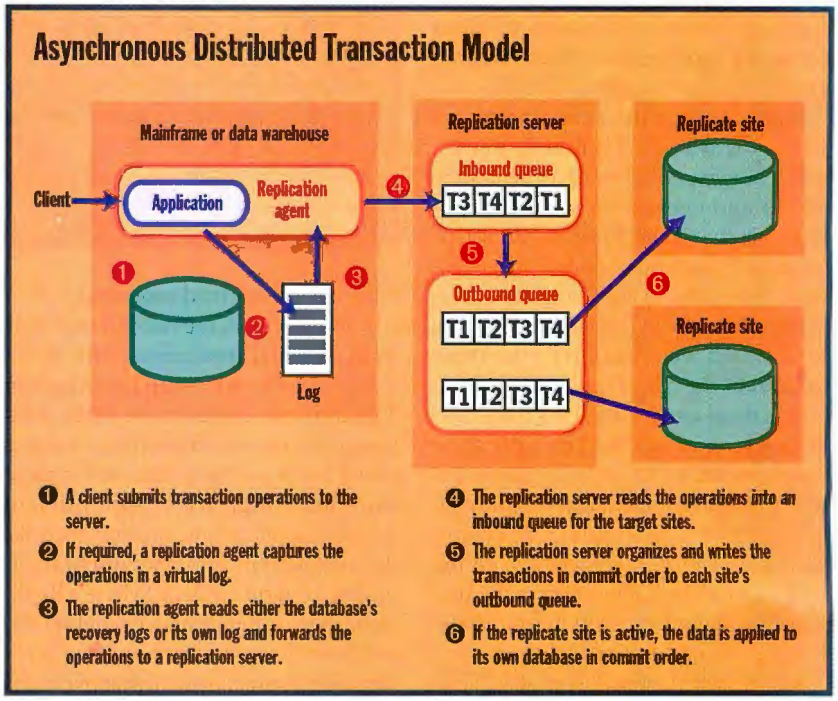
Choosing a Replication Strategy

There are a variety of ways to move data around the enterprise. Replication is a broad term that encompasses a variety of methods of data movement, including everything from simple, manual download/reload to automated, transaction-based methods. To determine how to best replicate your data, you first must clearly establish your requirements. Specifically, an effective data replication solution should be built on an open architecture and open APIs. This will ensure interoperability with a wide variety of data sources and targets, as well as with networks, operating systems, and future technologies. It should run asynchronously with operational applications, and it should refresh data with a reasonable latency that minimizes impact on operational systems. It is also important that a replication scheme be able to automatically recover from system and communication failures. Finally, it should be scalable and robust so that it can accommodate replicate subscriber growth. What follows are a few common strategies for dealing with replicating data.

The first strategy is known as dump-and-reload, also called "sneaker net." This involves manually distributing copies of data by transferring it to tape, for instance, and reloading it at a different site. Although this scheme is fairly easy, the replicated data can be days, weeks, or months old.

Another strategy is synchronous replication using a two-phase commit. As transactions occur, they are distributed to various sites by an elaborate handshake mechanism. Transactions are accepted only if all interconnected sites are available. While this can ensure real-time data synchronization, it has serious drawbacks. If any one site is unavailable, the transaction cannot complete, exposing the corporate information system to individual component outages. The handshake mechanism also puts a significant burden on the networks as it sends messages between sites attempting to coordinate acceptance of the data.

A third strategy is asynchronous repli-



Sybase's Replication Server uses transaction queues to provide data integrity in the event of a network outage or system failure.

cation via snapshots. Asynchronous snapshots involve the timely distribution of recent copies of data across the organization. This provides a more practical, cost-effective way of sharing data with less exposure in the event of network or component failures. The trade-off is that distributed sites have to work with data that is only as current as the snapshot interval. Care must be exercised that dependent tables are copied at the correct interval to ensure system consistency. For example, if invoices are copied before new customers are copied, then the replicate system might fail to correctly process new invoices for this customer.

Yet another strategy is the asynchronous distributed transaction model, which is increasingly the replication solution of choice. This model uses an event-driven mechanism that ensures the reliable, continuous delivery of transactions across the enterprise. *Event* in this context means any change to the data.

An example implementation of this strategy is Sybase's Replication Server. It uses a log-based approach to help coordinate and manage data changes, as shown in the figure "Asynchronous Distributed Transaction Model" (page 57). First, a replication agent captures database changes from the DBMS recovery logs, which were caused by database updates in the client application. Or, it inserts them into a virtual log if a recovery log is not available. The replication agents use the log to automatically transmit only the required changes to the replication server. The server in turn continually propagates table updates to the replicated copies. This ensures the best possible consistency across the enterprise without diminishing performance.

Remember: A critical issue in replicating data is consistency. The replication server receives the operations and places them into an inbound queue. It then writes the transactions in commit order into outbound queues for each active subscribing server. This store-and-forward mechanism insulates users from system or network failures. Since updates are distributed transactionally, replicate sites are always consistent. For example, if a new customer is added and an invoice is created in the same transaction, the replicate site commits the transaction only after receiving both updates. Because only changes to the data are distributed, the transactions are sent as they occur to the target systems. This strategy improves latency while reducing network overhead.

Real-World Replication

An effective replication system can provide operational efficiencies as well as a competitive edge. The southeastern division of Kaiser Permanente, a health-care delivery company, offers a case in point. Replication plays a key role in Kaiser Permanente's distributed enterprise.

Kaiser Permanente needed to supply its operational applications with up-to-the-minute membership information. This information resides in a DB2 database on an IBM mainframe, but it was necessary to get pertinent data into applications handling patient appointment scheduling, electronic medical records, decision support, and laboratory, radiology, and pharmacy data. Sybase's Replication Server, Replication Agent for DB2, and Open Server made it possible to replicate this information to these applications in near real time.

Every day, membership information changes on the company's mainframe. This amounts to some 15,000 transactions a day and about 1 GB of information. Originally, the IT staff queried the DB2 system to find out what data had changed. This required programming and took a lot of time. It also required the IT staff to timestamp all the updated information. This resulted in inconsistencies and inaccuracies in the information as it was copied to other applications. Now, as updates occur on the membership system, Sybase Replication Agent for DB2 automatically captures and sends them to a replication server. The server then distributes them to the pertinent applications.

Because of the diverse nature of its systems, Kaiser Permanente needed a heterogeneous replication solution. Its radiology, pharmacy, and decision-support systems use information replicated between DB2 and Sybase SQL Server. The company's laboratory system, however, employs a Universe database management system, while the electronic medical records system uses a MUMPS database with an EDI interface and an HL7 messaging system. To facilitate the replication of data to these systems, Kaiser Permanente used Sybase's Open Server to write applications that act as gateways to these non-Sybase systems. This solution allows data delivery in either real time or batch mode to Kaiser's OLTP and decision support applications. Critical patient information is sent to where it's most needed, and the company can migrate to more cost-effective platforms.

Today's user imperative—making information available where and when it's needed—requires a comprehensive replication solution. It must span mainframe, client/server, and desktop systems. It must also provide automatic recovery from failures. This seems like a tall order, but many organizations, like Kaiser Permanente, have found that the reward for meeting this challenge is a significant competitive edge. B

Bob Breton is responsible for product management and marketing for Sybase's replication and messaging technologies. He can be reached at **breton@sybase.com.**

You Need to Replicate Data When...

- You require a consolidated corporate overview of distributed operations that are running on a variety of DBMSes, or you need to supply consistent reference information across the enterprise.
- You want to place up-to-the-minute data closer to the business units that need it in order to insulate them from failures elsewhere on the network.
- You want to reduce network traffic and the overall communication costs of running against centralized systems.
- Operational systems are overloaded and ad-hoc access is disrupting on-line transaction processing (OLTP) response time.
- You have an occasionally connected mobile workforce that needs to access and update corporate systems.
- You're migrating off legacy systems and need to provide a transitional period for moving the data while keeping the systems in sync.
- You're planning to deploy a data warehouse or data mart and need to automate the movement of data between systems.
- Site failures are not adequately recovered using current disaster-planning strategies.

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See The Difference!

Crash-Proof Computing

Here's why today's PCs are the most crash-prone computers ever built—and how you can make yours more reliable.

By Tom R. Halfhill

Men are from Mars. Women are from Venus. Computers are from hell.

At least that's how it seems when your system suddenly crashes, wiping out an hour of unsaved work. But it doesn't have to be that way. Some computers can and do run for years between reboots. Unfortunately, few of those computers are PCs.

If mainframes, high-end servers, and embedded control systems can chug along for years without crashing, freezing, faulting, or otherwise refusing to function, then why can't PCs? Surprisingly, the answer has only partly to do with technology. The biggest reason why PCs are the most crash-prone computers ever built is that reliability has never been a high priority—either for the industry or for users. Like a patient seeking treatment from a therapist, PCs must *want* to change.

"When a 2000-user mainframe crashes, you don't just reboot it and go on working," says Stephen Rochford, an experienced consultant in Colorado Springs, Colorado, who develops custom financial applications. "The customer demands to know why the system went down and wants the problem fixed. Most customers with PCs don't have that much clout."

Fortunately, there are signs that everyone is paying slightly more attention to the problem. Users are getting fed up with time-consuming crashes—not to mention the complicated fixes that consume even more time—but that's only one factor. For the PC industry, the prime motives seem to be self-defense and future aspirations.

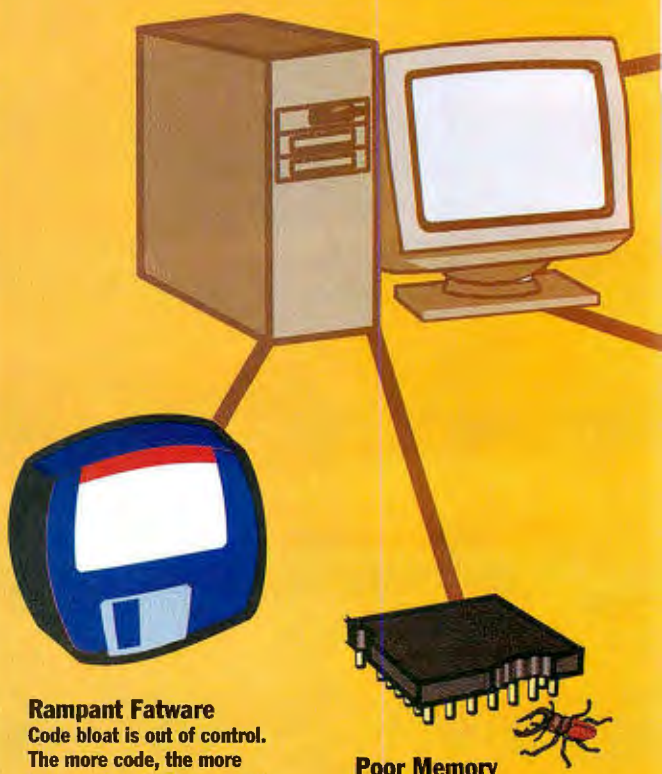
With regard to self-defense: Vendors are struggling to control technical-support costs, while alternatives such as network computers (NCs) are making IT professionals more aware of

Why PCs Crash . . .

Actually, mainframes do crash, but not like PCs—they don't just drop dead. Extremely rigid memory

So-What Attitude

PCs simply aren't designed to be reliable. From their hardware to their software, hardware and software developers cut corners, take chances, and value appearance over performance.



Rampant Fatware

Code bloat is out of control. The more code, the more bugs—unless testing expands, too. But developers are under more pressure to ship products in "Internet time." And virtually anyone can write and distribute software for PCs.

Poor Memory Protection

Buggy applications often squabble among themselves over scraps of memory and other system resources. OSes are gradually becoming better referees, but they still have a long way to go.

. . . and Mainframes Don't

protection, redundant hardware, and a totally different mind-set in the creation of software keep the mainframe up and running when similar errors on a PC might freeze it entirely.

Mission-Critical Attitude

For decades, high reliability has been a top priority for mainframe vendors. Mainframes can achieve 99.99 to 99.999 percent uptime and can cruise for as long as 20 years between critical failures.

Sloppy Administration

Millions of PC users are their own system administrators. They don't (or can't) keep maintenance logs, they rarely diagnose crashes, and they pay scant attention to system management.

Attentive Administration

Owners of expensive mainframes protect their investment by catering to the machine's every need. Full-time workers keep maintenance logs, troubleshoot problems, and approach changes with caution.

Cheap Hardware

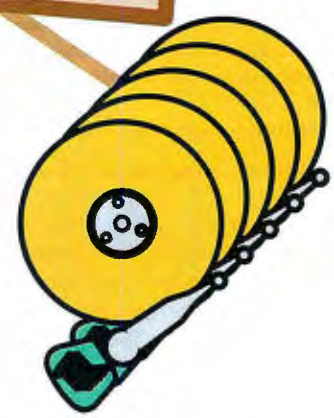
High-end PC servers have RAIDs, duplicate power supplies and fans, parity RAM, and other redundant parts. But most PCs use cheaper parts and have many single points of failure.

Reliable Software

Mainframe software doesn't grow by leaps and bounds. Customers demand a higher level of reliability, and they're willing to pay for it. Then, too, not just anybody can program a mainframe.

Robust Memory Protection

Mainframes do a much better job of insulating the OS, middleware components, and applications from each other so the system can recover from errors without rebooting.



Redundant Hardware

Mainframes have top-quality, redundant, hot-swappable components, and a typical installation might have a cluster of machines in case one system fails.

Why Mainframes Rarely Crash

Mainframes can achieve "four nines" or "five nines" availability: 99.99 or 99.999 percent uptime. That translates into only 5 to 53 minutes of downtime per year. In fact, IBM's Server Group claims that the mean time between critical failures (MTBCF) for its System/390 mainframes—that is, the average time between failures that force a reboot and an initial program load—is 20 to 30 years.

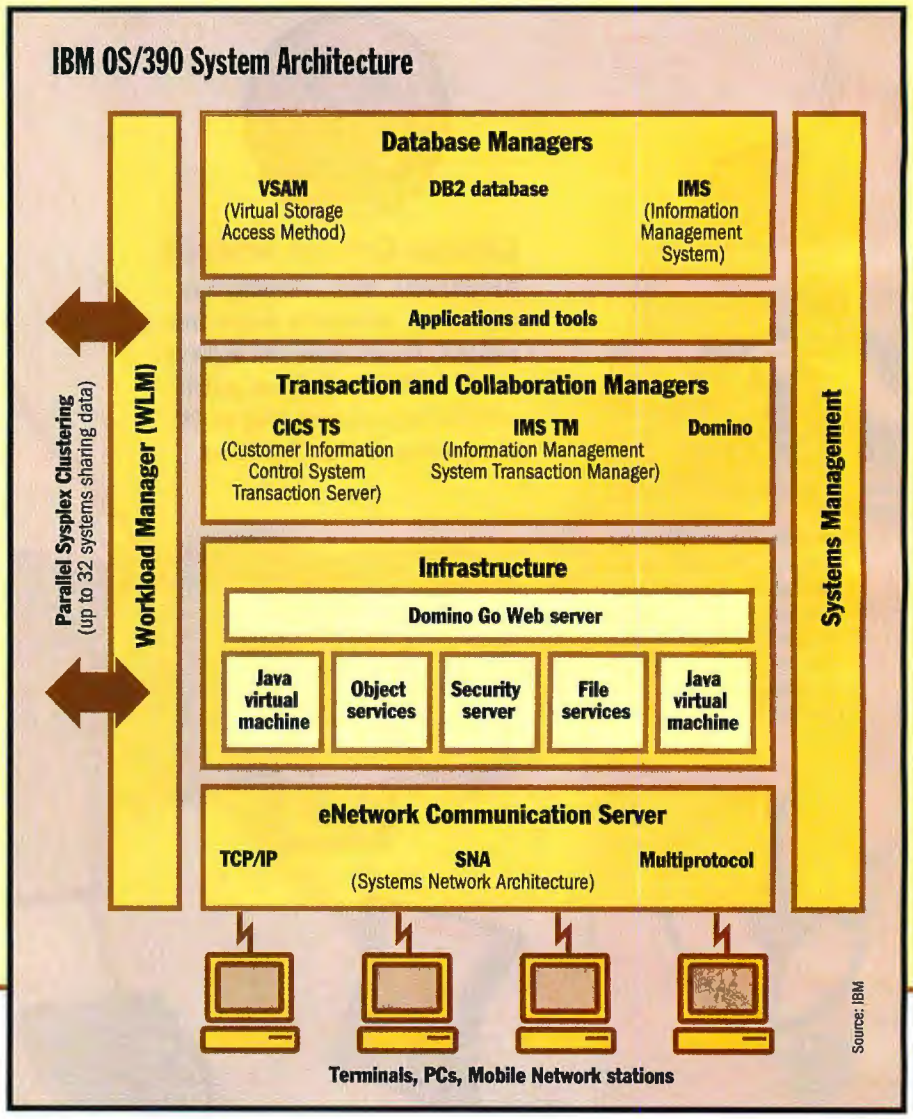
Millions of PC users would be overjoyed with an MTBCF of just one day. Yet mainframes are big, complex systems that often have clusters of CPUs, gigabytes of main memory, and thousands of users. What makes them so reliable?

Mainframe experts say that it's a matter of priorities. When a PC crashes, even the system administrator might not hear about it, much less the vendors who made the system, the OS, and the application software. The user shrugs, reboots, and keeps right on working. When a mainframe crashes, however, it's a major catastrophe. It's General Motors calling up IBM to demand answers. And even if GM doesn't make the call, the mainframe does. Periodically, the massive machines dial up IBM's lab in Poughkeepsie, New York, to upload error logs and download updates. "Even if it doesn't crash, we know about it," says Lisa Spainhower, System/390 senior technical staff member.

During the beginning of the 1980s, Big Blue set a goal of increasing availability by a factor of 100, as measured by yearly uptime. IBM achieved that goal, says Spainhower. "Frankly, we didn't do it because it was a fun engineering project," she explains. "We did it because our customers demanded it."

Because everyone keeps detailed logs, problems rarely get ignored for long. There's too much at stake. Of course, it helps that mainframes have full-time technicians available to keep them up and running. They also have redundant hardware, extremely protective OSes, and stable applications.

"The design of a crash-proof system must be pervasive," explains Guru Rao, System/390 chief engineer. "It starts with your choice of technology and components, and it extends all the way



the hidden expenses of PCs. With regard to future aspirations: The PC industry covets the prestige and lush profit margins of high-end servers and mainframes. But processing power alone does not a mainframe make. When the chips are down, high availability must be more than just a promise.

That's why the PC industry is working on solutions that should make crashes a little less frequent. We're starting to see OSes that upgrade themselves, applications that repair themselves, sensors that detect impending hardware failures, development tools that help programmers write cleaner code, and renewed interest in the time-tested technologies found in mainframes and mission-critical embedded systems. As a bonus, some of those improvements will make PCs easier to manage, too.

But don't celebrate yet—it's hardly a revolution. Change is coming slowly, and PCs will remain the least reliable computers for years to come.

CRASH TIP

Install as little software as possible. You'll have fewer software conflicts, an easier-to-manage system, and more disk space available for your own stuff. Unfortunately, this advice clashes with the reason why computers were invented in the first place: to run software.

Why PCs Crash

Before examining the technical reasons why PCs crash, it's useful to analyze the psychology of PCs—by far the biggest

to the design of the OS, the hardware and software, and the customer's applications."

System/390 maintains separate memory partitions for the OS (OS/390), the software-subsystem components (e.g., DB2 database drivers), the transactional middleware (e.g., the Customer Information Control System, or CICS), and the applications. IBM introduced this so-called Enterprise Systems Architecture (ESA) in the late 1980s, basing it on the earlier partitioning of MVS (Multiple Virtual Storage). Compared to MVS, ESA has more partitions and faster interprocess communications (IPC).

As a result, it's exceedingly rare for a crashed application to bring down the entire system. Even if a critical middleware component, such as CICS, fails, System/390's automatic restart manager can restore the task.

"These systems, like PCs, do fail," notes Spainhower. "It's just that when they fail, they detect the errors and recover from them with greater reliability."

Interestingly, mainframe OSes aren't any bigger than OSes for PCs. They contain a lot less code to support GUIs, and a lot more code for error detection, error isolation, and recovery. They're not growing as fast as OSes for PCs are, and their code tends to remain more stable.

"It would almost take an act of God to change the dispatcher in IBM's mainframe OS," says Dr. Barry Feigenbaum, senior software engineer for IBM network-computing software solutions. "It's not quite the same on PC OSes."

As ambitious PC vendors try to encroach on the territory of enterprise servers, they will have to address the same concerns that mainframe vendors did in the 1980s. The contest isn't about megahertz and megabytes; it's about high availability. And that will require PC vendors to radically change their priorities.

reason for their misbehavior. The fact is, PCs were born to be bad.

"The fundamental concept of the personal computer was to make trade-offs that guaranteed PCs would crash more often," declares Brian Croll, director of Solaris product marketing at Sun Microsystems. "The first PCs cut corners in ways that horrified computer scientists at the time, but the idea was to make a computer that was more affordable and more compact. Engineering is all about making trade-offs."

It's not that PC pioneers weren't interested in reliability. It's just that they were more interested in chopping computers down to size so that everybody could own one. They scrounged the cheapest possible parts to build the hardware, and they took dangerous shortcuts when writing the software.

For instance, to wring the most performance out of slow CPUs and a few kilobytes of RAM, early PCs ran the application program, the OS, and the device drivers in a common address space in main memory. A nasty bug in any of those components would usually bring down the whole system. But OS developers didn't have much choice, because early CPUs had no concept of protected memory or a kernel mode to insulate the OS from programs running in user mode. All the software ran in a shared, unprotected address space, where anything could clobber anything else, bringing the system down.

CRASH TIP

Install more RAM. Yeah, everybody says it, but it's true. If you can't stop buggy programs from leaking memory, you can at least give them more memory to leak. How much RAM do you need? According to a scientific survey of experts, you always need $n + 16$ MB, where n equals the amount of RAM you have now.

Ironically, though, the first PCs were fairly reliable, thanks to their utter simplicity. In the 1970s and early 1980s, system crashes generally weren't as common as they are today. (This is difficult to document, but almost everyone swears it's true.) The real trouble started when PCs grew more complex.

Consider the phenomenal growth in code size of a modern OS for PCs: Windows NT. The original version in 1992 contained 4 million lines of source code—considered quite a lot at the time. NT 4.0, released in 1996, expanded to 16.5 million lines. NT 5.0, due this year, will balloon to an estimated 27 million to 30 million lines. That's about a 700 percent growth in only six years.

"People who build reliable systems don't radically change the system very often," says Sun's Croll. (Solaris is holding fairly steady at 7 million to 8 million lines of code.) "PCs tend to have boatloads of fresh, virgin, untested code. The sheer number of lines of code makes bugs more likely. The code you never write has no bugs."

Engineers who work with mainframes and critical embedded systems agree. "Having 15 million lines of code isn't as bad as having 15 million lines of new code," notes Wayman Thomas, director of mainframe solutions for Candle, which makes performance monitors and other software for large-scale servers and mainframes. (See the text boxes "Why Mainframes Rarely Crash" at left and "Embedded Reliability: Bet Your Life" on page 69.)

However, Russ Madlener, Microsoft's desktop OS product manager, says that code expansion is manageable if developers expand their testing, too. He says the NT product group now has two testers for every programmer. "I wouldn't necessarily say that bugs grow at the same rate as code," he adds.

It's true that NT is more crash-resistant than Windows 95, a smaller OS that's been around a lot longer. And both crash less often than the Mac OS, which is older still. In this case, new technology compensates for NT's youth and girth. NT has more robust memory protection and rests on a modern kernel, while Windows 95 has more limited memory protection and totters on the remnants of MS-DOS and Windows 3.1. The Mac OS has virtually no memory protection and allows applications to multitask cooperatively in a shared address space—a legacy of its origins in the early 1980s.

Still, it will be interesting to see how stable NT remains as it grows fatter. And grow fatter it will, because nearly everybody wants more features. Software vendors want more features because they need reasons to sell new products and upgrades. Chip makers and system vendors need reasons to sell bigger, faster computers. Computer magazines need new things to write about. Users seem to have an insatiable demand for more bells and whistles, whether they use them or not.

"The whole PC industry has come to resemble a beta-testing park," moans Pavle Bojkavski, a law student at the University of Amsterdam who's frustrated by the endless cycle of crashes, bug fixes, upgrades, and more crashes. "How about developing stable computers using older technology? Or am I missing a massive rise in the number of masochists globally who just love being punished?"

Although there are dozens of technical reasons why PCs crash, it all comes down to two basic traits: the growth spurt of complexity, which has no end in sight, and the low emphasis on reliability. Attempts to sell simplified computers (such as NCs) or scaled-down applications (such as Mi-

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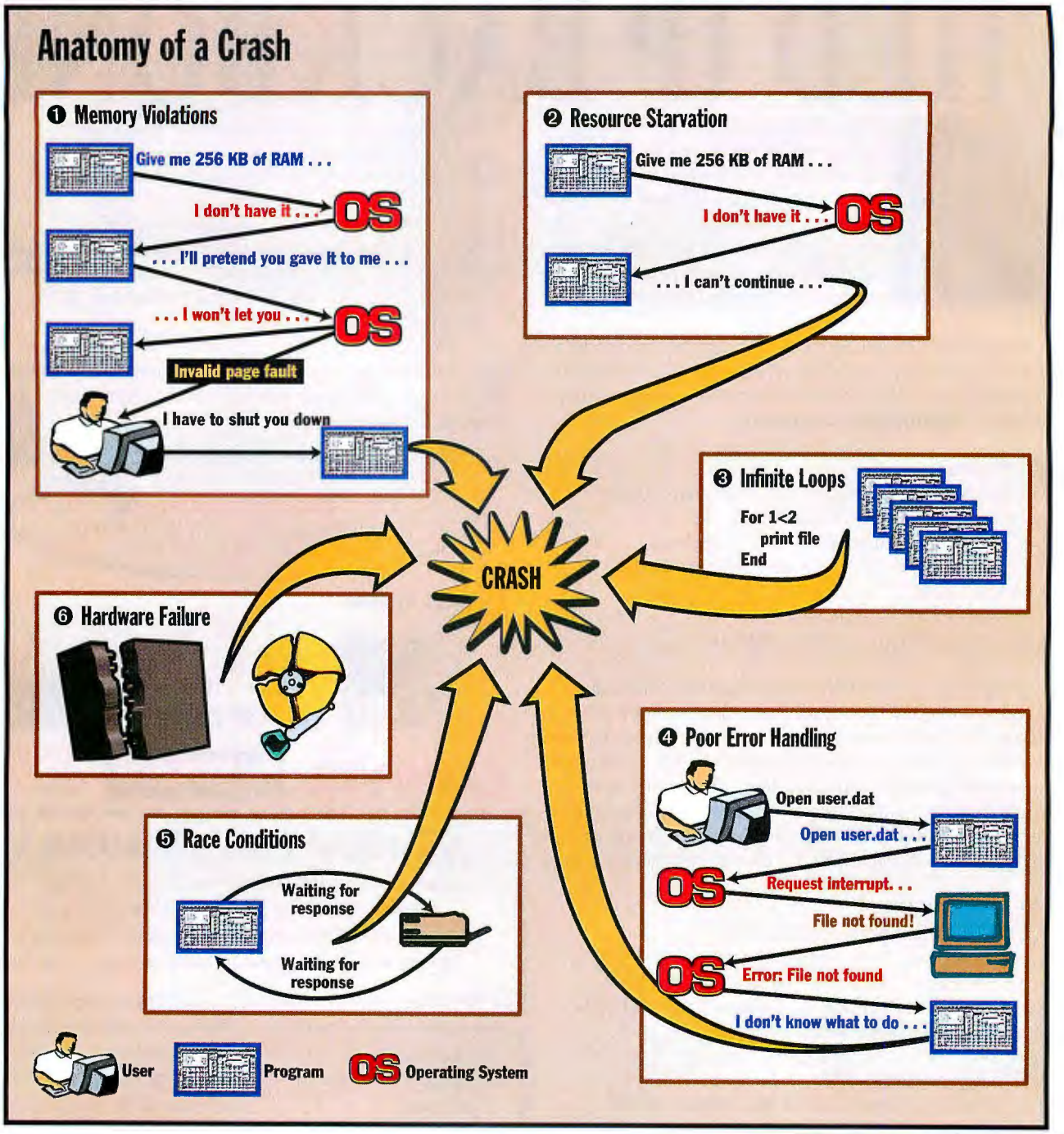


crosoft Write) typically meet with resistance in the marketplace. For many users, it seems the stakes aren't high enough yet.

"If you're using [Microsoft] Word and the system crashes, you lose a little work, but you don't lose a lot of money, and no one dies," explains Sun's Croll. "It's a worthwhile trade-off."

Causes Behind Crashes

You can sort the technical reasons for crashes into two broad categories: hardware problems and software problems.

Genuine hardware problems are much less common, but you can't ignore the possibility. One downside to the recent sharp drop in system prices (see "Disposable PCs," February) is that manufacturers are cutting corners more closely than ever before. Inexpensive PCs aren't necessarily shoddy PCs, but sometimes they are. (See the text box "It's a Hardware Problem!" at right.)

Another cause of mysterious crashes, outright sabotage, is beyond the scope of this article. The dangers of viruses, worms, and Trojan horse programs are well documented, and it's really a security issue. And, of course, nefarious behavior isn't limited to software. In a study of 10,000 help-desk calls, analysts at Workgroup Technologies discovered that 10 calls in one month at one company came from users whose SIMMs had been stolen. A former CIO at a publishing company told BYTE that his employees frequently upgraded their systems by pilfering SIMMs from other employees' machines. (Robin Hood strikes again.)

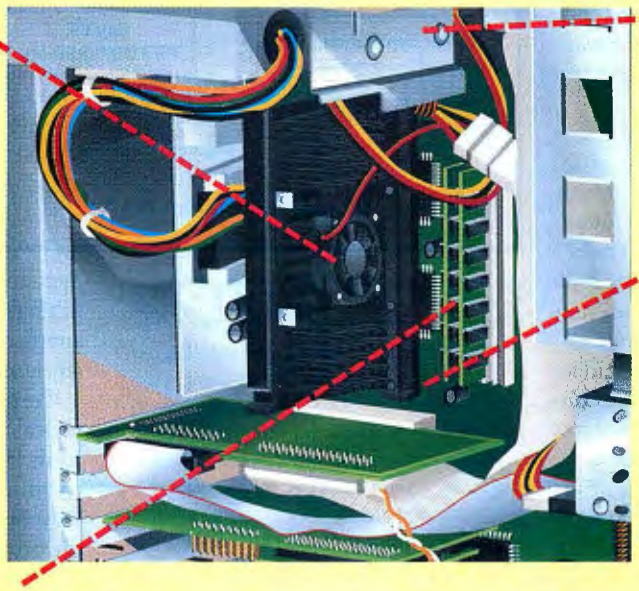
It's a Hardware Problem!

Sometimes the programmers are right—it really *is* a hardware problem. It's relatively rare, compared to the number of bugs that occur in software, but it does happen.

Scott Mueller, author of *Upgrading and Repairing PCs* (Eighth Edition, Que, 1997), sees all kinds of hardware problems during the course of his consulting work as president of Mueller Technical Research. "It has a lot to do with the way computers are built today," he explains. "There's a lot of skimping going on."

When in doubt, advises Mueller, stick with companies you recognize. "Generally, a name brand is an insulating factor," he says.

Cooling fans are a major source of trouble, especially the small CPU fans. Less expensive fans have sleeve-bearing motors instead of ball-bearing motors, and sleeve bearings have a life expectancy of only about a year. To make things worse, some retailers sell Intel chips intended for OEMs, and the OEM chips don't have genuine Intel fans. That's why some retailers offer very short warranties, often as little as 30 days, on those chips. Intel's "boxed processors," which are made for retail sale, come with a genuine Intel fan and a three-year warranty. The fan has a ball-bearing motor and a sensor that detects if the fan stops turning. If that happens, the CPU steps down to a slower, cooler clock frequency to prevent damage.



The most trouble-prone component of PCs is the power supply, according to Mueller. Prices for a 200-W power supply vary from $14 to over $100. "Guess which one Joe's Computer Shack is going to sell you?," he asks.

Some motherboards use aluminum electrolytic capacitors instead of costlier tantalum capacitors. Over time, the cheap capacitors dry out and lose their effectiveness. Because the motherboards need the capacitors for signal buffering and conditioning, the result is a series of hard-to-diagnose crashes. It's difficult to distinguish between the two types of capacitors—tantalum parts might be a little larger—so the best bet is to stick with name-brand motherboards.

Memory is another common source of problems. Mueller warns against putting gold-plated SIMMs and DIMMs in tin-plated sockets or vice versa. The dissimilar metals cause "fretting corrosion" in about six months. Result: mysterious crashes. Cure: Use contact cleaner to remove the corrosion, and don't mix tin and gold contacts.

Generally, though, when a computer crashes, it's the software that's failed. If it's an application, you stand to lose your unsaved work in that program, but a good OS should protect the memory partitions that other programs occupy. Sometimes, however, the crashed program triggers a cascade of software failures that brings down the entire system.

Then the only recourse is to reboot, sacrificing unsaved work in all open applications. And because neither the OS nor the applications get a chance to clean up after themselves—by closing open files, deleting temporary files, flushing I/O channels, and so forth—an abrupt reboot can leave debris on the hard disk or even scramble the disk. This leads to more instability, more crashes, and lost data.

So why do programs crash? Chiefly, there are two reasons: A condition arises that the program's designer didn't anticipate, so the program doesn't handle the condition; or the program anticipates the condition but then fails to handle it in an adequate manner.

CRASH TIP

Periodically flush your system. One of the surprising things BYTE learned while researching this article is that an apparently large number of users reformat their hard drives and reinstall all their software on a fairly regular basis. Even some companies do it. Some do this as often as twice a year. It seems drastic, but they claim it significantly improves reliability and performance.

In a perfect world, every program would handle every possible condition, or at least it would defer to another program that can handle it, such as the OS. But in the real world, programmers don't anticipate everything. Sometimes they deliberately ignore conditions that are less likely to happen—perhaps in trade for smaller code, faster code, or meeting a deadline. In those cases, the OS is the court of last resort, the arbiter of disturbances that other programs can't resolve. "At the OS level, you've got to anticipate the unanticipated, as silly as that sounds," says Guru Rao, chief engineer for IBM's System/390 mainframes.

To deal with these dangers, programmers must wrap all critical operations in code that traps an error within a special subroutine. The subroutine tries to determine what caused the error and what should be done about it. Sometimes the program can quietly recover without the user's knowing that anything happened. In other cases, the program must display an error message asking the user what to do. If the error-handling code fails, or is missing altogether, the program crashes.

Autopsy of a Crash

Crash is a vague term used to describe a number of misfortunes. Typically, a program that crashes is surprised by an exception, caught in an infinite loop, confused

by a race condition, starved for resources, or corrupted by a memory violation.

Exceptions are run-time errors or interrupts that force a CPU to suspend normal program execution. (Java is a special case: The Java virtual machine [VM] checks for some run-time errors in software and can throw an exception without involving the hardware CPU.) For example, if a program tries to open a nonexistent data file, the CPU returns an exception that means "File not found." If the program's error-trapping code is poor or absent, the program gets confused.

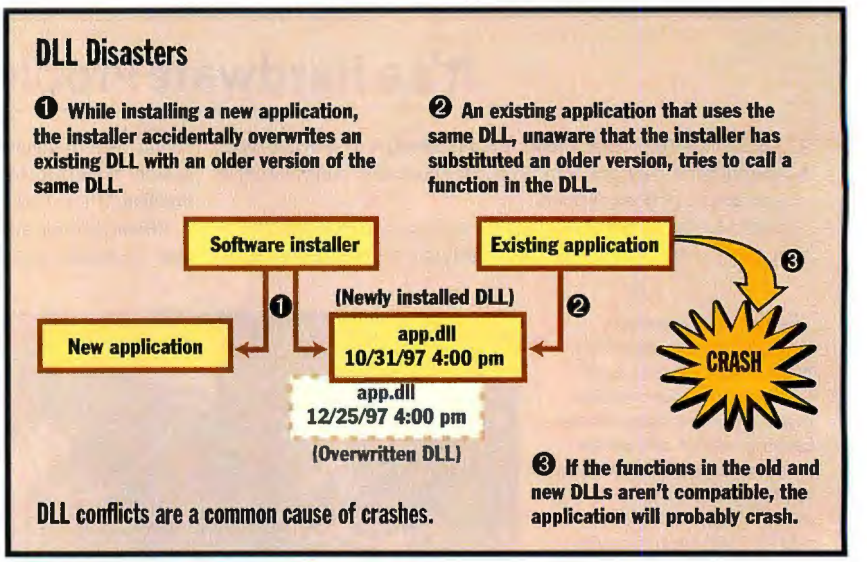
That's when a good OS should intervene. It probably can't correct the problem behind the scenes, but it can at least display an error message: "File not found: Are you sure you inserted the right disk?" However, if the OS's error-handling code is deficient, more dominoes fall, and eventually the whole system crashes.

Sometimes a program gets stuck in an infinite loop. Due to an unexpected condition, the program repeatedly executes the same block of code over and over again. (Imagine a person so stupid that he or she follows literally the instructions on a shampoo bottle: "Lather. Rinse. Repeat.") To the user, a program stuck in an infinite loop appears to freeze or lock up. Actually, the program is running furiously.

Again, a good OS will intervene by allowing the user to safely stop the process. But the process schedulers in some OSes have trouble coping with this problem. In Windows 3.1 and the Mac OS, the schedulers work cooperatively, which means they depend on processes to cooperate with each other by not hogging all the CPU time. Windows 95 and NT, OS/2, Unix, Linux, and most other modern OSes allow a process to preempt another process.

Race conditions are similar to infinite loops, except they're usually caused by something external to the program. Maybe the program is talking to an external device that isn't responding as quickly as the program expects—or the program isn't responsive to the device. Either way, there's a failure to communicate. The software on each end is supposed to have timeout code to handle this condition, but sometimes the code isn't there or doesn't work properly.

Resource starvation is another way to crash. Usually, the scarce resource is memory. A program asks the OS for some free memory; if the OS can't find enough memory at that moment, it denies the request.



CRASH TIP

Run as little software as possible. Do you really need to have five different applications open at once? Sure, it's convenient, but they'll squabble like naughty children over resources, and they'll increase the frequency of page faults (i.e., memory accesses that force the system to retrieve virtual pages from disk instead of from RAM).

Again, the program should anticipate this condition instead of going off and sulking, but sometimes it doesn't. If the program can't function without the expected resources, it may stop dead in its tracks without explaining why. To the user, the program appears to be frozen.

Even worse, the program may assume it got the memory it asked for. This typically leads to a memory violation. When a program tries to use memory it doesn't legitimately own, it either corrupts a piece of its own memory or attempts to access memory outside its partition.

What happens next largely depends on the strength of the OS's memory protection. A vigilant OS won't let a program misuse memory. When the program tries to access an illegal memory address, the CPU throws an exception. The OS catches the exception, notifies the user with an error message ("This program has attempted an illegal operation: invalid page fault"), and attempts to recover. If it can't, it either shuts down the program or lets the user put the program out of its misery.

Not every OS is so protective. When the OS doesn't block an illegal memory access, the errant program overwrites memory that it's using for something else, or it steals memory from another program. The resulting memory corruption usually sparks another round of exceptions that eventually leads to a crash.

Corruption also occurs when a program miscalculates how much memory it already has. For instance, a program might try to store some data in the nonexistent 101st element of a 100-element array. When the program overruns the array bounds, it overwrites another data structure. The next time the program reads the corrupted data structure, the CPU throws an exception. Wham! Another crash.

Altered States

Modern PCs suffer from a whole other class of problems related to their *state*—the sum total of all the information that defines the machine's status or condition. State information includes all the software installed on the hard disk, the configuration files, the control panel settings, the configurable data in the BIOS, and the user's preferences settings. It's everything that makes one system different from another system that has identical hardware.

Before PCs had hard drives, they were essentially stateless. They stored everything on floppy disks and tapes. Users and administrators never had to install, uninstall, or manage any software on the system. Because the state information was independent of the machine, it was almost impervious to any disaster that befell the machine. If a meteor destroyed your PC, you could replace it with another PC and get back to work immediately. There was nothing to reinstall or reconstruct. (Today, NCs attempt to re-create this pure state-

Embedded Reliability: Bet Your Life

Your life literally depends on millions of invisible computers that control everything from commercial airliners and antilock braking systems to traffic lights and medical equipment. It's a good thing those computers don't crash as often as PCs, because real life does not let you undo.

Embedded control systems far outnumber PCs, and they're multiplying faster than AOL disks. Occasionally they do fail, sometimes with catastrophic results. In 1996, an Ariane 5 rocket exploded after a program tried to stuff a 64-bit value into a 16-bit variable. In 1991, an Iraqi Scud missile killed 28 Americans when a computer's clock drift prevented a Patriot missile battery from tracking the target accurately. In 1986 and 1987, three cancer patients died when a pair of Therac-25 radiation-therapy machines accidentally blasted them with lethal doses of radiation.

But those kinds of failures make news precisely because they're rare. Millions of vehicles and other devices work flawlessly, day after day. What makes embedded systems so reliable?

Experts cite three factors: Reliability is a high priority; developers try to keep embedded systems as simple as possible; and developers

and customers alike resist making extensive changes to smoothly running systems.

IBM was the prime contractor for many of the software systems on the Space Shuttle. It took eight years to write the first programs, says Dr. Barry Feigenbaum, senior software engineer for IBM network-computing solutions. Neither IBM nor NASA is eager to change the code. "Old vintage code tends to be more reliable than new, fresh code that hasn't aged yet," he points out.

The microkernel in QNX Software Systems' embedded OS has not changed at all since 1991, notes Greg Bergsma, corporate communications manager for QNX. The QNX OS is found in the monitoring equipment at nuclear power plants, medical-imaging devices, chemical-processing systems, the Space Shuttle's "Canadarm," and the Shuttle's new payload bay vision system. Some QNX systems have been running without a reboot for three years.

QNX keeps the microkernel small—just 10 KB—and it contains only 14 calls. Just the kernel and the interrupt-service routines run in ring 0 (x86 terminology for a supervisor, kernel, or executive mode). Everything else—the file system, device managers, network services, the optional GUI, and other pieces of system software—runs as independent processes in separate partitions. One process is a "software watchdog," dedicated to handling memory violations.

To minimize complexity, some embedded systems shun multithreaded code, which is thorny to debug. NASA almost lost control of the Mars Pathfinder last year when a thread-priority conflict caused the lander's computer to repeatedly reboot itself. Engineers at the Jet Propulsion Laboratory traced the problem to a wrongly initialized Boolean parameter in Wind River's VxWorks OS. Luckily, they were able to upload a patch; on-site service wasn't an option.

That tale and other famous failures should raise a red flag for PC developers, who hurry larger programs to market with less testing. Unfortunately, the cold, hard realities of the marketplace make it almost impossible for PC developers to borrow much wisdom from their embedded-systems brethren.

lessness by storing everything on a server.)

By contrast, modern PCs hoard an immense amount of state information that's constantly changing. Even when you're staring blankly at the screen, a brief flurry of disk activity might signal that your OS is modifying its registry settings in the background. Problems arise when a change of state knocks the system off balance. Usually this happens after the installation of some new software—a new version of the OS, a new application, an updated device driver, or just about anything. Suddenly the system doesn't work like it used to. You are the victim of a software conflict that's often incredibly difficult to fix because you're not sure what changed or how to change it back.

CRASH TIP

Don't be a beta booby. Public beta releases are all the rage, but remember: "Beta" means "buggy." If you have a compelling reason to test some beta software, install it on a system you don't need for productivity. To do otherwise is like pasting a "Crash Me" sticker on your back.

Two of the biggest culprits are DLLs on Windows PCs and extensions on Macs. DLLs are code libraries that different programs can share. Extensions are programs that hook into the Mac OS during boot-up to modify the system's behavior or augment the capabilities of an application. Both types of components inflict ridiculous amounts of aggravation.

One common problem occurs when a software installer dumbly replaces a newer version of a component with an older version. The newly installed application works fine, but an existing application might start crashing. Users aren't sure whom to blame. Result: a series of frustrating tech-support calls.

Shouldn't the installer merely check a component's date stamp before replacing it? Alas, it's not always that simple. Sometimes the date stamp isn't definitive, or maybe it has changed. Windows allows an installer to query a DLL to discover its actual version number, which is safer. But even if every installer were this careful, version management is only one problem. "Some companies tend to change functions in a common DLL without telling everyone right away, and those changes can cause problems for existing programs," says Dave Galligher, product-development manager at Cougar Mountain Software, an accounting software vendor.

Programs expect their DLLs to contain functions that have a particular name, a particular list of calling parameters, and particular return values. But Windows has no standard mechanism for querying a DLL to confirm this information. A program that relies on a DLL function to return a 32-bit integer value could easily crash if a different version of the DLL returns a 64-bit-long integer instead.

The problem of managing a system's state has spawned a whole subindustry of utility programs and management tools: CleanSweep, Conflict Catcher, Extensions Manager, First Aid Deluxe, Norton Utilities, Oil Change, RealHelp, TuneUp, Uninstaller, and dozens more. OS vendors are rapidly adding new management features to their system software, too. It's all because today's PCs require more care and feeding than a barrel full of Tamagotchi Giga Pets.

It's also a classic example of accelerating complexity. Components such as DLLs were invented to reduce complexity; programs wouldn't grow so fast if they shared common code. But installers be-

gan splattering so many DLLs all over the hard disk that they created a new problem. That, in turn, spurs the industry to produce new management tools, utilities, and OS features—still more complexity. It starkly demonstrates how difficult it will be to transform PCs into truly reliable systems.

"The highest management cost in an IT environment comes from managing PCs," says Steve Mann, vice president of product strategy for Computer Associates. "They're not very manageable, and they're not very standardized in terms of configurations."

The chore of managing PCs is directly related to reliability. In a survey of 1800 IT professionals at the Computer Associates world user conference in 1997, 70 percent of the respondents agreed that mainframes are more reliable than PC-based client/server systems. "It's only recently that administrators have begun demanding the same levels of manageability and reliability that they're used to with mainframes and large servers," says Mann.

Searching for Solutions

Any solution must start with the way developers write, test, and debug their source code. Beyond that, installers must do a better job of loading finished programs onto systems. Finally, the OSes and applications must work together to make PCs easier to manage.

At the risk of igniting a flame war, it's only logical to place a large portion of the blame where it belongs: on C and C++. "Writing in C or C++ is like running a chain saw with all the safety guards removed," says Bob Gray, senior director of consulting services for Virtual Solutions, a developer of custom industrial applications. "It's powerful, but it's easy to cut off your fingers."

Few, if any, languages make it so easy to write bad code. Of course, anyone can write bad code in any language, but C and C++ are famously unforgiving. The computer industry standardized on C/C++ for commercial software development over a decade ago, creating a mountain of buggy software that will haunt us for decades to come.

Diehards protest that the sparsity of C/C++ is what makes it so fast. But PC hardware is getting so fast anyway that it's time to refocus instead on reliability. In the years ahead, as old-but-indispensable C/C++ programs continue to crash, the excuse that C/C++ conserves every CPU cycle will seem quaint—as quaint as coding the year in two digits instead of four, thus conserving 2 bytes of storage.

What's the alternative? Take your pick. All fourth-generation-language (4GL) tools are safer, including Delphi, PowerBuilder, TopSpeed, Smalltalk, and Visual Basic. Perhaps the best example of a modern language is Java. It contains numerous safeguards that stop many bugs before they happen (see the text box "Better Tools for Better Code" on page 72).

Rushing development cycles to match "Internet years" is another source of trouble. "If you look at the industry today, we see six- or nine-month development cycles instead of 18-month cycles," says Gary Ulaner, group product manager for Quarterdeck's RealHelp. "There are also more programmers doing software development, and not all of them have the same level of discipline for quality assurance. The requirements of time to market and revenue often cause products to be shipped before they're ready."

One dubious solution is public beta testing. Time was, you had to be someone special to be a beta tester. Now anybody who has a computer, a modem, and a reckless disregard for system stability can test beta software. The novelty of being an insider who runs prerelease products (even if a million other people are doing the same thing) has made public betas a huge hit. But public betas are also responsible for spreading buggy code, leaving a wake of system crashes and trashed hard drives.

"Some people might not realize what

Crash-Proof Tools

It seems silly to buy fast hardware and install the latest version of a desktop OS but then limit yourself to installing and running as few applications as you can. Yet that's the best way to keep crashes to a minimum. But isn't there something out there that will let you have your cake and eat it, too? The answer is yes. There's a variety of tools that can help you avoid crashes and recover from them a little more gracefully. Here are four.

Symantec Norton Utilities

Available in both Macintosh and Windows versions (although they are different), Symantec's Norton Utilities includes CrashGuard, Symantec's entry in the "catch the crash before it happens" field. The package also includes Symantec's mature Disk Doctor, for repairing damaged disk drives, and the Macintosh version includes a bootable CD-ROM. See http://www.symantec.com/.

Cybermedia FirstAid

Of all the features that are included in the FirstAid package, two are aimed specifically at killing system crashes: FirstAid Guardian and AutoFix. FirstAid Guardian monitors your system to watch for crashes, and it tracks changes to your system, making it easier to uninstall software. AutoFix can scan your system for missing or misplaced drivers and DLLs and automatically repair them. See http://www.cybermedia.com/products/firstaid/fahome.html.

Casady & Greene Conflict Catcher

On the Macintosh, extension conflicts are the source of a large number of system crashes. Conflict Catcher (which now supports Mac OS 8.1) has the ability to check for potential conflicts and allows you to choose which extensions to load. See http://www.casadyg.com/C&G/Products/CC4/features.html.

