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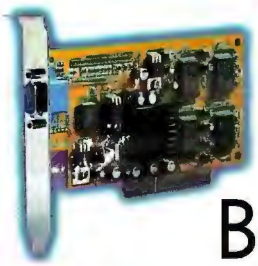

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BUILDING NETWORK APPLICATIONS

WEAVING a BETTER WEB

58

By Scott Mace, Udo Flohr, Rick Dobson, and Tony Graham

The Web is falling apart due to HTML's lack of essential features. But help is on the way.

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HSM moves little-used data where it belongs: elsewhere.

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A practical look at the giant's strategy.

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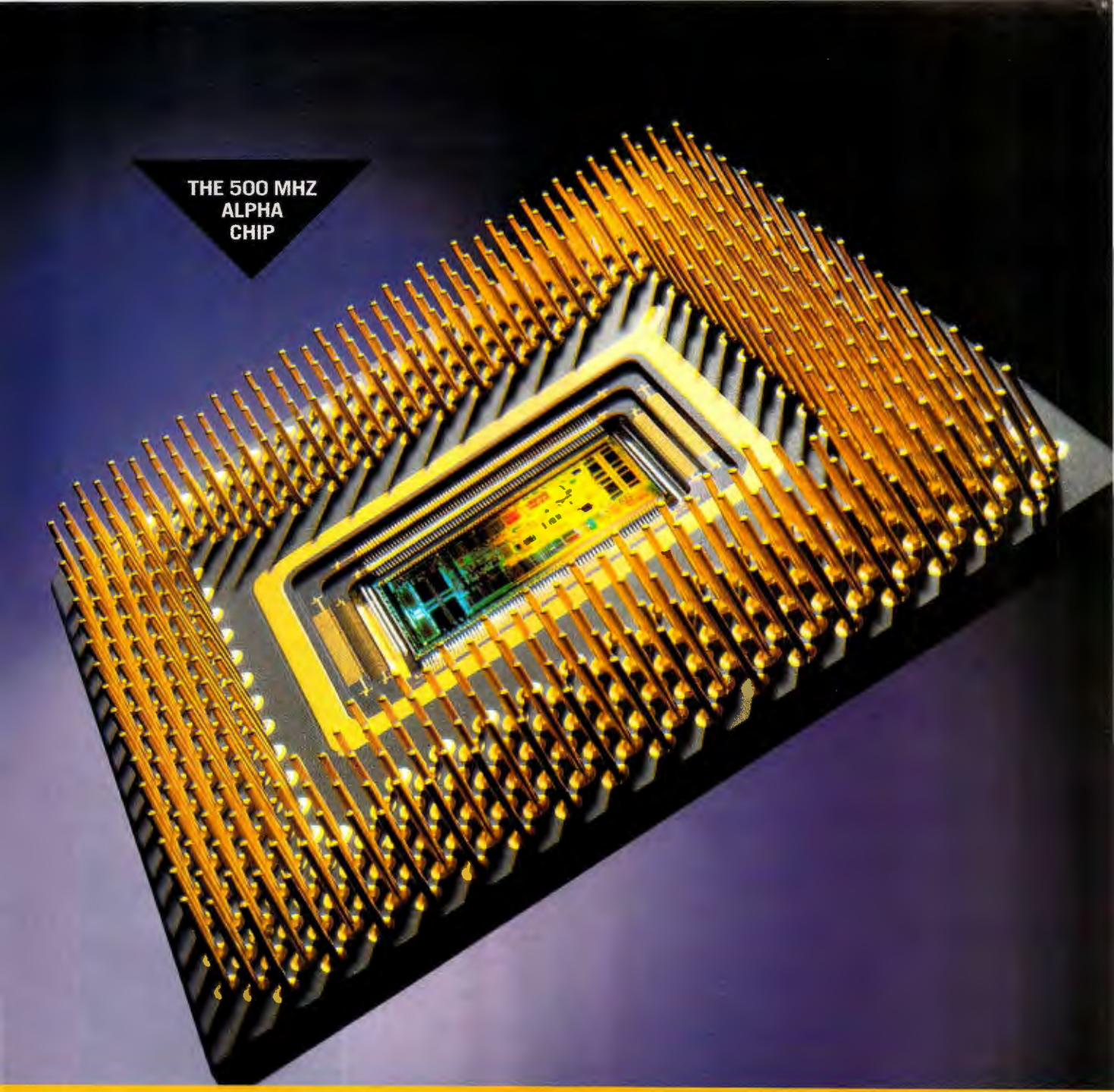

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Uncommon Sense

Why the industry's current mania to divide up the world into proprietary camps won't work.

I want to congratulate BYTE readers for their common sense, a quality that's uncommon in today's computer industry. A recent survey by our research department shows that BYTE readers are more in touch with reality than most computer-industry executives when it comes to the Sun/Microsoft war.

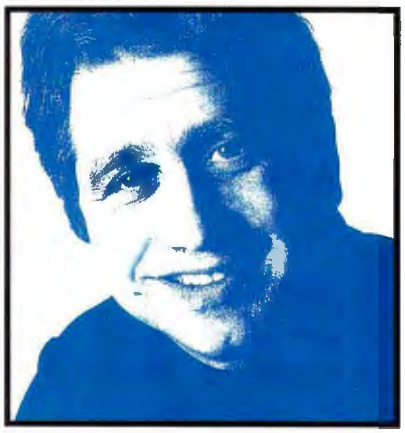
I've had a lot of back and forth with many of you on Java since I issued a call for standards. I've agreed with some that we should be careful to do this so the technology is not squelched. I also agree that Microsoft has not always been a good citizen in this market, but I stubbornly cling to the notion that Microsoft is not the greatest danger to Java. In the long run, the most likely outcome is that a major Java company will disagree with Sun, take its bat and ball, and go home. That's true even if Sun maintains its relatively high-minded approach. So, ultimately, the Java community needs its own way of resolving disputes.

BYTE set out to systematically discover what the first wave of Java evaluators thinks about the technology. You can read the full results on page 26. Nearly 300 people gave us their opinions about a wide range of issues, and we learned a lot about what these hardy pioneers think.

Judging from the survey, dreams of total control by one software company are foolish, at least for the late 1990s. Get over it, Bill. And you, too, Scott, Larry, and whoever else suffers from this malady.

The Java pioneers who answered our survey are among the best and brightest in computing. They must like what Sun has done—they overwhelmingly consider Java open—yet they want the technology turned over to a standards body. Here's a surprise: Two-thirds are doing their Java development principally on Windows NT, and they're going for multiplatform deployment. How can that be? The truth is that no one vendor has a solution for modern, large-scale computing.

Microsoft, for example, has a lot to prove about scale and scope before it can substitute for Unix across the board—it has its plate full just keeping Windows 95/98 from imploding under its own weight. Unix/Linux on the desktop, outside of technical computing, is not a solution for many people. Commercial Unixes are still much pricier than NT for servers, although for many they're a better value. Yet increasing numbers of NT server applications are driving down the cost of deployment. Java, in terms of reliability and applications support, is where Windows was 10 years ago. Yesterday's contenders—the Mac and OS/2—are still serviceable, but are they a more broad-based platform than Windows?



No one vendor has a solution for modern, large-scale computing.

Messy, isn't it? Diversity is the name of the game. Making diversity easier—not limiting it—should be the goal of all serious players for the foreseeable future.

That's why I'm glad that Sequent and Digital Equipment are cooperating to build a 64-bit Unix for Merced. It's worth pointing out that Sequent did more to get symmetric multiprocessing (SMP) up and running on the Intel platform than either Intel or Microsoft. Add to that Digital's background in 64-bit Unix on Alpha and in clustering, and you have a lot of know-how. They deserve Intel's support. In a strange way, they also deserve Microsoft's support; if you're buying a big SMP server to run 64-bit Unix, it's nice to know that it could also run 64-bit NT when that becomes available. That's a much better scenario than choosing between NT on a bitty box and Unix on a monster box.

Digital's alliances with Sequent and Intel suggest that the folks in Maynard have figured out that Digital is a computer company, not an Alpha company. Microsoft, which used to be exemplary in understanding it was a software company, seems to have regressed to a Windows company. Remember when IBM was an MVS-SNA-OS/2-PS/2 company? That was just before billions of dollars of red ink flooded Armonk. If it could happen to IBM, it could happen to anyone.

BYTE readers have spoken. Ultimately, I expect you'll hold the industry's feet to the fire: Make life in a mixed environment easier, or hit the road. And don't say we didn't warn you.

Mark Schlack

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

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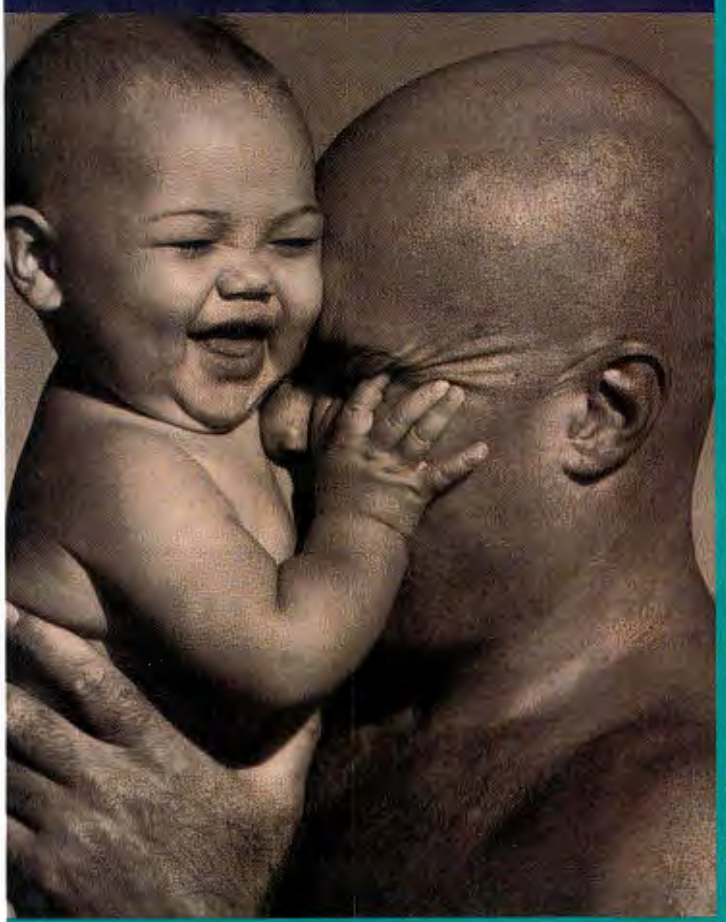

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inbox

Beyond the 32-Bit Operating System

I read "Beyond Pentium II" (December Cover Story) with great interest. I wonder what corresponding "radical" changes the IA-64 architecture means for operating systems, especially Microsoft Windows? Given the time frame and sponsorship, the introduction of IA-64 will have to coincide with a new OS, perhaps even one fundamentally rethought! Undoubtedly, the view from Redmond might be an important follow-up article.

Lynn Hopffgarten
hopffgarten@knight-hub.com

IA-64 will require a new 64-bit OS. The current 16- and 32-bit versions of Windows will still run on IA-64, of course, but only in x86 backward-compatible mode. The performance will be less than what you'd get from the best x86 processors available at the time Merced ships. To get the most from IA-64, you'll need a new 64-bit OS and new 64-bit applications.

Microsoft is already working on a 64-bit version of Windows NT. I think it's unlikely that Microsoft will port any other OS to IA-64; the current line of Windows 95/98 will always run on x86.

On the Unix front, SCO is working on UnixWare 64 with assistance from Hewlett-Packard, HP is working on its own 64-bit HP-UX, Digital is adapting its version of Unix, and Sun is porting Solaris to IA-64.

We'll have more articles on this subject as information becomes available.
—Tom Halfhill, senior editor

EPIC Flaw

I'm not so convinced of Intel's Explicitly Parallel Instruction Computing (EPIC) idea. Long instruction word (LIW) didn't get a bad name out of malice; the idea didn't work. It was an extension of the early RISC notion of making the compiler schedule to the pipeline, a bad idea because much parallelism is possible to discover only at run time, and recompiling every time a new microarchitecture is designed is a nonstarter. (Think of the time it took before we saw applications with Pentium-specific code.)

I'm betting on PowerPC to deliver performance in the short term. The PowerPC 750 is theoretically less superscalar than the 604e/Pentium II generation, yet it's faster. Why? More attention paid to making sure it does get close to its peak throughput rate through better memory architecture, better speculative execution, etc. Translate these gains to a design that can dispatch four or more instructions per clock at 500 MHz plus, which is what I expect of the PowerPC G4, and you're talking real speed. Check out IBM's Power3 design for a hint of what's to come.

Philip Machanick
Dept. of Computer Science
University of the Witwatersrand
South Africa

The PowerPC 750 is impressive. The latest Power Macs bear this out with their performance—higher than any single-processor x86-based PCs, according to some benchmarks. In the long term, however, I still have doubts that RISC vendors will be able to keep up with Intel. Without high-volume sales, it's hard to justify the expensive R&D it takes to compete. It will be interesting to see how often IBM and Motorola introduce new PowerPC cores in the years to come. I suspect they have enough new designs in the pipeline to last for a couple of years; beyond that, it gets fuzzy. I hope, for the sake of competition, the PowerPC doesn't die. Look for our story on the Power3 in the Core section of the April issue. —Tom Halfhill

Lose an Opcode?

What I don't get about IA-64 is why all instructions that rely on the speculative check can't make an implicit speculative check themselves and report an exception just as a pure speculative check may need to do. This would do away with that opcode. I find the check instruction most inefficient.

Ernesto A. Pérez
Isabela, Puerto Rico

The speculative check instruction must be separate from the speculative load because the CPU can't always determine the validity of the data when speculatively loading it from memory. The load may or may not cause an exception. Often, the CPU won't resolve that outcome until several instructions later, after a branch. Further-

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more, it wouldn't save time to combine the speculative load and the speculative check in a single instruction. Checking for the exception would lengthen the execution time of the load instruction. It's better to separate them so the compiler has more flexibility to schedule them in parallel with other instructions. —Tom Halfhill

How To

I enjoyed reading "HTTP Authentication" (January Web Project), but I have one question. What is the Java function that converts a string from Base-64?

David Levitan
wizardofoz@iname.com

```
import
sun.misc.BASE64Decoder;
BASE64Decoder decode =
 new BASE64Decoder();
byte[] bDecoded =
 decode.decodeBuffer
 (sAuth);
sCredentials = new
 String(bDecoded,256);
```

—Jon Udell, executive editor

The ODBCDirect Connection

Thanks for Rick Dobson's articles "Using ODBCDirect's Advanced Features" and "Fast and Flexible Access to Databases" (September and August Core/Programming). Until recently I have used Jet for ODBC work. A few months ago I was given a task to hit a legacy database that had huge tables. Jet was swamped, so I started using Passthrough SQL, but I lost Data Access Object (DAO) flexibility when working with the remote tables. I was starting to feel the pressure when I remembered your articles and tried ODBCDirect with your examples as a launching point. I now have a great connection to my legacy data source, and the comfort of DAO for all the recordsets. Just what I needed, just in time!

Ted Finley
tfinle@corp.atl.com

Vulnerable NCs

"Back to the Future with 9 Network Computers" (December Hardware Lab Report), your nice review of the state of network computers, found that the Neoware product was pretty good. I agree. I've installed 15 as X terminals on a couple of our subnets.

However, there is a serious flaw in current NC products: lack of an SSH (secure shell) client. Without SSH or the equivalent, things such as log-in passwords can be sniffed on insecure networks—certainly every campus network—and any log-in from such a network computer can be cracked with ease. Any vendor's X terminals that don't do encryption are vulnerable. If an NC is competing against low-end PCs, it loses when the problem of network security must be solved.

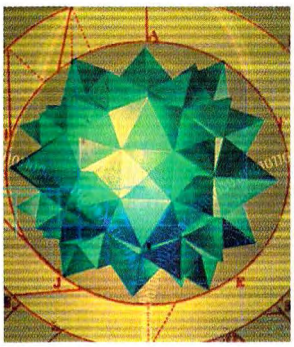
Technically, the remedy is simple: Just add SSH to the NC's OS. Let's hope vendors do so. Without it, our academic users cannot log-in to some of their own subnets without compromising them.

George Planansky
Manager, Computer Services Group; Division of Engineering and Applied Sciences
Harvard University

None of the vendors of Unix-capable NCs surveyed in our Lab Report plans to add SSH at this time. One reason NC vendors have been slow to grapple with the issue is lack of demand, suggests Gartner Group analyst Audrey Apfel. To date, most NCs have been deployed in trusted networks. —Editors

C++ Interface Representation

In "COM+: The Next Generation" (December), author David Chappell asserts that



C++ "currently has no standard way to specify interfaces." Abstract base classes, or classes consisting of pure virtual methods, are excellent interface representations. I wonder what Mr. Chappell could have meant. Certainly no extension to C++ is needed to provide this functionality.

Andrew Broadstone
andrewb@connected.com

You are absolutely correct—abstract base classes are excellent interface representations for C++ objects. They're not perfect, though, as a mechanism for defining interfaces to COM objects. From what Microsoft has shown us so far, the company plans to add to C++ syntax specifically focused on defining COM (and COM+) object interfaces.
—David Chappell

Have Clipboard, Will Travel

I don't know if Microsoft has any ambition to receive an ISO 9000 approval ("Components Battling Components," November), but it seems that the company has a long way to get there. I would enjoy taking part in an ISO 9000 inspection of Microsoft's software development process. Keeping track of all versions of various software components is crucial to those of us trying to ensure high quality.

Walter Krambring
Stockholm, Sweden

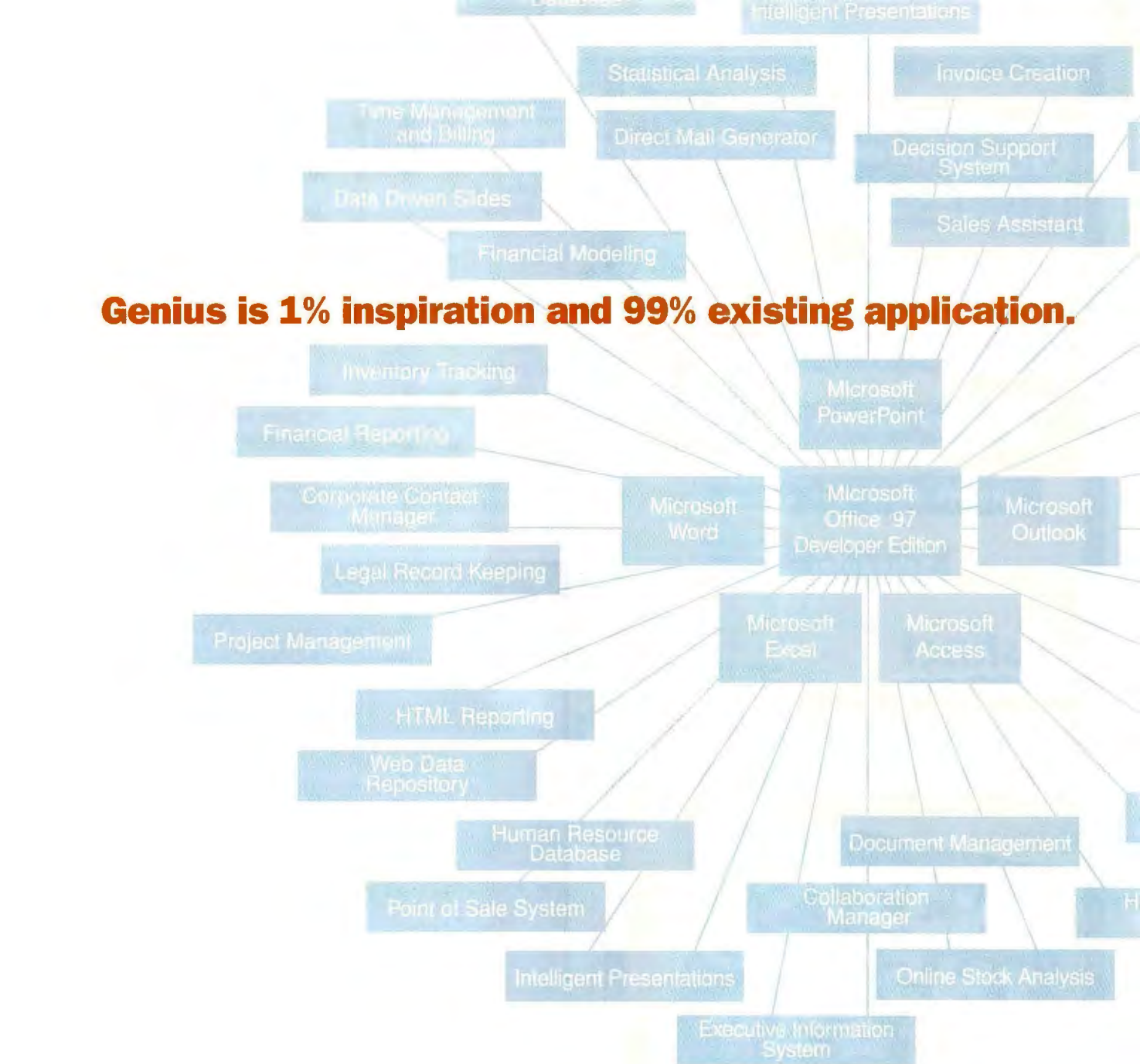
The Space in Space

I'm appalled that anyone would plan to launch the number of satellites discussed in "Fiber in the Sky" (November Cover Story). Assuming all launches are successful and the machines stay in the right orbit, what happens to the poor radio astronomers who depend on an ability to see into a pollution-free sky? After the 10- or 15-year life span of this new "flying Internet," the retirement of the hardware is going to be an interesting meteor shower.

Lance Weber
lweber@stratos.net

Beta Blues

John McMinn's letter (December Inbox) prompted me to write to offer support for his argument. It seems that most PC software vendors are demanding payment for beta-release items with the implicit promise of "service packs" somewhere down the line. I don't buy a Taurus in the hope that Ford will release a modification to get the brakes working in six months. Why should I put up with that kind of marketing from Microsoft, Lotus, Corel, et al? Maybe if we all remember that we're being



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Paul Harper
IT Manager, British Council
Bangkok, Thailand

We agree that reliability is an important issue for all of us. That's why we're devoting next month's cover story to crash-proof PCs.
—Editors

FIXES

In the performance chart on page 116 of the review "Do You Hear What I Say?" (January), the bar labeled ViaVoice/Word should have been labeled ViaVoice/SpeechPad.

In "The Value of Free Software" (December Web Project), we failed to attribute the Web-server market share data on page 109; the source is Netcraft, http://www.netcraft.com/survey/.

Due to a typographical error in "Déjà Vu All Over Again" (November), we described the Out of Band (OOB) attack as affecting port 80; the connection is to port 139, a NetBIOS port.

COMING UP IN APRIL

COVER STORY
Why Do PCs Crash?
More important, how can we make them crash less often? Can the reliability of mainframes and critical embedded systems be brought to PCs? We explore what's being done to make PCs more dependable.

NETWORK INTEGRATION
Two Heads Are Better Than One
Clusters, multiprocessing, storage area networks: the new boons to fault resilience, scalability, and performance. BYTE examines what each solution brings to these three critical areas.

MANAGING DATA
Michael Stonebraker Manifesto
The creator of object-relational databases speaks out on OR technology and the future of thin clients and fat databases.

HARDWARE LAB REPORT
Color Laser Printers
Can the current crop of network color laser printers handle the demands of the business environment?

SOFTWARE LAB REPORT
E-Mail Servers for the Enterprise
We test IMAP-compliant e-mail servers, including Lotus Domino Mail, Microsoft Exchange Server, Netscape Messaging Server, and others.

REVIEWS
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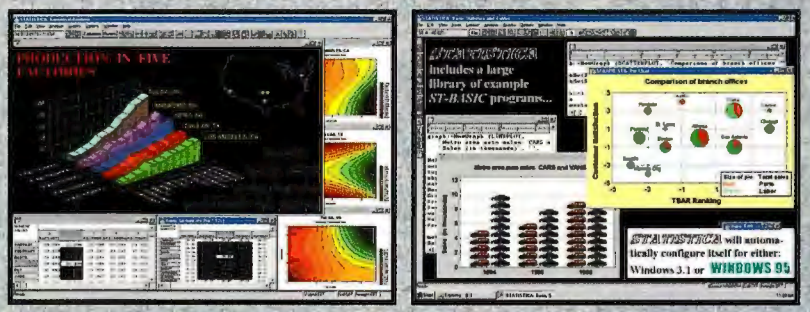

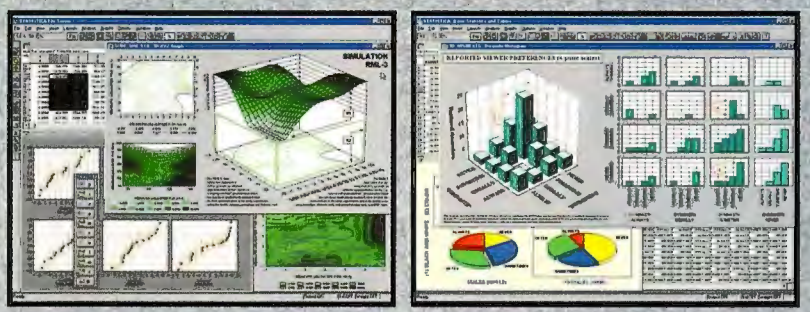

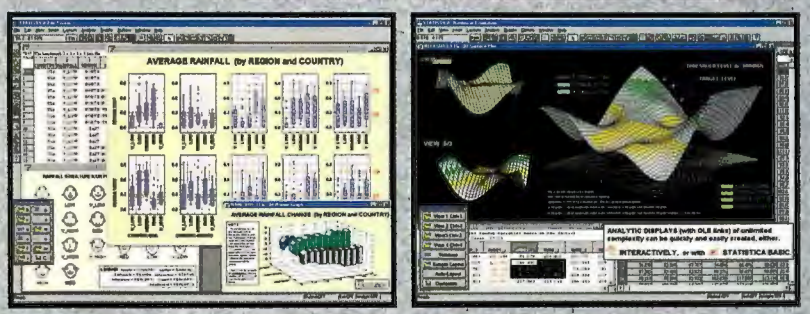

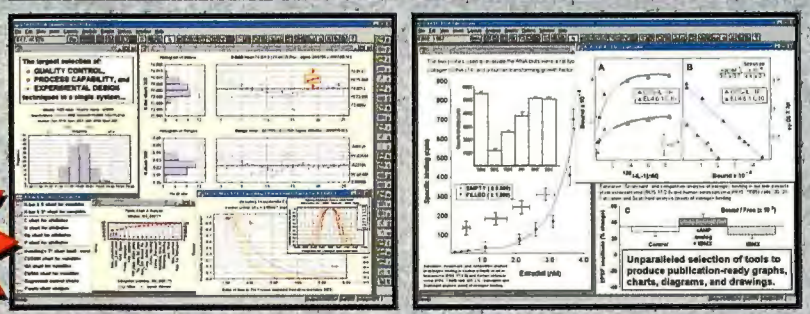

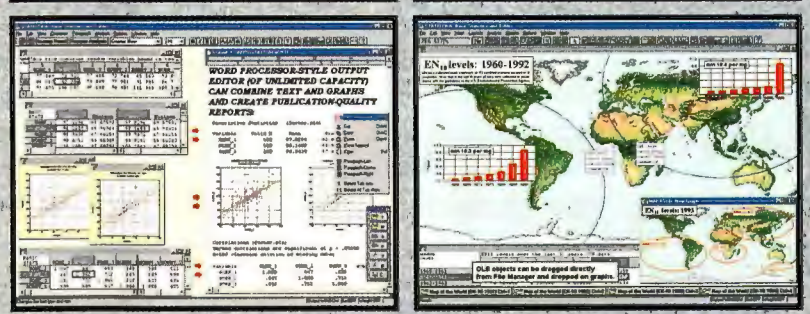

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Deschutes: Pentium II Breakout

Intel's new processors, chip sets, and motherboards will establish the Pentium II as the standard in 1998 for low- and high-end PCs and servers.

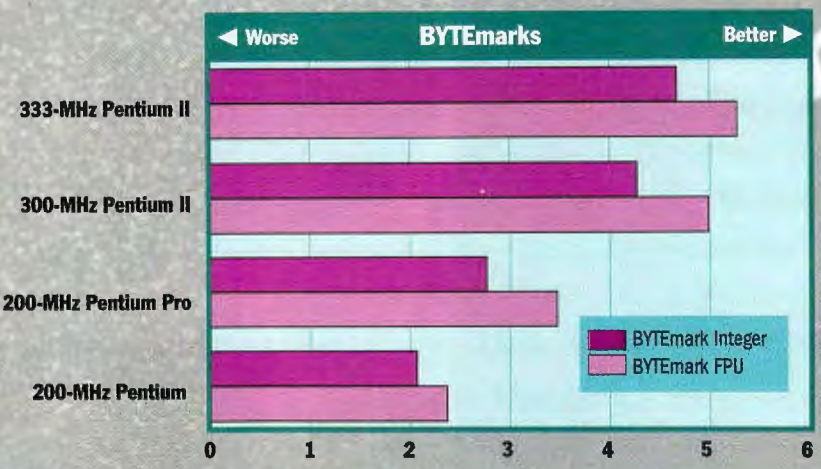
Intel has high hopes for its Deschutes-series Pentium II processors, which made their debut on January 26. If successful, Deschutes will be the turning point in Intel's campaign to make the Pentium II a mass-market product, phase out the Pentium, bring sixth-generation x86 technology to mobile systems, and render the Socket 7 interface obsolete.

Deschutes could also strengthen Intel's influence over the PC standard and, later this year, offer more diverse options for both high- and low-end PCs. All things considered, it's a lot to expect from a single product that essentially introduces no new features.

No new features? How can that be? If you're confused, join the club. No other Intel processor has been surrounded by as much market confusion as Deschutes.

Contrary to widespread belief, Deschutes implies nothing about the chip's core clock frequency, front-side bus speed, back-side bus speed, cache size, CPU interface, MMX, or system chip set. Deschutes is merely Intel's code name for a Pentium II processor manufactured on a 0.25-micron CMOS process. Nothing else distinguishes the Deschutes-series Pentium II from today's Klamath-series Pentium II.

Faster Pentium IIs Come Down the Chute*



* For more test results, see page 41.

Deschutes Pentium II Road Map for 1998

CPU	Interface	CMOS process	Core speeds	Front-side bus	Back-side (L2 cache) bus	L2 cache
Klamath	Slot 1	0.35 micron	233, 266, 300 MHz	66 MHz	116.5, 133, 150 MHz	512 KB
Deschutes	Slot 1	0.25 micron	333 MHz	66 MHz	166.5 MHz	512 KB
Deschutes	Mobile slot	0.25 micron	233, 266 MHz	66 MHz	116.5, 133 MHz	512 KB
Deschutes	Slot 1	0.25 micron	350, 400 MHz	100 MHz	175, 200 MHz	512 KB
Deschutes	Slot 2 (for servers)	0.25 micron	350, 400 MHz	100 MHz	350, 400 MHz	512 KB, 1 MB, 2 MB
Deschutes	Slot 1	0.25 micron	233, 266 MHz	66 MHz	Not used	None
Deschutes	Mobile slot	0.25 micron	300 MHz	66 MHz	150 MHz	512 KB
Deschutes	Slot 1	0.25 micron	>233 MHz	66 MHz	Core speed	128 KB, 256 KB on-chip
Deschutes	Slot 1	0.25 micron	450 MHz	100 MHz	225 MHz	512 KB
Deschutes	Slot 2 (for servers)	0.25 micron	450 MHz	100 MHz	450 MHz	512 KB, 1 MB, 2 MB

*The 440FX and 440LX may also support the low-cost Deschutes.

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Apparently there are those who do not subscribe to an all-Microsoft approach.

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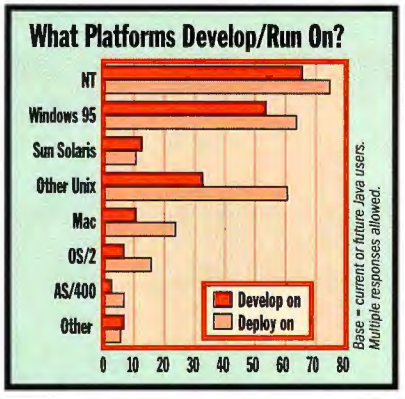
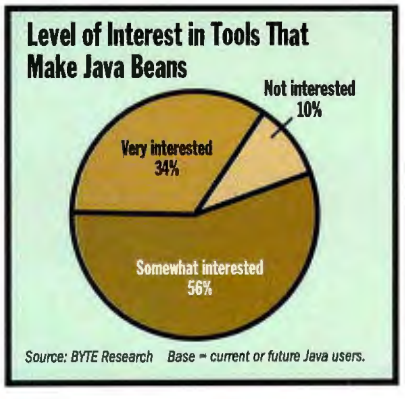
"What Developers Will Create with Java").

More than half of the sites surveyed will develop at least one application considered mission-critical (see "Rate the Importance of Your Java Program"). And Java is clearly a do-it-yourself platform for most respondents. Only 12 percent





are using Java programs developed outside their organization.

Despite the high interest in Java's write once, run anywhere capability, respondents are mostly developing or deploying on Windows 95 or NT (see "What Platforms Develop/Run On?"). But various flavors of Unix are also a popular platform for deploying and, to a lesser extent, developing Java programs.

When asked about Java tools, the responses were generally favorable: 28 percent were very satisfied, and 35 percent were somewhat satisfied. One percent said they were very dissatisfied with their tools, and 10 percent were somewhat dissatisfied. However, satisfaction does not equal complacency. Almost 60 percent say they are evaluating tool vendors all the time.

One thing Java users are interested in are tools that can produce client/server Java Beans (see "Level of Interest in Tools That Make Java Beans?"). Java Beans make up the component architecture for Java and let developers create reusable components. Half say some of their applications will use both client and server Java Beans.

And what about issues that tend to get prominent coverage in the mainstream press, such as the Sun/Microsoft legal conflict? That doesn't appear to be a big deal to BYTE subscribers. Of the current and future Java users, 82 percent said it would not affect their plans to use Java. And of those who said it has affected their plans to use Java, 39 percent said the only result of the lawsuit was a reevaluation of Java, but with no subsequent changes planned. About half (53 percent) of those saying the lawsuit would change their plans said it would slow adoption considerably; 8 percent said it had actually accelerated adoption considerably.

–Dave Andrews

Bug of the Month

Driver Wanted: Must Be Easy to Work With

BYTE editors recently tried to install a new Hewlett-Packard 5Si MX laser printer, only to discover that buggy driver software packaged with the printer made setup a perplexing, impossible task. When we installed the JetAdmin 2.33 software on a PC, the Windows 95 shell crashed whenever we tried to print. When printing from QuarkXPress on our Power Mac, the 5Si MX printed any page with a background as a solid black image and then crashed the system.

After consulting HP's technical-support people, we learned that our driver had a conflict with the Windows 95 shell. A source said that version 2.33 also had memory leaks and that "numerous defects were corrected between version 2.33 and the latest release, 2.50."

Discovering the cause of our Mac printing problems was a whole new kettle of toner. It turns out our HP driver crashes a Mac running QuarkXPress 3.32 if Quark's Balloon Help file is located in the QuarkXPress folder (where it ought to be). The conflict occurs between QuarkXPress 3.32 and Adobe PostScript drivers, and is documented only on the Adobe Web page. Once we moved the Balloon Help folder to the desktop, the problems ceased.

Our solution for printing from a PC? Simplify, simplify, simplify. Instead of installing all the software on our JetAdmin CD-ROM, we simply installed the Jet Direct protocol from a Windows 95 CD and pulled appropriate drivers from the HP Web site using Windows' Add New Printer function.

–Jason Krause

Send yours to jason.krause@byte.com

Future Watch

New Hard Drives Hold More Data

A recent breakthrough by IBM's Storage Systems Division presages hard drives by the year 2001 that store almost four times as much data as drives in desktop PCs today. IBM recently announced that its scientists have developed a hard drive that can store 11.6 Gb of data on a square inch of a disk space. IBM predicts you'll be able to buy products using this technology by 2001. Today's notebook hard drives store about 3.12 Gb per square inch, according to IBM officials, while desktops and servers hold a little less.

IBM used the combination of an advanced giant magneto-resistive head, a narrow-track thin-film inductive write head, ultra-low-noise cobalt-alloy magnetic medium, and extended partial response maximum likelihood (PRML) channel electronics to achieve the feat. In addition to more data per the same-size disk, the achievement could also lead to drives that hold the same amount of data as before but are smaller and consume less energy, useful for portable computers.

How much is in 11.6 Gb? Every square inch of disk space using this technology could hold more than 725,000 pages of double-spaced typewritten pages, which would make a stack taller than an 18-story building.

–Vishal Doshi

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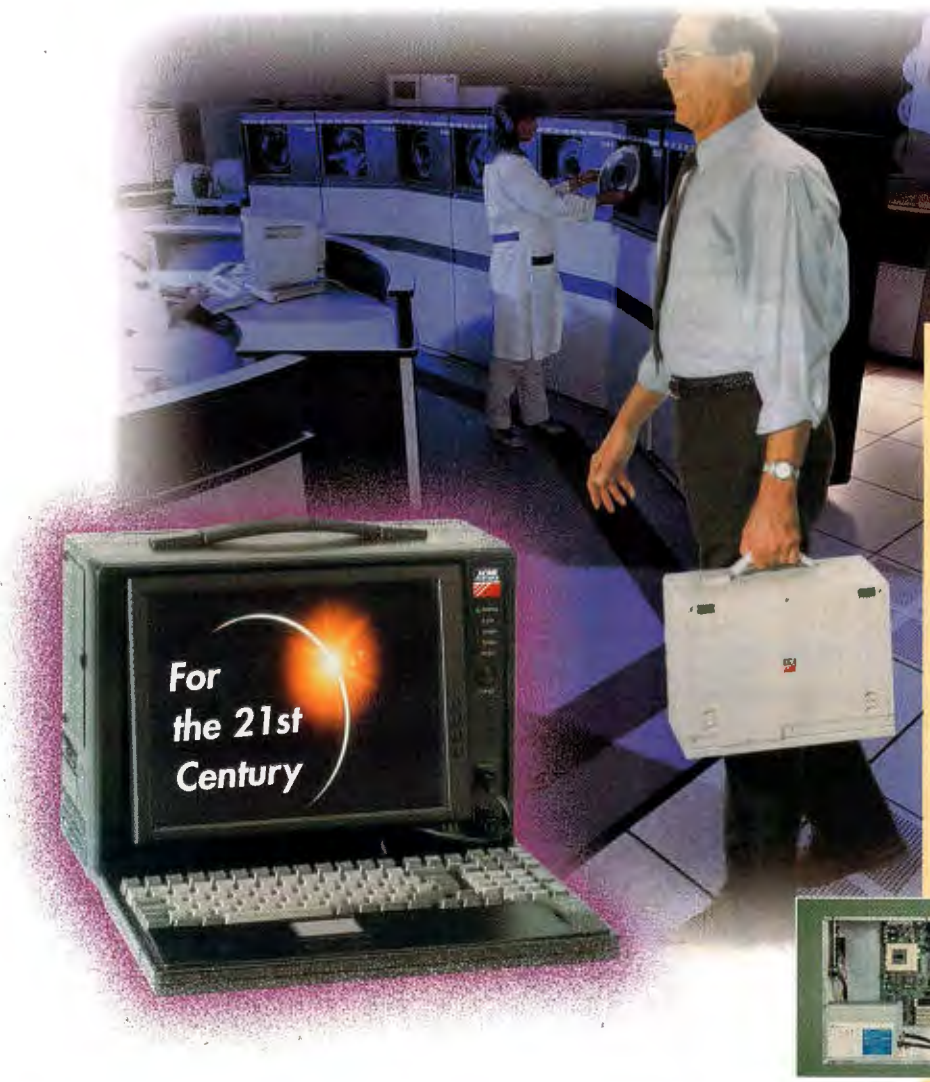

It took **ACME** to incorporate TFT LCD flat panels ranging from 10.2" to 13.3", 14.1", and 15.1" diagonally in a package only 15 3/4" x 11 1/2" x 8 1/4". Features include a 105 keyboard with built-in GlidePoint touch pad, language localization, high resolution (1024 X 768 max,) with full 262,000 colors, 3.5" floppy and 5.25" CD drives, super durable case and auto-sensing power supply.