Network Associates Nuts & Bolts

The Nuts & Bolts utility includes two tools that are of particular interest to the anti-crash crowd. First is the Registry Wizard, which is a tool for making sense of the Windows Registry. More important is the Bomb Shelter tool, which (in theory, anyway) catches crashes before they happen and enables you to close the program that's crashing. See http://www.nai.com/products/retail/diagnostic/nuts.asp.

–John Montgomery

CRASH TIP

Buy good hardware. A brand-name motherboard, no matter where it's made, is more reliable than a cheap generic one, and the cost difference isn't huge. Spend a few dollars more on things like cooling fans and power supplies. Buy the kinds of SIMMs your motherboard supplier recommends. Buy good cables. Little things matter.

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"the Microway system blew away the best Intel-based workstations we've tested. . .on our number-crunching Lightwave 3D test."

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beta means," says Virtual Solutions' Gray. "It's not just a trick way to get an early copy of a new product."

True, public betas expose fresh code to mass testing. But how many casual beta testers report unique bugs—or any at all? How many of them bother to remove the buggy software (including all its hidden components) from their system after the final product ships? How many realize what they're doing to their systems?

Microsoft's Madlener defends the practice of public betas but acknowledges that developers and users should be more careful. "Of late, we've been reviewing the disclaimer messages that come with these beta products," he says. "They call for some responsibility on the part of the beta testers, too, so they don't install the beta on a system that's mission-critical."

The next step is software installation—and installers need to get smarter. OS/2 Warp 4 has an integrated Feature Installer that makes sure the right files get saved in the right places without stepping on other components. It's not just for installing OS software, either; third-party developers can use it for applications. Unix package installers, who have been around a lot longer, do the same thing. There are also some good third-party installers, such as InstallShield for Windows and MindVision's Installer VISE for the Mac.

CRASH TIP

If it ain't broke, don't fix it. Stable systems are stable because they don't change much. (Duh.) Don't upset a system by endlessly tinkering with it—unless tinkering is your hobby or you get paid to write about your adventures, as Jerry Pournelle does.

Madlener says Windows NT 5.0 will have a new Application Installer Service, which sounds a lot like OS/2's Feature Installer. It means that developers will no longer have to write their own setup code. Instead, NT 5.0 will execute a script that tells where each file goes. NT will arbitrate any DLL conflicts and keep a log of all new files and registry changes. According to Madlener, this will make it easier to cleanly uninstall the software or reinstall individual components.

Madlener says he doesn't know yet if other versions of Windows will get the installer, but he says Windows 98 will have a management tool called the System File Checker. This is a diagnostic program that

Better Tools for Better Code

Debates concerning the merits of various programming languages often reach a near-religious fervor. Not everyone shares the same priorities.

In the early days of computing, raw performance was the chief goal. When computers got faster, compiled languages, such as COBOL and C, largely replaced assembly language. This was because code portability and shorter development cycles became more important than maximum performance. When code reusability became an issue, object-oriented languages, such as C++, gained popularity. The 50-year trend in programming has been to trade off execution speed for more efficient development and higher levels of abstraction above the hardware.

Today, the most lively debate is over C/C++ (the standard for commercial software development) and Java (the newest language to achieve wide commercial appeal). It's no accident that Sun designed Java for high-level hardware abstraction, rapid development, and code safety.

The most often-cited difference between these languages is memory management. On the one hand, C/C++ requires programmers to manually allocate, manipulate, and deallocate memory. One of the most common bugs in C/C++ applications is a "memory leak"—the system gradually loses resources because a program keeps grabbing memory without giving it back. As the program consumes more and more memory, other processes become starved for resources until eventually there's a crash.

Java programs, on the other hand, are virtually leak-proof because the Java virtual machine (JVM) manages memory, not the programmer. The JVM has an automatic garbage collector that frees up memory not being used by objects and data structures. The garbage collector eats up some CPU cycles, but it eliminates a huge source of bugs and crashes.

Likewise, Java stops programs from corrupting memory by automatically checking the bounds of all array references. You can't accidentally store data in the 101st element of a 100-element array, as you can in C/C++. Although you can purchase tools that add bounds-checking to C/C++, they're not universal.

There are dozens of less-publicized safety features in Java. For instance, another common flaw in C/C++ programs is poor error handling. It's easy to write a C/C++ program that has no error handling at all. In Java, if a class has a method that might throw an exception, a Java program must check for the exception, or it simply won't compile. Of course, you can still write sloppy error-handling code in Java, but Java at least ensures that some error trapping will be there.

Java also requires an explicit cast if a variable type conversion might lose precision. In C/C++, you can coerce a 64-bit double-precision floating-point value into a 32-bit single-precision floating-point variable without realizing it. Java requires an explicit cast, so you're at least aware that a precision error might result. This might seem like a small thing, but an Ariane 5 rocket exploded after liftoff in 1996 when a similar type mismatch caused an overflow that confused the inertial guidance system.

Perhaps the most controversial of Java's safety features is its single-inheritance model, as opposed to the multiple inheritance of C++. Classes can inherit methods from only one parent class, not from multiple parents. Java's designers believed this would reduce complexity and yield a cleaner class hierarchy.

C++ devotees insist on multiple inheritance. However, it's worth noting that Java actually does allow multiple inheritance—of interfaces, not implementations. A Java class can inherit the interface definitions of multiple parent classes (in other words, the method calls), but it must implement those methods itself. This protects the integrity of the child class if the method implementations in the parent classes change.

Java is by no means the only language to emphasize code safety. Eiffel, an object-oriented language developed by Bertrand Meyer in 1988, goes even further than Java in some ways. Eiffel requires methods to expose their calling parameters at run time. Most other languages, including Java and C/C++, rely on documentation for this purpose. Ada, a 1970s language developed for the U.S. Department of Defense, contains similar safeguards. But Java is the newest language to win broad support from tool vendors, developers, OS vendors, and schools.

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checks system components and can reinstall missing or broken pieces. It also keeps a log that's a snapshot of the system's state, making it easier to reverse changes.

Automated Maintenance

An interesting but potentially hazardous solution to system maintenance is automatic updating. Few users or administrators have time to scour the Internet for the latest upgrades and patches. That has opened the door for utilities such as CyberMedia's Oil Change and Quarterdeck's TuneUp and RealHelp. They compare your system configuration to a database on the Web. Then they help you download and install any relevant updates. It's such a good idea that Microsoft is thinking about adding similar features to Windows.

But there's a danger: Every change of your system's state, no matter now minor, can potentially break some existing software. An older program might crash with a newer DLL or device driver, forcing you to upgrade that program as well. Sometimes this triggers a cascade of failures and fixes before the system returns to a stable state. Sometimes you reach a dead end in which no update for a broken program is available. And inevitably, the upgrades consume more memory, disk space, and CPU resources, accelerating the day when your PC becomes obsolete.

The phenomenon of new software breaking old software is well known to software engineers. Alan Wood, senior engineer at Tandem Computer, says fixes to Tandem's NonStop Kernel typically break something else in the OS about 5 percent to 10 percent of the time. Tandem catches those problems with thorough regression testing. But it's hard to perform that kind of formal testing on PCs: Every PC is slightly different.

Utilities such as Oil Change and TuneUp recognize this hazard. They log every alteration and save replaced components in a compressed archive, so you can undo an installation. But there's still a chance you'll wade deep into a series of changes and won't be able to roll back the system.

Applications can take some responsibility for system management, too. When a user launches Office 98 for the Mac, it performs a self-diagnostic. If it can't find any of its shared libraries—perhaps the user mistakenly disabled a library with the Extensions Manager—Office 98 installs a fresh copy from a compressed archive on the hard disk. It all happens invisibly, so the user won't even notice. Microsoft says future versions of Office for Windows will also be self-repairing.

CRASH TIP

Run diagnostic programs. This is especially important if you've been suffering from system-stopping crashes, because each calamity is sure to leave broken files and other debris on your disk. You can use the diagnostics that came with your system (the disk tools included with Windows and the Mac aren't bad) or a third-party utility.

The Essence of PCs

Of course, every new feature, management tool, OS upgrade, and utility program adds still more code and complexity to a system. Some experts think PCs won't stop crashing until everyone accepts the futility of "feature shock." In other words, the shortest path to stability is simplicity: simpler hardware, simpler software, simpler user interfaces. But this demands a whole new way of thinking, says Michael L. Dertouzos, director of the MIT Laboratory for Computer Science: "It's more difficult, a little bit like birth control."

He says the change, if it ever comes, could begin as a grass-roots rebellion. Someone will use the Web to distribute a leaner, meaner OS that circumvents the entrenched platforms. It'll be more stable, easier to use, and better understood.

It sounds a lot like what's happening today with Linux, or the early days of Mosaic. But Linux flunks the simplicity test, and Mosaic begat Navigator, which begat Communicator. Simple software doesn't stay simple for long.

At the other extreme is the NC concept: a stateless, simplified client designed for a wired world. But NCs sacrifice the crucial essence of a PC—unlimited local control. Mainframes and critical embedded systems achieve their high reliability by sacrificing local control, too. For better or for worse, many users and IT professionals would rather crash than switch.

That's why the ultimate solution is a long way off. Realistically, developers will continue to write bigger programs that ship before they're ready. OSes will continue to grow more complicated. Users will continue to vote with their dollars for feature-laden software. Established platforms and applications will continue to overshadow radical alternatives. And PCs will continue to crash. B

CRASH TIP

If it's broke, fix it. When a system keeps crashing, don't shrug it off. If a particular program seems to be the problem, look for patches on the publisher's Web site. If there aren't any patches, consider upgrading to a newer version of the software or reverting to an older version. You might even consider switching products. If your system crashes for no apparent reason, try a diagnostic and repair utility, such as First Aid Deluxe, Norton Utilities, or RealHelp. If you're desperate, try the tip on page 67.

WHERE TO FIND

Candle
Santa Monica, CA
310-829-5800
http://www.candle.com/

Computer Associates
Islandia, NY
516-342-5224
http://www.cai.com/
(Merit Project)
http://www.meritproject.com/

Cougar Mountain Software
Boise, ID
208-375-4455
http://www.cougarmtn.com/

IBM Server Group
Poughkeepsie, NY
770-863-1234
http://www.s390.ibm.com/

MIT Laboratory for Computer Science
Cambridge, MA
617-253-5851
http://www.lcs.mit.edu/

QNX Software Systems
Kanata, Ontario, Canada
613-591-0931
http://www.qnx.com/

Quarterdeck
Marina del Rey, CA
310-309-3700
http://www.quarterdeck.com/

Sun Microsystems (Solaris)
Mountain View, CA
650-786-7737
http://www.sun.com/solaris/

Tandem Computer
Cupertino, CA
408-285-6000
http://www.tandem.com/

Upgrading and Repairing PCs
Que
317-581-3500
http://www.mcp.com/info/0-7897/0-7897-1295-4/

Virtual Solutions
Irving, TX
972-550-7900
http://www.vsol.com/

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Behind THE Benchmarks

Marketing tool or precise measurement? IS buyers have to judge.
By Michael Hurwicz

To buyers, published benchmarks are tools for measuring the power and performance of processors, graphics cards, computers, networks, OSes, applications, and just about any other hardware or software component or system. To vendors, published benchmarks are tools that are more for marketing purposes than for measurement purposes. Therein lies a world of problems.

The Sun Also Falls

Last year, Sun Microsystems was caught optimizing the just-in-time (JIT) compiler for its Java virtual machine (JVM) for the CaffeineMark benchmark from Pendragon Systems. In a move that could be compared to finding a shortcut in the Tour de France and finishing two days before any of the other contestants, Sun found "dead code"—routines that calculate variables that are never used—that could simply be skipped. As a result, the Sun JIT's score on one of the nine tests in the CaffeineMark suite was 50 times better than any previous result. When Pendragon altered the code slightly so that Sun's JIT couldn't recognize the benchmark, its score dropped 300-fold.

Did Sun think that nobody would be suspicious of its compiler's phenomenally high score? Or did the company actually believe, as one Sun employee was quoted as saying, that its job was to obtain the best possible score on the benchmark, and that's exactly what it had done?

Sun's results amounted to false advertising, because Sun's optimizations worked only with the CaffeineMark. They bore absolutely no relationship to the real world, and Sun knew it. At the same time, however, this incident revealed a flaw in the benchmark. It's conceivable that a compiler might have been able to exploit this flaw without any benchmark-specific optimization. In that case, although the optimization might not have been terribly relevant for most applications, it would still have been "legal," because the compiler would have performed the same optimization with any similarly flawed code (see the text box "Walking the Line" on page 76).

With version 2.5 of the CaffeineMark, for instance, products from a number of vendors, including Microsoft and Sun, got unrealistically high scores on one test, the "loop" test. It turned out that there was dead code in that test, which some clever compilers skipped. Nevertheless, vendors published their results for CaffeineMark 2.5, and no one cried foul.

"In that case, the problem was with the benchmark," says Ivan Phillips, president of Pendragon. "CaffeineMark 2.5 was too optimizable. By making completely valid optimizations, you could get an unrealistically high score."

Standard compilers for languages such as C and FORTRAN do such dead-code optimizations routinely. It's quite

Walking the Line

Technicians running benchmarks for vendors behave like lawyers in court. They're not supposed to lie (i.e., do optimizations that work only for a specific benchmark). That wouldn't be ethical. But they're supposed to do everything in their power short of lying to make their "client" look good. Sometimes what's legal doesn't much resemble what's realistic.

Sun's CaffeineMark optimization is an example of a time when lying in court took place. A similar incident is widely rumored to have occurred in early 1997, in connection with PC Player's Direct3D benchmark, which was designed for testing 3-D displays in computer games.

At that time, it was rumored that the driver for NEC's PowerVR chip looked for D3DTEST.EXE and then produced higher figures using techniques that, because they produce "picture tear," would not normally be used for games. If this was true, then it's definitely an example of lying in court. Testers got truer numbers by renaming the D3DTEST.EXE file.

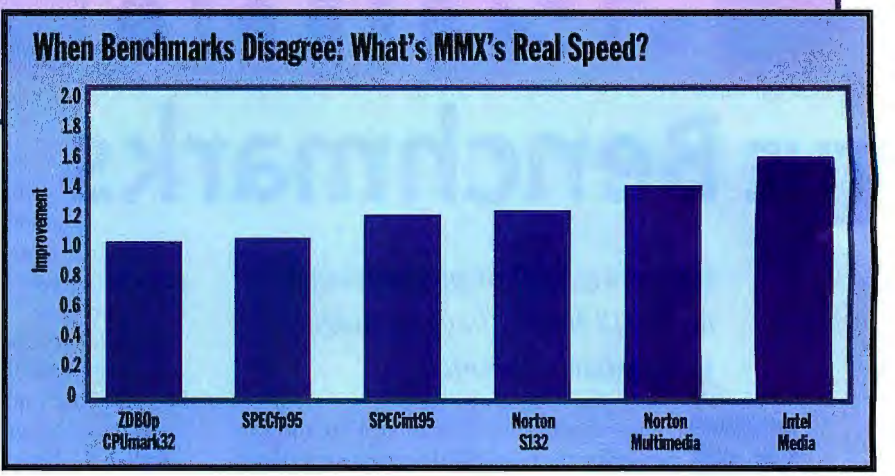
A more borderline case occurred about three years ago, in connection with the TPC benchmarks: Oracle was accused of turning off transaction logging. This greatly speeded up transactions. It also meant that, if the server crashed, all transactions that hadn't completed would be lost.

In real-world situations, transaction logging would probably be turned off only for batch uploads, which could be repeated in case of a crash. Today, with the rigorous reporting and auditing required by the TPC, such tricks are immediately flagged. Today, everyone runs TPC tests with transaction logging turned on.

"Customers have largely stopped paying attention to benchmarks because they know the results are 10 to 100 times higher than what is achievable," says Richard Finkelstein, president of Performance Computing, a database consulting firm in Chicago. "Vendors now avoid obvious chicanery. They do things that are much more subtle, ambiguous, and difficult to prove or explain, but that nevertheless provide unrealistically good results for everyone."

In 1992, on over-the-network write tests, a NetWare server would report a "commit" to the client while data was still in a memory cache, and LAN Manager servers would not report a commit until the data had been written to disk. As a result, "We were getting beat up pretty badly on benchmarks," says Wilhelm Fitzpatrick, who worked for Microsoft during the early 1990s. Eventually, Microsoft implemented an undocumented option for LAN Manager to cause it to duplicate NetWare's reporting behavior, and thus produce more comparable results.

In the late 1980s, Kuck and Associates wrote a preprocessor, called KAP, that attempts to optimize source code. It was used by everyone running the SPEC89 benchmarks because it improved performance on the Matrix300 test significantly. However, it did not improve real-life performance nearly as much. The optimizations were legal, but the benchmark was over-optimizable. As a result, the Matrix300 test was eliminated from the SPEC92 benchmark suite.



Different synthetic benchmarks yield different improvement when an MMX CPU is substituted for a non-MMX CPU.

difficult to do, though, with Java's JIT compilation. Because a Java program compiles and runs in real time, the compiler has only split seconds to perform any optimizations.

Although it's conceivable that Sun's results could have been obtained with valid optimizations, which the compiler would do with any similar chunk of code, they were achieved with optimizations specific to just one benchmark, which is also known in the business as cheating.

Still, it's interesting to reflect that if Sun had optimized its JIT compiler to beat the competition by a believable margin, no one would have been the wiser. But a modest gain on one test would not have increased the compiler's overall score by very much.

This incident points up a fundamental flaw of all synthetic benchmarks, which attempt to mimic the behavior of typical applications but do not contain actual application code. The only thing that these benchmarks really measure is how well the system or component (in this case, the JVM and JIT compiler) runs the benchmark. Any resemblance to real life is just that—a resemblance. Furthermore, it might be accurate for one generation of a microprocessor (or whatever is being evaluated) and wildly inaccurate for the next generation.

Keeping Your Tools Sharp

No matter how hard benchmark developers work on keeping up to date, synthetic benchmarks can only approximate real-world behavior. This is pointed up by the fact that different synthetic benchmarks can give very different results when measuring the same component, such as a processor.

For instance, say you're considering buying two PCs. Both are based on 200-MHz Pentiums, but one has Intel's MMX technology, and the other doesn't. Since the critical difference between the machines is in the CPU, you might look for a processor benchmark to see how much faster the CPU with MMX really is.

Either the Norton SI32 benchmark, from Symantec, or the CPUmark32, from Ziff-Davis Labs, might seem appropriate. Both are synthetic benchmarks designed to test the performance of 32-bit processors. When Intel ran these two tests, however, the Norton SI32 results showed that the MMX Pentium is 1.27 times faster than the plain Pentium (58.4 versus 45.9), while the CPUmark32 said it was only 1.11 times faster (437 versus 392). To put it another way, the SI32 benchmark reported pro-

portionally more than twice as much improvement as the CPUmark32.

Intel got yet a different result when it ran CPU95 (which is commonly referred to as SPEC95), two suites of processor benchmarks from the Standard Performance Evaluation Corp. (SPEC). CPU95 differs from Norton SI32 and CPUmark32 in that the SPEC code contains pure benchmark code as well as application code that has been modified to be compute-bound and portable. The CINT95 (commonly called SPECint) suite focuses on integer performance, while the CFP95 suite (commonly called SPECfp) represents floating-point performance.

SPEC has two subgroups: a High Performance group for supercomputers, and a Graphics Performance Characterization (GPC) group, which produces the Viewperf benchmark (for 3-D graphics performance) and the GLperf benchmark (for the OpenGL graphics language). The OpenGL Performance Characterization subgroup of the GPC produces GLperf. Using a 200-MHz Pentium, as in the aforementioned test, SPECint95 results show the MMX processor to be 1.25 times as powerful as the non-MMX processor (6.44 versus 5.17), while SPECfp95 says it's 1.13 times as fast.

All three of these benchmarks (SI32, CPUmark32, and SPEC95) are designed to test the processor, cache, and memory subsystem. They're designed to minimize the effects of other system components, such as disks and monitors.

You might guess that the SPEC benchmarks could be closer to reality than others, since they include actual applications. But which applications are they? Historically, SPEC was almost exclusively a Unix stronghold. All the SPEC applications, such as the GCC compiler, the LI list interpreter, and the Perl scripting utility used for the integer test, come from the Unix environment. SPEC tests are designed to be portable, but in practice SPEC benchmarks are used mostly for testing Unix workstations.

Even in that environment, the SPEC benchmarks have some limitations. SPEC has to be able to get the source code for each application so that it can modify the

Benchmarks at a Glance

Organization	Benchmark	Type	Tests what?	Comments
Business Applications Performance Corp. (Bapco)	SYSmark	Application	System	
BYTE	BYTEmark	Synthetic	Processor	
Intel	Media	Synthetic	Processor	Multimedia; uses MMX instructions
Mercury Interactive	LoadRunner	Application	Web servers	Developer tool
Mercury Interactive	WinRunner	Application	Client GUI	Developer tool; Windows only
Mercury Interactive	XRunner	Application	Client GUI	Developer tool; X Window only
Pendragon Systems	CaffeineMark	Synthetic	JVM	
Segue Software	QA Partner	Application	Client/server interactions	Developer tool
Softbridge	Automated Test Facility (ATF)	Application	Client/server interactions	Developer tool
Standard Performance Evaluation Corp. (SPEC)	CPU95	Synthetic	Processor	Two suites: integer and floating-point
SPEC	GLperf	Synthetic	3-D graphics	
SPEC	Viewperf	Application	3-D graphics	
Symantec	Norton Multimedia	Synthetic	System	Multimedia; uses MMX instructions
Symantec	Norton SI32	Synthetic	Processor	
Transaction Processing Council (TPC)	TPC-C	Application (database)	Transaction-processing performance	
TPC	TPC-D	Application (database)	Decision support, data-warehousing performance	
Ziff-Davis Benchmark Operation (ZDBOp)	BrowserComp	Application	Browsers	Windows only
ZDBOp	CPUmark32	Synthetic	Processor	Windows only
ZDBOp	NetBench	Application	Network performance	Windows only
ZDBOp	ServerBench	Application	Server performance	Windows only
ZDBOp	WebBench	Application	Web server	Windows only
ZDBOp	WinBench	Application	Component subsystems	Windows only
ZDBOp	Winstone	Application	System	Windows only

code to be compute-bound and portable and then blend it seamlessly into the benchmark. The SPEC integer test uses the Vortex database. Microsoft's SQL Server, Oracle, and IBM DB2 are much more popular, but their vendors don't release their source code.

If the SPEC suite turns out to be the benchmark that bests suits your needs, you'll pay a price to use it: Running application-based benchmarks like SPEC can take hours. (With older, slower machines, it used to take days.) The time required to run synthetic benchmarks, such as SI32 and CPUmark32, is more likely to be measured in seconds or minutes.

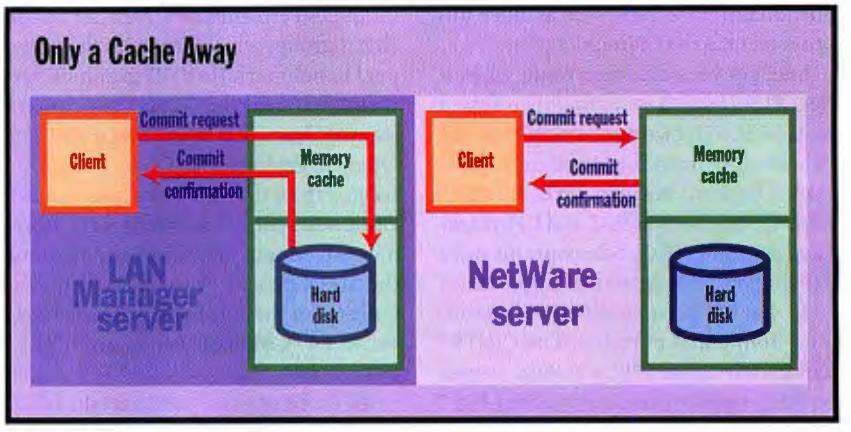
Million-Dollar Benchmarketing

Some application-based benchmarks are so exacting and time-consuming that it's generally cost-prohibitive to run them in connection with any particular project or requirement of a user organization. That's the case, for instance, with benchmarks from the Transaction Processing Council (TPC), a consortium of 47 vendors, including such system vendors as Compaq, Digital Equipment, IBM, NCR, and Sun, and such software vendors as Computer Associates, Informix, Microsoft, Novell, Oracle, and Sybase, as well as Intel and EDS.

The two most commonly quoted TPC benchmarks are TPC-C, which tests online transaction processing (OLTP) performance, and TPC-D, which tests decision-support system (DSS) performance. (see the text box at right). Vendors use full copies of databases such as Informix, Microsoft SQL Server, Oracle, and Sybase.

For all TPC benchmarks, vendors provide voluminous information about the software and the machine tested. Only other TPC members get the full report, which is typically hundreds of pages long. (Nonmembers can get an executive summary that might run a mere 10 pages or so.) When the other members—the tester's most ferocious competitors—get the report, they go over it with a fine-toothed comb, looking for any violations of the strict execution and audit requirements.

TPC testing is expensive and time-consuming. Running a TPC-D benchmark, for example, can take months and cost more than $1 million. Consequently, vendors have a huge incentive to avoid successful challenges to their results. They try hard to obey the rules, and results are seldom withdrawn "with prejudice" (for violation of a rule).



In a 1992 test, Novell NetWare would report a "commit" when it had cached data only in memory, making it seem to run faster.

Inside the Orders and Queries of the TPC

The TPC-C benchmark simulates a standard business order-entry system under a demanding work load. Execution rules require a response time of less than 5 seconds for 90 percent of new orders, payments, deliveries, and order-status transactions, as well as a response time of less than 20 seconds for 90 percent of stock-level transactions. If response times are too long, the test is invalid. The results are expressed in transactions per minute "C" (tpmC).

TPC-C focuses on how many order-entry transactions a system can process in a given amount of time. Transactions vary from simple to moderately complex. The benchmark requires the simultaneous execution of multiple queries from multiple on-line terminals.

The TPC-D test suite, on the other hand, focuses on complex queries that require the loading and analyzing of large amounts of data. For instance, one test finds a minimum-cost supplier; another forecasts revenue change; still another finds, for each nation and year, the profit for all parts ordered in that year that contain a specified substring in their part names and that were filled by a supplier in a certain nation. TPC-D is the best benchmark available for data-warehouse solutions. Most TCP-D testing reflects single-user usage.

The TPC-A and TPC-B test suites are now obsolete.

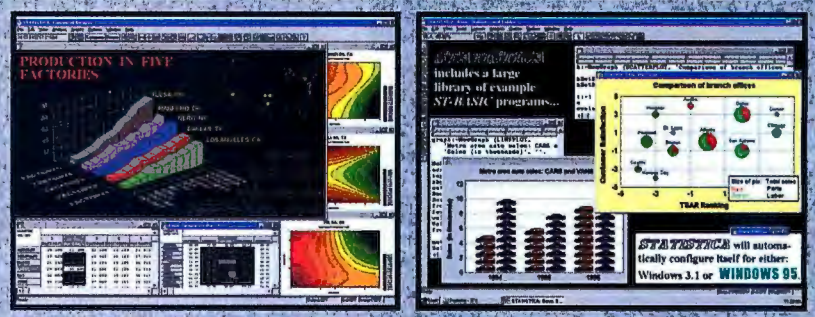
Results are regularly withdrawn for other reasons, however, such as a system that's about to be superseded by a newer product; results that are about to be superseded by newer, better results; or the delay of a product or an associated OS release. Results must represent products that will be available within the next six months. (One way to get an early warning about delayed products is to watch for withdrawn TPC results, which remain on its Web site and are listed as "withdrawn.")

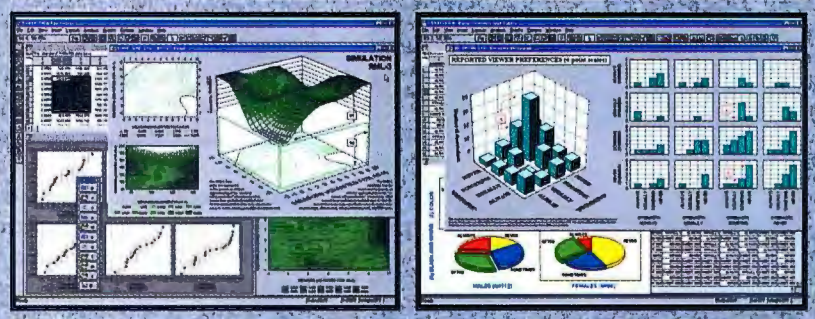
Despite all this, the majority of TPC results bear only a loose relationship to real-world performance. That's because vendors publish TPC results for their own purposes—namely, to have something to brag about. True, vendors run TPC tests while they're designing products, too, to check their designs. And sometimes, when a user organization is in the planning or purchasing stages of a critical project costing tens of millions of dollars, a TPC member will run, or help the user organization run, TPC benchmarks. But you'll never see the results of those tests published.

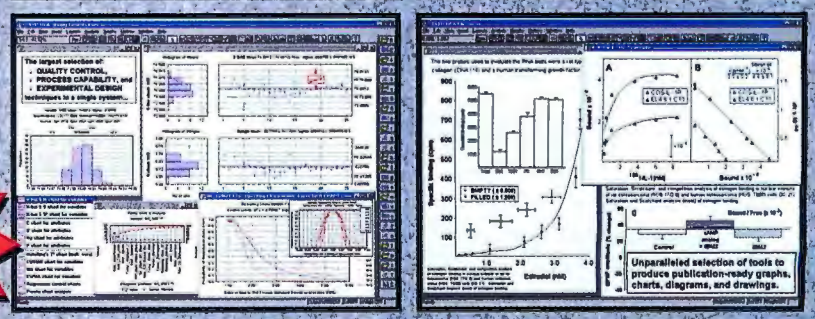
When you see a published result, you can be pretty sure that the vendor configured the hardware and software with one goal in mind: to get the highest possible score. The configuration might bear no faint resemblance to anything a user organization would ever consider, and the cost of the system might be nothing short of astronomical. But that's all secondary. The score's the thing.

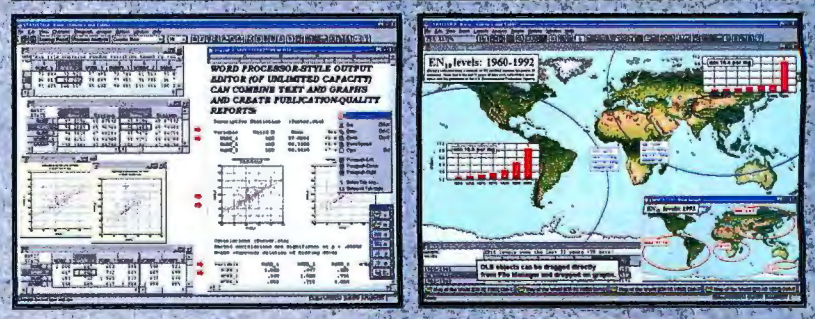
The TPC publishes price and price/performance numbers, as well as simple performance numbers, so buyers can at least get some indication that they're dealing

STATISTICA









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Winstone and WinBench Explained

Winstone has two variants: Business and High-End. Business Winstone 98, which runs on Windows 95 and NT, uses nine applications: CorelDraw 7, Corel Quattro Pro 7, Corel WordPerfect 7, Lotus 1-2-3 97, Microsoft Access 97, Microsoft Excel 97, Microsoft PowerPoint 97, Microsoft Word 97, and Netscape Navigator. The High-End Winstone 98 runs only on NT. It uses seven demanding applications: Adobe Photoshop 4.01, Adobe Premiere 4.2, AVS/Express 3.1, Microsoft FrontPage 97, Microsoft Visual C++ 5.0, MicroStation 95, and PV-Wave 6.1.

A new Winstone 98 category, Business Task Switching, is scored separately. It tests how well a system performs when switching between applications. One test switches between Word and Excel; the other does so between CorelDraw and WordPerfect.

WinBench 98, which runs on Windows 95 and NT, tests five major component subsystems: processor/RAM, graphics, disk, CD-ROM, and full-motion video. The suite's Graphics WinMark and Disk WinMark tests play back the graphics and disk activities, respectively, of Winstone 98.

The 3D WinBench 98 suite tests performance and rendering quality for 3-D graphics, using a series of 19 scenes.

In addition, Ziff-Davis has four server/Internet benchmarks (WebBench, NetBench, ServerBench, and BrowserComp), a Macintosh benchmark (MacBench), and a battery-life benchmark for laptops (BatteryMark).

with a supercharged, gold-plated system. Happily for vendors, price/performance numbers can also provide an alternative bragging point. Even if a system doesn't provide the highest number of transactions per minute, for instance, it might cost the least per tpm.

New products let users take server-side and networked Windows NT benchmarking into their own hands. Bluecurve (Oakland, CA) offers Dynameasure 2.0, which stresses file, print, SQL, and messaging applications to help IS managers determine how a network operates under load. Transaction editors let users measure capacity and reliability with transactions from their own applications.

Historically, TPC was Unix territory. These days, more TPC tests are actually done under Windows NT. But the tests are still limited to the large databases.

Yes, We Do (Benchmark) Windows

Users of Windows applications other than large databases might prefer benchmarks that use popular Windows applications. Examples include the Winstone and WinBench benchmarks, from the Ziff-Davis Benchmark Operation (ZDBOp), the R&D division of Ziff-Davis Publishing; and the SYSmark tests (SYSmark32 and SYSmarkNT), from the Business Applications Performance Corp. (Bapco). Both SYSmark and Winstone are system benchmarks that test the capabilities of a computer as a whole system. WinBench tests specific components. There's also a 3-D WinBench test, which measures 3-D graphics performance. The WinMark benchmarks are the individual component tests within WinBench.

The ZDBOp and Bapco benchmarks both exercise applications using compiled scripts written using the Visual Test tool from Rational Software. "Canned" (i.e., nonconfigurable) versions of the applications are included on the benchmark CD. For instance, SYSmark32 contains eight 32-bit (Windows 95 and NT) applications: Word 7.0, Lotus WordPro 96, Excel 7.0, Borland Paradox 7.0, CorelDraw 6.0, Lotus Freelance Graphics 96, PowerPoint 7.0, and PageMaker 6.0. SYSmarkNT contains five native 32-bit NT applications: Word for Windows 6.0, Excel 5.0, Texim Project 2.0e, Orcad MaxEDA 6.0, and one 16-bit application, PowerPoint 4.0. (See the text box above for the applications used for Winstone and WinBench.)

Both the Bapco and the ZDBOp benchmarks provide individual test scores for particular categories of applications and a combined score for all tests. Thus, you can find out how a system performs for spreadsheet work as opposed to word processing or database activity.

Bapco has a peer-review process, which might not inspire quite as much confidence as the TPC's independent auditors. Bapco members *could*, for instance, have an unspoken agreement to let one an-

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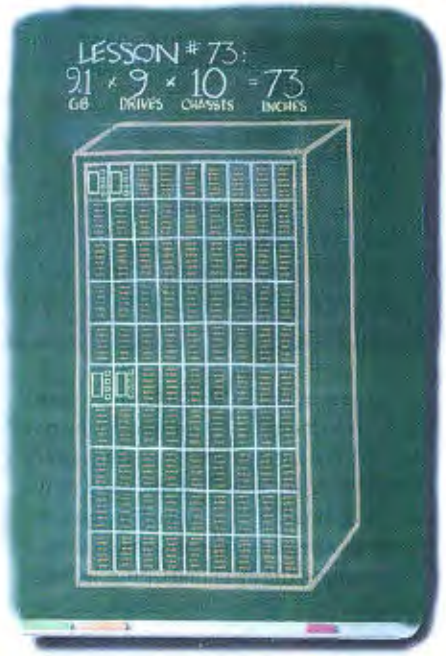

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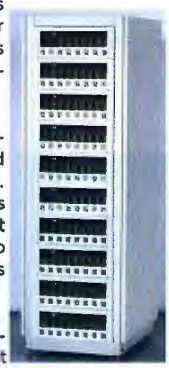

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other off the hook in certain regards. But Bapco's tests are also entirely canned. Thus, there are no application-configuration options to tweak or report, and the testing-and-reporting process is a lot simpler than the TPC's—and so offers fewer opportunities for unfair optimizations.

A criticism that sometimes comes up regarding the ZDBOp benchmarks is that the source code for the scripts is not made public. With SPEC, TPC, and BYTE benchmarks, the source code is publicly available. Bapco source code is available to Bapco members. Thus, the source code for all the other benchmarks has undergone multivendor scrutiny, while that for the ZDBOp tests has not.

But the ZDBOp benchmarks are widely used, and some users, such as computer manufacturers, scrutinize the results closely, even down to running the benchmarks under low-level debuggers, watching the system calls, and comparing them to the system calls made by noncanned versions of the same applications. If they don't think that the benchmarks behave in ways typical for the applications, Ziff-Davis hears about it.

The BYTEmark benchmark suite was developed by the BYTE Lab in 1995. Although BYTEmark is considered a synthetic benchmark in the sense that it's not composed of real-world applications (such as those contained in Bapco's SYSmark), it's based on algorithms widely found in popular engineering, multimedia, and business applications. All 10 programs in the BYTEmark suite report their results in terms of iterations per second, but their problem-solving nature sets them apart from the typical repetitive loops in smaller benchmark programs. Instead of repeatedly performing simple calculations, the BYTEmark programs use sample data to generate results that closely approximate the performance of real applications.

The Four Categories of Benchmarks

- **An application-based benchmark runs real applications or parts of applications, either in full or modified versions.**
- **A synthetic benchmark emulates application activity.**
- **A playback test uses logs of one type of system call (e.g., disk calls) and plays the calls back in isolation.**
- **An inspection test exercises a system or component without attempting to emulate application activity.**

You should use synthetic and playback benchmarks to get a rough idea of how a system or component performs. If application-based benchmarks are available that match your application mix, use them to refine your evaluation. Use inspection tests to determine whether a system or component is functioning properly.

Multimedia Benchmarks

If you're going to be running multimedia applications, especially ones designed to exploit MMX CPUs, then you might be interested in the results of the Intel Media benchmark, which was introduced in January 1997, or the Norton Multimedia benchmark, which was released shortly thereafter. The Intel benchmark is a component benchmark, testing only the capabilities of the processor. The Norton benchmark is a system benchmark. Both are weighted toward functions such as audio and video playback, image processing, and 3-D geometry.

Using the Intel Media benchmark, the Pentium MMX chip comes out 1.64 times faster than the non-MMX chip (257.3 versus 157.3). Using the Norton Multimedia benchmark, an MMX system comes out 1.44 times faster than a non-MMX system (9.8 versus 14.1). These high scores reflect the fact that these benchmarks contain MMX instructions. The central feature of the MMX technology is a set of 57 new instructions specifically designed for multimedia. When an MMX-enabled application detects that it's running on an MMX computer, it uses these instruc-

tions instead of less efficient non-MMX instructions that do the same job.

Why does the Intel test indicate about 45 percent more benefit from MMX technology than the Norton test does? Perhaps, as the maker of the MMX chip being tested, Intel has an incentive to create a test that shows it off best.

Do It Yourself

But even when you're conducting your own tests, you have to be careful or you might end up getting spurious results, especially in network or multiuser environments. For instance, although it might seem that running benchmarks on production systems would give the truest results, that's not necessarily the case if end users might be on the system at the same time.

"The number-one problem [for end-user organizations using automated testing tools in distributed environments] is data control and environment control," says Alex Marchicelli, director of the testing practice for IMI, a consulting firm based in Mellville, New York. "Failure to maintain a stable test-bed is the number-one reason for failing to get meaningful results with automated test tools."

Marchicelli notes that a tool might attempt to open and close a single record many times in rapid succession. On a production system, a user could already have that record locked. The tool's "open" requests would either fail immediately or else be delayed until the user released the record. It might be difficult to tell what happened from the tool's reports.

"Test tools are pretty dumb," explains Marchicelli. "They don't know if they're encountering a record lock or a [system] bug. Most of the time, it's data-related."

IMI helps clients test their distributed systems and applications, using tools from three different vendors: Mercury Interactive (LoadRunner, WinRunner, and XRunner), Segue Software (QA Partner), and Softbridge (Automated Test Facility [ATF]). All these tools focus on helping programmers test the behavior of distributed applications, one aspect of which is testing performance.

WinRunner and XRunner test client GUIs in client/server environments for Windows and the X Window System, respectively. LoadRunner tests Web servers under varying client loads. QA Partner and ATF both test client/server interactions.

These tools permit you to do testing using your own applications, either by creating scripts using special programming languages or by recording and playing back actual application sessions. But they are complex and can cost thousands of dollars per seat. They are used mostly by developers.

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Intel benchmark results
http://www.intel.com/procs/perf/index.htm

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http://www.sbridge.com

Transaction Processing Council
San Jose, CA
408-295-8894
http://www.tpc.org

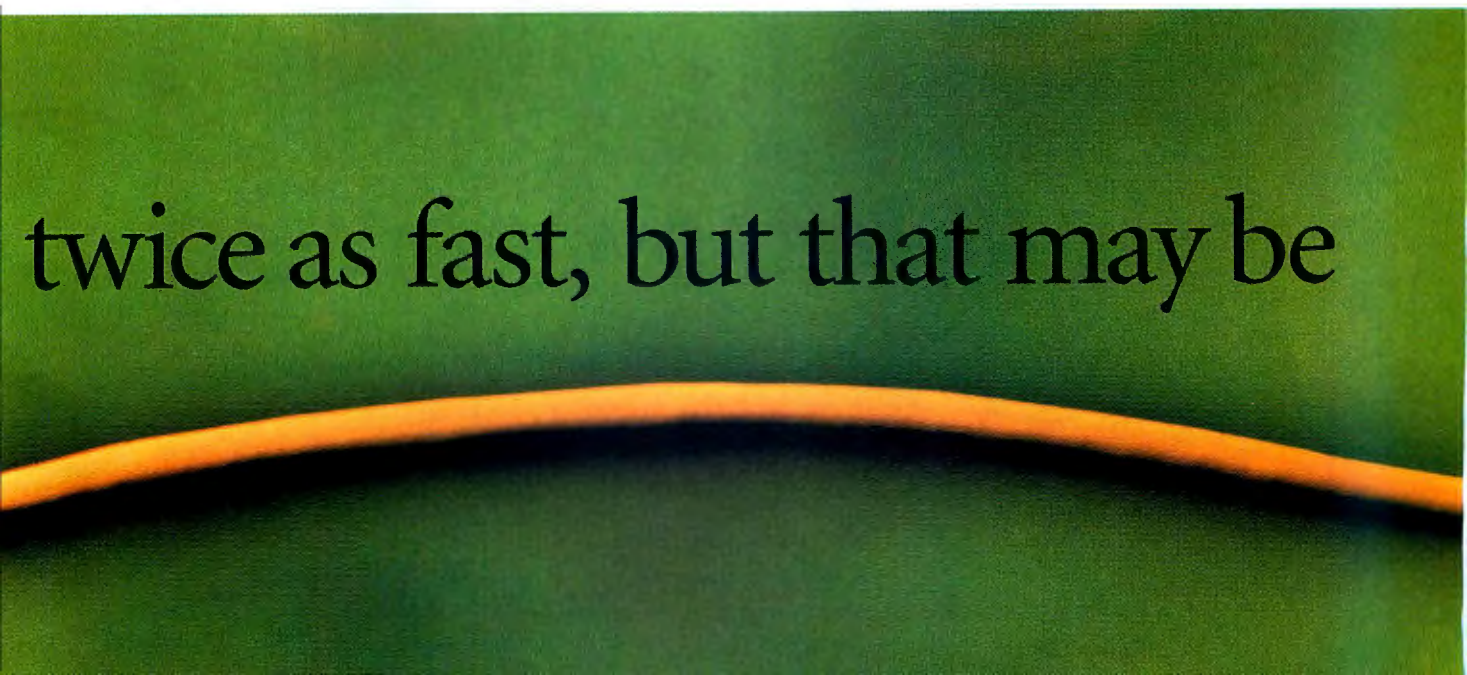
Ziff-Davis Benchmark Operation
http://www.zdnet.com/zdbop

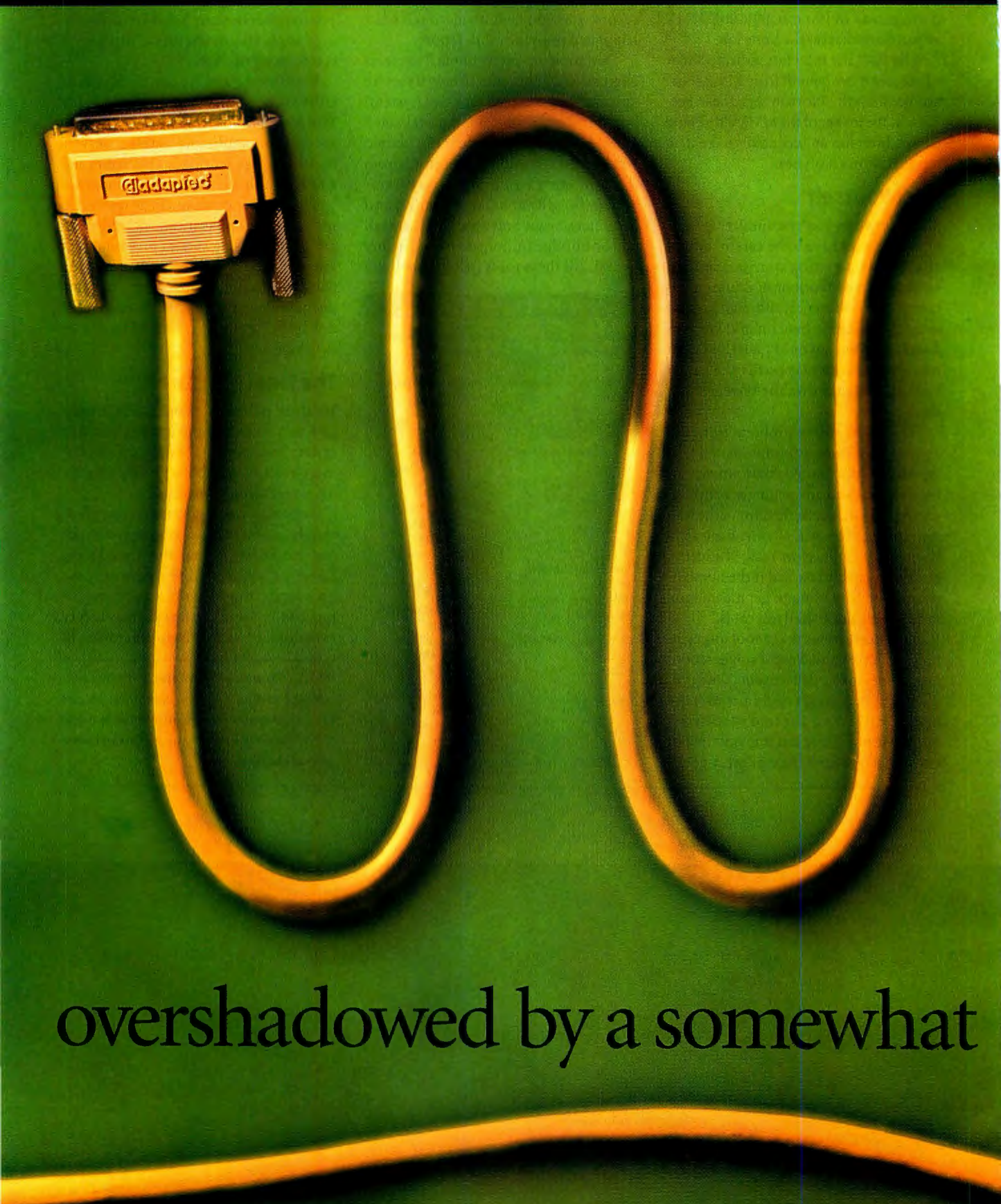
The Final Measure

Vendors' published benchmarks usually give you an idea of the upper limits of a system, component, or application. For more realistic numbers, you'll probably have to run your own tests.

Running a synthetic or canned application-based test on a system or a component can be fairly straightforward. Doing rigorous, automated testing with your own applications usually requires a separate test-bed and can be expensive, very expensive, or prohibitively expensive. B

Michael Hurwicz is a freelance writer and consultant based in Brooklyn, New York. He can be reached at **mhurwicz@attmail.com**. *Some of his other articles can be seen at* **http://www.durrassociates.com**.





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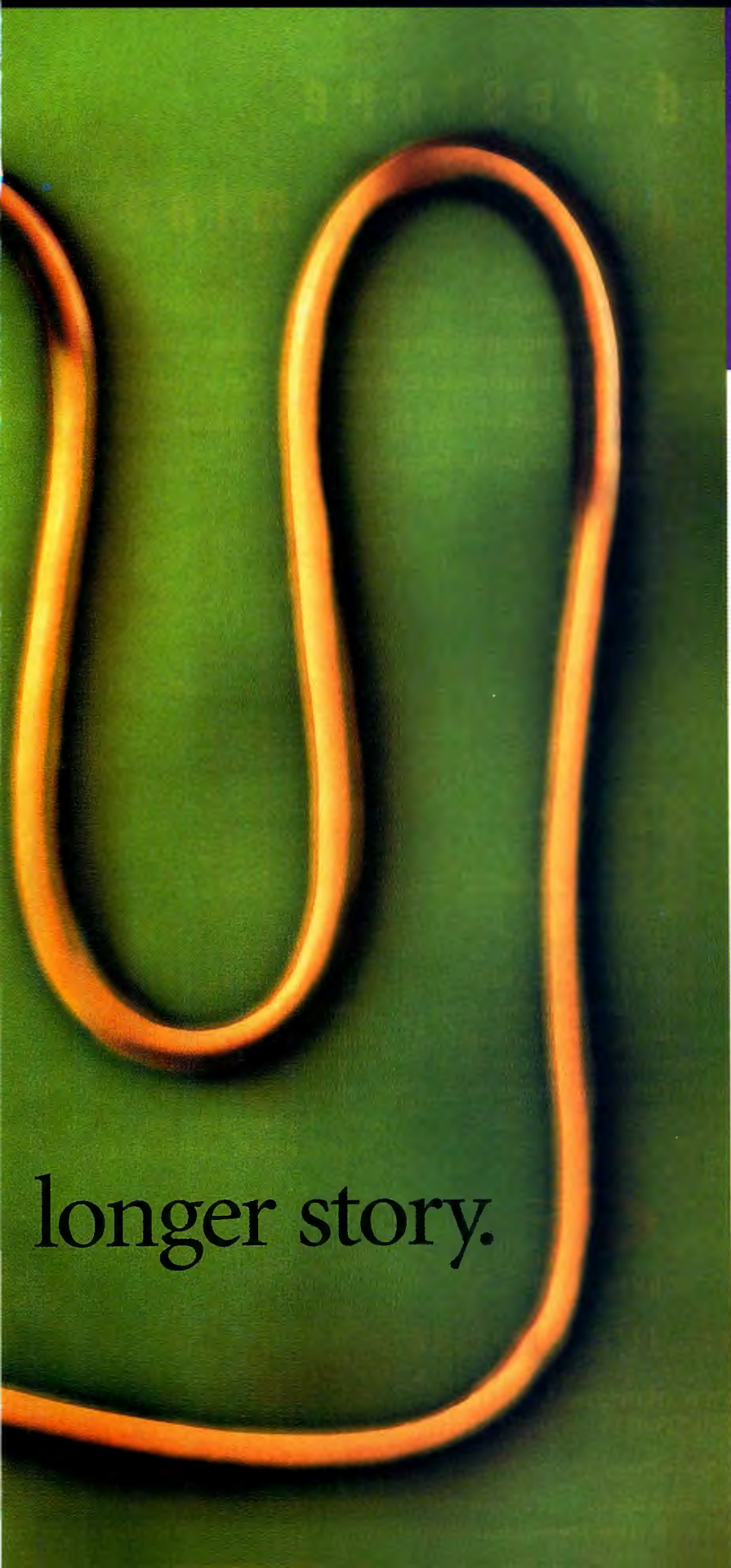

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COMMODITY CLUSTERS

The VIA removes bottlenecks and drives interoperability.

By Scott Mace

On December 16, 1997, Intel, along with Microsoft and Compaq, officially announced version 1.0 of a software and hardware specification to create server clusters out of inexpensive symmetric multiprocessing (SMP) servers. Intel is calling them standard high-volume (SHV) servers. Called the Virtual Interface Architecture (VIA), it will let applications on Storage Area Networks (SANs) treat groups of servers as a single server with remote DMA across the cluster. This is potentially the most important advance for affordable servers since SMP.

VIA will enable fault-tolerant, distributed server clusters built out of multiple vendors' SHV servers and high-speed networks to do work traditionally given to expensive, proprietary, centralized servers. While big server systems will maintain a performance edge for demanding applications, VIA will usher in a wave of inexpensive, high-performance computing.

VIA will enable the creation of interoperable, multivendor cluster components; minimize the network delays typical of clusters built out of commodity hardware; and deliver acceptable scalability at commodity prices. VIA also removes bottlenecks by getting around much nontunable overhead in the typical OS, such as software interrupts, context switching, and buffer copies.

Getting the Message

The inspiration for VIA, which Intel is the driving force behind, came from many SAN technologies, including Tandem's ServerNet and Digital Equipment's Memory Channel (by the time you read this, both companies should be Compaq subsidiaries). VIA is designed to avoid the TCP/IP and UDP bottleneck built into today's server OSes. Today, messages passing between SHV servers must be copied by the IP stack at least twice—once on the sending side and once on the receiving side.

A recent published test showed that Gigabit Ethernet, used as a cluster interconnect, could max out at 30 percent of capacity, due to the high overhead of today's standard networking protocols. Those protocols aren't there for window dressing, of course; their job is to guarantee that packets get where they're supposed to. VIA assumes that the network's physical layer itself guarantees the delivery of packets.

For more than 10 years, cluster vendors, including Digital and Sun Microsystems, have had their own "thin" network layers for getting around the latency problems of TCP/IP and UDP. Now, Intel's group aims to bring the same thin layers to SHV servers. More than 100 companies have contributed to the specification, including Data General, Hewlett-Packard, Hitachi, NEC, Sequent Computer Systems, and Stratus.

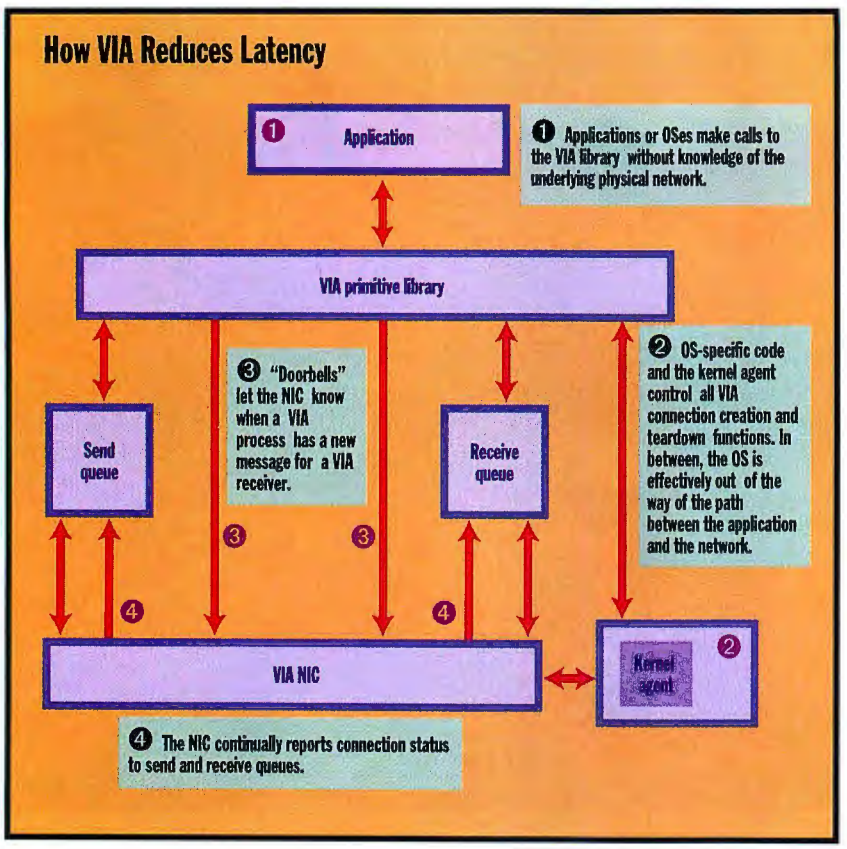
For VIA to work, VIA firmware must be added to network interface cards (NICs). This firmware will queue up messages; server hardware can then grab the messages without going through an OS context switch (see the text box "How VIA Works" on page 88). In 1999, VIA silicon will reduce the cost of implementing VIA even more, according to Intel.

Rolling It Out

Already, VIA NICs are available from Myricom. Last August, it delivered Myrinet, a 160-MBps full-duplex NIC supporting VIA in firmware and selling for $1300. Myricom also sells a crossbar Myrinet switch for $300 per port. Amdahl has licensed Myricom technology for its own use.

continued

For their part, Intel and its partners are out to convince a skeptical world with VIA demonstrations. Intel has demonstrated a VIA-compatible version of IBM's DB2 running on a six-node, 24-processor cluster, with linear scalability, according to Jim Henry, director of business development at Tandem Computer Systems.



VIA creates more direct pipes between applications and networks to avoid protocol and OS latency.

How VIA Works

Each node running Virtual Interface Architecture (VIA) has a user agent, provided by the hardware vendor, which can read from or write to another VIA node's memory. The other key components of VIA are a network interface card (NIC) that can queue up reads and writes, and a "doorbell" that lets the VIA NIC know when a message has arrived.

VIA-aware applications can open a VIA connection by sending a request to a receiver NIC. That NIC requests blocks of memory from the remote VIA user agent, which keeps track of the reserved blocks in descriptor queues, linked lists of buffer addresses. Once a VIA connection is opened and added to a descriptor queue, remote DMA operations can take place without going through high-latency OS calls.

From then on, the sending VIA process can send any amount of data—a million records if need be—over the network into a receiver NIC's work queue, periodically ringing a VIA doorbell to tell receiver user agents when new data has arrived to be written into the receiver's memory. When no longer needed, VIA can tear down the receiver's VIA memory reservation with a final request. Each VIA agent and NIC can simultaneously be talking to and listening to multiple VIA connections. Tandem's NIC will have 1000 doorbell registers.

While application vendors can and have programmed directly to the VIA interface, things don't get really easy for application developers until OS vendors, including Microsoft, Novell, and The Santa Cruz Operation, map the VIA to higher-level resources in the OS (see the text box "Balancing the Load" on page 89).

More recently, Compaq demonstrated Oracle Parallel Server running on a six-node, 24-processor Compaq E2000 cluster connected via ServerNet. Many components of the Compaq cluster are already available, although Compaq hasn't announced a delivery date for its own VIA-compatible NICs.

Digital will implement the VIA APIs in its Unix and VMS OSes "as soon as the technical people are satisfied" that VIA is stable, says Dave Poole, Digital's director of enterprise servers. Digital is also planning to release a modified Windows NT with VIA support on its hardware before Microsoft modifies NT.

Microsoft will support VIA in a future version of Windows NT Server Extended Edition. But database vendors, including Oracle, Informix, and IBM, are rewriting their software to take advantage of VIA-compatible hardware expected out by the end of the year.

All or Nothing

VIA is designed to work with both loosely coupled, shared-nothing clusters as well as tightly coupled, shared-everything servers. VIA has intensified the years-long debate about the scalability of shared-nothing versus shared-everything clusters, but IS managers may find their choices dictated not by technology, but by the cost of ownership and software availability.

Shared-everything (SMP is an example) uses an ultrahigh-speed interconnect. Processors share memory to improve availability and performance, and reduce bottlenecks. Companies such as Sequent and Sun have championed such tightly coupled architectures as easier to manage than shared-nothing clusters. They point to the years that database software vendors such as Oracle have spent tuning their software to produce impressive performance benchmarks and commercial success of their high-end systems as proof.

But commodity SMP scalability beyond four processors has eluded the market. Over time, a transition to eight-way systems will take place, thanks to technology from Corollary that brings four CPUs together in a 4-GB bank of memory and makes two of them look like a single eight-way system. But such tweaks are expensive. Only gradually will an eight-way system become the SHV server node of choice.

Nonuniform memory access (NUMA) extends SMP by making a cluster masquerade as an SMP server. But for NUMA

Balancing the Load

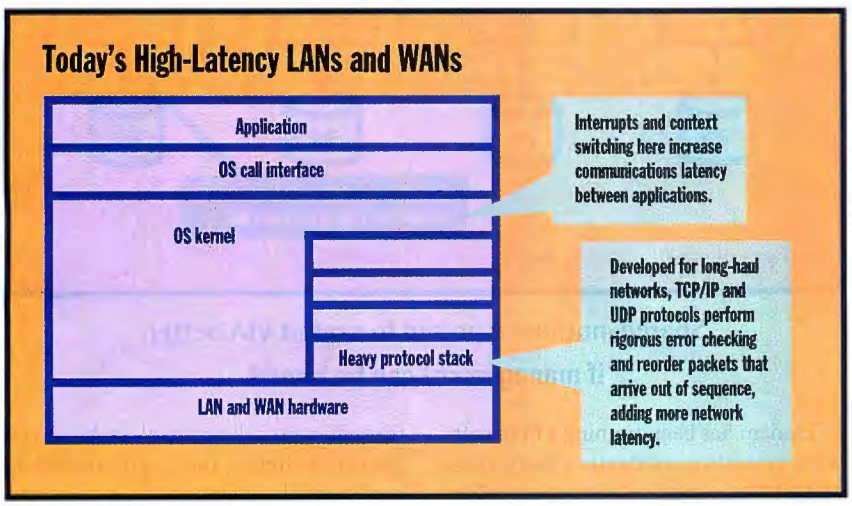
Load balancing has been around about as long as the mainframe, but it's still relatively new to PC technology. Clusters are changing all that.

Microsoft and Novell are nearing the release of network OS (NOS) extensions to make applications scale on any cluster by automatically load-balancing work across nodes. Microsoft Cluster Server, formerly known as Wolfpack, promises to change all that. Initially aimed at high availability of Windows NT applications, Cluster Server will, during phase two, support more than two processors and offer scalable performance and capacity (see "What Wolfpack Means for Parallel Computing," May 1997 BYTE, p. 88NA 8—only in the North America edition). "Copies of Cluster Server phase two will talk to each other in a highly intelligent way so it appears to the programmer that there's one node," says Jim Henry, director of business development at Tandem Computer Systems.

Other companies are working on balancing loads between clusters attached to each other via TCP/IP. HolonTech's HyperFlow SP800 is an all-IP load balancer that tackles the problem of round-robin Domain Name System (DNS) services being used to distribute requests over a shared medium to multiple Web servers. The HyperFlow SP800 senses which attached server has the least work to do and switches traffic there at 100 Mbps. An eight-port switch sells for $17,995, and a 16-port switch sells for $24,995. Users can also stack the switches for added scalability.

Finally, disk array makers are finding ways to spread data across as many disks as are in the array—the ultimate expression of the RAID concept. Xiotech's new Magnitude disk array for NT and NetWare claims to be able to process more than 50,000 I/Os per second, as opposed to the 12,000 I/Os per second of previous disk arrays. "Our intelligent virtual disk stripes the data across all drives to get all disks active at one time," says president and CEO Phil Soren. Prices start at $55,000, and Xiotech will add Unix support this year.

One other way to load-balance across a cluster is to develop a sophisticated file subsystem to underlie an off-the-shelf OS. Tricord Systems is active in this area, offering its scalable Tricord File System for Storage Area Networks. Special I/O adapters use knowledge of how a file is distributed to send an access request to the particular storage unit that has the needed data. This technique in many cases lets processing be done on multiple disk drives in parallel.



Existing OS and network layers are not optimized for short-haul cluster communication.

to work, someone must completely parallelize an OS or use an L3 cache, which in a large system requires complex synchronization between caches, adding cost.

Shared-nothing architectures—massively parallel processing (MPP) is an example—are the basis for the fastest computers yet built (see "Parallel Goes Populist," May 1997 BYTE—only in the North America edition). Not only do compute nodes have no shared memory, even the disk storage they appear to share is actually owned by a particular processor—at least, at the instant that processor accesses that disk.

VIA borrows the message-passing architecture used in the shared-nothing ASCI Red project and extends it to standard networks and OSes, with slight modifications. The VIA specification is also CPU-independent, so clusters could be built out of any kind of processors, but mixing and matching different vendors' CPUs in the same cluster is not a design goal of VIA, says Mitch Shults, director of server platform marketing at Intel.

Building VIA Software

There are downsides: Shared-nothing requires applications to be rewritten using technologies such as objects passing messages between each other—techniques just now beginning to find their way into critical server-based applications. Other, more monolithic software won't be able to take advantage of VIA directly, but instead will benefit from load-balancing techniques, including but not limited to Microsoft Cluster Server (see the text box "Balancing the Load").

Fortunately, software is evolving to a message-based paradigm that is a good fit for VIA. If some of VIA's strongest advocates are to be believed, message-oriented software will be able to scale beyond the largest SMP system. The Object Management Group's (OMG) Common Object Request Broker Architecture (CORBA) and Microsoft's Distributed Component Object Model (DCOM), Transaction Server (MTS), and Message Queue Server (MQS) are all message-based systems. Applications such as Baan and SAP have application layers where messages fly between components or to and from a database.

A message-oriented system wouldn't need to keep duplicate copies of data in sync on each node of the cluster. For instance, an 8-TB table could be partitioned over 128 nodes, and each node would have in its buffer cache only the rows from that partition. No other buffer cache would have rows from that partition, so the overhead and expense of L3 cache synchronization would be unneeded.

VIA will also accelerate the pace of cluster-software development. "Right now, intelligent middleware hides the cluster hardware from the application programmer," says Tandem's Henry. "VIA makes it easier for the middleware programmer

and implements a standard API for clustering for all middleware." So programming to VIA will eventually be as easy as programming to the Winsock 2 layer or a database middleware layer.

"Acceptance of Memory Channel has been hampered by lack of a standard VIA API," says Digital's Poole. "Big database vendors can adopt VIA and be portable across a number of different vendors' architectures."

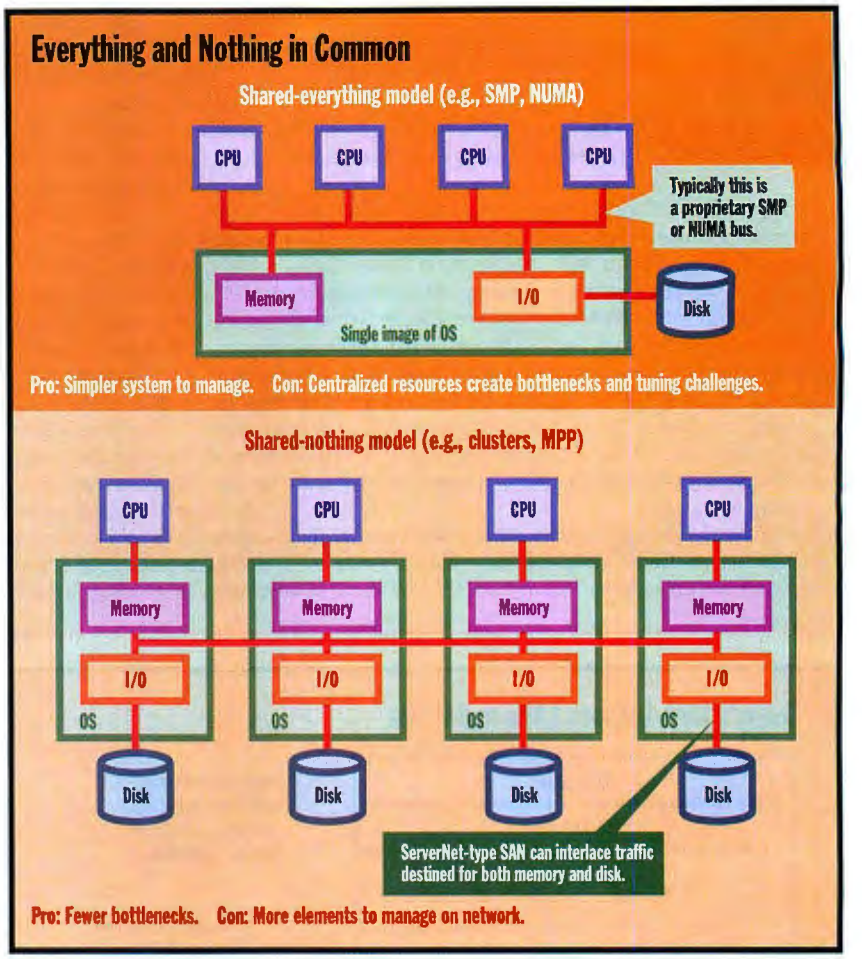
Microsoft Cluster Server phase one, now released, is shared-disk technology, limited to two nodes. Assuming that the shared-nothing, load-balancing technology of Microsoft Cluster Server phase two is efficient, application developers can simply program to VIA for satisfactory performance and scalability.

Cluster hardware vendors such as Sequent and Sun spend years tuning OSes to bypass the same network layers that VIA is designed to replace. Unix cluster vendors have freely altered Unix with proprietary extensions to optimize cluster performance. In the NT world, Sequent has altered NT appropriately, but you can't yet buy it. Sequent is reluctant to release it without Microsoft's blessing.

4 X 64 or 64 X 4?

The big question: In a world of VIA server hardware and software, will billions in R&D continue to be poured into creating bigger and bigger tightly coupled SMP boxes, or will relatively small SMP boxes simply be chained together into MPP systems? Simply put, will we be buying four-way servers clustered into 64 nodes or 64-way servers clustered into four nodes?

Tandem, whose MPP systems have powered such applications as the New York Stock Exchange, is betting on many nodes. At the time it rolled out the NYSE system, it created a 250-node cluster, because the largest memory each node could hold was 128 MB. Now that NT can hold 4 GB per node, the same system could be built with fewer nodes. Moore's law (and NT 5.0) will continue that trend.



Shared-nothing is poised to exploit VIA better, if management can be tamed.

Tandem has been running VIA in software-emulation mode since last August and will incorporate it into ServerNet NICs this year, Henry says.

When VIA is widely available, shared-nothing really kicks into gear. Take a data-warehouse application, such as scanning 4 billion rows, which even the lowliest ODBC front-end request could trigger. Today, shared-nothing systems might dole out the scan to many nodes and then reduce the results and return them to the client. Now, imagine VIA helping out. Instead of the results having to wade through network protocol stacks and OS context switches, the results are fed directly into the memory of the server creating the result set. "Your latency goes way down," Henry says.

One last advantage of shared-nothing: If one node goes down, the application can keep running. If part of a shared-everything NUMA system crashes, "You could bring the whole system down," says Digital's Poole.

Despite its increasing cost of ownership, commodity-priced, microprocessor-based technology has been taking business away from monolithic computer architectures for 20 years, using software to make multiple components look like and be managed like one system. If the momentum behind VIA and shared-nothing technology is any indication, that trend hasn't played out yet. B

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BETTING ON ORDBMS

Informix CTO Michael Stonebraker analyzes the capabilities of object-relational databases in line-of-business applications.

By Michael Stonebraker

At corporations throughout the world, information systems programmers perform software's most Herculean tasks: developing and maintaining the applications that will make or break their companies. These are the "bet the ranch" (BTR) applications that are the operational lifeblood of most large enterprises.

These critical systems share a number of characteristics that make them a substantial challenge. They need to support lots of users and with the highest availability (or else). They need to support many kinds of users, with different kinds of computers, often scattered around the world. They must integrate diverse data and applications from an assortment of divisions acquired over the years (the "stovepipe legacy"). They must be modified often and rapidly. And unlike Hercules, who got to drop support after Release 12.0, application developers have perpetual "legacies."

It is a common premise that BTR applications should be implemented with distributed-object architectures. However, I claim that object-relational databases can significantly augment distributed-object architectures in BTR systems. Let's explore object-relational technology and its benefits.

Distributed-Object Architectures

If we were to "Name the Decade" from an application programming perspective, the 1990s would be "The Decade of Object Orientation." The next will probably be "The Decade of Distributed Applications." The best way to build large-scale software systems for environments where users, data, and application components are physically separate is by creating and deploying systems where the functional components of the system—data objects, business processes, and user interfaces—are physically separable. How better to deal with the Internet ("Do you know where your user is?") or the replication of data and applications that high availability requires than component-based software?

Objects and distributed applications are made for each other. Application components with well-defined interfaces and well-encapsulated (hidden) implementations are much easier to combine into distributed applications than code that is less well disciplined. Furthermore, standard object frameworks (such as the Object Management Group's Common Object Request Broker Architecture [CORBA], Microsoft's Distributed Component Object Model [DCOM], and Sun's Java Remote Method Invocation) provide automatic mechanisms for one object to call another without regard to physical machine location. Compared with the previous generation of roll-your-own remote procedure call facilities, distributed object frameworks are easy for developers to manage.

So much for the good news. As any enterprise-application developer knows, there are a number of gaps between the promise of simple distributed-object application development and the reality of today's environments. Some of these gaps have to do with the lack of maturity of any of the object standards (and the bewildering array of standards themselves), but others are caused by mismatches between the object model and the data management model being used to create the components of distributed applications.

Data Management Choices

In the commercial marketplace today, there are three main choices for data management support for BTR applications.

Relational Databases For almost 20 years, the standard for database management has been the relational database management system (RDBMS). An RDBMS differs from earlier kinds of database systems in that it's based on an elegant mathematical model that combines a simple way to organize

Example of Enterprise Database Extension

Let's illustrate the benefit of moving the enterprise object model into the DBMS with a simple example that dates from the late 1980s. At the time, I was employed by another relational database company, and we had just implemented the then-new SQL standard notion of date and time. The company, of course, implemented Julian calendar semantics for time, as mandated in the SQL standard.

One customer, eagerly awaiting this new functionality, called a few days after the release in a state of extreme agitation, stating that we had implemented time incorrectly. The customer had an application that computed interest on financial bonds on Wall Street, using a typical relational table data organization:

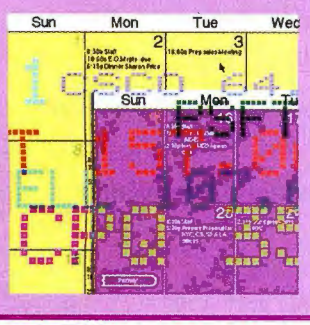
```
Bond (name, coupon_rate,
date_sold, date_bought,
interest)
```

His application included the following calculation:

```
UPDATE Bond
SET interest = coupon_rate
* (date_sold -
date_bought)
WHERE ...
```

In effect, he wished to use SQL to compute the interest due to the bond holder. Unfortunately, the above SQL statement failed in his application because, in the U.S. bond market (but not in most other countries), you get the same amount of interest during each month, no matter how long the month is. Hence, Wall Street bond traders use a calendar in which a year of 360 days is decomposed

continued



the managed data with a powerful structured query language. This mathematical foundation has allowed RDBMS vendors to provide very efficient SQL engines, enabling applications to support thousands of simultaneous users accessing and modifying the same data. This mathematical robustness, plus some 20 years of continual improvement, make today's relational database products some of the most bulletproof software in existence. The combination of power, maturity, and robustness has made RDBMSes ubiquitous as the foundation for BTR applications.

Unfortunately, RDBMSes store only numbers and character strings. BTR applications that require the management of more complex objects must simulate them outside the database management system. This impedance mismatch has been a major difficulty in BTR systems.

Object Databases Another kind of database management system has appeared during this object decade: the object database management system (ODBMS). An outgrowth of OO languages (like C++), an ODBMS adds *persistence* to native language objects. This is a great convenience for programmers, who avoid the necessity of mapping their OO language objects to the RDBMS organization. Unfortunately, ODBMSes have been slow to add SQL support to their systems, thereby making some BTR tasks very difficult to code. In addition, ODBMSes have been optimized for efficient support of persistence in a programming language, and not for support of thousands of simultaneous users accessing and updating mission-critical data. Finally, ODBMSes are not upward-compatible with existing RDBMSes, making it difficult for BTR applications to have a migration path from this technology. This lack of SQL, scalability, and migration facilities has limited the utility of ODBMSes in BTR applications.

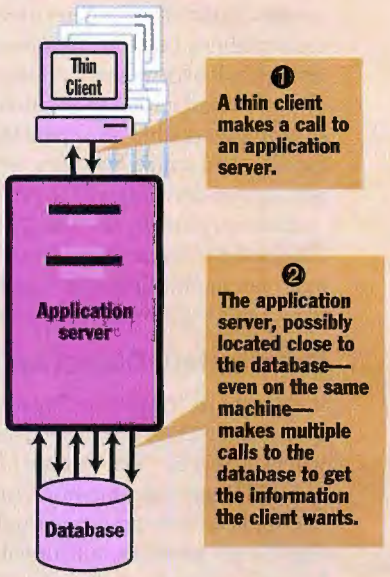
Object-Relational Databases A third approach promises to rescue BTR programmers from the dilemma of having to choose between a rich object model and scalability. Object-relational database management systems (ORDBMSes) are designed to provide all the power and robustness of an RDBMS, and natively manage objects in addition to the numbers and strings that relational systems have been limited to.

An ORDBMS is extensible. All the facilities of the SQL query processor are available, but the language operates on general *user-defined types* as well as on the predefined types of earlier relational engines. As such, an ORDBMS represents the most desirable DBMS choice for BTR applications.

The Three Places Business Logic

Three-Tier Architecture

Three-tier architectures scale better than thick clients, but they still have to remove data from a database in order to work on it.



Pros:

Off-loads processing from central database computer; has low client-management requirements; scales well.

Cons:

Possibility of poor performance as data is removed from database.

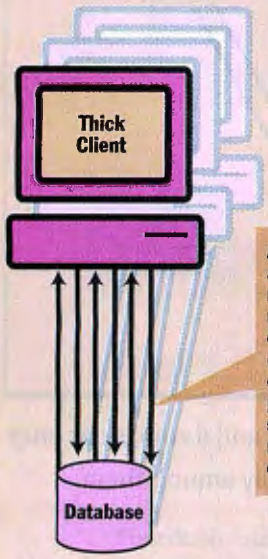
Major Benefits

Enterprise foundation elements are one of the most useful sets of classes for BTR applications. A `Customer` object, for example, can guarantee that all applications perform common integrity checks to prevent inconsistent entries into the customer database. Trying to simulate `Customer` objects in an RDBMS is often not a simple task, due to the impedance mismatch. And using the natural metaphors of object orientation within SQL queries (like inheritance relationships to guarantee that a `Premier_Customer` is also a `Customer`) is impossible.

Can Reside

Thick-Client Architecture

Although useful for screen-intensive applications, thick-client architectures don't scale well.



A thick-client application needs to make multiple calls to the database in order to populate itself so it can manipulate the data.

Pros:

Off-loads processing from central database computer; enables users to manipulate data however they want.

Cons:

Increases client-management requirements; increases network traffic.

Thick-Database Architecture

By performing processing in the database, thick-database architectures can improve performance over thick clients or servers.

A thin client makes a single call to a thick database. The thick database acts as its own application server, performing data manipulations while the data is still in the database; it then returns the data to the client.

Pros:

Has low client-management requirements; keeps data manipulation in database for fast performance.

Cons:

Can pose problem for load balancing.

In an ORDBMS, the enterprise's view of itself may be inserted right into an object-database engine, and SQL queries will automatically know about `Customers` and `Premier_Customers`. Thus, the first benefit of an ORDBMS is a more natural and customized data vocabulary for BTR programmers.

BTR applications are increasingly called upon to deliver graphical, audio, video, and other rich data types to users. Other less obvious, but no less critical, type extensions include geospatial ("Find the five closest dealers to this customer") and time-series ("Find the portfolio that will have greatest value one year from now"). The second major benefit of an ORDBMS is the support for databases containing a mix of rich content with traditional numbers and character strings.

Application Partitioning

There has been tremendous discussion in the press and at trade shows about whether an enterprise should choose an application architecture based on a thin- or a thick-client architecture. Briefly, the advocates of thick client suggest putting enterprise business logic on the client desktop machine. In contrast, the thin-client or three-tier camp advocates placing the same business logic on an application server and not on the client desktop. In either case, the business logic must communicate with a DBMS server layer to obtain data management services.

With the advent of the ORDBMS, a third application-partitioning scheme is possible because logic can run in the database engine itself. This *thick-database* architecture is inherently faster in many cases. (For a real case of how an ORDBMS can benefit a corporation, see the text box "Example of Enterprise Database Extension," page 92.) In general, it must be possible to support object behavior in any of the three tiers (client, application server, database server).

Traditional Architectures

The move to client/server computing in the 1980s spelled a radical change in the way applications were designed. Previously, all processing—both business logic and DBMS access—was done on a centralized server, typically a mainframe. With the advent of client/server computing, the application program (or business logic) was removed from the mainframe and run on a client machine, typically on a user's desktop. This led to the thick-client architecture (shown in the figure at left). Thick client became the architecture *du jour* in the late 1980s.

Unfortunately, a thick-client application architecture has flaws. It is both difficult to manage and does not scale. For one, servers and LANs are stressed to the limit. Secondly, a developer wants to write the application just once and then deploy it on all desktops. This becomes very difficult with thousands of separate desktop machines with possible different instruction sets (such as Mac, PC, and Unix). Additionally, when it is time to upgrade a thick-client application, a system administrator must find and upgrade all desktops. This manual process is tedious, expensive, and error-prone. Lastly, the cost of administering a large number of PC desktops is often significant.

These are all problems that did not exist on a centralized mainframe. The application existed only on a single central machine. Hence, disparate desktops and upgrades were not a problem.

To regain the benefits of centralized mainframes, architects began to propose the three-tier architecture. Here, the business logic is moved from the client to an intermediate application-server layer. A three-tier architecture has several advantages over thick client. New applications can be installed in one place, and a single

Example of Enterprise Database Extension (continued)

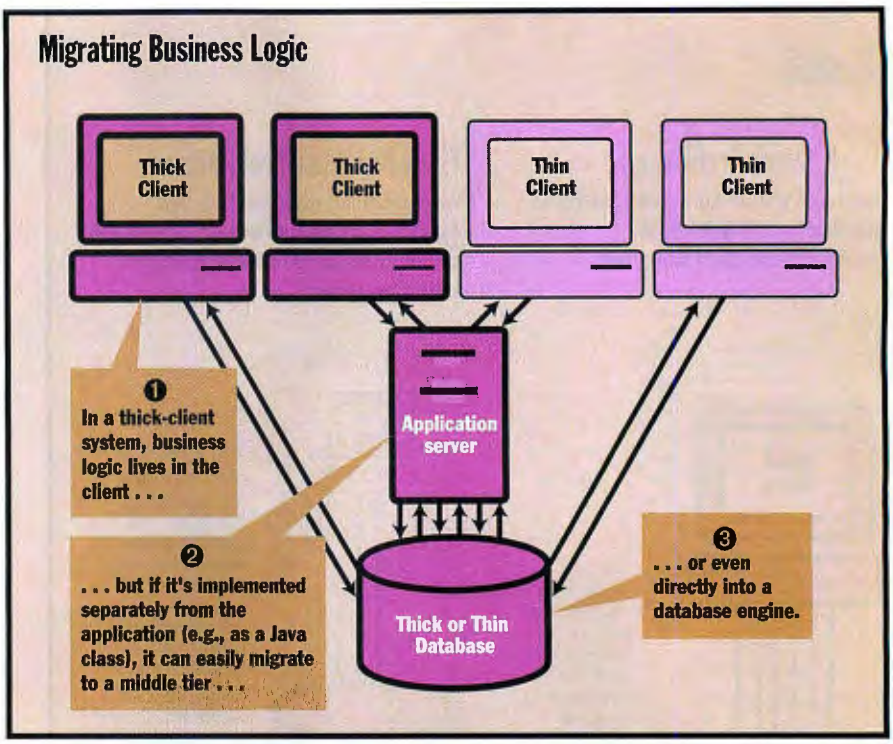
into 12 equal-length months. As such, March 15th minus February 15th is 30 days. We will call these semantics *bond time* in contrast to Julian time.

Unfortunately, the preceding SQL command implements Julian time, so the interest computed was incorrect. The customer was forced to utilize the following work-around:

```
Set up a cursor for the
query on Bond
Iterate over the result
set, for each qualifying
row retrieving the two
dates and the coupon rate
Compute bond time subtrac-
tion in user code, followed
by the rest of the interest
calculation
Put the answer back into
the database by updating
the current record.
```

This work-around has two serious drawbacks. First, it is very slow. Instead of performing a set-oriented update in SQL with a single round trip from the application to the DBMS, the customer requires a cursor and a round trip per qualifying record. Moreover, the data must be copied from the DBMS to a user program. In aggregate, the customer reported that the work-around was three times slower than the native code.

The second problem is the requirement to maintain a library of routines that programs can call to perform bond-time calculations. This presents serious system administration difficulties. Hence, the work-around was both slow and painful. *continued*



A good architecture can employ thick client, server, and database at once by allowing business logic to migrate seamlessly among them.

large application server is easier to administer than multiple client PCs. If the application server is closer to the data than the client machine, network traffic will be reduced, increasing system performance. Also, application servers can easily be run on a single kind of hardware but support a mix of thin-client user computers. As such, a three-tier architecture retains many of the advantages of a centralized mainframe without the expense of returning to mainframes.

A variation on this theme is the Java applet running in a browser, after being downloaded from a central Web server. This three-tier solution dynamically moves methods from middle to client tier and thereby combines some attributes of both thick-client and three-tier systems.

Tier Independence

The ORDBMS allows application object methods to run in the database engine. This is a third application-partitioning scheme, which we call *thick database* (shown in the figure on page 93).

We have seen how bond-time `Interval` is an example of a method that can achieve optimal performance when running in the database. The question then arises: "When is it appropriate to run thick client, thick middle tier, or thick database?"

Most data-intensive functions should be run as near the actual data as possible, i.e., in thick database. In this way, communication traffic of DBMS objects to other layers of the system is minimized. However, there are certain functions, such as display functions and edit checks, that are "screen-intensive." Such functions convert small objects into much larger ones, such as bit maps, or involve interactions with a human. Such functions are naturally run as thick client. Lastly, functions that are data-intensive and would ordinarily be candidates for a thick-database implementation may instead be run as middle-tier application servers. This approach can be used to achieve load balancing of CPU resources over a larger collection of machines, or to support interoperability with other objects using a standard framework.

For example, bond-time `Interval` will best support queries over large bond portfolios if it executes closest to the portfolio data, i.e., thick database. It is also easy to find business logic that is best run in a thick client. Consider a method, `New(Bond)`, to enter a bond into the system. This function requires substantial data entry from the user and invariably includes edit checks on entered values. If they are invalid, the `New(Bond)`

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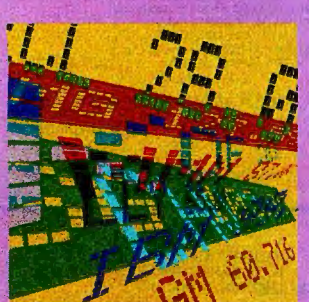
Example of Enterprise Database Extension (continued)

The better solution is to use an ORDBMS that supports type extension. In such a system, the customer can add bond time and the correct notion of subtraction to the DBMS. After the ORDBMS is extended with the bond-time object class, a natural SQL statement works properly:

```
UPDATE Bond
SET interest = coupon_rate
* Interval(date_bought,
date_sold)
WHERE …
```

The code reduction results because the impedance mismatch has been removed. Better performance results from running the methods of the object inside the DBMS. For methods (such as subtraction of bond times) that may be called hundreds or thousands of times for a single SQL query, this will represent a huge speed advantage over performing the computation in user code.

The ability to accept the definition of arbitrary objects and to optimize SQL queries for them represents a formidable engineering task for ORDBMS vendors. A few have made the investment to design a type-extensible engine from the bottom up, while others have attempted to take shortcuts. The shortcuts always significantly compromise performance. One such corner-cutting tactic is to call methods outside the DBMS process, using remote procedure calls or even an object request broker. Such a tactic will nullify the performance gains that result from method invocation inside the server.



method must conduct a dialog with the end user to fix the errant values.

If `New(Bond)` is run in an application server or inside the DBMS, then substantial interactions will be conducted with the ultimate user that will entail considerable network traffic. It is more efficient to run such screen-intensive methods on the client. This leads to these useful rules of thumb:

1. Data-intensive methods that are useful to queries should be run as thick database.

2. Screen-intensive methods should be run as thick client.

Both modes of operation are needed to produce high-performance applications. But there are also good reasons for middle-tier objects. A CORBA portfolio-management object that encapsulates individual bond queries for reuse by other clients is a good example of a middle-tier object. Typically, this kind of object will itself use thick-database objects.

3. Some business logic is best run in an intermediate layer between client and server, namely thick middle tier, especially in heterogeneous object environments.

Where a method should run depends on many factors, such as speed and congestion of the network; how screen-intensive it is; the relative speeds of client, application server, database server, and network hardware; kinds of clients that must be supported; and many others. These factors will change over time as business logic, object frameworks, and hardware evolve. This leads us to the next rule:

4. A good application architecture should allow business logic to migrate seamlessly among thick client, thick middle tier, and thick database as business and technical circumstances change.

A good application architecture must allow you to write business logic once and then deploy it as either client code, application-server code, or database code as conditions warrant. Some application systems allow migration between the first two layers. Expect to see a new generation of development tools that will allow objects to migrate among all three, based on the blending of object middleware and object-relational database technologies.

Future of Object Middleware

We have explored some reasons why object-relational technology will have an increasing place in the development of BTR applications. I believe that in time, the ORDBMS will become a significant component of middle-tier object systems. Both such systems must perform the following tasks:

- queuing of requests
- execution of business logic
- thread management
- security
- session management
- recovery from failures
- control of transactions

Most vendors have been suggesting specialized middleware software (application servers or transaction-processing monitors) to perform the above tasks. The CORBA Object Transaction Service and Microsoft Transaction Server are examples of service layers designed for this purpose.

If you look inside any well-engineered ORDBMS, you'll find that it manages all these same services. Execution of business logic is required to support the thick-database architecture. Moreover, multithreading and efficient session management have long been required in any DBMS that scales to the thousands of desktops in BTR applications.

When a database engine processes a query that involves customer information in a Chicago database and product information in a New York database, all the same services are invoked as when an object request broker (ORB) manages a method call across the Internet.

I believe it is inevitable that applications will eventually use the same set of services for both distributed data access and distributed application interconnection. Moreover, these services will be provided by a single high-performance code line. I expect a major component of this code line to be an object-relational DBMS. In other words, an ORDBMS will be a major component of all object middleware frameworks that support BTR applications.

The ability to migrate application code among all three layers, and the ability to use the same tools to manage application and dataset components, are two immediate advantages that BTR programmers will see from such an integration. As we move toward a world where distributed object state is kept in an ORDBMS, the differences between the database and the ORB must disappear. A single framework for distributed applications and distributed data may in fact be what the next decade ends up being known for. B

Michael Stonebraker, CTO of Informix Software, is the creator of the object-relational database concept. You can reach him c/o **editors@byte.com.**

SCRIPTLETS TO ENERGIZE YOUR SITE

This Microsoft technology brings code reusability and easy programming to your Web pages—if you have IE 4.

By Rick Dobson

Microsoft's 1997 introduction of scriptlets went largely unnoticed. With all the hullabaloo about browser wars, Dynamic HTML (DHTML), and Java foundation classes, it was easy to miss the scriptlet announcements. Nevertheless, this technology could profoundly impact many Web developers and their clients.

Scriptlets have five important potential implications for Web developers and Microsoft. First, scriptlets empower Web developers to create Web objects without Java, C++, or even Visual Basic expertise. Second, DHTML developers can more easily share the fruits of their labors. Third, developers can use scriptlets as Component Object Model (COM) objects in Win32 applications. Fourth, Microsoft may be able to divert some developers away from creating Java applets in favor of scriptlets, because scriptlets are easier to create and faster to download. Finally, because scriptlets are exclusive to Internet Explorer (IE) 4 and because of all their other benefits, Microsoft may hasten the upgrade from IE 3 and attract others from Netscape browsers.

This article presents major scriptlet benefits and features before giving an overview of how to design and use them. It also summarizes selected scriptlet weaknesses. The article closes by helping you decide if scriptlets are right for your site.

Benefits and Features

Scriptlets provide one core benefit—encapsulation—and a cluster of related ones that can speed, simplify, and broaden the reach of a Web developer's work. Many of these benefits follow from the tight integration between scriptlets and IE 4.

Web developers can encapsulate their work with scriptlets. This results in simplified reuse, faster debugging, and easier maintenance across multiple Web pages and even non-Web environments. A new type of `OBJECT` tag lets one Web page reference another, just like a main program calling a subroutine. This clean interface reduces the chances for error when reusing code. Simplifying reuse leads to more full-featured applications by making it easy to add functionality. Encapsulation also helps developers isolate bugs more quickly. Another major benefit is the reduced maintenance from making a single change to a scriptlet that can impact many other Web pages referencing it.

Scriptlet developers can use either HTML or DHTML. The use of DHTML is very powerful. By coding multimedia effects in scriptlets, developers can disseminate standard visual effects all across a site. Data binding makes it easy to build components that access and manipulate remote data sources. The user of a data-binding scriptlet needs to know nothing more than how to install the component on a page, which will typically be dramatically easier than creating a link to a remote data source.

Scriptlets significantly downgrade the entry-level skills for Web object development. As mentioned earlier, developers can build Web objects without Java, C++, or Visual Basic programming (see the figure "Scriptlet Application Architecture" on page 96NA4). Microsoft supports scriptlet development with JScript, its JavaScript look-alike, or VBScript, which is familiar to millions of Visual Basic and Office developers.

Scriptlets offer a familiar object metaphor. Most developers already have a basic grasp of object properties, methods, and

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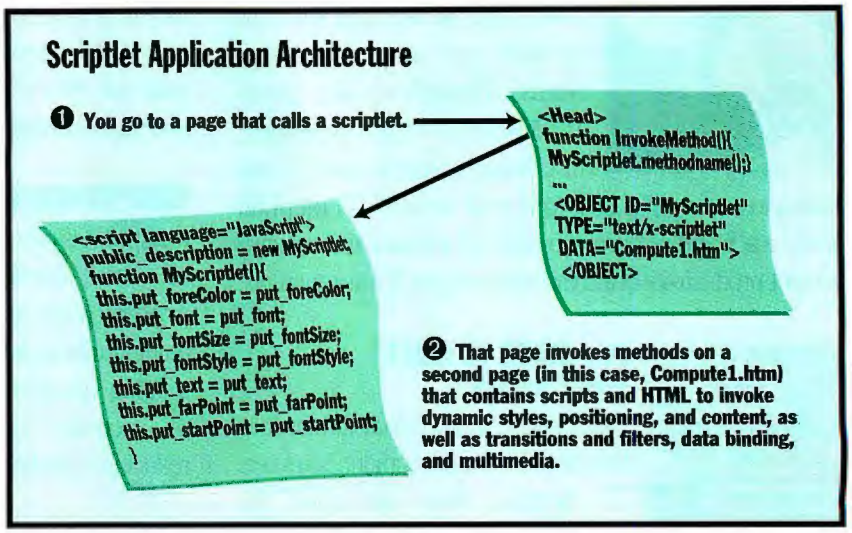
events. DHTML developers can build custom objects and then expose them for use by a host application. Users can benefit from scriptlet objects by invoking methods and by setting and reading properties. Events provide a notification mechanism for a scriptlet object to pass events to a host application.

Scriptlets enjoy two advantages that make them fast to execute. First, they express their HTML and script as plain text. These files will typically be small and will download rapidly from a Web server. Second, browsers will store scriptlets in the local Internet cache for fast reuse across multiple Web pages.

Gary Graham, a professional Web developer at Alphanet Technology (http://www.alpha-tek.com/ie/), reports that scriptlets provide superior performance to server-side includes for menu bars, footers, and other items that appear on many Web pages. A scriptlet incurs only a one-time download time no matter how many pages use it. By contrast, developers must download server-side includes separately for every page.

He also notes that you are likely to require browser detection and alternate page designs when tapping these benefits, because scriptlets work exclusively with IE 4.



To create scriptlets, all developers need is a basic knowledge of HTML and scripting.

Microsoft offers scriptlet support across a wide range of platforms and computing environments. Because scriptlets tightly integrate with IE 4, you can run them on Windows, Mac, and some commercial Unix platforms. Data binding through the Tabular Data Control is available in all these environments as well. Thus, scriptlets can offer data-binding support with this control across these diverse platforms.

Scriptlets behave like an ActiveX control in Win32 applications, such as Visual Basic, Office 97, and Delphi. This is possible because IE 4 wraps scriptlets in the Microsoft Scriptlet Control. This control is found in the WebBridge library. You can examine its properties, methods, and events with the Office 97 Object browser. This means that Visual Basic forms and Office applications can host scriptlets and work with them just like a host Web page. Developers can use the Visual Basic 5 Object browser to view the properties, methods, and events of a Microsoft Scriptlet Control that contains a scriptlet.

Designing and Using Scriptlets

There are two procedures for exposing properties and methods (see the figure "Two Ways to Create Scriptlets" on page 96NA6). First, the `Public_Description` object method is available exclusively to JScript developers at the time of this writing. (Microsoft announced plans to upgrade VBScript with its next release.) This technique stores the exposed scriptlet properties and methods in a special object.

Second, the Default Interface Description technique exposes properties and methods by preceding their name with a special prefix. This method of exposing properties and methods is available to both VBScript and JScript developers.

These two methods are covered in more depth in the Core Programming

Server Scriptlets

Recently, Microsoft announced a beta test of a twist on its scriptlet technology: server scriptlets. These are reusable COM components written in scripting languages and XML that are used on the server. (For more information on XML, see "Weaving a Better Web," March BYTE.) This means that Active Server Page (ASP) authors can componentize and reuse common scripts such as those used to access data, perform business logic, or participate in a transaction. In addition, these scriptlets are simple to create, according to Microsoft. Developers can use VBScript or JScript to create the components as well as straightforward conventions to define their component interface.

How do these server scriptlets differ from the regular DHTML variety? Both are scripting components, but they are used in different places for different purposes. To begin with, DHTML scriptlets are client components. Server scriptlets are obviously server components. DHTML scriptlets are most commonly used for displaying a UI using DHTML. Server scriptlets, while still COM components written in a scripting language, work with a server, in particular, Microsoft's Internet Information Server (IIS).

Microsoft's ActiveX scripting architecture enables the creation of many different scripting engines that will be able to run server scriptlets. Currently, the two engines supported are VBScript and JScript (i.e., ECMAScript).

Although not directly related to client scriptlets, server scriptlets show that Microsoft understands the value of component software and is addressing some of the code problems developers have encountered on their sites. An example of these are undocumented code snippets at sites with more than one Webmaster.These snippets, usually scripts in a language such as Perl, may perform valuable functions but lack any documentation as to what they do. Consequently, Webmasters end up duplicating code they might already have. Client and server scriptlets allow for a standard and clean way to cut down on unnecessary code generation.

–John Montgomery

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column, "Scriptlets Simplified," found on page 55.

The `Public_Description` object method offers two advantages over its counterpart. First, it consolidates all the exposed property and method definitions at a single location. Second, it does not require renaming local scriptlet functions and variables to expose them.