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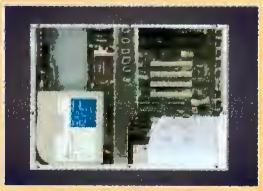

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Dual Modem Routers Double Your Bandwidth

The dual analog router is a new product that offers more than 100 Kbps of download speed over ordinary analog phone lines by bonding two 56-Kbps modems into a single high-speed connection. When downloading files, dual analog performance is about 75 percent as fast as a two-channel bonded ISDN connection (128 Kbps). Dual analog performance when uploading is slower (about 50 percent of the speed of ISDN).

The dual analog router can be found in several forms. Complete units include internal modems (e.g., the 3Com OfficeConnect Remote dual analog router, available for $745). Other units require external modems, such as the Ramp Networks WebRamp M3 (without modems, $439), and software solutions, such as the MidCore MidPoint Gateway.

The latest update of Windows NT 4.0, with the Service Pack 3 and the Routing and Remote Access update, has the ability to bond multiple modems but isn't as fully featured as the specialized products. Several more dual analog products (including offerings from Angia and Diamond) are expected soon.

Several important technological considerations need to be considered when choosing a dual analog router. One is channel-bonding implementation. The more technically elegant method is to use multilink PPP (MLPPP) to bond the modems into a single connection, so that the full bandwidth of both channels is available for any file download, whether it contains many small files or individual large files. This method (used by the 3Com OfficeConnect Remote product) lets bandwidth be most efficiently allocated. The only slight drawback is that it must be supported by the server at your ISP or main office. Fortunately, most current equipment supports MLPPP.

The second method of bonding channels (used by the WebRamp M3 and MidCore MidPoint Gateway) is to simply divide file requests among the modems. This method eliminates the need for MLPPP support and works well for Web pages consisting of several small files, but it performs poorly when transferring large files. Both methods require that your ISP or remote-access server allows multiple log-ins to the same account (one for each modem).

Another consideration is routing capability. If you plan to connect to multiple locations rather than just a single ISP (e.g., if you need to connect to the Internet and another office or if you want two ISPs for redundancy), be sure to choose a unit that supports multiple routes and destinations.

The dual analog router isn't simply a modem. You must configure and manage it just like any other router. A comprehensive configuration tool and configuration wizards help you to quickly (and correctly) configure your router. If the configuration tool is Web-based, you can manage your router from any convenient browser-based computer.

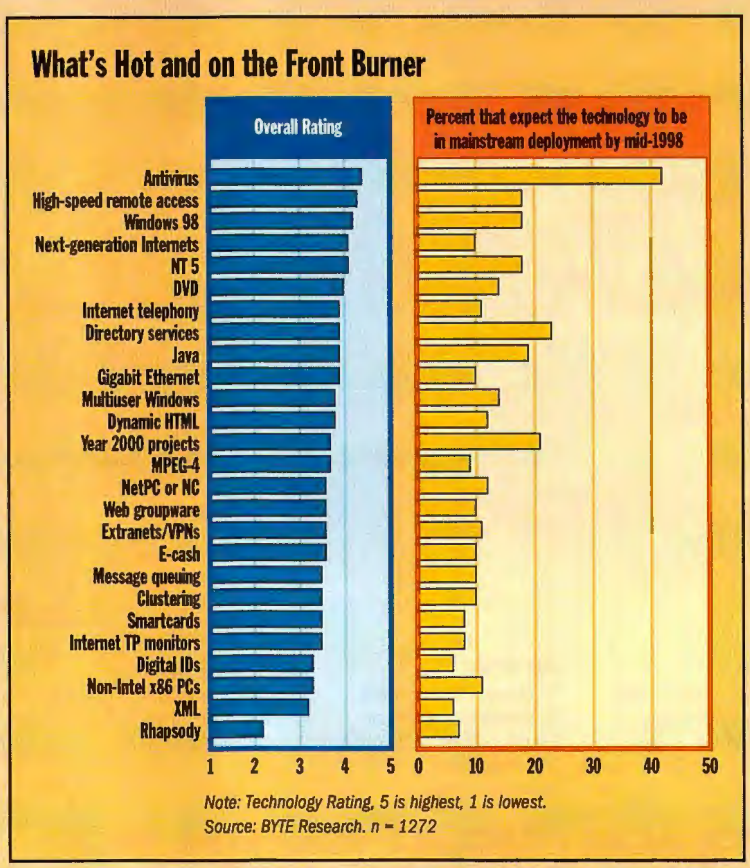
If you choose a router with internal modems, choose a unit (such as the one from 3Com) that you can flash-upgrade to comply with the new ITU 56-Kbps standard when it is finalized. Whether you choose a router with internal or external modems, you should ensure that your ISP or server supports the same 56-Kbps standard as your router.

continued

Survey

Top Technologies Adoption by Mid-1998

BYTE Research conducted a survey of Fall Comdex attendees to gauge how important certain technologies will be in 1998. Respondents (1272 total) were asked to rate on a scale of 1 to 5 (5 being the highest) a list of top technologies and to also estimate if they believed the same technologies would be in mainstream use by their organization by midyear. Clearly, virus detection and elimination is a hot area of concern, but other technologies such as directory services, Java, remote access, and Windows scored relatively high on the implementation meter.



Note: Technology Rating, 5 is highest, 1 is lowest.
Source: BYTE Research. n = 1272

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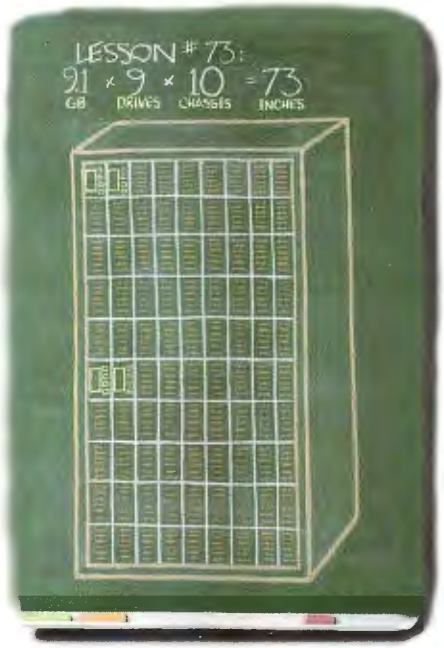

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GartnerGroup Report

ERP Customers to Vendors: Prove It First

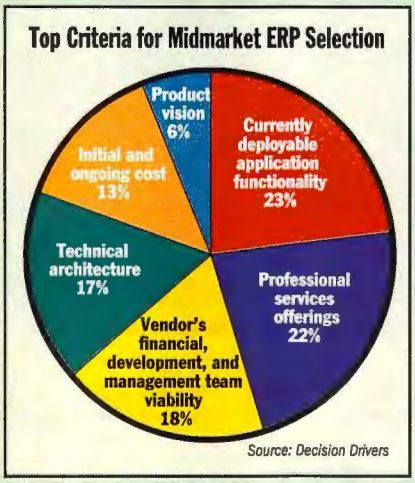
Prove it, or we won't purchase it. That's what customers are increasingly saying to vendors of enterprise resource planning (ERP) applications, and the reason is dissatisfaction with current product-selection procedures and their end results. A recent study conducted by Decision Drivers, Inc. (DDI), a GartnerGroup company specializing in information technology (IT) product selection, reveals severe deficiencies in the processes customers use when choosing their ERP package. According to the DDI survey, 64 percent of the ERP application-selection teams who used a traditional request for proposal (RFP) selection process reported a low level of confidence with that effort, the resulting decision, and the selected vendor's ability to deliver on promised functionality.

ERP evaluation teams working at midmarket organizations (i.e., ones with annual revenue between $250 million and $1 billion) are struggling to reconcile this confidence gap while making a vendor selection in an increasingly complex environment. A shrinking number of remaining tier 1–size prospects (those with more than $1 billion annual revenues), the availability of lower-cost computing platforms including Windows NT, and slowly decreasing implementation costs have driven ERP vendors that previously focused on tier 1 customers to look for new business in the midmarket segment. Companies unable to get high-end vendors to respond to an RFP one year ago, now find themselves courted by recently announced major initiatives from SAP, Baan, Oracle, and PeopleSoft.

Smaller deal sizes, equally complex requirements, and increased vendor hype have produced a tornado of activity in the midmarket. Traditional midmarket vendors are fighting back. Companies such as Symix, Data Works, and Glovia are creating partnerships, acquiring functionality, and developing vertical strategies to counter these new entrants.

Meanwhile, caught in a cross fire between these two sides, midmarket project teams have a much smaller margin of error than their counterparts working in bigger companies and are struggling to locate accurate vendor information, define mandatory requirements, and justify their selection to management. Application vendors have also been affected by this environment of uncertainty and must dedicate up to 40 percent more time per engagement from a presales consulting perspective. Vendors are spending precious additional weeks or months responding to increasingly demanding project teams, who are not willing to risk individual reputations or careers by relying on sophisticated, but standardized, vendor presentations that sell more sizzle than substance.

The result of all these factors has been a huge increase in the use of scripted demonstrations. Scripted demonstrations document and clearly communicate a comprehensive list of steps, processes, and compliance guidelines that a vendor must execute during a live presentation of its application. In this manner, the project team, rather than the vendor, determines the content of a live application demonstration and clearly sets expectations. The use of scripts represents a small but integral part of a structured selection methodology developed by DDI.



Demonstration scripts focus on organization-specific business processes, or technical requirements, and are developed by a selection team, in cooperation with functional or technical champions. Scripts must be specific enough, including the use of sample data, to custom-tailor a vendor's demonstration of its application capabilities. Scoring occurs during the vendor's response over a two- to seven-day presentation, on a pass-fail basis, and includes a value that correlates the suitability of the process used to the organization's requirements.

A standard scripted demonstration provides a list of steps that must be performed, includes the data that the transactions must be based on, and is typically designed along process-flow boundaries. Between 20 and 200 scripts are created in a typical selection, and their scope includes application-specific processes (e.g., the order-to-cash cycle) and technical requirements (e.g., security, disaster recovery, and backup strategies). Standard guidelines must also be developed and should include a requirement for a live presentation using the architecture being evaluated. This serves as proof of concept from a technical environment perspective and is most often focused on identifying and validating fledgling NT-based application capabilities and satisfying scalability concerns.

Jim Lebinski, *senior analyst for Decision Drivers, Inc., a GartnerGroup company. For more information, call 203-316-3631; fax: 203-316-6161; or james.lebinski@gartner.com.*

Software solutions, such as the capability built into Windows NT, require that you provide two or more 56-Kbps modems and a host PC. Hardware solutions without internal modems, such as the WebRamp M3, require that you provide two or more external modems. (Don't expect to use any old modems you have on hand—using anything less than current 56-Kbps devices will not give you the performance for which you are paying.) If you are using the router to dial into a main office, the main office remote-access server must support 56 Kbps—which means that it must have a digital (usually T1 or ISDN Basic Rate Interface [BRI]) connection.

If you need routing capabilities and a faster connection than 56 Kbps offers, but prefer not to make the jump to ISDN, a dual analog router may be just what you need. It will give you near-ISDN performance at moderate cost over ordinary phone lines. For best performance and flexibility, be sure to choose a router that uses MLPPP channel bonding, provides standard routing capabilities such as multiple route destinations, and offers a Web-based configuration tool, so you can manage it from any handy browser-equipped computer.

Keith Levkoff is a senior product analyst at Progressive Strategies (New York, NY), a technology assessment and market research firm.

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108 Years of National Geographic on CD-ROM

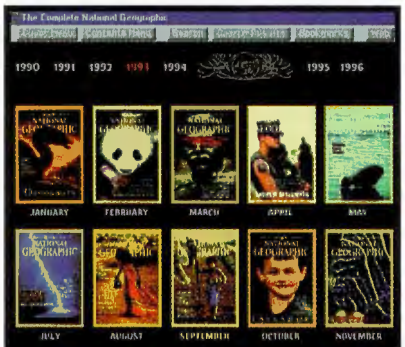
More than a century of National Geographic on CD doesn't disappoint.

When I was growing up, everyone knew someone with shelf upon shelf of aging, yellow-spined *National Geographic* magazines. Now, in a single 12-inch-wide box, I've got over a century's worth of them—every last article, photograph, and ad from 1245 issues, complete from the first issue in 1889 to the end of 1996. The only things not included on this set of 30 hybrid (Mac and Windows) CD-ROMs are the inserted supplemental maps.

This computer-publishing landmark is an extraordinary repository of information and images, and it's priced at a bargain-basement $199. This is thanks to sponsorship by Kodak. The sheer amount of content makes all those CD-ROM encyclopedias, however useful, seem puny by comparison.

To digitize the *Geographic*, Dataware Technologies needed five copies of each issue—6225 magazines, 2200 pounds worth, occupying 90 feet of shelf space. The initial images occupied over 300 GB, which had to be compressed to fit onto a reasonable number of CDs.

As a result, article text is much less crisp than I'd like. Viewed on a 14-inch monitor at 640 by 480 pixels, the type is readable but somewhat fuzzy. At 1024 pixels, it's smaller and thus looks a bit smoother. Some type, particularly in captions and graphics, is difficult (or occasionally impossible) to read. Photos are displayed in 8-, 16-, or 24-bit color, depending on your system. You can blow up the pages on-screen, which you'll need to do for ease of reading.



The Complete National Geographic
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Mindscape, Inc., 415-897-9900
http://www.mindscape.com/

Extensive research or browsing can involve shuffling a lot of discs in and out. And almost 20 percent of each CD is occupied by the entire setup program and search index. This lets you start a session with any disc and run from the CD without copying 100 MB of search program and index to your local hard drive.

Because the pages are all graphic images, the text isn't indexed comprehensively, as we've come to expect on CD-ROM publications. But you can search on date, issue, subject, contributor, title, advertiser, photo, map, or keyword.

I printed out a number of pages with a high-resolution Lexmark 7200 color inkjet. The quality was decent, though not nearly as good as the original magazine pages.

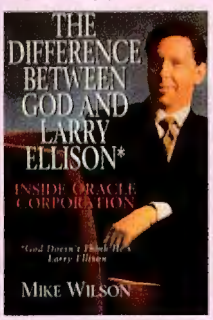
All in all, I'm much less bothered by the compromises needed to fit all this on CD than I am impressed and excited about this achievement. Bravo!

–Russell Kay

Book Reviews

The Inscrutable Larry Ellison

If you enjoy reading biographies about rich, obsessive egomaniacs who occasionally show they have a heart, you may want to pick up a copy of Mike Wilson's book, *The Difference Between God and Larry Ellison*: Inside Oracle Corporation (*God Doesn't Think He's Larry Ellison)*. Lawrence Joseph Ellison is the founder and driving force behind Oracle Software, the second-largest software company in the world.



The early part of this book delves into the founding of the company and the development of relational-database software. It becomes clear that Ellison owes his fortune to an article published in June 1970 by an IBM researcher named Edgar H. Codd entitled "A Relational Model of Data for Large Shared Data Banks." Ellison and his partners were astute enough to build a working relational database based on SQL, a functional language that implemented Codd's theory, and the rest, as they say, is history.

Very quickly, the book shifts away from database technology and concentrates on Ellison's life both inside and outside of Oracle. We watch as he creates a corporation based on winning at any cost, even if that means using questionable, if not unscrupulous, business practices. For this book, Wilson interviewed hundreds of people—nearly everyone who ever knew or was close to Ellison. Unfortunately, you come away from this book with the sense that the truth about this man will never be known. Was Ellison a poor kid raised on the wrong side of the tracks in Chicago, or was he a middle-class child from a modest home? Did he receive a university degree, or was he simply a genius at inventing and reinventing his past? What role did Bill Gates play in fueling Ellison's fierce sense of competition? The book never says definitely. Readers of this well-documented exposé get a rare, if incomplete, glimpse behind the scenes of a powerful software corporation and a detailed portrait of its arrogant yet complex CEO—the inscrutable Larry Ellison.

Brad Browne *is the international licensing director for The McGraw-Hill Companies' Information Technology and Communications Group.*

The Difference Between God and Larry Ellison*: Inside Oracle Corporation (*God Doesn't Think He's Larry Ellison)
by Mike Wilson, William Morrow and Co., 1997, $25, ISBN 0-688-14925-1

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Blasts from the Past

5 Years ago in BYTE

You have mail! We predicted that e-mail would become a prevalent tool for business; but thanks to the Internet's popularity, it has become for many people a part of everyday life. Also covered: new applications from Lotus for OS/2, EO's Personal Communicator 440, and 600-dpi laser printers (priced from $2000 to $4595).

10 Years ago in BYTE

SQL was starting to gain acceptance in the PC database world, with vendors such as Oracle, Microrim, and Ansa (the developer of Paradox before Borland bought it) announcing support for the standard, although some supported it more than others.

15 Years ago in BYTE

A 5-MB hard drive that cost $3000 retail illustrates how far the storage industry has

come in 15 years. In fact, this month's editorial noted that unless hard drives become less expensive, they won't become standard outside the office. Luckily for today's users, hard drive prices have fallen and will continue to plummet.

20 Years ago in BYTE

We reviewed two early personal computers, the Apple II and the Commodore PET, Model 2001. The Commodore system featured a version of BASIC developed by a small, but growing, company called Microsoft, which at the time was still located in Albuquerque, New Mexico.

How to Survive the Big Squeeze

Howard Rubin, computer science educator and editor of IT Metrics Strategies, on how to survive the productivity crunch.

BYTE: *Recent studies have forecast an increasing demand for programmers. How bad will this be?*
Rubin: A number of pieces of research have indicated there's a shortfall of programmers in the U.S. and a large number of vacancies. To give you an idea, a study that was done and published by the Information Technology Association of America last year shows that at the time there were 200,000 unfilled jobs. Looking at the Department of Labor numbers and other people's numbers, there are somewhere between 1.2 and 2 million people in this country who would be classified in the software engineering field. That means there's about 10 percent fewer people than there are positions for them. That number looks like it will continue to rise. Business demand for information systems is growing by about 25 percent to 30 percent a year right now.

BYTE: *How can corporations deal with this shortage?*
Rubin: There a few things they can do. The crisis right now is not necessarily worldwide. There are core skill sets and competencies that are available around the world. Companies can get smarter and start adopting global sourcing strategies. You can get high-tech skills in Ireland, or India, so to overcome the crisis in the very short term, companies should not be looking at outsourcing, they should be looking at sourcing. That means moving work electronically around the world to the right price/performance point where the skills exist. Outsourcing usually means you hire a company and tell it to take over your mainframe or your application maintenance. A good example of sourcing is if you have some Java development that needs to be done, you send the work to another country. Sourcing really involves buying skill futures from companies, securing them in advance, and getting the rights to use those people. But sourcing is a short-term approach. More critically, companies need to focus on what their sources of labor are, because it looks like the offshore market will be saturated itself when it absorbs about 30 percent of U.S. demand.

BYTE: *What can companies do if that market gets saturated?*
Rubin: Companies need to start focusing on staff-retention strategies, because as salaries increase, people will be more tempted to jump. They also have to start looking at establishing their own farm league, their own supply of labor. They need to do that by looking within their organization to see if a change in skill mix is needed for the company and if other people need to be retrained. And they need to set up farm leagues in terms of alliances with universities to get first shot at new graduates, and partner with universities and technical institutions on curriculum to make sure when people do join, they hit the ground running. They also need to be focusing on the internal performance of their personnel and learning appropriate productivity strategies. Where can they use packages instead of writing things themselves? Where can they use other service providers and outsource business processes where they can be handled more efficiently? A whole range of strategies is needed, so that IT resources can be focused on the most strategic and important projects.

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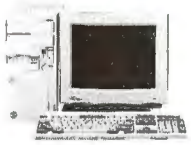

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Learn programming the easy way in this new course featuring graphic simulations, animation, and sound effects. Not only will you learn the fundamentals of game programming, but you'll also gain an in-depth understanding of your choice of programming languages: Visual Basic, C++, or Java. An exploding field in programming, computer gaming has a strong and growing market among the MTV-generation. This course teaches you how a popular computer game was written, from storyboarding to coding. In addition to covering game design, performance, and debugging, you'll gain hands-on experience as you make direct modifications to the game itself.

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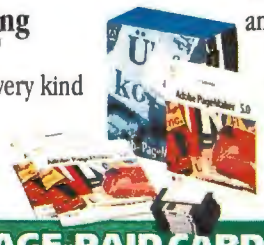

Today, businesses of every kind need skilled desktop publishers to create eye-catching, result-getting publications. And now, NRI has just updated its popular desktop publishing course to feature today's most sought-after software, Adobe PageMaker 5.0. NRI's course moves from the basics of design to the intricacies of electronic publishing and the Internet, giving you the complete know-how you need to succeed in a new career or an exciting home-based business.

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Two early Deschutes systems are fast and affordable, but upgradability is limited. By Michelle Campanale

Shooting the Rapids at 333 MHz

With a computer's life cycle now lasting about two years at best, it almost seems silly to buy the most expensive computer on the market. Enter the 333-MHz Pentium II. Systems with this newest Intel processor (code-named Deschutes) are bargain-priced to make way for next-generation machines with a 100-MHz system bus and Intel's BX chip set. (See "Deschutes: Pentium II Breakout," page 24.)

The 333-MHz speed offers an obvious performance advantage over systems with 300-MHz/Slot 1 CPUs (see the graphs on page 42). Unfortunately, the 333-MHz Deschutes represents the end of the line for the PII/Slot 1 upgrade path, according to Intel.

We tested two of the first available 333-MHz Pentium II-based systems: Hewlett-Packard's Vectra VL, an entry-level PC for corporate environments, and Compaq's Deskpro 6000, targeted at corporate power users. Performance testing with BYTEmark, Bapco's Sysmark 4.0 for Windows NT, and Van Horn's Photoshop V.4 real-world application benchmarks shows that these 333-MHz systems yield an 11 percent performance gain, across the board, over their 300-MHz counterparts. Performance differences between the two systems are negligible, which is no surprise given their common 333-MHz processor.

HP VECTRA VL

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

COMPAQ DESKPRO 6000

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

HP Vectra VL

For the most part, I like the HP's choice of components. They include a 6.4-GB Ultra ATA hard disk, a 24X Max rewritable CD-ROM drive that uses HP's SureStore rewritable technology, an embedded Sound Blaster Pro-compatible sound chip, and internal speakers. For graphics, HP offers a Matrox Millennium II PCI card with 8 MB of Window RAM. All this fits on two ISA slots, two PCI slots, and two shared slots. The Vectra starts with 32 MB of RAM, which seems silly considering it comes loaded with NT 4.0. (At our request, HP accommodated us with 64 megs.) Of course, you can purchase the system with as much as 384 MB of SDRAM. Note, though, that the system does not support error-correction code (ECC) memory. One surprise is that the machine does not come with a network interface card (NIC). HP considers this a custom-order option. This is an interesting choice for a line that is marketed at corporate buyers, but a decision likely influenced by a need to keep the price down. And, at an estimated street price of $2450 without a monitor, the price is right.

I really like the design of the HP. Its HPX motherboard holds all its components. Like the ATX design, the HPX

TECH FOCUS: PROCESSORS

What's New About Deschutes

Deschutes does not offer any architectural changes to the PCs it sits in. Both the 333-MHz Compaq and the 333-MHz HP we tested have an L2 cache that runs at half the core speed. However, some Pentium IIs have error-correction code (ECC) cache and some don't. HP says its Vectra VL's 333-MHz processor does not support ECC cache memory, whereas the Compaq Deskpro 6000's does. What's really at the core of the Deschutes 333-MHz processor is simply its manufacturing. It is made with a .25-micron process, while its predecessors were made with a .35-micron process. As a result, the whole chip is physically smaller, and the time it takes for the signal to travel even the longest distance (i.e., the signal path) is now shorter. According to our series of BYTEmark and other tests, shrinking that signal by 10 percent gives 333-MHz machines an 11 percent performance advantage over 300-MHz machines based on the .35-micron process.

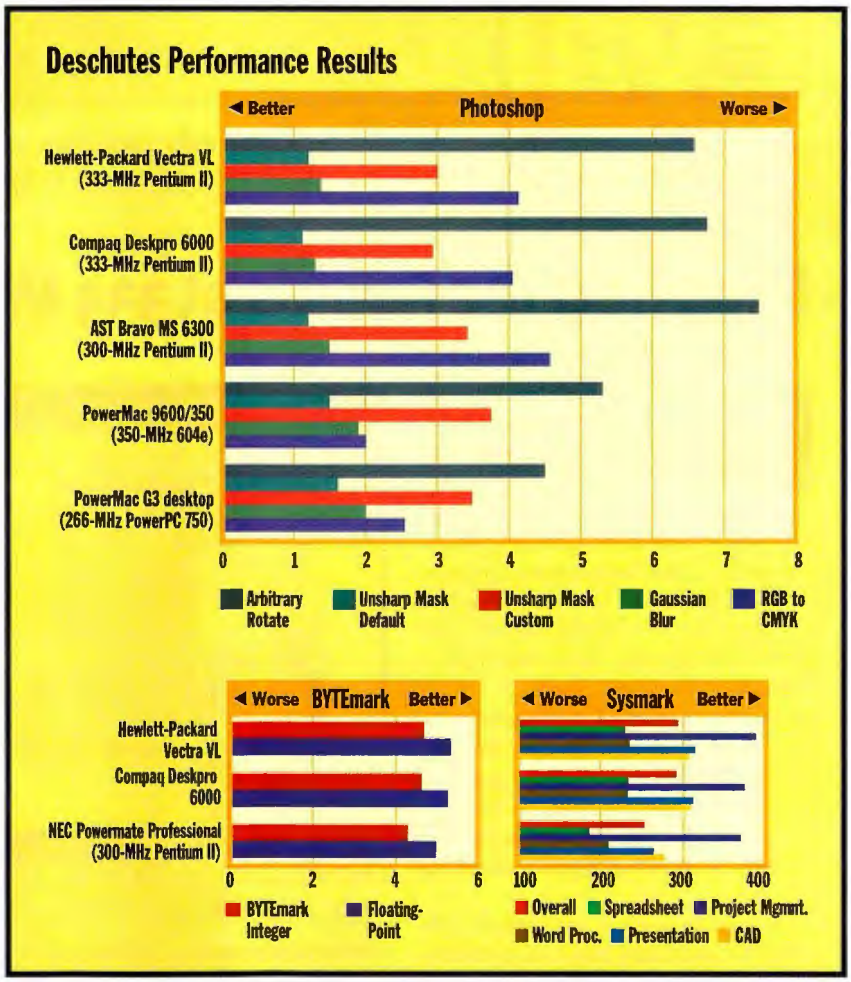
design allowed me to lift a single lever to remove the whole motherboard. I was able to get to the motherboard without taking out the riser card. Additionally, I could slide the entire case right off once I pulled out two levers located on the front face of the chassis. I appreciate the fact that the inside is uncluttered. I could quickly access processor and RAM by lifting the power supply up and over the top of the machine. Like the Compaq, the HP has two fans, one of which pulls air in. An air duct funnels heat away from the components and out through another fan. I disconnected one of the fans and ran the machine for a week without noticing any thermal interference. Unlike other vendors (including Compaq), HP supports OS/2 and Windows 3.11, in addition to Windows 95/98 and NT, on the Vectra VL line.

Compaq Deskpro 6000

Compaq markets its Deskpro 6000 at the power user in a networked computing environment, so its 4.3-GB Ultra SCSI hard drive and 64 MB of ECC SDRAM are appropriate choices. The system is configured similarly, but is by no means identical, to the HP Vectra VL. The Compaq has two universal serial bus (USB) ports, a Matrox Millennium II 4-MB Accelerated Graphics Port (AGP) board, integrated Netelligent 10/100 Ethernet controller, integrated 16-bit sound chip, and internal 56K modem. Its 24X CD-ROM drive is read-only, unlike the HP's. Its three PCI slots, one ISA full-length slot, two ISA half-length slots, and one shared (PCI/ISA) slot are contained within the LPX motherboard, which is a Compaq design.

Compaq's processor cartridge is mounted differently on the motherboard. The model 6000 has a modified Slot 1 that is 90 degrees to the motherboard, allowing the processor cartridge to be parallel to the motherboard. The layout of the PCI slots makes it a little difficult to add PCI modules. Additionally, I noticed that the AGP card slot is buried behind the PCI slot connector board. I had to dismantle a lot of things to get at the AGP slot.

The memory slots are also hard to reach without removing the motherboard—a difficult process in itself. But to Compaq's credit, its design attempts to put as many things as possible into a small footprint.



Best Bang for Your Buck

There will always be a faster processor or a newer technology over the horizon. With the onslaught of a new Intel processor every few months, you've got to wonder, "Should I buy now or wait six months until the next technology comes out?" If you really need to buy a fully configured system now, and want a system that will last for a couple of years, you can't go wrong with either of these machines from two of the top vendors.

However, the HP Vectra VL's price and performance, large hard disk, rewritable 24X CD-ROM drive, and ease of access to internal parts, make it an excellent choice. If you plan on doubling your workstation as a server, you might want to go with the Compaq since it uses ECC SDRAM. However, the Deskpro is $479 more than the Vectra, offers the same performance, and adds only a NIC and a 56K modem. Also, it has a smaller SCSI drive, and its 24X CD-ROM drive is not rewritable. B

PRODUCT INFORMATION

Hewlett-Packard Vectra VL
$2450
(6.4-GB Ultra ATA hard disk, 64 MB of RAM, 24X CDRW-ROM, Matrox Millennium II graphics card, 16-bit sound, internal speakers, floppy drive, NT 4.0)
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http://www.hp.com/vectra
Enter HotBYTEs No. 1072.

Compaq Deskpro 6000
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(4.3-GB Ultra SCSI hard drive, 64 MB of SDRAM, Matrox Millennium II AGP graphics board, integrated Netelligent 10/100 Ethernet controller, integrated 16-bit sound, two USB ports, three PCI slots, one ISA full slot, two ISA half slots, one shared PCI/ISA slot, one AGP slot, 56K PCI modem card, floppy drive, NT 4.0)
Compaq Computer
Houston, TX
800-345-1518
281-514-1740
http://www.compaq.com
Enter HotBYTEs No. 1073.

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

Michelle Campanale is a BYTE technical editor for hardware reviews. You can reach her at **michelle@dev5.byte.com**. *Lab director Al Gallant assisted with testing.*

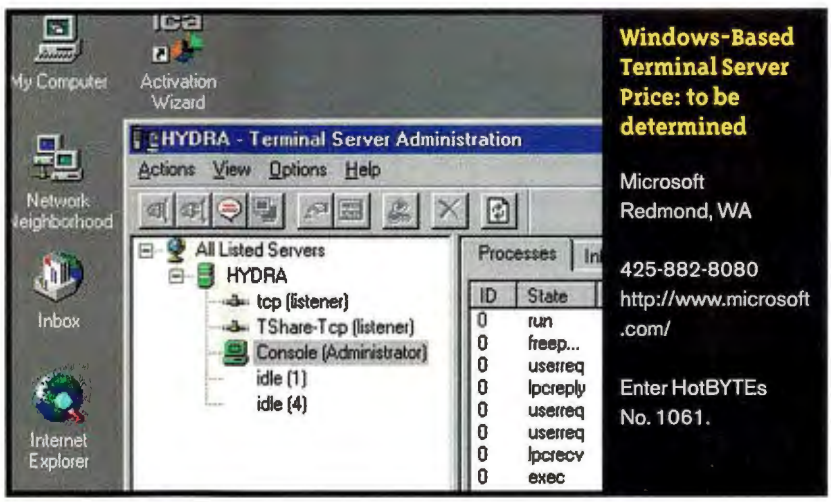
Hello, 1970s! We're headed back to the future with Windows-based terminals. By Morgan Stern

Terminal Compromises

With its forthcoming Windows-Based Terminal Server (WBTS), Microsoft is either making a giant leap forward or taking a step back in time. Or both. Terminal Server is based on technology from Citrix Systems, whose WinFrame multiuser application server is based on Windows NT. (See below for Citrix's new pICAsso add-on to WBTS.)

Like WinFrame, Terminal Server lets multiple users access Windows applications running on a centralized NT server. Users need only a small software client or a low-cost, dedicated terminal. Sound familiar, Mr. Mainframe Manager?

With WBTS, organizations can focus support, development, and maintenance efforts on a single server farm, without worrying about constant hardware upgrades, software distribution, and configuration management. Each server supports multiple simultaneous users, each appearing to control his or her own desktop. System managers can also incorporate bits of Microsoft's Zero Administration Initiative, such as restricting user access to specified applications. For many organizations, this could significantly reduce help-desk calls and support costs.



The Windows-Based Terminal Server administration utility provides control over terminal sessions.

Terminal Server needs serious hardware and memory: 32 MB of RAM plus 8 MB (or more) per user. We'll likely see quad-CPU servers with 1 GB of RAM to support 50 to 100 people.

Terminal Server is optimized for 32-bit applications. Using DOS and 16-bit apps is memory-intensive and will degrade performance. Also, a single server failure will affect many users. Many organizations will need pICAsso's Load Balancing option to provide continuous availability for mission-critical applications.

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

We tested beta copies of WBTS and pICAsso and had clients hooked to the server 5 minutes after installation. We used PC clients plus Wyse and Neoware terminals. Both packages showed impressive performance and should serve many organizations handily. Indeed, for many NT administrators, the challenge will not be choosing to implement WBTS but finally admitting that the mainframe folks had a good thing going! B

Morgan Stern is a network consultant in Boston and the coauthor of NT Enterprise Network Design *(Sybex, 1997). He can be reached at* **morganst@world.std.com.**

pICAsso Paints Mac and Unix Windows

Citrix extends terminal support to DOS, Mac, and Unix clients through pICAsso, a WBTS companion based on the company's patented Intelligent Console Architecture (ICA) protocol. ICA has already been implemented in a number of network terminals, a Web browser snap-in, and a stand-alone client. With pICAsso, clients can access the Windows terminal server via the T-Share protocol, while other platforms use ICA for client-to-server communications. pICAsso also has an optional Load Balancing module and enhanced support for client-side resources, letting users print to a local printer.

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

PRODUCT INFORMATION

pICAsso (Price: to be determined)
Citrix Systems, Inc.
Fort Lauderdale, FL
954-267-3000, http://www.citrix.com/
Enter HotBYTEs No. 1060.

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

NetWare 5's native TCP/IP and Java support fill in the missing links in Novell's Internet strategy. By James E. Gaskin

NetWare Enters the Nineties

Think of NetWare as a 1970s VW Beetle—solid, reliable, and everywhere. Now, with NetWare 5, Novell plans to retool that Beetle into a Porsche. Novell is making it easier than ever to use TCP/IP for all network client communications, and Java support explodes all over this current beta version, which is code-named Moab.

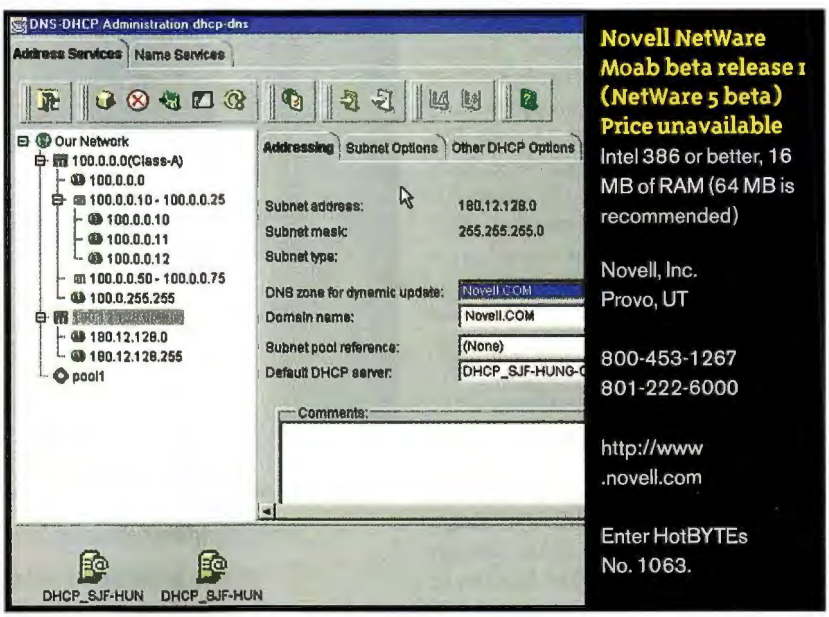
The graphical splash screen on the server may shock those who, familiar with NetWare, expect an aging character-based menu system in shades of blue, yellow, and white. Even more radical is the X Server Graphical Console. Clicking on the Novell button on the task bar opens a menu offering Applets, Background, and Exit GUI. Applets offers standard Unix tidbits like a clock and a wireframe box, written in Java. The server includes dozens more Java sample applets along with necessary libraries for programmers.

Developers, increasingly put off by Novell's clunky NetWare loadable module (NLM) application server, have flocked to Windows NT. Moab's inclusion of NT management tools acknowledges NT as the platform of choice for most network management. Novell says it wants to entice developers back to NetWare by coating all server functions with Java software interfaces to simplify development. Moab isn't there yet, but Java should keep the most painful NLM problems out of sight by the time NetWare 5 ships.

Traditional NetWare clients should run reliably with NetWare 5. My test server worked for weeks without a hiccup while plugged into an existing NetWare directory tree. Though Windows 95 couldn't see the new server, older DOS and Windows 3.1 clients could, as could the NetWare NT client software.

You can now choose TCP/IP, IPX, or a mixture during installation, but the mixture won't work with this release. Windows 3.1 complained at the lack of IPX when starting, but connections to the server worked well without IPX, including the Windows File Manager, which happily displayed server directories.

Using TCP/IP for NetWare client to NetWare server communications also means that client browsers work over the internal network without needing the Novell IPX to TCP/IP gateway. Suddenly, NetWare is an intranet server system supporting every TCP/IP client on the network, just like the press release promised. When the final release (expected this summer) supports both TCP/IP and IPX clients, Novell's NetWare will be back as the world's most connectable network. B



Novell's new Java-based graphical interface to NetWare 5 may surprise some, but it will simplify network management tasks.

TECH FOCUS

Migrating to IP

Novell's IPX was based on the best protocol available at the time of Xerox Network Services (XNS), before TCP/IP's acceptance made IP the network protocol of choice. Untying IPX from the NetWare server software came first, starting when NW 3.0 was rewritten in C in 1989. Client software started the move with the NETX software in NW 3.0 on through the virtual loadable module (VLM) clients of early NW 4.x, and separated totally with the latest Client32 versions released with this beta version.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

James E. Gaskin writes books about NetWare and the Internet, including his latest, IntranetWare BorderManager *(Sybex, 1997). You can reach him at* **james@gaskin.com.**

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

Sun's Software Suite is a scalable set of OS and application components for hand-held and embedded devices. **By Tom Whittaker**

An OS for Information Appliances

As consumer demand for information access continues to rise, technology companies face the challenge of developing operating systems that are ideally suited for information appliances (IAs). These are consumer devices that perform only a few targeted tasks and are controlled by a simple touchscreen interface or push buttons on the device's enclosure. IAs can receive information from networked or nonnetworked sources: via modems, telephone lines, or CD-ROMs (as shown at right). IAs must use very little memory and processing power in order to be affordable so that average consumers will adopt them.