No matter how you expose properties and methods, you reference them with standard object-oriented syntax. Invoke a method with the syntax `MyScriptlet.methodname`, where `MyScriptlet` is the `ID` setting for the `OBJECT` tag in the host application. You can optionally set one or more parameters to determine how the method performs. The syntax for properties follows the same conventions.

A scriptlet can expose two types of events to a host: standard events, such as a click or a key press, and custom events, such as the changing of content or style inside a scriptlet. Exposing events lets a host respond to events occurring in a scriptlet.

For a scriptlet to propagate either event type to a host, the host must be available to receive the event, and the scriptlet must be operating in a host and not as a standalone Web page. The `window.external` object lets developers assess both conditions. This object houses scriptlet extension properties and methods to the DHTML Object Model.

A scriptlet can pass standard events to a host by applying the `bubbleEvent` method to the `window.external` object. Within the host, you can use the `window.event` object to process the event. You can also send custom events.

Scriptlet Weaknesses

Scriptlets work only with IE 4. This complicates their use in any type of environment, such as on the Internet, where many different types of browsers can access a page. At the very least, you will require browser detection and multiple versions of a page if you decide it is best to optimize for the IE 4 browser.

There are a few security topics that reveal scriptlet disadvantages. First, you cannot hide your code, since it is HTML. In addition to not protecting your intellectual property, scriptlets expose your code for inadvertent damage by users. Second, scriptlets do not download to browsers with a high security setting. Browsers can have a low or medium setting as well as a custom security setting with special options selected for scriptlets.

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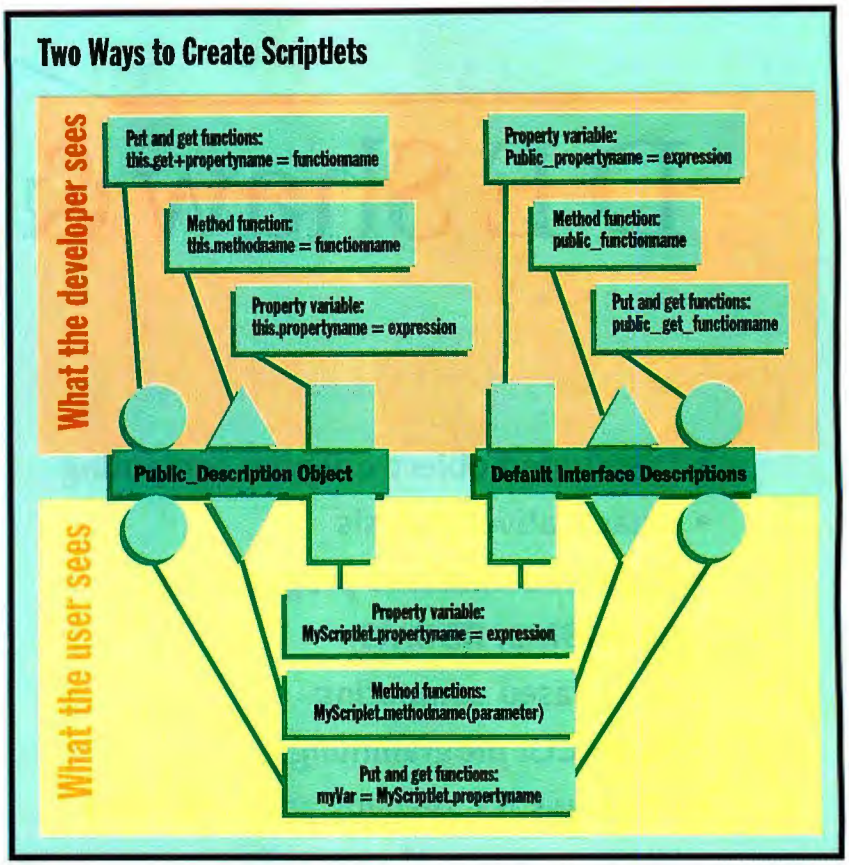


You design scriptlets with either Public_Description objects or Default Interface Descriptions, depending on your source language.

Are Scriptlets for You?

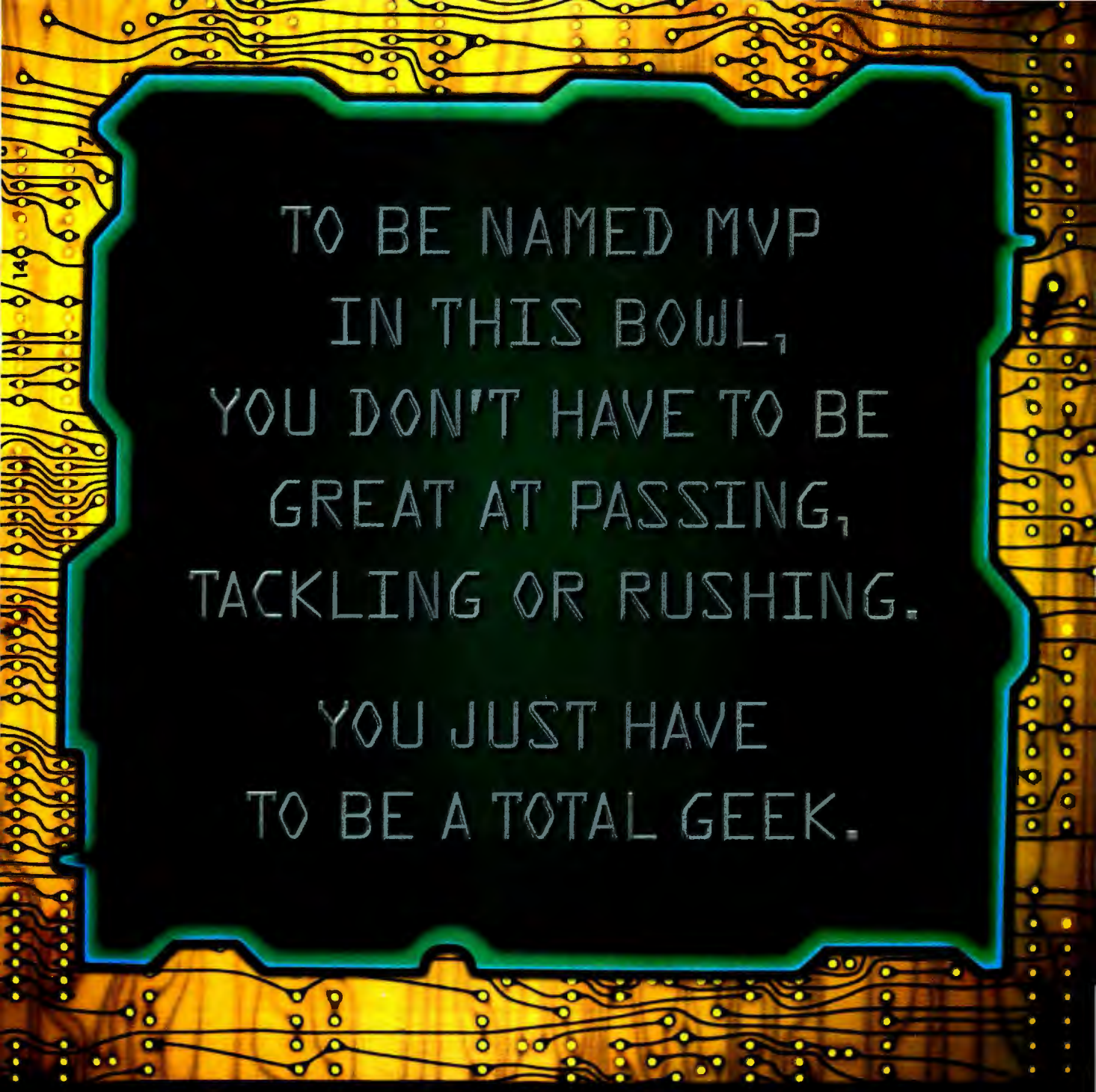
Scriptlets offer a mixed bag of benefits and disadvantages. The decision about whether to use them at your site hinges on whether the advantages outweigh the weaknesses.

A major advantage is that there are literally millions of HTML, VBScript, and JScript developers with the skills necessary to build scriptlets—you, your staff, or your consultant may be among this group. Scriptlets reduce the need for content providers to depend on Java applets and ActiveX controls. This can provide authors more creative freedom while it speeds download times. Scriptlets can reduce the cost of reusing DHTML, and you can incorporate scriptlets in Win32 applications as COM objects.

These advantages improve the value of DHTML investments by spreading the cost of development over more applications. Scriptlets also reduce maintenance costs, because you can update multiple applications with changes to a single scriptlet.

Scriptlets are not for sites that have little or no IE 4 traffic. While it is possible to accommodate non-IE 4 surfers with browser detection, the cost-effectiveness of this strategy depends on a sizable proportion of site visitors using IE 4. Sites with a "lowest common denominator" development strategy or sites that have standardized on a browser other than IE 4 are also not likely to find much use for scriptlets. Sites that prefer WYSIWYG design to code development will find scriptlets unacceptable. B

Rick Dobson, Ph.D., is president of CAB, Inc., a database and Internet development consultancy. He is a contributing editor for Microsoft Interactive Developer. Visit his firm's Web site at **http://www.cabinc.win.net.**



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PROPHETable SOFTWARE

Business-forecasting software is using new ideas in statistics to improve the bottom line.

By George A. Stewart

Francis Bacon was probably thinking of business forecasts when he wrote, "they ought all to be despised; and ought to serve but for winter talk by the fireside." Bacon knew his stuff. Three criticisms of forecasting in his essay "Of Prophecies" help us understand the strengths and limitations of business-forecasting software today.

Companies use forecasting software to guess at the future, make appropriate plans, and either avoid losses or reap gains impacting the bottom line. As the field of statistics advances and changes, so does the software embodying it. Understanding the capabilities—and limitations—of both will lead to more useful forecasts and better planning.

Confidence in Numbers

First, Bacon noted that "men mark when [prophecies] hit, and never mark when they miss." That is, people exaggerate the accuracy of forecasts. Modern forecasting software discourages this by providing confidence levels as a part of every forecast, as well as after-the-fact measures of forecast accuracy.

In any forecasting program, look for the confidence limits for a forecast. Such limits show users the likelihood that the actual data will exceed or fall short of the prediction, and by how much. That can often be more important than the forecast itself.

Suppose a software package forecasts that 931 units of a product will sell. The likely range of sales is as important as the best guess: It helps businesses determine how much product to have on hand to avoid selling out.

The 95 percent upper-confidence level, or safety-stock level, tells a manager how much to keep on hand to ensure that supplies will satisfy demand 95 percent of the time. The 931-unit estimate might, for example, have a safety-stock estimate of 1003: With 1003 units on hand, you can be 95 percent sure you won't run out.

Monday-Morning Quarterbacks

Besides confidence limits, software should also check predictions against what really happens. There are at least eight common ways to objectively evaluate forecast accuracy, including the symmetric mean absolute percentage error (MAPE), root mean square error (RMSE), median absolute percentage error (MEDAPE), and geometric mean relative absolute error (GMRAE). A recent comparison (see the text box "Shoot-Out at the M-3 Corral" on page 98) concluded that the ranking of forecasting methods is generally consistent, though not identical, regardless of which measure of accuracy you use.

According to Eric Stellwagen, vice president of Business Forecast Systems (BFS), the median relative absolute error is one (not entirely successful) attempt at deriving a scale-independent measure of accuracy. In any event, this is one instance where checking the rear-view mirror can keep you on the right road.

Just in Time

Bacon also doubted the validity of forecasting, noting that "the nature of man, which coveteth divination, thinks it no peril to foretell that which indeed they do but collect." That is, forecasters do not predict the future as much as project the past.

This is most applicable to time series. Modern forecasters make no claim to powers of divination, but instead give nearly total credit to the power of the past, in the form of a time series, to predict the future.

A *time series* is a set of measurements made at regular intervals. The essential idea is to predict future activity based on sta-

ILLUSTRATION: MARK STEARNEY © 1998

tistical analysis of past history.

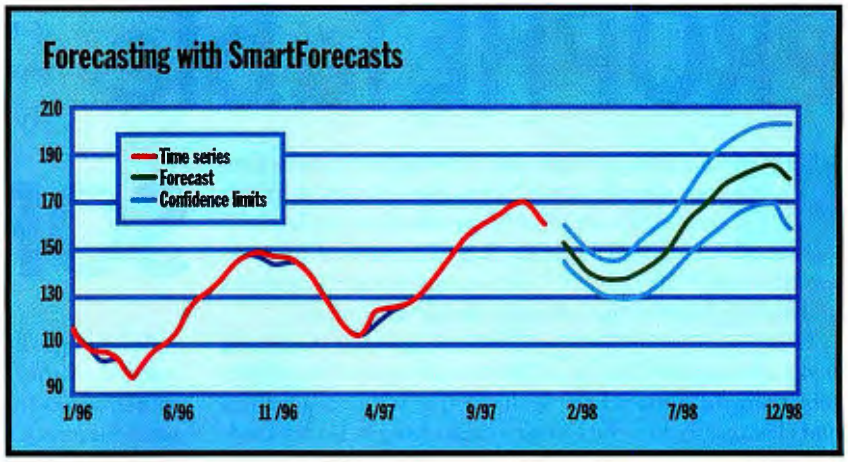
A common misconception often leads people to try to use forecasting software to predict stock prices. As SmartSoftware president Charles Smart explains, sophisticated time-series-based models are not the best means of predicting stock prices; there are too many factors that you cannot extract from a time series. Forecasts based on time-series analysis are not likely to improve upon the so-called "naive forecast": Tomorrow's price will be pretty close to today's.

However, this is not to say that forecasting software is useless in predicting the performance of a company. Often, one or more variables are known to affect that performance. In such cases, using multivariate regression—and even ordinary univariate methods—you can often predict sales, profits, and so forth with a reasonable confidence level. Such a projection might in turn support expectations as to the future stock price.

Dissecting Time

Some key concepts in time series include seasonality, trend, and irregularity, or randomness. *Seasonality* measures the tendency of the data to vary predictably with the season or other period of time. A time series of sales of, say, holiday wrapping paper or heating oil would exhibit strong seasonality.

Seasonality is not always so obvious to the user, however. BFS's Stellwagen recounts the story of a tobacco manufacturer using a three-month moving average to forecast sales. (Future sales were projected by averaging sales over the most recent three-month period.) Independent statistical analysis revealed that demand was in fact seasonal. The manufacturer immediately recognized that the seasonality corresponded to annual price increases traditionally announced by tobacco growers at the same time each year. Recognizing that its sales were seasonal enabled the tobacco manufacturer to forecast its sales with greater accuracy.



SmartForecasts takes a time series (red), smooths it (dark blue), and produces a forecast (green) and confidence limits (light blue).

Trend is the tendency of measured data to increase or decrease over time. *Irregularity* (also called randomness or noise) is the tendency of a time series to exhibit fluctuations that seasonality, trend, or other patterns cannot explain.

Forecasting software should be able to recognize each of these characteristics in time-series data. When it knows these characteristics, the software should be able to select the most appropriate forecasting model for the data. The correct model then provides the basis for computer-generated forecasts and the calculation of the associated confidence limits.

Rewriting History

Bacon's final criticism of prophecy was that "almost all [prophecies] have been... merely contrived and feigned after the event past." Within this is an idea at the very heart of modern forecasting methodology: out-of-sample analysis.

With out-of-sample analysis, a computer holds out one portion of the time series. Using the remaining entries in the series, the computer then selects one of several mathematical models to "forecast" the held-out portion. In effect, the computer pretends as if part of the past is the unknown future. (In this sense, the forecast is "feigned after the event past.")

The computer then compares the out-of-sample forecast with what actually occurred. It measures how accurately the forecast method would have been with the held-out portion of the time series. The computer uses other forecasting methodologies to determine which method most accurately predicts the out-of-sample portion of the data. Whichever method is best at predicting the known portion can then try predicting the true unknown future.

continued

Shoot-Out at the M3 Corral

The largest and most comprehensive empirical forecasting study to date was conducted last year under the auspices of the International Journal of Forecasting. Professors Spiros Makridakis and Michele Hibon of the French business school INSEAD directed the study. This study, the third that Makridakis has conducted, was called M-3.

M-3 compared the accuracy of 26 different approaches used to prepare 3003 forecasts. These forecasts used actual time-series data from business, industry, finance, and demographics.

Human statisticians using traditional methods competed against automatic forecasting programs, such as Autobox, Forecast Pro, Peer Planner, and SmartForecasts. M-3 researchers then compared the submitted forecasts to the actual future values of the series, which the participants did not know.

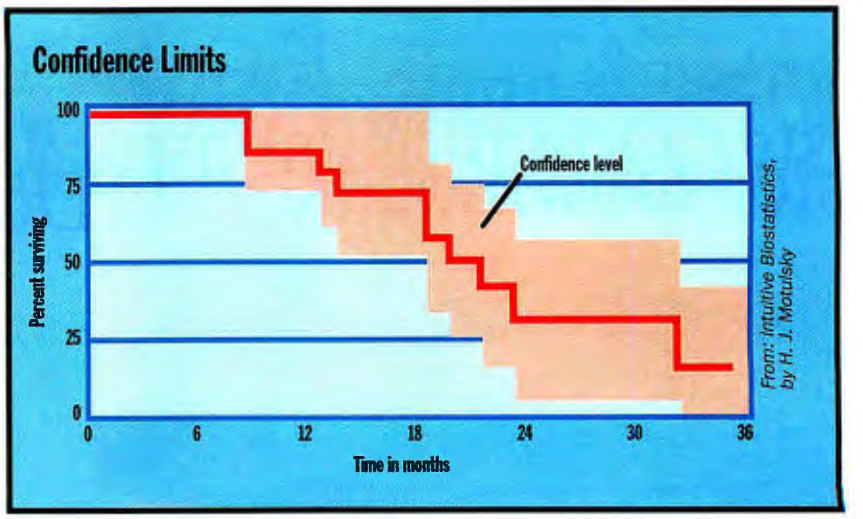
Although conclusions won't appear until June, early results indicated that one or more of the automated systems generally ranked in the top three of all the methodologies under various accuracy measures. The study also indicated that the accuracy of different methodologies varies, depending on the length of the forecasting horizon (i.e., how far ahead the forecast looks) and the measurement interval of the data (whether it's yearly, quarterly, monthly, or whatever).

Naturally, the significance of the M-3 competition, and the validity of its conclusions, are subject to ongoing debate. You can check out a discussion of M-3 on the International Society of Forecasters Web page (http://www.weatherhead.cwru.edu/forecasting.html).

Picking Your Prophet

Unless you have training in statistics or econometrics and are comfortable using statistical models to prepare your own forecasts, it's likely that you'll find automatic software necessary if you wish to take advantage of current knowledge in the field. Representative products are listed in the table "Forecasting Software" below. (I've omitted general-purpose statistical packages that might be capable of doing the forecasting function but are not dedicated to that purpose.)

The nature of your business will determine which forecasting products you should consider purchasing. Automatic forecasting-software packages generally differ in terms of capacity (ability of the program to calculate forecasts on a batch of time series, as opposed to handling just one time series at a time); ability to do product-line forecasting, either top-down (projecting individual item sales based on projected line sales) or bottom-up (projecting line sales based on sales of items in the line); and the forecasting methodologies available.



Forecasts aren't always right. This graph shows a forecast and a 95 percent confidence interval.

The most commonly used methodologies are exponential smoothing, moving averages, Box-Jenkins, and, for multivariate forecasting, dynamic regression. Croston's intermittent demand model is

Forecasting Software

	PRICE	PLATFORMS	METHODS	OTHER
Autobox (Automatic Forecast Systems)	$395 and up	DOS; Windows 3.x	Box-Jenkins, others	Tests model for adequacy; makes modifications.
Forecast Pro (Business Forecast Systems)	$595	DOS; OS/2; Windows 95, 3.x, NT	Moving averages, exponential smoothing, Box-Jenkins, dynamic regression, others	AI guides user to best method. Out-of-sample MAPE and MAD statistics measure performance.
Forecast Pro for Windows (XE) (Business Forecast Systems)	$995	Windows 95, 3.x	Forecast Pro plus multiple-level forecasting, event models, Census X-11, cumulative forecasts, expanded batch forecasting	Safety stocks, discrete distributions, and Croston's intermittent demand model.
Forecast Pro for Windows (batch) (Business Forecast Systems)	$4995	DOS; OS/2; Windows 95, 3.x, NT; AT&T Unix System V	Automatic forecasts using moving averages, exponential smoothing, Box-Jenkins, and event models	Automatic model selection, confidence limits, model details, and diagnostics.
Peer Planner for Windows (Delphus)	$9500–$150,000	Windows 95, 3.x, NT	Expert statistical forecasting system	Allows forecasters to link together results.
SmartForecasts (standard) (SmartSoftware)	$995 (up to 150 items)	Windows 95, 3.x, NT	Regression analysis and others	Automatically selects best method. Lets users adjust forecasts based on business judgment.
SmartForecasts (commercial) (SmartSoftware)	$3495 (up to 750 items)	Windows 95, 3.x, NT	Regression analysis and others	Automatically selects best method. Lets users adjust forecasts based on business judgment.
SmartForecasts (unlimited batch) (SmartSoftware)	$9995	Windows 95, 3.x, NT	Regression analysis and others	Batch processing of very large jobs. Includes automatic forecasting system.

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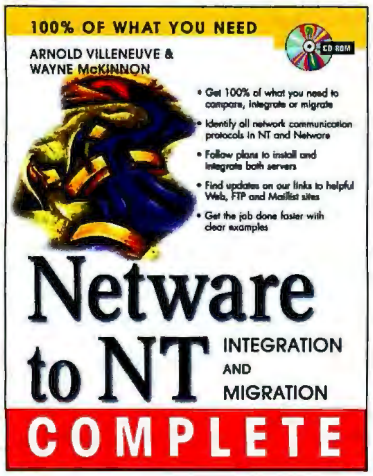

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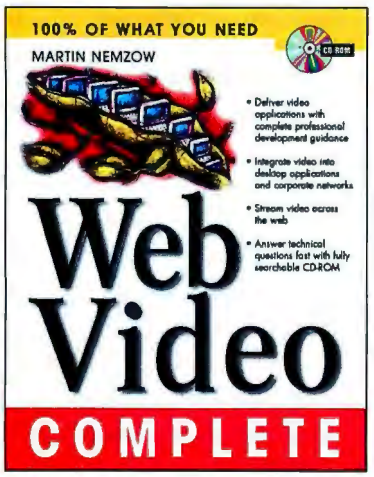

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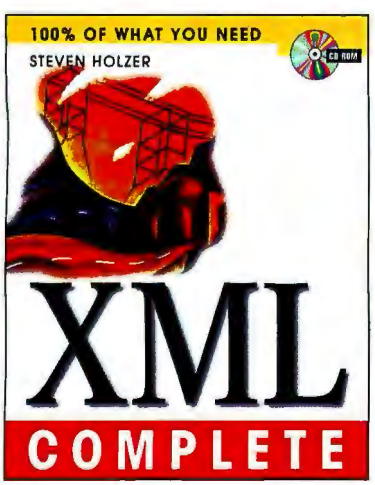

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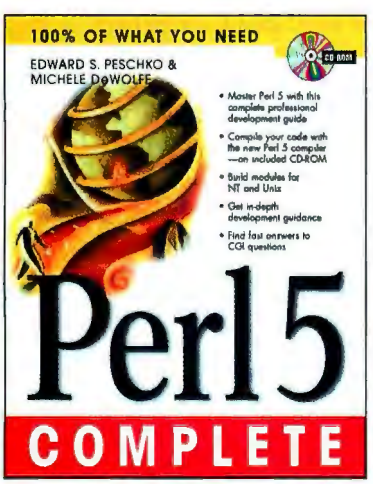

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a recent addition to the standard methodologies and is available in Forecast Pro. This method is specifically designed for data containing lots of zero-demand periods, a situation that's not unusual with time series representing demand for spare parts and big-ticket items.

Only a few of the products now available (e.g., Forecast Pro and SmartForecasts) avail themselves of 32-bit computer architecture. This feature is of greatest interest to users with large data sets.

Last, the available packages differ in terms of their ease of use (a largely subjective issue). Unless you are an expert in statistics, you'll want a product that guides you through the process. All the packages listed in the table on page 100 have Windows 95 implementations, which gives them a certain interface advantage over non-Windows products.

Predictive statistics continues to advance, and forecasting software will continue to embody the best of the latest ideas. You're sure to find good reasons to retire your coin and dartboard when making business forecasts. B

George A. Stewart (Hancock, NH) is a former BYTE editor. He has a B.A. in mathematics. You can reach him at **editors@bix.com.**

Glossary

BOX-JENKINS is a complex method of extrapolating correlations of data from the past to the future. Where correlations are strong, Box-Jenkins is likely to give better forecasts than exponential smoothing.

CONFIDENCE LEVELS indicate the statistical significance of a given "point forecast": the probability that actual results will exceed or fall short of the point forecast. For example, the 95 percent upper-confidence level is the value that will exceed the actual value 95 percent of the time.

EXPONENTIAL SMOOTHING encompasses a variety of statistical methods for modeling time series, especially those showing seasonality and trend. It works well with data that has a lot of randomness.

MOVING AVERAGE is a simple forecasting method that averages the values of a variable's recent history. This method is usually inappropriate with seasonal or trended data.

REGRESSION is a statistical method for predicting the value of one variable given the values of one or more others. For example, a model might estimate sales based on age and gender.

MULTIVARIATE REGRESSION uses multiple variables to predict another variable.

UNIVARIATE REGRESSION uses one variable to predict another.

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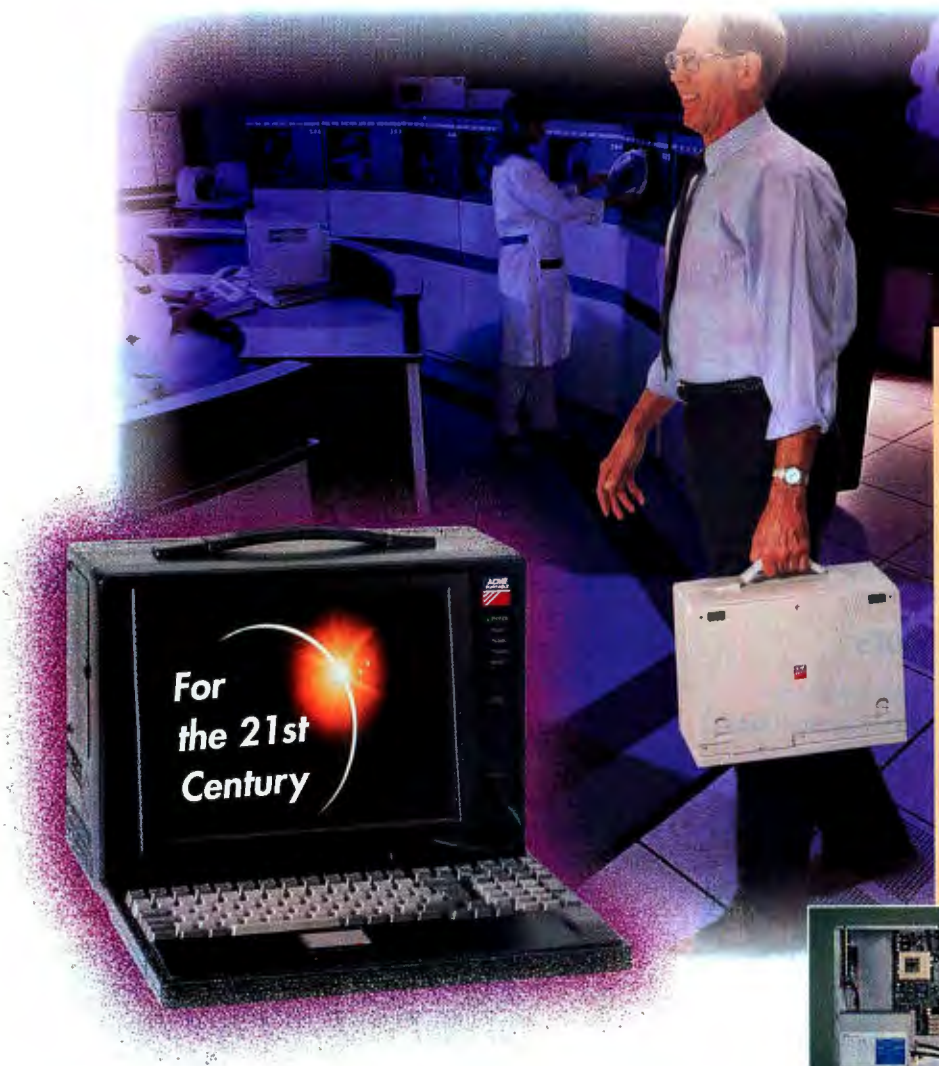

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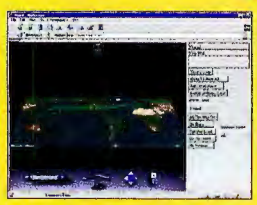

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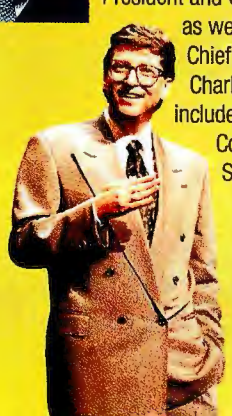

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Securing Mail and News

Exploring the SSL modes of Netscape's Messaging and Collabra servers.

In theory, thanks to near-universal Internet dial tone, my BYTE office and my home office should be functionally equivalent. In practice, there's one big difference: My work office is inside McGraw-Hill's corporate firewall, and my home office is outside.

Like many of you, I do a great deal of Internet-enabled work in both locations and elsewhere. The challenge is to find a safe and effective way to extend my work environment beyond the firewall. SSL-enabled (Secure Sockets Layer) applications are one kind of solution. This month, I've been evaluating the trade-offs involved in running Netscape's mail and news servers in secure mode.

You'd think that secure mail would need no justification. Who wouldn't want to keep personal and business communication private? And yet, although Secure Multipurpose Internet Mail Extensions (S/MIME) technology has been widely available for almost a year and PGP for far longer, I know very few people who routinely encrypt messages using these tools.

Why? It's a hassle. In the case of S/MIME, you have to acquire a personal certificate. Then you have to exchange keys with each correspondent with whom you intend to communicate securely. Then you have to remember to use encryption when sending messages. When some recipients can receive encrypted messages from you but others can't, you have to make complicated adjustments. If you switch from your work browser with a certificate installed to your home browser without one, you have to make more complicated adjustments.

It's no wonder that PGP and S/MIME haven't exactly taken the world by storm. The infrastructure that's needed to make using these technologies a no-brainer for most people just isn't here yet.

So Internet mail, which increasingly carries vital business and personal communication that ought to be encrypted, still travels the wires mostly in the clear. It's relayed through a patchwork quilt of intermediate hosts, some of which may have been hacked and may harbor concealed network sniffers that capture mail account names and passwords, or even assemble packets into complete data files.

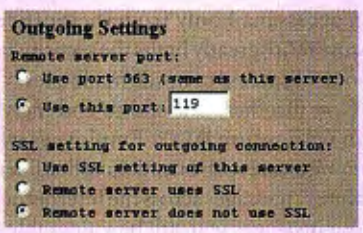
In the long run, we need to go beyond virtual private networks (VPNs). We must be able to make secure point-to-point network connections to arbitrary locations as easily as phone calls. Applications shouldn't need to know anything about encryption; it should just be a property of the transport layer.

For the next few years, though, we will be stuck with application-specific security protocols. S/MIME is an example of such a protocol, and it's available now, but it lacks the infrastructure needed for effective deployment. Meanwhile, there's a pressing need for a quick fix. Secure IMAP, though by no means a perfect solution, nevertheless offers some important immediate benefits. So does a closely related technology, secure NNTP.

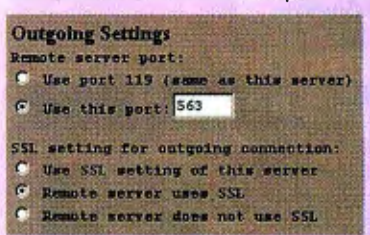
Configuring SSL/Non-SSL NNTP Replication

To replicate between normal and secure NNTP servers, you have to inform each of the other's SSL status.

The secure host, running securely on port 563, replicates with the nonsecure host on port 119.



The nonsecure host, running on the normal NNTP port 119, replicates with the secure host on the secure port 563.



Netscape's SSL-Enabled IMAP Mail Server

For the past few weeks, I've been trying out Netscape's Messaging Server. Its IMAP capability was what first attracted my interest. I've used POP3 for a few years, but that's a poor solution because I access my mailbox from two or three workstations every day. Since I never know when I'll need a particular message to be in a particular workstation's local message store, I'm in the habit of leaving mail on the server and doing redundant full dumps to each workstation.

It's futile to try to reorganize your local message store under this scenario, since you'd have to repeat all folder-related actions once per client. So I'm a prime

candidate for IMAP's server-based folder management.

Netscape's Messaging Server does IMAP with a twist. You can access your mailbox in unencrypted mode on port 143 (comparable to POP3's port 110), or you can fetch and send messages securely on port 993. Secure IMAP is much stronger than APOP, a POP variant that encrypts log-in credentials but not message data.

With secure IMAP, log-in credentials and messages are encrypted. All communication between client and server uses an SSL channel. If your client is Communicator, you'll see the whole-key icon in the message-reading window, just as you do when viewing a secure Web page fetched from an `https://` URL.

How does secure IMAP compare with S/MIME? They're very different (see the table "Secure IMAP vs. S/MIME"). S/MIME's security benefits are far more comprehensive. Once you encrypt a message, it can travel safely over any mailbox-access pathway (POP or IMAP), through any number of relay hosts, to any destination, with no performance degradation.

If every Internet mail user had a digital ID, and if every user's public key were available in a directory, S/MIME would be unbeatable. Until these conditions prevail, though, secure IMAP can provide a much narrower—but still valuable—benefit. It can secure the mailbox-access pathway.

Secure IMAP vs. S/MIME

Secure IMAP is a narrow solution that can help extend the corporate firewall to encompass remote work locations. S/MIME offers wide-ranging security benefits, but it requires more infrastructure and user training.

	Secure IMAP	S/MIME
End-to-end encryption	No	Yes
CPU overhead	High	Low
Administrative overhead	Low	High
User-training overhead	Low	High

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This handy utility empowers you to set a cookie policy that's more finely granular than what the major browsers support. CookiePal can accept or reject cookies on a per-site basis.

BOOKNOTE

Web Security: A Step-by-Step Reference Guide ($29.95)

by Lincoln D. Stein
Addison-Wesley Longman
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Comprehensive analysis and advice from the author of the popular World Wide Web Security FAQ.

To appreciate the value of secure mailbox access, consider the dilemma faced by a company wishing to deploy Internet mail. How do you set up your mail server? If you put it outside the firewall, the POP and/or IMAP ports are highly vulnerable, as are the log-in credentials and messages traveling across those ports. If you put it inside the firewall, the ports are either left open, creating the same vulnerabilities, or closed, in which case employees can access mail only from their offices. Secure IMAP greatly limits the security risk of outside access to inside mailboxes.

Note that there's no end-to-end encryption with secure IMAP. Employees who communicate with outsiders will still send plaintext messages across the Internet, and those messages will still be vulnerable to interception. But from a corporate perspective, the communication that most needs protection is communication that occurs within the company. Secure IMAP encrypts these messages far more conveniently than S/MIME can. Users just need to enable the SSL option in the mail client. Administrators likewise just need to turn on SSL in the mail server.

Implementing Secure IMAP

There's a bit more to secure IMAP than just turning it on in the server. As with secure Web connections, the security handshake involves authenticating the server to the client. (The reverse procedure—client authentication—is optional; see "Digital IDs," March 1997 BYTE, http://www.byte.com/art/9703/sec8/art1.htm.) During server authentication, a secure server presents its digital ID to a client.

To enable secure IMAP, therefore, you need to acquire and install a server digital ID. Messaging Server comes with the tools you need to generate a key pair and the document (a certificate signing request, or CSR) that you use to relay your server's public key to a certificate authority (CA) that affixes its digital signature to the key.

For a secure Web server, you typically want to send your CSR to one of the well-known CAs (e.g., VeriSign or Thawte) that browsers are hard-wired to recognize. For secure IMAP (or NNTP), it is not necessary, and arguably not desirable, to use a well-known CA. What's the alternative? You can become your own CA and configure your mail or private news server to use a self-signed certificate.

The advantages of the do-it-yourself CA approach are twofold. First, it can be cheaper, quicker, and easier to stamp out your own server digital ID than to acquire one from a commercial CA. Second, it's somewhat more secure, because only the clients that you configure to recognize your homegrown CA's signature will be able to connect to servers presenting IDs with that signature.

There are trade-offs. Some CA toolkits are free for noncommercial use, notably SSLeay and IAIK-SSL, but RSA Data Security patents prohibit the use of these in the U.S. Shrink-wrapped CA toolkits, such as Netscape's Certificate Server, may or may not prove cost-effective; it will depend on your scale of operations. Then there's the learning curve associated with CA tools.

If you decide to present self-signed certificates to your intranet mail or news users, there's one other hurdle to clear. You have to convince the client software to trust your homegrown CA. If the client is Communicator, there are two ways to do that. Assuming that mycert.cert contains a Privacy-Enhanced Mail (PEM) version of your CA certificate, you can:

Method 1 (server-based): Configure your Web server to map the .cert extension to

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the MIME type application/x-ca-cert and instruct users to fetch mycert.cert into their Web browsers from a URL.

Method 2 (client-based): Configure each browser to map the .cert extension to the MIME type application/x-ca-cert and instruct users to fetch mycert.cert from a URL.

Hybrid SSL/Non-SSL IMAP Service

Once I'd worked through the certificate rigmarole, I fired up Messaging Server, configured Communicator's mail client for secure IMAP, and tried to connect. No joy. The server's log files provided no clue, but eventually I found the answer in a readme file on the Netscape site.

There are actually two mail servers. The normal (unencrypted) one launches from Netscape's server administration interface. However, the SSL-capable SIMAP4-Server must be launched separately from the command line. Why? In Netscape's implementation, you can start a secure mail (or news) server only locally, because at start-up you have to type in your private key's passphrase.

It's a chicken-and-egg problem. You can't start up a secure server remotely, because you can't authenticate over a secure connection until there is a secure connection. As a result, any reconfiguration that requires a server restart can't be done remotely.

When you launch SIMAP4, you're running two servers at once. The unencrypted server listens on port 143, and the secure one on port 993. (Optionally, POP3 service can also be available on port 110.)

This turns out to be an extremely useful configuration. Why? SSL slows things down a lot. Depending on your intranet situation, you may wish to encrypt the mailbox-access pathway internally as well as externally. But if you trust your inside network, it's really handy to be able to give inside users fast unencrypted mailbox access and restrict the performance hit of SSL to just those users who reach in from outside. To enforce this policy, you need to locate your secure mail server on the inside, behind a router or firewall that allows port 993 but denies port 143.

Quite often, of course, an inside user during business hours becomes an outside user after business hours. The hybrid SSL/non-SSL approach is simple if the user maintains a work machine whose mail client talks to port 143 and a home machine that talks to port 993. In the case of a portable computer, it's a bit more complicated. The user must now redirect the mail client once per boundary crossing. Is there a way to automate this procedure? If someone knows how, please let me know.

Netscape Messenger vs. Netscape Collabra

IMAP and NNTP implementations overlap significantly, but not completely. Maybe it's time to merge the two into a unified collaboration protocol.

	Messenger (IMAP)	Collabra (NNTP)
HTML/JavaScript content	Yes	Yes
Off-line client capability	Yes	Yes
Authentication by name/password or client digital ID	Yes	Yes
Group-accessible folders	No	Yes
Full-text-searchable message base	No	Yes
User-reorganizable folders	Yes	No
Server-based read/unread message tracking	Yes	No
Can run on SSL channel?	Yes	Yes
Hybrid SSL/non-SSL	Easy; single server provides SSL and non-SSL listeners	Hard; requires replicating SSL and non-SSL servers

Implementing Secure News

Secure NNTP closely resembles secure IMAP. For private staff newsgroups, we are running Collabra Server on the secure news port (563) rather than the default port (119). The certificate procedures are identical, and you can in fact use the same server certificate for Collabra Server as for Messaging Server.

Unfortunately, the hybrid SSL/non-SSL solution is more elusive for NNTP than for IMAP, because Collabra Server cannot simultaneously listen on secure and insecure ports. For us, the non-SSL option is a high priority. Most of our private newsgroup usage occurs on a trusted internal network, and the slowdown caused by SSL is quite noticeable.

SSL creates another problem, too. We're avid users of Collabra's HTML features. One of these features, the ability to post messages that refer to external Web content, fails with SSL turned on, because the client refuses to display insecure content (e.g., from a normal http:// URL) in the context of a secure message.

The only solution is to run two Collabra servers, one secure and one not, and replicate between them. Collabra can do this, though, not surprisingly, the setup is even trickier than for a pair of conventional port-119 NNTP servers, which is in itself a notoriously tricky thing to make work. To do SSL/non-SSL replication, you have to tell the two servers about each other's SSL status (see the figure "Configuring SSL/Non-SSL NNTP Replication").

If you're using a commercial server certificate on the secure server, this setup should suffice. But if you add a self-signed certificate, as I have been doing, there's another puzzle piece to deal with.

When I turned on replication in both servers, it worked in only one direction. To achieve bidirectional replication, you have to convince `innxmit`, the replication agent on the insecure server, to trust the signature on the server certificate presented by the secure server. After appealing to Netscape for advice, I finally solved this problem by copying the certificate database from the secure server to the insecure one and naming that database in the insecure server's nsnews.conf file.

Whew! This all sounds like a lot of configuration hassle, and indeed it is. Partly that's because IMAP and NNTP are overlapping but fundamentally different collaboration protocols that probably, at this point, should merge. And partly it's because SSL is just plain complex. There's no doubting the benefit of secure mail and news. But I'll grant that not many administrators will be willing or able to jump through all the hoops I've described. Let's hope it gets easier soon. B

*Jon Udell (**jon.udell@byte.com**) is BYTE's executive editor for new media.*

Rick Grehan

Javatalk

Small Footprint, Will Travel

Cloudscape's JBMS stores data and Java methods in a relational database that's under 2 MB.

Object-relational databases can store relational data as well as more complex data types, such as graphics files and other objects, but most need a server with at least 16 MB to run. Cloudscape's JBMS is an object-relational database system that implements a subset of the SQL-92 standard in less than 2 MB. It runs under Windows NT 3.5 or higher, Windows 95, or Sun Solaris. JBMS, which requires a JDK 1.1.1 or higher Java virtual machine (JVM), was scheduled to ship in February for $495.

It's important to recognize that JBMS is not a persistent storage database running atop a relational database engine (as is, for example Ardent Software's JRB, which I reviewed last month). It's a Java front end to a relational database back end. Consequently, whereas in a persistent storage system you fetch and store objects directly, with JBMS you issue SQL-style SELECT and UPDATE statements.

This would seem to make JBMS no better than a thin layer atop Java Database Connectivity (JDBC). But it's more. For example, JBMS lets you store any serializable Java class in the database. This means that a database can hold not only data, but the classes—and, therefore, methods—that manipulate the data as well. Because the database holds data in addition to executable code, you don't have to compile the classes that manage stored objects into the application; those classes can be loaded at run time.

Cloudscape has extended the SQL to a variant that it calls SQL-J. This allows you to use a class's methods in SQL statements. Suppose, for example, that a database holds objects of class `Hotel`, and one of the Hotel methods is `amenitiesIncludes()`. The `amenitiesIncludes()` method takes a string as an argument and returns a Boolean value indicating whether the string is in the set of Hotel amenities. You could then issue the following SQL-J statement against the JBMS database:

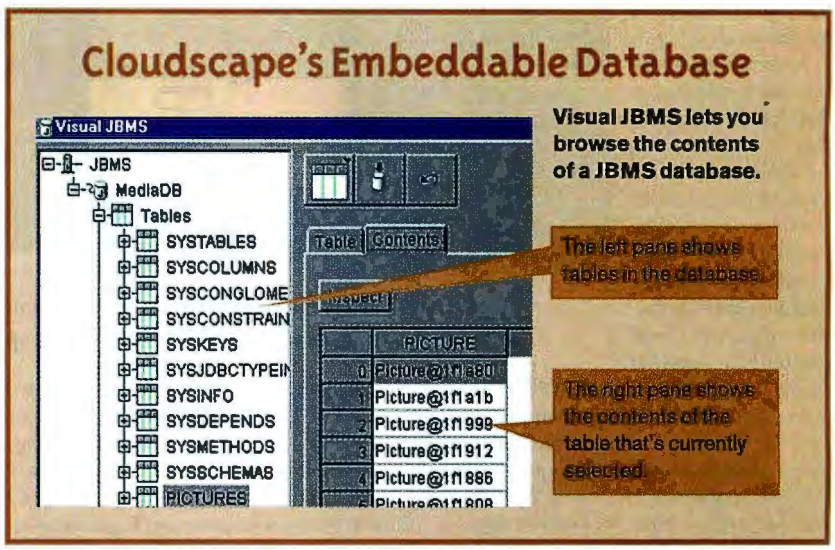
```
SELECT hotel FROM Hotels
WHERE hotel.amenities
  Includes('Pool')
```

In addition, JBMS supports "replication" (although a better word for this capability is probably "synchronization"). JBMS's replication capabilities allow remote database users to connect to the home database intermittently. The package synchronizes the remote user's view of the database with the home database. The remote user can disconnect, perform modifications, and then reconnect at a later time, and JBMS automatically ensures consistency between the home and remote databases.

You can deploy JBMS in one of two configurations. The first is an "embedded" form of JBMS: You embed the entire JBMS system in an application. JBMS is small enough (1.5 MB) to make this feasible. And if that's still too large, JBMS is modular enough so that you can excise unneeded portions. For example, if your application will be using predetermined queries, they can be compiled to Java methods. In that case, you can remove the portion of JBMS that parses SQL statements and yield a trimmer run time.

The other configuration is a client/server form. This requires a JBMS server engine (which uses the Web Logic remote JDBC drive). Client applications run a thin JBMS layer that communicates with the server. The advantage of this scheme is that it permits multiuser access to a database; the JBMS server is the access coordinator. (By contrast, the embedded configuration permits only single-user access to a database.)

Along with copious HTML- and PDF-based documentation, JBMS comes with



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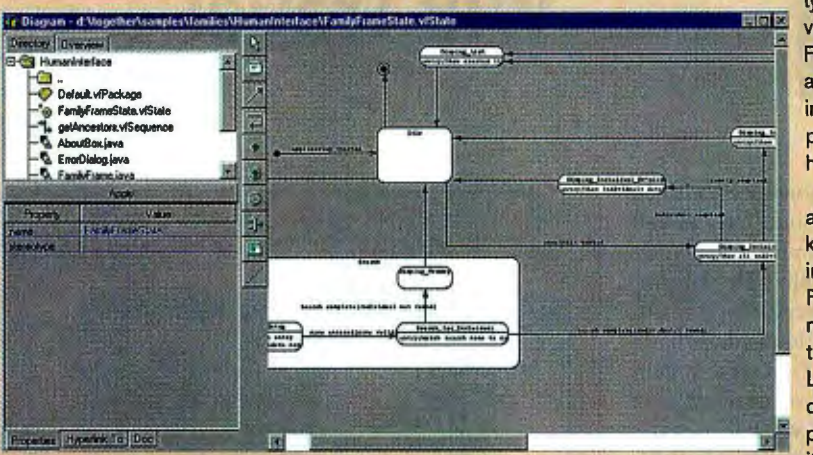
Java and UML Come Together

Object International's Together Java offers the kind of cradle-to-grave development environment that—if the object-orientation (OO) methodologists have their way—we'll be seeing more of. Together Java merges the design and implementation phases of your Java programming project; one flows smoothly into the other. The idea behind Together Java is that the developer proceeds directly—and I do mean directly—from application design to implementation.



Together Java offers many UML-compliant diagramming tools. Pictured is a state-chart diagram for the current application.

Together Java has the look and feel of an IDE. Pull down the File menu, and you can create a new project. Within a project are all the files and packages that comprise an application; this includes source code files, diagram files, and documentation. Together Java's documentation is all in HTML. (The 1.0 version that I tested included three documents: "Getting Started," "How To," and a user's guide.) Consequently, Together Java's search capabilities are limited. Unless you know which document your search target is in, you have to hunt through them all using your browser's Find command.

The visual-design portion of Together Java makes available four different kinds of visual diagrams: class, use-case, sequence, and state. Each diagram models a particular aspect of the system. The class diagram lets you model class structures as well as relationships between classes in the system. With the use-case diagram, you capture and illustrate the various ways in which an external agent (i.e., a user) can use the system. The sequence diagram (sometimes referred to as a message sequence chart) portrays the interactions between objects as the system carries out a particular operation. Finally, the state diagram is a BLTZFG state chart, which lets you model the behavior of the system.

As wonderful as Together Java's design-level modeling tools are, what really makes them shine is their close coupling with the implementation. That's a fancy way of saying that modifications you make to the visual models are reflected in the associated source code, and vice versa. Add a new operation to a class in the class diagram, and Together Java automatically writes an empty method into the associated source code file. Alter the name of a method in the source code file, and the altered name reflects upward, back into the visual model (the system alters the name in the class diagram).

When you create or open a project, Together Java launches a four-paned window. The upper left pane is the navigation pane, which allows you to browse through the different packages and files that make up a project. The upper right pane is the content pane, which is where Together Java draws the current diagram (which you choose by selecting the appropriate file from the navigation pane). The inspector pane, in the lower left-hand corner, provides a table-style view of the properties and attributes of whatever object is selected in the content pane. (For example, the properties of a method would be its returned data type, input arguments, visibility, and so on.) Finally, you can view and edit source code in the text pane, in the project's lower right-hand corner.