Recognizing that the bills of materials for IAs must be as low as possible, the Consumer Technologies Group (formerly Diba, Inc.) at Sun Microsystems built its software from the ground up. They did this because pared-down PC systems often include power-hungry interface features and components that are unnecessary in efficient IA designs. As a result, Sun's IA software—called the Sun Information Appliance Suite—is compact, open, and flexible. The software can be adapted to run almost any consumer electronics devices, such as Internet-enabled TVs, Internet phones, vertical-application hardware, and more.

Open and Modular Platform

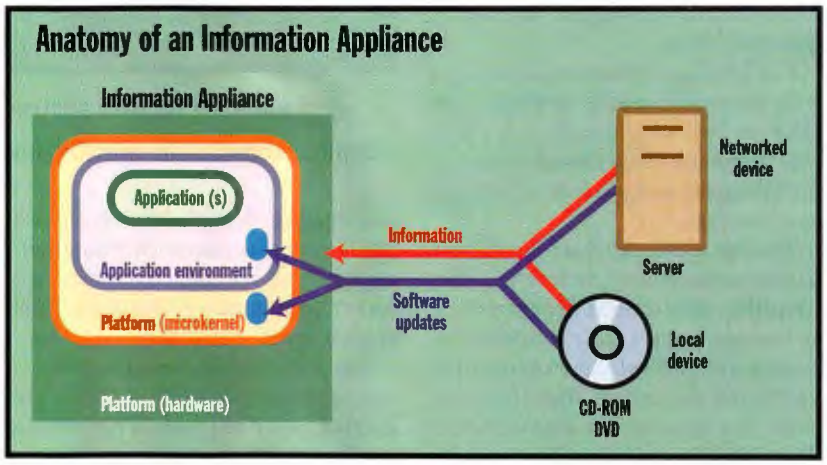
The Sun IA Suite consists of four levels, as shown in "The Sun Suite Levels" (see next page). Each level uses an open API that allows the system to be extensible and portable. As a result, the IA Suite is processor- and microkernel-independent, which gives manufacturers a vast range of implementation choices. The first and lowest level is the platform implementation level. It consists of both hardware and software components. The hardware components include a microprocessor, memory, and peripherals. The software components include a microkernel, device drivers, and networking protocol stacks.

Sun's platform implementation is based on an open architecture that includes no proprietary transport protocols. This allows developers to port the software to any real-time microprocessor or microkernel, and it enables cross-platform development. Sun has already ported the software to a number of processors, including the Mitsubishi M32RD, the Motorola PowerPC and 680x0, and the NEC V830 and V831.

The platform implementation's portable microkernel is 80 KB and is multithreaded, priority-based, and preemptive. It supports semaphores, message queues, mutexes (mutual exclusion flags), multiple timers, and events. It is written mostly in C, with small portions—the context-switching and interrupt services—written in assembly language. Note that the Sun IA Suite can run on any microkernel, and the suite has been ported to a number of OS kernels, including pSOS, Linux, Solaris, Windows NT, OS-9, and ITRON.

The operating system-specific (OSS) interface handles application services that are specific to the microkernel. The OSS lets developers create low-level services for one microkernel and then move them to other microkernels quickly and easily. To do this, developers first port the OSS to the target microkernel, and then load the recompiled and linked application onto the IA for execution.

This level also includes Sun Service Link, a mechanism that allows software to be upgraded easily and quickly via an Ethernet or modem connection to a Web site. Through a point-to-point protocol or the TCP/IP stack, upgrades and maintenance are performed transparently, without user interaction.



An information appliance is a consumer device that's optimized to perform only several specific tasks.

Foundation to Build On

The next level is the Sun application foundation. It can be considered a "virtual"

OS that provides the basic software for building IA applications. Developers write directly to these APIs to create customized programs for new IAs or other appliances—such as DVD players or fax systems—that don't require an extensive GUI-based application. If less customization is required, developers can take advantage of the architecture's application modules and applications in the upper levels.

The application foundation consists of graphics and font libraries, an opaque device library (ODL), and a system library. All are written in C. The graphics library provides developers with a set of software functions for drawing and displaying graphics, fonts, and images. It supports various displays, such as VGA, LCD, and TV, and includes 2-D drawing modules, imaging and rasterizing functions, screen and color controls, and JPEG and GIF libraries. Developers can configure the graphics library to support any display type at any time.

The font library formats fonts for a wide variety of possible displays, from black-and-white to color, from NTSC to LCD. It provides anti-aliased characters for TV display and a variety of LCD and monitor types.

The ODL uses an API that has one interface yet supports many device types. This simplifies application programming and lets developers easily substitute devices. It also enables IA applications to be hardware-independent, since these APIs make the details of manipulating a device's hardware "opaque" to the application. For example, the Sun Browser application can receive data from a modem, CD-ROM, or server: It uses the same ODL calls no matter the data delivery mechanism.

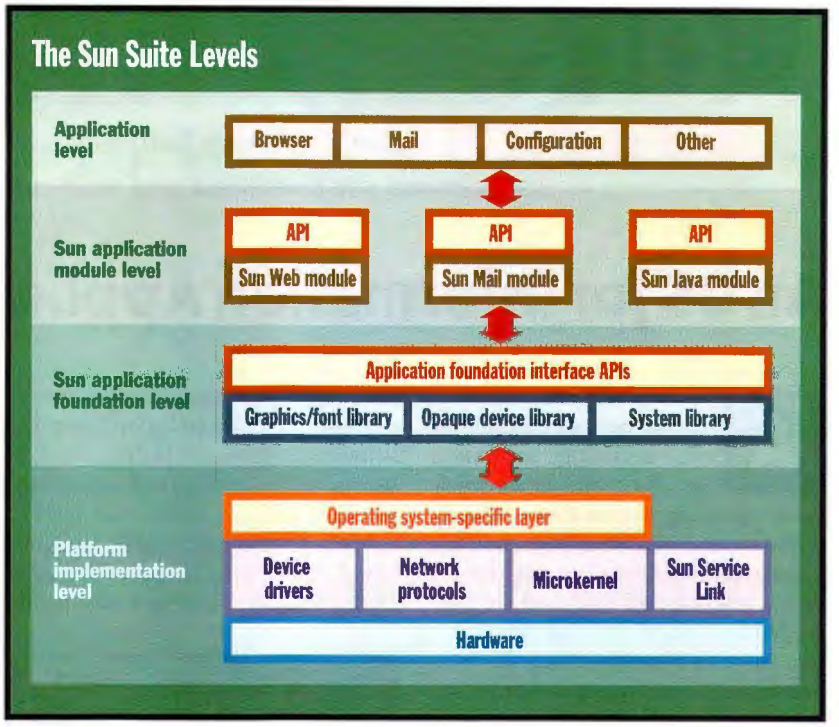
The system library acts as the intermediary between an application and the microkernel and helps make the applications OS-independent. It does this through a "generic" API that provides access to basic system services, such as memory management, error handling, thread and state management, messaging, and real-time clock/time interface. The most important of these services is memory management, since many IAs have limited physical memory with no virtual paging.

Modules and Applications

The third level consists of a set of Sun application modules that helps developers quickly create IA applications. Each module contains core pieces of software, written in C, that are common to many different appliance applications. Each module works with different displays.

The Web module provides designers with a toolkit for creating URLs and making HTTP requests. This module also parses HTML content and returns HTML marks to the application programs in a tree format, allowing designers to easily reformat the content. The Sun Mail Module allows designers to include multimedia e-mail in applications. It supports Internet mail messages using SMTP, POP3, and IMAP4. Multimedia type and multiport document handling is included, as well as a Multipurpose Internet Mail Extensions (MIME) engine for encoding and decoding character translation. Other modules provide basic services such as GUI widgets, telephony, real-time audio, real-time video, and Java.

The end-user applications are at the highest level of the Sun Information Appliance Suite. They implement the targeted task that the end user operates to obtain information. Sun has created several complete turnkey applications that developers can customize to bring IAs to market quickly. Some of these applications include Sun Browser, Sun Mail, Sun Configuration, Sun Telephony, and Sun Address Book. These easily customized applications enable developers to modify the underlying graphics and personality of the base application to create unique versions for specific products; for example, a developer might customize the Address Book application to operate on a cellular phone.



Each level further abstracts the IA's OS and hardware; applications can be quickly ported or customized for new devices.

OS for the Future

As consumer demand for easy access to information grows, it will further promote changes to information-access devices. OSes for these devices must be flexible, open, and modular, while offering high-level, easily customized applications. Sun has created such an OS, which can be licensed today in its complete form or as individual components. For more information, visit the Sun site at http://www.sun.com and request a copy of the Sun technology white paper entitled "Technical Architecture for the Information Age." B

Tom Whittaker is chief scientist for the Consumer Group at Sun Microsystems. You can reach him in care of **editors@byte.com.**

This object-oriented RPC architecture is built on standards, yet it is extensible. ***By Paul Clip***

DCOM: Microsoft Enhances DCE

Unlike Java's remote method invocation (RMI) or CORBA's Internet Inter-Orb Protocol (IIOP), the Distributed Component Object Model was not made from scratch. Rather, Microsoft built DCOM, introduced in Windows NT, upon an existing standard called the Distributed Computing Environment. DCE, created by heavyweights including IBM, HP, Sun, and DEC as a cross-platform environment, provides a common set of services such as remote procedure calls (RPCs), naming, thread management, and security.

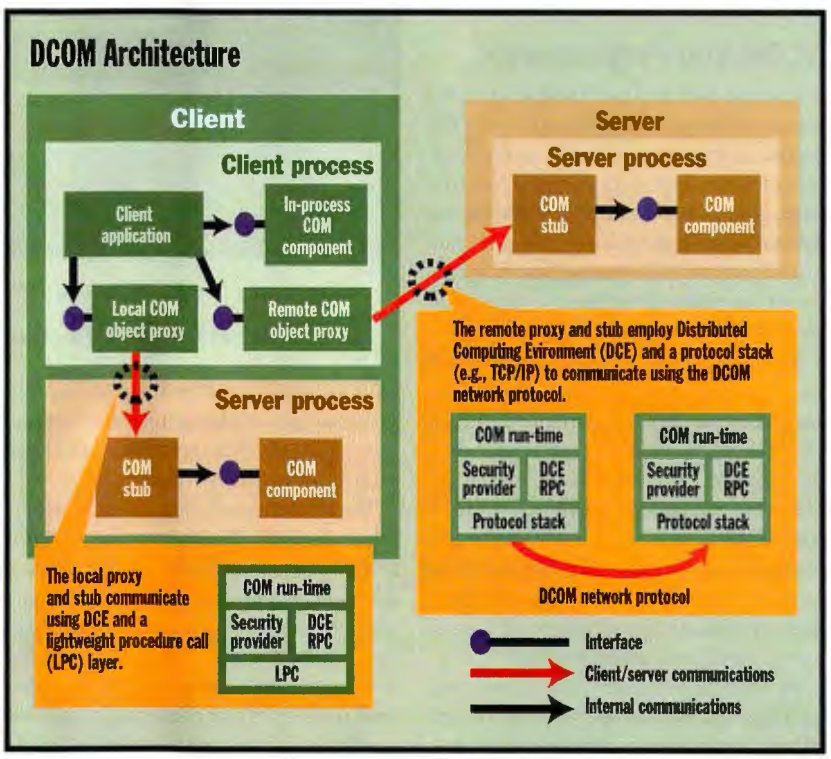
DCOM is also called Object RPC (ORPC) to indicate that it is an object-oriented extension of DCE RPC. In this article we will use the term DCOM more generally to refer to the distributed version of Microsoft's Component Object Model (COM), which defines how components interact with client applications. As such, DCOM builds on COM's strengths to bring features such as location independence, language neutrality, garbage collection, and component versioning to distributed environments.

A component exports one or more interfaces. Each interface is essentially a group of methods that the component implements and clients may call. The figure "DCOM Architecture" shows the different invocation models. If a component is in-process, a client invokes its methods directly, as it would invoke functions in a library. Otherwise, the client uses a proxy to call remote components, independent of whether they reside on the same machine or not. Each proxy has a stub counterpart on the server side that it communicates with to invoke a component's methods.

DCE RPC

DCE RPC is a complex RPC mechanism with a wealth of capabilities. For data marshaling, DCE provides the network data representation (NDR), which supports the encoding of arbitrary data types. In the realm of security, DCE RPC offers various levels of authentication, authorization, and message integrity. DCE can be configured to use the host computer's security mechanisms, hence the security-provider layer shown in the figure. DCE also supports a number of protocols, both connectionless (CL) and connection-oriented (CO). Perhaps most important, DCE RPC has been in use for a number of years and has proven its worth.

DCE RPC defines 20 different messages (called *protocol data units*, or PDUs) that are exchanged between client and server. Some are specific to CL or CO transport protocols; three are common to both. Each PDU consists of a header containing control information (e.g., the PDU's type and length), optionally followed by a body and an authentication verifier, depending on the PDU type and whether authentication is in use.



DCOM lets clients transparently invoke a procedure locally or remotely.

The figure "DCE RPC Messages" (see the next page) provides a high-level overview of the different PDUs, indicating their origin and grouping them by function. For brevity, only the connectionless PDUs are shown in their entirety. The most important messages are shared between CO and CL protocols: Request, Response, and Fault. A client uses a Request to invoke a remote pro-

cedure call; the server uses Response and Fault to return results or to return an error, respectively.

In CL mode, clients send an Ack to acknowledge receipt of a Response PDU. Servers send a Reject PDU to indicate that a Request is rejected, and why. A Ping is sent by a client to inquire about an outstanding Request. The server may reply either with a Working PDU that tells the client it is processing the Request or with a Nocall message that indicates it has not received the Request or that some of its fragments have been lost.

A client can cancel an RPC by sending a Cancel PDU, to which the server replies with a Cancel_Ack. When a message is too long to be sent in its entirety, both parties may send the Fack PDU to acknowledge receipt of a fragment of a Request or a Response.

DCOM and Performance

Although DCOM uses DCE as its RPC mechanism by default, much of DCOM can be overridden and customized. For instance, an application might not use NDR and instead handle marshaling on its own. Or it might not use DCE at all and provide its own RPC mechanism. This can be very useful to wrap legacy system services inside a COM component.

To reduce method invocation time, DCOM provides ways for components to copy their state to the client side, thereby eliminating network communication overhead on calls. Objects can even handle some operations on the client side while forwarding others to the server for further processing. For example, a component could cache a subset of a SQL query result, then incrementally fetch more rows if and when required.

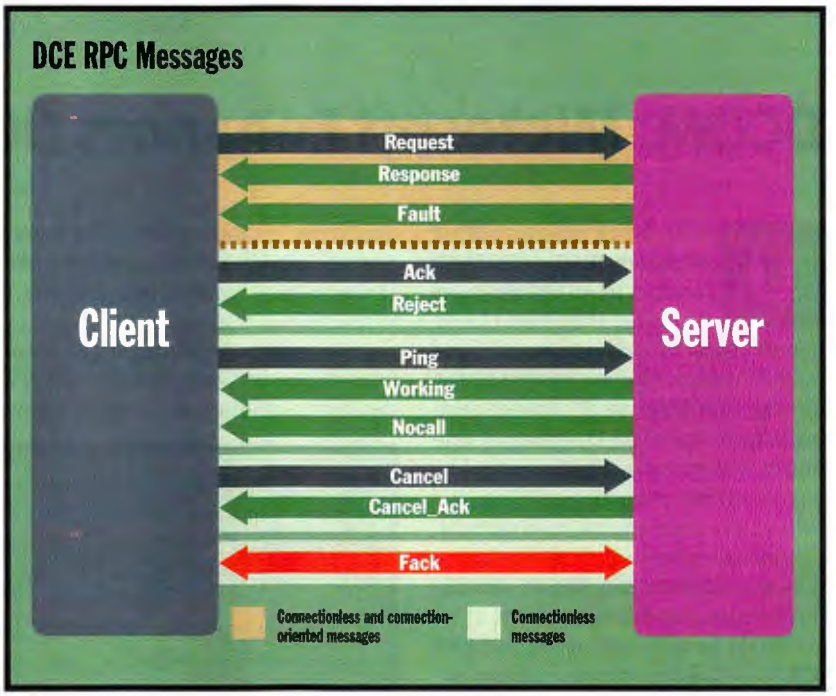
As with other distributed systems, garbage collection is a thorny issue: When does a server garbage-collect one of its objects, and how can it be sure no more clients are using it? DCOM solves this problem in two ways: reference counting and pinging.

Every time a new reference (i.e., an interface) to a component is obtained, the client calls DCOM's `AddRef` method to tell the server to increment the reference count for that object. When the client no longer needs the interface, it calls the `Release` method, which causes the server to decrement the reference count. A component with a count of zero can then be garbage-collected.

To improve performance by eliminating unnecessary network activity, DCOM combines multiple `AddRef` calls to increment the reference counts of different interfaces by arbitrary amounts. `Release` calls are also combined. In addition, a proxy defers releasing an object's interfaces until all local references to those interfaces have been released.

No reference-counting mechanism is impervious to clients crashing and not releasing their interfaces properly. To address this situation, DCOM uses a sophisticated pinging technique (unrelated to DCE's Ping PDU) that not only sends pings on a computer-to-computer basis (instead of object-to-object) but also employs delta pinging to combine objects into sets. This strategy reduces the size of each ping message. For example, 10 clients running on the same machine using the same server component results in only one ping—containing references to the 10 clients—not 10 individual pings. Delta pinging further groups the 10 references into a set to eliminate the need to include 10 client references at every ping.

DCE RPC specifies that RPCs be handled in arbitrary threads. COM provides support for both single-threaded and multithreaded invocation models. In the former, COM serializes RPCs to free the programmer from dealing with concurrency issues, possibly resulting in suboptimal performance. The multithreaded model allows various threads to invoke an object's methods simultaneously. This requires the programmer to use synchronization primitives to serialize access to shared data, but it improves call throughput.



Messages are exchanged through protocol data units (PDUs) that contain control, data, and security information.

More to DCOM

Although DCOM is still predominantly a Windows standard, Microsoft's partners are busy porting it to other platforms, such as Sun's Solaris and IBM's OS/390. DCOM's DCE foundations greatly facilitate this work since DCE has been widely ported. In an effort to move DCOM into the Java space, Microsoft's Java virtual machine incorporates the necessary capabilities for Java classes to access or become COM components.

Microsoft will be extending DCE RPC in NT 5.0 to enable clients to make asynchronous RPC calls. Further out, Microsoft's announced COM+ will substantially enhance COM by making it easier to use and more powerful. B

Paul Clip (**paul@clip.org**) *is an IT consultant at Sapient Corporation's San Francisco office. He focuses on object and Web technologies.*

The Mips processor architecture offers you ways to extend computing power for custom applications. ***By Reynaldo Archide***

A Flexible CPU for Digital Cameras

The Mips microprocessor architecture offers a number of major designer benefits, among them, flexibility. You can use its flexible architecture to partially customize the CPU core. Also, four coprocessor interfaces let you accelerate the core's computing power via tightly coupled, special-purpose processors.

These capabilities were especially valuable in the design of LSI Logic's CW4003 RISC processor. It represents the CPU in a system on a chip, the DCAM-101, that's the heart of LSI's digital camera (DCAM).

The CW4003's core is a derivative of the Mips R3000 architecture, with two additions: a multiplier-arithmetic bolt-on (MABO) unit and the use of the coprocessor 2 (CP2) interface to build a high-speed pixel processor. The DCAM-101 provides interfaces that support various peripherals, further simplifying a DCAM's overall design and reducing its cost.

DCAM Close-Up

The DCAM-101 consists of modules that implement the CW4003 processor core, the peripheral controllers, and a host of device interfaces. (See the figure "Digital Camera Processor.")

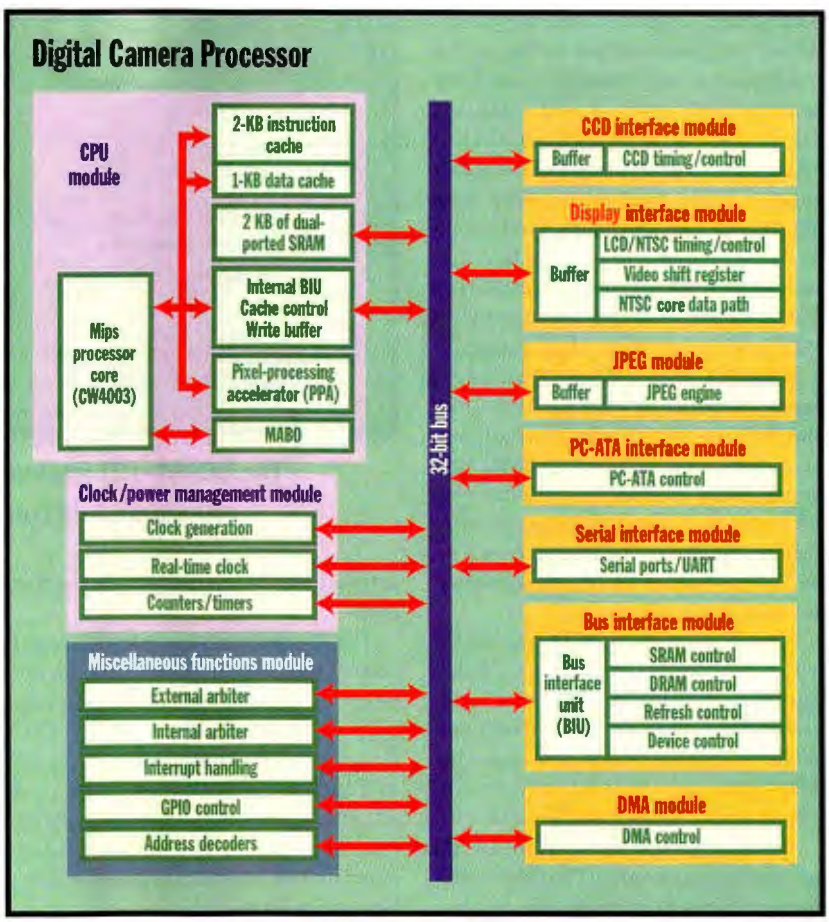
Some of the modules provide interfaces to the major DCAM subsystems: a serial interface for connections to desktop computers, a PC-ATA flash-memory interface for image storage, a charge-coupled device (CCD) interface for image capture, a JPEG compression/decompression unit, and an NTSC/PAL unit. This last module implements a 4-2-2 encoder input format and contains 10-bit programmable-video D/A converters (DACs) that generate S- and composite-video output for use on TV.

Other modules supply the signals and control for system parts: a bus interface unit (BIU) that handles external static RAM (SRAM) and DRAM, a DMA controller that moves data throughout the chip, and power management circuitry.

The CPU module contains the 32-bit CW4003 processor, the internal BIU, a 2-KB instruction cache, a 1-KB data cache, 2 KB of dual-ported SRAM, a pixel-processing accelerator (PPA), and the MABO. The processor core essentially controls the flow of data through the hardware-processing stages. It operates between 0 and 54 MHz, performs any load scheduling, and runs a subset of the Mips-II instruction set.

A new wait-for-interrupt (WAITI) instruction halts the core and keeps it from executing instructions until an interrupt is observed. This wait state dramatically reduces power consumption.

The MABO unit adds fast integer multiply instructions to the CPU core. When the core detects a multiply instruction, it is forwarded to the MABO, where it is



The Mips R3000 architecture lets the CW4003 core support special coprocessors and a slew of device interfaces.

executed. The MABO instructions include six multiply instructions that perform operations on unsigned and two's complement 32-bit numbers.

Besides multiply instructions, the MABO also executes the Mips divide and divide-unsigned instructions. All MABO instructions are pipelined, and its pipeline runs independently from the processor core pipeline.

The SRAM implements a direct-mapped architecture, where one memory address corresponds to one location in the cache. Because the SRAM is dual-ported, this lets the CW4003 and the DMA controller access it simultaneously.

Digital Camera Overview

The figure "Digital Camera System" shows how the system on a chip works. It connects to a CCD daughtercard that contains the DCAM lens, CCD array, and A/D converters (ADCs). The DCAM lens focuses an image onto the CCD, which is an array of photosensitive diodes. Each photodiode has a green, red, or blue filter, which causes it to respond to different ranges of the optical spectrum. The CCD and its associated circuitry construct a digital representation of the image.

When you snap a picture, the CW4003 reads out the light level of each pixel into SRAM. It uses the PPA to produce a 24-bit-per-pixel color image. You can display this image on an LCD or TV. You can also JPEG-compress it for storage in nonvolatile memory. The image shown on the LCD is stored in flash memory as soon as you take a picture.

The DCAM chip provides the DCAM with three modes of operation: Finder, Capture, and Display. Finder mode is used when you scan the environment. While you pan the DCAM, it processes the data captured by the CCD into an RGB format and presents it on the LCD.

As soon as you take a photo, the DCAM goes into Capture mode. The chip's operation and data flow are similar to those of Finder mode. However, the final image is JPEG-formatted, compressed, and transferred to flash memory. Display mode lets you view stored pictures. The DCAM retrieves an image from flash memory, uses the JPEG engine to decompress it, and maps it to the LCD or TV.

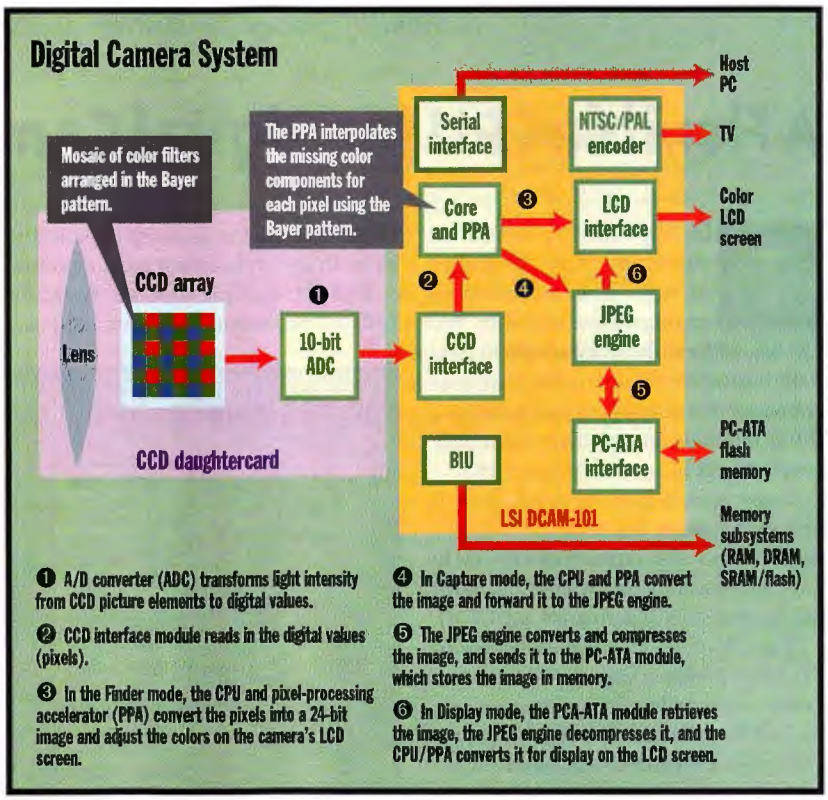
Making Picture Perfect

Acquiring an image with good color fidelity requires substantial processing of CCD image data. You begin by moving a CCD data block into SRAM, where it is transferred to the PPA. The CPU, PPA, and MABO (which executes single-cycle multiply/accumulate [MAC] instructions) run software algorithms that process the pixel data.

The PPA performs the heavy-duty processing that converts the CCD data into either an appropriate RGB image (for display on the DCAM's screen) or YCbCr image (for JPEG compression). The PPA first expects the CCD image to use a mosaic of colored dots arranged in the Bayer-pattern format. As shown in the figure, it consists of alternating green-red and blue-green lines.

The pixel color-processing operation is segmented into preprocessing and postprocessing stages. In the preprocessing stage, the PPA interpolates green pixel values by subtracting the green value from the corresponding red and blue values. In the postprocessing stage, it filters the red and blue values, and adds the green value back in.

The PPA then does the color-space conversion that compensates for the different types of displays and edge enhancement. The pixel-processing algorithms that were developed for this DCAM application are implemented via five dedicated hardware instructions (e.g., color plane separation and pixel subsampling) that significantly accelerate the interpolation process.



The DCAM-101 implements most of the camera's functions and controls on a single chip.

The One-Chip Solution

The simple act of taking a picture on a DCAM creates a lot of data traffic and requires great processing power—enough to perform complex color-space conversions and data compression/decompression at near real-time rates. Through the Mips architecture, LSI was able to add custom coprocessors and custom instructions to accomplish this task. The DCAM-101 does all this, while reducing the price of a cost-sensitive consumer product by providing glueless support to various DCAM subsystems. B

Reynaldo Archide is a project engineering manager for microprocessor cores at LSI Logic. You can contact him via the Web page at **http://www.lsilogic.com.**

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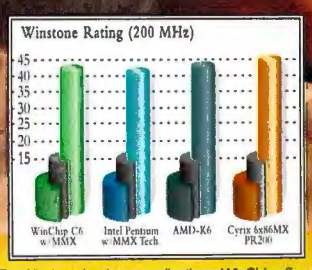
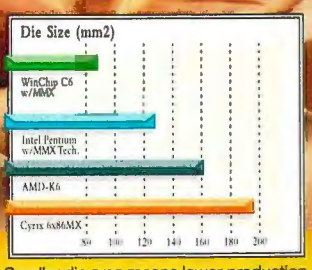
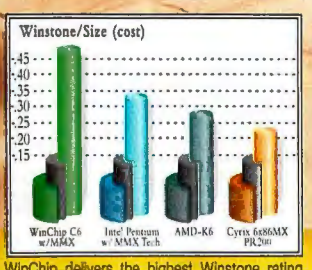


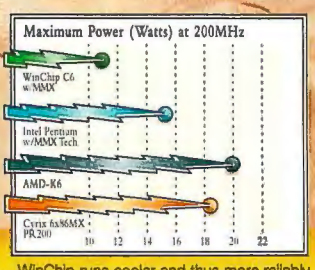
For Windows business applications, WinChip offers comparable performance to Intel Pentium with MMX Technology, AMD-K6 and Cyrix 6x86MX™.



Smaller die area means lower production cost, lower power consumption and heat dissipation.

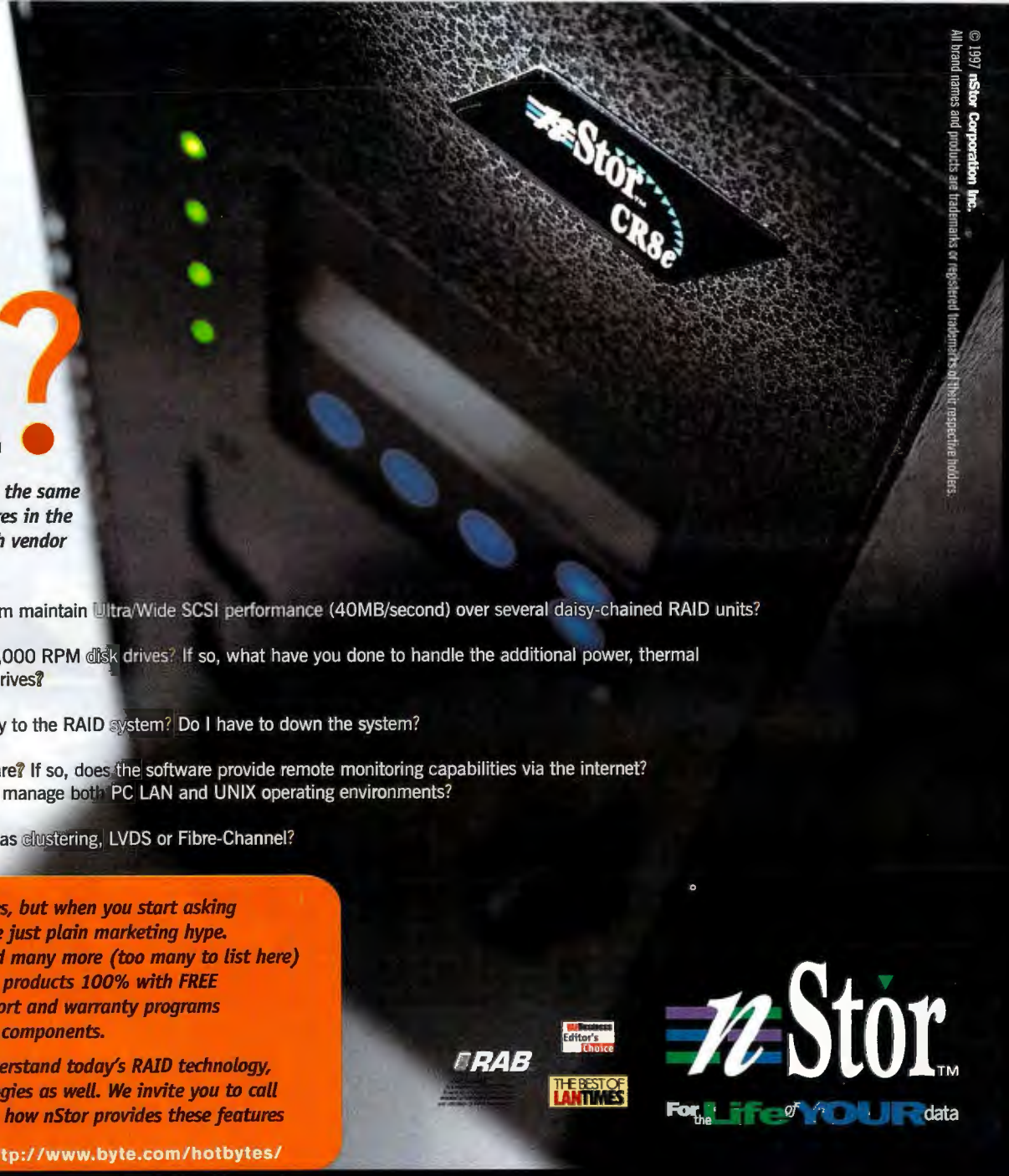


WinChip delivers the highest Winstone rating per square millimeter of die area among Pentium-class microprocessors.



WinChip runs cooler and thus more reliably than others, extending battery life for mobile users.

THINKING ABOUT RAID *for your* MISSION-CRITICAL data?



Then THINK about this: many RAID storage vendors list the same features, but not all companies implement those features in the same way. Before you purchase a RAID system, ask each vendor how their products provide the following features...

- Given Ultra SCSI's cable length restrictions, can the system maintain Ultra/Wide SCSI performance (40MB/second) over several daisy-chained RAID units?
- Does the system support the new higher performance 10,000 RPM disk drives? If so, what have you done to handle the additional power, thermal and vibration requirements of these higher performance drives?
- What if I need to reconfigure or add more storage capacity to the RAID system? Do I have to down the system?
- Does the system include free storage management software? If so, does the software provide remote monitoring capabilities via the internet? Does it include a common GUI interface to configure and manage both PC LAN and UNIX operating environments?
- Can this system be upgraded to future technologies such as clustering, LVDS or Fibre-Channel?

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You can use Java's run-time error checking to improve a program's performance. By David Orchard

Better Performance with Exceptions in Java

An *exception* is a special condition, usually an error, that interrupts the normal flow of program execution. You're probably all too familiar with processor exceptions, where a desktop computer's CPU detects a situation—such as a reference to a nonexistent memory address—that it can't recover from. But a few programming languages provide the means of detecting and responding to certain type of exceptions.

Why support exception handling when most function calls return error codes? Exceptions are an improvement over the use of return codes in two key ways. First, they provide a formal mechanism that generates an error condition and passes it to an error handler. Second, since they separate error handling from the regular flow of program operation, they let you consolidate all the handlers within one section of a program rather than strewing them about.

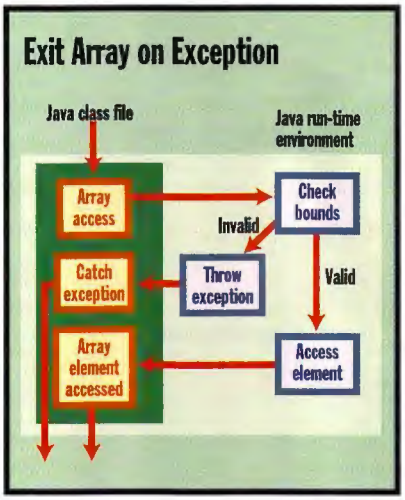
Java's exception mechanism provides a powerful means for asynchronously transferring program control outside of a method. In this article, I'll show how to use this feature to improve the performance of certain operations.

Taking Exception

In Java, you create an exception with the `throw` keyword. As the word *throw* implies, once an error occurs, the program's flow typically jumps to another method far, far away from the original one. The `throw` keyword creates an exception object, which contains information that's passed to a `catch` block.

The `catch` keyword specifies the code sections that execute when a particular exception happens. Put another way, the `catch` block contains the exception handlers. Since `throw` creates an object, you can throw distinct exception classes in response to different error conditions. Only the method whose class matches the exception object's type executes in the `catch` block.

If the method containing the `throw` statement doesn't have a `catch` block, Java throws the exception to the calling method. If this method doesn't have an exception handler for the exception type, it's thrown to its calling method. This act of passing the exception up the call stack ensures that, at some point, a method deals with the problem.



Java's built-in boundary checking lets you easily exit an array.

In situations where you want to limit the `throw` to handlers within the method that caused the exception, you use the `try` keyword. For example, a custom I/O method might require special handlers that deal with unusual conditions. This `try` block contains the methods that create—either accidentally or by design—exceptions, followed immediately by its `catch` block of handlers.

The `finally` keyword completes the description of exception handling in Java. A `finally` block specifies a section of code that always executes before the method returns. This includes any `return` statements within and without `catch` blocks and `throw` statements. Collectively, these code sections are known as the `try/catch/finally` statements, which are often abbreviated as the `try/catch` statements. A code fragment representing all these keywords and blocks is shown in the text box "Code Gallery" on page 54.

Run-Time Exceptions

While the Java compiler tries to catch as many errors as it can, most errors don't show up uninvited until a program runs. Java has many built-in exception classes that handle a variety of errors. The base class is `RuntimeException`, which handles most exceptions created by programming errors. Some of the exception types that `RuntimeException` handles include sanity checks on array and vector accesses, casting a class to the wrong type, and reading and writing from streams.

If your application does many of the preceding operations repeatedly and performance is a concern, consider replacing the error-checking code with an exception handler. Before firing up that code editor, you must first determine the cost of a `try/catch` block without the `catch` being executed. This shows you whether the cost of using such blocks can actually boost performance.

Compare the following two code samples, both of which use a loop.

Loop with error checking:

```
for( int i = 0; i < 2000; i++ )
  {
  message = String.valueOf(i);
  }
```

Loop with exception handling:

```
for( int i = 0; i < 2000; i++ )
{
try
  {
```

continued

```
  message = String.valueOf(i);
  }
catch (Exception e)
  {
   System.out.println("Should
     not be printed");
  }
}
```

Both of these loops yield almost identical benchmark times using JDK 1.1.3 on a system that has a 133-MHz Pentium and 48 MB of RAM, running Windows NT 4.0. (Since Java implementations are constantly updated, your mileage may vary.) This means that the `try/catch` clause takes time only when the `catch` statement executes. It's this feature that leads to the significant performance improvement of replacing array bounds-checking with a `try/catch` clause.

I also tried this code using Visual J++ 1.1 under NT. The results were completely unexpected: The Jview benchmarks resulted in a 15 percent performance degradation when using `try/catch` statements. Apparently, `try/catch` statements under Microsoft's virtual machine (VM) exact a substantial overhead. But I'll press on, discussing the use of JDK 1.1.3, assuming that not all Java developers are targeting the Microsoft VM.

Improvement by Exception

The traditional way to access an entire array is through a `for` loop. By slightly altering the `for` loop syntax, you can improve code legibility and performance all at once.

My test case was an array operation on integers. Both code fragments are shown in the text box at right. First I looped through a 2-million-element array, setting the values to the index. (The initial `for` loop code is in the section "Loop with bounds check.") For comparison, I deleted the bounds check and encapsulated the `for` loop in a `try/catch` statement, as shown in the section "Loop using exception." The second implementation yields a staggering 30 percent to 40 percent speed improvement using JDK 1.1.3 on the same hardware configuration.

Why is this so? I let Java's `java.lang.ArrayIndexOutOfBoundsException` handler break the thread of execution out of the loop while eliminating any bounds-checking code and its overhead. The figure on page 53 shows the execution flow. This example can boost the performance of applications that are processing large data arrays, such as algorithms that display or modify text or images.

But using exceptions is not a panacea. When I tried the improved code with the Microsoft VM, it yielded a 30 percent to 40 percent speed reduction. Obviously, the Microsoft VM handles exceptions differently than Sun's VM. While using exceptions can dramatically improve a program's performance for certain operations, it does so only with specific implementations. The situation is exacerbated by the fact that users can be running a medley of OSes, Java VMs, and browsers.

If this statement appears to make the task hopeless, remember that as good as Java is as a client-side language, it's a fabulous server-side language. For server applications, you can be certain of the Java VM that's running and tune your code accordingly. If you're using Sun's JDK, you should be able to achieve significant improvement in array-access performance by replacing bounds checking with exception handling. B

David Orchard is a technical architect at the IBM development center in Vancouver, British Columbia, Canada. You can contact him at **orchard@pacificspirit.com**.

Code Gallery

Sample try/catch/finally statements

```
Public class test
{
    public void aMethod()
    {
        try
        {
            // Normal method calls and processing
         }
         catch( myException me)
         {
             // Catch myException and handle condition
         }
         catch (Exception E)
         {
             // Catch all Exceptions except myException
         }
         finally
         {
             // code that must always be executed
         }
     }
}
```

Loop with bounds check

```
int anInt[] = new int[2000000];
for( int i = 0; i < anInt.length; i++ ) // Limit test in "for"
  {
  anInt[i] = i;
  }
```

Loop using exception

```
int anInt[] = new int[2000000];

  try {
    for( int i = 0;; i++ ) //No limit test here
    {
    anInt[i] = i;
    }
  }
  catch (ArrayIndexOutOfBoundsException e)
  { } // When we get here, we're out of the loop
```

Based on object-oriented standards, this language supports complex data types and distributed computing. ***By Daniel Evans***

The OQL Standard Emerges

We are now witnessing the advent of the next major wave in client/server computing. This change is the result of the convergence of distributed computing, object technology, and the Internet.

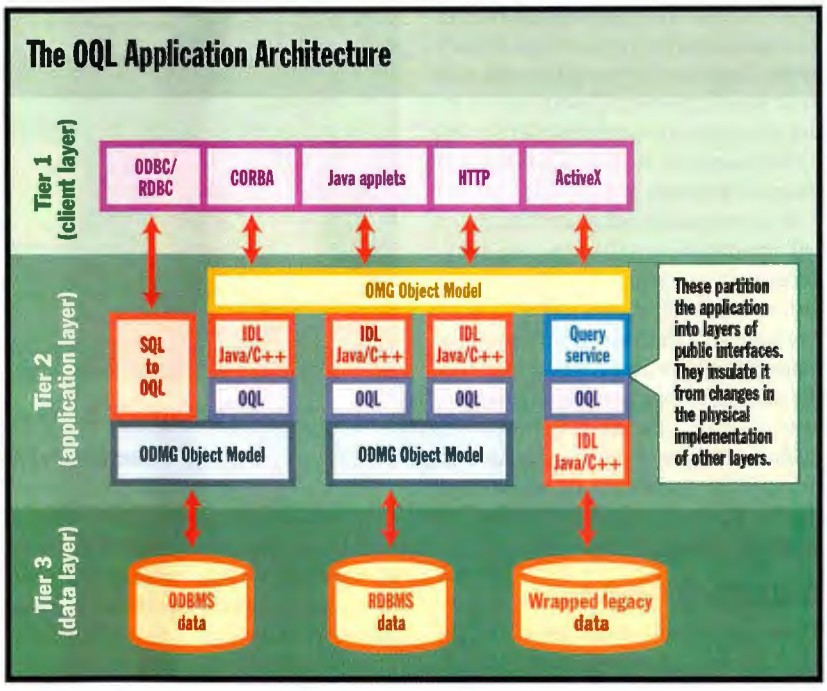
At the heart of this new paradigm is a simple yet powerful query language designed for managing data objects, called Object Query Language (OQL). Defined by the Object Database Management Group (ODMG) industry consortium, OQL is a superset of the SQL-92 query language. OQL is designed to leverage existing skills and knowledge while integrating support for industry-standard object models, such as the Object Management Group's (OMG) object model.

Two Forces

Two important market forces are driving the emergence of OQL as the standard for executing queries on objects: the need to manage complex data and its relationships, and the move to distributed object applications. I'll examine each of these forces in turn.

The first springs from the changing nature of data itself. While the quantity of data stored in relational databases has grown rapidly over the past decade, the explosion of complex data within corporate application environments is even more remarkable. Much of this data exhibits complex structure, such as spatial and multidimensional data, project plans, compound documents, and CAD designs. The growth of the Internet has only intensified the use of such data, since organizations deploy multimedia content on it at an ever-increasing pace.

To manage these data types, the ODMG OQL environment offers a number of object-oriented features. Using standard programming interfaces, you define new types of data objects and their related built-in operations (i.e., methods). You can invoke these operations within standard queries and execute them under the control of a query optimizer.



Using a variety of protocols, OQL provides transparent management of complex data objects.

The second force is the result of traditional two-tiered client/server application architectures giving way to *n*-tiered architectures. This move toward distributed object applications is related to a more fundamental shift toward object-oriented computing in all stages of the application life cycle.

Object Roots

To meet the needs of distributed object applications, the ODMG OQL environment embraces the best technologies available within the industry, including the following:

- **An Object Model (OM)**, based on the OMG object model.
- **An Object Definition Language (ODL)**, based on the OMG Interface Definition Language (IDL).
- **An Object Query Language (OQL)**, based on the SQL-92 query dialect.
- **An Object Manipulation Language (OML)**, defined by bindings to object-oriented (OO) languages, such as Java, C++, and Smalltalk.

By building on the existing OMG object model and IDL, developers can stay within a single object model for object programming, object messaging, and object management. The ODMG OM and ODL provide a consistent object model and definition language for mapping object schemata to data in other environments, such as object DBMSes, relational DBMSes, and object request brokers (ORBs), as shown in the figure "The OQL

Application Architecture" on page 55.

Since OQL builds on the SQL-92 query standard, it lets developers leverage existing programming skills. Because OQL uses the OMG object model, the integration with OO programming languages and ORBs is seamless, allowing OQL statements to be invoked within these environments. Conversely, OQL can directly invoke operations within other object environments.

Because OQL is based on OO programming language standards, developers can implement direct and transparent database interfaces for applications. This enables client- and server-side application logic to be implemented in a portable and nonproprietary manner instead of using a DBMS-specific stored-procedure language or database API.

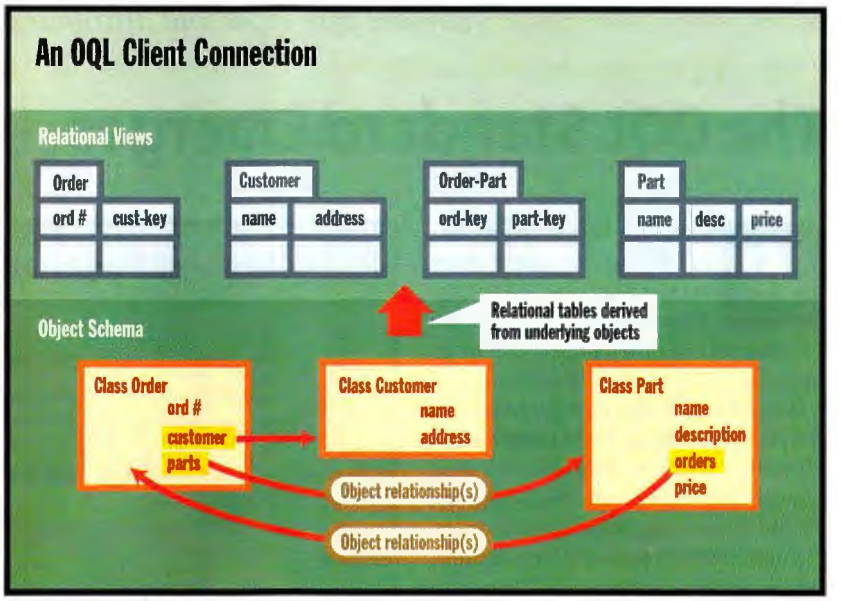
A current trend indicates that vendors will standardize on ODMG as a single and consistent environment for accessing relational and object data alike. A recent example includes JavaSoft's announcement to support the ODMG standard as the common object-relational mapping above the Java Database Connectivity (JDBC) API layer. A few vendors are also providing Java and C++ developer tools that transparently support relational and object database systems.

Ways to Connect

There are at least three ways in which OQL can be accessed from client applications. The first is to use ODBC or JDBC client connections to converse with OQL. A client application connects with the server using ODBC and sends SQL commands, which are directly mapped to OQL commands. On the server, a dispatcher process receives the connection request and transfers it to the first available OQL server process, which provides service directly to the client until it disconnects.

Relations are derived from objects by the generation of a tabular view of object schemata. Queries and update statements are processed against this view and translated into equivalent OQL query operations on native object data. Each class is mapped into a relation; atomic attributes of the class definition are mapped into the corresponding SQL atomic columns; and attributes referring to objects and one-to-one, one-to-many, and many-to-many relationships are translated into foreign keys, as shown in the figure "An OQL Client Connection" below.

The second way to access OQL is by using Common Object Request Broker Architecture (CORBA) application connections. A new generation of object-oriented tools leverages the capabilities of CORBA, giving clients a way to communicate easily with server-side resources using object messaging. Object messaging offers more flexibility to scale or partition distributed resources, making it the communications mechanism of choice for building distributed applications.



Through OQL, relational views are derived from underlying object classes.

In this technique, OQL is defined as the query language within a CORBA service called Object Query Service (OQS). This is a set of interfaces that map directly to OQL queries. Using OQS, an application executes standard OQL queries against collections of CORBA objects, independently of their physical location and storage mechanism.

Non-object-oriented data and legacy applications can be integrated using an implementation approach called "wrappers," which hide legacy data behind CORBA IDL object interfaces. These so-called wrapped objects then participate in distributed applications the same way that other CORBA objects do, using messaging and OQL-based query services.

The third means of accessing OQL is through HTTP/HTML Web connections. A rising percentage of new applications requires Internet-based data access. Dynamic Web interfaces can be combined with object messaging and OQL queries to provide high-performance transactional applications. Queries are requested using an OQL command embedded in URL links, which are sent to a gateway OQL process via an HTTP server. The query results are dynamically generated as HTML pages. The resulting pages can contain references to other objects (i.e., composite objects) that in turn contain other embedded OQL query links as URL addresses.

The Object Advantage

Application portability is a central concern within the design of any application system. Rather than inventing proprietary extensions to SQL to define and manipulate objects, OQL complies with industry standards defined by SQL, the OMG, and the ODMG. Support for ODBC, CORBA, and HTTP connections provides plug-and-play access for productivity, query, and development tools.

OQL's fundamental principle of deriving relations from objects, rather than extending relations to provide partial object support, yields significant advantages for users in performance, scalability, capabilities, and adaptability to change. B

Daniel Evans (Denver, CO) is product manager for object technologies at Unidata. He can be reached at **daniele@unidata.com**.

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Weaving a Better Web

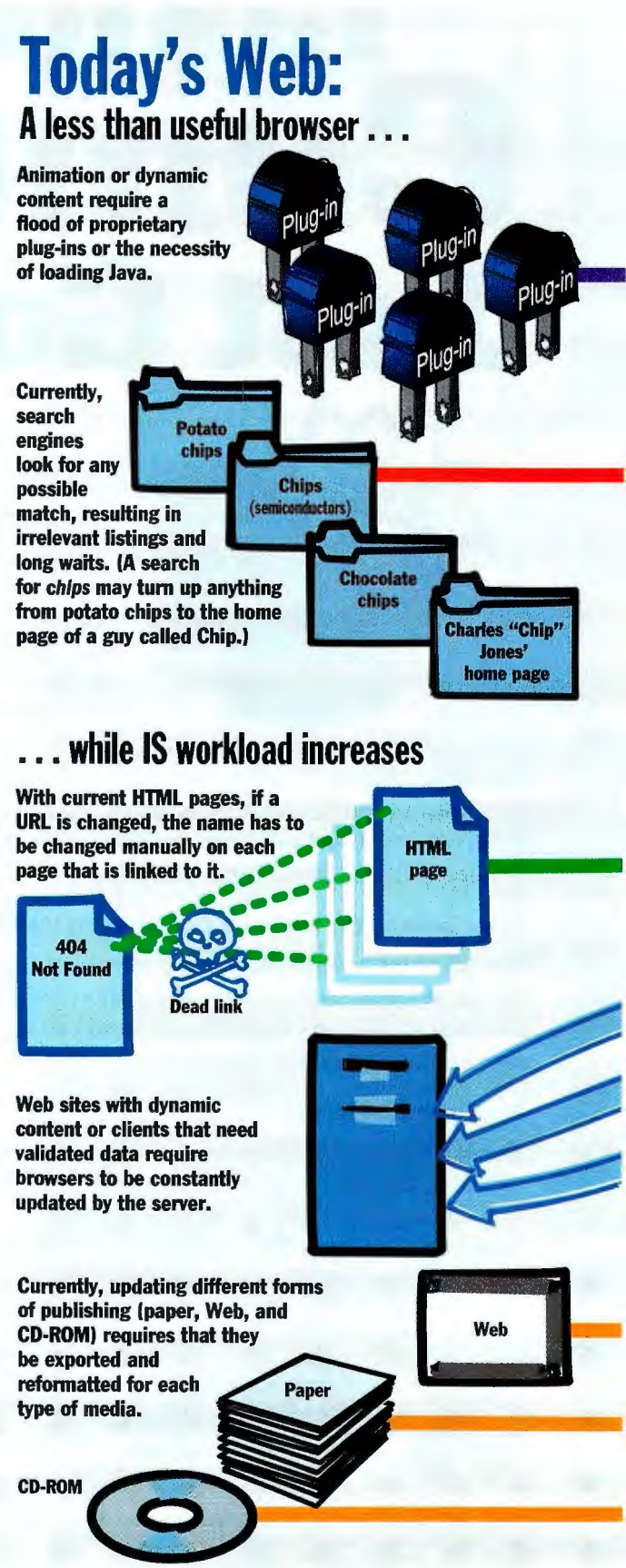
The features that made HTML so popular are causing the Web to fall apart. What's next?

By Scott Mace, Udo Flohr, Rick Dobson, and Tony Graham

We have a love/hate relationship with HTML. We love its easy learning curve and universality, but we hate its easily broken links and limited formatting. We love its simple and compact syntax, but we hate its rigid formatting and inflexibility. To keep what we love and jettison what we hate, we've scripted it, styled it, tabled it, and framed it. Yet, after more face lifts and tummy tucks than an aging Hollywood star, today's HTML is still just HTML. The broken links and formatting problems are just warts and cellulite that won't go away.

It's time to find some new, fresh talent. Although you probably won't discover them in the corner soda shop, a few new stars are about to break onto the scene with names like Extensible Markup Language (XML), cascading style sheets (CSS), and Dynamic HTML (DHTML). Each works on a slightly different set of HTML 3.2's problems: XML on helping organize and find data, CSS on Web page inheritance and presentation, and DHTML on dynamic presentation of Web content. Aided by the recent HTML 4.0 refresh, these new technologies will beat back HTML's legacy of too many dead links, slow searches, and static pages on today's Internet and intranets.

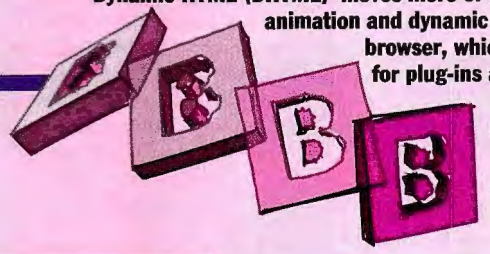
The bad news: At the time of this writing, browsers are between generations, not yet fully ready to embrace these new technologies and standards. But this lag may be just what hatching standards need, giving developers enough time to rethink the way their Web applications should work before a



1999 Web:

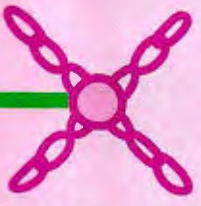
Browsers are doing their job better . . .

Dynamic content standard–cascading style sheets (CSS) and Dynamic HTML (DHTML)–moves more of the processing for animation and dynamic content to the browser, which reduces the need for plug-ins and will be much quicker. Some clients may use specialized Extensible Markup Language (XML) browsers.



XML documents contain tags that pertain specifically to the information you are interested in. You're able to navigate to desired data more quickly, and when entire industries agree on sets of tags, search engines don't have to work as hard, and results returned are consistently relevant.

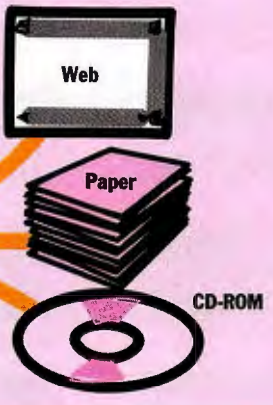
. . . while IS gets some help



With XML, centralized link management can update all instances of a URL by entering the new site just once, because aliases are used.

With XML data schemas (e.g., Resource Description Framework) more data validation will be performed at the browser. Dynamic content, too, will often be browser-based.

All forms of publishing can be done from one master XML document using XML tags and style sheets or Extensible Style Language (XSL).



rewoven Web hits with full force, starting at the end of this year.

Fixes on the Horizon

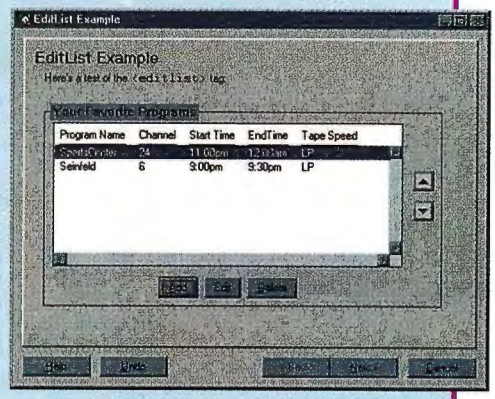
The fact that HTML has problems is hardly news (see "What's Wrong with HTML," below). Netscape, Microsoft, Macromedia, and a host of other companies have invested considerable effort in fixing the problems. We've all seen the results: proprietary HTML extensions, ActiveX controls, Java applets, and plug-ins that try to work around HTML's weaknesses. But these fixes all have problems of their own: They're proprietary, or they require users to install an application extension, or they're not completely supported by all browsers.

This year we'll start to see open, standard fixes to many of HTML's problems. XML, DHTML, style sheets, a document object model, and HTML 4.0 will create standard ways to get around most of the big problems we have with HTML today.

XML is probably the most notable. It's already a standard ratified by the World Wide Web Consortium (W3C), and it rep-

XML in Action

IBM's TaskGuide technology lets technical writers and user-interface developers generate "wizards"–task-oriented dialogs that guide the user, automating the task–without writing code. The XML-based system includes the option to create a recursive document, a wizard that builds another wizard. The following sample script defines a list of TV programs to be recorded; it generates the panel shown here.




```
<sguide>
<title>Editlist Example</title>
<panel name=programs next=done no-
image>
<p>Here's a sample editlist:</p>
<editlist
  name=programs
  type="progName(key), channel
   (format=integer),start, end, speed"
  headers="Program Name,Channel,
   Start Time,End Time, Tape Speed"
  add=addProgram
  edit=editProgram
  delete=deleteProgram
  separator=^A
  ordered
  init="SportsCenter^A31^A11:00pm^
   A12:00am^ALP^ASeinfeld^A6^
   A9:00pm^A 9:30pm^ALP^A"
 >Your Favorite Programs
</editlist>
</panel>
...
</sguide>
```

What's Wrong with HTML

The main thing that has made HTML so popular–its simple syntax–is also what has turned it into our biggest headache. Here are the main trouble spots.

Link tracking. Web pages move constantly, and Webmasters can't keep up with the changing URLs. Sure, there are automatic link checkers that will tell you when a link is broken. But the real problem is that HTML does not have the notion of a central link repository.

Syntax checking. HTML obstructs validation because it is not a rigid specification. Rather than checking documents for validity, HTML browsers specifically ignore syntax violations to make the display process more robust.

Extensibility. Because HTML is not extensible, developers cannot create their own tags to reflect their content's semantic relationships. HTML extensions are either proprietary features of the client (which leads to "browser wars" and unreadable documents) or require approval by a committee. They also fatten the specification because they cannot be imported as needed.

Structure. HTML lacks support for structure, such as nested information hierarchies. Documents are relatively flat, which limits searching to full-text searches and makes navigation cumbersome. (Wouldn't it be nice to have not just "Back" and "Forward" buttons but be able to traverse hierarchies with "Up" and "Down"? To automatically create site maps and tables of content? To "collapse" a page, showing just headings?)

Content-awareness. HTML searches have to look at all the content of every page. Therefore, they come up with too many hits. This is because HTML jumbles information and meta-information. Style and logic are hard-coded inside the document. Different views and presentations of the information (e.g., a large-print version) have to be generated by the server. Fancy formatting, such as two-column text, requires hacks by the content developer. (Cascading style sheets are an approach to solve this problem.)

Internationalization. Support for special and international characters (particularly characters with 2 or more bytes and mathematical formulae) is lacking or, at best, inconsistent in HTML. Where provided, it sometimes breaks when changing platforms.

Data interchange. Similarly, HTML does not help with automatic, reliable data interchange. Its markup controls the appearance of a document but does not provide for tagged data fields.

Reuse. HTML makes it difficult to reuse information. For the same data to be published on the Web, printed as a catalog, and maintained in a database, conversion and sometimes manual reformatting is necessary. Worse, this has to be repeated each time the information changes.

Dynamic content. Today's HTML-created pages don't let you refresh the look of a Web page – attributes like its color, font properties, font size, or background images–without loading a new page or invoking Java. Any data stored in Java becomes inaccessible from search engines. For any number of reasons, Java hasn't proven to be a panacea for serving up dynamic Web content.

Object orientation. Developers are hungry to seize the power of object orientation. Today's HTML tags don't map into an object model that would allow any part of a Web page to be treated as an object.

Applications Will Drive XML Acceptance

Once we have newly structured Web documents powered by XML tags, how will we share them and the data contained within them? The unfolding answer appears to be through metadata, as well as a host of industry-specific applications, followed by a surge of e-commerce and Electronic Data Interchange (EDI) efforts.

Resource Description Framework
http://www.w3.org/Metadata/RDF

XML's most important application will probably be the Resource Description Framework (RDF), which will let applications describe to each other not only the data in each document but also new data fields and classes. RDF defines relationships between XML data otherwise left undefined, such as whether the data's position in a document is important.

Netscape's Aurora, a future piece of the Communicator browser, reportedly will use RDF to store bookmarks, mail preferences, and local file and channel identification.

RDF consolidates several earlier, similar metadata syntax efforts, including Web Collections, developed by Microsoft and IBM; Meta Content Framework, developed by Netscape; and XML-Data, developed by Microsoft.

RDF benefits will include better search engines; being able to describe the content and content relationships available at a particular Web site, page, or digital library; facilitation of knowledge sharing and exchange; content rating for child protection and privacy protection; being able to describe collections of pages that represent a single logical document; and being able to specify intellectual property rights of Web pages.

Channel Definition Format
http://pushconcepts.com/microsoft.htm

Microsoft's proposed CDF is an XML application that allows Web publishers to control push technologies. It has been submitted to the World Wide Web Consortium (W3C). Among other things, CDF can be used to specify channels, the information they provide, and their update schedules. The hope is that CDF will help make different push technologies interoperable by doing away with proprietary push technology: Using a CDF-compliant receiver, people could get content from different, previously incompatible kinds of sites (which also would have to comply with CDF, of course).

Open Financial Exchange
http://www.onestandard.com/developers_ofx_specification.html

OFX is a framework for exchanging financial data and instructions among financial institutions and their customers. It allows institutions to connect directly to their customers, without an intermediary. OFX integrates Microsoft's Open Financial Connectivity, Intuit's OpenExchange, and CheckFree's electronic banking and payment protocols.

OFX, which is based on SGML, predates XML and was at the time of this writing incompatible with XML, lacking end tags. Microsoft says OFX will soon be based on XML.

XML/EDI
http://www.geocities.com/WallStreet/Floor/5815

Electronic Data Interchange has for years struggled to take existing paper documents exchanged between companies and automate them. XML just might make EDI fly. XML/EDI is an effort to provide a standard format for XML documents to describe different types of data—for example, loan applications, invoices, or health-care insurance claims, with gateways to existing X12 and EDIFACT systems.

Open Software Description Format
http://www.w3.org/TR/NOTE-OSD.html

Automatic software distribution, like EDI, has been around as a concept for years. OSD, jointly submitted to the W3C by Marimba and Microsoft, is a set of XML tags for describing software packages and their dependencies, and for dealing with software running on multiple platforms.

Chemical Markup Language
http://www.venus.co.uk/omf/cml/doc/tutorial/xml.html

Chemical Markup Language (CML) started out as a Standard Generalized Markup Language (SGML) application but was recently upgraded to XML. It describes molecular and crystal structures, analysis spectra, and other chemical objects.

Mathematical Markup Language
http://www.w3.org/TR/WD-math/

MathML is an XML application for describing mathematical expression structure and content. It would properly display mathematical characters and equations within browsers for the first time since the Web was invented.

resents the largest departure for people used to writing standard HTML. XML, which defines document structures rather than how a browser should display a document, will give Web developers a lot more flexibility. It changes the way browsers display, organize, and search information. It could even make broken links a thing of the past. There are rumors that the next version of the Netscape browser (due this spring) will be XML-compliant. Netscape declined to comment. Microsoft has already built an XML-compliant application with the Channel Definition Format. Expect some major changes in the Web starting at the end of this year as sites start using XML.

It is important to note that HTML and XML are not competitors: They complement each other. Browsers will be able to process both, and future HTML standards will likely allow mixing HTML and XML in the same document.

For its part, DHTML aims to provide richer graphics and data with fewer, faster page downloads. In particular, it makes it easy to present information differently depending on user feedback. DHTML is currently undergoing some standards-body fighting as Microsoft and Netscape pitch their different flavors for ratification by the W3C.

Style sheets enable you to create pages that inherit properties from other pages. Currently, CSS goes hand-in-hand with HTML. It appears that XML, too, will have style sheets, specified using the Extensible Style Language (XSL).

W3C's Document Object Model (DOM), now a draft recommendation as part of the DHTML spec, will allow HTML and XML scripts, and other programs, to access structured data under program control. DOM also adds object orientation to page layout and design. For example, HTML elements appear as objects and collections that expose properties and methods. Developers can use DOM and a scripting language, such as JavaScript, JScript, or VBScript, to manipulate the DOM and achieve dynamic styles, content, and positioning. Scripts can manipulate positioning attributes to create animations on an HTML page.

DHTML, and to some extent DOM, have had a rougher birth than XML, with Microsoft and Netscape taking radically different tacks toward serving up dynamic content and defining Web elements as objects. Let's take a closer look at some of

New Tools for a New Web

XML-enabled tools will be the next big wave. More than 150 SGML software packages will be fitted with an XML output filter within months of the final adoption of XML 1.0. There will also be some XML support for non-SGML word processors—which makes sense as long as they are capable of producing some kind of structured text. On the receiving end, expect XML plug-ins for standard HTML-based Web browsers, XML support via Java apps, as well as full-fledged native XML browsers.

Adobe FrameMaker
Adobe is implementing support for XML in both FrameMaker and FrameMaker+SGML, expecting to ship the XML-enabled versions in the second quarter of this year.

In addition to creating structured XML documents, both FrameMaker and FrameMaker+SGML can convert unstructured documents to XML. In this case, they map paragraph and character tags to element names. Adobe's current implementation creates a cascading style sheet with each XML instance. XSL support, Adobe says, will be implemented "as the XSL specification becomes more stable."

ArborText Adept & Cedar
ArborText is a leading supplier of SGML software. The company's Adept Series lets users create and maintain textual and document information as reusable elements. It includes an interface for document management as well as Document Architect for handling DTDs and style sheets. It was recently upgraded with XML capability.

In December 1997 ArborText previewed its Cedar project at the SGML/XML conference in Washington, D.C. A downloadable beta version should be available by the time you read this. Cedar "is focused on the creation of style sheets based on XSL for XML documents." ArborText was (with Microsoft and Inso) one of the three companies that originally submitted the XSL proposal to the W3C in September 1997.

Grif doc+
Grif's Symposia started out as an HTML browser and editor, which Grif codeveloped with INRIA, France's national computer science research institute. At the time of this writing, Grif was beta-testing Symposia doc+, an intranet publishing solution that includes a WYSIWYG authoring tool, a database publishing mode, and a graphical site manager. A free evaluation version is available for downloading.

Microsoft Internet Explorer 4.0
Microsoft has been instrumental in the proliferation of XML so far, has codeveloped some of the related standards, and has developed the first public implementation of an XML engine, which is part of Internet Explorer 4. Currently Microsoft is giving away a number of tools, including MSXML, a validating XML parser written in Java. It checks for well-formed documents and optionally permits checking for validity. Once parsed, the document is exposed as a tree through a set of Java methods, which Microsoft is working with the World Wide Web Consortium to standardize. These methods support reading and writing XML structures, such as the Channel Definition Format (CDF), enabling developers to build XML-based applications.

these technologies that promise to revolutionize the Web.

XML: Bigger Than HTML, Smaller Than SGML

HTML is based on Standard Generalized Markup Language (SGML), a much larger metalanguage that predates the Web. SGML specifies grammars for document markup languages, and SGML documents bring their grammar definition with them in the form of the Document Type Definition (DTD). DTD specifies tags used in the document and the meaning of those tags.

HTML is a single SGML application—a hard-wired set of tags. HTML 3.2, for example, specifies about 70 tags and 50 attributes. Because HTML is a fixed, nonextensible grammar, HTML documents do not need to include the DTD. Its fixed nature makes HTML easy to learn and makes it easy to write HTML viewers. It also means that it can be very difficult to get HTML to do what you want.

The incredibly extensible SGML would fix that particular problem, but SGML is too cumbersome to learn and implement easily. Instead of bringing all of SGML to the Web, the World Wide Web Consortium has proposed a thinner version: XML. You can think of XML as a kind of SGML Lite, intended to bridge the gap between SGML's richness and HTML's ease of use in Web applications. XML is a metalanguage like SGML, but while changes to HTML require an update of the standard, XML is meant to be extended. As soon as an extension is specified within XML, it becomes universally available.

At the SGML/XML conference in Washington, D.C., last December, version 1.0 of the Extensible Markup Language specification was issued as a W3C Proposed Recommendation. Before that, W3C's XML Working Group, chaired by Jon Bosak of Sun Microsystems, had published several working drafts, edited by Tim Bray (Textuality/Netscape), Jean Paoli (Microsoft), and C. M. Sperberg-McQueen (University of Illinois at Chicago). Final ratification of XML 1.0 was due for late January.

XML was designed to be easier to use than SGML. As Richard Light writes in his book *Presenting XML*: XML offers "80% of the benefits of SGML for 20% of its complexity." The XML designers tried to leave out only those parts that are rarely used. That turns out to be quite a lot: The XML specification needs about 30 pages, compared to 500 for SGML. One objective of the XML Working Group is that experienced programmers should be able to develop an XML parser in a week. That said, XML is a verbose format compared to HTML, though compression features in newer versions of the Hypertext Transfer Protocol (HTTP) should ensure that XML documents download efficiently over networks.

What's the catch? XML is not compatible with today's HTML. For one thing, this means you'll need to upgrade your HTML browser to an XML browser. While SGML tools can handle XML (see "New Tools for a New Web," above), an XML tool will not be able to read all flavors of SGML—and one of those is HTML. That's because XML uses a slightly different syntax than HTML and enforces syntax rules more rigorously. (See "The Power of XML Syntax," page 63.) HTML documents will require changes, albeit minor ones, to become XML-compatible.

Why the changes? XML breaks the bounds of HTML's fixed set of tags, letting developers define an unlimited number of tags to describe any data element in a document. These data elements can be nested hierarchies of information, orga-

The Power of XML Syntax

If you're familiar with HTML, you know that it has a fixed set of tags that control the appearance of information (things like font names, styles, and sizes). In other words, HTML describes the presentation of information. XML, on the other hand, should describe the data, rather than the formatting; an external style sheet should control a document's appearance. Tags can be application-specific or they can be imported from a public Document Type Definition (DTD).

What all this means is that XML looks kind of like HTML, but its function is drastically different. The following example has tags for a book's title, price, author, and so on, much like fields in a database.

```
<ORDER>
 <SOLD-TO>
  <PERSON><LASTNAME>Layman</ LAST
   NAME>
   <FIRSTNAME>Andrew</FIRSTNAME>
  </PERSON>
 </SOLD-TO>
 <SOLD-ON>19970317</SOLD-ON>
 <ITEM>
  <PRICE>5.95</PRICE>
  <BOOK>
   <TITLE>Number, the Language of
    Science</TITLE>
   <AUTHOR>Dantzig, Tobias</AUTHOR>
  </BOOK>
 </ITEM>
 <ITEM>
  <PRICE>12.95</PRICE>
  <BOOK>
   <TITLE>Introduction to Objec-
    tivist Epistemology</TITLE>
   <AUTHOR>Rand, Ayn</AUTHOR>
   <ISBN>0-452-01030-6</ISBN>
  </BOOK>
 </ITEM>
 <ITEM>
  <PRICE>12.95</PRICE>
  <RECORD>
   <TITLE><COMPOSER>Tchaikovsky</COM
    POSER>'s First Piano Concerto</TITLE>
   <ARTIST>Janos</ARTIST>
  </RECORD>
 </ITEM>
 <ITEM>
  <PRICE>1.50</PRICE>
  <COFFEE >
   <SIZE>small</SIZE>
   <STYLE>cafe macchiato</STYLE>
  </COFFEE >
 </ITEM>
</ORDER>
```

In addition to the fact that none of these tags describes what the data will look like when you view it (that's up to the DTD), there are two other notable differences between HTML and XML:

First, note that each tag has a matching end tag (HTML is more lenient about this). Note also how elements are nested—an element may contain text and other elements, but elements may not overlap. XML calls anything that appears between an element's start and end tags the element's contents.

Second, XML documents should begin with a declaration of the XML version being used:

```
<?xml version="1.0"?>
```

This allows an XML "processor"—a kind of parser—to automatically recognize the version of a document it receives and reject versions it does not support. Unlike HTML browsers, which simply ignore syntax they don't understand, XML parsers can reject content.

nized just as naturally as papers within file cabinets. A valid XML document is one in which these hierarchies are properly defined and nested.

Declaring these tags and hierarchies at the outset greatly reduces the amount of procedural code a developer has to write to create a structured application. The downside: Developers can't embed any XML tag in any order in documents. Furthermore, for the XML document to be valid, each new tag must be included in a DTD, which can be stored in a separate file. (As a performance boost, a server can offer up an XML document without its DTD, in which case XML parsers can declare the document "well-formed" without having to refer to the DTD.) If the tags aren't embedded within each other properly, the parser declares the XML document invalid. All this validity checking is more work than HTML, but it yields greater rewards.

The benefits of reworking documents in XML are substantial. Because encoding Web content in XML makes the information's structure more accessible, it helps search engines return more meaningful results. (See "XML Namespaces," page 64.) XML also introduces concepts that will ease maintenance and make Web applications more stable, including bi-directional and externally stored links. Web clients can be more intelligent and take over tasks that are currently handled by the server.

XML's Structure and Language Elements

Although XML has many parts, you really need to know about three in order to understand how it works: the Document Type Definition (DTD), XML's layout language; the Extensible Style Language (XSL), XML's version of style sheets; and the Extensible Link Language (XLL), a system for handling links beyond HTML's hard-coded, in-line hrefs.

DTD The Document Type Definition specifies the logical structure of a document. It enables you to define the grammar of a document, which, in turn, enables an XML parser to validate a page's use of its tags (see "The Power of XML Syntax," at left). The DTD defines a page's elements and its attributes as well as the relationships among those elements and attributes. For example, the DTD can specify that a list item can occur only within a list.

Ideally, the definitions should be oriented toward describing the data structure associated with the application, rather than how the data should be displayed. In other words, define an element as a headline, and let the style sheets and scripts define how a headline should look. XML DTDs are getting a running start by leveraging the work done on DTDs for a range of applications for SGML. (See "Applications Will Drive XML Acceptance," page 61).

DTDs aren't mandatory. For simple applications, developers need not build their own DTDs (which is no mean task); they can use predefined, public DTDs, or none at all. Even if a DTD exists for a document, the parser may choose not to check the document's validity against the DTD (as long as the document is well-formed). The server may have already done the check—time and bandwidth will be saved.

XSL Extensible Style Language is the language used to specify style sheets for XML documents. XSL enables Web browsers to change the presentation of a document—for example, the order in which data is displayed—without further

XML Namespaces

We make a big deal out of the fact that XML describes data, not presentation information. But what good are data descriptions if you are the only one who describes a particular kind of data that way? XML allows authors to invent new element names and publish them for others to use and thus agree upon standard terms for common data elements. These published namespaces prevent name conflicts and indicate who defined a term. They also will make the work of search engines easier, as tags become more meaningful.

A name begins with a letter or one of a few punctuation characters, and continues with name characters, which include letters, digits, underscores, hyphens, colons, and periods. Names beginning with the string `xml` are reserved. Here's an example of some XML that calls two defined data description namespaces—one for an order, one for a digital signature (such as a VeriSign signature):

```
<xml>
 <xml:schema>
  <namespaceDcl href="http://www.company.com" name="co"/>
  <namespaceDcl href="http://www.dsig.org" name="dsig"/>
 </xml:schema>
 <xml:data>
  <ORDER>
   <SOLD-TO>
    <PERSON><LASTNAME>Layman</LASTNAME>
     <FIRSTNAME>Andrew</FIRSTNAME>
    </PERSON>
   </SOLD-TO>
   <SOLD-ON>19970317</SOLD-ON>
   <dsig:DIGITAL-SIGNATURE>1234567890</dsig:
    DIGITAL-SIGNATURE>
  <ORDER>
 </xml:data>
</xml>
```

An author can also specify an element's data type and format. A `lextype` attribute can be used for this purpose:

```
<SOLD-ON lextype="DATE-ISO8061">19970317</SOLD-ON>
```

"DATE-ISO8061" specifies that `SOLD-ON` contains a date in the format specified by ISO 8061. Authors can design their own data types and use public types. Microsoft is working with the World Wide Web Consortium to define a set of standard types and will publish a list that anyone can freely use.

interaction with the server. By switching style sheets, the same document can be displayed in large print or Braille, collapsed to show just the outer hierarchical layers, or formatted for print. Imagine a technical manual that adapts to the learning curve of the user: It has styles for beginners and for the more advanced, all generated from the same text base. (Now you see why the DTD shouldn't control how the information is displayed.)

XSL can handle an unlimited number of tags, each in an unlimited number of ways, by virtue of its extensibility. It brings advanced layout features to the Web, such as rotated text, multiple columns, and independent regions. It supports international scripts, all the way to mixing left-to-right, right-to-left, and top-to-bottom scripts on a single page.