Object International is working hard at keeping Together Java in line with standards. First, its diagramming notation is based on the Unified Modeling Language (UML) standard. In addition, the package has the ability to generate documentation; it does so by producing standard HTML files. Finally, although I tested Together Java as a stand-alone package, you can configure it to operate as an add-in for Borland's JBuilder. This provides a single station for designing, coding, compiling, debugging, and documenting your Java application.

Object International (919-772-9350; fax 919-772-9389) recommends at least a 100-MHz Pentium CPU, Windows 95 or NT 4.0, and at least 48 MB of RAM for running Together Java. In addition, the installation guide suggests that you have 15 to 18 MB of available hard disk space. The commercial edition of Together Java is available for $2400. A so-called whiteboard edition (which lacks capabilities such as printing, HTML documentation generation, and some of the diagrams) is available free for the downloading from Object International's Web site, which is located at http://www.oi.com.

Visual JBMS, a visual browser that allows you to inspect a JBMS database. Visual JBMS is unique in that it's written in Java. So, if you've stored Java objects and associated methods in the database, you can execute those methods on their associated objects from within Visual JBMS. (For example, if you've stored picture objects and the picture objects' class includes a `display()` method, you can, from within Visual JBMS, request the display method to display a picture.)

Cloudscape's product information is frank about the limitations of version 1.0. It does not support triggers, replication is incomplete, and some SQL-92 elements are not yet implemented. Cloudscape hopes that a future release will support "pluggable index methods," which would allow you to select the indexing method—B-tree, hash table, or whatever—your JBMS application will use. B

WHERE TO FIND

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http://www.cloudscape.com

Rick Grehan (Hancock, NH) works for Metrowerks' Discover Products division. You can reach him at **rgrehan@austin.metrowerks.com.**

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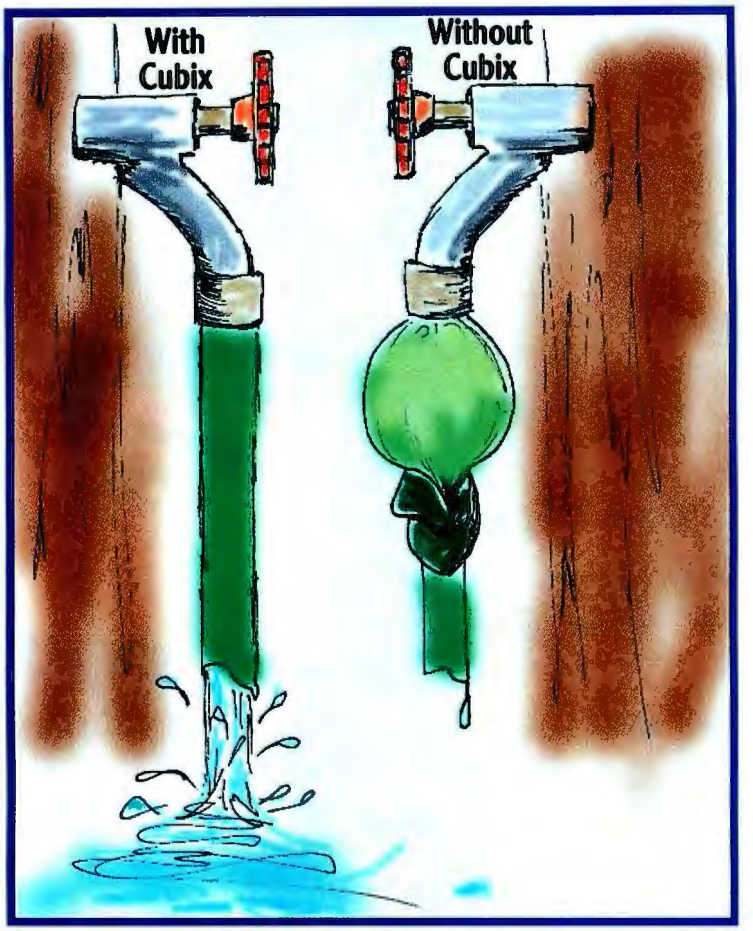

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BYTE Reseller

Smartcards Mean Security

As they migrate to the U.S., smartcards are finding usefulness as security tokens.

Page 112C

Customer Service Gets Web-Savvy

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Page 112K

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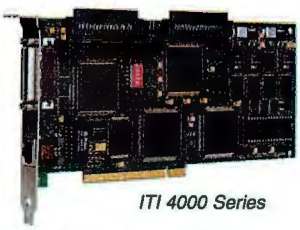

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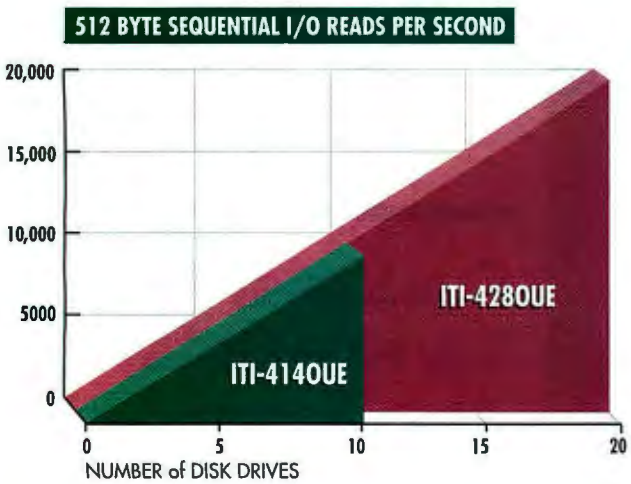

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Security applications will be the spearhead for smartcards, with financial applications to follow. By Stephen Cobb

Smartcard Invasion Continues

Think of smartcards as credit cards with brains. The same size as magnetic-stripe cards, their 8-bit processing power almost equals the first desktop computers (see "Working Smart," next page). Analysts have tagged smartcards as one of the top 25 technologies of 1998. But how can this be if most Americans have never even seen one?

Deployment Maneuvers

To start, be aware that smartcards are widely used all over the world. They first appeared in 1974. The first smartcard trial took place in 1982, in France, and by 1993, French banks had issued 22 million of them. Today smartcards are common in Europe, with over 100 million pay-phone cards in France, 80 million health-insurance cards in Germany, and "electronic purse" cards in more than 20 countries (see "Smartcards in Action," page 112F).

Theories about why such applications have lagged in the U.S. probably outnumber successful American smartcard trials. It could be a case of leapfrog technology. By the time practical smartcards appeared, America's love affair with mag-stripe cards was already in full swing. In contrast, mag-stripe use in many European countries was not yet entrenched. Other explanations involve American attitudes toward public infrastructure, privacy concerns, and even religious opposition (from those who see smartcards as the "mark of the beast"—at least one smartcard company executive has received death threats).

Secure Perimeter

But we still think that there's a smartcard in your future. Consider this: As a BYTE reader, you likely use computers that either contain, or access, valuable information—and it's information-security applications that are leading the smartcard invasion. According to Chandra Shah, vice president of Litronic, a leading provider of smartcard-enabled security solutions, "Just as personnel ID badges have become commonplace in company and government offices throughout America, we expect smartcards to become practically universal for authenticating computer users." At the RSA Data Security Conference

"We expect smartcards to become practically universal for authenticating computer users."

—Chandra Shah, Vice President, Litronic

PHOTOGRAPH: THEO FRIDLIZUS © 1998

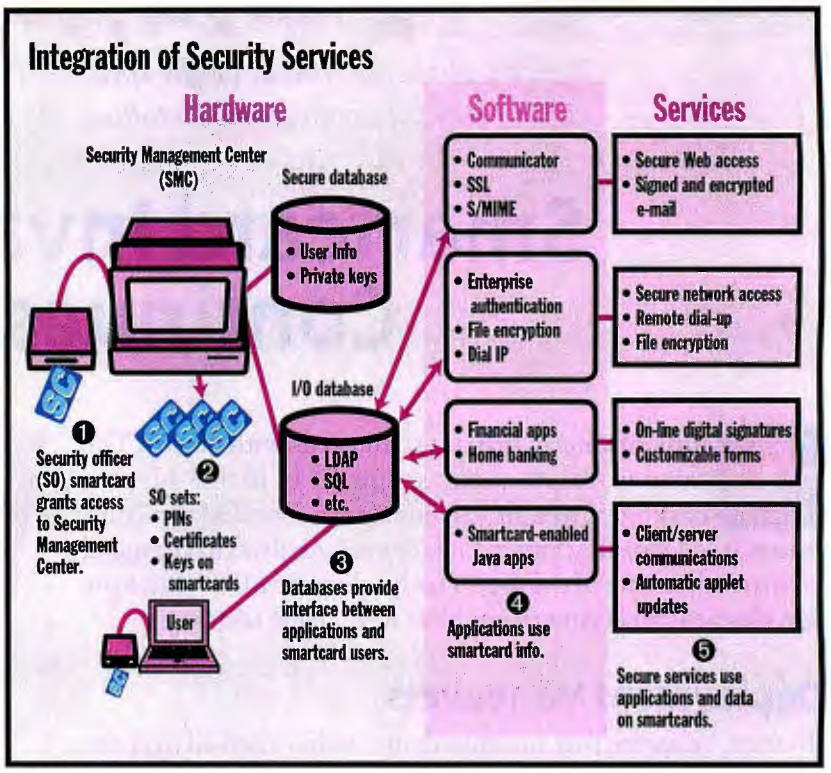
in January, Litronic was handing out photo ID/smartcards that double as both logical authentication and physical identification.

Security concerns are certainly nothing new, but these days they are magnified by the widespread use of a public and notoriously insecure data network: the Internet. Conditions are now ripe for smartcards to emerge as the answer to many concerns. Commercial public-key encryption is now widely available in toolkit and end-user formats from companies like RSA and Network Associates (which acquired PGP). Digital certificates, which enable commercially acceptable levels of assurance for secured transactions, are now available. The problem is: Digital keys residing on a computer are only as reliable as the access controls on that computer. Secure sessions authenticate the computer, not an individual.

The two most obvious solutions are: install strong access controls or remove the keys from the computer. Smartcards can do both. Public-key transactions at unsecured computers or open-access terminals can depend on inserting the certificate-bearing smartcard at the appropriate time. Cryptographic functions on the smartcard prevent any unauthorized access, or change, to data stored on it.

Alternatively, you can control access to a computer. If it requires inserting your smartcard and entering your PIN, there's a high probability that it's really you logging on. This is two-factor authentication ("something you have" plus "something you know"). Traditional username/password authentication is only single-factor ("something you know") authentication. If you require a biometric, such as a fingerprint scan to compare to a digital fingerprint on the smartcard, you add "something you are": three-factor authentication.

One strong indicator of smartcard growth in this area is that two leading suppliers of token-based authentication, Security Dynamics and DataKey, are now offering smartcards as alternatives to their proprietary tokens. The partnership between crypto-maker RSA and BIOS-maker Phoenix Technologies enhances the ability of smartcards to further lock down PC security. Through the jointly developed Preboot Crypto API, it will be possible to integrate smartcards into the PC's preboot, ROM-based routines.



Smartcard security must integrate hardware, software, and services. (Example based on Litronic's SMC model.)

Working Smart

A full-blown smartcard consists of a CPU, ROM, nonvolatile read/write memory (EEPROM), temporary working memory (RAM), and an optional crypto-coprocessor. To develop card applications, you need a toolkit that can handle the life cycle of smartcard application development, from defining the prototype card through mass card production to support of subsequent changes.

The project flow generally goes like this. First you create a card layout definition: a high-level description of the smartcard and its EEPROM files. This serves as source input to a layout compiler. The compiler generates the card layouts used for rapid prototyping as well as for initializing and personalizing large quantities of cards.

Special high-level interface modules, called agents, enable applications to access smartcards. As IBM, which offers its Smart Card Toolkit, puts it: Agents are the application program's data-oriented interfaces to the smartcard. They "encapsulate the specifics of an individual card operating system by interactively communicating with the card." Agents process all necessary access conditions and generate any requests for cryptographic services, thus off-loading a considerable amount of application development work.

Like hard drives and floppy disks, smartcards have their own file systems. An IBM Multifunction card, for example, has a master file (the root directory), dedicated files (application directories), and elementary files (the actual application data). Several file types are supported, including linear files with either fixed- or variable-length records, linear cyclic files with fixed-length records, and transparent files.

There are also application-specific command (ASC) files that contain executable code. The commands in the ASC are executed when the application using the ASC is within the selected path and an appropriate ASC command is issued.

Security Scenario

To see where smartcards fit into the information system security picture, look at

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the figure "Integration of Security Services" on page 112D. The figure includes applications for which people might encounter smartcard readers, such as e-mail encryption, file encryption, remote access authentication, Web site authentication, network log-in, and software access. Card readers, the size of a cigarette pack, are less than $100 and attach to serial, parallel, and keyboard ports. Smaller readers fit in PC Card slots on laptops or, using Fischer International's Smarty, in floppy disk drives. HP and Keytronic offer keyboards with integrated smartcard readers.

Suppose you are logging on to the corporate network from your smartcard-enabled office workstation. Instead of the usual dialog box, you insert your smartcard and enter your personal identification number (PIN). Next, you check your e-mail. Someone in the Rome office has sent you an encrypted message. Again, your smartcard and PIN decrypt it. At home you need to access the network from your laptop. Guess what? The RSA password you don't even know is on your smartcard. Insert it into the PC Card smartcard reader, enter your PIN, and you can make that connection, too. You work on the spreadsheet you have to present to a client. You store the file on your laptop, encrypted by keys stored on the smartcard, just in case someone steals your machine.

All this activity can use off-the-shelf applications, like Netscape Communicator, or applications modified with existing cryptographic APIs and available toolkits. The security management center (SMC, on the left of the figure "Integration of Security Services") manages the activity, and the security officer's smartcard controls the SMC. None of this is a projection; all the pieces are in place.

Compelling Forces

To a security professional like David Brussin of Miora Systems Consulting (Los Angeles), this is good news. "Password-based protection of computing resources just doesn't cut it any more. Moving to digital IDs and tokens is just common sense, particularly if one token can support multiple services."

Of course, it may be a while before all applications support digital certificates and public-key encryption. A contractor developing intranet applications for the military, speaking on condition of anonymity, admitted that, "Our client will rely on passwords for remote access for some time, so hiding hard-to-crack passwords on smartcards lets us increase the effective security level without completely reengineering current systems."

While the cost of deploying smartcards (now about $7 just for the card) continues to decline as technology matures, it is still a resistance factor. However, in situations where security breaches obviously equate to losses, like insurance fraud, the return on investment can be substantial. Litronic's Shah cites an HMO that cut fraud losses dramatically as soon as it deployed smartcards containing a scan of the holder's fingerprint.

On the Home Front

But what about the American mass market? As BYTE's January article on smartcards indicated (see "The Smartcard Invasion"), financial institutions cite lack of infrastructure and merchant acceptance

Smartcards in Action

Financial: Global Transactions

Visa has more than 70 chip-card programs under way and claims 21 million chip-cards have been issued. MasterCard International owns 51 percent of Mondex, whose technology is currently used in 21 implementations around the world. Mondex claims to have deployed in excess of one million reloadable cards through the end of last year and projects 5 million by the end of 1998.

Military: Medical Identification

The U.S. Department of Defense is working on the Multi-Technology Automated Reader Card (MARC). This involves a smartcard with several media in addition to the embedded chip, including bar code, magnetic stripe, embossed data, printed information, and an integrated circuit. The goal of using MARC is to improve a military commander's ability to access information such as medical treatment data, readiness status, immunization records, and next of kin.

The primary software developer and system integrator for MARC is U.S.-based 3-G International (3GI). In an encouraging development for American smartcard developers seeking to enter overseas markets, 3GI is to deliver a smartcard-based medical documentation system to the U.K. Ministry of Defense. The system will employ smartcards to replace the existing paper records of patient medical and treatment information during medical encounters. Medics will record treatment information onto a soldier's smartcard electronically, enabling the soldier to carry this information to the next treatment location so that subsequent medical decisions can be made based on the most current data.

Transportation: Contact Free

You read most smartcards by placing them in contact with a reader. You read a contact free card with RF signals when in proximity of a reader. There are also dual-mode cards, such as the Transcarte, developed by Bull. The cards, which are being used by the urban transport management company of Valenciennes, France, operate in contact-free mode to speed up the process of getting onto the bus. Claimed transaction speed with this card is approximately one-tenth of a second, compared to the transaction speed of using paper tickets or contact cards, which ranges between half a second and one second.

A contact mode is also provided, which allows personalized management of user accounts. For example, you could "charge" the card for access to certain municipal services such as canteens, libraries, and swimming pools.

Government: Biometrics

The British government is planning to deploy smartcards to allow people to pay taxes, including income tax, national insurance, and local taxes, as well as apply for passports, state benefits, and forms of government welfare. Citing "huge potential savings" as the primary motive for the introduction of the smartcard, the minister responsible has acknowledged that the civil liberties lobby will probably oppose any card whose possession is mandatory. However, while plans call for use of the card to be voluntary, the minister has admitted that people could find it difficult to operate in the future without such a smartcard.

Initially, the U.K. citizen smartcard will rely on traditional PIN protection systems to allow a person to identify himself to the government computer systems. In the longer term, and certainly within the next five years, the plan is to allow an individual to use a fingerprint or similar biometric system for positive identification.

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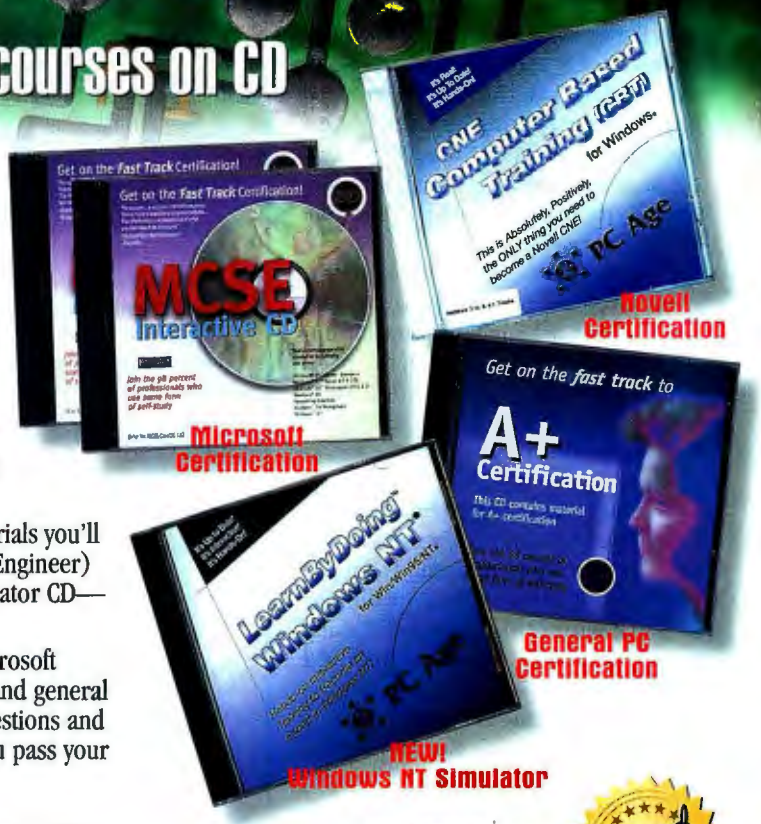

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as hurdles to wide deployment. But developers should not take a wait-and-see attitude to smartcards. Don't underestimate the interest in smartcards of major players like Visa and MasterCard, for whom fraud is a costly motivator.

On the technology end, big names like IBM, Hewlett-Packard, Sun, and Oracle all have heavy commitments to smartcards. Now is definitely the time to acquaint yourself with this technology, if you haven't already. Some American companies are already competing successfully for the huge market outside the United States.

For developers, start with a toolkit, from companies such as Gemplus, Aladdin, IBM, Schlumberger, and Litronic. This is a big change from the past, when developers, even major system integrators, had a hard time getting the cooperation they needed from card manufacturers.

That led to the Independent Smartcard Developer Association, a nonvendor organization that emerged from the Cypherpunk group. Says coordinator Lucky Green (not his real name), "Many members are potential users of smartcard technology in their daytime jobs. But we found it challenging at best to get information from vendors." Not only are development toolkits highly vendor-specific, says Green, "one vendor in particular will not provide specifications for its cards unless you agree to use only their solutions."

Such attitudes are a red flag to cypherpunks like Green who test and advance security technology. The group has released a *free* software toolkit that will talk to any smartcard. Group members created a reader-independent abstraction layer and have pretty much finished a card-independent abstraction layer. The software, which is available at the group's Web site (go to http://www.cypherpunks.to), supports the more popular crypto-capable cards and, says Green, "makes it trivial to add support for additional cards."

Security is part of every smartcard application, whether it's a cyber-purse, a bus pass, or a network access control system. However, the smartcard invasion in the U.S. will be led by security-specific applications, from e-mail encryption on PCs to user authentication on network computers. B

Stephen Cobb is the author of numerous computer books and is also a Certified Information Systems Security Professional. You can reach him at **stephen@iu.net.**

Standards

To claim that a lack of standards for smartcards has impeded their deployment misses the point. There are plenty of standards, most notably the International Standards Organization's 7816 series, which specifies everything from physical dimensions to block transmission protocols and interindustry data elements. Unfortunately, as in other areas of technology, manufacturers have found it hard to stick to the standards, if some competitive advantage in performance and functionality can be gained by deviating from them.

However, interoperability has been steadily improving in key areas. For example, several major players, including IBM, Netscape, Network Computers Inc., and Sun Microsystems, recently announced the OpenCard Framework, a set of guidelines for integrating smartcards with network computers. The OpenCard Framework provides an architecture and a set of APIs that enable application developers and service providers to build and deploy smartcard-aware solutions on any OpenCard-compliant network computer.

The key components of the OpenCard Framework Architecture include the CardTerminal, which encapsulates all card terminal-related classes so that access to a card terminal can take place only through classes of the card terminal component. The CardAgent provides the necessary infrastructure to interact with a multitude of card operating systems. The CardAgent is the only component not directly accessible to the applications. The CardIO provides access to the file system functionality of a smartcard; for example, an application can open, read, and update an existing elementary file on a smartcard or create new files.

The CardAgentExtensions component handles non-file-related smartcard functions. For example, interfaces to cryptographic functions or other application-specific commands (ASCs) are handled by CardAgent extensions.

Another area in which standards are being forged is Java. The Java Card API enables any card manufacturer to build smartcards that can interoperate, not only with each other but also with existing cards and card-reading terminals. Support for the Java Card API among smartcard manufacturers is driving partnerships such as the one between Visa and Sun Microsystems.

Visa, along with other key industry players, is now contributing to the development and joint promotion of a Java-based smartcard microprocessor core. Dhaval Ajmera, director of product marketing at Sun's microelectronics division, says he sees a microprocessor designed specifically to support Java Card as a boost to Java Card's momentum in the marketplace: "This is a great way for us to leverage our experience in Java microprocessors to develop an optimized processor core that meets the cost and increased functionality requirements sought by smartcard vendors."

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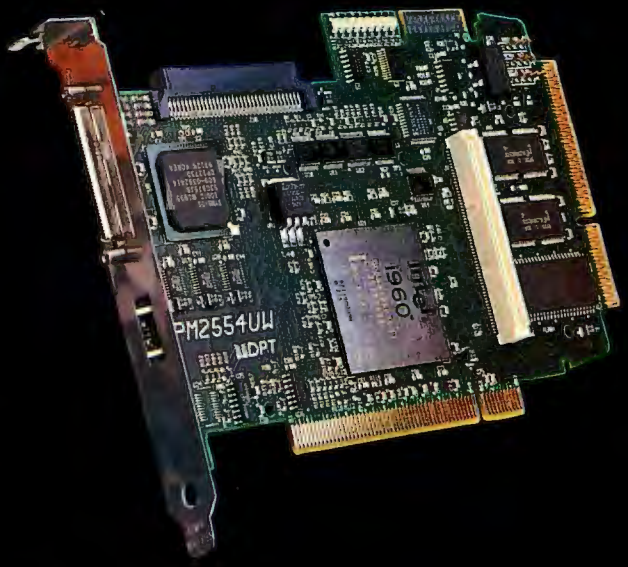

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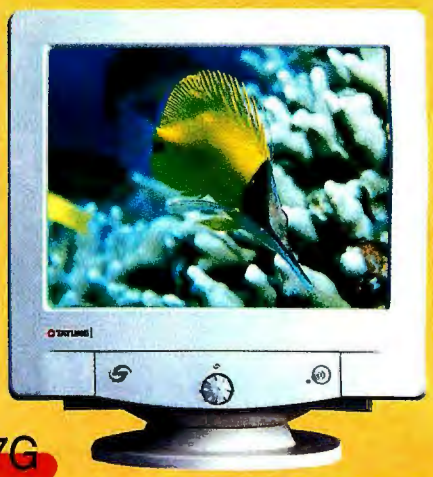

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Web-based customer service offers a variety of benefits for providers and users. ***By Anne Bilodeau Zieger***

Help Desks Make the Web Connection

Another successful escape: Customer support is heading for the Web. Whether internal (the help-desk folks who rally 'round when a stuck application needs a tow) or external (the technical support notorious for 20-minute waits on hold), the switch to Web-based customer service has benefits and pitfalls for providers and users alike. Also, whether you decide to do it yourself or use a shrink-wrapped solution, you can choose from a variety of customer-service styles. Customers may never have to listen to "Feelings" by phone again.

The reasons are simple. Call centers are expensive. Trained support is expensive. Dissatisfied customers are expensive. The only thing more expensive than helping people is *not* helping them. Help-desk software has been around for a while, but the Web is adding new twists. Users can help themselves quickly (they like that) and inexpensively (you like that).

When implementing a Web-based customer interaction software (CIS) system, you also have a number of options. You can do so from an existing system (either internal or third party) or from scratch. Web CIS systems offer a variety of features—at a variety of costs—and a variety of savings. Any support organization—including IS, independent software vendors (ISVs), and developers—needs to examine this new support choice closely.

The Web Connection

Software vendors know the value of the Web for sharing information and have rolled out scores of Web-based options over the past year. Typically, Web-support applications run on the same Web-server host machine, thus simplifying integration. In most cases, you just slap the product onto the server, and you've opened a new support channel.

This was not always true. Companies that invested big bucks in customer systems in the early 1990s were often stuck when it came to Web integration. These enterprise-wide systems—with proprietary clients and an integrated database—could not translate Web protocols. For two years, however, vendors have sold Web interfaces to their systems, giving customer support to anyone with a browser.

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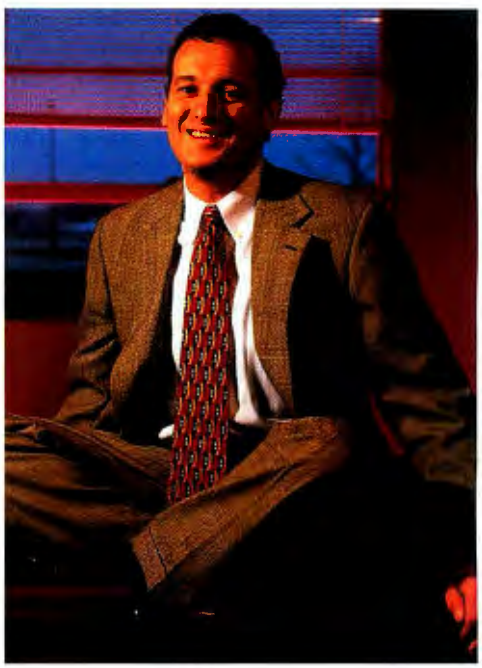

"Customers really like these applications."

—Steve Roberts
MIS director,
MindSpring

PHOTOGRAPH: ANN STATES © 1998

Welcome to the Web

For example, Clarify's ClearExpress 2.0 family, Clear Helpdesk and ClearSupport, offers two Web modules in the standard package. "The Web is just another access into our system," says Marshall Powell, senior marketing manager.

At $20,000 per server license plus a concurrent user fee, ClearExpress products now have ClearExpress WebSupport and WebUser functions. WebSupport integrates with the corporate Web server, usually outside the firewall, translating Web messages into formats the underlying Clarify system understands. WebUser, a Java applet, also allows access to Clarify applications. Support staffers can accept a case, access internal knowledgebases, and view customer account information.

Vantive takes a similar approach with Vantive Enterprise 7, which is a suite of client/server-based sales, marketing, field-service, and call-center tools costing $25,000 per server license plus a per-client fee. Enterprise 7 has ObjectStudio, a component-based development environment that includes ActiveX, Visual Basic, Java, and HTML tools. Vantive just added a Java applet that lets Web users access its proprietary applications in real time.

Scopus put its customer-care wares onto the Web with its WebTeam 2.0 modules. At $99 per user, WebTeam lets Scopus-based companies generate both the HTML interface and CGI scripts to connect Web sites to the Scopus database.

Web from the Start

Not every company already has such formerly proprietary products in place. Companies that passed on comprehensive packages can choose anything from an integrated Web-based package to tools that add one new function to their site.

Some companies are experimenting with one beefed-up package, Silknet Software's eService 98. Part of an emerging generation of Web-based products, many of which are still in beta testing, eService combines enterprise-wide reach with an open Web architecture.

Starting at $150,000, eService provides both a public server for external contacts and a private server for internal personnel. A work-flow function routes cases to agents with skills to best match requests.

Service representatives use eService to publish solutions that include text, graphics, sound, and video. They can share their solutions with colleagues over an intranet.

Customers, meanwhile, use a separate public server. As a customer answers questions about his or her problem, the system searches the knowledgebase for solutions, returning relevant entries. If a customer isn't happy with the answer, the application lets her or him access live representatives, by e-mail, Internet conference, Web-site posting, or a phone call.

But applications like this are unusual. Few companies offer comprehensive Web-based customer-service packages, perhaps because they're not willing to bet the farm on still-maturing technologies.

Some customer-service providers are cautiously accepting Web solutions. Stream International, which provides outsourced customer support for high-volume products including Windows 95, handles almost

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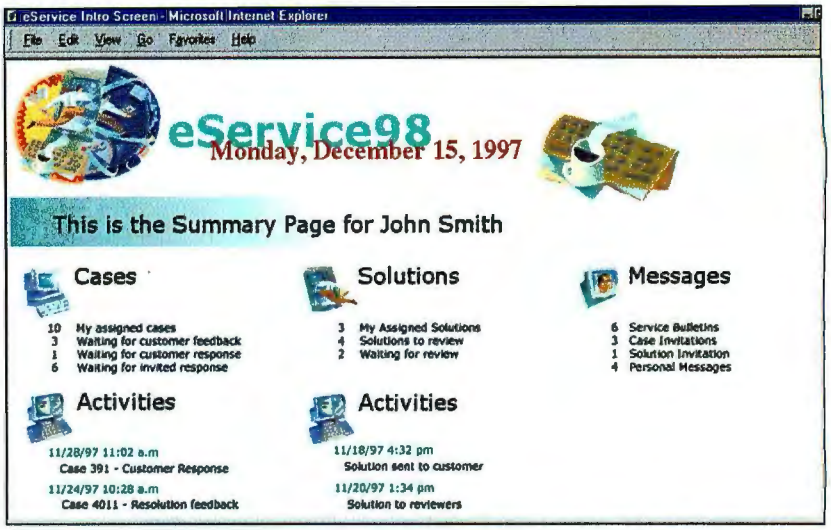
15 million requests a year, about 10 percent Web-based. Although they do expect Web volume to go through the roof in a few years, Stream executives aren't yet ready to implement enterprise-level Web-based systems. However, they are experimenting with smaller components.

"Some vendors have pretty slick tools," says Lloyd Linnell, Stream's CIO. "But most are relatively new and immature. They haven't been built with millions of transactions in mind."

Adding Functions

Web-based customer-support solutions don't require such a complete leap of faith. Most preserve the infrastructure of a site while adding useful functions.

Callback request options are hot, for example. Versatility's OpenWeb 1.1, $6000 for the server license and $200 per user, works with Versatility's telesales/service package. An OpenWeb button connects a customer-service site to the company's call center. Customers can send a message to the call center asking for a call back, either immediately or at a chosen time. They can also ask agents to join them in a chat area. Agents know what information a customer entered and which Web pages he or she viewed.



Silknet Software's eService 98 generates a personalized screen for customers as they log in.

If e-mailed call requests aren't direct enough, eFusion's eBridge Interactive Web Response system puts a "Push to Talk" button on Web sites, letting customers originate an Internet-based call.

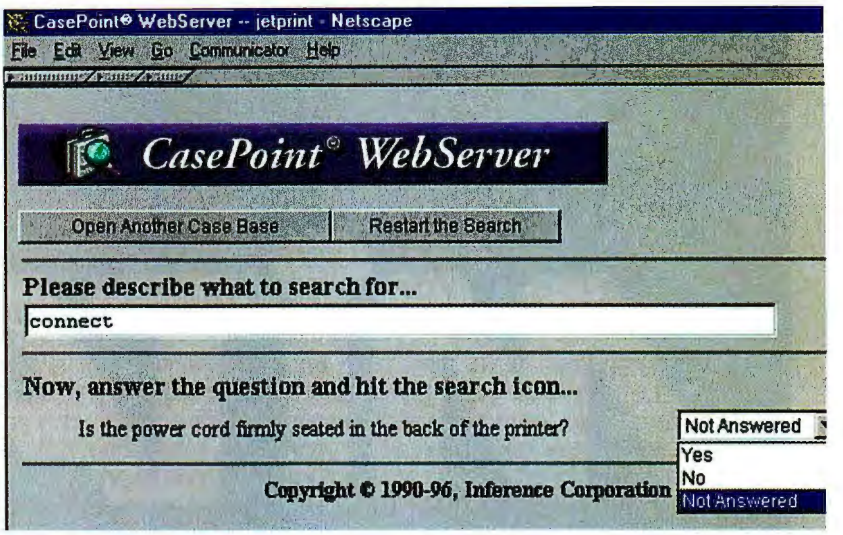
Then, eBridge translates the incoming

IP telephony call into a standard call at the corporate call center. Agents talking to an Internet telephony caller can both discuss problems and even push Web pages out to the end user.

Web of Knowledge

There are also many ways to give your customers direct access to technical or support information. These days, virtually every vendor selling solution-oriented databases provides tools to connect to the Web. Companies use these tools to connect not only end users but VARs, vendors, and other partners to critical information. Those partners can even publish their own information on the site.

Primus, which specializes in knowledge management systems, offers three Web-support products. SolutionBuilder 2.1 lets technical-support staff compose solutions for the Web even if they don't know HTML. SolutionExplorer gives support staff—and other qualified outsiders on an intranet or extranet—access to the knowledgebase. SolutionPublisher 2.0 lets partners and customers access their solutions directly via the Web.



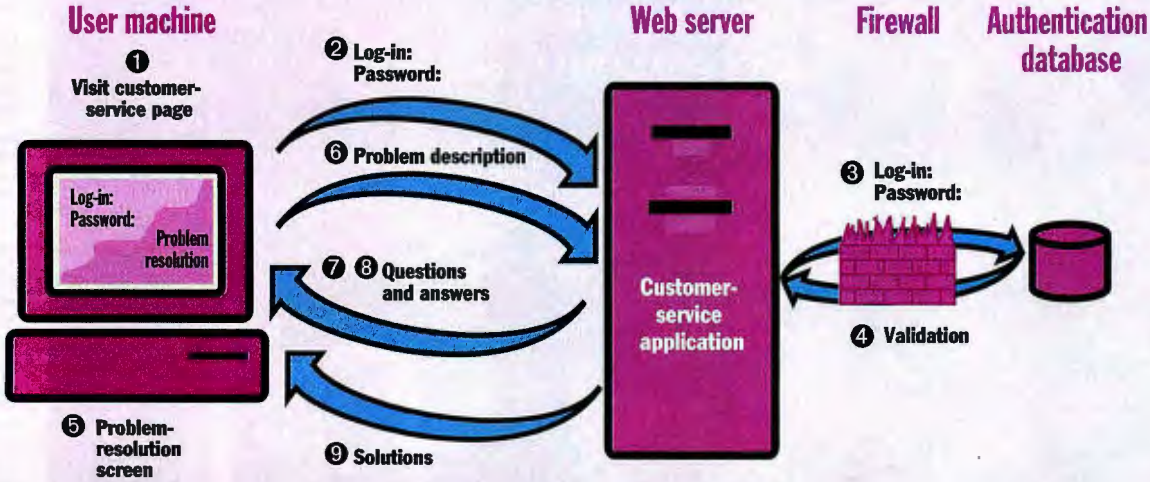
Inference's CasePoint asks customers a series of questions to help them figure out how to solve their problems.

Inference's CasePoint WebServer gives customers Web access to the Inference knowledgebase. Using case-based reasoning (CBR), the server asks customers to answer questions narrowing down the problem. Then, CasePoint digs solutions out of the database and passes them to the customer, generating HTML on the fly.

Kenwood USA, well-known maker of audio products, put its manuals and technical-support solutions on the Web last year using CasePoint. Within months,

Typical Web-Based Customer-Service Transaction

Web-based customer service funnels problem information through the server to the diagnostic database.



❶ Customer enters log-in information on Web page.

❷ Log-in and password travel to customer-service application on company's Web server.

❸ Customer-service application sends log-in information to authentication database on internal side of corporate firewall.

❹ Authentication database verifies log-in name and password.

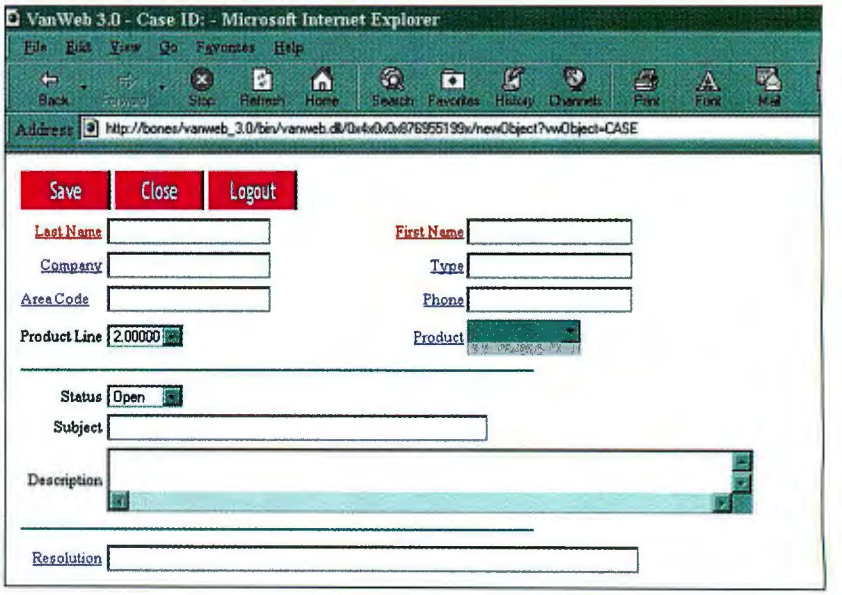
❺ Customer enters description of problem (e.g., "Windows 95 won't boot up").

❻ Request travels to application server.

❼ Application server sends "narrowing-down" questions (e.g., What type of PC are you using?) and suggested answers to customer, in HTML.

❽ Customer answers questions, until last relevant question.

❾ When all questions are answered, most appropriate solutions go to customer in HTML.



Vantive's VanWeb provides an interface to many of Vantive Enterprise 7's key features, including problem-resolution tracking.

calls to Kenwood's fulfillment house had dropped 12 percent and in-house calls 10 percent, saving about $45,000 on those reductions alone.

"This technology has increased the volume of problems customer support can solve," says Susan Hotta, Kenwood customer-service manager. "We get many thank-yous from customers. They didn't have to call in and didn't have to wait."

Bulking Up

While Web-based customer service isn't resource-intensive itself, it can alter site traffic flow—and turn sleepy sites into traffic jams. If you intend to meet a pent-up need for self-service, prepare to bulk up your server farm fast.

For example, executives at ISP MindSpring Enterprises had to move customer-service applications off the corporate Web site and onto a dedicated server when eager customers overloaded the existing infrastructure. The MindSpring team designed the pages in a few weeks with Progress Software's WebSpeed development environment, which the ISP had used to develop its billing system. The new function is so popular that MindSpring reassigned some live support away from answering repetitive questions.

"It's not always convenient for customers to contact the call center, and we can't always anticipate call volumes when they do," says Steve Roberts, MindSpring's MIS director. "But customers really like these applications."

Whether you're supplementing—or replacing—existing customer service or setting up new customer service from scratch, you now have a new tool. Web-based customer-service products will grow in popularity and capability—a plus for providers and users alike. B

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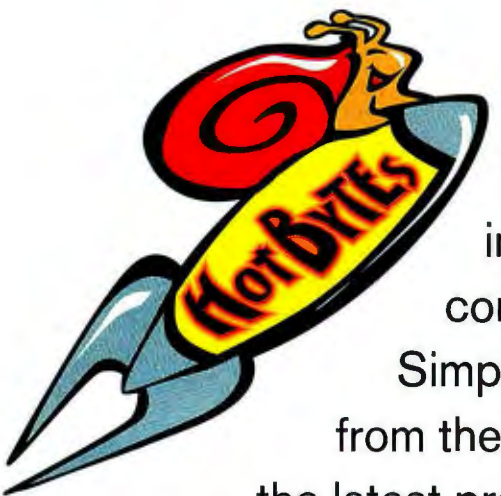

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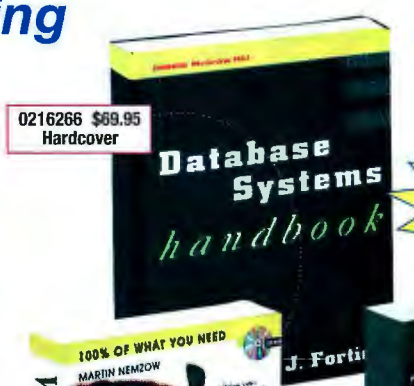

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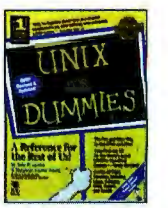

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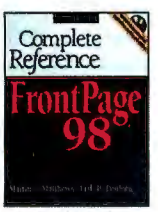

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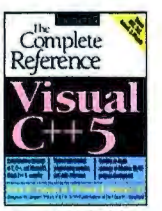

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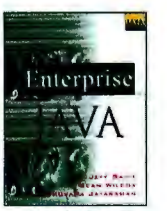

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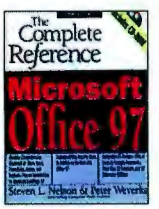

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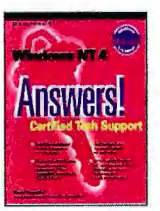

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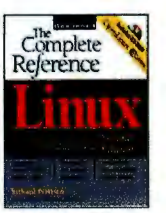

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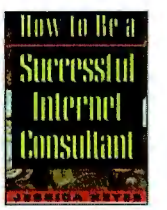

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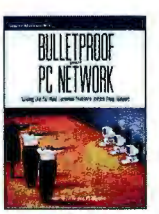

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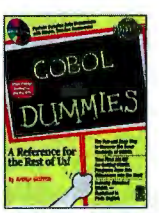

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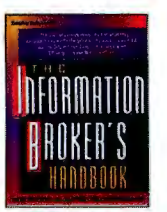

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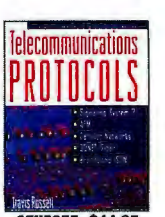

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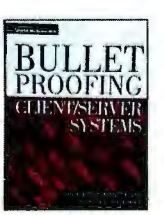

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E-Mail Servers for the Enterprise

Next-generation e-mail servers add IMAP to SMTP for sophisticated communication within and without the organization.

By Tom Yager

Internet e-mail clients and accounts are now so simple that users can take them for granted, but network managers faced with setting up e-mail services are not so lucky. They must deal with issues of availability, accountability, security, and control, which are impossible to manage when someone else runs your mail server. As e-mail grows in importance, many organizations are finding they must move it in-house.

Unlike proprietary e-mail systems that run on specific LAN OSes or on mainframe computers, Internet e-mail uses open standards, so clients and servers can interoperate across heterogeneous networks and between dissimilar computer systems. The Simple Mail Transport Protocol (SMTP) first defined the behavior of Internet e-mail clients and servers in RFC 821 in 1982. Though first defined in 1983 in RFC 918, the third version of Post Office Protocol (POP3, specified in RFC 1460) handles the exchange of e-mail between a client with sporadic connectivity and an e-mail server. The Internet Message Access Protocol (IMAP), first defined in RFC 1730 and updated in 1996 with RFC 2060, adds the ability to manage a user's messages and folders on a server, without downloading them all to a local client message store. The Network News Transport Protocol (NNTP, RFC 977), adds the ability to distribute and participate in discussion groups across the Internet.

All these protocols germinated largely in a Unix environment, with each implemented on a server as a separate module (see the Tech Focus, page 116). But now, bowing to demand for Windows products, vendors have made Windows NT another important platform choice for e-mail services.

The Contenders

For this review, we looked at enterprise e-mail servers that support SMTP, IMAP, and POP, choosing five products: Lotus Domino 4.6, Novell GroupWise 5.2, Netscape SuiteSpot Messaging Server 3.01, Eudora WorldMail 2.0, and Microsoft Exchange Server 5.5. We also ran Red Hat's freeware distribution of Linux 5.0; see "Linux: Standards-Compliant E-Mail on the Cheap," page 118.

BYTE BEST
ENTERPRISE E-MAIL SERVERS

Netscape Messaging Server 3.01
Hip to the latest standards, Messaging Server installs in minutes on several platforms, and it administers easily via a Web browser.

We used three different servers to accommodate different OS requirements: We installed Lotus Domino, Eudora WorldMail, and Microsoft Exchange Server on an ALR Revolution 2X with 128 MB of RAM, dual 300-MHz Pentium II processors, and a pair of 4.5-GB Ultra-Wide SCSI drives. Novell's IntraNetWare 4.11 and Red Hat's Linux shared space on a 180-MHz Pentium Pro server with 64 MB of RAM and a 4.2-GB Ultra-Wide SCSI drive. We tested Netscape Suitespot Messaging Server on a Ross Technology SPARCplug system with dual 125-MHz CPUs running Solaris 2.5.1. The client systems were one Windows NT and two Windows 95 machines, connected to the servers via an Internet-routed 10-Mbps Ethernet LAN and running Microsoft's Outlook Express, Internet Explorer 4.01, and Netscape's Communicator 4.04.

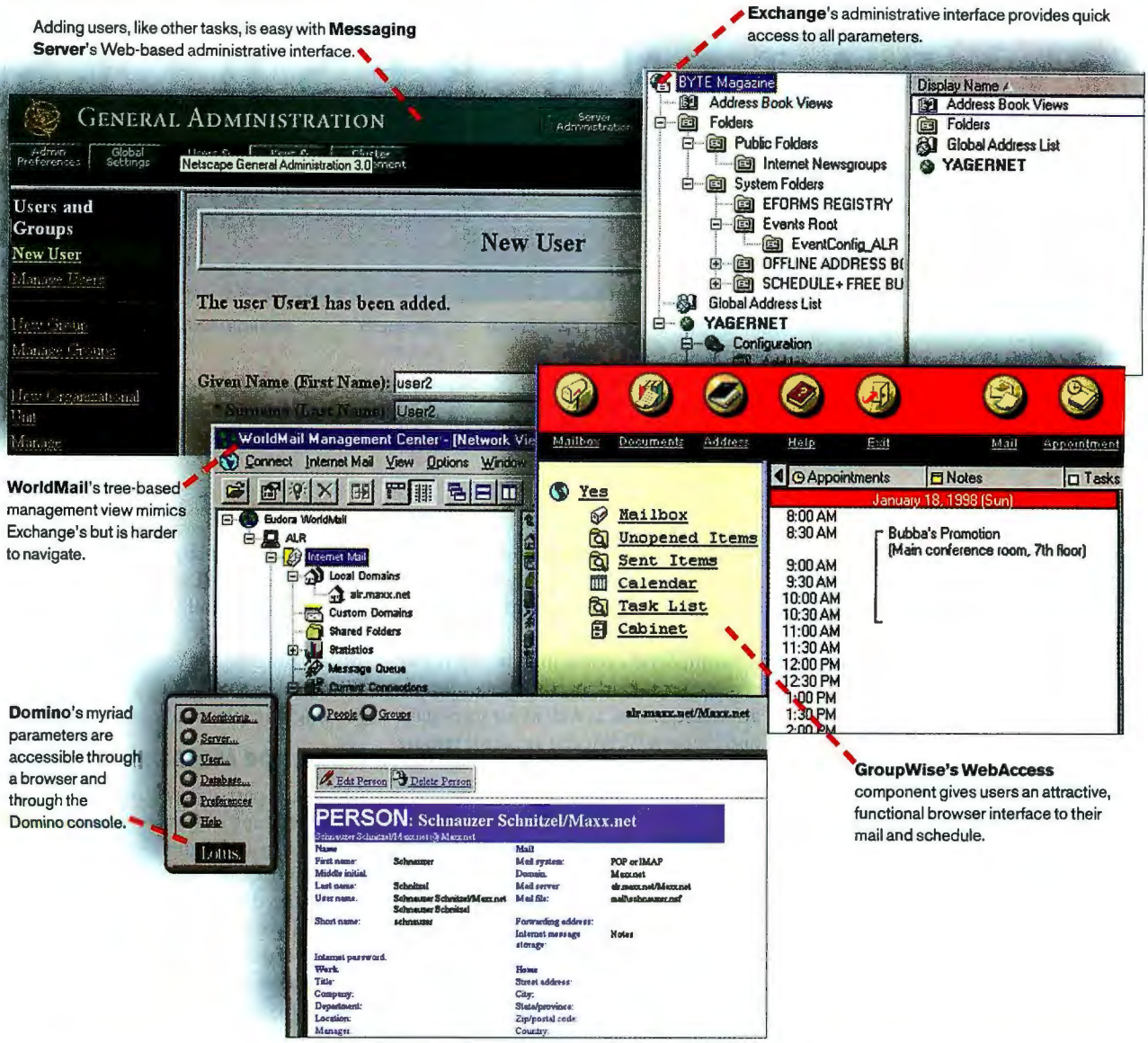
We tested mail-handling capacity two ways with a simple SMTP benchmark: The first test had each of three clients send 50 copies of a 136-KB message (including two MIME attachments) to the server; the second test had the same clients each send 333 shorter (2.3-KB) messages.