Much as XML takes the middle ground between HTML and SGML, the proposed XSL standard takes the middle ground between CSS and SGML's Document Style Semantics and Specification Language (DSSSL). DSSSL defines a full-featured model for formatting objects. Widespread implementation of DSSSL may have been impeded because it uses Scheme syntax, and because it is very complex. In comparison, CSS uses a simpler model (for example, it cannot reorder elements). The XSL proposal supports DSSSL flow objects and CSS objects, uses XML syntax and a declarative language, and provides an escape into ECMAScript for complicated tasks and to allow extensions. Mechanical mapping from CSS to XSL will be possible—content developers need not learn the full language.

As a technology preview, Microsoft recently released two XSL processors: a command-line utility that produces HTML output from an XML document and an XSL style sheet, and an ActiveX control for displaying XML in a browser. The Microsoft XSL Processor runs on Windows 95 and Windows NT (x86 only) with Internet Explorer 4.0.

XSL is a bit behind the timetable for XML. ArborText, Inso, and Microsoft submitted a proposal for XML to the W3C in August 1997 as a note for discussion. The W3C is creating a separate XSL working group because completing XSL requires a different range of expertise than previous components of XML.

XLL XML's Extensible Link Language will support simple links as they exist on the Web today, but it will go on to implement extended links, including indirect links that can put an end to the dead links and the connector "|" that causes only the relevant part of an element to be retrieved from the server.

In the words of Jon Bosak, who chairs the XML Working Group, "HTML, this so-called 'hypertext markup language,' implements just a tiny amount of the functionality that has historically been associated with the concept of hypertext systems. Only the simplest form of linking is supported—unidirectional links to hard-coded locations. This is a far cry from the systems that were built and proven during the 1970s and 1980s."

In a true hypertext system of the kind envisioned for the XML effort, Bosak explains, all the classic hypertext linking mechanisms will be supported:

- location-independent naming
- bidirectional links
- links that can be specified and managed outside of documents to which they apply
- n-ary hyperlinks (e.g., rings, multiple windows)
- aggregate links (multiple sources)
- transclusion (the link target document appears to be part of the link source document)
- attributes on links (link types)

These will be achieved through XLL, which is currently under development. As XML is based on SGML and XSL on DSSSL, XLL is basically a subset of HyTime

Summary of DHTML Benefits

Benefit	Microsoft DHTML	Netscape DHTML	Description
Dynamic styles	✔	✔	Change the appearance of styles on a Web page.
Dynamic content	✔	✔	Change the content on a Web page.
Dynamic positioning	✔	✔	Move the position of content on a Web page.
Font embedding	✔	✔	Download fonts with a Web page so content always displays in a specified font.
Data binding	✔		HTML extensions that facilitate tight client-side integration with data sources. Current Microsoft approach relies heavily on ActiveX controls.
Filters and transitions	✔		Filters and transitions to achieve low-level multimedia effects, such as fades, glows, drop shadows, and checkerboard transitions.

✔=yes

Other XML Tools and Applications

Copernican Solutions XML Developer's Toolkit
http://www.copsol.com/products/xdk/XDK
Checks, validates, loads, and accesses XML documents.

Norbert's XML Parser
http://www.edu.uniklu.ac.at/~nmikula/NXP/
Used during development of XML; downloadable from NXP Web site.

Jade
http://www.jclark.com
Will be one of the first packages to support XSL; downloadable from Jade Web site.

Silknet eService 98
http://www.silknet.com/
Enterprise customer-service application will support XML during 1998 to integrate data from Vantive, Scopus, and Remedy customer-service applications.

(Hypermedia/Time-based Structuring Language, ISO 10744). It also follows linking concepts specified by the Text Encoding Initiative.

Where Is XML Going?

Since development began in September 1996, XML has acquired an avalanche's momentum. Version 4 of Microsoft's Internet Explorer supports XML, and Netscape may have followed suit by the time you read this. Many other companies, including Adobe, ArborText, Sun, and Xerox, have announced their support. XML will no doubt become the vehicle for publishing SGML-based information on the Web.

Netscape has proposed combining the Meta Content Framework (MCF) with XML. Microsoft based its Channel Definition Format (CDF) on XML.

According to Bosak of the XML Working Group, the applications that will drive the acceptance of XML can be divided into four broad categories:

1. Applications that require the Web client to mediate between two or more heterogeneous databases.
2. Applications that attempt to distribute a significant proportion of the processing load from the Web server to the Web client.
3. Applications that require the Web client to present different views of the same data to different users.
4. Applications in which intelligent Web agents attempt to tailor information discovery to the needs of individual users.

One of the applications that falls into the first category is electronic commerce, particularly if based on Electronic Data Interchange (EDI). In this context, it comes in handy that the structure XML brings to Web data makes it easier to attach digital signatures, as well as to encrypt a document or parts of it. The W3C Digital Signature Initiative is working on XML-based security and authentication. In other applications, where automation and information reuse are required, XML will complement HTML. Whatever the future, the transition will be smooth and users will not have to suffer.

DHTML: HTML Gets Richer

XML, despite any technical advantages, is still new and different from HTML. Many Web developers are going to have problems migrating large sites to XML or training their staffers to work with this more sophisticated language. Wouldn't it be better to just extend HTML's capabilities while maintaining at least some of the familiar syntax? Netscape and Microsoft, with the 4.x releases of their respective browsers, introduced something that each called Dynamic HTML (DHTML). The concept: provide richer graphics and data with fewer, faster page downloads.

Three core benefits of DHTML include dynamic styles, content, and positioning. Dynamic styles enable developers to change the appearance of content without forcing users to download all the content again. Dynamic content lets developers change the text or images that appear on a page so that content can respond interactively to user mouse and keyboard behavior. Dynamic positioning lets page authors move text and images around a page either automatically or in response to user behavior.

Unfortunately for developers, Netscape and Microsoft implemented DHTML differently. The two different DHTML flavors deliver a mixed bag of benefits (see the table above). Until the W3C releases a DHTML standard, we will likely continue to see few pages that take advantage of this capability.

DHTML's Four Parts

Web developers can combine four things to create dynamic Web pages: cascading style sheets (CSS), HTML 4.0, Document Object Model (DOM), and scripts.

HTML 4.0 In December 1997, the W3C issued a final specification for HTML 4.0. Its many enhancements include incremental display of large tables, scrollable tables with fixed headers, and better support for printing long tables. Enhance-

ments to HTML forms focus on making them more flexible. A new Button tag enables forms to have more than just Submit and Reset buttons. An `accesskey` attribute provides keyboard shortcuts to form fields. An `accept` attribute for the Input tag permits authors to designate valid content. Character sets get a boost: The legitimate HTML 4.0 character set extends beyond the one for Western European languages while still maintaining HTML documents in conformance with SGML.

CSS Controlling the presentation of a document written in a language like XML or HTML, cascading style sheets allow more precise layout and formatting than HTML alone. A new version of CSS is on the horizon: W3C's draft statement for CSS2 at the time of this writing includes a chapter devoted to aural style sheets. Aural rendering of HTML documents will help sight-impaired users gain convenient access to Web content. It can also serve other contexts, such as in-car use, presentation over a home entertainment system, and teaching pronunciation of words.

CSS2's specification chapter on the visual rendering model describes relative and absolute positioning issues. These designate rules for the two-dimensional layout of content in an HTML document. A section within the chapter addresses stacking issues that define how to arrange content in a third dimension.

DOM The third major DHTML component that the W3C is creating specifications for is the Document Object Model, which will define a platform-independent programmatic interface to HTML documents. This interface will be able to manipulate the content, structure, and style of the document. With DOM, Web developers can introduce dynamic and interactive content into their Web pages without having to rely on a Web server to provide new content or to change how existing content displays. The W3C will provide DOM bindings for Java and ECMAScript. The DOM FAQ indicates an independent group will submit a COM interface to the DOM that will appear as a W3C Note. There are expectations that various firms will provide bindings for other languages, such as Perl, C++, and VBScript.

Scripts The fourth DHTML component is scripting, and W3C proposes to issue an initial binding of its DOM to

Creating XML Objects

The following three screenshots show an XML document being imported into an XML-enabled HTML editor (Grif's Symposia Pro). During import, the tool verifies that the document is "well-formed." If it encounters tags that are not recognized (i.e, they do not belong to the HTML 3.2 Document Type Definition, or DTD), it automatically builds new tag definitions. The document is displayed using HTML 3.2 tag formatting rules, with default rules for new tags. The user can then interactively add cascading style sheets (CSS) style rules to improve the display of these new document elements.

The user can define and insert new tag definitions at any time, using the Add New Tag command. SGML editors, as well as other document authoring tools, are also adding the capability to create XML tags like these.

New tags are inserted in the structure. The user can interactively specify the way they should be formatted by associating a set of CSS style rules. Content of new tags can then be entered interactively in WYSIWYG mode.

User-defined tags are saved in the XML structure, and the CSS style sheet definition remains associated with them. The document can be read by any other tool that supports XML and CSS specifications.

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ECMAScript. The European Computer Manufacturers Association (ECMA; http://www.ecma.ch/) issued an initial version of ECMAScript-262 in June 1997. Another version is due in 1998. Microsoft reports that its version of JScript in Internet Explorer 4.0 is compliant with ECMAScript. Extra features in Microsoft's JScript, including COM support, do not violate its conformance with ECMAScript. Netscape's JavaScript 1.2 is not compliant with the current ECMAScript version. The next releases of the Netscape browser and ECMAScript will bring the two into conformance.

Browser Wars

So, those are the parts of DHTML. They seem simple enough, yet DHTML probably won't be standardized until well after you see XML as a standard part of your browser. Why? The browser wars: Netscape wants to do things its way, and Microsoft wants to do things its way.

In order for DHTML's components to interact successfully with one another, they must be compatible with one another. The browser must recognize both the HTML and the CSS syntax. DOM must expose HTML and cascading style sheet elements. The scripting language must recognize the browser as a host, and it must be able to respond to object events while it manipulates object and collection properties and invokes their methods.

Unfortunately, each company has its proprietary extensions to selected components. In general, Microsoft's implementation is more faithful to the current W3C recommendations, possibly because it released its 4.0 browser later than Netscape. Here are some examples.

Microsoft's approach to dynamic styles, positioning, and content exposes all HTML tags as elements and lets page authors directly manipulate their properties as well as allowing dynamic reflowing of the text and images on a page. Netscape's approach exposes fewer elements and relies heavily on layers of HTML content. Authors establish these content layers with layer tags or CSS positioning coordinates. By changing the properties of the layers with JavaScript, page authors can achieve dynamic effects after a page loads. Developers using Netscape's Visual JavaScript Pro can drag and drop HTML, Java, and JavaScript components from a component palette to a Web page. They can also drag third-party JavaBeans and CORBA services from the component palette. Developers can visually build event-based connections or bound property values for two components so they remain synchronized. The package supports Oracle, Informix, Sybase, or ODBC data sources using the included JavaScript components that leverage database connectivity in Netscape Enterprise Server 3.0. A custom property editor enables developers to build interactively a SQL statement for specifying a data extract.

Fonts are another area of contention. Downloadable fonts allow an author to determine the precise font family for text whether or not that font already resides on the browser's workstation. Netscape relies on a font definition file that links to a Web page of installed fonts from any source. Microsoft's approach extends CSS notation to reference font styles. It also incorporates support for Microsoft True Type fonts.

Data binding and multimedia effects are another problem. Only Microsoft's DHTML implementation supports these. Data binding makes it easy and fast for surfers to interact with a data cache in a page because filtering and sorting operations on a local cache do not require a round trip to the server. Also, page authors can apply filters and transitions through style sheets, in-line style attribute settings, and scripts. A set of 14 filters, such as Blur and FlipH, can add multimedia effects to HTML content. Web developers can also invoke transitions for entering or leaving a URL.

The purpose of standards is to create a reference for the components so browser manufacturers can have a minimum set of requirements to meet. Then, at least for some core set of functions, DHTML code will behave consistently across browsers that are in conformance with the standards. As browser manufacturers strive to deliver the best value to their clients, we can expect a continuing stream of extensions to the standards that result in differences outside the core functions.

The two standards organizations, W3C and ECMA, are busy issuing DHTML component specifications. When these organizations finish their work, browser manufacturers will have an open set of specifications to which they can conform for cross-browser compatibility.

Call to Arms

HTML isn't dead, but it is suffering from its own success—and every time you get a "404 URL not found" error message, you're suffering, too. In order to keep the Web growing and push its power into more applications, we need to start replacing simple HTML with more powerful alternatives. Perhaps the most powerful alternative within reach is XML 1.0, the recently ratified standard. Its power is that it forces developers to describe content rather than presentation.

Couple XML with style sheets (which *do* control presentation), scripting, and a document object model (which enables developers to change content without revisiting a server) and you have a solution to problems as diverse as too many AltaVista hits and poor performance. Although it will require developers and users to retool, the migration to XML must begin. The future of the Web depends on it. B

WHERE TO FIND

Adobe
San Jose, CA
408-536-6000
http://www.adobe.com

ArborText
Ann Arbor, MI
313-997-0200
http://www.arbortext.com

Grif
St. Quentin en Yvelines Cedex, France
+33 (0)1 30 12 14 30
http://www.grif.fr

Macromedia
San Francisco, CA
415-252-2000
http://www.macromedia.com

Microsoft
Redmond, WA
425-882-8080
http://www.microsoft.com/standards/xml

Netscape
Mountain View, CA
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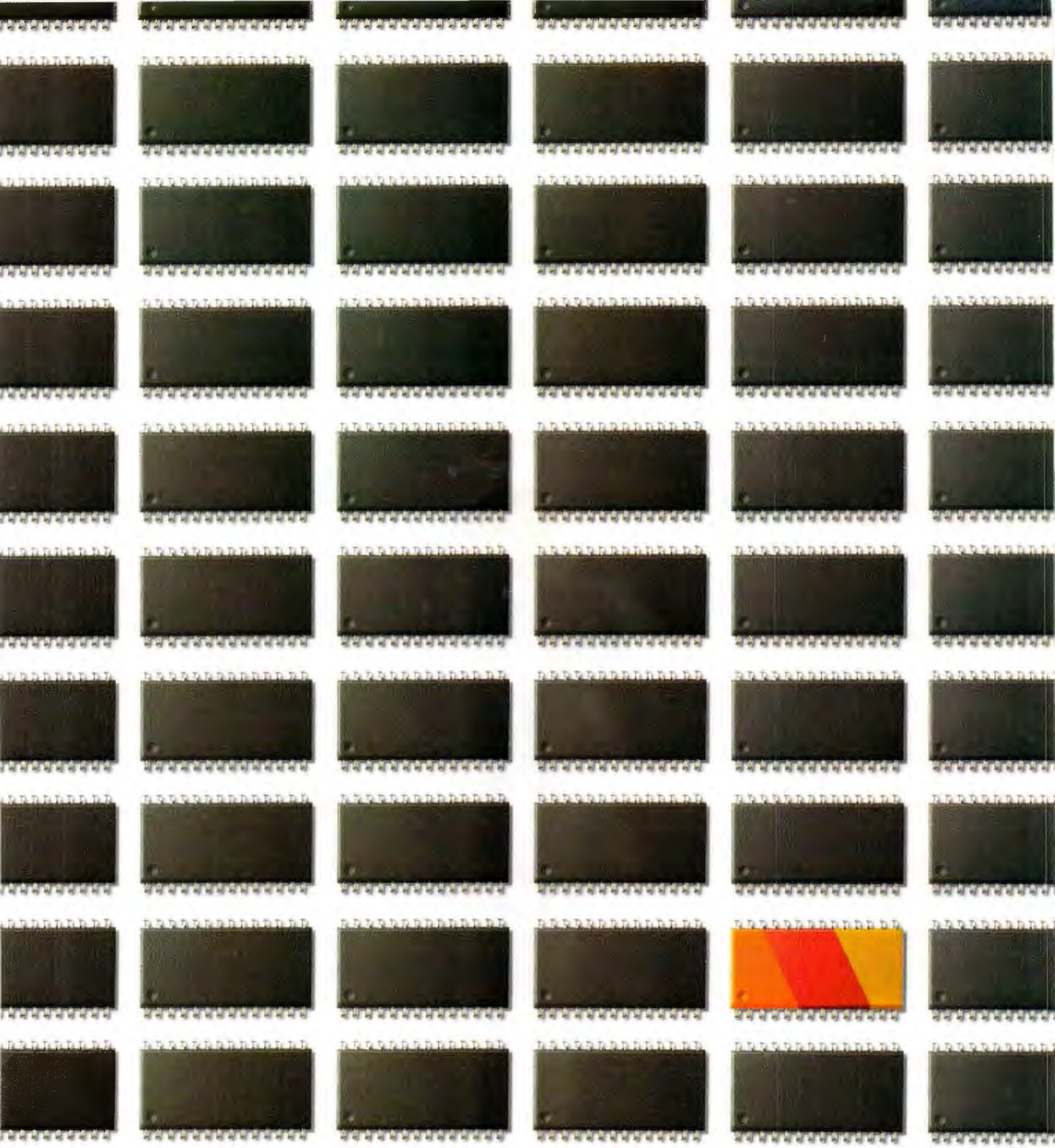
Scott Mace is a senior editor at BYTE. He can be reached at **scott.mace@byte.com.** *Udo Flohr is a BYTE contributing editor based in Hannover, Germany. You can reach him by sending e-mail to* **flohr@dfn.de.** *Rick Dobson, Ph.D., is president of CAB, Inc., a database and Internet development consultancy. You can reach him at his firm's Web site,* **http://www.cabinc.win.net.** *Tony Graham is an SGML consultant with Mulberry Technologies, Inc. (Rockville, MD) and the maintainer of the DSSSL users' mailing list. You can reach him at* **tgraham@mulberrytech.com.**



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Technologies that make the application programmability vision a reality.

By Bill Gates

Ten years ago in BYTE, I proposed a software architecture vision that would greatly extend the power and scope of application macro languages. In "Beyond Macro Programming," I outlined the problems with numerous proprietary macro languages, each tied to a particular application. I expressed the need for Interapplication Communication (IAC) and control using a common development language and environment. This would free developers from learning the idiosyncrasies of each language and focus instead on the core functionality of applications. I also called for the creation of object models that would enable developers to control all the elements of an application, providing full application programmability. It took more than two years to see this vision realized, but 10 years later, application programmability achieved higher levels than anyone would have imagined a decade ago.

Future developments will be driven by the same three factors that have propelled us to this point. First, broad adoption of standards and technologies such as COM and Visual Basic for Applications will provide the foundation for application customization and automation. Second, every end-user feature we add to applications to make people more productive should be accessible by a solution developer. Third, the reach of both application automation and the information derived from its use must be extended as far as possible, using existing technologies such as the Internet as delivery mechanisms.

How far have we come in 10 years? Perhaps the most important development in terms of application automation (and distributed computing in general) was the maturation of a common application protocol. The Component Object Model (COM), and our most recent initiative, COM+, is the foundation for IAC and control. By defining a standard way for software components to share information, we have constructed the foundation on which integrated applications can run.

The second most important achievement has been the development of a common, component-driven language engine, Microsoft Visual Basic for Applications (VBA). VBA meets the requirements for a program-creation tool and program engine that I outlined 10 years ago.

The most powerful and compelling aspect of VBA is that it is truly shared among many applications. The programming experience is the same regardless of whether a developer is working with Excel, Word, AutoCAD, Visio, or Great Plains Dynamics (starting in June 1996, Microsoft began licensing VBA to third-party software developers). The only difference to the developer is the object model and functionality that are provided by the host application components.

VBA derives its components using software designed around COM. It is not enough for component developers to expose functionality via COM interfaces. Solution developers must have powerful and productive programming tools with which to control these interfaces. VBA fulfills this need.

ILLUSTRATIONS: JANE STERRETT © 1998

VBA and COM

In a certain sense, VBA is moving beyond being a single technology and is fast becoming a standardized *platform* for development, just like Windows and the Internet.

Moving Forward: The Next 10 Years

The next decade will see many things change. But one thing will stay the same: Companies will have to do more with less. To a large degree, this means moving away from custom applications toward the integration of existing components, solutions, and business processes. More and more companies and industries are standardizing on the same platform and architecture. In this environment, the competitive advantage comes from customizing off-the-shelf applications to map to creative and efficient business practices.

This "buy and customize" approach offers the best of both worlds: rapid development with the ability to integrate business processes while taking advantage of an application's core functionality. You will evaluate software applications on how extensively and easily you can customize them. COM and VBA are the pivot points for automating and enhancing this integration. By adding COM interfaces to existing applications, developers can open their capabilities to other applications. They can then access these capabilities from other applications through VBA. Furthermore, having VBA broadly available in applications throughout the enterprise enables developers to extend their expertise to more applications.

The Component Object Model (COM), and our most recent initiative, COM+, is the foundation for Inter-application Communication and control.

But these seeds are already planted and growing. Looking forward, what goals should we set in order to meet the requirements of customization and integration while maintaining existing investments? I've identified five aspects of application programmability that must be enhanced in the next decade:

- object-model convergence
- Internet integration
- data representation
- componentization
- enhanced user involvement

Object-Model Convergence

With VBA becoming the predominant application programmability language, the greatest cost associated with working with a particular component or application is no longer adapting to a different language and tool set, but rather the need to learn that component's object model.

In the next decade, developers seeking to create integrated solutions will demand as much convergence of object models as possible across all applications. Components will be judged on how much their object models resemble those with which developers are already familiar. Eventually, object models, like programming environments, will become similar enough so developers can focus on the core functionality of a component. Likewise, component vendors can spend more effort refining the true added value of their software.

Internet Integration

The Web is about much more than browsers. It's about connectivity that has radically increased the amount of data available to any individual. Technologies such as Web Queries have already enabled Web-based data to be integrated directly into desktop solutions such as Microsoft Office.

In the future, a component's location on the network must become as irrelevant to the developer as its source language is today. Developers will expect to be able to compose, distribute, and troubleshoot solutions wherever, whenever. Distributed COM (DCOM) is just the beginning. Directory services must merge with COM to provide a catalog of components from which a developer can shop. Debugging tools must be enhanced to account for issues that arise in a distributed environment, such as network load, communications protocols, and security. The work necessary to create such a seamless distributed development environment is under way as part of Windows DNA.

Data Representation

One of the most perplexing issues revolves around how components represent data. Many of the applications that expose data are COM-enabled, but the way that they expose data differs—the concept of data in a database is different from data in a spreadsheet or slide presentation. As components continue to evolve, they must be able to represent data in a way that is, while not identical, at least transferable. Components must be able to describe the data they contain when interrogated, and this data must be easily manipulated, regardless of its source. We must develop a set of rules that enables us to describe data both

precisely enough to implement using existing language technology and generally enough to capture the richness of data.

Microsoft is solving this problem in phases. Initially, we will use the Extensible Markup Language (XML). Like HTML, XML is a system that encodes data using named tags. Unlike HTML, however, XML is designed to describe the content, rather than the presentation of data (for more information on XML, see "Weaving a Better Web" on page 58).

Developing rules for representing data as a series of linked concepts rather than a precise structure tied to a specific application will extend this approach. By creating a way for the semantics of data to be expressed as a set of predefined concepts, software developers could construct query and analysis tools applicable to all forms of information.

Componentization

Solutions based on Microsoft Excel assume that most of the application functionality is necessary for the solution to run. At the same time, traditional software development has moved to a component-based approach that emphasizes smaller, single-purpose building blocks such as ActiveX controls and DLLs.

In the next 10 years, these two models must be reconciled and merged. When an application responds to an automation request from another program, it should be smart about loading into memory only the code absolutely necessary to satisfy the request. If these applications aren't made more intelligent, they risk being undermined by stand-alone components that offer less functionality but use fewer resources.

As VBA becomes the language of choice for application programmability, vendors should pair it with sophisticated macro-recording technology.

Applications such as Microsoft Office represent years of development effort and provide incredible functionality to developers and end users. The easier it is to create robust, high-performance solutions using Office, the more solutions will be created. Part of our effort has been to ensure that all the functionality that an end user can tap into is made available to developers. We've accomplished this by constructing comprehensive object models comprising discrete functional components and exposing them via COM. When an application is called on to provide one of these discrete components, it should do it in a way that has the least impact on system resources.

This doesn't mean that all current applications will become just a box of parts that developers scrounge through. Developers will lean toward several key applications as their core components, because of feature sets, robustness, and the like, just as they rely today on other familiar tools. How well an application exposes its components, though, will be one consideration.

Another important aspect of componentization is the ability to combine components into new components. For example, using Visual Basic, a developer can assemble both built-in controls and existing ActiveX controls into an entirely new ActiveX control with a customized set of interfaces. VBA offers this ability now through a feature called *class modules*.

On a larger scale, as more applications integrate, VBA developers will be able to create solutions that span the entire line of business by using customized components created using different applications. Accounting programs can be linked to the manufacturing and sales process, and post and retrieve information via the Internet—all possible by using the already-existing functionality of VBA-enabled applications.

Enhanced User Involvement

One advantage that application customization has over traditional software development is that end users are intimately involved in the development process, so solutions closely meet their needs. Application vendors must find ways to further engage end users.

One of the best ways to do this is to capture user interaction through some type of macro recording. This lets end users participate in the development process not only by creating content but by prototyping automation functionality. Developers can then examine and/or use the recorded macros to construct a more robust solution by adding error handling, parameterization, and common code routines from other projects.

Microsoft has worked to enhance the macro-recording capability of its products. As VBA becomes the language of choice for application programmability, vendors should pair it with sophisticated macro-recording technology.

The more sophisticated and intelligent the technology, the more useful the resulting code. For example, macro recorders should take advantage of language features such as For Each loops and With statements. Doing so will produce source code that is streamlined, efficient, and suitable for reuse by a professional developer. Not only will this make end users more productive and self-sufficient, it will aid developers by providing a learning tool for understanding an application's capabilities.

Conclusion

I recently outlined the concept of a company's "digital nervous system," the way in which a company uses technology to gain important insights to respond to planned and unplanned events.

One of the key requirements of that nervous system is a software-creation process that uses existing components and infrastructure to produce useful solutions in a short amount of time. Application programmability will continue to play a key role in the construction of digital nervous systems in companies of every size, structure, and industry.

This fact speaks to one of the three goals of application programmability—to fully expose application functionality to developers so that they can create solutions more quickly. Accomplishing this depends on the second goal, which is adherence to standards and adoption of enabling technologies such as COM and VBA. As these and other technologies become more pervasive, application developers will be able to reach more users and interact with more data. Finally, making the product of the digital nervous system instantly available throughout the organization, using the Internet and Windows DNA technologies, ensures maximum impact and flexibility with minimal friction and inefficiency. B

Bill Gates is the chairman and CEO of Microsoft.

TeraFLOPS POWer

Sandia Labs puts the Pentium to work on the largest problems.

By Dick Pountain

ILLUSTRATION: LYN BOYER-NELLES © 1998

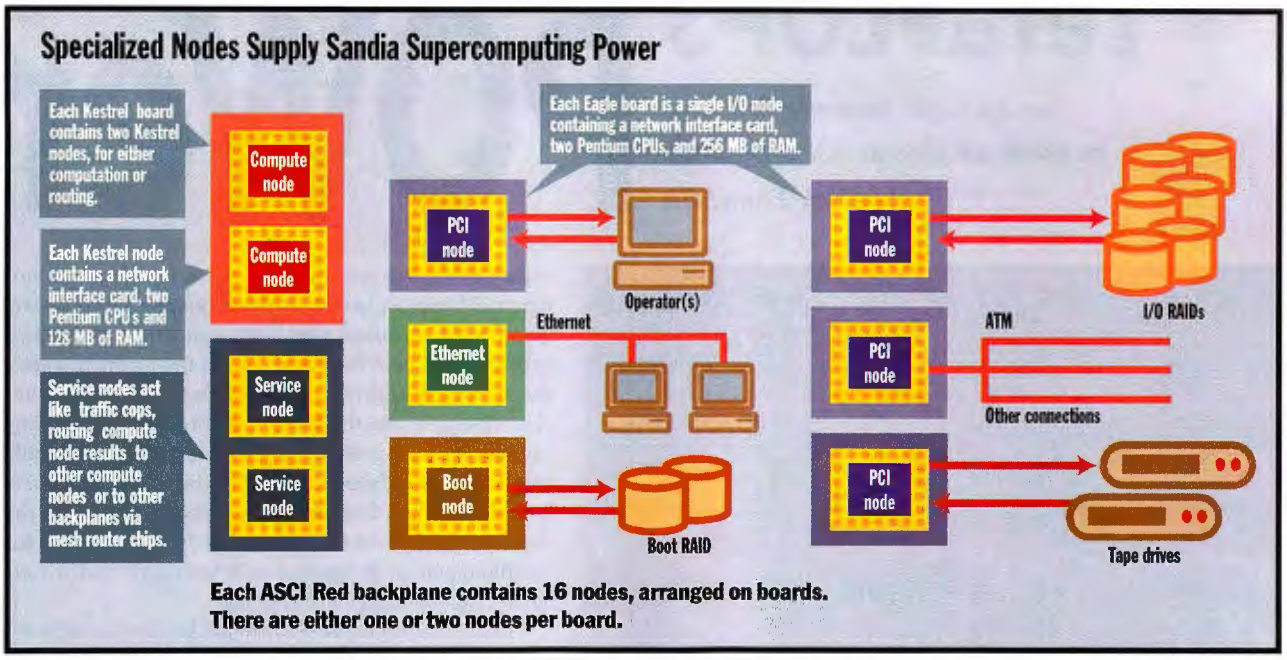
On December 17, 1996, at the Sandia National Laboratory in Albuquerque, New Mexico, another milestone in computing history was passed: An Intel supercomputer performed one trillion floating-point operations per second, or 1 teraFLOPS. Said Intel's chief operating officer Dr. Craig R. Barrett: "Today's accomplishment is computing's equivalent to breaking the sound barrier."

Breaching the teraFLOPS barrier had been the goal of supercomputer designers for many years. But who needs that amount of computing power? The answer, at the moment, is the U.S. government. The Intel supercomputer, called ASCI Option Red, is owned by the U.S. Department of Energy, and its rationale can be summed up in a single word: simulation. The U.S.A. has committed itself to ending the underground testing of nuclear weapons, but the need remains to test whether weapons in the existing stockpile are still effective. Computer-based modeling, simulation, and virtual prototyping form the backbone of the effort to verify the safety, reliability, and performance of the U.S. nuclear stockpile, and the Accelerated Strategic Computing Initiative (ASCI) is one element of the DOE's Stockpile Stewardship and Management Program. ASCI's planners have determined that simulating nuclear weapons to the required level of detail will create a demand by 1999 for machines that can perform 10 to 30 teraFLOPS and by 2004 a need for 100-teraFLOPS systems.

There's no mystery about how all this computing power gets used. Simulating a nuclear warhead impact—or for that matter crash-testing a new car or predicting the weather over the Atlantic—involves dissecting everything that happens within a region of space into a 3-D grid of cells and then applying equations of motion, elasticity, or gas diffusion to the contents of each cell at successive time intervals. Since there would be millions of these cells, they must be calculated on a parallel supercomputer that assigns the cells to different processors and computes them concurrently. ASCI Red is massively parallel, containing over 9000 Pentium Pro CPUs (though only 80 percent of the system had been installed when it reached the teraFLOPS level).

The resolution of a simulation, exemplified by how small its cells are, has enormous bearing on its realism. But in practice, resolution is limited both by how much memory the supercomputer can address (for cell storage) and by how long you can wait for it to compute each time step. Hence the demand for memory and computing power in simulation is almost limitless; you would eventually want one cell per molecule and computation in real time (or maybe better).

Weather forecasting is another field where there's no end in sight to the demand for computing power. Modeling the atmosphere involves a 3-D grid of cells, too, but the resolution is limited by absolute time constraints. The U.K. Meteorological Office currently uses the world's third-fastest supercomputer, a Cray/SGI T3 with 700 processing nodes, running a model of the world atmosphere at 60-km resolution, which increases to 17-km resolution over the U.K. to capture extra detail. According to the Meteorological Office's Alan Dickinson, "If we were to run with the U.K. resolution over the whole globe, the computational cost would be 125 times greater, and a 24-hour forecast would take 24 hours to complete!" In climate modeling, increasing the resolution can make whole new classes of structure visible, like ocean eddies or individual clouds, which can dramatically affect the



accuracy of the modeling. For example, increased computing power will play a crucial role in resolving the arguments over global warming, one way or the other.

The greatest consumer of FLOPS is classified, namely cryptography. Breaking the largest public-key codes remains a priority for government intelligence agencies.

Then there are real applications that even a teraFLOPS machine can't touch. The revolution in molecular genetics is shifting the pharmaceutical industry's interest toward proteins and peptides rather than simple synthetic chemicals. Automated equipment now makes it relatively easy to establish the amino acid sequence of a protein, but what determines its biological activity is the way the protein coils and folds on itself to create the active site (a hole shaped like the target molecule). A computer that could predict the folded conformation of a protein from its sequence would have enormous commercial value for drug designers, but this process would involve trying out every possible folding of a long bead-like chain while calculating the forces of interaction between hundreds of atoms at each step. If possible at all, it would require computing power on the order of petaFLOPS (10^{15} FLOPS) rather than teraFLOPS.

Super Commodities

Nowadays almost all parallel computers are built from commercial off-the-shelf parts. They use commodity microprocessors like the Pentium or DEC Alpha in their compute nodes, commodity DRAM and SRAM for memory, and commodity RAID arrays for storage. Unfortunately for supercomputer designers, development in these different component areas is very uneven. In CPU and hard-drive design, progress is rapid; it's impossible to imagine any government research program that could deliver more spectacular results than the competition between Intel, AMD, Cyrix, and the RISC vendors has done.

While CPU speed increases by roughly 60 percent per year, the speed of DRAM increases by only 7 percent, which means that more than 60 percent of the transistors on modern CPU chips are squandered on caching logic, just to hide the memory latency. Worse still from the supercomputing viewpoint is that inter-CPU communication and operating system technology lag even further behind: The fastest commodity buses, like PCI, have nowhere near the performance required for a teraFLOPS, let alone a petaFLOPS, computer. Parallel-computer vendors have to be more concerned with ease of programming and software compatibility than absolute performance, so they'd rather settle around a group of commercial standards like PCI, Windows NT, and SMP clustering. The market for teraFLOPS computers is too small to tempt vendors away from this path.

Hence the ASCI PathForward Project, set up to give a selective push to those lagging technologies that are needed to attain 100 teraFLOPS by the year 2004. ASCI doesn't have the funds to design and build hardware from scratch, so it employs commodity components and contracts the services of companies like Intel and IBM to build machines, adding funding for extra effort in crucial integration technologies: hierarchical memory systems to reduce memory latency; high-speed, low-latency communication fabrics and parallel I/O systems; and scalable distributed operating systems and programming environments.

This ASCI work will be shared between the three U.S. national defense labs. The first machine, ASCI Red, is now running at Sandia. IBM is building ASCI Blue Pacific at Lawrence Livermore (see "PowerPC TeraFLOPS," page 76). And Cray/SGI is extending an existing machine at Los Alamos to become ASCI Blue Mountain.

A Pentium Punch

The ASCI Red machine at Sandia Labs is the world's biggest supercomputer, more than twice the size and speed of the second biggest (the CP-PACS at Japan's University of Tsukuba). ASCI Red is a distributed-memory parallel computer with 4500 compute nodes, contained in 79 cabinets that occupy 1600 square feet.

ASCI Red is built from four different kinds of nodes: Compute nodes are used solely to execute parallel application code; I/O nodes perform file and network services; system nodes are used to boot the machine and to run diagnostics; and

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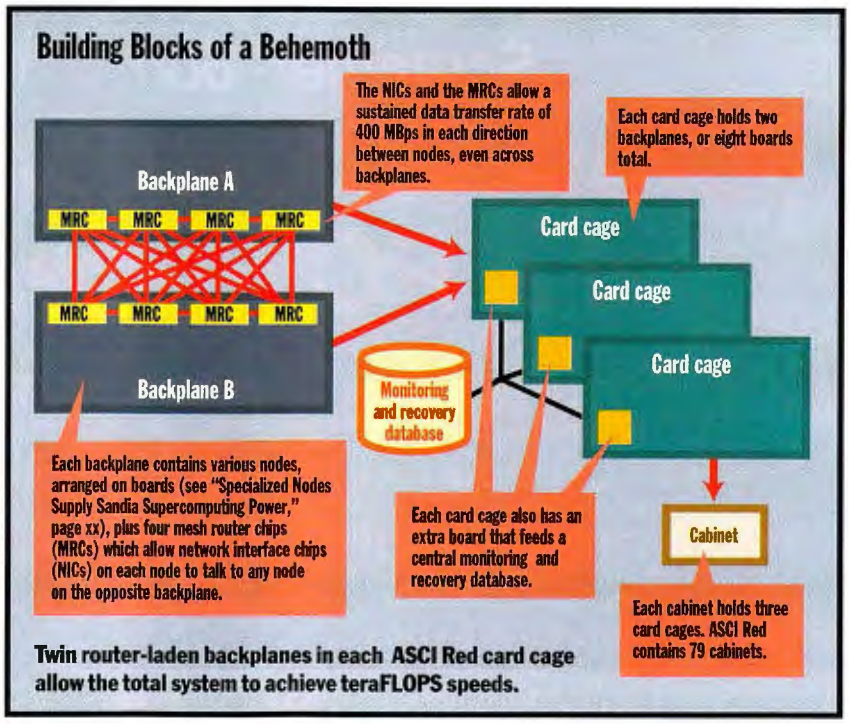
service nodes interact with the user and provide the front-end "host" system. All these types of nodes contain twin 200-MHz Pentium Pro CPUs (making a total of 9216 in the whole machine), plus several banks of interleaved DRAM (in standard SIMMs) on a custom-built 64-bit local processor bus. Compute nodes currently have 128 MB of memory each. I/O nodes also contain two 133-MBps PCI interfaces that can take Ultra-SCSI adapter cards for disk arrays, or ATM and FDDI network cards.

Two custom chips—the network interface chip (NIC) and the mesh router chip (MRC)—are the building blocks for the interconnect fabric of ASCI Red. The NIC provides a fast interface from the local memory bus to the MRC, which is a six-way switch, capable of routing messages at a sustained 400 MBps in each direction. Each of the MRC's six ports is divided into four virtual lanes, so that four independent message streams can pass through it at once (sharing the total bandwidth) to avoid contention bottlenecks. Every node contains one or two NICs, and the whole machine is based upon twin backplanes consisting of two-dimensional meshes of MRCs (see "Building Blocks of a Behemoth," at right). Using twin backplanes makes for better reliability, since the system can bypass a bad router by skipping across to the other plane and back (so-called *Z-X-Y-Z routing*).

ASCI Red runs two separate operating systems. The service, system, and I/O partitions all run Intel's distributed Unix (System V.3 with 4.3BSD Reno VSD extensions), which presents to users as a single Unix machine. The compute nodes each run a small operating system named Cougar. This OS is based on a microkernel called the Q-Kernel, which occupies less than half a megabyte and handles memory management, context switching, and message passing. Cougar performs low-level communication via *portals*, windows into a Unix process's address space. Portals exist in user address space, to avoid having to copy messages between kernel and user space, so they offer very low communication latency. ASCI Red's programmers will normally use a message-passing interface library built on top of this portal layer.

Reliability, availability, and serviceability (RAS) capabilities are crucial on a machine this size; whatever the individual mean time between failures (MTBF) rating of the components, when you have 10,000 of them, something is going to fail all the time. The RAS goal for ASCI Red is greater than four weeks of continuous operation with 97 percent of the resources available. The system contains redundant components, like 16 on-line spare compute nodes. All major



PowerPC TeraFLOPS

IBM and Lawrence Livermore National Laboratory (LLNL) may take the PowerPC to near-teraFLOPS speeds this year, thanks to a new PowerPC chip.

The ASCI Blue Pacific "tech refresh," the second generation of LLNL's ASCI program, was scheduled to become operational in January. Unlike ASCI Red, ASCI Blue employs a four-way symmetric multiprocessing architecture, based on the Power PC 604e-X5 chip. This experimental IBM supercomputer can use message passing as well as shared memory parallelism, says Randy Christiansen, deputy ASCI program manager at LLNL.