Lotus Domino Mail

If you're already running Notes or Domino, an upgrade to Domino Mail version 4.6 is a good idea. Notes users can direct their Internet e-mail into a Domino in-box, while e-mail bound for the Internet is routed through the mail server. Standards-based e-mail clients can access Internet e-mail as well as Notes mail; even from outside, the unified in-box works.

Notes forms are still best viewed with the Notes client, but they can be accessed through a standard browser, too. With Lotus' enhanced Web access to Notes through Domino, users can now view in-boxes and administrators can view and change server parameters. We had no trouble accessing either client or administrative pages using Netscape and Microsoft browsers.

For all its capabilities, Domino Mail feels less like a cohesive multifunction server than a stitched-together collection of services that don't know each other. The sheer quantity of data entry the administrator must do to bring up Domino



Graphical management tools set modern e-mail servers apart from their harder-to-use ancestors.

Mail Server is daunting, and the interface doesn't help. The printed documentation seems hopelessly disorganized, and the on-line manuals loaded slowly even on a powerful server's console. Too many procedures—from setting Notes up as a Windows NT service to enabling IMAP4 access—are poorly documented operations that should have been automated.

We had problems during testing. For example, by default all inbound e-mail forwards to itself, resulting in mail delivery loops: The server forwarded incoming messages to itself. We had to manually clear the queues and modify user records.

Domino's failure to complete our benchmark tests, though most likely caused simply by some unfortunate interaction between the server and other software installed on the server or the network, was still disturbing. More disturbing was that attached binaries were unreadable by the clients. A Lotus representative suggested the enclosure problem may have been caused by inconsistencies in the clients' implementations of Multipurpose Internet Mail Extensions (MIME). The representative added that Lotus's own tests had uncovered interoperability flaws between clients that would cause such problems; the fault lies with the browsers rather than the server, which acts only as a message store.

Domino Mail Server offers Notes shops vital Internet e-mail connectivity. But considering the difficulty of its installation and configuration, poor documentation, and other problems, we wouldn't recommend Domino Mail Server to any organization not already running Notes.

Novell GroupWise

Novell's GroupWise builds on IntranetWare's services like TCP/IP, IPX-to-IP gateway, and integrated Web server, and extends them to support electronic mail and group collaboration. Like Lotus with Notes, Novell wants you to buy a proprietary client to access GroupWise's collaboration, work-flow, and document-handling features, as well as to view rich-text formatted messages. We tried the GroupWise client but didn't like it; shifting to Outlook Express for e-mail was a relief.

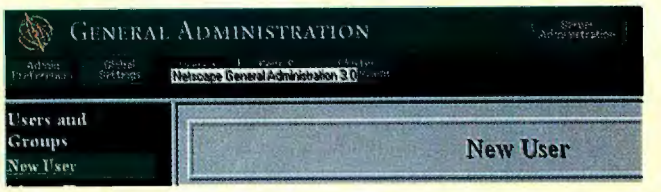
Strictly speaking, GroupWise by itself doesn't do open standards e-mail: You

LAB RATING RESULTS

ENTERPRISE E-MAIL SERVERS

Netscape Messaging Server 3.01

A standards-compliant e-mail server that installs and administers easily. Available by itself or as part of Netscape's SuiteSpot server bundle. Value-priced as a stand-alone product at only $25 per mailbox.



	TECHNOLOGY	IMPLEMENTATION	USABILITY	PERFORMANCE	OVERALL
Messaging Server 3.01	★★★★★	★★★★★	★★★★★	★★★★	★★★★★
Microsoft Exchange Server 5.5	★★★★★	★★★★	★★★★	★★★★	★★★★
Novell GroupWise 5.2	★★★★★	★★★★	★★★★	★★★★	★★★★
Eudora WorldMail 2.0	★★★★	★★★	★★★	★★★★	★★★
Lotus Domino 4.6	★★★★	★★★	★★	★★	★★★

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

need to use an Internet e-mail agent, which runs on Unix, Windows NT, or NetWare, and which mediates SMTP, IMAP, and POP requests between clients and the server. Like Domino, GroupWise builds cryptic default e-mail addresses that you must override manually. We also ran into a looping delivery problem with GroupWise that was similar to the one encountered with Domino and was equally easy to fix. Overall, server administration with a Windows 95 client was a breeze.

GroupWise earned high marks for its speedy benchmark performance and relative ease of use, as well as for its elegant and efficient WebAccess agent for remote Web access to e-mail, shared folders, and group schedules. If you run any flavor of NetWare, you should upgrade it now and consider buying GroupWise. If you're not already running NetWare, sample GroupWise for Unix or Windows NT, anyway; you might be pleasantly surprised.

Netscape Messaging Server

An integral part of the Netscape SuiteSpot suite, Netscape's Messaging Server stands on its own as a delightful product. Unlike other vendors, Netscape sent us only a single CD: no documentation, no press kit, although paying customers get a complete box full of documentation. In any case, we didn't need it. Messaging Server installs effortlessly in about 20 minutes, even on Unix, and uses sensible defaults. We configured it easily with its Web-based interface and got support for all key Internet messaging standards.

Unlike Domino and GroupWise, Messaging Server does e-mail only. If you're looking for groupware, Netscape offers Collabra.

SuiteSpot's built-in Web server supports administrative tasks and lets users change their own account parameters. User-modifiable parameters are pretty basic: For example, users can notify the server when they go on vacation, or they can make password changes. As a nice touch during installation on Unix, Messaging Server shuts down sendmail, the Unix-standard SMTP server daemon that often provides a point of entry for hackers.

Messaging Server's benchmark results were typical for servers following the Unix design, which, instead of queuing incoming mail for later delivery to mailboxes,

TECH FOCUS: SMTP

Simply a Better E-Mail Protocol

Without the Simple Mail Transfer Protocol (SMTP), no Internet e-mail could be delivered. Originally specified in 1982, in the dark ages of the Internet, SMTP's purpose was to provide a single simple messaging interface that could be used to send mail between any two computers, regardless of operating system or hardware.

Implementing SMTP produces a server that will respond to telnet commands received through its TCP port 25 by sending or accepting a message. The SMTP standard describes a command interpreter that works from a narrow vocabulary (see the table on page 117). Every server must support a basic set of seven commands with which an e-mail client can identify itself and the sending user, set up recipients, and send message data. Three optional commands support seldom-implemented direct-to-terminal messaging. Another command provides rare interactive users with on-line help. The two most useful optional commands—VRFY and EXPN—verify the existence of a recipient and expand a recipient address into a user's full name. The expansion command will also, if the server allows it, list all the members of a named distribution list.

By 1994 **it was clear that although SMTP remained an incredibly useful and robust specification, there was room for improvement. RFC 1651 defined a mechanism to add services to SMTP, called SMTP Service Extensions, also known as Extended SMTP (ESMTP). This standard adds a new command for initializing a connection between client and server: If the client uses the new command (EHLO instead of the original HELO) when beginning a session with a server, and if the server recognizes EHLO as a valid command, the two can use any extensions that both support.**

SMTP handles ASCII e-mail, period. Service extensions help SMTP clients and servers negotiate things like the option to decline a message transfer if the message is above a certain size, or do smart transfers of large messages across dicey circuits in such a way that avoids retransmitting entire files. One option even allows messages to contain 8-bit characters for binary files; with plain SMTP, you've got to convert 8-bit data into a 7-bit format for transmission.

writes the user's mailbox file at the time of receipt. Only one process at a time can lock and write to a mailbox file, so multiple inbound messages destined for the same user are handled sequentially. It's a trade-off: External hosts must sometimes spend a few extra seconds delivering a message, but mail hits a user's inbox the instant it arrives.

Messaging Server is priced at $1250 for 50 seats. It offers strong support for standards and fast, easy setup; it earned our respect by doing e-mail nearly perfectly. Its low cost per seat makes it practically irresistible for any organization running Unix or Windows NT servers. Messaging Server truly earns its BYTE Best star.

Eudora WorldMail

Eudora's Windows NT-based e-mail server offers excellent performance and good standards coverage. But Qualcomm's product trailed the others reviewed here in usability and implementation.

Eudora's WorldMail 2.0 best supported SMTP and extended SMTP standards, but it fell short on security by failing to handle Secure Sockets Layer (SSL) connections for accessing mailboxes or its Web administration interface. Though authentication with X.509 certificates is missing, it supports POP and IMAP authentication standards as defined in RFC 1939 and RFC 2195, respectively.

WorldMail's Windows-based administration interface imitates Exchange Server's tree view, which is sometimes hard to navigate. Fortunately, WorldMail installation defaults produce a workable e-mail server configuration. Once you figure out just where in the tree view the option to add users appears, you can configure users for e-mail. The built-in Web server gives users access to the directory, but we found the design to be so poor as to render it virtually useless.

WorldMail pushed the limits of the 10Base-T LAN it was running on. It transferred data at nearly the capacity of the wire. The server acknowledged every message to test clients on delivery. However, we experienced some operating difficulties during testing, including a Windows NT crash. Fortunately, all test messages were visible in the inbox after rebooting WorldMail.

The package is priced attractively at $159 for the server and 10 mailboxes. But with so many strong e-mail servers available, WorldMail's lack of polish should give a prospective buyer pause. Our limited tests produced wildly mixed results. Qualcomm lets you download and test Eudora; check it out for yourself before you choose, or choose to write off, WorldMail 2.0.

Microsoft Exchange Server

A key component of Microsoft's BackOffice server suite, Exchange Server 5.5 carries the company's flag in the open-standards e-mail server market. While the most expensive of the servers we tested, it is also the one that integrates most completely with Windows NT Server. Some of Exchange Server's hyped capabilities weren't shipping at press time, such as support for X.509 version 3 key certificates, though it does support v. 1 certs.

Installing Exchange Server was generally a hassle. For example, sensing that Lotus Notes was installed even though it had been removed, Exchange attempted to install a Notes e-mail gateway, aborting the whole installation; according to Microsoft, this may have been due to a failure to remove all the Notes DLLs. In any case, we had to dissect the installation

E-MAIL SERVERS FEATURES

	Netscape	Lotus	Novell	Eudora	Microsoft
Server type	E-mail	Groupware	Groupware	Groupware	E-mail
OS SUPPORT					
Windows NT server	✔	✔	✔	✔	✔
Unix server	✔	✔	✔		
NetWare server		✔	✔		
Other OS		OS/2			
SECURITY & CONTROL					
X.509 encryption	v3	v3	3rd party		v1
X.509 signatures	✔	✔	3rd party		✔
SSL POP & IMAP	✔	✔	✔		✔
SSL SMTP	✔				✔
Mailbox quotas	✔				✔
Multiple domains	✔	✔	✔	✔	✔
Message store encryption		✔	✔		
NNTP	option	✔			✔
WEB ACCESS					
User inbox	option	✔	✔		option
Administration	✔	✔		limited	
User settings	✔		✔	✔	
Web scripting	option	Java	Java		opt. (free)
HTTP server	internal	in Domino	in IntranetWare	internal	IIS in NT 4.0
GENERAL					
Mailing lists		✔	✔	✔	✔
Discussion groups	option	✔	✔		✔
Proprietary client		✔	✔		✔
SMTP/ESMTP SUPPORT					
Native or gateway	Native	Native	Gateway	Native	Gateway
EHLO (ESMTP init)	✔	✔	✔	✔	✔
VRFY (verify recipient)	✔	✔		✔	
EXPN (expand address)	✔	✔		✔	
HELP (command help)	✔	✔	✔	✔	✔
ETRN (start queue)	✔	✔	✔	✔	✔
Pipelining (batch commands)	✔	✔		✔	
DSN (delivery notify)	✔	✔		✔	✔
SIZE (message size)		✔	✔	✔	✔
8BITMIME (binary messages)		✔	✔	✔	

= BYTE Best ✔=yes

Linux: Standards-Compliant E-Mail on the Cheap

Linux presents a tempting alternative to the e-mail servers reviewed here. At $49.95, Red Hat Linux 5.0 includes not just a rock-solid Unix-style operating system that runs on Intel, Alpha, and RISC hardware, it also provides support for SMTP, IMAP4, POP3, and NNTP servers (as well as DNS, HTTP, and other Internet applications). Many of the features common to commercial packages, such as X.509 key certificates and encrypted mailboxes, are absent, but Linux's low price, minimal hardware requirements (80386 processor and 8 MB of RAM), and no per-mailbox fees make some of this leading-edge jazz look pretty expensive.

Red Hat is perhaps the easiest of the Linux distributions to install and configure. If you keep your hardware simple and use supported video and network cards, Red Hat configures itself. Only disk partitioning still presents a challenge, but even this has been greatly improved. You can be up and running in a couple of hours. If you choose this option during installation, all the mail-related servers are installed and started for you. After that, every Linux user, current and future, is ready to send and receive e-mail. Their Linux user name and password gets them POP3 and IMAP4 access.

There is no graphical e-mail administration; in fact, only the sendmail SMTP server offers much in the way of configuration. However, sendmail's configuration file is famously bewildering and shouldn't be tweaked by novices. Red Hat provides a sendmail configuration that works for just about everybody. A blessedly simple description in the Red Hat manual describes altering sendmail for the common requirement of masqueraded domains.

Whatever you want beyond basic e-mail is either in Red Hat or easily obtained from other sources. The widely respected Apache Web server, which now supports SSL connections, is included. Mailing list management, data encryption, X.509 support and other features exist for Linux, and people report great success running Linux in business-critical environments. But to get along with Linux, you must still possess a tinkerer's heart. Building the perfect Linux server takes time and research, plus a healthy dose of patience and a love for the technology. If you have these, and your organization can afford to wait a little while, check out Linux. You may find it's all the e-mail server you need. Look for Red Hat on the Web at http://www.redhat.com; Linux International lives at http://www.li.org.

script and hack the registry to fix things—not a pretty sight. The fun continues even after installation. For example, Exchange Server supports Internet connectivity only if you know enough to go through the Internet connectivity wizard separately. The gateway module installs easily with an array of configuration options and a wizard that names your domain and can modify active users' directory records to install Internet-valid e-mail addresses.

Exchange Server's cozy relationship with NT makes it a natural for Windows shops, allowing you to easily import users from any NT domain. Linking with the domain gives you one shared password for file and print access, IMAP4 or POP3 access, and Web access to your mailbox. Some of Exchange Server's more glamorous features, like on-line forms, require the full version of Outlook or the use of a special conversion utility. Scheduling and public discussion folders are built into the Web interface. The interface, not available for administration, takes a long time to initialize following a connection, but once up it is feature-rich and fairly responsive.

Exchange Server performed well but not exceptionally, especially considering the Enterprise Edition version we reviewed starts at $3549 for 25 mailboxes. Even with its much-vaunted integration with NT, Exchange Server's lack of general usability leaves it a distant but solid second behind Netscape Messaging Server—on Unix or NT.

Sealed and Delivered

The e-mail server market has something for everyone. Netscape Messaging Server offers effortless setup (even in Unix) and easy Web-based administration, all for $25 per mailbox. Notwithstanding our problems with Lotus Domino Mail, its best feature, a Notes foundation, is still the best intranet solution for those organizations that can't develop their own. Novell's GroupWise gives NetWare fans another reason to be proud: It's a solid and fast e-mail server. Qualcomm's Eudora WorldMail may have some warts, but at $159 for 10 licenses, it's irresistibly affordable and certainly worth an in-house trial.

Microsoft's server is versatile and a good performer. It's a bit behind more recent standards, but it's secure and it integrates nicely with Microsoft's free Web and NNTP servers. As they say, "No one ever got fired for buying Exchange Server." And finally, if you have the time and skill to manage it and don't mind some limitations, Linux lets you bring e-mail in-house for $50.

Whether you're shooting for a certain price, support for standards, or special features, one of these products is sure to meet your organization's e-mail needs. With powerful servers now so affordable, you no longer have to trust your sensitive communications to a third-party Internet provider. B

Tom Yager is a regular BYTE contributor who operates an independent research lab in Texas. He can be reached at **tyager@maxx.net.**

PRODUCT INFORMATION

Eudora WorldMail 2.0
$159 with 10-user license
Qualcomm, Inc.
San Diego, CA
619-658-1291
http://www.eudora.com
Enter HotBYTEs No. 1075.

Lotus Domino 4.6
$2490 (with Domino server); $55 to $69/user
Lotus Development Corp.
Cambridge, MA
617-577-8500
http://www.lotus.com/dominomail
Enter HotBYTEs No. 1073.

Microsoft Exchange Server
$999 with 5-user license
Microsoft Corp.
Redmond, WA
http://www.microsoft.com/exchange
Enter HotBYTEs No. 1076.

Netscape Messaging Server 3.01
$25/user (minimum 50 users)
Netscape Communications Corp.
Mountain View, CA
650-254-1900
http://www.netscape.com/comprod/server_central/product/mail
Enter HotBYTEs No. 1072.

Novell GroupWise 5.2
$718 with 5-user license
Novell, Inc.
Provo, UT
http://www.novell.com/groupwise
Enter HotBYTEs No. 1074.

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Seven Workgroup Printers Prove the Future Is Color

Vendors argue that color workgroup printers will soon be the norm for business. But do the newest ones have enough quality to justify the cost?
By Michelle Campanale

Empowered by the ability to bring desktop publishing, business reports, and promotional printing in-house, companies will soon start replacing their old monochrome printers with color workgroup printers. For these tasks, as well as everyday printing, the newest batch of color laser printers are cheaper, easier to set up and use, and more powerful than ever. Color laser printer costs are decreasing (they are down $2500 to $4500 from last year), and print-quality, long-term, up-front, and per-page costs have dropped.

Still, color laser printers haven't replaced monochrome printers in the way that color ink-jet printers made black-and-white ink-jets obsolete. Color speed hasn't caught up to monochrome speed; the median is about 25 percent as fast. Similarly priced and configured black-and-white laser printers continue to offer faster and slightly cheaper monochrome output than color laser printers.

Additionally, color laser price tags haven't dropped as significantly as their monochrome cousins. (Currently, color laser printers range anywhere from $600 to $3500 more than their black-and-white counterparts.) But those deltas are shrinking. And monochrome cost per page nearly rivals that of black-and-white-only printers.

What the Tests Exposed

Our tests provided some interesting results. Surprisingly, the most expensive printer had the worst overall performance, features, and quality. Yet the two most affordable printers in our roundup scored the highest in overall quality.

The age-old quality/performance conundrum is still alive. For example, in our tests, the best-quality printers have among the slowest output. Printers that were very fast tended to rank lower in quality. There's less middle ground than we'd like to see.

On the upside, depending on your network bandwidth and the system you use as your print server, your performance can increase significantly. (Keep in mind that our performance tests were conducted via parallel port, which is the slowest means of transmission and equals the worst-case performance scenario.)

BYTE BEST
COLOR LASER PRINTERS

QMS Magicolor 2CX

QMS's relatively low-cost magicolor 2CX makes a clean sweep in all categories, including best-overall, best-quality, and best-value color laser printer.

The Usual Suspects

We asked vendors to submit color laser printers in the $2000–$5000 price range, with a minimum resolution of 600 by 600 dots per inch, that could print three to seven color pages per minute. We requested that all systems include parallel and Ethernet interfaces, and a PostScript option, if available.

We received the following seven printers: Hewlett-Packard HP Color LaserJet 5M, Lexmark Optra SC 1275n, Minolta Color PageWorks PS, Panasonic KX-P8410 Series, QMS magicolor 2CX Print System, Tektronix Phaser 360, and Xerox DocuPrint C55. (Technically, these are considered laser printers, except the Tektronix Phaser 360, which uses solid-ink technology.)

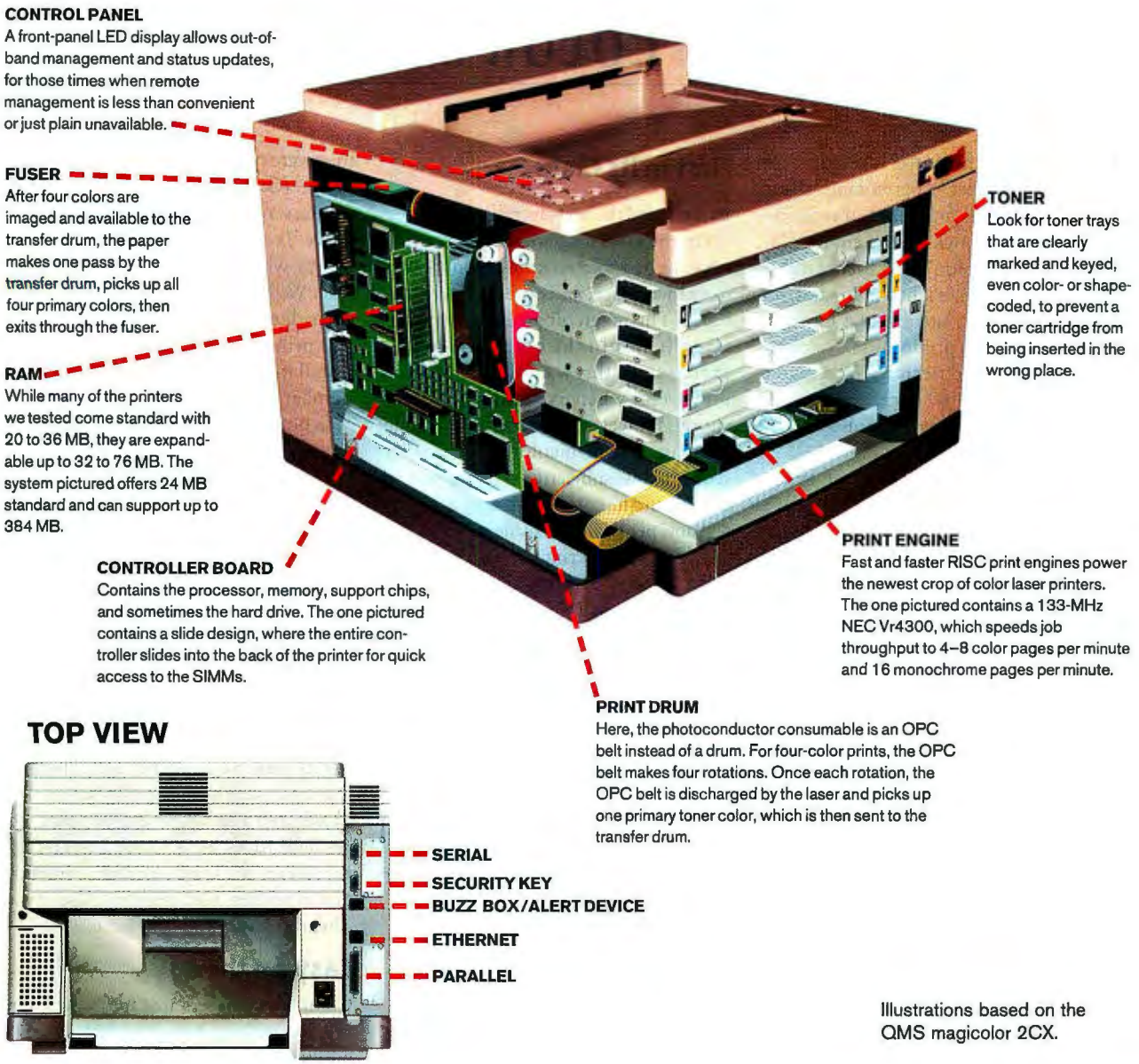
IBM declined participation in this roundup, because its Network Color Printer is at the end of its life cycle and a new product will be available by the time this issue hits. Also, Apple no longer manufactures its Color LaserWriter.

Each printer we tested shared some differences and a few things in common, beyond the initial specifications we requested. All print on regular paper. Additionally, all have Windows NT drivers that successfully ran on a 200-MHz Pentium Pro running NT 4.0 with Service Pack 3, though this often needed some additional prodding.

A few of the printers exceeded our request of 600 by 600 dpi and could scale to 800 by 450 dpi (Tektronix) and1200 by 1200 dpi (Panasonic, QMS). The HP Color LaserJet 5M supports just 300 dpi. (HP says its color-enhanced software elevated the 300 dpi to a 1200-dpi-quality level.)

Only the Panasonic printer includes a straight-through paper path, which handles mixed media well since it avoids a series of turns. However, nearly all the printers we tested will handle at least one form of mixed media.

Additionally, most of the printers we tested minimally support Printer Control Language (PCL) 5c, PostScript 2, or both built-in languages. Panasonic's KX-P8410 is the first color workgroup laser printer with built-in support for Windows Graphical Device Interface (GDI), which is a



Illustrations based on the QMS magicolor 2CX.

host-based device that depends on the host system and the GDI capabilities of Windows.

Another exception is the Tektronix Phaser 360. This printer supports PCL for monochrome only and utilizes PostScript 3. This new PostScript has an expanded font set, including 136 built-in fonts. Printers with PostScript 3 include a "pull" print feature and boast an improved ability to print Web pages.

Technology

This small group of color laser printers offers clear evidence of just how far printer technology has evolved. With PostScript 3 and GDI, in addition to new compression techniques, faster RISC processors, falling RAM prices, and straight-through paper paths, it's easy to see why these printers can get 10 to 14 pages per minute in monochrome and three to six pages per minute in color.

But beyond these technical advances, the key attributes have not changed. Buyers still want the right balance of performance, price, and quality. We define performance primarily from speed of printing and return to cursor. We judge quality by a series of subjective comparisons between the printer's color output and an original photograph. The printers' street prices help us complete our competitive analysis. From these criteria, we form the basis for our rating system.

Beyond quality, speed, and value, we look at the printer's color and black-and-white costs per page, estimated by the vendor. Also important to us is usability: the ease of maintenance and setup, including documentation and manageability. To establish an implementation score, we add in the printer's features, including warranty and technical support; driver support; color-matching, utility, and network management software; cost of toner replacement; print modes; and the ability to print from a floppy disk.

Technology and innovation in ink-transfer methods, as well as the innovativeness of the print engine, help us complete our rating package.

Contributors
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BEST OVERALL COLOR LASER PRINTERS

With the color laser printer market experiencing falling prices and leaps in technology, picking the right color laser printer shouldn't be difficult, right? Wrong. Finding the right combination of color laser printer attributes is far from a black-and-white proposition. For many people, price and performance take a back seat to quality. For some people, brand recognition is key, followed by quality and features.

For most people, however, a brand name will get you only so far, price is a key determining factor, performance can affect the total cost of ownership, and quality reigns supreme. Sprinkle in a good dash of features and usability, and that's a recipe sure to please a lot of people. Such is the approach we take for our best-overall rating, broken down in this way: 30 percent speed, 40 percent quality, 10 percent usability, 5 percent features, 10 percent price, and 5 percent cost per page.

First in Its Class

We awarded the best-overall printer honors to the QMS magicolor 2CX, because it has the best combination of quality, performance, price, and other printer attributes. The magicolor 2CX was exceptionally fast in the black-and-white exercises we threw at it, but it slowed down a bit when executing our color chores. However, the benefits outweigh the wait. The magicolor 2CX's quality scores in our subjective tests topped all others, and its color and clarity at 600 by 600 dots per inch are excellent.

Xerox's DocuPrint C55 and Panasonic's KX-P8410 printers are second and third best overall, respectively, in combining quality and performance at a decent price. When we printed Xerox's color business graphic, we noticed that it could create smooth and ridgeless shadows. However, its colors (most noticeably red) were oddly much darker when they were compared to the original photo image. (Our tests were performed on all printers' out-of-box configurations.)

We liked the DocuPrint C55's smart design, which allows easy access to the inside. We had no trouble changing toner cartridges or upgrading RAM. Though this printer was not difficult to set up, installation was lengthy due to its large number of components.

In both the color business graphic and color photo used in our subjective tests, the KX-P8410 produced quite true-to-life images. However, its features and usability scores were such that it gained only third-place status.

The printers from Lexmark, Minolta, and Tektronix trail behind in close intervals. Though the Tektronix Phaser 360 excelled in speed and uniqueness, which includes its efficient toner-cartridge design and PostScript 3 support, its grainy quality and long warm-up time for melting its wax ink cubes brought down its features, usability, and quality scores. The Phaser 360 also has an eye-popping 174 resident fonts. HP's Color LaserJet 5M represents the least desirable combination of printer characteristics. Also, it was a bear to set up and configure.

Easy on the Buy

Color laser printers are rapidly declining in price, making them affordable for most businesses. Once an expensive item, color lasers are no longer off-limits to businesses that need to maximize efficiency and minimize costs. The seven printers that we tested range in price from $2999 to $5199, with the majority closer to $2999.

The QMS magicolor 2CX stands out as the best value among all the printers we tested. At $3200, it has one of the best scores in our subjective color tests, when compared to the other printers' documents that contain complex graphics.

In addition to its low price, its consumables are not outrageously expensive: $99 for black-and-white and $129 for color. Its 2 cents per monochrome page (at 5 percent coverage) rivals monochrome-only printers. However, its 11 cents per color page (at 20 percent coverage) is slightly higher than average compared to its competitors. Its rated duty

TECH FOCUS PRINT PROCESS

Pass the Paper, Please

Historically, color laser printers have made up to four passes, one for each color, during the four-color print process. To bring speed up and costs down, companies have had to devise a more efficient color print process. Today, however, new technologies and techniques are available. The ramifications of these more efficient print processes primarily affect speed, though color quality and total cost of ownership are added benefits.

The QMS magicolor 2 uses a four-color print process where the paper passes through just once. The organic photoconducting cartridge (OPC) belt makes four rotations. Once each rotation, the OPC belt is discharged by the laser and picks up a primary toner color, which is then sent to the transfer drum. After four colors are imaged and available on the transfer drum, the paper makes one pass by the transfer drum, picking up all four primary colors at once before exiting through the fuser. By moving the paper only once, the printer maintains excellent color registration.

The Tektronix Phaser 360 solid-ink printer, not actually a laser printer, melts the solid inks inside the printer. These inks resolidify immediately once the image is transferred onto paper. The inks harden rapidly and do not bleed into the paper. The process entails a single pass-through of the paper. Additionally, the technique that is used is similar to that used in an offset press, because it does not print directly onto the paper (or other medium) itself.

Here's how it works. A hard anodized drum spins as a maintenance cartridge cleans and then lightly oils the surface of the drum. The solid ink loaded at the top of the printer is pressed into a heater that liquifies into the print head. The print head keeps the ink in a liquid state and during the print process propels all four colors through piezoelectric jets onto the thin film of oil on the drum. As the mirror image is created on the spinning drum, the paper is pulled from the tray to preheaters. When the image has completely printed onto the drum, the warm paper is pressed across the drum as it exits out of the printer, immediately transferring the image onto the paper.

LAB RATING RESULTS

BEST OVERALL

QMS Magicolor 2CX

Best-overall honors go to the QMS magicolor 2CX, whose mix of speed and quality stood out among its peers. Additionally, its makers factored in a winning combination of features, usability, technology, and cost per page.

BEST VALUE

QMS Magicolor 2CX

At $3200, QMS's magicolor 2CX represents a real bargain in relation to its quality. Also, its consumables won't burn a hole in your pocket.

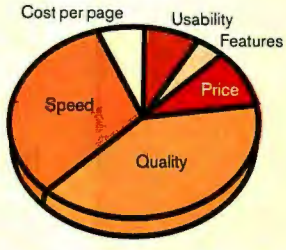
BEST QUALITY

QMS Magicolor 2CX

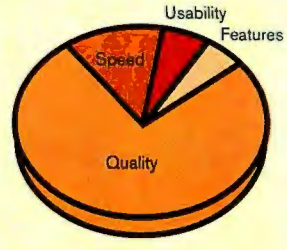
QMS's magicolor 2CX offered quality to be reckoned with in both 600-dpi PostScript and PCL configurations. And it is capable of scaling to 1200 dpi. Best for business graphics, promotional material, desktop publishing, and for some art uses, the magicolor 2CX offers surprisingly true-to-life color.

WEIGHTING

WEIGHTING



WEIGHTING



	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	QUALITY	VALUE	OVERALL RATING
QMS magicolor 2CX	**$3200**	★★★★	★★★★	★★★	★★★★★	★★★★★	★★★★★
Xerox DocuPrint C55	$3500	★★★	★★★★	★★★★	★★★★	★★★★	★★★★
Panasonic KX-P8410 Series	$2999	★★★★	★★	★★★★	★★★★★	★★★★★	★★★★
Lexmark Optra SC 1275n	$4450	★★★★	★★★★★	★★★★	★★★★	★★★	★★★★
Minolta Color PageWorks PS	$3299	★★★★	★★★	★★★★	★★★★	★★★★	★★★★
Tektronix Phaser 360	$3695	★★★★	★★★	★★★★	★★	★★★★	★★★★
HP Color LaserJet 5M	$5199	★★★	★★	★★★	★★★	★★	★★★

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

PHOTOGRAPH: STEVEN GREENBERG © 1998

cycle is up to 5000 color pages per month and 20,000 or more for monochrome.

At $2999, the Panasonic KX-P8410 also represents a good buy. Continuing in descending order of value, we come to the $3500 Xerox DocuPrint C55, followed closely by the $3299 Minolta Color PageWorks PS. Further down is the $3695 Tektronix Phaser 360. The $4450 Lexmark Optra SC 1275n trails just behind. Finally, the $5199 HP LaserJet 5M also brings up the bottom in the value arena. (The best-value score is broken down as follows: 75 percent print quality, 15 percent performance, 5 percent features, and 5 percent usability.)

Image Is Everything

In the best-quality category, comprised of 75 percent quality, 15 percent speed, 5 percent usability, and 5 percent features, QMS was again the clear winner. The magicolor 2CX is our top pick for producing top-quality brochures and professional-looking reports. And, unlike some of its competitors, it will do well for some artistic, prepress, and desktop publishing functions. Interestingly, though, we saw no difference in its quality between 1200 dots per inch and 600 dpi.

The QMS magicolor 2CX also has a high usability rating, because of its easy installation and setup, well-implemented Windows NT drivers, quick warm-up time, and its dummy-proof procedure for replacing the toner.

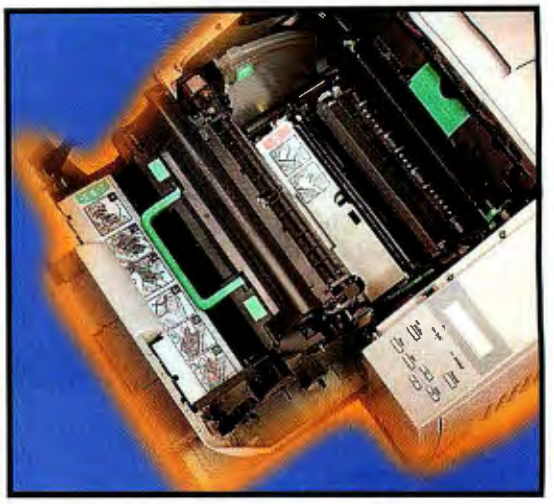
As in the best-value category, the Panasonic KX-P8410 was second best in the best-quality rating, with the Xerox DocuPrint C55 trailing closely behind. Following just behind are the printers from Minolta and Tektronix. The latter was the only printer we tested with a single paper pass; this impacts speed positively. The Phaser 360's quality left much to be desired, however, even at 800 dpi. It supports PostScript 3 but Printer Control Language (PCL) only for monochrome.

The Minolta Color PageWorks PS, conversely, offers excellent color output at 600 dpi, and it's the only one that prints from a floppy disk. It prints legal size for black-and-white only. The Tektronix Phaser 360 can scale to 1200 dpi but offers little difference in quality compared to its 600-dpi setting. Also, it won't print legal-size paper, giving it a slight disadvantage. At second to last, Lexmark's Optra SC 1275n gained its ranking due to obvious rigid edges at 600-dpi PostScript and noticeable pixelation at 600-dpi PCL. Finally, the HP printer's quality was worst on all counts, most notably due to its 300-dpi output and weak, faded-looking color.

DETAILS

Something Old, Something New

Panasonic's KX-P8410 Series and Tektronix's Phaser 360 are both firsts. Panasonic's Graphical Device Interface (GDI), which allows seamless transaction with Windows OSes, is not new, but the KX-P8410 *is* the first GDI-based networked color laser printer. Tektronix adds Adobe's new PostScript 3 to its Phaser 360. It offers such enhancements as extended fonts and Web-ready printing.



You Say You Want a Revolution

Minolta's Color PageWorks PS has a very simple revolving system of toner cartridges. Open the cover, and the photosensor drum and toner outlet are covered and out of the way. This makes changing the toner a cinch.

Pigment-Based Inks Leave a Lasting Impression

A number of color printers that create good to excellent prints have been introduced over the last several years, but virtually all of them share one common defect: The prints don't last. Dye-sublimation and ink-jet prints do well in dark-keeping. When exposed to the light, however, they quickly fade away. Coating a print with a UV filter helps, but not a lot. The weak link in the chain is the dye-based inks themselves.

Several printer manufacturers have released a new generation of pigment-based inks that offer significantly longer life spans for prints. I tested a large-format printer, Hewlett-Packard's 2500 CP, that prints up to 32 inches wide and a desktop model, the Alps MD 1000, to see how the new pigment-based inks compare to their dye-based cousins.

The $11,995 HP 2500 CP is a true 600- by 600-dot-per-inch PostScript 3 printer featuring a large-capacity CMYK ink system that uses both dye- and pigment-based inks. It comes with a 2-GB hard drive, 20 MB of RAM (upgradable to 68 MB), and a JetDirect card for connection to a network, PC, or Mac.

The ink system itself is a marvel. Included in a set are 410 milliliters of each ink color, a print head, an ink cartridge, and print-head cleaner. When necessary, the print heads stop and replenish themselves. There is no need to prime or pump the system to get it going, and it is capable of long periods of unattended printing. The 2500 CP prints a 3- by 2-foot image in 17 minutes and cuts it when it's done. It can simultaneously rasterize one print while printing another one, using an Intel 960 HD processor, and can nest multiple prints of various sizes in memory and lay them out for printing for efficient paper use.

Before working with the pigment-based inks, I ran some tests with the standard dye-based inks on a variety of media as a point of comparison. For one test, I scanned an 8- by 10-inch gouache painting (flat opaque watercolor) at 600 dpi on an HP 6100C scanner, used the 2500 CP's raster-image processor (RIP) to blow it up to 24 by 30 inches, and then printed it on a matte paper stock. Except for the enlarged size, the print was indistinguishable from the original in detail, color, tone, and surface quality. Assured that the hardware was doing its job, I switched to the pigment-based inks. The results were very close but not identical.

The Alps MD 1000 is a $349 desktop printer that uses the pigment-based Alps Micro Dry Ink System. The Micro Dry inks use ribbons in separate cartridges to deposit the ink in resolutions of up to 600 by 1200 dpi. The MD 1000 uses a thermal controller to send data to the print head, creates high-density print patterns in units of 40 microns per dot, and fuses the dry ink to the print medium. The resulting prints have no paper warping and are water-fast.

In addition to the standard CMYK colors, the ink cartridges come in white, which offers a dramatic result not available in other printing systems. There is also a cartridge that provides a transparent protective-finish coat. The MD 1000 prints up to 8 by 10 inches on a variety of media, including laser paper, overhead transparencies, and card stock. Alps also sells a high-performance photo-realistic paper that yields results that, in certain cases, rival traditional photographic media. The weak link in the Alps system is the cartridges themselves, which must make multiple passes over the surface of the print medium, inevitably leaving traces on the surface of the print.

While no digital print I've seen so far can be considered truly archival, prints made with the new generation of pigment-based inks will unquestionably provide significantly longer-lived prints than those created with traditional dyes.

–David Em

This Hardware Lab Report represents the first of a new generation of hands-on product tests to be done entirely in the newly upgraded BYTE Lab. For this particular group of printers, we modeled our tests after those originally developed for BYTE by NSTL, with some additions. The areas we tested include performance (primarily output speed) while printing a variety of images, monochrome image quality as measured by a set of standardized test pages, and subjective juried evaluations of color quality on both photographs and business graphics.

All tests were conducted using a Compaq ProLiant 800 with a 200-MHz Pentium Pro and 160 MB of RAM running Windows NT 4.0 Server with Service Pack 3 (SP3). The printers were connected directly to the test system's parallel port.

Before testing, we set up each printer and installed its drivers to verify that it worked properly. During this phase, we uncovered a number of problems. On the Hewlett-Packard printer, for example, the Printer Control Language (PCL) drivers didn't work properly under NT, although it printed just fine with PostScript. HP verified that SP3 had "broken" the drivers that came with the machine, but we got new ones from its Web site.

Performance

Before each performance test, we rebooted the computer and the printer, and installed the drivers to ensure there would be no conflicts. Initially, we ran the NSTL/BYTE InterMark tests to measure print speed for both text and graphic images in both PCL and PostScript modes. Then we discovered that those tests wouldn't run on the Panasonic printer, which uses a Graphical Device Interface (GDI) instead of PCL or PostScript. A few PCL printers also gave us trouble with tests, although they printed fine with normal applications such as Word and Photoshop. Therefore, we also tested all the units by printing, from Word 97, a 10-page compound document containing font changes, graphics, and color. In addition, we measured the time to produce the first page and uncovered some surprising variations.

Our test plan called for generating a weighted geometric average of the individual subtests, but the InterMark test's failure to run on the Panasonic printer presented a thorny problem. With no time to create a new set of benchmarks, for those tests we could not run, we assigned the Panasonic printer scores that were the average of the other six. This was not a very satisfactory solution, because in practice with normal applications, it was one of the faster printers in the group. However, it seemed to be the best we could do and still rate the KX-P8410.

Quality

There were two components to our image-quality tests: objective ratings of such things as minimum line size, closeness, and text rendering (for both normal and white-on-black images), plus edge straightness, and gray-scale rendering, all done using black only. In addition, we prepared two special color pages (both JPEG files) to reflect the real-world use of these printers. One page had four photographs chosen for subtleties of color that would be difficult to reproduce, and the other had business graphics, including a map and a flat color logo.

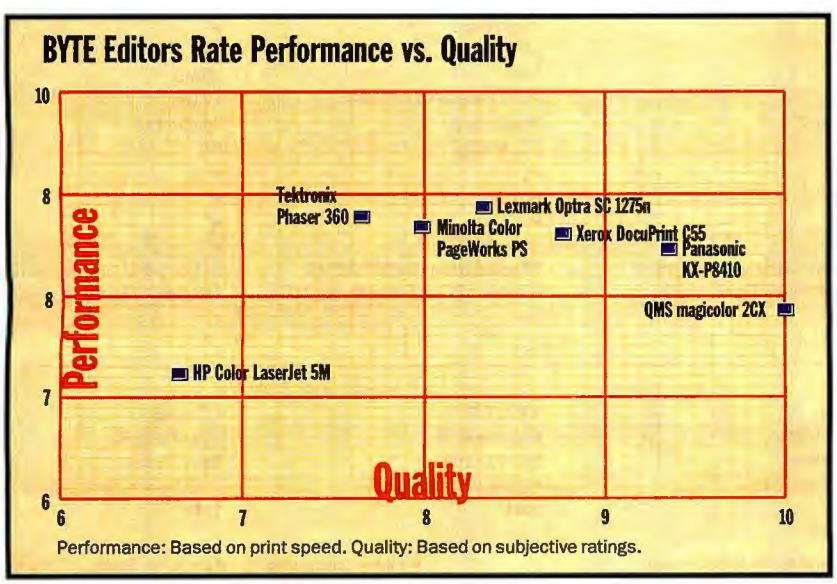
We printed these two sample pages from Photoshop, using each printer in its best-quality output mode onto quality laser-printer paper. We made all prints at the printers' highest resolutions except for the Panasonic printer.

It is capable of 1200 dots per inch, and indeed produced stunning results on smaller images. However, the unit we received for testing had only 8 MB of memory installed, and it balked at our 6-MB test files. Therefore, we ran the KX-P8410's quality prints at 600 dpi.

For both pages, we prepared an expensive Iris print to serve as an absolute color reference. A jury of 14 BYTE staffers judged the pages (identified by a letter only) on a 1 to 10 scale. For our final quality ratings, the objective tests counted 70 percent, and the subjective color quality 30 percent.

Overall Ratings

For our overall ratings, we weighted price at 15 percent, quality at 40 percent, performance at 30 percent, and features and usability at 5 percent each. We did compute separate ratings, using different weightings, based on quality and value as criteria. However, the results didn't change significantly. **–Russell Kay**



LASER COLOR PRINTERS FEATURES

	Hewlett-Packard HP Color LaserJet 5M	Lexmark International, Inc. Optra SC 1275n	Minolta Corp. Peripheral Products Division Minolta Color PageWorks PS
Street price as of 1/30/98	$5199	$4450	$3299
Overall rating	★★★	★★★★	★★★★
SPECIFICATIONS			
Dimensions (HWD in inches)	14.8 x 24.4 x 19.3	15.87 x 19.8 x 20.75	20 x 20.9 x 15.7
Weight (pounds)	102.5	77	88
Rated engine speed (pages per minute)	2–3 (color)/10 (B&W)	3 (color)/12 (B&W)	3 (color)/12 (B&W)
Engine manufacturer	Konika	N/A	Minolta - NC-L3001
Standard/maximum RAM	36/76	32/32	20/68
Memory-compression technology	Memory Enhancement technology (MEt)	RAM Smart	RealTime Memory Compression
Maximum resolution (dpi)	300 x 300	600 x 600	600 x 600
Maximum interpolated resolution (dpi)	1200 x 1200 with HP Image REt 1200	N/A	N/A
Processor speed (MHz)/type	40/AMD 29040 RISC	66/Intel 1960 RISC	33/Intel i960JF RISC
Interface	10Base-T Ethernet, parallel (serial optional)	10/100Base-T Ethernet, parallel (serial optional)	IEEE-1284 parallel, Ethernet
Bidirectional/ECP parallel port	✔/✔	✔/No	No/✔
C-size parallel/LocalTalk/IrDA port	No/✔/Optional	Optional/Optional/Optional	No/✔/No
Simultaneous active ports	✔	✔	
Printer-description language	Enhanced HP PCL5 with color Adobe PostScript 2	PostScript 2, PCL5, PCL6	Adobe PostScript 2 and PCL5c
PAPER HANDLING, CAPACITY, INKS			
Input/output tray capacity (sheets)	250/100	250/250	400/250
Capacity (sheets)/price of extra input tray	250/$445	250/$124	250/$129
Use trays from previous model	No previous model	N/A	✔
Heaviest paper (pounds)	24	43	90
Number of paper paths	1	1	2
Paper types	Plain paper, including legal size, transparencies, glossy paper, up to 24-lb. paper stock	Plain paper, including legal size, transparencies, labels, up to 90-lb. paper stock	Plain paper, including transparencies, labels, envelopes, letterhead, postal card, up to 90-lb. paper stock. Legal on B&W only.
Cost of replacement toner	$8.95 (black)/$43.95 (color)	$75 (black)/$69 (color)	$69 (black)/$84 (color)
Low-ink/toner alert	✔	✔	✔
Estimated cost (in cents) per page	1.8 (B&W)/5 at 15% coverage (color)	2 (B&W)/11 (color)	2 (B&W)/11 (color)
Toner or cartridge capacity (pages)	3K at 5%	4.5K (B&W)/3.5K (color)	4.5K (B&W) at 5%/3.5K (color)
SOFTWARE AND DRIVERS			
Rated duty cycle (pages per month)	30,000 (color at 5% coverage)	20,000 (color)	30,000 (color), 75,000 (B&W)
Drivers	Windows 3x, 95 (except Win 95 32-bit), NT, OS/2, Mac OS, DOS	Windows 3x, 95, NT, OS/2, Mac OS	Windows 3x, 95, NT
Driver applet features	Swor SIMM	Self-install/uninstall	N-up printing, watermarks, negative image and mirror
Watermarks/booklets	✔ (PN/PostScript SIMM)/✔	✔/No	✔
Thumbnail (*n*-up) printing	✔	4-up/16-up	✔
Manual duplexing		✔	
RAM required on PC for GDI printing	N/A	N/A	15 MB
Highest PCL	PCL5	PCL5 (color)/PCL6 (B&W)	PCL5c
PostScript interpreter/print gear	PostScript 2	PostScript 2	PostScript 2
Other print emulations/modes	N/A	PCL5/PCL6	N/A
Color-matching software included		✔	✔
Utility software included		N/A	✔
Network management software included		✔	✔
Application software included		N/A	✔
Resident fonts	45 built-in scalable typefaces (35 intelligent, 10 TrueType)	75 scalable fonts in PS/PCL5, 45 scalable in PCL5. Fontvision available	39 type 1 (PS), 35 Intellifont (PCL), 1 bit map, 10 TrueType
Prints from floppy disk		N/A	✔
Prints to edge of page			
CUSTOMER SUPPORT			
Warranty length (years)/coverage	1/On-site	1/P, L, F, R	1/On-site
Toll-free phone	800-527-3753	800-539-6275	800-459-3250
Toll number	208-323-2551	606-232-2000	See Web site
On-line address	http://www.hp.com	http://www.lexmark.com	http://www.minoltaprinters.com
HotBYTEs	**1080**	**1081**	**1082**

★ = BYTE Best

✔ = yes; N/A = not applicable.