While LLNL officials wouldn't say what speed this new IBM chip was running at, it can do two floating-point operations per cycle. The total peak capability of the system is 897 gigaFLOPS. With 320 compute nodes, and four times that many CPUs, the clock speed of the chips works out to about 332 MHz.

Each node on the system has 512 MB of RAM. There are also 16 disk I/O nodes built out of PowerPC 604 chips and 16 I/O-to-network nodes using older IBM Power SP2 chips. Similar to ASCI Red, the I/O nodes operate at about 800 MBps total. To keep costs low, ASCI Blue Pacific's designers avoid using custom chips, Christiansen says. Disk storage is 2.5 terabytes global, as well as another 2.3 TB of local storage, for a total of 4.8 TB of disk space.

LLNL plans to break through the teraFLOPS barrier at the end of 1998 by demonstrating its Sustained Stewardship TeraFLOP (SST) system. That system will be designed to scale up to a peak sustained rate of 3.2 teraFLOPS. LLNL and IBM will increase the number of symmetric multiprocessing nodes to 512 and also double each node to eight CPUs. The newest Power PC 630 chips, with copper interconnects, will be employed, and the supercomputer's central switch will itself be upgraded to increase transfer speed—to between one and 10 gigabits per second—and to reduce latency. Total memory will rise to 2.5 TB of RAM and approximately 75 TB of disk. Disk I/O will be between 1 and 10 gigabytes per second. LLNL hopes to have the system operational by the first quarter of 1999. **– Scott Mace**

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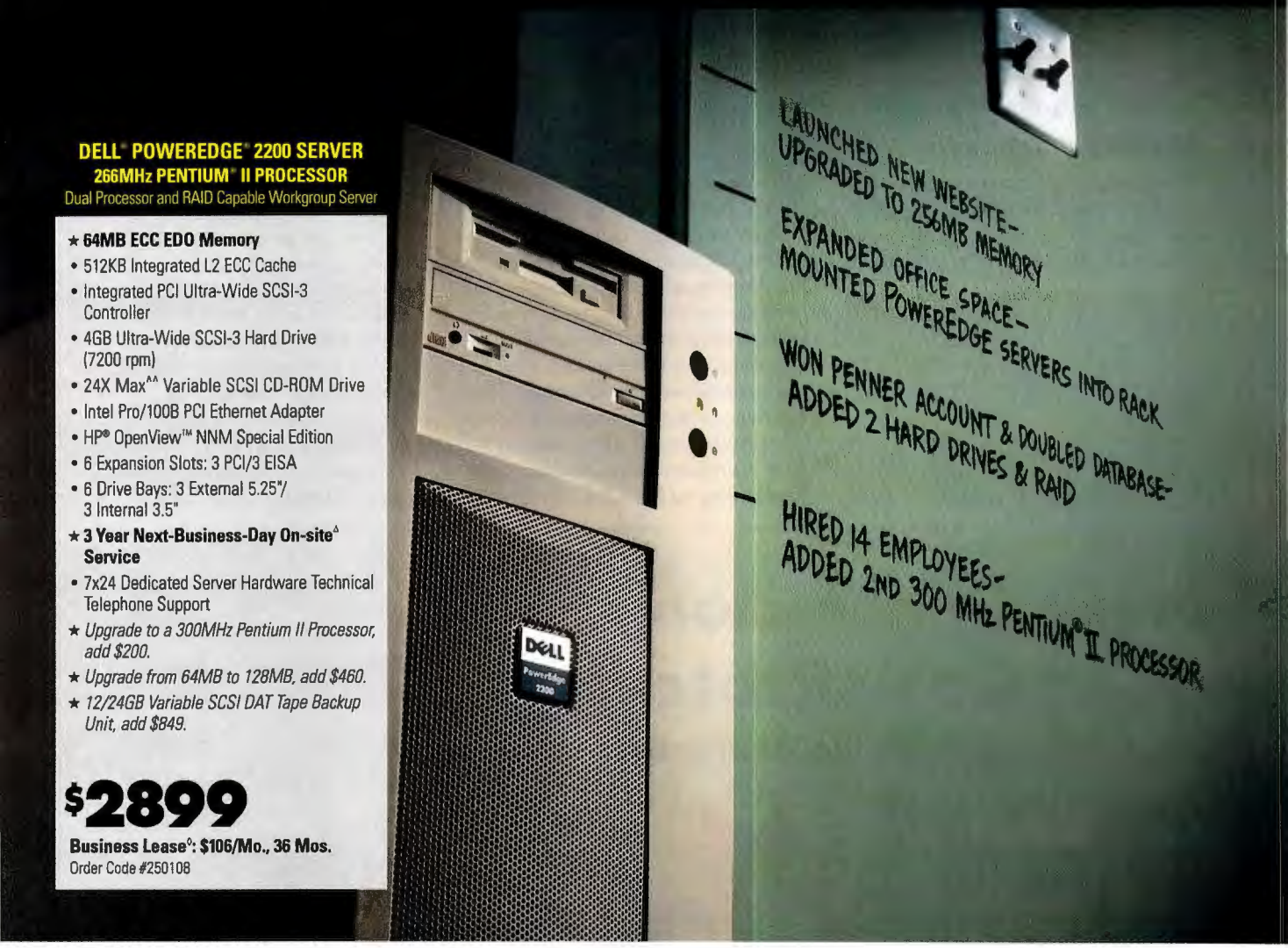

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components, including compute nodes, disks, and power supplies, are hot-swappable while the system is running and without powering down any other modules. To manage these RAS features, there's an active monitoring and recovery subsystem (MRS). Each card cage of eight node boards contains an extra board that monitors all the others, and these are all connected via dedicated RAS Ethernet (completely separate from the interconnect fabric) to a central MRS database that records the state of the units.

The Problematic PetaFLOPS

It will be far tougher to build a petaFLOPS machine, where interprocessor communications costs may swamp all other considerations. Researchers in various universities are currently working on technologies that may some day contribute to a petaFLOPS computer, and NASA has set up PetaFLOPS Enabling Technologies and Applications to coordinate this work. David Patterson, the inventor of RISC, is working at UC Berkeley on intelligent RAM (IRAM), which combines processor and memory onto a single chip to reduce the memory latency. Patterson reckons that such combined chips could reduce latency by a factor of 10. For a message-passing parallel architecture, there would still remain the question of communication between IRAMs. So it's likely that IRAM might be better employed to implement a "vector processor on a chip" with multiple arithmetic units plus memory, which could then be combined in clusters. Another research avenue takes the opposite approach—that is, to deepen the memory hierarchy rather than flatten it—by adding extra levels of caching and implementing more sophisticated dynamic caching and load-balancing algorithms.

Meanwhile, teraFLOPS power may pop up in many more places, such as helping routers scale up further. Each chip in an ASCI Red design could be reconfigured to act as a router, said Hank Zanini, of Avici Systems, at the Next-Generation Networks conference in November 1997.

Of course it's also possible that the teraFLOPS milestone may turn out to be an artifact of the Cold War that makes little economic sense in more peaceful times. This is certainly the view of Horst D. Simon, director of the National Energy Research Scientific Computing Center at Lawrence Berkeley, a major customer for high-performance computing (HPC) systems. "HPC is not a money-maker, so commercial companies have little incentive to innovate with radical new technology toward petaFLOPS," says Simon. "HPC technology is no longer 'hot' in U.S. research universities either, and there is no concerted federal petaFLOPS program. All these facts imply that HPC will follow an evolutionary growth curve, which will not lead to commercial petaFLOPS systems in the next 10 years." B

WHERE TO FIND

ASCI Blue Pacific Program http://www.llnl.gov/asci	**NASA's PETA Program** http://www.aero.hq.nasa.gov/hpcc/petaflops
Intel TeraFLOPS Program http://www.ssd.intel.com/tflop.html	**IRAM Research** http://iram.cs.berkeley.edu

Dick Pountain is a longtime BYTE contributing editor based in London. You can contact him at **dickp@bix.com.**

Writing for Rhapsody

Apple's latest OS offers several rich application-development environments.

By Tom Thompson

Rhapsody—Apple's latest OS—offers a rich set of object-oriented frameworks for rapidly building GUI-based applications. These can range from complete cross-platform applications to Rhapsody-specific utilities that hide the messier details of configuring a server. This elegant melding of OS and development environments endows Rhapsody with the ability to both provide and manage industrial-strength server services by just pointing and clicking.

Rhapsody itself offers all of a modern OS's features: memory protection, preemptive multitasking, and threading. Its Unix-like services provide sophisticated OS features such as multiuser support and distributed file access. As such, Apple positions Rhapsody as a server and high-end user OS. But its development features set it apart from the crowd.

While Rhapsody may be starting fresh, it suffers from the same problem that has killed many an aspiring OS: few useful applications so far. You can translate this into: "How can I write programs for it?" Because Rhapsody is such a complex environment, the answer isn't simple. A closer look at the OS is necessary to understand why.

Both Old and New

Rhapsody's roots are surprisingly old. It began life a decade ago as NextStep, an object-oriented OS for the Next Computer (see "The Next Computer," November 1988 BYTE). Over the years, NextStep's object-oriented environment was ported to other systems, including Sun's Solaris, Hewlett-Packard's HP-UX, Windows 95, and Windows NT. In so doing, the OS achieved a level of portability that earned it the moniker OpenStep. Apple acquired Next in late 1996, and OpenStep became Rhapsody, the OS. Rhapsody also inherits what's best about the Mac OS: a simple yet powerful user interface (UI), plug-and-play hardware expansion, hot-swappable peripherals, and multimedia services such as QuickTime and QuickTime VR.

This tangled lineage actually confers two advantages on Rhapsody. First, the class libraries that implement many of Rhapsody's functions have been ported several times, which invariably exposes subtle code bugs. They have also been field-tested for years, which reveals more bugs. Thus, Rhapsody starts life with very robust and stable code.

Second, Rhapsody offers several application environments: BSD

4.4 Unix, the Yellow Box application frameworks, and the Blue Box process that hosts the Mac OS (see the text box "Rhapsody Architecture"). Each environment offers a different way to write programs.

For Unix wizards, the BSD Unix emulation will be comfortable territory. Rhapsody literally provides a window into it: A Terminal application opens a console-style window, where you type Unix commands and write scripts. Typically, you use either telnet or FTP to transfer source code onto a Rhapsody system, edit it, and compile. An enhanced GNU 2.7.2 C compiler translates C, C++, and Objective-C programs directly into executable code.

Rhapsody Architecture

Like many modern OSes, Rhapsody has a kernel that implements most low-level functions, such as task creation. Higher-level services, such as file I/O, typically operate outside the kernel but make requests to it for resources. Rhapsody uses the Mach kernel, which was developed at Carnegie Mellon University, as a lightweight, communications-oriented kernel. It provides basic services such as tasking, interprocess communications (IPC), memory management, timing, and synchronization. Rhapsody's kernel is a port of Mach 2.0, with enhancements added by Apple, and releases 2.5 and later.

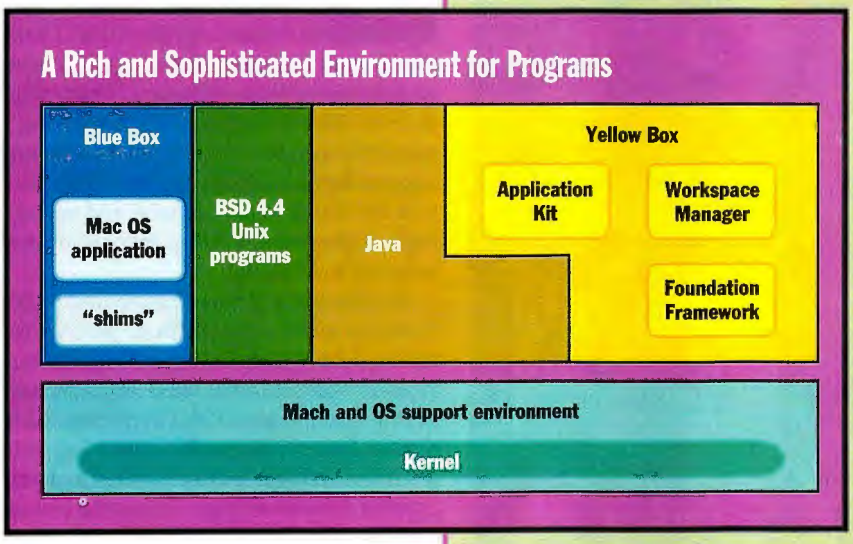
Another part of Mach, the OS support environment, manages networked IPC, distributed file access, and remote-execution services. It provides BSD Unix 4.4 emulation. In addition, Mach system calls are compatible with BSD 4.4 system calls, and Mach supports BSD 4.4 commands. After a simple recompile, BSD 4.4 Unix programs can run without modification under Mach.

Apple plans for Rhapsody to host a 100 percent pure Java environment. The Commercial release will implement Java Beans, part of the Java Development Kit (JDK) 1.1 specification. Rhapsody supports JFC, IFC, AFC, and other Java class libraries, letting it run most Java programs.

At higher levels, Rhapsody provides the Yellow Box APIs, which are a set of OS-independent object-oriented frameworks. They are based on OpenStep 4.2 and are retooled with Apple enhancements. The Yellow Box provides a set of ready-made objects for managing the user interface (UI), drawing objects (via Display PostScript), handling text (using the Unicode 2.0 character set), and accessing system resources such as memory or disk I/O. If you need finer control over the display, the Yellow Box offers a set of graphics primitives that lets you manipulate the frame buffer. A Workspace Manager operates similar to the Mac OS Finder by placing a graphical interface over the BSD Unix emulation. It lets you view files or remote directories as icons or lists. The Workspace Manager also lets you launch programs and copy files by dragging and dropping icons.

Last but not least is the Blue Box. This is a preemptive Rhapsody process that hosts the Mac OS. Because it relies on a modified version of the Power Mac ROMs and the 680x0 emulator, the Blue Box runs only on PowerPC-based systems.

Rhapsody's OpenStep origins let it operate on different platforms. The OS is available on both PowerPC- and x86-based systems. The Yellow Box APIs operate on these systems and, with suitable run-time support, on systems running Windows NT.



A Mach kernel provides the base for Mac OS, Unix, Java, and Rhapsody-specific programs.

Classy Classes

The Yellow Box APIs are a framework of object classes that implement various GUI elements, save/restore the state of your program, and access system services. Many of these objects have weathered the test of time. I wrote about their original incarnation nine years ago ("The Next Step," March 1989 BYTE). Then known as the Application Kit, this object framework consisted of 38 classes. Under Rhapsody today, the Application Kit has more than 100 classes. These objects provide application services that handle user events, draw to the screen, and manage the GUI.

A second framework, the Foundation Framework, provides a certain amount of OS independence. It also provides low-level services through some base utility classes and manages object persistence.

The major problem with the Yellow Box is that it's a whole new set of APIs to learn. However, there are some good reasons to do so. First, on PowerPC systems, the Yellow Box classes and the underlying OS are completely native, which means that applications harness the processor's full power. Second, applications can use Unix features such as distributed processing and remote procedure calls (RPCs).

Finally, an application's potential reach is as large as the desktop computer market itself. That's because the Yellow Box frameworks can also be subclassed from Java, which lets Java programs seamlessly invoke them. Because every computer has some sort of Java virtual machine (VM), a Yellow Box application could run without recompilation on PowerPC- and x86-based computers running Rhapsody, several flavors of Unix, and Windows.

Resolving Resources

As a Mac developer, you're probably wondering how Rhapsody deals with Mac resources: bytes that describe a GUI element's appearance and screen location, encoded into a special format. For example, a MENU resource specifies a menu and data that says the menu has four selections, labeled File, Open, Save, and Quit.

Latitude's Sleight of Hand

Metrowerks' CodeWarrior Latitude is a set of libraries that implements many Mac OS APIs for Rhapsody, Sun's Solaris, or Silicon Graphics' IRIX. It supports over 1200 of the most common Mac OS calls, which Latitude routes to the appropriate low-level Unix calls. It uses a layered architecture that successively abstracts the details of the host Unix system while providing Mac OS services.

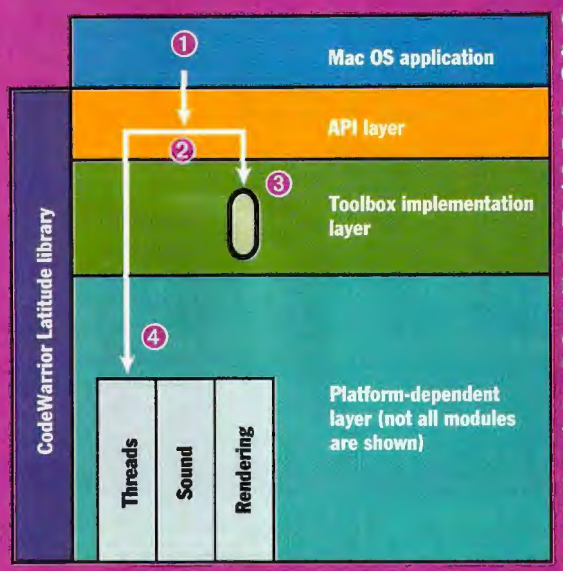
The topmost layer is the API layer, which presents the Mac OS interface to an application. The next layer is the Toolbox implementation layer. It uses platform-independent code that either performs the requested service or calls a function within a platform-dependent module. The lowest layer is a set of platform-dependent modules. These modules handle groups of functions, such as sound generation or threads, that rely on hardware- or OS-specific features to perform the requested operation. For example, a Rendering module calls Display PostScript for Rhapsody; the Silicon Graphics version uses the X Window System. Latitude also performs housekeeping operations such as converting Mac OS file path names to Unix path names.

API layer calls use the same 680x0-processor A-trap exception mechanism to jump to the proper function in the Toolbox implementation layer, similar to what happens on Power Macs. This level of indirection guarantees that Mac applications that patch traps to add custom features will continue to run.

Adapting your program for Latitude requires a few tweaks to the source code. If you have functions written in 680x0 assembly language, you'll have to rewrite them in C. Next, you compile the program using the GNU C compiler for your target system and link in the Latitude libraries. Now the application can run on the target system, and its user interface (UI) inherits the look and feel of the native OS.

Latitude deals with Mac OS resources several ways. There's a conversion tool that translates a file's resource fork into a C data array for compilation. At run time, Latitude can also access resources placed into data files by Unix conversion utilities like AppleDouble.

How the Latitude Libraries Perform Their Magic



1. Recompiled application makes Mac OS call.
2. Latitude API layer uses jump table to vector calls to functions in Toolbox implementation layer.
3. Toolbox implementation layer performs desired operation for certain Mac OS calls.
4. Other calls are routed to modules in the platform-dependent layer that perform the operation using OS- and hardware-specific services.

Metrowerks' CodeWarrior Latitude routes Mac OS calls to Unix services.

Consequently, a Mac application file has two sections: a data fork that stores application data and a resource fork. The resource fork has the resources that store program code and the UI description.

Using resources for the application's graphic elements uncouples them from the program code. To change the size of a window, a button's name, or translate the File menu's selections into French, you modify only the resource's data, not the program code. While resources sound like objects, they're not. A special part of the OS known as the Resource Manager understands each resource format and uses their data to build a UI element onscreen. Customizing the behavior of, say, a button requires some intervention by the programmer, typically through calls inside the program.

With the Yellow Box, UI elements actually *are* objects. For example, a button uses the `NSButton` class, an object that contains the methods that know how to draw the button and emit a message when it's clicked on. If you want to customize an object's behavior, you simply write some code to override the required methods and let object inheritance supply the remaining capabilities.

You use Rhapsody's Interface Builder (IB) to quickly build and customize the application's graphic interface. It provides a set of objects (e.g., a button, a dialog box, or a window) to choose from. You can change an element's size, color, and displayed name by just pointing and clicking. IB also lets you specify the message the element emits when acted on, and you can also select the target object that responds to the message.

This and other information is stored inside a Next Interface Builder (NIB) file, an archived object that's similar to a Java Bean. When an application loads a NIB file, the objects and their data are instantiated. NIB files are part of the regular file system—there's no resource fork. Rhapsody applications can be NIB directories that contain bit maps (e.g., file icons), the program code, and other NIB files.

Other Choices

While the Yellow Box has its merits, what do you do if you've already got some killer Mac OS application code? One choice is to link the code, with a little effort, to Metrowerks' CodeWarrior Latitude. (See the text box "Latitude's Sleight of Hand.")

Latitude lets you extend the reach of your Mac application to Rhapsody and other Unix platforms without drastically revamping existing code. It also lets the program take advantage of Yellow Box features, such as preemptive multitasking and memory protection, while still using the Mac OS APIs.

Rhapsody itself offers a course of action for those with lots of Mac OS binaries: You can take it with you. The Blue Box, as

mentioned previously, hosts a complete Mac OS environment within a Rhapsody process (see the text box "How the Blue Box Works"). The Blue Box consists of a Mac OS application that you can launch or have Rhapsody launch automatically.

When Mac OS application starts, you get the Mac OS start-up screen, followed by the dancing icons of Extensions loading. The Mac OS takes over the entire display, but you can toggle between the two

How the Blue Box Works

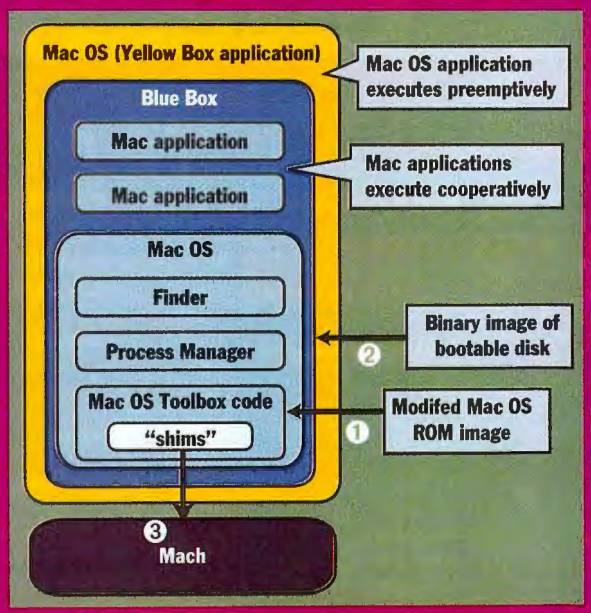
A Rhapsody program called Mac OS application manages the Blue Box. Mac OS application is actually a directory that contains Yellow Box Next Interface Builder (NIB) files, a Mac OS application, and a file that's a modified image of the Mac ROMs. The ROM image presents code "shims" to the Mac OS that prevent it from directly accessing the hardware. These shims are thin layers of code (to minimize a performance loss) that map Mac OS hardware calls to Unix software calls.

When the Mac OS application launches, it first loads this ROM image into memory and then "boots" from it. (Rhapsody never uses the computer's actual Mac ROMs.) The Yellow Box process next locates a binary image file of a Mac OS disk in /MacOSLibrary that contains a System folder. The process fetches code resources from this image's System file and a Blue Box enabler file. This latter file contains Rhapsody-compatible drivers that the unmodified Mac OS 8 code uses. Now, Rhapsody is running a preemptive process that is executing the Mac OS. Mac applications execute cooperatively, as before.

Importantly, the Blue Box runs native code most of the time, down to the drivers and Mach/BSD Unix calls, so its performance should be about as good as the Mac OS itself. (Recall that some of the Mac OS's low-level I/O code executes in a 680x0 emulator.)

Both the Blue Box and Rhapsody can share resources, because all Mac OS calls eventually wind up at the Rhapsody kernel. Currently, there's no conflict in accessing files, because the environments don't share disk volumes. For the Ethernet interface, its driver multiplexes Open Transport (Blue Box) Ethernet packets with Berkeley sockets (Rhapsody) packets.

Building the Virtual Mac



❶ When the Mac OS application launches, it reads a file of the Mac ROMs into memory and executes its bootstrap code.

❷ During the boot process, additional code resources and files (such as the Finder) are read into memory from a disk image file.

❸ When applications call the Mac OS, either Toolbox code executes or the call gets translated via shims into the proper Mach service call.

Rhapsody's Blue Box emulates a Mac OS environment.

Rhapsody Decisions

Decision	Pros	Cons
Writing to Yellow Box	APIs are based on NextStep, which has been out for over a decade and is thoroughly field-tested.	Yet another API to learn, and for the Mac developer, there's no code compatibility.
	By using Java, have the potential of the application running everywhere.	
	While the initial market is small, it is the lucrative, high-profit server market.	
Blue Box	Writing for the Mac OS lets you tap into a large mass market.	Highly dependent on the integration of the Blue Box into Rhapsody.
	Low-level Rhapsody services offer better concurrency and more stability.	Has the same problems as the Mac OS: cooperative multitasking and little memory protection.
CodeWarrior Latitude	No new APIs to learn.	Doesn't have the reach that using Yellow Box APIs would.
	Able to use existing Mac OS code to build applications for Rhapsody and Unix.	Not all Mac OS calls are implemented.
	Code exploits Rhapsody features (e.g., memory protection and scheduling).	

environments easily. The Blue Box mounts all Mac HFS-formatted hard drives. It doesn't recognize any UFS drives or the Unix partitions that Rhapsody uses. AppleTalk works on the Ethernet interface, so you can use printers, run file sharing, or access AppleTalk servers. (The Blue Box implementation I tested didn't support TCP/IP directly: The protocol is encapsulated in AppleTalk packets, which must be sent to a gateway. Also, neither the serial port nor sound works.)

As you switch between Rhapsody and the Blue Box, you soon realize that the two environments are running separately from one another. Only a basic form of cut and paste for data is supported between the two. Hopefully, the situation will improve when both OSes support the Extended HFS format introduced with Mac OS 8.1, and the Yellow Box supports Apple Events.

I am very impressed with the Blue Box's capabilities. It loaded all my favorite Extensions and ran critical applications such as cc:Mail, Acrobat, Illustrator, Photoshop, PowerPoint, Word, and Excel without a hitch.

Apple still targets the Mac OS as a mass-market solution, and for a developer with limited resources and a successful product, sticking with the Blue Box makes sense. There's no risk on the developer's part, but there *are* long-term issues. It remains to be seen how well Apple can integrate the two environments. Part of what scuttled Copland was the difficulty of adding modern OS services while supporting the existing code base. If the Yellow Box and Blue Box applications can't seamlessly share data, such as via drag and drop, the future for Mac OS applications under Rhapsody will be problematic. B

WHERE TO FIND

Apple Computer
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http://www.apple.com

Metrowerks
Austin, TX
800-377-5416
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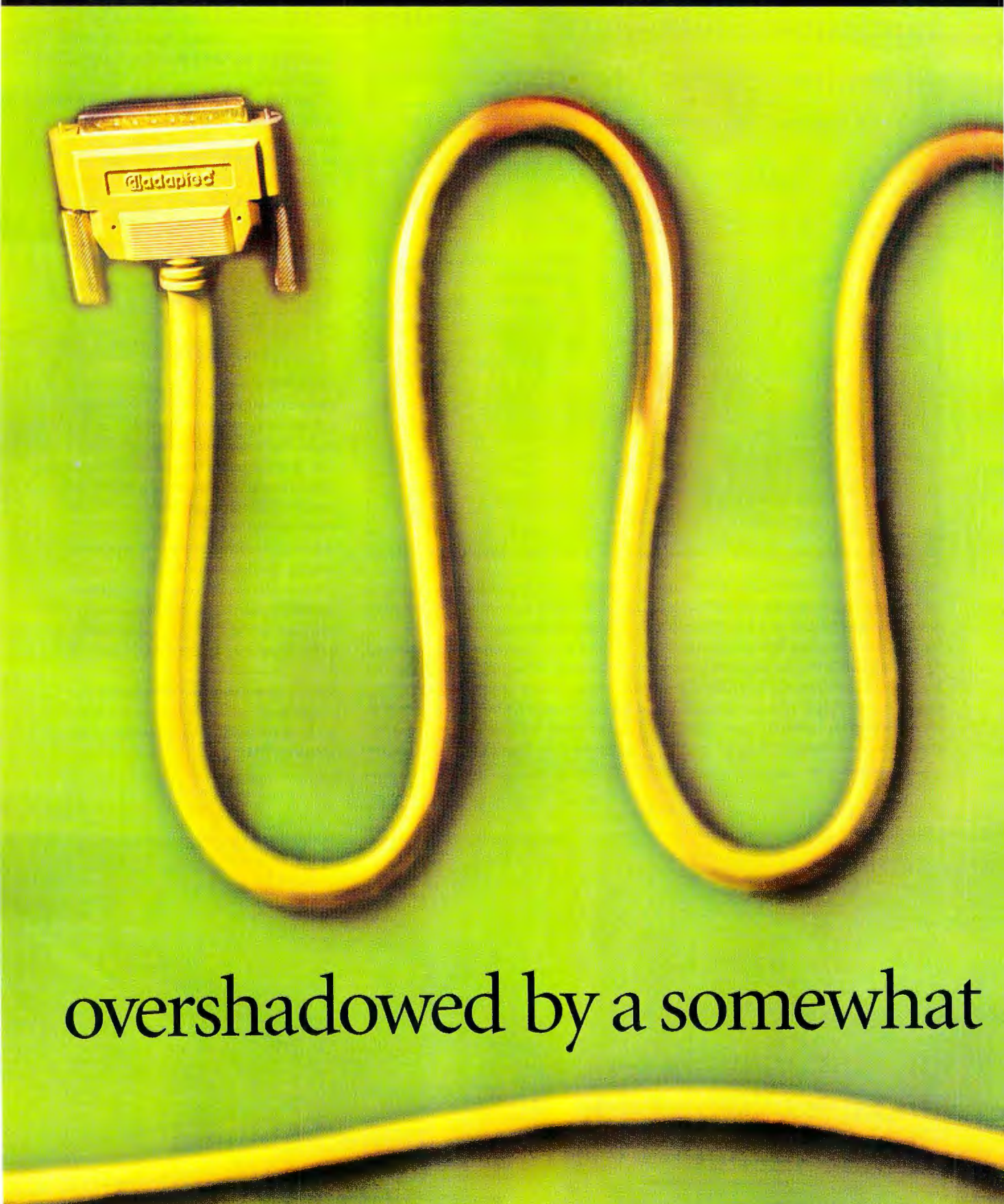
*Tom Thompson (**tom_thompson@byte.com**) is a senior technical editor. He is the author of the book* PowerPC Programmer's Toolkit *(Hayden, 1996).*



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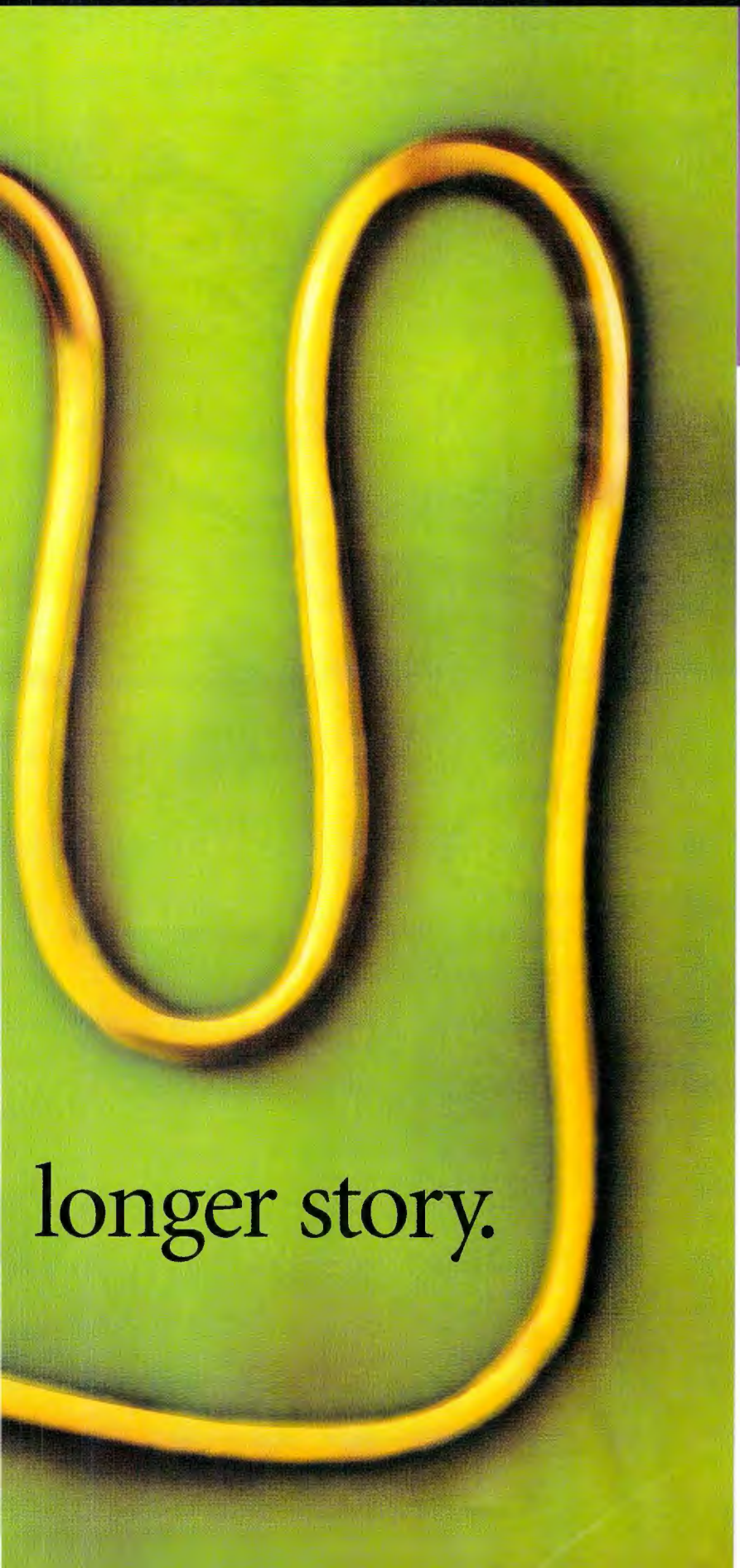

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STORED PROCEDURES:

THREAT OR MENACE?

Stored procedures in database programming sure make it easy—to violate database rules, create inefficient code, and hinder portability.

By Joe Celko and Jackie Celko

Stored procedures are trouble in the making. Usually written in a procedural programming language (a third-generation language, or 3GL), stored procedures enable programmers to cast off the bonds of SQL and handle data sets as if they were data in sequential files. They can make database programming easier and database access faster, but in many ways they're not worth the trouble. Not only do they violate the theoretical rules of databases, they can be inefficient and make portability difficult.

True, stored procedures allow you to put a sequence of SQL statements into a single block of code and pass parameters to those statements. But for this type of use, you could instead replace a stored procedure with a simple batch file. Such a batch file might even offer some advantages, since it could also access other programs from its position at the OS level.

The real reason to use a stored procedure is to gain access to control structures and row-at-a-time access to database tables. But this is the seduction that leads to doom. Most programmers know how to write procedural code better than they know how to write tricky SQL. When they can't think of a simple way to solve a problem nonprocedurally, they go back to more familiar ways of doing things.

A Good Theory—in Theory

Theory is more practical than some younger programmers want to admit. Older programmers remember when Bohm and Jacopini proved that you don't need to use a GOTO in a program and laid the foundations for modern structured programming. This is what the relational model did for modern databases.

When Dr. Codd wrote his list of the Twelve Rules for Relational Databases, he had some restrictions as to what a relational database could be like. (You can get Chris Date's version of the rules from *An Introduction to Database Systems*, Fifth Edition, pages 389 through 393, if you want to read them all.)

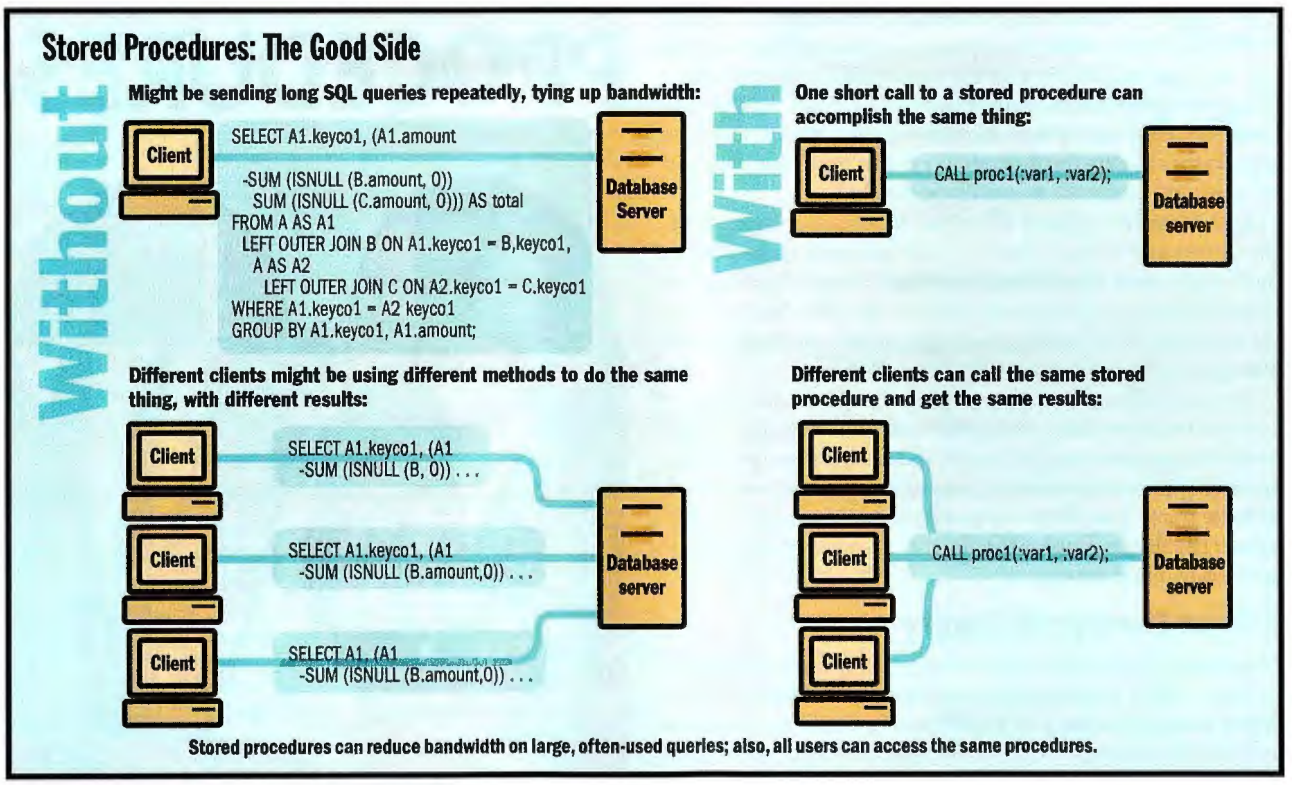
Rule zero (yes, there is a rule zero) says that "for a system to qualify as a relational database management system, that system must use its relational facilities (exclusively) to manage the database." That excludes a second (procedural) access method to the database from the start. In theory, this is not a handicap because anything that a procedural programming language can do, a nonprocedural language can also do. The proof and the definitions of this theorem are part of formal language and computability theory, which show you that it's possible, but not how to do it.

Rule two, the Guaranteed Access Rule, is essentially a restatement of the fundamental requirement for keys. In the relational model, every scalar value in a database must be logically addressable by specifying the name of the containing table, the name of the containing column, and the primary key value of the containing row. In a procedural model, on the other hand, you navigate a file by the position of the records that it contains. Then you find the fields within the record by their location. This does not require keys at all; you do this by either explicit or hidden cursors in the stored procedure language.

Rule 12, the Nonsubversion Rule, says that "if the system provides a low-level (record-at-a-time) interface, then that interface cannot be used to subvert the system," for example, bypassing a relational security or integrity constraint.