Warranty: P = parts; L = labor; F = freight to repair center; R = return to customer.

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

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

Panasonic Computer Peripheral Co. KX-P8410 Series Digital Color Laser	QMS, Inc. QMS magicolor 2CX Print System	Tektronix, Inc Phaser 360	Xerox Corp. Xerox DocuPrint C55 Color Laser Printer
$2999	$3200	$3695	$3500
★★★★	★★★★★	★★★★	★★★★
18.2×20.1×19.4	15.3×19.7×19.3	13×15.8×19.8	16.5×18.5×16.5
120	90	70	89
3.5 (color)/14 (B&W)	4–8 (color)/16 (B&W)	6 (color)	3–6 (color)/12 (B&W)
Matsushita, Electrophotographic	Hitachi HL-1	Tektronix	Sharp
8 (8410E)/72 (8410N)	24/384	24/48	24/64
Lossless	QMS proprietary	N/A	N/A
1200×1200	600×600	800×450	600×600
N/A	2400×600	800×450	N/A
16/Intel	133/NEC VR4300 RISC	100/RISC	50/AMD 29040 RISC
Parallel, SCSI, (Ethernet optional)	10Base-T Ethernet, parallel, or serial	10Base-T Ethernet (100Base-T or Token Ring opt.), parallel, (serial opt.)	IEEE-1284 parallel interface (serial optional), Ethernet
✔/✔	✔/No	✔/No	✔/No
No/No/No	No/Optional/No	No/✔/Optional	No/Optional/No
✔	✔	✔	✔
GDI	PostScript, PCL5C, HPGL, and line-printer emulations	Adobe PostScript 3, PCL5 for monochrome	PCL5c and PostScript 2
Up to 850	250/250	200/200	250/150
250/$125	250/$479	625/$495	250/$595
N/A	No previous model	✔	N/A
44	90	32	24
2	1	2	2
Plain paper, including legal size, transparencies, envelopes, labels, up to 90-lb. paper stock	Plain paper, including legal size, transparencies, envelopes, labels, up to 90-lb. paper stock	Plain paper, transparencies, up to 32-lb. paper stock. No legal size.	Plain paper, including legal size, transparencies, labels, envelopes, up to 24-lb. paper stock
$84 (black)/$170 (color)	$99 (black)/$129 (CMY)	$99 (3 color/2 black ink sticks)	C, M, and Y $50 each/K $18
✔	✔	✔	
3 (B&W)/10 (color)	2 at 5% (B&W)/11 at 20% (4-color)	6	<10 at 20% coverage
12K (B&W)/10K (color)	10K (B&W)/6K (CMY)	4.3K at 5%	4K (C, M, & Y)/5K (K)
10,000 (B&W)/25,000 (color)	20,000 (B&W)/5000 (color)	N/A	20,000 (50% B&W, 50% color)
Windows 3x, 95, NT	Windows 3x, 95, NT, OS/2, Mac OS, SunOS, Solaris, AIX, HP-UX, System V.4, Silicon Graphics	Windows 3x, 95, NT, OS/2, Mac OS, Unix	Windows 3x, 95, NT, OS/2, Mac OS, Unix
Hyper-Tetra color matching	N/A	N/A	
	✔/No	Via supplied Win 95 Adobe driver	✔/No
✔	✔	Via supplied Win 95 Adobe driver	✔
✔	✔		
16 MB	N/A	N/A	N/A
N/A	PCL5c/GL2	PCL5 monochrome	PCL5c
N/A	PostScript emulation	PostScript 3	PostScript 2 (optional)
N/A	LN03 Plus, XE5, CGM, (CCITT optional)	HPGL	N/A
✔	✔	✔	✔
N/A	✔	✔	N/A
N/A	✔	✔	✔
		✔	
No resident fonts	42 resident fonts (PS), 18 scalable	174 resident fonts	35 with PCL (Intellifonts), 35 with PS (scalable Adobe Type 1 fonts)
			Optional
1/P, L, F - 90 days/On-site	1/On-site	1/On-site	1/P, L
888-744-2424	800-523-2696	800-835-6100	800-832-6979
201-348-7973	334-633-4300	503-682-7377	716-264-2466
http://www.panasonic.com/alive	http://www.qms.com	http://www.tek.com	http://www.xerox.com
1083	**1084**	**1085**	**1086**

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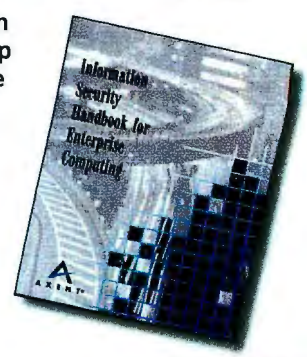

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We've waited a long time for Jasmine, CA's new object database. It's a worthy contender. By Barry Nance

Jasmine Challenges Traditional Databases

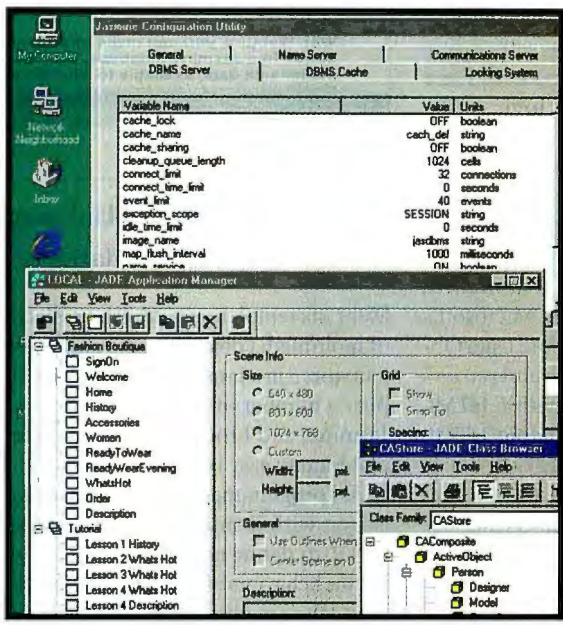
The busy marketplace for database software just got busier. Computer Associates' CA-Ingres relational DBMS, which competes with Oracle, DB2, Adaptive Server, and SQL Server, has a new object DBMS sibling called Jasmine. CA's Jasmine 1.1—no, you didn't blink; 1.0 never happened—is Fujitsu's OD2 database enhanced by CA with Web access and visual object-oriented programming tools.

At least for the present, Jasmine far surpasses the object orientation of the popular RDBMS products. OD2 is a top-quality object-oriented database, but its sales have been lackluster. Why does CA believe it can sell an object DBMS by adding OOP tools to OD2 when Fujitsu couldn't sell OD2 without them? This was but one of the many questions I asked while evaluating the Windows NT version of Jasmine in my network lab.

Vendors of the popular databases, realizing the value of object-oriented data stores, took a small step toward object DBMS technology by providing for binary large objects (BLOBs) and user-defined data types. However, I found that the OD2 database within the Jasmine product offers a high level of true object technology that includes multiple inheritance, class and instance properties (attributes), and methods. Indeed, I particularly like Jasmine's ability to fully traverse an inheritance tree at run time. Jasmine also comes with support for a wide range of data types, including image, video, text, 3-D VRML, audio, streaming video and audio, geographic, and financial. Jasmine is an exceptionally good repository for multimedia.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★

Jasmine itself runs on NT and several Unix flavors (HP-UX, Solaris, and AIX), while clients can be NT or Windows 95 machines. I began testing Jasmine on a 32-MB Pentium II machine running NT Server 4.0 and almost instantly ran out of memory as the page file doubled in size. On a 64-MB machine, Jasmine behaved better; you should plan on giving Jasmine lots of RAM.



Jasmine's visual design environment includes an object class browser and a database inspector.

Jasmine 1.1
$800 for NT Server version with 50 client licenses
(NT version requires NT Server 4.0 with 32 MB of RAM, 200 MB of disk, and Visual C/C++ 4.2 or higher for development.)

Computer Associates, Inc.
Islandia, NY

888-752-7646
516-342-5224

http://www.cai.com

Enter HotBYTEs No. 1015.

The Jasmine Application Development Environment (JADE) component, which runs only on Windows NT and Windows 95, is a visual design aid for Jasmine-based applications. JADE emits Object Data Query Language (ODQL) programs, which Jasmine stores as database objects. At run time, the database server executes an object's methods by parsing and interpreting the ODQL. ODQL itself is a full-featured object-oriented language that is somewhat like Smalltalk, and I find it's as easy to use as Oracle's PL/SQL database language.

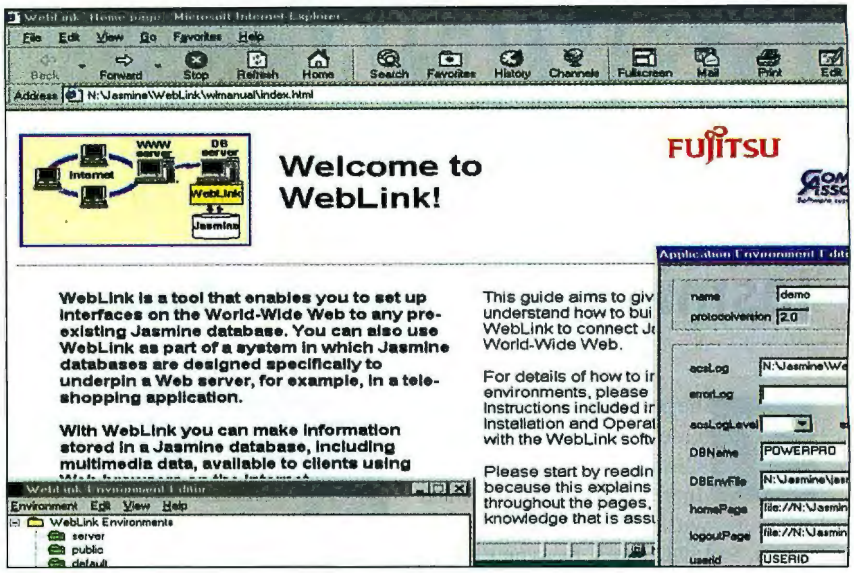
Dragging and dropping objects in JADE lets you easily design the rudimentary structure of an application. With JADE, I both designed database schemas and developed programs that populated the schemas. With its Explorer-like interface, JADE can be an administrative tool as well as a development environment. Its tree-view display of objects is conducive to defining classes, modifying classes and objects in the database, editing class properties, and building methods and queries.

In JADE parlance, a client window and associated program code together are a *scene*. Each scene is an application screen or Web page that you assemble visually by manipulating JADE objects. The visual design environment uses an event-action metaphor to help you relate programmatic database behaviors with pushbuttons and other graphic controls.

continued

Jasmine's emphasis on multimedia shows in JADE, which offers predefined actions like playing audio or video that you can specify for mouse clicks or other object-generated messages. In the lab, JADE eased the programming burden by prompting for appropriate parameters as I created multimedia-based Web pages. Managing multimedia with Jasmine is child's play and in stark contrast to the hoops you would have to jump through to retrieve and display BLOBs through an RDBMS such as Oracle. However, once I progressed beyond merely publishing multimedia, I quickly found myself coding database server ODQL statements by hand to instantiate the business logic of the application.

I used Jasmine's WebLink component to gather and present data via a browser window (Jasmine comes with plug-ins for both Internet Explorer and Navigator). WebLink provides facilities similar to, though less sophisticated than, Microsoft's Active Server Pages and Remote Data Objects technologies for storing and retrieving database content from within HTML documents. Unlike other dynamic HTML tools, WebLink stores the HTML documents themselves as database (Jasmine) objects. Running as a Common Gateway Interface (CGI) process launched by a Web server, WebLink receives data-retrieval requests from the Web server, accesses the Jasmine database via a WebLink server, and produces responses in the form of dynamic Web pages. A WebLink template is a Web page containing WebLink data-access script statements along with model HTML. I quickly and easily designed a Web-based application using



Jasmine's WebLink component is a tool for publishing Jasmine database contents via Web pages.

WebLink templates to publish a collection of multimedia objects (audio and video) I had stored in a Jasmine repository. CA supplies a number of sample templates with Jasmine, and I found creating new templates quite easy to do.

As I programmed a small business application with Jasmine, I used server-side ODQL to define not only the data objects but the behaviors of those objects (i.e., classes and their methods). Each database entry was simply a program object whose lifetime persisted beyond that of the running of the application, a concept that is natural and easy to work with (see the Tech Focus). From Java, on the other hand, I struggled a bit with JDBC calls to the Jasmine database. The programming became easier when I gave up on JDBC and used the supplied JasmineDB class to access data. I found Jasmine's Java classes to be ODMG 2.0-compliant, permitting direct object-to-object mapping between database and program.

Lab testing showed Jasmine to be robust, but it wasn't as fast as Oracle or SQL Server running on the same computer. Jasmine's architecture is necessarily multithreaded and SMP-aware. I say "necessarily" because a server workload consisting of both data storing/retrieving as well as concurrently executing methods can be a considerable computing burden.

Partly because of the weight of the Computer Associates name, partly because of the new tools, and partly because of the growing need for databases that can model complex multimedia-based business operations via objects, Jasmine will be much more popular than OD2. Companies that have embraced object-oriented programming as a corporate standard will be some of the first to adopt Jasmine. But trusting your data to a new database is a risky decision. Oracle, IBM, Sybase, and Microsoft don't have to wave the white flag of surrender quite yet. Applications not needing object technology will persist for a long time to come. B

Barry Nance, a computer analyst and consultant for 25 years, is the author of Introduction to Networking, *(Que, 1997),* Using OS/2 Warp *(Que, 1994), and* Client/Server LAN Programming *(Que, 1994). You can reach him at* **barryn@bix.com.**

TECH FOCUS | DATA TYPING

Let's Stop Impeding Performance

No official ANSI or ISO standard exists yet for object databases. Jasmine closely follows the current Object Database Management Group (ODMG) object model, ODMG-93, which proposes a direct relationship between objects within programs and objects in a database. The result is a reduction in "impedance mismatch" as programs retrieve, manipulate, and store database material. Mismatch is the extra work a program does to convert database entries to and from its own format (dates are a prime example). This extra work can sometimes add 30 to 40 percent to the bulk of a program. In contrast, programs written in Jasmine's own Object Data Query Language and (via Jasmine-supplied bindings) C, C++, and Java can operate directly on entries in a Jasmine database. Indeed, Jasmine stores methods in the database as objects belonging to a specific class. Jasmine-based applications can dynamically modify and extend class- and instance-level methods and properties. Oracle's PL/SQL and Microsoft's Transact-SQL languages also give you server-side data manipulation, but they lack ODQL's object orientation.

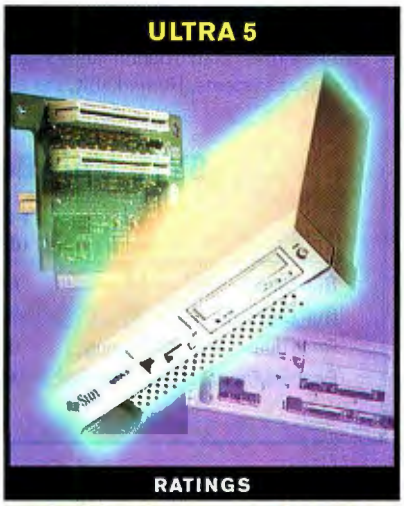
Odds are Sun won't hit paydirt with its Ultra 5 and 10—one is lean on features, one is lean on value. ***By Tom Yager***

Sun Makes a Desktop Gamble

Unix workstation manufacturers curse their limited market. Once in a while, a brave vendor makes a stealthy foray into desktop territory, trying to entice some lucrative business away from Intel and Apple. The latest example is Sun Microsystems. Armed with a new Ultra IIi CPU, some impressive performance-enhancing technology, PCI slots, and a lower price, Sun's Ultra 5 might turn a few Mac and PC heads. But the more powerful Ultra 10 workstation offers little in the way of value.

Prior Unix workstation vendors' efforts to woo the desktop market have been characterized by low-performing systems in boring configurations. This time Sun avoids a few of its previous mistakes, but not enough to entice. The Ultra IIi, though, does perform well relative to previous SPARC chips, as the benchmarks show (see chart on page 132).

Standard features of these new Solaris-based systems include 100-Mbps Ethernet, digital audio, accelerated graphics, roomy 4.3-GB hard drives, expandable RAM, and, for the first time, PCI slots. Signs of miserly old design habits can still be seen, however, and these may make it more difficult to push PCs and Macs off power users' desks.



RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★
PERFORMANCE	★ ★ ★ ★
FEATURES	★ ★
USABILITY	★ ★ ★

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★
PERFORMANCE	★ ★ ★ ★
FEATURES	★ ★ ★
USABILITY	★ ★ ★

Breaking Even?

Of the two machines, the Ultra 5 looks the most like a Sun product and sports the familiar pizza-box chassis. The front of the Ultra 5 cabinet is uncluttered. The optional CD-ROM drive mounts in the system's only front-accessible 5¼-inch drive bay, and the floppy drive occupies the only exposed 3½-inch bay. Actually, there is another bay: An odd flip-up door reveals a space for, of all things, a PC Card socket. The socket is not a very desirable option, unless you test PC Cards, and it leaves no room for a second, sorely needed 3½-inch drive bay.

Among the most notable and surprising twists in the Ultra 5's design is the abandonment of SCSI in favor of Enhanced IDE. I was initially disappointed with Sun's choice of EIDE for the drive controller. It's typically much slower than Wide SCSI and can place a serious drain on the system. But Sun seems to have worked some of that out. In sequential I/O performance tests (best case), the EIDE drive churned out buffered writes at 5.7 MBps, and it read at 5.8 MBps. In both cases the CPU utilization (18 percent write, 15 percent read) was within respectable limits. Random-access operations, like index and directory-tree searches, fared poorly, however. Additionally, the drive's low rotational speed (4500 rpm) and slower access time hurt it when seeking was required. Synchronous (unbuffered) writes, which for Unix are also seek-intensive, tested worst of all, clocking in at only 266 KBps. Fortunately, synchronous writes are not needed as often in Solaris because lazy cache flushing isn't nearly as lazy as under Windows NT.

An additional disk controller, like the Adaptec SCSI designed for this platform, is the only way you'll be able to add hard drives and backup devices to the Ultra 5. If you plan to upgrade your drive, proceed with care. Solaris is infamous for making integration of off-the-shelf drives difficult. Sun won't support or encourage the use of off-the-shelf IDE drives, nor will it publish a list of certified drives.

The on-board display controller is the quite capable ATI Rage 3D+DVD. Why does Sun arbitrarily limit this worthy chip to 8-bit 2-D graphics? Sun is protecting its market for add-ons and stratifying its base-model configurations by not shipping standard high-color graphics. But who will settle for 256 colors when CAD, graphics design, Web authoring, and oth-

er workstation-class applications now expect at least 16-bit color?

The star attraction inside the Ultra 5 case is the trio of PCI slots. These are 32-bit, just like the ones in PCs—but don't think of plugging in your favorite PCI card just yet. Only a very limited number of cards are supported now on the Ultra platform, from Fibre Channel adapters to multiport serial boards.

Sun's base system price of $2995 gets you 64 MB of RAM and the 4.3-GB hard drive, but nothing else. The recommended configuration for most uses is 128 MB, especially if you run the hungry Common Desktop Environment (CDE) graphical shell. With 128 MB of RAM and a CD-ROM drive—our test configuration—the price of the Ultra 5 rises to $3595.

Is it worth it? That much money buys a lot of PC these days. For that, you can have 128 MB of RAM, Ultra-Wide SCSI, and true-color, accelerated 3-D graphics. You could buy a 333-MHz Pentium II, or even an Alpha. I still have a fondness for Unix, and I like this little system. But too many of the corners Sun cut are important to me. If you've got a $3600 budget, the Ultra 5's performance and features aren't so alluring that you shouldn't also consider a PC or Power Mac in that price range.

Doesn't Stack Up

Like the Ultra 5, the Ultra 10 comes standard with 100-MBps Ethernet, digital audio, accelerated graphics, roomy 4.3-GB hard drive, expandable RAM, and PCI slots. Configured with 256 MB of RAM, a CD-ROM drive, and 24-bit graphics, the Ultra 10's base price slides in at a pause-inducing $7895. For that additional $4300, you get the 24-bit Creator graphics subsystem, an additional 128 MB of RAM, a faster CPU—300 MHz vs. the Ultra 5's 270 MHz—and external cache bumped to 512 KB. A fourth 32-bit PCI slot accepts a full-length card. You also get the option to install one additional 4.3-GB EIDE drive (per Sun) in the chassis' single 5¼-inch open bay.

PRODUCT INFO

Sun Ultra 5 $3595
128 MB RAM, 4.3-GB disk, CD-ROM, ATI 8-bit on-board graphics

Sun Ultra 10 $8440
256 MB RAM, 4.3-GB disk, CD-ROM, Creator3D graphics adapter

Sun Microsystems
Palo Alto, CA
650-960-1300
800-786-3463
http://www.sun.com

Enter HotBYTEs No. 1014.

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

About the Benchmarks

I had hoped to run the new BYTEmark tests on these systems, but the code wasn't yet ready. To give these machines a workout, I chose to reach all the way back to 1991. At that time, BYTE technical editor Ben Smith and I adapted a collection of university benchmarks and dubbed them the BYTE Unix Benchmark.

BYTE stopped using the benchmark some years later, and it vanished from BYTE's online archives. But the Linux community picked it up, and since then it has enjoyed prominence as the de facto performance measure for Linux systems. Remarkably, the Linux group has resisted the urge to change it. The BYTE Unix Benchmark's reappearance here may be temporary, but since its results are still sound, perhaps you'll see it again.

Disk performance measurements came from a tool I developed called Bigio (see main text for results). This C program performs large (1- to 2-GB) sequential writes and reads, times them, and derives a throughput figure based on the time. The raw numbers are useful, but don't apply them too broadly. Few applications do sequential disk I/O, so your actual disk throughput will be considerably lower than this best-case figure.

BYTE Unix Benchmark Results

	FP (double)	Integer (dhry2)	Execl (syscall)	Shell
Sun Ultra 5	64,899	452,975	46	21
Sun Ultra 10	72,306	505,086	60	15
Ross dual-CPU SPARCplug	51,215	191,369	20	19
Pentium Pro 180/Red Hat Linux	46,577	343,137	216	161

This doesn't add up. The real value of the Ultra 10 is that its graphics are upgradable. For about $1300 extra, you can configure in Sun's Creator3D, which plugs directly into the system's innovative packet-switched memory/UPA graphics bus. For about $5750 list, you can upgrade to the powerful Elite3D m3.

The Ultra 10's tower cabinet is solidly built and attractive, but it is stricken with one of the dumbest ideas I've ever encountered: The case's cover removes from the bottom. To take it off, you must lift the heavy, fragile system vertically out of the cover, scoot the cover out of the way with your foot, and set the system back down.

Inside the case, the Ultra 10 differs little from its affordable cousin. The slots are laid out differently, the front fan is larger, and the DIMM RAM sockets are more accessible. Without one of the Creator cards installed, the selection of ports and connectors (including on-board video) is identical. The Creator cards use the Sun 13W3 monitor connector, but you can readily convert that to a DB15 using an adapter from Sun and other sources.

On overall system performance, the Ultra 10 delivers the boost Sun promises from the higher clock speed, extra RAM, and the larger cache. Numbers are up across the board compared to the Ultra 5, with the puzzling exception of the concurrent shell script test (see the benchmark results above). Disk performance, not surprisingly, remains about the same.

Value Crapshoot

Much is being made about the Ultra 5 and 10's ability to run PC software. Like other Windows emulators, Insignia SoftWindows 95, which is optional, makes a fascinating demo, but it is a wholly impractical solution compared to, say, putting a $750 Pentium system on your desk.

Of the two, the Ultra 5 is the more appealing overall value due to the packet-switched memory/UPA graphics bus, surprisingly fast IDE, PCI expansion, and low cost. If you make your living on 3-D, and a hardware-accelerated edge means something to you, the Ultra 10 is worth your consideration. But you should seriously look also at lower-cost systems from Digital and Intergraph, and also see what Silicon Graphics and Hewlett-Packard are up to. They're certain to respond to Sun's challenge. B

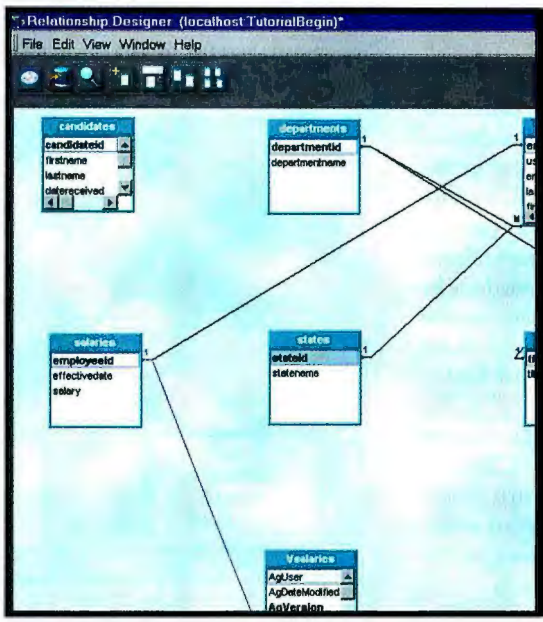
Tom Yager, a regular contributor to BYTE, operates an independent lab in Texas. You can reach him at **tyager@maxx.net.**

SilverStream serves up a RAD stew with its application server and client, seasoned with third-party tools. By Tom Shafron

Slip into SilverStream's Web App Services

Web application development increasingly uses visual integration of precoded objects à la Microsoft's Visual Basic and opens up access to database applications à la Microsoft's Active Server Page (ASP). SilverStream Web Application Platform 1.0 pushes the envelope in both directions, enhancing visual application development while improving back-end Web-site integration. The server and development tools run on Windows 95 or NT, but developed applications are accessible to any JDK 1.1-enabled (Java Development Kit) browser.

Included are SilverStream Designer, a tool for building Java applications and applets; SilverStream Server, a Web and application server; Fulcrum Technologies' Fulcrum SearchServer, for full-text searches; Sybase's SQL Anywhere database; and a Java development tool that uses the Symantec Café Java compiler. The SQL database provides the glue that keeps it all nicely integrated. All Web objects are stored in the database, and the Server provides access to Designer users as well as users of finished applications.



SilverStream Web Application Platform 1.0
$495, Single-User Starter Pack
$5995, Group Starter Pack, (Windows 95/NT for development)

SilverStream Software, Inc.
Burlington, MA

888-823-9700
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Enter HotBYTEs No. 1007.

The Relationship Designer allows you to visually manage the inner and outer joins in your database.

Strapping In for Takeoff

My hopes for a quick installation were dashed when I had to enter every parameter by hand when installing the database, a process that screamed for automation. Even so, it took only 45 minutes before I got everything working properly with help from my trusty NT Event Viewer.

If you have any experience with visual-programming tools, you'll feel right at home with SilverStream in no time. You develop applications by dragging objects onto a form, assigning them properties, and writing code for events such as mouse-clicks. The Java compiler stores all code in the database, so it's available for either continued development or deployment. The SilverStream Designer speaks HTTP to the server, so the server doesn't need to distinguish between users and developers other than to restrict them to authorized objects.

All coding, for both client and server, is in Java (some SQL knowledge is useful but not required). Wizards handle most client-side coding, saving time for everyone and enabling novices to easily integrate back-end databases into their sites. SilverStream's tight integration means that every member of your team can train and work on one system.

Programmers can develop relational databases, create interactive forms, and program agents to handle everything from interpreting and responding to e-mail to downloading the latest news every hour. Designers can create layouts and assign graphics and sounds while administrators create groups and assign user permissions, all using the same interface.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★

SilverStream bundles SQL Anywhere because it needs a database to run, though many SQL databases will work. Application forms are compiled locally and stored on the server along with any other code, application metadata, HTML pages, and objects. Objects are retrieved with SQL calls over an ODBC connection, giving the development process a level of abstraction that lets you run SQL queries on virtually every aspect of your site.

However, this design decision leads to one of SilverStream's potential problems. Database retrieval is slower than the file-system retrieval used by other Web servers, though a combination of optimization by SilverStream and the use of

server caching of frequently served objects should minimize problems.

Another issue related to the SilverStream data store is that SilverStream sites are not easily portable to other platforms. While all HTML pages and Java code are strictly standard, SilverStream uses its SQL database to link everything. If you use precoded SilverStream objects in your code, you would have to copy the code to the new server and recompile it to create files instead of the objects stored in SilverStream's database. Once you commit to this architecture, it will be tough to switch.

Cog in the Virtual Machine

All server-side programming is done in Java via agents. SilverStream uses the Microsoft Java virtual machine (JVM) on the server, which lets you make calls to Windows native code through Java (see the Tech Focus). Agents do Web-site-related tasks that have traditionally been done by CGI, ASP, and NT services or some combination of these three, and even making calls to Common Object Request Broker Architecture (CORBA) objects.

Anything you can do with Java can be executed as a server-side agent. You can activate an agent on a schedule, in response to e-mail or a direct user request, or whenever a database is updated. You can also have it called by another program.

NT treats agents as if they were part of the server, giving them the same permissions and run-time environment. Because agents are not applets, they have more access to your server, including access to the file system. Security for agents can be handled through NT or SilverStream.

SilverStream makes it easy for a developer to create applets for things such as forms that have traditionally been done with HTML. While this makes SilverStream very Java-friendly, it is not necessarily HTML-friendly.

For example, a Java form wizard can generate a template and let you add, position, and set properties and events of any controls you need. Using a Java-to-HTML tool, you lose much of the functionality (e.g., checkboxes, radio buttons, listboxes, combo boxes, client-side calculations, nonform buttons, and back-end coding). Doing HTML forms with SilverStream means using an HTML page designer and building in server-side logic through an agent.

Despite the examples included with SilverStream, the process can get hairy. The included HTML editor is so limited that it almost feels like coding with NotePad, and the server-side agent you need to write to handle an HTML form is more complicated and time-consuming than the equivalent script in ASP.

I Stream, You Stream...

If you're sure visitors to your site will be Java-capable and that first-timers will hold still for a 1-MB download of Java classes, creating forms in Java with SilverStream is simple and powerful. The Java programming wizard that writes the code to handle your most common tasks is also a good Java tutor, letting you see and edit the code it generates. The Java designer will also let you import code from other applications, including JavaBeans.

The bugs I found have mostly been fixed in release 1.01, now available. I found this an elegant tool for developing Web applications quickly and efficiently. If you don't worry about putting all your apples in one basket and are developing an intranet or extranet application, a better combination of development and administrative tools will be hard to find. SilverStream is a powerful, well-thought-out package, despite its meager support for HTML. B

Tom Shafron, president of Polychrome Interactive, a New York City new media agency, can be reached via e-mail at **ts@polyint.com**.

TECH FOCUS: E-SMTP

Sticking It to the Platform

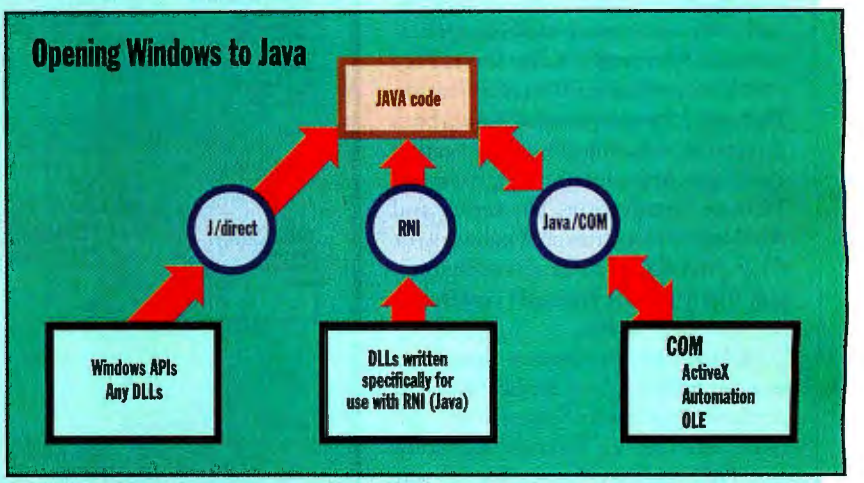
It doesn't take long to run into a brick wall with Java. Microsoft's Raw Native Interface (RNI) offers a way around some of the limitations. RNI lets you call Windows native code directly from Java. Microsoft's Java virtual machine (JVM) is the only place you'll find it, and for a very good reason: If you use RNI, you're no longer creating Java programs; you're creating Windows programs.

To use a Windows DLL with RNI, you must create a wrapper DLL to work as a translation layer. This is necessary because Java and Windows native code handle many things, such as data types and structures, very differently. The fact that Windows offers more functions than Java further complicates matters. For example, the RNI wrapper has to take care of issues such as pointers to functions for callbacks, because there are no pointers in Java.

Microsoft built two tools into its JVM to help resolve these and other problems related to building Java-ized Windows programs: Java/COM and J/direct. Both can handle all the translation necessary to make Windows native calls in Java.

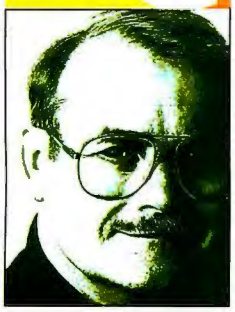
Java/COM acts as a translation layer between your Java code and a Component Object Model (COM) object. This lets you treat COM objects as Java classes and Java classes as COM objects. So, you can write ActiveX controls in Java or turn Java apps into ActiveX controls. But Java/COM only lets you interact with COMS\s. If you wish to call DLLs directly, you must use another method.

J/direct lets you call a DLL without a COM or RNI wrapper. It handles all the calling issues, such as mapping data types and handling callbacks, giving you direct access to DLL functions, without the fuss.



Jerry Pournelle

Chaos Manor



Good Enough Is Good Enough

Spring is around the corner, and the Orchids and Onions are sprouting in Dr. Pournelle's garden.

I am weary of writing about adventures, and even more weary of having them. Fortunately, although there have been adventures aplenty this month, I can spare you the tales. This column gives my annual User's Choice Awards plus the annual Orchids and Onions parade.

Ground rules: since it is impossible to see and use everything, I can't possibly pretend that I know what's "best." What I can do is tell you about programs and equipment that I consider good enough. In most cases, this will be stuff I use myself; and since I can get almost anything I want, this usually means I use it in preference to anything else. In all cases, though, these awards are subjective, reflecting my opinions and recommendations.

Second, since I consider a year to end in December instead of in time for the January issue, I present my awards in April. That's still the way it is.

So here we go.

A large half-rotten Onion to Congress, the FCC, and the industry in general for making such a mess of the HDTV standards. We have the technology and more; we need only standards. There are arguments for and against all the proposals, but there has to be a decision. Or let the market decide. But to keep things bottled up while the regulators don't decide is plain silly.

A small Orchid and a large Onion to ***Sun, both for Java.*** Java was a good idea, and trying to make it standard is even better, and deserves an Orchid. However, suing Microsoft over Java turns out to do more harm than good, and gets the Onion. The first result of this was that Netscape took the Java logo off their product. Now that neither major browser even pretends to standard Java, it's probably the end of Java as a standard at all.

It may have been inevitable that Java would fragment into incompatible flavors, but the lawsuit pretty well ensured that. It made Java developers choose between the "pure" stuff with its limitations or the Windows version with development tools and a way of reaching some 90 percent of Web users. It does not seem like a difficult choice.

An enormous Onion to Ralph Nader, with garlic clusters to everyone involved in bringing him into our industry. I don't think we need government, or lawyers, or both, in the computer industry; but even if we do, what need have we of a consumer advocate who doesn't understand computers and has never exhibited the slightest interest in them? I am adding to Pournelle's law: companies that need government to help move their products are in trouble; but companies that need "consumer advocates" to compete are ready for Kevorkian.

A large half-rotten Onion to Congress, the FCC, and the industry.

A BIG ORCHID TO BORLAND for Delphi. When memory and disk storage were limited, and machines were not very fast, it was important that programs be written in languages that generated fast, small, and resource-efficient code. Add to that portability to several platforms and processors, and a huge number of programmers adopted C.

This was unfortunate, because while C has the merit of portable and reasonably efficient code, it is not very readable, and it doesn't do strong type and range checking. C will compile nonsense if you write nonsense, and debugging programs is a significant part of writing them.

By contrast, highly structured languages such as Pascal don't need a lot of debugging; or rather, the debugging takes place as part of compilation. Pascal is fussy about types and ranges. Once you get the program compiled and running, much of the debugging has been done. Unfortunately, Pascal and big brother Modula-2 did not generate tight and resource-efficient code that ran fast.

Modern machines have resources out the ears. Memory is nearly free. Processor speed is so fast that we benchmark differences in seconds. Disk space is under 50 bucks a gigabyte. It is far more important that programs be out and running fast than that they be resource-efficient.

Delphi is the old Turbo Pascal with a number of multimedia features. It's every bit good enough for many professional applications, and I guarantee you that programs written in Delphi will be out the door quicker and much easier to maintain than the same programs written in C. Many cheers to Borland for fighting the good fight; and we can hope that more programmers will begin to see the light.

Two cheers to Microsoft for delaying Memphis, otherwise known as Windows 98, while they do some more work on it. From experience with the beta versions, we like Windows 98, and I suspect it will get a User's Choice Award next year; meanwhile, a small Orchid for Microsoft for waiting until they can fix some beta-discovered problems.

Big Orchids to both Microsoft and

Macromedia for their attention to Web development tools. I was ready to give the Chaos Manor User's Choice Award for Web tools to FrontPage 98, which is pretty nifty; but then Macromedia brought out Dreamweaver, which is even better.

Dreamweaver is better because it writes cleaner HTML and because it knows how to add new stuff without rewriting all the old code. FrontPage 98 is useful, and many professional Web designers like it a lot; but it does tend to be something of a busybody when it comes to rewriting your code. Dreamweaver is just enough better that it gets the User's Choice Award for 1997.

For high-end graphics work, Intergraph's RealiZm II boards have no peers.

THE MOST USEFUL WINDOWS utilities of the year are Zip Magic and FreeSpace, both from Mijenix. Both do things you want done: Zip Magic makes dealing with ZIP and CAB files simple and painless. FreeSpace does selective file compression to create more disk space, useful on a desktop and vital in a laptop. Try both. You'll love them.

Not far behind and definitely on the Orchid list: Golden Bow Systems' Vopt, the best disk defrag utility I know of for DOS, Windows 3.1, and Windows 95; and Executive Software's Diskeeper 3.0, the only disk defrag utility to consider for Windows NT Workstation or Server. All four utilities get User's Choice Awards.

Two User's Choice Awards for video boards: for all-around general-purpose work, the Number Nine Revolution 3D, which works with Windows 95 and NT, is fast enough in both 2-D and 3-D for games, and has good enough color resolution and good steady line definition for text work.

For high-end graphics work, Intergraph's RealiZm II boards have no peers. We have tried a lot of them, and Chaos Manor graphics associate David Em has both the skills and the tasks to stress video boards to their limits; and we are agreed, Intergraph boards are outstanding.

A few months ago, I wrote about the Avant Stellar keyboard from Creative Vision Technologies (http://www.cvtinc.com/). It's a great keyboard, and I still recommend it.

But the User's Choice Award for keyboards goes hands down to Ortek Technologies (their U.S. branch is called KBtek America) for their MCK-142 Pro. The MCK-142 has the heft and feel and keyclick of the old Northgate OmniKey. It has function keys across the top and on the side as well. Above the keyboard are 24 keys you can program to do almost anything, including address and signature, and opening programs with parameters; essentially, any text string you like at the touch of a button. The MCK-142 feels good and is as solid as a rock. It doesn't have the "Windows" key, but then that's nothing more than control-escape anyway.

My Northgate OmniKey keyboards are old, and several have broken down. Now I don't worry about that so much. If you liked the Northgate OmniKey, you will like the Ortek MCK-142.

THE MOST USEFUL PRODUCTION software of the year was Adaptec's Easy CD Creator Deluxe. This works with Ricoh, Philips, and Yamaha drives to make CD-ROMs as well as audio CDs. (I'm sure it will work with other makes of drives, but those are the ones I have worked with.) It works easily and painlessly, and can work with CD Recordable (CD-R) and CD Rewritable (CD-RW) drives. It has become wellnigh indispensable here and wins my User's Choice Award for production software.

A USER'S CHOICE AWARD FOR 3Com/Palm Computing's PalmPilot. PalmPilot and Apple's Newton are mature PDAs; I like PalmPilot better because it is smaller.

I find I have learned to use the "graffiti" symbols, and I can make notes rapidly with it. It keeps appointments, checklists, expense accounts, telephone numbers, and random notes. I have taken to carrying it on the trail when I go hiking in the hills with my dog, and while I wouldn't use it to write long paragraphs of notes, it's certainly good enough for memos. Battery life is good, and the interface is good. I believe I have finally found a PDA I will carry.

Toshiba's Libretto 50CT gets a User's Choice Award for palmtops. This one is a bit larger than the Windows CE machines, which means the keyboard is more or less usable. I put it that way because I really am a touch-typist, and 50 years of habits are hard to break.

To properly use a palmtop, including the Libretto, you need to be good at two-finger typing. Some palmtop users have developed a really odd technique using two fingers of the right hand and the left thumb to do shift and space. It looks odd, but they are quite fast at it. As for me, I very much miss the old Gateway HandBook. Still, the Libretto, which reminds me a lot of the Atari Portfolio, is small enough to fit in a briefcase or shoulder bag. The keyboard, while too small, is still large enough to use; and the screen is readable.

I recall one night in a Moscow bar enviously watching journalist Tom Bethell write an entire column pounding on an Atari Portfolio with two fingers. Ever since, I have wished I had a system I could carry in my pocket that I could do a couple of thousand words with. The Libretto is the first one as good as the Portfolio that I've seen since Atari imploded.

I eagerly give my Compaq Armada 4160T the laptop User's Choice Award. I have carried that Armada in four countries, on airplanes and ships, including a Navy missile destroyer. I have used it for writing in cars, hotel rooms, the ship's wardroom, and on top of a mountain; and while I could wish it were lighter, that's my only complaint. The keyboard is good, the screen is bright, the battery life is satisfactory, and the docking and "sleep" software work perfectly. There are a lot of good laptops, but this one is plenty good enough and was the most useful to me in 1997.

IT'S A BIT HARDER TO PICK DESKtop hardware, because a lot depends on what you want it for.

My User's Choice Award for all-around useful desktop goes to the Compaq Professional Workstation 5000 with dual 200-MHz Pentium Pros. Regular readers will recall I've named her Princess. She runs NT 4.0 (soon to be 5.0), and I use her for almost everything: communications, graphics, Web-page design and maintenance, calculations, printing, manipulating pictures taken with my Olympus digital camera in Photoshop, and a good part of my writing. (I write my novels on an old 486 in the "monk's cell," a room without telephones and modems, and the computer is too slow for most computer games.) Princess is fast and reliable, and I don't hesitate to recommend the Compaq Professional Workstation 5000 for all but the highest-end graphics work.

I have no need for high-end graphics

capabilities (e.g., animation of 3-D objects). David Em does, and he reports that for all-around utility, the most useful machine is the Intergraph TDZ 2000 with dual Pentium II chips and dual RealiZm II video-accelerator boards. On the strength of that recommendation plus some personal time spent with that system, I am giving Intergraph the User's Choice Award for 1997 in the graphics workstation category. See David's report in this month's Web Exclusive for more details.

Similarly, I have two User's Choice Awards for monitors. For general all-around use, including writing, you will not find one better than the 21-inch ViewSonic PT813. That is the monitor that is attached to Princess, and I use it every day.

The size and clarity are such that I just sit in front of the system with my keyboard on an ordinary typing table adjusted to the height I like and look straight ahead. No tilting my head to use bifocals, and more important, I have just about given up using my prescription set of computer glasses, except with laptops. It's a great feeling of freedom. ViewSonic has made high-quality big monitors affordable, and if you're not using one, you're depriving yourself.

Incidentally, while artists can use much larger monitors, for writing, a 21-inch monitor is about right. Adjust your word processor window so that you see a full line without swinging your head, and Bob's your uncle.

ViewSonic monitors with a Number Nine Revolution 3D graphics board are more than good enough for nearly anything I do; but for those who need absolute color fidelity, I recommend the Eizo Nanao FlexScan FX E8, also 21 inches, or their larger model if you need even more high-quality display capability. This gives a gorgeous display. Needless to say, it is rock-solid, the straight lines are truly straight, and the images are as steady as if they are painted on. If you need the very best, you will not do much better at any price, and the FX E8 gets my User's Choice Award for high-end graphics monitors.

An honorable mention goes to the ViewSonic flat-panel display, the VPA150. A flat-panel monitor meets some rather specialized needs. It's small and light, and it does not make a lot of heat.

It's not really large enough to write on, but I say that because I am spoiled by 21-inch monitors with bright colors; for years, I did my work on monitors not as good as the ViewSonic flat-panel monitor. For a busy executive with a space problem, it is the answer to a prayer: good enough for daily use, yet handy enough to move out of the way when you need the desk space.

FOR DRAWING TOOLS, YOU WILL not do better than Wacom. My User's Choice Award goes to the ArtZ II graphics tablet. Mine has a drawing area of 6 by 8 inches. This serves as my mouse pad as well as a digitizer. It stays hooked up all the time; so long as the pen isn't brought to the pad, the machine ignores it and listens to the mouse.

When I need to draw, or when my hand is tired and I want to use the pen for a mouse, I can do that. When I draw with it, there are programs that make use of the Wacom pressure-sensitivity feature, so the harder I press, the thicker the line. The eraser works just the way a pencil eraser does.

I am no artist, but if I had to produce real artwork, I'd want the right tool; and this is it. Wacom makes them in several sizes. I like 6 by 8 inches, but you may want a larger one, and some like them smaller.

I have always tended to use CorelDraw

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simply because I learned an early version, but up to now I haven't strongly recommended the program because of interface idiosyncrasies. Comes now CorelDraw 8, which is quite different. This one is easy to recommend with some enthusiasm. It wins the User's Choice Award for drawing software for 1997. For details, see David's graphics report.

ONE REASON I LIKE MY COMPAQ machines is that they come with 100-Mb Ethernet. Most of my machines are only 10 Mb. Worse, half of them are on coax (thin-wire Ethernet). The other half use 10Base-T. The solution to that was the Garrett Communications Magnum H-80 Personal Hub, which has a coax connector plus six 10Base-T sockets.

Now I have the Garrett Magnum 600ES Personal Hub Plus, which operates at 100 Mb. Obviously, that has no coax slot on it; what it does have is an uplink connector that can be set to either 10 or 100 Mb as needed. The 100-Mb systems plug into the 600ES, a line goes from the 600ES to the H-80, and the 10-Mb systems are connected to the H-80. It took about 2 minutes to set up, and it all works.

If you have a small network with both 10- and 100-Mb Ethernet, you won't find a simpler or more reliable solution than to get the appropriate Garrett products, plug them in, and forget them. The Garrett Magnum 600ES Personal Hub Plus gets the User's Choice Award in networking hardware for 1997.

There are two printers of the year. First, for all-around printer productivity, get yourself an HP LaserJet 4000 TN. This won the BYTE Best of Comdex award last fall, in part because of the JetSend technology that lets peripherals talk to each other without involving you or your CPU; but I'm giving it the User's Choice Award because it is so blooming convenient.

It is easy to set up, easy to network through Ethernet, and simple to use. It is fast. It goes to sleep when not in use, so it's not heating up the room; but it wakes up fast when it has a job to do. It has good resolution. I can print novels that look like finished work. It has three, count 'em, three paper sources, and it feeds envelopes and small-size paper well. In a word, it's hard to find anything not to like about the LaserJet 4000 TN.

I had my HP LaserJet II rebuilt into a LaserJet III; it got User's Choice Awards in both configurations and has been in use for so many years I literally can't remember when I installed it. I have finally retired it for the LaserJet 4000 TN (which is both smaller and faster), and I have no doubt I'll have that printer for many years. It well deserves the User's Choice Award for the best monochrome printer of 1997.

There are a lot of color printers, and I'm not qualified to comment on high-end production-speed printers, but I can tell you about the Alps MD4000 Color Printer and Scanner that I use. It's not fast, but it makes really good-looking color prints on slick paper. The Micro-Dry process makes colorfast copies: I have one print I soaked in water, let dry, and hung in normal light for almost a year. It has not faded, nor did it run or wrinkle. This is unusual for a color printer, most of which use dyes that can't stand either water or sunlight.

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report cover, go to Kinko's or your professional graphics shop. For that quick-and-dirty copy of a color page, or for those five color covers, or for the 20 copies of a page with one color graph in it, you will find the MD-4000 just the thing to have around the office. It gets the User's Choice Award for color utility printer.

THE USER'S CHOICE AWARD FOR simulation software goes to Joshua M. Epstein and Robert Axtell for *Growing Artificial Societies* (Brookings, ISBN 0-262-55025-3), their first report on Sugarscape. You can find my report in the June 1997 issue or on-line at the BYTE site; if you have any interest at all in modeling social sciences or artificial life, read my report and then get their book.

A User's Choice Award to Encyclopedia Britannica for their CD-ROM encyclopedia. It installs simply either locally or on Ethernet (mine resides permanently on a Pioneer six-pack CD-ROM changer attached to the NT Server), uses either Communicator or Internet Explorer to view its files, and is about as simple to use as the books themselves. In CD-ROM, as in book versions, Britannica is still the encyclopedia to get.

DK Publishing (http://www.dk.com) has published so many excellent CD-ROMs this year that I hesitate to single out any one of them; but I have no trouble at all giving the company my User's Choice Award as CD-ROM publisher of the year. Their history series is excellent, their natural science series may be even better, and in general, you can rely on their titles as being about what they claim to be.