Fooling the Theory

In fairness, most SQL products are pretty good about rule 12 when they put data back into the database and apply all the con-

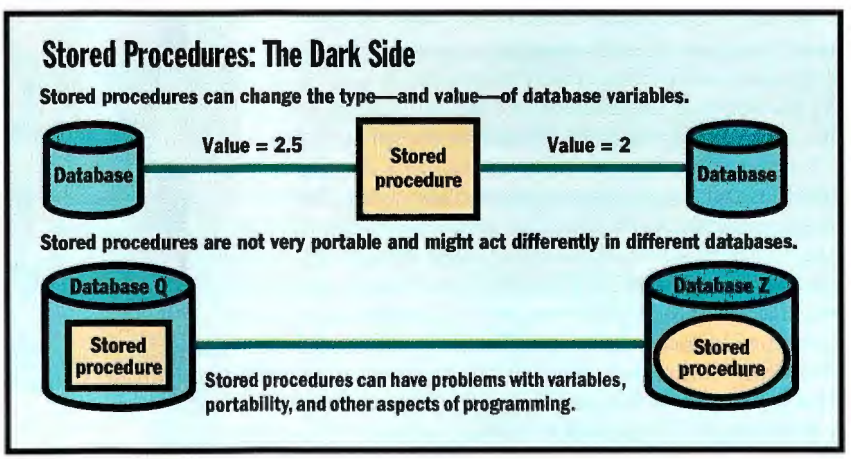


straints to it. The problem is that, more often than not, the stored procedure is working with local variables that have no constraints on them whatsoever and that can get their values from sources other than the database. This means that, even if the local variables come from the database initially, they need not represent anything in the database when they give the user information or return data to the database.

One simple example of this problem is loading a database value into a local variable that's of a different data type and nullability. You get a hidden automatic type conversion and the possibility of a different nullability (whether or not the variable can be NULL) from the original data.

This sort of error isn't even portable. Reading 2.50 into a local integer variable can give a value of either 2 or 3, depending on how the SQL engine treats rounding and truncation. Since the SQL standard leaves numeric-precision questions "implementation-defined," this practice is perfectly valid.

Correspondingly, using a local variable of a different data type and nullability to put data into a database can create type-conversion and nullability errors in the other direction. Integrity constraints prevent some errors, but not all of them.



Cursed Cursors

If you don't know exactly what a cursor is, think of it as a way of turning a SQL query into a simple sequential file. An updatable cursor must access only one row in the original table at a time. This leads to concurrency problems when someone else needs that row, too. The usual solution is to lock everyone else out of the table, and to heck with performance.

But this doesn't answer another question. If the cursor is on one row of a table and, in the same stored procedure as the cursor, an UPDATE statement updates all the rows in the table, does the data under the cursor also change? The answer varies from product to product, but it's always a surprise to the programmer who thinks a cursor should behave like a file.

Not Portable

The ISO has approved a SQL/PSM (Persistent Stored Module) language standard, based on Ada, that's better for use with SQL than with existing proprietary languages. It uses a block structure that can execute a statement group as a sequence (e.g., BEGIN...END) or as a unit (e.g., BEGIN ATOMIC...END), and it has the program flow-control statements needed for structured programming. A table can have

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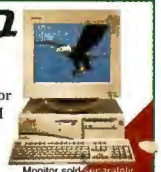

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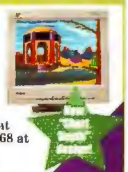

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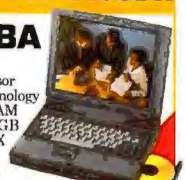

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multiple attached triggers that can fire in order before, after, or instead of the triggering action.

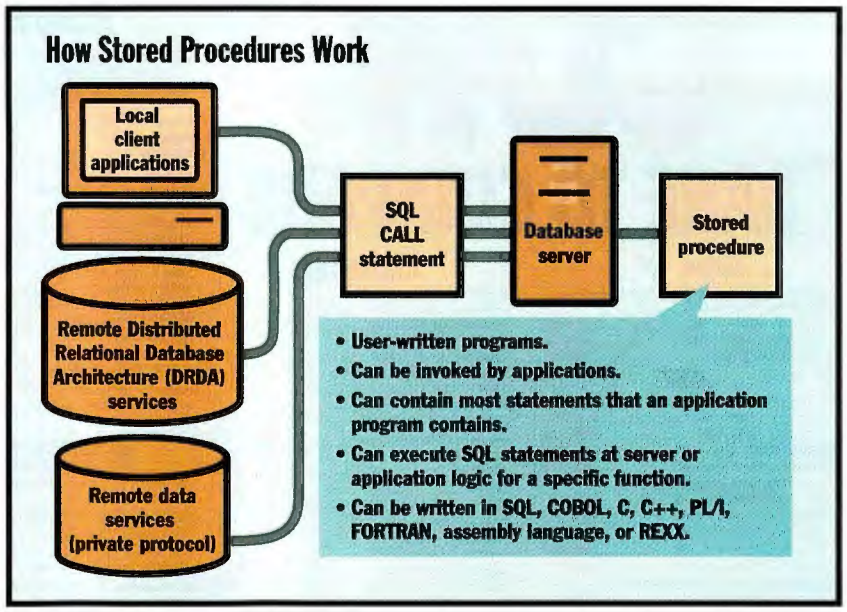
It's a nice standard, but only the Mimer database from Sweden has implemented it thus far. Most SQL products support triggers and/or stored procedures—each with its own proprietary language, which is usually based on an existing 3GL. Sybase/SQL Server's T-SQL language is based on C. Informix's fourth-generation language (4GL) is based on the ALGOL/Pascal language family.

But problems arise. An IF...THEN...ELSE statement, one of the fundamental building blocks of structured programming, uses two-valued, Boolean logic (i.e., TRUE, FALSE), while SQL uses three-valued logic (i.e., TRUE, FALSE, UNKNOWN). When a predicate in the IF clause returns UNKNOWN, should the THEN clause execute? The ELSE clause? Neither of them? SQL has no clear guidelines. UNKNOWN acts like FALSE in the WHERE clause of a SELECT, UPDATE, or DELETE statement, but like TRUE in the CHECK() constraint and other declarative referential integrity clauses.

Proprietary languages are just a minor problem in a one-vendor IS shop. However, such one-product shops are going the way of the dinosaurs. Modern IS shops have several different databases, usually as a migration-path plan for applications to scale up.

Software vendors who develop applications on many platforms and databases face this language problem on a daily basis. Their solution most often is to avoid writing proprietary script code for every database in their packages. Instead, they keep procedural code out of the database entirely and write procedures in C or another standard cross-platform language that can host SQL.

That's why ODBC, and now Java Database Connectivity (JDBC), are popular with developers of shrink-wrapped software. They permit you to link the object program (which the C source code containing SQL created) to a different backend library for each target database. The software vendor doesn't expose source code to the buyer and can maintain just one version of the source code.



Clients or remote processes can invoke stored procedures, programs that reside on the database server itself.

Let's Get Practical

4GL performance is several orders of magnitude worse than that of pure nonprocedural SQL. SQL database engines are optimized to handle large blocks of data on physical data pages in storage.

In addition, database-optimizing compilers are complex and sophisticated, while procedural languages have simple compilers. T-SQL is a classic example: It's a one-pass compiler that can't handle a forward reference and needs a @ in front of local variables. There's not much code optimization in a one-pass compiler; about all you can do is rearrange the expressions a little and hope for the best.

Procedural code is also much bigger than pure SQL. A SELECT...GROUP...BY...HAVING statement does the same work as over 100 lines of procedural code. The extra code is for error checking, opening or closing cursors, and so forth.

We once replaced a block of over 400 lines of T-SQL code with a few SQL statements. The pure SQL ran 2700 times faster. Anecdotal, perhaps, but indicative.

Also, many databases automatically recompile stored procedures whenever they are used—even several times in the same session. The system itself might cause this by paging a stored procedure out of main storage and not retaining the executable. A worse situation is when stored procedures call each other and push each other out of main storage, guaranteeing maximum compiling times.

Whoa, Trigger!

Another disadvantage is that triggers and stored procedures do not communicate anything to the query optimizer. The user calls the stored procedure, so the database has no idea when it will execute, or even what code it contains. If you maintain referential integrity with the PRIMARY KEY, FOREIGN KEY...REFERENCES, and CHECK() clauses on the tables instead of in triggers, then the optimizer can pick up the predicates in the CHECK() clauses and use them in its execution plan.

An advantage of many SQL databases is that a FOREIGN KEY...REFERENCES declarative referential integrity-constraint clause creates a special indexing structure inside the engine on the two tables involved and speeds up the joins on the primary and foreign keys. Stored procedures and triggers simply cannot do this, since they are added to schemata after the tables are created. B

Joe Celko and Jackie Celko are Atlanta-based technical writers. You can contact them at **1062.1056@compuserve.com.**

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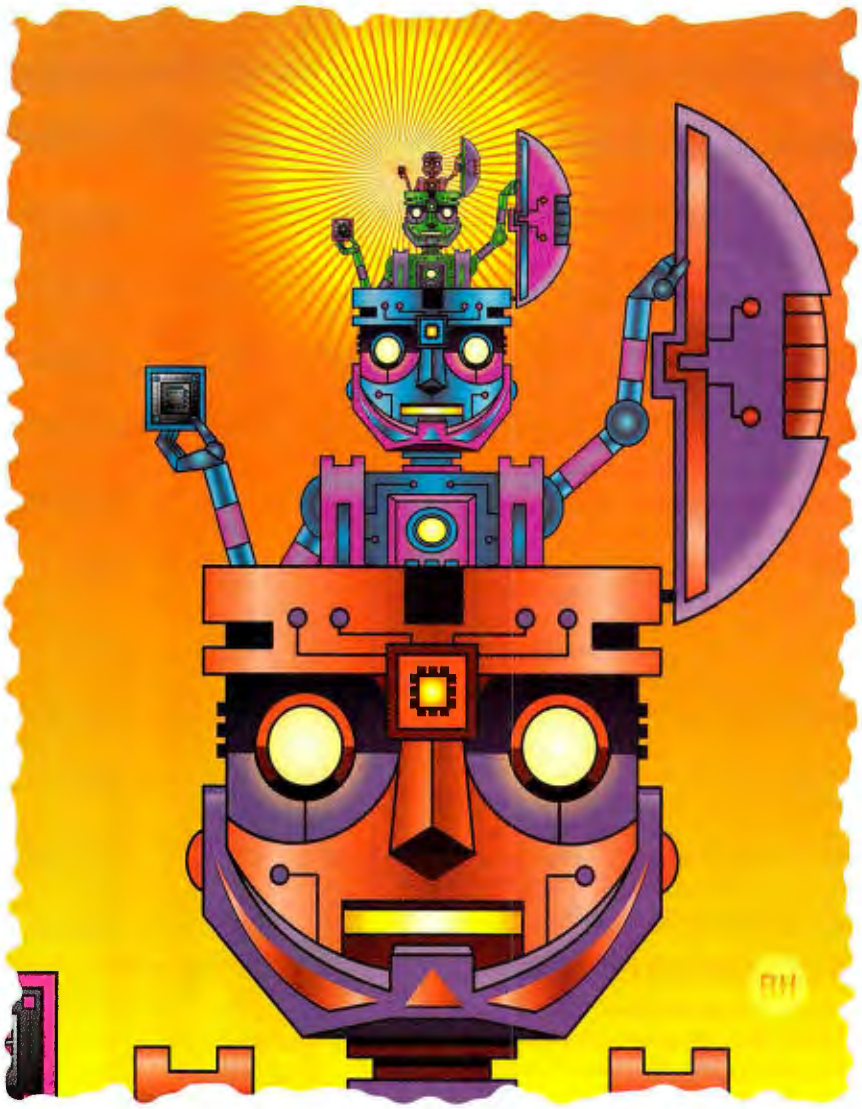


AMENDING MOORE'S LAW

For over 30 years, Moore's law has described exponential increases in chip power. Finance, technology, and physical law might change that.

By Dick Pountain

We've been living with Moore's law for 34 years now, so the idea that one day soon it might cease to apply could be hard to accept. Back in 1964, four years before cofounding Intel, Gordon Moore noticed that the number of transistors that could be squeezed onto a single chip was doubling every year. Those early chips contained a few thousand transistors, but once the semiconductor business got into its stride, the pace slackened a bit. The transistor count was doubling *only* every 18 months, and it's been doing that ever since.

Now the Intel Pentium Pro contains 5.5 million transistors, and the next-generation Merced will have closer to 10 million. What's more, as the number of transistors doubles, next-generation chips don't cost much more per unit to manufacture than the previous generation, so the cost per transistor is actually halved every 18 months.

As Luck Would Halve It

This halving of transistor costs happens because chips are fabricated using photolithography—in effect, a kind of printing process—so the economics work rather like print on paper. For instance, it would cost almost exactly the same for BYTE to print—with the same technology—twice as many words, at half the size, on this page, although destroying your vision is not in our mission statement.

Luckily, that problem doesn't arise with transistors, because a half-size transistor is just as good as its full-size predecessor. Actually, it's better, because smaller transistors are faster than big ones. For one thing, as the density of transistors on a chip rises, the distance between transistors is reduced, so the electrons don't have to travel as far (and, thus, they arrive sooner). Also, as you shrink CMOS transistors, you can switch them proportionally faster by raising the clock frequency. The power each transistor consumes remains the same.

The fortunes of Intel and other semiconductor giants have rested for nearly 20 years on this virtuous circle of physics. Smaller transistors mean more on each

chip, resulting in greater processing power and faster speeds. It's the reason that the 166-MHz Pentium machine I use today is hundreds of times more powerful than the single mainframe that served all of London University during my student days in the 1960s.

Every few years someone predicts the end of this exponential growth of chip density, but so far they've all been wrong. Now a slackening of the pace is in sight—not next year, but within the next decade. The reasons might be as much financial as they are technical.

You may have already spotted a weakness in my print-on-paper analogy. Printing twice the number of words on each page might not raise the cost per page, but the overhead would double from buying twice the amount of materials. Also, new technology might be necessary. Analogously, as chips get denser, the cost of designing them and the cost of fabrication equipment go up, too—perhaps not quite so fast, but following a similar exponential growth curve. An increasing number of industry commentators believe that it will be the cost of new fabrication plants, rather than technological obstacles, that causes Moore's curve to plateau.

Reproductive Problems

The current-generation Pentium Pro and PowerPC microprocessors use CMOS technology with a 0.35-micron feature size (roughly the size of each transistor and the metal tracks that connect them). The next versions of these chips, currently in sample production, will shrink to a 0.25-micron process. As Tom Thompson explains in "What's Next?" (April 1996 BYTE), these sizes are already pushing up against a technical barrier in the lithography process itself.

Physical law requires using a light with a wavelength smaller than or equal to the smallest feature of a chip to accurately copy the chip's layout masks onto silicon. Current litho machines use mercury arc light with a wavelength of 0.365 micron. Next-generation machines will move to exotic krypton/fluorine UV lasers that emit at 0.248 micron.

As chip fabricators try to reduce the feature size further, the illumination sources they need become ever more exotic, more expensive, and less manageable. UV lasers, plus optical tricks to enhance their resolution, are good down to about 0.1 micron. Below that, X rays are needed, and then things get *really* tricky. There is no method to focus X rays. That means you can't employ optical reduction, so chip masks must be the same size as the chip itself, making them terribly difficult to manufacture. Another difficulty is finding mask materials that are sufficiently opaque to X rays. Despite decades of research, X-ray lithography has never made a commercial chip.

Halve Mercy

Lithography is only the first obstacle. At feature sizes around 0.1 micron, problems with transistor threshold voltages, capacitance, and resistance in the metal in-

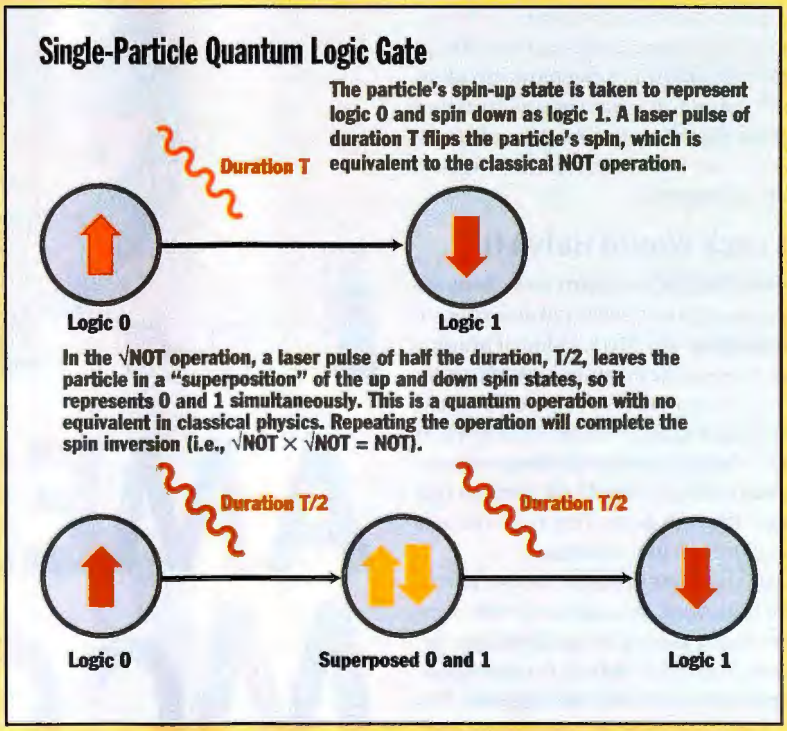
The Square Root of Not

To create a quantum computer based on binary logic, you need a quantum particle that has at least two states (a ground state and an excited state) and some means of forcing it to switch between the states. These states could be the spin of a single electron, electronic orbitals in an ion, or the magnetic dipole of an atomic nucleus. Corresponding switching agents could be pulses of laser light or microwaves.

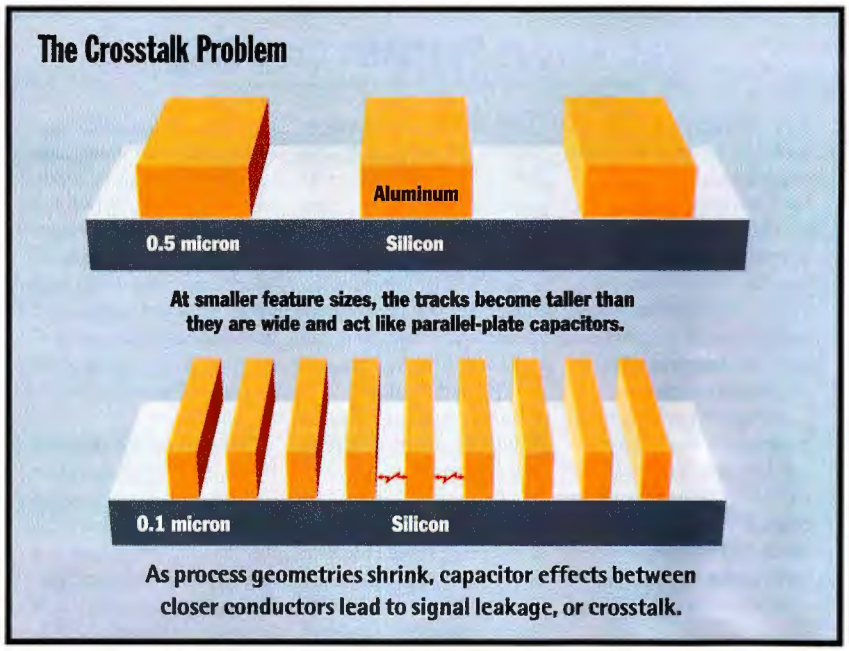
Designate one of the states (say, the ground state) as representing 0 and the other as 1, so the particle encodes the values of a classical digital bit. As shown in the top portion of the figure below, applying a switching pulse of duration p turns a 0 into a 1 (or vice versa), so the particle behaves as a Boolean NOT gate.

What makes a quantum gate different is what happens when you hit the particle with a pulse of $p/2$ duration. The particle's state now becomes a "coherent superposition" of both states; that is, it represents both 0 and 1 at the same time (see the bottom portion of the figure below). If you apply the $p/2$ pulse again, this superposed state collapses into the opposite of the original state.

David Deutsch christened this device the √NOT gate, because applying it twice in succession is equivalent to a single NOT operation (√NOT × √NOT = NOT). He also demonstrated that this is a universal operation (as are almost all quantum interactions), so you can perform any quantum computation by using a combination of them—just as you can use NAND gates to create any classical computation. Deutsch explains this situation in a more dramatic fashion: "Almost anything is a quantum computer if you shine the right kind of light on it."



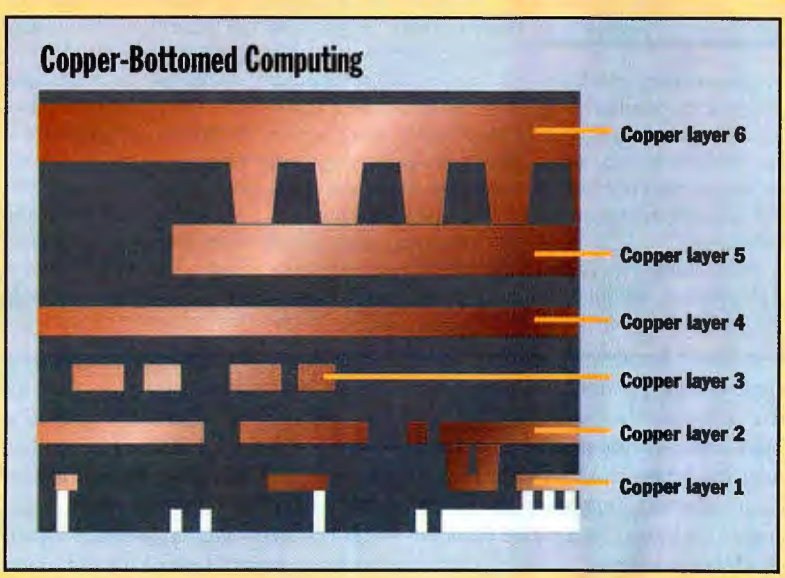
Single quantum particles can "remember" the previous state, so they can flip to the opposite logical state.



The Copper Connection

Last September, IBM announced that it had cracked the problems of copper metallization for its new CMOS 7S process (see the figure "Copper-Bottomed Computing" below). Manufacturers have long known that copper, a superior conductor, would be better than the aluminum currently used to make the tracks connecting transistors: Copper permits thinner tracks at the same resistance. However, aluminum is much easier to deposit by evaporation, and it sticks better to the silicon substrate.

IBM's CMOS 7S process will lead the market in several parameters (that is, until Intel catches up). Using six metal layers and a 0.2-micron feature size, it can pack 150 to 200 million transistors onto a die and operate at 1.8 V. IBM will be introducing ASICs built using CMOS 7S this year, and it will migrate the PowerPC chip to the process soon.



IBM has solved the problem of bonding copper to silicon, allowing the creation of tracks with superior conductance.

terconnects also hit crisis points. One benefit of CMOS is that—in contrast to competing technologies—transistors consume almost no current when they're turned off. This enables immensely complex chips, such as the Pentium, to have reasonable power consumption. As chip designs shrink, each individual transistor can run faster while consuming the same amount of power.

However, the total *number* of transistors per unit area increases by a square law, so the power consumed (and, hence, the heat dissipated) per unit area rises by a square law: half the feature size and quadruple the power per unit area. Fortunately, another property of CMOS technology comes to the rescue: The transistors' voltage and power consumption also relate by a square law. This means that lowering the supply voltage can compensate for this increased power consumption. Dropping from a 5-V operation to a 2-V one brings a sixfold power saving (52/22=25/4); dropping to 1 V would reduce power consumption 25-fold.

That's why chip designers have been reducing CPU core voltages over the past decade as feature sizes get smaller, by steps from 5 V, through 3.3 V and 2.8 V, down to 2.5 V, and even as small as 1.8 V for next-generation chips. As a result, we keep getting double the computing power for almost the same power consumption.

But in semiconductor design, the tradeoffs keep coming over the plate a little too fast. Unfortunately, reducing the supply voltage reduces the maximum clock rate for a chip by increasing the gate delay; the transistors switch slower. Fortunately, you can offset this by also reducing the transistor's *threshold* voltage (the voltage at which the transistors switch on). Unfortunately, if you lower the threshold voltage too far, the transistors won't work at all. But even before you reach that point, they begin to leak current, even when turned off.

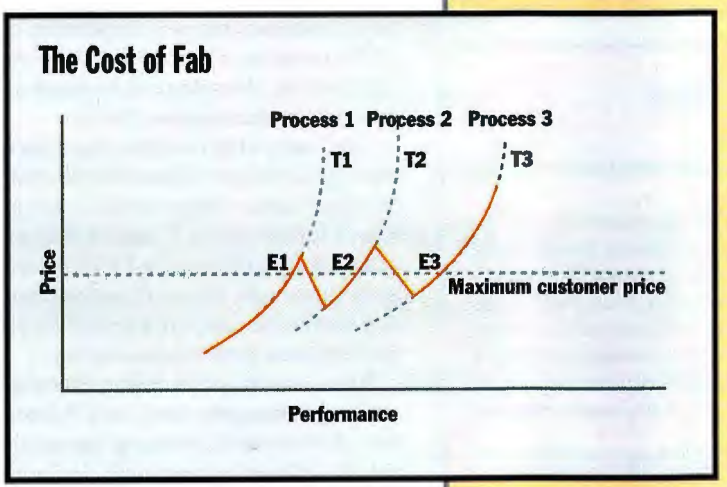
Steve Furber, professor of computing at Manchester University, is an authority on low-power chip architectures (he designed the original ARM chip). He describes the situation like this: "In standard bulk CMOS, for every 60 millivolts that you lower the threshold, leakage goes up by an order of magnitude. At the moment, the industry is lowering the supply voltage only as fast as it has to, to avoid transistor breakdown."

The bottom line of this mind-boggling

series of trade-offs is that just-under-1-V operation looks like a fundamental limit for CMOS technology. That's exactly where sub-0.1-micron chips are headed.

Crosstalk Act

Crosstalk is another gremlin that will make 0.1-micron features hard to achieve. Today's chips are essentially two-dimensional objects, so as you shrink them you have to cram everything closer together. The tracks that join the transistors must get narrower, but to avoid increasing their resistance too much, they still have to be relatively thick. Eventually they look more like walls than roads (see the figure "The Crosstalk Problem" on page 93). Worse, neighboring pairs of tracks start to behave as long, parallel plate capacitors, which slows down signal transmission and allows the signal on one track to leak into its neighbor (i.e., crosstalk).



Each new generation of a chip design has its own cost/performance curve.

Chip designers will be fighting an uphill battle against crosstalk. For example, the latest generation of CAD tools spaces the tracks farther apart than the minimum width. As Furber observes, "That's good for reducing crosstalk, but it starts to negate the advantage of the small feature size." One solution that promises to delay the inevitable is employing a better conductor, copper, so that these thick tracks can be made narrower. This will reduce intertrack capacitance (see the text box "The Copper Connection" on page 93).

The Everests of Chip-Making

Keeping up exponential growth beyond 0.1 micron will mean moving beyond the current universe of 2-D CMOS fabrication. There are hundreds of university research projects into 3-D chip structures and molecular-level transistors built from exotic organic polymers, but none of these technologies yet looks like a viable basis for such a huge industry.

The combination of all these difficulties might cause Moore's exponential curve to level off—at somewhere just below the 0.1-micron feature size, with more than 100 million transistors per chip, a 1-GHz clock rate, and 1-V operation—sometime during the next decade. According to Furber, "We've been blessed so far, in that the sorts of things ECL [emitter-coupled logic, as used in 1970's mainframes] board designers used to worry about—transmission-line effects, ringing, and so forth—have not existed in CMOS chips to any significant extent, but they're definitely coming." *continued*

Fab Forces Systems on a Chip

Business models, rather than technical obstacles, might halt the exponential growth in chip density. In 1981, G. Dan Hutcheson developed the nonlinear return on investment (ROI) model, which big semiconductor companies still use to guide their investment in plants and equipment.

He points out that price-based decisions, not technical obstacles, ultimately control chip life cycles. "The costs of achieving higher levels of chip performance rise very rapidly as the limits of a manufacturing technology are approached," he explains. "Increasing costs might drive prices beyond what buyers are willing to pay, causing the market to stagnate before the actual barriers are encountered."

In the figure "The Cost of Fab" above, the solid red line depicts the overall cost/performance history of a hypothetical chip family; the dotted curves show the cost/performance curves for successive generations. E1, E2, and E3 show the points at which the economics force the abandonment of the old technology, long before the technical "brick-wall" region (T1, T2, and T3) does.

Every peak in this cycle requires a new fabrication plant, the cost of which is rising about half as fast as Moore's law itself, doubling about every three years. Intel just spent $1.3 billion on its new fab in Arizona. Both Samsung and Siemens have paid $1.5 billion for new fabs.

You need to sell a lot of chips to recoup such investments, and eventually that won't be possible. Then you have to raise prices. Hutcheson says, "The semiconductor industry is not likely to come screeching to a halt anytime soon. When the cost per bit begins to rise permanently, the most likely result will be an industrial phase change that significantly alters business models."

Other industries experienced similar phase changes long ago. If this happened in the semiconductor business, big-iron chips, such as the Intel Merced, would remain expensive and change less often. Semiconductor firms would have to branch out horizontally, using spare silicon real estate to add more functions to a chip: Digital signal processors (DSPs), graphics accelerators, and eventually whole computer systems would be on one die.

There are signs that this is happening. Intel is rapidly diversifying into graphics, telephony, networking, and video. It has just reorganized itself and has finally conceded it needs to produce an inexpensive Pentium II for sub-$1000 PCs.

This is also a scenario that Robin Saxby, chairman and CEO of ARM, endorses. The firm has no fabrication facilities of its own; instead, it uses commercial foundries. Saxby sees the company's future in designing ASICs based around the ARM core, and eventually whole systems on a chip. "If you look at the motherboard of today's PC, you'll find devices from around 15 silicon vendors: a CPU from Intel, graphics from Chips & Technologies, a modem from Cirrus Logic, a sound chip from Yamaha," he explains. "The future PC 'motherboard' will be a single chip, but just one silicon vendor will supply that chip. The biggest challenge is getting the intellectual property for all those circuits to work together and connect."

ARM is one of 128 firms (including Alcatel, Fujitsu, IBM, Sony, and Toshiba) that have formed the Virtual Socket Interface Alliance (VSIA; http://www.vsi.org) to create standards for integrating such system-on-a-chip products by sharing and licensing the circuit components.

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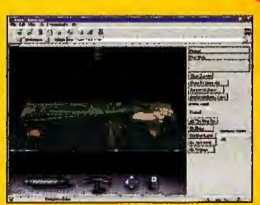

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The Semiconductor Industry Association's (SIA's) *National Technology Road Map for Semiconductors*, a collection of best-guess predictions from experts across the industry, agrees with this assessment. It hints at a slackening of the increase in clock speeds to around the 1-GHz level by the year 2010.

There are other obstacles besides CPU design. In DRAM fabrication, progress is slowing as cell sizes fall below 0.2 micron: Moving to expensive silicon-on-insulator technologies might be necessary to get past the 1-Gb level. Bus speeds currently lag five times behind CPU speeds (for example, a 300-MHz Pentium on a 66-MHz bus). This puts tremendous pressure on cache technologies to absorb the difference. A 1-GHz CPU will demand at least a 100-MHz bus. Intel already has motherboards in its labs running that fast, but such boards are hard to design and expensive to make, which may further upset the economics of the commodity PC market. But in a way, none of these technical obstacles is the real problem; it might be the business model that's in danger of topping out (for more information, see the text box " Fab Forces Systems on a Chip" on page 94).

Quantum Barrier or Bridge?

In addition to technology and finances, quantum mechanics presents a problem as well. At the 0.1-micron size, quantum effects start to become important. The electrons in the body of each transistor number only a few thousand, rather than billions. Ohm's law and other macroscopic rules that electrical engineers work by describe only the statistical average behavior of huge numbers of electrons. Once you start dealing with electrons on their own, they follow the very different laws of quantum mechanics. As Furber puts it, "The probability that a few hundred electrons will spontaneously migrate to the next transistor might be only zero-point-many-naughts percent, but given billions of transistors, in a chip that's expected to perform billions of operations per second without error for years, you'd eventually start to see that happen."

But what about the possibility of harnessing quantum effects to create a new kind of computer? Although many researchers are pursuing that goal, there aren't any working quantum computers as yet. Present experiments are still at the level of demonstrating one or two working quantum gates. However, the motivation that drives the search for a quantum computer is that it might solve classes of problems that will be forever denied to conventional computers.

Rather than operating on the bulk properties of electrons, as a "classical" digital computer does, a quantum computer operates at the level of single particles: atoms, ions, single electrons, or photons. Promising systems have beryllium or cesium atoms trapped inside resonant cavities, and quantum "dots": single electrons trapped in the energy wells at the junction of two layers of doped silicon.

Many experiments on quantum computing use lasers and mirrors—not because that's the way to invent practical devices, but because quantum optics is a well understood field. Which physical implementation eventually triumphs, if any, is not too important at this stage, however, as the principle underlying them all is the same, in a very profound sense (see the text box "The Square Root of Not" on page 92).

Quantum computers have a different range of usefulness than classical computers do. Also, in the opinion of David Deutsch of Oxford University, "They will probably never be used to add up accounts in banks."

Deutsch also doubts that quantum computers will ever be fabricated with the sort of large-scale integration that is seen in CMOS devices. As Deutsch says, "For classical computers, the difficulty has been making them smaller and faster. But for quantum computers, the difficulty will be to put more bits into the interactive region."

Exciting as quantum computers are in theory, they are not in a direct line of descent from MOS technologies. The same economics are unlikely to apply to their fabrication. In fact, these machines are likely to have to face their own equivalent to Moore's law. B

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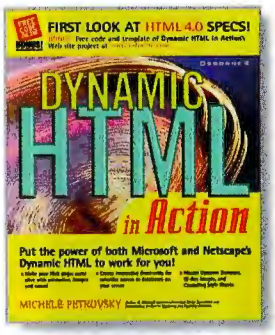

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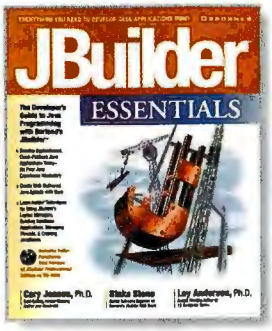

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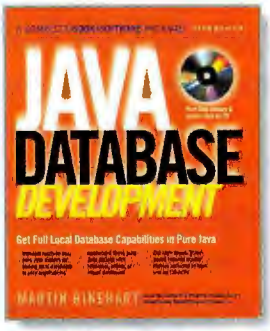

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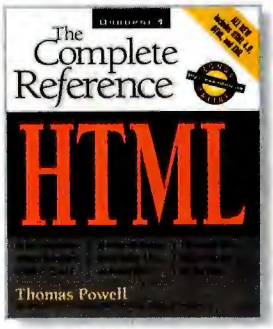

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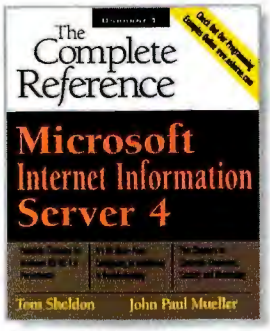

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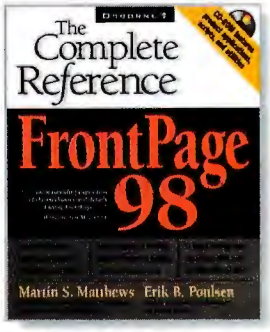

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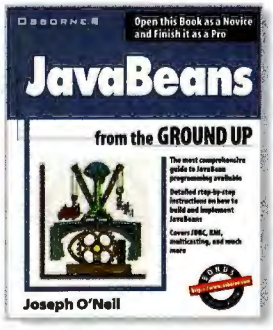

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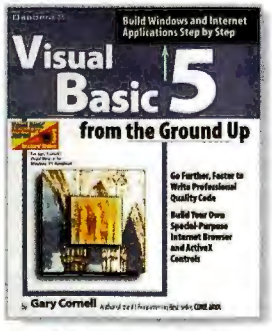

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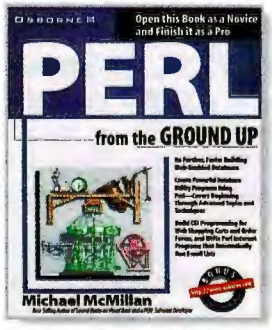

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REQUIRED READING for the Information Age

The Internet relies on a network layer protocol—the Internet Protocol, or IP—to provide worldwide interconnectivity of many individual networks into a greater whole. Although the current version of this protocol, known as IPv4, has served the Internet well for over 20 years, it is reaching the limits of its design. A new version, IPv6, is waiting in the wings. (See "IPv6: Coming to an Internet Near You," page 96NA 4.)

Boning Up on IPv6

The 6bone is leading the way to test the next-generation Internet Protocol, IPv6, and help move it into the Internet mainstream.

By Robert Fink

By early 1996, it was obvious that IPv6 needed its own testing environment to simulate the Internet operating under the new protocol. Several implementers and users met and started an international test bed, called the 6bone (short for IPv6 Internet backbone). By June of 1996, two groups were racing to provide the first IPv6 connectivity: One group consists of the University of Lisbon (Portugal), the Naval Research Laboratory (U.S.), and Cisco Systems (U.S.); the other includes consortia of Danish universities (UNI-C), French universities (G6), and Japanese universities (WIDE). The result: the 6bone test bed.

The 6bone is an international IPv6 test-bed network that the IPng Transition Working Group (ngtrans) oversees and directs. The 6bone provides a means for:

- testing IPv6 implementations and standards;
- testing IPv6 transition strategies;
- gaining early applications and operations experience;
- giving implementers, users, and Internet service providers (ISPs) a chance to try IPv6; and
- making an experimental first step toward the transition from IPv4 to IPv6.

The 6bone follows in the footsteps of the MBONE, the Internet multicast tunneling backbone, which provides IP Multicast transportation over existing unicast infrastructure by tunneling where native IP multicasting is not available. Similarly, the 6bone tunnels IPv6 traffic across the existing IPv4 Internet infrastructure, since IPv6 native transports are not yet widely available.

In the early phases of IPv6 deployment, most native IPv6 transport is restricted to sites with the capability to experiment with it locally. ISPs and other private IPv4 transit providers are generally unwilling to place IPv6 in production use in their routers until it is thoroughly debugged and proven and ensures minimal operational impact. This leaves most early IPv6 testers with the need to use tunneling to deliver IPv6 packets among themselves when remotely located.

Also, at the present time, the 6bone consists of many research and development organizations in the implementer, user, and ISP communities. Many sites allow packets to travel based on the site's research and development status. Thus, production IPv6 traffic is not carried on the 6bone because it might conflict with the acceptable-use policies of these organizations. You can expect that a variation of the 6bone will soon provide early IPv6 users with the capability to carry actual production traffic.

Anatomy of a 6bone

The 6bone provides the needed IPv6 transport infrastructure by relying on:

- dual IPv4 and IPv6 stacks in the client;
- IPv6 encapsulated in IPv4 packets;
- dual-stack backbone routers that know IPv6 routes of 6bone participants;
- Domain Name System (DNS) that supports IPv6 "AAAA" records;
- a 6bone routing registry to track sites and their tunnels;
- a mail list, various IPv6 tools, and a 6bone Web site (http://www.6bone.net).

Dual stacks handle both IPv4 and IPv6 traffic. This is also one way to turn IPv6 into IPv4, and vice versa, so that IPv6 can tunnel on the Internet.

The figure "6bone Conceptual Architecture" (page 96NA 6)

IPv6: Coming to an Internet Near You

What's so wrong with IPv4 that IPv6 should replace it? IPv4 is difficult to configure, has no built-in security features, is running out of addressing space, and provides no site renumbering features for changing easily from one Internet service provider (ISP) to another. Despite various mechanisms (including IPsec, DHCP, and NAT) to alleviate these problems, they have their own limitations and must be added on, often at great expense.