THERE WERE A LARGE NUMBER of really great games last year. I greatly enjoyed Interplay's Fallout. Strategic Simulations' Imperialism is a well-paced strategy game. MicroProse Software's Civilization II was not as much better than Civilization I as I had hoped, but in a year of less strong competition, it could have been the game of the year. Origin's Wing Commander Prophecy is much closer to the original in terms of fun and sheer playability. There are upgrades of Steel Panthers, Panzer General, and other modern armored warfare games.

However, the Chaos Manor User's Choice Award for game of the year was Diablo, from Blizzard Entertainment, which plays well in both multiplayer and single-player configurations. When the boys were here for Thanksgiving, we spent a lot more time with that one than I should have. If you like that kind of game at all, you will love this one.

The first book of the month is Peter Kent's *Poor Richard's Web Site: Geek-Free, Commonsense Advice on Building a Low-Cost Web Site*. Check out http://www.poorrichard.com for details; the title says all that's needed. The second book of the month is Elizabeth A. Parker's *Home Page Improvement* (IDG Books, ISBN 0-7645-3083-6), another "Gee how did you do that?" Web-page book that's written in English with lots of examples. It may or may not be significant that she is married to Rich Grace, a writer whose works I have admired. In any event, I wish I had had either, or preferably both, of these books when I set out to build a Web site.

Those are my awards. For more Orchids and Onions, see the Web Exclusive section of the column. B

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BYTE

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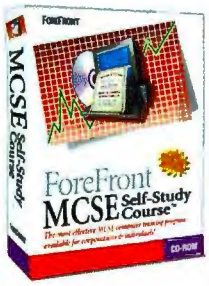

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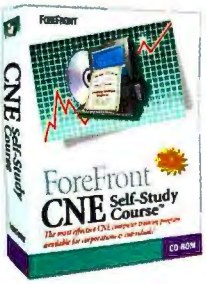

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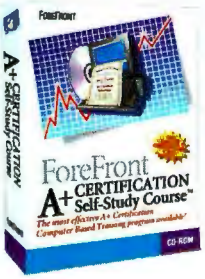

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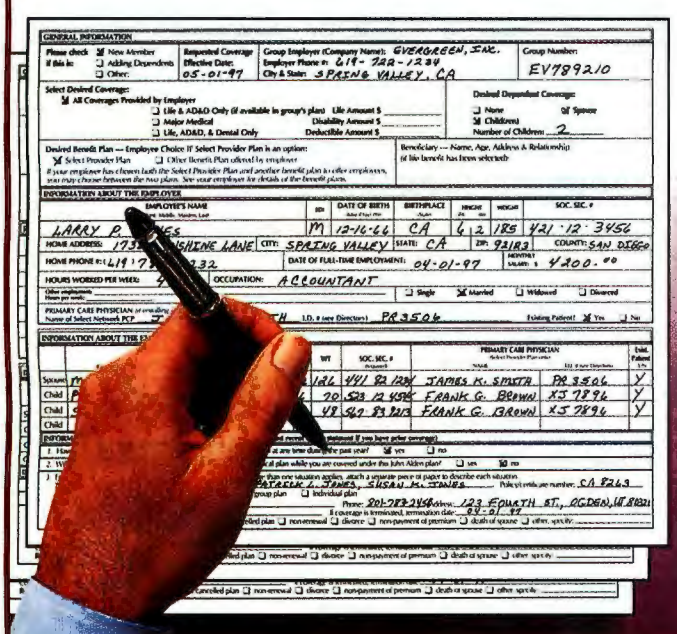

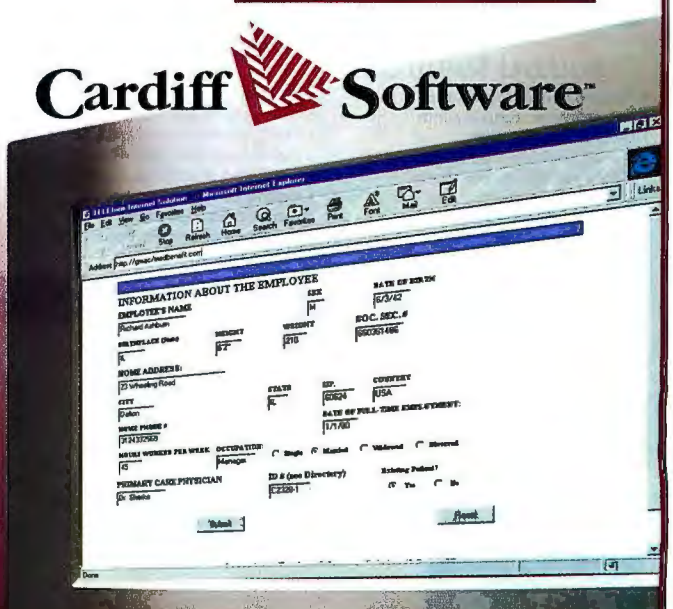

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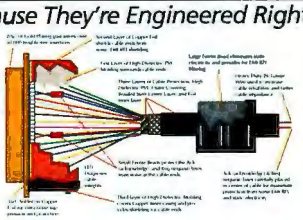

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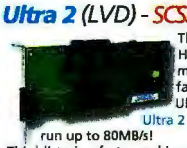

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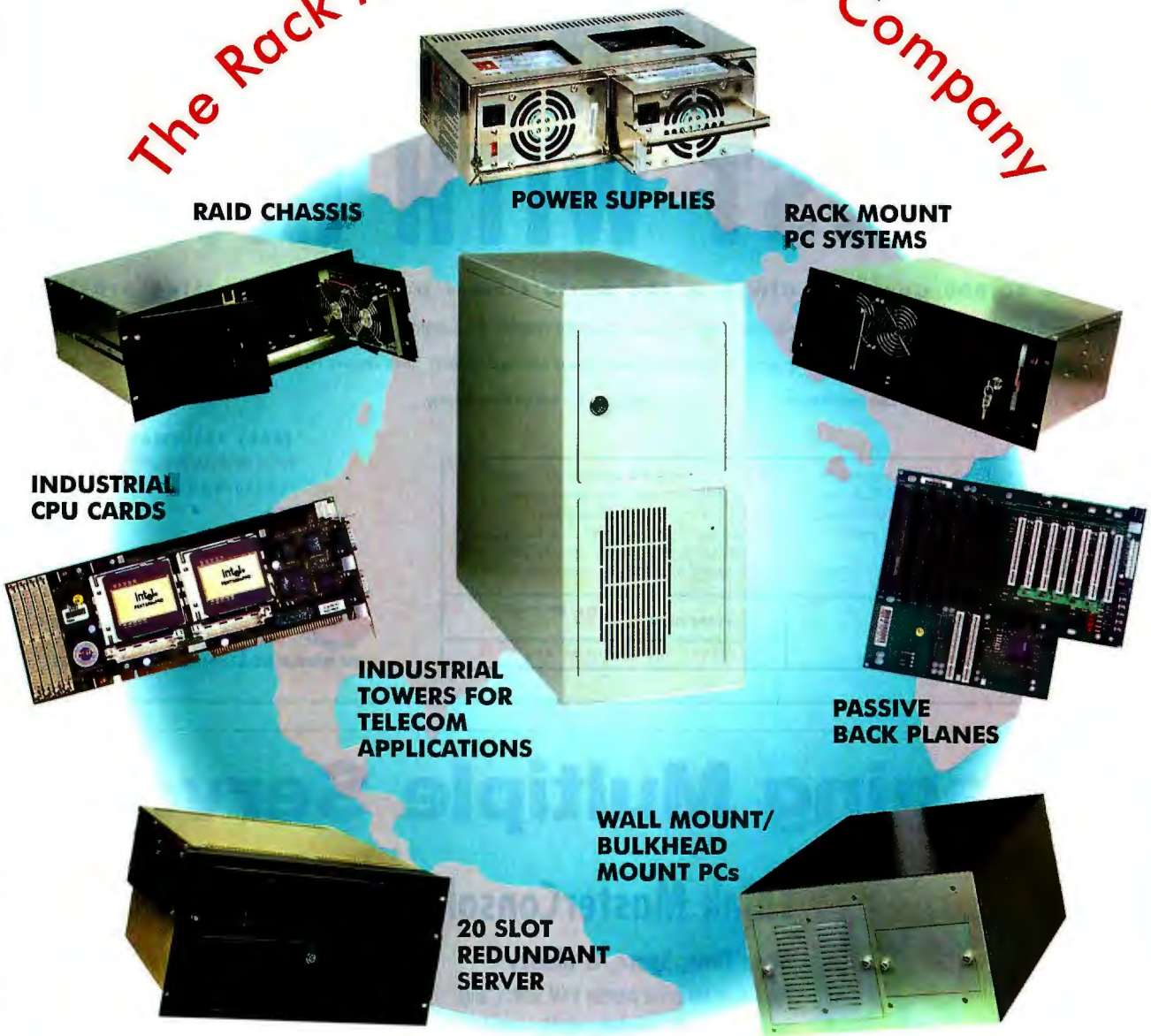

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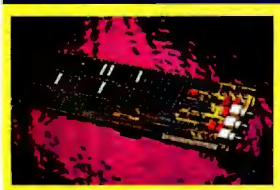

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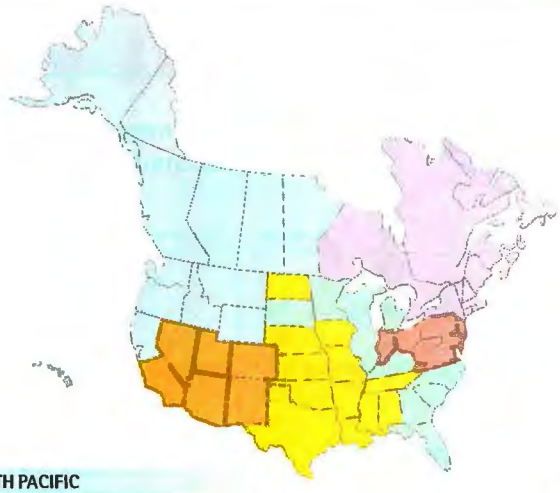

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EDITORIAL INDEX

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 and K pages appear only in the Reseller edition. NA pages appear only in the North America edition.

What's New

Hardware

Check out Sony's ultra-small notebook, new plasma monitors, network switches, an XML style editor, and a virtual operator.

PREVIEW

VAIO PCG-505
$2500

Enter HotBYTEs No. 1006.

Sony Electronics, Inc.
San Jose, CA
800-476-6972
941-768-7676
http://www.sony.com

The Little Notebook That Can

This year, Sony has emerged with what might be the ideal notebook size in its amazing new VAIO PCG-505, a full-featured notebook in a 0.95-inch-thick, 3-pound, 10- by 8-inch case.

The PCG-505's magnesium alloy case is remarkably durable, and inside Sony has squeezed a 133-MHz Pentium with MMX, 32 to 64 MB of EDO DRAM, a 10.4-inch SVGA TFT display, and a 1-GB hard drive. In February, 166- and 200-MHz MMX systems were introduced in Japan, so expect to see these faster CPUs when these machines become available in the U.S. later this year.

The PCG-505 has a good-size keyboard; it's large enough that I could easily touch-type, and it has all the interfaces of a full-size laptop. An IrDA port, a USB port, audio-in, a headphone jack, and a 33.6-Kbps data/14.4-Kbps fax modem are supplemented by a port replicator with serial and parallel ports, as well as monitor, keyboard, and mouse connectors. The ingeniously designed battery, which provides about 2 hours of power, doubles as a hinge so as to be unobtrusive. It comes with an external floppy drive; an external CD-ROM is available, but it requires AC power.

Using NeoMagic's MagicGraph 128ZV+ 128-bit accelerator with 1 MB of graphics RAM, the PCG-505 is able to run multimedia applications, although such applications tend to drain the battery quickly. Also, the system is limited to SVGA resolution.

The amazing VAIO PCG-505 notebook is tiny, but not cramped, and it has ample power. This system is a significant advancement for portable computing.

–Jason K. Krause

PHOTOGRAPH: STEVEN GREENBERG © 1998

Laptops

A Laptop for the Long Haul

COMPAQ'S ARMADA 4200 SERIES MIGHT have the same gray-colored case as the Armada 4100 Series, but it sports new internal components and features that are intended for high-endurance road work. The 4220T ($3999) is a 266-MHz Pentium MMX system that weighs a mere 5.2 pounds and is 1½ inches thick. It can sustain itself for 500 hours in suspend mode or for up to 10 hours during normal use. The system supports three batteries: one residing internally, another in the optional docking station, and another sitting on the back of the unit and doubling as a handle. The 4220T has a 3½-inch floppy drive; the 20X CD-ROM drive is located in the docking station.

Contact: Compaq Computer Corp., Houston, TX, 800-345-1518 or 713-370-0670; http://www.compaq.com.
Enter HotBYTEs No. 984.

Printers

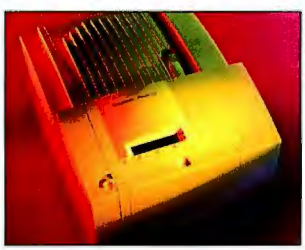
A Switch-Hitting Utility Printer

HEWLETT-PACKARD'S DESKJET 1120C ink-jet printer ($499) is built to handle almost any print job you can throw at it. It prints on paper measuring up to 11 by 17 inches and has three paper paths for printing on a variety of media, including greeting-card stock, transparencies, envelopes, labels, and plain paper. It has a maximum print speed of 6½ pages per minute for black text and 4½ ppm for color. The unit prints black text at a resolution of 600 dpi and comes with Hewlett-Packard's PhotoREt II software to control color printing on various paper stocks.

Contact: Hewlett-Packard Co., Palo Alto, CA, 800-752-0900 or 650-857-1501; http://www.hp.com.
Enter HotBYTEs No. 977.

Solid-Ink Printing

THE TEKTRONIX PHASER 360 SOLID-INK workgroup color printer offers 6-ppm color printing at 800-dpi resolution for $3695. It comes with a built-in 10Base-T Ethernet interface (upgradable to 100Base-T), a 100-MHz RISC processor, and a paper path that can handle most grades of paper.



Contact: Tektronix, Inc., Wilsonville, OR, 800-835-6100 or 503-682-7377; http://www.tek.com/color-printers.
Enter HotBYTEs No. 978.

CPU Upgrade

Add Power to a Mac

IF YOU'RE READY TO TOSS OUT AN OLD Power Mac, UMax, or Power Computing Mac OS–based computer, then consider installing one of Newer Technology's MAXpowr G3 processor-upgrade cards. The cost for a 275-MHz G3 CPU running a backside cache at a 1:1 ratio is $1999.

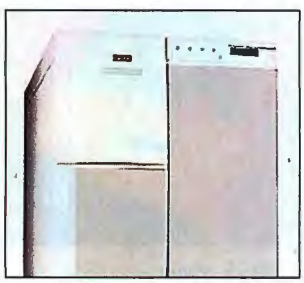
Contact: Newer Technology, Inc., Wichita, KS, 316-943-

0222; info@newertech.com; http://www.newertech.com.
Enter HotBYTEs No. 980.

Servers

Pentium Pro Servers from Digital

DIGITAL EQUIPMENT HAS REVAMPED ITS server offerings with Pentium Pro– and Alpha-based servers. The newest high-end Pentium Pro enterprise-class machines, the Digital Server 9000 series, come with up to eight 200-MHz CPUs with a 512-KB or 1-MB L2 cache per processor, 8 GB of memory, 14 PCI slots, three EISA slots, 218 MB of internal storage, and 10/100 PCI Fast Ethernet. The systems start at $18,719 for a configuration with four CPU slots and go to $29,999 for a unit capable of handling up to eight CPUs. All configurations come with Digital's Clusters for Windows NT and Microsoft Cluster Server software for fail-safe operation.



Contact: Digital Equipment Corp., Littleton, MA, 800-722-9332 or 978-493-5111; http://www.windows.digital.com.
Enter HotBYTEs No. 981.

Servers with a Future

INTERGRAPH'S INTERSERVE 8000 IS BUILT to be an enterprise-class workhorse for handling loads such as large databases, Internet and intranet applications, thin-client Citrix or Hydra applications, and messaging applications. It comes with up to four Pentium Pro processors and has an upgrade path for Pentium II Deschutes CPUs. The InterServe 8000 also has up to 1 TB of disk-storage capacity. The system, which

costs $10,400, has 13 expansion slots (nine PCI, three ISA, and one shared external I/O port) and fixed or hot-swappable power supplies, depending on your server-availability needs.
Contact: Intergraph Computer Systems, Huntsville, AL, 800-763-0242; http://www.intergraph.com/ics/interserve.
Enter HotBYTEs No. 982.

Join the Clustering Revolution

ALR JOINS THE CLUSTERING WAR WITH A two-server configuration based on a 200-MHz Pentium Pro, 6x6 rack-mounted Revolution systems with a Fibre Channel or SCSI data I/O subsystem, and up to 216 GB of shared data storage for fault-tolerant mission-critical server protection. Each server runs up to six 200-MHz CPUs on a shared RAID subsystem and has a hot-swappable power supply, hot-swappable hard drives, and optional redundant network-interface configurations. Prices start at $44,000.
Contact: Advanced Logic Research, Irvine, CA, 800-444-4257 or 714-581-6770; http://www.alr.com.
Enter HotBYTEs No. 983.

Add-Ins

3-D for the Mac

WITH 8 MB OF SGRAM, PCI CAPABILITIES, 1600- by 1200-pixel true-color support, and ATI's 3D Rage Pro graphics-accelerator technology, the Xclaim 3D graphics accelerator for the Power Mac gives Mac users realistic 3-D imaging for $219. It can render 1.2 million triangles per second, has a 4-KB texture cache, and offers perspective-correct texture mapping.
Contact: ATI Technologies, Inc., Thornhill, Ontario, Canada, 905-882-2600; http://www.atitech.com.
Enter HotBYTEs No. 986.

Systems

Pentium IIs Galore

DELL'S DIMENSION XPS DESKTOP SYSTEMS come with your choice of Intel's high-end Pentium II processors. Prices range from $1999 to $2979. The systems come with a 233-,

266-, 300-, or 333-MHz Pentium II processor. Other options include 9.1-GB hard drives, a 19-inch monitor, and 64 to 384 MB of ECC SDRAM or up to 128 MB of non-ECC SDRAM. Pentium II Deschutes processors will be an option when they are available.
Contact: Dell Computer Corp., Round Rock, TX, 512-310-9776; http://www.dell.com.
Enter HotBYTEs No. 985.

Monitors

Bigger, Brighter, and Unobtrusive

THE FUJITSU PLASMAVISION 42 TV DISplay/computer monitor is probably the biggest, brightest, most versatile screen on the market, yet it's highly unobtrusive. The whole unit is only 6 inches thick, but it has a 36.2-inch-wide, 20.4-inch-high, 160-degree viewing area. The display has an 852- by 480-pixel native resolution; can display input from analog RGB, composite video, S-video, and component video (NTSC, PAL, and SECAM); and will be compatible with digital TV signals. The latest release, which costs $10,999, has a 400:1 contrast ratio and four algorithms that resize images to fit the wide screen while minimizing distortion. It also has an optional PC Card viewer for inputting data without a PC.
Contact: Fujitsu General America, Inc., Fairfield, NJ, 888-888-3424 or 973-575-0380; http://www.plasmavision.com.
Enter HotBYTEs No. 1050.

Modems

HDSL and Fiber-Optic Modems

HIGH-BIT-RATE DIGITAL SUBSCRIBER LINE (HDSL) provides full-duplex T1 (1.544 Mbps) or E1 (2.048 Mbps) data transmission across existing twisted-pair copper wiring without repeaters. RAD Data Communications' HCD-E1 HDSL modem ($3308) has a transmission range of 4½ miles over copper wires at rates up to E1. Another modem from RAD, the FOMi-40 ($1200), extends a LAN as far as 31 miles with data transfer rates of 56 to 2048 Kbps with SMNP management over fiber-optic links.
Contact: RAD Data Communications, Mahwah, NJ, 201-529-1100; market@radusa.com; http://www.rad.com.
Enter HotBYTEs No. 988.

Log On from Anywhere

THE XIRCOM GSM/PCS 1900 CONNECtion Kit ($129) uses the emerging PCS 1900 digital cellular standard to give mobile laptop systems wireless digital access for e-mail, remote access, or Internet services over 56K

PC Card modems. Users connect through a digital cellular handset and are able to send or receive files at 9600 bps through their cellular service provider (as long as the provider supports PCS 1900). The unit comes with bundled software for relaying and receiving up-to-160-character Short Message Service messages.
Contact: Xircom, Inc., Thousand Oaks, CA, 800-438-4526 or 805-376-9300; http://www.xircom.com.
Enter HotBYTEs No. 989.

Networking

New Cisco Switches and Hubs

THE CISCO 1548 MICRO SWITCH 10/100 and the 1528 Micro Hub 10/100 are designed to work with the Cisco 1600 series of routers and the 1500 series of Ethernet Micro Hubs. They are intended for use in building a high-performance LAN in a small- or branch-office environment. These stackable units promise secure Internet access via the Cisco IOS firewall feature set or through the Cisco Centri firewall for Windows NT, which is available in a 50-user configuration for smaller businesses. The Cisco 1548 Micro Switch 10/100 and 1528 Micro Hub 10/100 cost $1295 and $645, respectively.
Contact: Cisco Systems, Inc., San Jose, CA, 800-553-6387 or 408-526-4000; http://www.cisco.com.
Enter HotBYTEs No. 987.

Network Switches

IntelligeNT Network Switches

WHAT DO YOU GET WHEN YOU EMBED WINDOWS NT into a switching platform? A switch that's aware of the applications flowing through its network and that can address their needs on an independent basis. Berkeley Networks claims its exponeNT Windows NT–integrated net-

work-switch platform can process up to 70 million packets per second with 48 Gbps of network I/O capacity. This gives the system independent scaling of control and data processing and provides a single, extensible network OS with the integrated routing, bridging, IP addressing, and other services necessary to control and smoothly direct network applications. An entry-level system with 48 Fast Ethernet ports costs $40,000.
Contact: Berkeley Networks, San Jose, CA, 408-325-0330; http://www.berkeleynet.com.
Enter HotBYTEs No. 979.

Backup

Backup for Workstations and Servers

THE AIWA TD-8001 TRAVAN NS 8 TAPE drive ($399) gives workstations or entry-level server applications 8 GB of backup protection and pro-

vides a read-while-write feature that ensures data integrity while data is being written. It has a SCSI connection and is available in externally or internally mounted form factors. The TD-20001 Travan NS 20 ($549) is a tape backup unit for PC servers with 20 GB of storage capacity, a Fast SCSI-2 connection, and 25-MBps transfer rates.
Contact: Aiwa America, Inc., Irvine, CA, 714-862-0200; http://www.aiwa.com.
Enter HotBYTEs No. 990.

SOFTWARE

Authoring

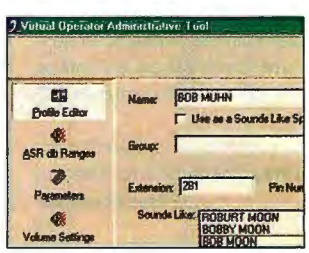
XML Style Sheets Have Arrived

WITH THE RECENT BLESSING OF THE WORLD Wide Web Consortium, the Extensible Markup Language (XML) is quickly becoming a Web standard. ArborText's XML Styler is an XML style-sheet editor that supports Internet Explorer 4.0 and XML. Created by ArborText, Inso, and Microsoft in conjunction with XML specifications, this package allows for existing documents to be translated on the fly into XML. In addition, it creates and modifies Extensible Style Language (XSL) style sheets and documents with a GUI, without requiring an understanding of XML syntax or structure. XML Styler runs under Windows 95 and NT and is available for free downloading from http://www.arbortext.com/xmlstyler/.
Contact: ArborText, Inc., Ann Arbor, MI, 313-997-0200; info@arbortext.com; http://www.arbortext.com.
Enter HotBYTEs No. 1094.

Telephony

An Operator Who Really Listens

IF YOUR AUTO-ATTENDANT VOICE-MAIL SYSTEM seems inefficient and impersonal, consider the Virtual Operator. It answers telephone calls, understands spoken commands and requests from callers, and directs calls accordingly. Callers don't need to know anyone's extension or spell out a name with their telephone keypad because the Virtual Operator identifies spoken requests for

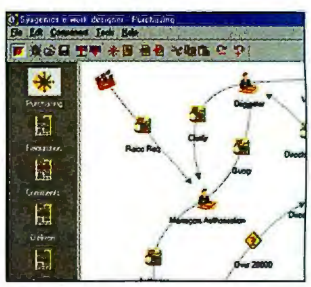


up to 500 specific names or departments—even nicknames and alternate pronunciations. The program, which is based on Lernout and Hauspie's voice-recognition technology, can answer 12 calls simultaneously and runs on Windows NT. Prices start at $13,000 for a four-port system.
Contact: Registry Magic, Boca Raton, FL, 888-762-4428 or 561-367-0408; http://www.registrymagic.com.
Enter HotBYTEs No. 992.

Work Flow

A Worker's Work Flow

SYSGENICS' EWORK IS A WORK-FLOW APplication designed for nontechnical workers. Priced at $199 per seat,



ework has an Integration Wizard that merges applications such as Word, Excel, and e-mail and database programs into ework so that you can use documents from those programs within the ework interface. Reports can be generated by ework or through third-party ODBC-compliant applications.
Contact: Sysgenics, Ltd., London, U.K., +44 181 296 9091; enquiries@sysgenics.com; http://www.sysgenics.com.
Enter HotBYTEs No. 993.

Multimedia

Bridging the Director and Photoshop Gap

MEDIA LAB HAS INTRODUCED TWO PRODucts to make Adobe Photoshop more complementary to Macromedia's Director. PhotoCaster ($199) makes it possible to import Photo-

shop files directly into Director, layer by layer, with each layer appearing as an individual cast member, antialiased, and properly registered with transparencies preserved. AlphaMania ($299) is an add-on for Director that eliminates "jaggies" in Director and is especially useful for importing PICT, TGA, and Photoshop files.
Contact: Media Lab, Inc., Louisville, CO, 800-282-5361 or 303-499-5411; xtra-sales@medialab.com; http://www.medialab.com.
Enter HotBYTEs No. 994.

Trinity
$4995

Enter HotBYTEs No. 1005.

Play, Inc.
Rancho Cordova, CA
916-851-0800
http://www.play.com

Play's Trinity: Does It Meet the Promise?

Trinity, a desktop unit that combines a video switcher, a chroma-key/matte, a special-effects generator, 2-D paint, and a text creator, has been eagerly awaited as a harbinger of computer and TV convergence. Priced at just $4995, and including features that previously cost tens or hundreds of thousands of dollars, it promises to send shock waves through the video-production field.

Trinity is a rack-mountable box with a host PCI interface. A Windows 95/NT PC acts as a control system, while all video processing is done by Trinity itself. Because the package is Windows compatible, all programs have a consistent look and feel. I used the package to successfully integrate video from a camera, two tape machines, and software and then save it to another Beta SP tape deck in real time, with full resolution and few discernible video glitches.

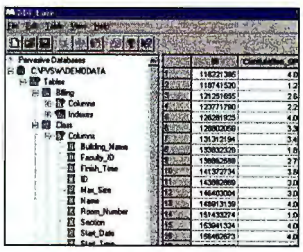
All images are manipulated in full Serial Digital (D-1) quality, the maximum possible in broadcast video. Video I/O (up to eight channels) is handled by add-in cards and fed through a dual-channel time-base corrector. For playback, you can choose from composite/S-Video (consumer), component analog (news-quality), or D-1. In addition, 1394/FireWire I/O is promised for a future release. The bundled software includes a video switcher, a character generator, a full-resolution title maker, a relatively simple 3-D image creator, a chroma-key tool, and "Panimation," which combines 2-D paint, animation, and compositing.

Without question, Trinity will send a magnitude-8 tembler through the world of broadcast TV. It lowers the price barriers for a host of image-editing functions. **–Alex Pournelle**

Databases

Mo' Better Processing and Querying

DO YOU WANT YOUR DATABASE TO HAVE the speed of transactional processing or the complex querying capabilities of relational processing? Pervasive.SQL ($995 for 10 users) promises both. This embedded ODBC-compliant software installs in less than 2 MB on Windows NT, 95, 3.x, and NetWare clients, offering client/server applications transactional and relational



database access, depending on the functionality you demand.
Contact: Pervasive Software, Inc., Austin, TX, 800-287-4383 or 512-794-1719; info@pervasive.com; http://www.pervasive.com.
Enter HotBYTEs No. 996.

Intranet

A Web of Productivity Applications

E:FOLDERS ($4995) IS A SUITE OF 12 intranet applications for scheduling, messaging, tracking, searching, archiving, and other collaborative functions. The package is optimized for Microsoft and Netscape Web servers and relational databases from Microsoft, Oracle, and Sybase, and it can be accessed through a browser. The e:Folders

suite can perform on 14.4-Kbps and faster dial-up connections, and it supports any TCP/IP WAN/LAN environment.
Contact: IntraBlocks, Deerfield, IL, 888-773-1133; fax: 847-940-1132; http://www.intrablocks.com.
Enter HotBYTEs No. 995.

Streamline Supply Purchasing and Save Money

ONE THING SURE TO DRIVE A PURCHASING manager crazy, especially in a big company, is employees who buy supplies through unapproved suppliers and without taking advantage of discounts negotiated by the company. Requisite Technology's Re:Quest for Buyers, an electronic business-to-business solution, can help you reduce those headaches. Re:Quest provides a universal catalog of products that are offered by your company's preferred suppliers. Instead of digging through catalogs or making phone inquiries, employees look through electronic catalogs using a Web browser, fill an electronic shopping cart with desired products, and order them with a mouse-click. Requisite Technology works with your company to design the product and consult on integrating it with other systems. Prices vary, depending on the number of employees and the product categories selected, but they range from $250,000 to $1 million per year.
Contact: Requisite Technology, Inc., Boulder, CO, 303-546-0610; info@requisite.com; http://www.requisite.com.
Enter HotBYTEs No. 1095.

Web-Enable Database Apps with Ease

WALL DATA'S CYBERPRISE DBAPP PROgrams let you create intranet-ready database applications for Microsoft's Internet Information Server (IIS) with little or no programming. Cyberprise DBApp Developer's ($2500) tools, for creating Internet and intranet database applications, include Wall Data's Semantic Ob-

ject Modeling (SOM) technology, for modeling, creating, changing, reengineering, and migrating databases; Semantic Templates, which provide predefined page-layout templates used by Cyberprise DBApp Publisher to generate the HTML code; and Page Generator, which uses the Semantic Templates and the Semantic View of the database model and generates Active Server Pages (ASPs). Cyberprise DBApp Publisher ($200 per concurrent user) is a set of ActiveX/COM components that are installed on Microsoft's IIS. DBApp Publisher permits users to interact with applications and allows full create, read, update, and delete capabilities against a database, using a Web browser.
Contact: Wall Data, Inc., Kirkland, WA, 800-915-9255 or 650-812-1600; http://www.cyberprise.com.
Enter HotBYTEs No. 1096.

Imaging

Professional Photo Effects

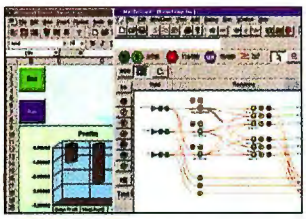
PHOTO-IMAGING TOOLS ON THE PC GIVE home users powers that only professionals once had. Professor Franklin's Instant Photo Effects

($49.95) lets you selectively blur or enhance parts of an image, control lighting, create the effect of a photographic filter, turn color pictures into high-contrast two-color or black-and-white images, artificially age a picture, and make an image look like a mural or jigsaw puzzle.
Contact: Streetwise Software, Santa Monica, CA, 310-829-7827; info@swsoftware.com; http://www.swsoftware.com.
Enter HotBYTEs No. 998.

Business

Make Your PC Think for You

CAN YOUR COMPUTER MAKE BETTER BUSINESS decisions than you can? MindWizard ($149) graphically captures,



displays, interprets, and performs reasoning functions on corporate data to help users make real-world business decisions. Its processes are designed after the actions in a neuron. Through the point-and-click interface, users can ask it what-if questions or ask it to forecast the outcome of various scenarios and propositions. MindWizard works with OLE-compliant data and runs on any 486-based or faster PC with 16 MB of RAM.
Contact: Richter Paradigm Corp., San Jose, CA, 888-366-4269 or 408-278-0360; rpc@neuronetics.com; http://www.mindwizard.com.
Enter HotBYTEs No. 999.

Presentation

Standout Presentations

IF YOU'VE NOTICED THAT MULTIMEDIA PRESENTATIONS, especially those created with Microsoft's PowerPoint, all look the same, Visual Thunder offers over 400 slide templates and 700 graphical elements for PowerPoint 7.0 or 8.0 to help set your demos apart from the rest. The package, which costs $89.95, includes clip art, interactive buttons, sound elements, stylized headers, tiles, and new font styles.
Contact: Muddy Shoes Software, LLC, Barrington, IL, 847-381-3695; http://www.muddyshoes.com.
Enter HotBYTEs No. 1000.

Software Updates

Attachmate's **Remote LAN Node (RLN) 5.0** remote-access software is more secure and more versatile than previous releases, thanks to support for more authentication and networking protocols. New capabilities include integrated ISDN B-2 support, multilink Point-to-Point Protocol (PPP) support, IP/IPX Windows 95 and NT dial-out, and TACAS support, which is similar to Radius authentication. Radius will be available with future releases. RLN 5.0 works with third-party firewalls and has dial-back two-factor authentication, support for third-party security, and Challenge Handshake Authentication Protocol (CHAP) security measures built in. Prices start at $595 for the basic software and run up to $15,995 for support for 64 server ports. Connections can be made over Token Ring, Ethernet, IP, IPX, NetBEUI, 802.2, and Vines network-communication protocols.
Contact: Attachmate Corp., Bellevue, WA, 800-426-6283 or 425-644-4010; http://www.attachmate.com.
Enter HotBYTEs No. 1001.

If you're afraid that a distributed SAP R/3 enterprise system is too complex to handle, look to the new **SAP Business Workflow 4.0**, which is included in the price of deploying R/3. It provides unlimited global access to all SAP Workflow forms, automatically generates HTML forms, and integrates with Microsoft Exchange, Outlook, and any MAPI client. A Workflow Wizard expedites creating and changing business forms to simplify the work-flow process.
Contact: SAP America, Inc., Wayne, PA, 610-725-4500; http://www.sap.com.
Enter HotBYTEs No. 1002.

LANtegrity 4.0 for NetWare is a server software package that promises real-time, byte-level, data-protection safeguards for databases and applications. Data protection is provided by capturing only the bytes that are modified on a server, which means that administrators don't have to rebuild their databases during recovery operations. The latest release can be set to limit the impact on system performance, verify which protected server(s) has failed, and protect servers running SMP. Pricing for the LANtegrity 4.0 server software is $6995, including a 100-user license.
Contact: Network Integrity, Marlborough, MA, 800-638-5518 or 508-460-6670; info@netint.com; http://www.netint.com.
Enter HotBYTEs No. 1003.

The fourth generation of Symantec's Café product family, **Visual Café for Java Macintosh**, comes in two flavors, a Professional Development Edition and a Database Development Edition for Java applet and application development. Both support Apple's MacOS Runtime for Java (MRJ 2.0) and offer support for JDK 1.1 and JavaBeans. The Database Development Edition ($499.95) is integrated with the Claris FileMaker Pro and the BlueWorld Lasso middleware products. The Professional Development Edition ($299.95) provides templates, JavaBean components, and basic database tools. It includes over 100 reusable JavaBeans components and automatically saves new classes for reuse.
Contact: Symantec Corp., Cupertino, CA, 800-441-7234 or 541-334-6054; http://www.symantec.com.
Enter HotBYTEs No. 1004.

improbable

Advances and Retreats in Computing

An unlikely new use for toothpaste and a call for Ugly Techno Building photos.

Quality Problems

A qualified "Thank you" goes to the many readers who donated crates of surplus quality. We had offered to send the quality to third-world high-tech manufacturing enterprises, which typically can't afford to buy the premium quality manufactured in the U.S. and Canada. It is our unhappy lot to report that much of the quality we received is stale. It either outlived its expiration date or was previously opened and spoiled by careless human resource departments.

As to the remaining items—the good-quality quality—an accident at our Midwest warehouse resulted in the crushing of nearly all of it. The quality is still recoverable, though, because we protected it using compression. It's the compression, not the crushing, that is the problem. The compression was done using modified RSA-style encryption, which the U.S. government has declared illegal for export.

So here is our dilemma. We now have more than 23 tons of compressed, crushed, good-quality quality. We are forbidden to send it out of the country. And it is unsalable in the U.S. because the quality is in unpopular colors and styles. Please e-mail suggestions to marca@improb.com.

Makes You Tingle All Over

What does toothpaste have to do with computers? Ask the 62,000 or so people who took the seminar "Clean, Bright Computing," given by Dennis Kafforey, Ph.D., of the Dennis Kafforey Paradigm Collective. Kafforey's book, *Clean, Bright Computing* (Kafforey Press, 1997, $24.95), has been quietly, but intensively, marketed to corporations, as have his seminars.

Kafforey's main message is that clean, shiny computers make for efficient organizations. He recommends injecting toothpaste (two tubes minimum) into the main cavity of every computer, being sure to drizzle it onto the motherboard.

Who's buying this? Almost exclusively, it's training departments. Despite the resulting repair bills–in one case more than $3.2 million–training departments continue to snap up Kafforey's rap.

Most of these seminars and books are for newly hired employees. Experienced employees are never made to take the seminars. Apparently, they already know the value of clean, bright management theories.

UGLY, UGLY

Announcing the First Annual Ugly Techno Building Contest! If you survey the vast number of buildings that house technology companies, departments, and organizations, you'll see that not all of them are beautiful. Some are triumphantly ugly. Help us find the ugliest techno building of them all. We will choose winners in two categories:

- ☛ Ugliest techno building completed this year
- ☛ Ugliest techno building of all time

Please send in one or more photographs, accompanied by a brief description of the building. All photos become the property of the Ugly Techno Building Contest Committee and will not be returned. Put your entry in a pretty envelope and mail it to:

Ugly Techno Building Contest
c/o Improbable
c/o BYTE, 29 Hartwell Ave.
Lexington, MA 02173

First Prize winner will get a letter of introduction from us to the building manager. Second Prize winner will get a letter of introduction to the First Prize winner.

Marc Abrahams is the editor of the Annals of Improbable Research. *You can contact him by sending e-mail to* **marca@improb.com.**

OUR INSPIRON NOTEBOOK HAS THE FASTEST MOBILE INTEL PROCESSOR ON EARTH.

(FOR ANYTHING FASTER, YOU'LL HAVE TO LOOK ELSEWHERE.)

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- • 512KB L2 Pipeline Burst Cache
- ★ **4GB Ultra ATA Hard Drive**
- • Modular Bay accepts 24X Max^AA Variable CD-ROM, 3.5" Floppy Drive (both included) or Optional 2nd Li-Ion Battery
- • 128-bit Graphics Accelerator with 65K Colors at 1024x768
- • Zoom Video and USB Ports
- ★ **Stereo Speakers with 3D Surround Sound and Yamaha SW Wavetable**
- • Smart Lithium Ion Battery
- • Cardbus Ready/Fast IR1.1
- ★ **MS® Office 97 Small Business Edition**
- • MS Windows® 95 and Internet Explorer
- ★ **6.9 Pounds*/Touchpad**
- • Extendable 1 Year Limited Warranty†
- ★ *Upgrade to 96MB SDRAM, add $199.*
- ★ *56K Capable** x2 Modem, add $149.*
- ★ *2nd Smart Lithium Ion Battery, add $169.*
- ★ *Leather Carrying Case, add $99.*
- ★ *Inspiron Port Replicator, add $159.*

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Business Lease◊: $109/Mo., 36 Mos.
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THE DELL INSPIRON 3000 NOTEBOOK–NOW EQUIPPED WITH A 266MHz PENTIUM PROCESSOR WITH MMX TECHNOLOGY.

When work needs to leave the office, don't let your computer slow you down. Dell introduces the new Inspiron™ 3000 notebook with a 266MHz Pentium® processor with MMX™ technology. This notebook really knows how to fly. And it comes loaded with features such as a 13.3" XGA Active Matrix display. SDRAM, the fastest mainstream memory. And 3D Surround Sound. With the Dell® Inspiron 3000 M266XT, applications now run faster, which means you and your employees will, too. For more information, give us a call or stop by our website. Such high performance in a notebook may seem out of this world, but fortunately it's at a price that's very down to earth.

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DELL DIMENSION® DESKTOPS FOR BUSINESS

Common features: ◆ Mini-Tower Model ◆ 512KB Integrated L2 Cache ◆ 3.5" Floppy Disk Drive ◆ Two USB Ports ◆ MS® Office 97 Small Business Edition plus Bookshelf 98 ◆ McAfee VirusScan ◆ MS Windows® 95 ◆ MS Internet Explorer ◆ Dell® Quietkey® Keyboard ◆ MS IntelliMouse® ◆ 3 Year Limited Warranty† with 1 Year On-site^ Service ◆ Lifetime Toll-free Hardware Phone Support **Upgrades:** ◆ HP® DeskJet® 722C, add $299 ◆ HP LaserJet® 6Lse, add $429 ◆ APC Back-UPS Pro 650 PnP, add $289

NEW DELL DIMENSION® XPS D333
333MHz PENTIUM® II PROCESSOR
FEATURING MMX™ TECHNOLOGY

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- 128MB SDRAM Memory
- 8.4GB Ultra ATA Hard Drive (9.5ms)
- 1600HS 21" (19.8" 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-90 Speakers
- Iomega Zip 100MB Internal Drive

$3399

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DELL DIMENSION XPS D300
300MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 64MB SDRAM Memory
- 8.4GB 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 Sound Card
- Altec Lansing ACS-90 Speakers
- Iomega Zip 100MB Internal Drive

★ *Upgrade to 128MB SDRAM, add $199.*

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DELL DIMENSION XPS D266
266MHz 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
- STB nVidia 4MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- *NEW* Turtle Beach Montego A3D 64 Voice Sound Card
- Altec Lansing ACS-90 Speakers
- 3Com® 3C905 Fast EtherLink™ XL 10/100 PCI Card

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DELL DIMENSION XPS D233
233MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 32MB SDRAM Memory
- 4.3GB Ultra ATA Hard Drive (9.5ms)
- 800HS 15" (14.0" v.i.s., .26dp) Trinitron Monitor
- STB nVidia 4MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive

★ *Upgrade to 64MB SDRAM, add $99.*

★ *Upgrade to a 1000LS 17" (15.9" v.i.s.) Monitor, add $79.*

★ *Upgrade to a 3Com 3C905 Fast EtherLink XL 10/100 PCI Card, add $79.*

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MEGAHERTZ AND MEGABY

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Common features: ◆ Mini-Tower Model ◆ 512KB Integrated L2 Cache ◆ 56K Capable** U.S. Robotics x2 WinModem ◆ 3.5" Floppy Disk Drive ◆ Two USB Ports ◆ MS Home Essentials 98 with Money 98 ◆ McAfee VirusScan ◆ MS Windows 95 ◆ MS Internet Explorer ◆ MS IntelliMouse ◆ 3 Year Limited Warranty† with 1 Year On-site^ Service
Upgrades: ◆ 3 Years On-site^ Service, add $99 ◆ HP ScanJet 5100Cse Scanner, add $299 ◆ MS Sidewinder Pro, add $69 ◆ Riven (the sequel to Myst), add $59

NEW 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)
- *NEW* 1600HS 21" (19.8" v.i.s., .26dp) Trinitron Monitor
- Diamond 8MB 3D AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- Integrated Yamaha Wavetable Sound
- *NEW* Altec Lansing ACS-495 Full Dolby Surround Sound Speakers with Subwoofer
- Dell Quietkey Keyboard

$3499

Personal Lease°: $169/Mo., 24 Mos.[Ω]
Order Code #500304

DELL DIMENSION XPS D300
300MHz PENTIUM II PROCESSOR
FEATURING MMX TECHNOLOGY

Common features listed above plus:
- 128MB SDRAM Memory
- 6.4GB Ultra ATA Hard Drive (9.5ms)
- 1200HS 19" (17.9" v.i.s., .26dp) Monitor
- STB nVidia 4MB AGP Video Card
- 2X DVD-ROM Drive and Decoder Card
- *NEW* Turtle Beach Montego A3D 64 Voice Sound Card
- Altec Lansing ACS-295 Speakers with Subwoofer
- Dell Quietkey Keyboard

★ *Upgrade to an 8.4GB Ultra ATA Hard Drive, add $49.*

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Personal Lease°: $145/Mo., 24 Mos.
Order Code #500303

DELL DIMENSION XPS D266
266MHz 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.) Trinitron Monitor
- STB nVidia 4MB 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 Comfort Key Keyboard

$2399

Personal Lease°: $117/Mo., 24 Mos.
Order Code #500302

DELL DIMENSION XPS D233
233MHz PENTIUM II PROCESSOR
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 AGP Video Card
- 32X Max^ Variable CD-ROM Drive
- Integrated Yamaha Wavetable Sound
- Altec Lansing ACS-90 Speakers
- Dell Quietkey Keyboard

★ *Upgrade to a 6.4GB Ultra ATA Hard Drive, add $49.*

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Personal Lease°: $93/Mo., 24 Mos.
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These are just a few of the tho

MMX™ intel inside pentium® II processor

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DUAL PROCESSOR/RAID CAPABLE
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Common features listed above plus:
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- 6 Expansion Slots: 3 PCI/3 EISA
- 6 Drive Bays: 3 External 5.25"/ 3 Internal 3.5"
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DELL INSPIRON 3000 M266XT
266MHz PENTIUM PROCESSOR
WITH MMX TECHNOLOGY

Common features listed above plus:
- 13.3" XGA Active Matrix TFT Display
- 144MB SDRAM Memory
- 4GB Ultra ATA Hard Drive
- 128-bit Graphics Accelerator with 65K Colors at 1024x768
- 56K Capable[π] K-Flex Modem
- Leather Carrying Case
- MS Office 97 Small Business Edition
- 6.9 Pounds*

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★ *2nd Smart Lithium Ion Battery, add $169.*

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DELL INSPIRON 3000 M266XT
266MHz PENTIUM PROCESSOR
WITH MMX TECHNOLOGY

Common features listed above plus:
- 13.3" XGA Active Matrix TFT Display
- 64MB SDRAM Memory
- 3.2GB ATA Hard Drive
- 128-bit Graphics Accelerator with 65K Colors at 1024x768
- Leather Carrying Case
- MS Office 97 Small Business Edition
- 6.9 Pounds*

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★ *Upgrade to a 4GB Ultra ATA Hard Drive, add $99.*

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DELL INSPIRON 3000 M233ST
233MHz PENTIUM PROCESSOR
WITH MMX TECHNOLOGY

Common features listed above plus:
- 12.1" SVGA Active Matrix TFT Display
- 48MB SDRAM Memory
- 3.2GB ATA Hard Drive
- 128-bit Graphics Accelerator with 16 Million Colors at 800x600
- MS Office 97 Small Business Edition
- 6.4 Pounds*

★ *Upgrade to a 13.3" XGA Active Matrix TFT Display, add $200.*
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★ *2nd Smart Lithium Ion Battery, add $169.*

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WITH MMX TECHNOLOGY

Common features listed above plus:
- 12.1" SVGA Active Matrix TFT Display
- 32MB SDRAM Memory
- 3.2GB ATA Hard Drive
- 128-bit Graphics Accelerator with 16 Million Colors at 800x600
- MS Office 97 Small Business Edition
- 6.4 Pounds*

★ *Upgrade to a 233MHz Pentium Processor, add $200.*
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WHY 1998 PROMISES TO GO EVEN FASTER THAN 1997.

***NEW* DELL DIMENSION® XPS D333**
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- Mini-Tower Model
- ★ **64MB SDRAM Memory**
- 512KB Integrated L2 Cache
- ★ **6.4GB Ultra ATA Hard Drive (9.5ms)**
- ★ **1200HS 19" (17.9" v.i.s.) Monitor**
- ★ ***NEW* Diamond Permedia 2 8MB 3D AGP Video Card**
- 32X Max^ Variable CD-ROM Drive
- Microsoft® Office 97 Small Business Edition Plus Bookshelf 98; McAfee VirusScan
- Microsoft Windows® 95 and Internet Explorer
- Dell® Quietkey® Keyboard
- Microsoft IntelliMouse®
- 3 Year Limited Warranty[1] with 1 Year On-site[Δ] Service
- ★ ***Upgrade to Integrated Yamaha Wavetable Sound and Altec Lansing ACS-90 Speakers, add $89.***
- ★ *Upgrade to 128MB SDRAM, add $199.*
- ★ *Upgrade to an 8.4GB Ultra ATA Hard Drive, add $49.*

$2499

Business Lease[◊]: $91/Mo., 36 Mos.
Order Code #590309

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Prepare to go roaring into 1998 with more PC processing power than you've ever had before. The Dell Dimension® XPS D333 features the latest Pentium® II processor from Intel, the 333MHz. The XPS D333 contains new components especially selected to harness the additional power. Like the new Diamond Permedia 2 8MB 3D AGP Video Card, which takes advantage of the high-end Accelerated Graphics Port to render 3D and 2D video with amazing speed and clarity. A 19" (17.9" v.i.s.) high-resolution monitor. And our optional 8.4GB Ultra ATA hard drive, ideal for storing and retrieving massive graphics and data files. So if your New Year's resolution was to work faster and smarter, then pick up the phone and give us a call. Or visit our website. And leave 1997 behind in a blur.

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