The Internet Engineering Task Force (IETF) tackled IPv4's problems by starting the IPng (Internet Protocol next-generation) project. The original work leading to IPv6's selection by the IETF completed in mid-1994. Then these protocols evolved and improved enough to allow the start of various implementations of IPv6.

IPv6 Addressing Replaces IPv4

The current IPv4 provider-based addressing in the current Internet relies on ISPs getting separate IPv4 addresses in contiguously numbered blocks for routing efficiency: The routers need to carry fewer routes. However, one ISP may use most of its assigned block of addresses and may be running out, while another might use few of its addresses, wasting the rest. Sites cannot renumber easily, causing many more separate routes than necessary. This then leads to route computation complexity.

The new Aggregatable Global Unicast Address Format provides an answer. IPv6 addresses are larger (128 bits) than IPv4 addresses (32 bits). This allows more flexibility in designing newer addressing architectures. You can divvy up IPv6 blocks more efficiently, for example. There are also more than 10^{28} more IPv6 addresses than IPv4 addresses. That should hold us for a while.

IPv6 Public Routing Topology

Half of the new bits in an IPv6 address are a flexible way to specify the address of the ISP. With the new aggregatable addressing (see the figure at right), the left-most 48 bits of the address are a public routing prefix. The first 3-bit field specifies that the addressing format is aggregatable: It allows a hierarchy of addresses.

The next 13-bit portion specifies the Top-Level Aggregator (TLA) ID. This constrains the top level of Internet routing to 8192 major transit ISPs. Each TLA (the top-level transit ISP) is then responsible for the public routing below it, the Next-Level Aggregator (NLA) ID.

As the figure shows, the NLA may have a tiered hierarchy to allow multiple sublevels (NLA1, NLA2, etc.) of ISPs, each of which would then have control of the assignment of the space below it. The right-most portion of the NLA field, at whatever sublevel it may be, would identify the ultimate end-user "leaf" site.

This style of addressing allows automatic address clustering, or aggregation, into a constrained set of routes, which the TLA field represents. (If 13 bits proves to be insufficient in the future, another piece of the IPv6 128-bit address may serve as part of this addressing format later.) It is still too early to say how successful this new style of addressing will be.

IPv6 Site Topology and Interface ID

The TLA and NLA take us to the ISP site. A site itself can have aggregation also, using a 16-bit Site-Level Aggregator (SLA).

The SLA might be as simple as a subnet number or a tiered hierarchy of sublevels such as the Next-Level Aggregator provides. The site controls the SLA and identifies the subnet that a host interface attaches to. (IPv6's addressing, like IPv4's, specifies interfaces on systems, not the entire system.)

Having reached the site and subnet, an interface ID specifies the local logical address of the system's interface on the local subnet (or link). The interface ID derives from the new IEEE EUI-64 media-level address, an expansion of the well-known Ethernet 48-bit address format that allows each manufacturer to assign more device identifiers. This will allow newer technologies, such as IEEE 1394 Firewire, to have unique addresses, as networking addresses more elements than just host systems (e.g., the old joke about an Internet toaster—maybe light bulbs, too!).

If the IPv6 node attaches to an Ethernet "link," then the 48-bit address turns into 64 bits by a filler field stuck into the middle (see the figure "Aggregatable Address Format," above).

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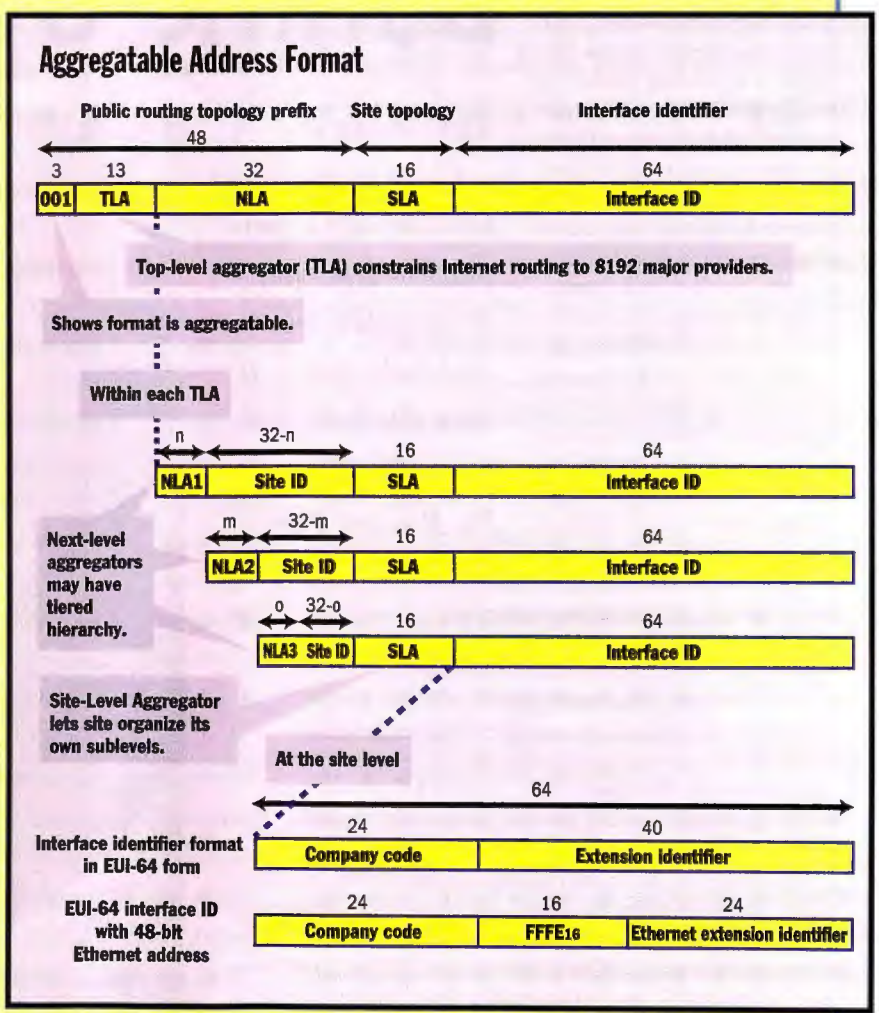

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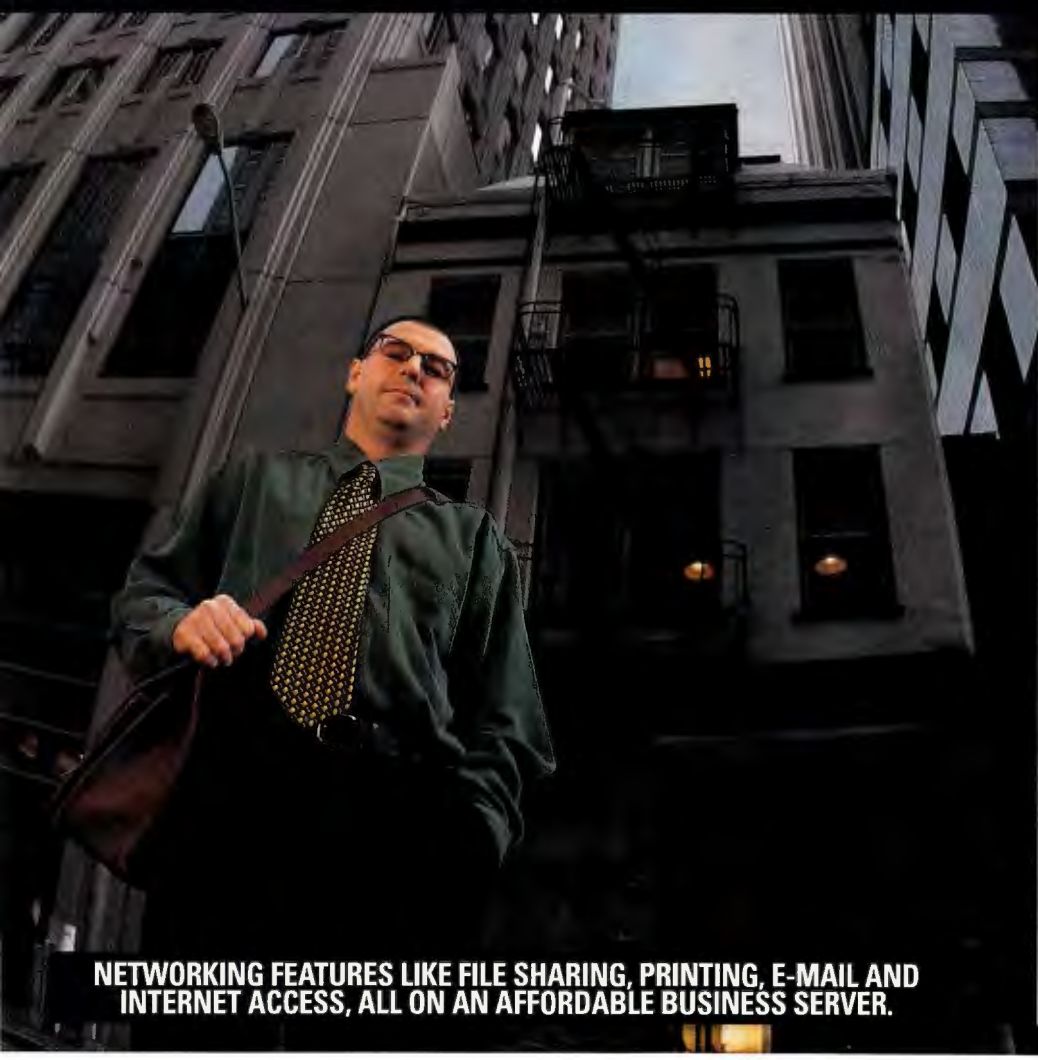

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Continued IPv6: Coming to an Internet Near You

IPv6 Autoconfiguration

Seem complicated? Automatic configuration of IPv6 end-systems (hosts) may be the most important feature of IPv6. In the current IPv4 Internet, you must manually configure IP address, network mask, and default gateway, or else rely on a Dynamic Host Configuration Protocol (DHCP) server. With IPv6, this can take place automatically, with no outside systems, using stateless autoconfiguration.

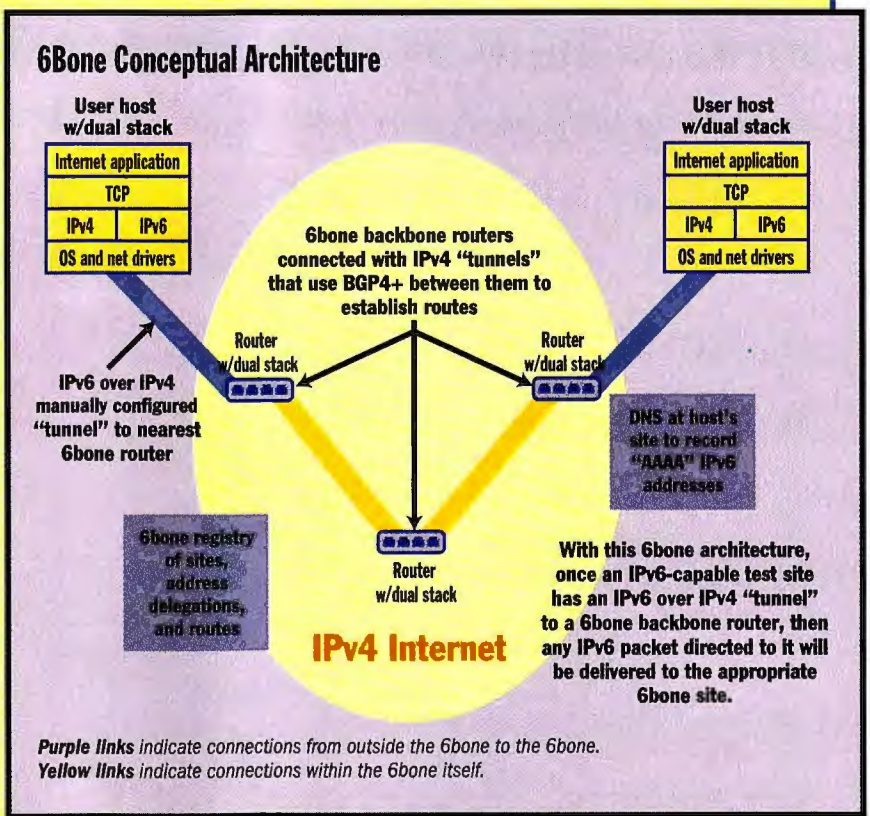
IPv6 autoconfiguration provides for standalone operation of two or more hosts on a local LAN link with no router. It also provides for operation within a site with no outside Internet connectivity present. Finally, it allows for easy changing of the site's public routing prefix, either when external connectivity comes online or when the external connectivity changes–such as when you choose a different ISP.

IPv6 Site Renumbering

Because IPv6 addressing uses a number assigned by the ISP that provides Internet service to a site, it is essential that it be easy for a site to renumber itself when the choice of ISP changes. A new router-renumbering protocol–in conjunction with autoconfiguration, the Neighbor Discovery Protocol, and the well-defined Public Topology Routing prefix from the aggregatable addressing format–helps with this.

Here's an example. Let's say that a new ISP service is going to take over 30 days from now, while the old ISP will continue to provide service until 60 days from now. After 30 days, hosts will start using the new prefix (that is, the new ISP) for all new connections, while existing connections will continue to work until the old prefix expires (in 60 days, in this example).

So far we estimate that there are over 50 different IPv6 host and router implementations completed or under way. Of these, 14 host and 14 router implementations have operated on the 6bone.



Dual-protocol stacks are the on-ramp for IPv6 packets to gain access to the 6bone's pure IPv6 tunneling backbone.

With the new Dynamic DNS Registration Protocol, and IPv6's autoconfiguration, a user might boot up his system after it has been enabled with an IPv6 stack (in addition to its IPv4 stack) and become IPv6-ready. The system would automatically configure with an IPv6 address and start talking IPv6 to remote hosts. One aim of the 6bone is to thoroughly test IPv6 before the end user has to rely on it.

shows a conceptual overview of what a basic 6bone implementation would look like. The figure shows the current backbone structure. The figure "The 6bone Backbone" (page 96NA 8) provides a global perspective of the many IPv6 tunnels between a multitude of participating sites.

The 6bone Gains Muscle

The 6bone became operational in mid-1996. To date, the 6bone has spread to 200 organizations in 30 countries. By the end of 1997, the 6bone had converted to a new aggregatable addressing format, a change necessitated by having originally adopted a provider-based addressing format discussed during early IPng design efforts.

Along with the change to a new addressing format was the need to clean up the routing used among the 6bone backbone transit sites. Originally, it seemed that IDRPv6 (a new Internet Domain Routing Protocol based on earlier IPv4 work) would be the prevailing Exterior Gateway Protocol (EGP) used for IPv6 Internet peering.

By mid-1996, various ISPs made it known that a new EGP for IPv6 was not a practical alternative given the explosive growth of the Internet and the evolution and widespread use by ISPs of BGP4. (BGP—Border Gateway Protocol—is a TCP/IP routing protocol for interdomain routing and an alternative to EGP.) There was a need to allow for multiprotocol extensions to BGP4, enabling ISPs to adapt their operations to IPv6 more easily. This led to the rapid evolution of BGP4+, an extension of BGP4 to include IPv6 and IPv4 multiprotocol routing. By mid-1997, the decision was made to convert the 6bone backbone to BGP4+ for its EGP. (The figure "The 6bone Backbone" shows the backbone sites that are using the new aggregatable addressing and provides a status report on the conversion to BGP4+.)

continued

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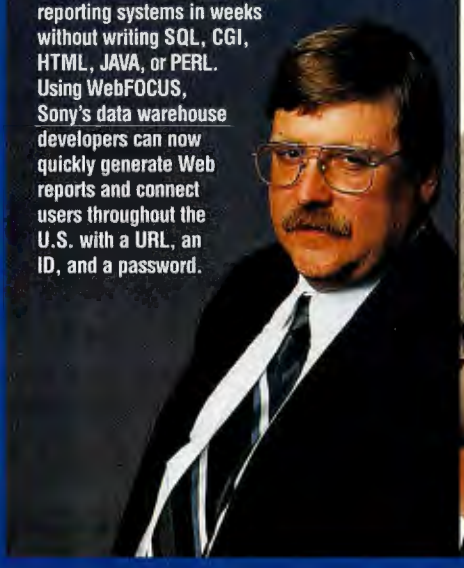
Gary Fisher, Manager Strategic Systems, Sony Electronics Inc.

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 inadequate. 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.



"In less than two months, we reduced order status calls by 40%, enhanced customer relations, and stimulated new business by driving customers to our Web site."

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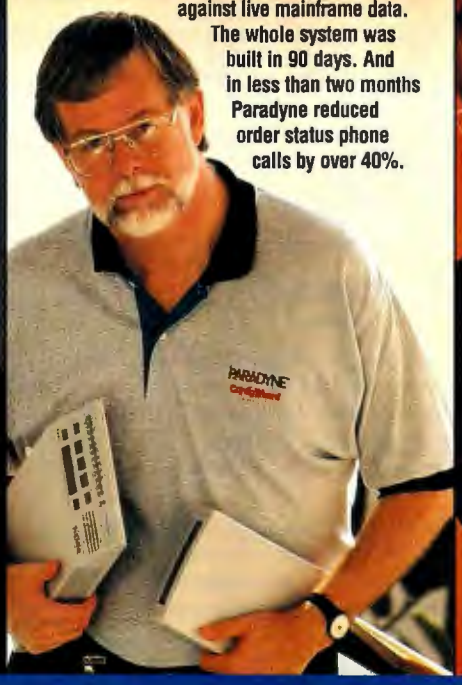

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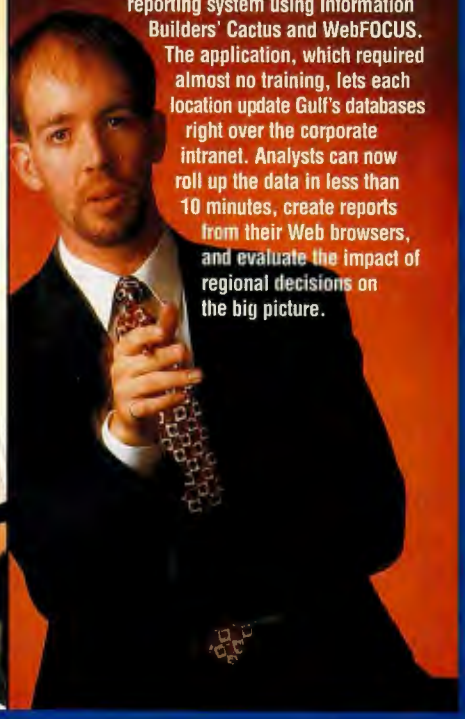
In the oil and gas business, proactive monitoring of production and costs versus operating budgets is a mission-critical function. That's why Gulf decided it needed a faster way to collect and analyze this information from its field locations around the world. The solution... a Web-enabled data entry 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 intranet. 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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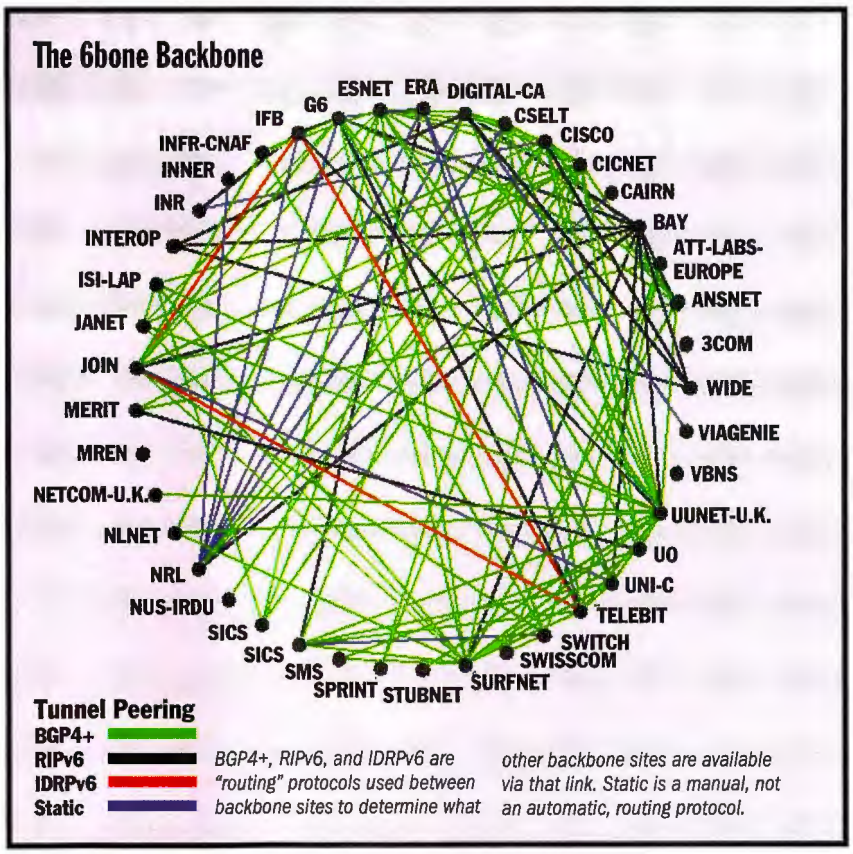
Wish Bones

Most 6bone efforts have attempted to prove basic IPv6 interoperability among the many implementations, and to create a reliable international test-bed infrastructure. This has included making the backbone operational with the new aggregatable addressing format and using BGP4+ for high-reliability routing and transit.

Now that the 6bone has completed these conversions and improvements, serious work can begin on testing site renumbering, applications, transition mechanisms, and other features that IPv6 will encompass.

Several other venues have also tested IPv6, including the University of New Hampshire Inter Operability Laboratory (IOL) and various trade-show demonstration networks, such as Networld+ Interop. By the end of 1997, the UNH IOL had hosted five IPv6 bake-offs. Though the group doesn't release specific details about participating vendors, it is worth noting that in July 1997, 15 companies participated, providing 11 host and three router implementations.

In a positive sign of industry response to evolving IPv6 specifications, the July '97 UNH testing resulted in the successful interoperability of all participants using the new aggregatable addressing format. This achievement, no more than two months from its first Internet Draft, is a major milestone.



Lines represent the tunnels through the backbone between backbone sites. Colors show the type of Exterior Gateway Protocol (EGP) used.

It is too early to predict with certainty that the Internet will adapt easily and transparently to the use of the IPv6 protocol. However, it should be obvious by now that IPv6 provides many important features for a next-generation Internet: automatic configuration, greatly expanded addressing, easy site renumbering, built- in security, and more.

WHERE TO FIND

6bone information, including diagrams, hook-up info, and registry access: http://www.6bone.net

IPng and IPv6 information, including formal specifications: http://playground.sun.com/pub/ipng/html/

The 6bone is helping to prove and demonstrate these features to the groups involved globally. The 6bone thus ranks as one of the most international test-bed collaborations in networking history. B

*Robert Fink (**fink@es.net**) is a network researcher with ESnet (the U.S. Department of Energy's Energy Sciences Network) at the Ernest Orlando Lawrence Berkeley National Laboratory. He is cochair of the Internet Engineering Task Force ngtrans (IPng Transition) Working Group and leads the 6bone project.*

Acronym Explanations

NATs - Network address translators allow private (nonunique) IPv4 addresses to translate into unique IPv4 addresses where a site interconnects to the Internet. This clever way around the limited number of IPv4 addresses is based on the assumption that not all systems at a site need to communicate with the public Internet at once, thus saving unique IPv4 addresses. (IPv6 solves this problem by having more than sufficient addressing space to eliminate the need for NATs.)

DHCP - The Dynamic Host Configuration Protocol provides automatic address configuration information from a server that knows what IPv4 addresses are currently available. This relieves IPv4 of one of its worst characteristics: the need to configure addressing information manually. (IPv6 solves this problem without the need for a server by providing stateless autoconfiguration.)

IPsec - The IP security architecture the IETF is developing retrofits IPv4 with IPv6 security features.

SIP/PIP/SIPP - The Simple Internet Protocol (SIP) and the "P" Internet Protocol (PIP) merged to make the SIP Plus Protocol (SIPP) that eventually evolved into the winning IPng proposal: IPv6.

TUBA - The TCP/UDP with Bigger Addresses protocol used the ISO OSI protocol as its basis. Also known as IPv9, TUBA represented the variable-length address alternative to SIPP.

Jon Udell

Web Project

Perl and Apache

Apache's embedded Perl interpreter, mod_perl, powerfully integrates Web services with scripting.

Lots of people use Apache and Perl, but I've met only some who use mod_perl, Doug MacEachern's extraordinary synthesis of these two technologies.

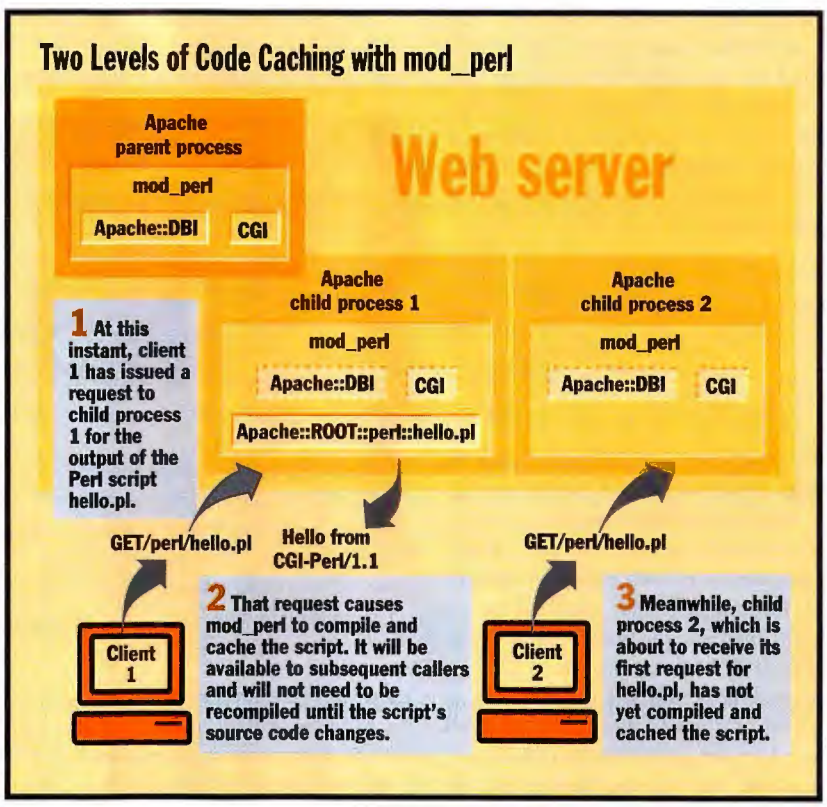
Why? Because mod_perl is, frankly, scarier than a typical Apache module. It doesn't just attach to one of Apache's module hooks, à la mod_auth or mod_rewrite. It can attach to all of them, so the Perl interpreter that it binds into the server can directly implement Apache extensions. It also exposes Apache's configuration and run-time data structures to Perl, so Perl code in the Apache configuration file or in conventional scripts can manipulate these structures. Plus, mod_perl isn't just "fast Perl for Apache"—although it is surely that, too. It's a deeply integrated Apache/Perl hybrid.

To use mod_perl effectively, Perl and Apache users alike need to acquire some new skills. The learning curve's a little steep, but the rewards are substantial.

An Introduction

I'll assume that you're running some flavor of Unix because, although an NT port of Apache is in the works, it's not quite ready for prime time yet. Begin by retrieving the latest recommended Perl distribution (see http://www.perl.com/). Build, install, and test Perl—that is: `./Configure`, `make`, `make test`, `make install`.

Now do the same for Apache (see http://www.apache.org/). Configure Apache to suit your taste—that is, edit the Configuration file so that it includes the modules you want—and then build (`./Configure`, `make`) and test (adjust settings in httpd.conf, run httpd, and point a browser at it). Now retrieve mod_perl (see http://www.perl.com/CPAN/). Here's the drill: `Perl Makefile.PL`, `make`, `make test` (this step requires the LWP module), `make install`.



Perl modules, such as Apache::DBI and CGI, can be compiled and cached at server start-up by means of the PerlModule directive.

The mod_perl make file, when invoked, will locate your Apache source tree and offer to create the new, Perl-ified httpd in that location. Don't forget to `make install` because, in addition to the new httpd, mod_perl comprises a set of Perl modules that must be added to your Perl installation.

If all went well, your Apache httpd is now much fatter. Should you worry? Admittedly, it's a concern. Since Apache, like most Unix Web servers, uses the flock-of-daemons approach to scalability—one master process and 10 or 20 or more children handling requests—the extra bulk of mod_perl multiplies accordingly. Throw lots of memory at the problem, and it will go away.

Alternatively, you can partition your Web application into dynamic parts that require the services of mod_perl, and static parts that don't. So, for example, a handful of mod_perl daemons listening on port 81 might serve the computation-

al needs of a large flock of standard Apache (or other) httpds listening on port 80.

Next you'll want to try the mod_perl version of "Hello, world." Standard CGI Perl is governed by a line like the following in httpd.conf:

```
ScriptAlias /cgi-bin/ /cgi-bin
```

If the file /cgi-bin/hello.pl contains the following:

```
#!/usr/bin/perl print
"Content-type: text/html\n\n";
print "Hello from
$ENV{'GATEWAY_INTERFACE'}";
```

then invocation of the URL /cgi-bin/hello.pl from a browser will produce the phrase "Hello from CGI/1.1" on-screen. Behind the scenes, the Web server spawns a Perl process to achieve this effect. Eliminating that process-creation overhead is one of the major benefits of mod_perl. Here's the standard recommended setup in httpd.conf:

```
Alias /perl/ /perl

<Location /perl> SetHandler
  perl-script PerlHandler
Apache::Registry Options ExecCGI
  </Location>
```

This incantation names the directory /perl as a place where mod_perl scripts can live. And it establishes Registry.pm, a crucial Apache/Perl module, as the handler for Perl scripts that run from that directory. If you copy hello.pl to /perl and invoke it from a browser, the phrase "Hello from CGI-Perl/1.1" should appear.

Behind the scenes, things are quite different from the CGI example. The Web server does not need to spawn a Perl process to run this code because it already contains Perl. In this respect, mod_perl resembles Win32 ISAPI Perl. Both implementations are much quicker than conventional CGI Perl because the interpreter shares the Web server's process. However, mod_perl's performance edge goes beyond that of ISAPI Perl.

Two Kinds of Cached Compilations

An ISAPI Perl version of hello.pl is compiled once per invocation. So while Perl itself springs into action much more quickly than it would with conventional, out-of-process CGI, it must still do the work of compilation once per request. For a toy program like hello.pl, that work is negligible, but for real Perl programs with hundreds or thousands of lines of code, it becomes significant.

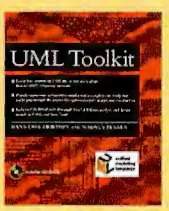
Consider CGI.pm, a very popular Perl module that offers a wealth of CGI-related services. You can use CGI.pm under ISAPI Perl, but you might not want to, because each time a client invokes a script that contains the statement `use CGI;` there is a perceptible delay as Perl compiles the module.

Can't CGI.pm's components be brought in individually? Yes, that's true, and it's often a good idea to selectively pull them in. But the fact remains that each component you use is compiled once per request.

With mod_perl's Registry.pm, CGI.pm compiles only once per httpd, and thereafter is instantly available to calling scripts.

BOOKNOTE

UML Toolkit



$49.99
by Hans-Erik Eriksson and Magnus Penker
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http://www.wiley.com/compbooks/
ISBN 0-471-19161-2

UML, the Unified Modeling Language, defines a common approach to object-oriented modeling. This tutorial walks you through various UML design scenarios and includes a case study complete with a Java implementation.

How? Registry.pm conjures up its own Perl package, compiles your scripts into that package's namespace, time-stamps all the code, and recompiles only if the source files are newer than the compiled bytecodes.

Now for one of the interesting things about mod_perl that took me a while to get used to. Although you can use this compile-on-demand feature for a package like CGI.pm, you probably don't want to. Instead, you should use one of several httpd.conf directives to load CGI.pm when the server starts up. Here's one approach:

```
PerlScript /perl/startup.pl
```

This directive loads startup.pl when the server starts. If startup.pl contains `use CGI;`, it's compiled and made available to all subsequent scripts handled by mod_perl. Alternatively, you can do this:

```
PerlModule CGI
```

This directive names up to 10 Perl modules that should load at server startup.

Why not just let Registry.pm handle the caching of this code? It compiles into a unique package namespace that becomes cluttered and unwieldy if you pull lots of standard methods into it. There are two different code caches. The "startup" cache, loaded by the PerlScript and PerlModule directives, is immutable. If you change CGI.pm or another module, you need to restart Apache to propagate those changes to the mod_perl environment.

The "runtime" cache, maintained by Registry.pm, is, on the other hand, mutable. If you alter /hello.pl and rerun it, you will see the result of your change immediately. Registry.pm, noticing a newer source file, automatically updates the code cache. This occurs on demand once per Apache httpd—that is, each instance of Apache pays a one-time cost to recompile that script, and it does so only when the changed script is first invoked.

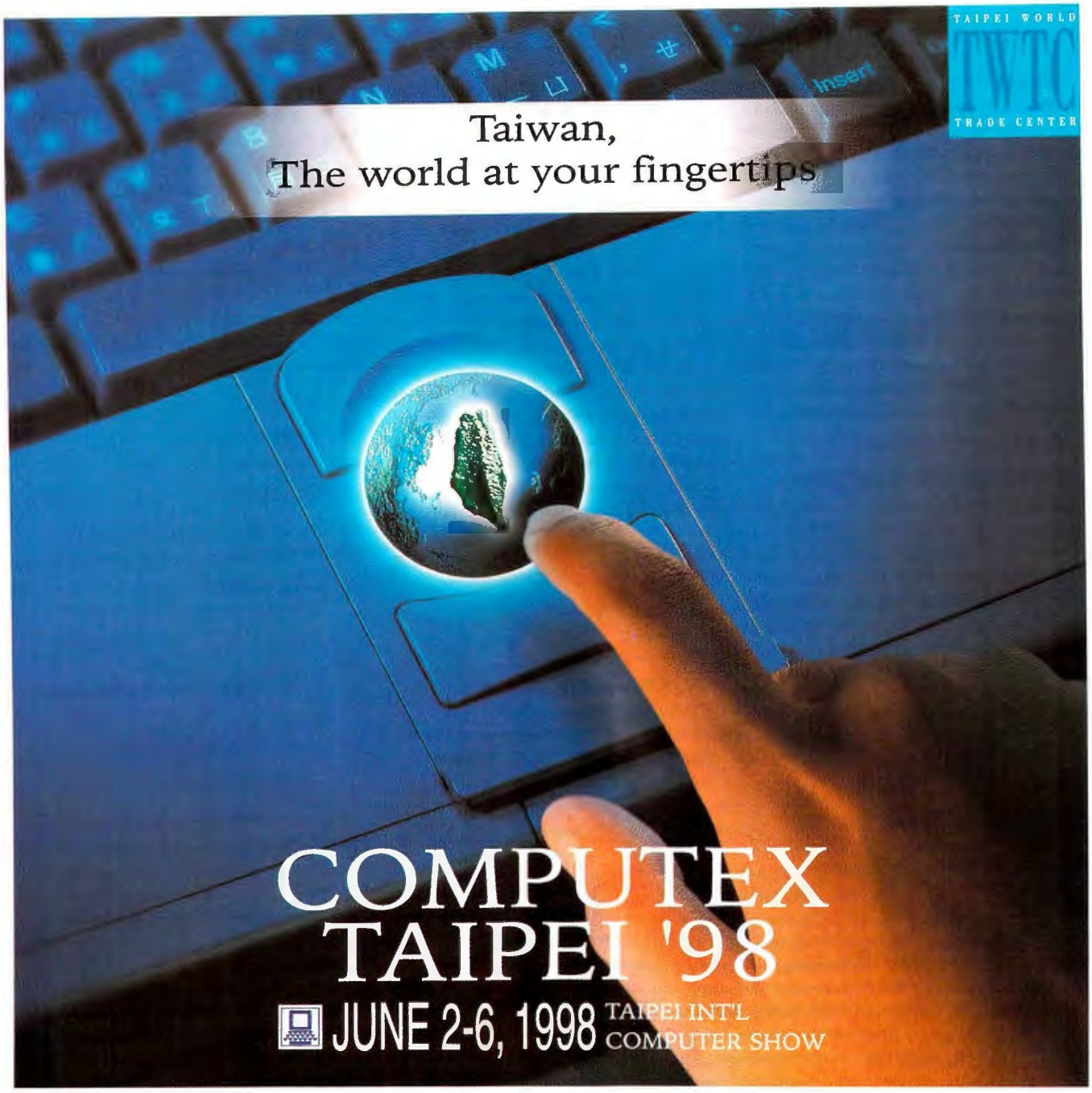
These two strategies are complementary. Per recommended Perl practice, I've divided a mod_perl application that I'm currently developing into a set of modules that export core services and a set of scripts that use those services. Because the modules change infrequently, it makes sense to compile them once at server startup. Because the scripts change often, it makes sense to compile them on demand using Registry.pm.

Avoiding Pitfalls

The cardinal rule of mod_perl is to preface every module and script with the statement `use strict;`. This oft-ignored tenet of good Perl practice will, among other things, prevent use of global variables.

Consider the difference between standard CGI-based Perl and mod_perl. In CGI Perl, the interpreter starts up, loads modules, runs a script, and then goes away. The whole Perl environment is transient. Even here you can get into trouble with global variables. Suppose a module opens a global `$DebugFile`. Then a script, expecting its own `$DebugFile`, does the same thing. If the module and the script intend to open different files, there's going to be a problem: The global variable is the same, and so is the file it represents.

With mod_perl, there is far greater danger. Each child process inherits the parent's global Perl namespace and then



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handles many transient scripts that can all scribble on that copy of the namespace.

It's true that the mod_perl environment is not actually immortal. Apache's `MaxRequestsPerChild` directive (default: 30) sets an upper bound on the lifetime of every httpd. Child processes that reach this limit expire and are replaced. This cleansing mechanism, intended to limit Apache's vulnerability to memory leaks, also forces a periodic flushing of the mod_perl environment. Nevertheless, the potential havoc that can be caused by contamination of Perl's global namespace makes the discipline of strictness well worthwhile.

Database Connection Caching, the Wrong Way

Inheritance of the master daemon's Perl namespace, though dangerous, has its uses. And mod_perl depends on this effect to make preloaded modules universally available to all children. It's tempting to try to cache handles to your own data this way. Here's a naive attempt to use a global variable as a persistent database handle:

```
use Fcntl; use SDBM_File;
tie(%myData,'SDBM_File','data',
  O_RDWR,0666);
```

This fragment uses Perl's `tie` facility to associate a DBM file (disk-based hash table) with the Perl hash table `%myData`. After this fragment executes, the statement

```
$myData{'Jon'} = 41;
```

does two things. It inserts the key `'Jon'` into an in-memory hash table, along with the value 41. And it synchronizes a permanent on-disk representation of the hash table with the transient in-memory table.

This is just standard Perl DBM practice. But suppose you include the tie construct in startup.pl and instruct mod_perl to run startup.pl when Apache starts:

```
PerlScript /perl/startup.pl
```

Now the global variable `%myData` is part of mod_perl's environment, available to scripts. For example, a script called lookup.pl could retrieve the value of `'Jon'` like this:

```
print $main::myData{'Jon'};
```

The tied hash variable looks like a kind of persistent database handle. Scripts running in any Apache child process can read, and even write, the keys and values of this database.

This scheme is incredibly fast. Unfortunately, it's also completely unreliable. And it's more fatally flawed than you might suspect. I thought at first that it would be safe to read values from the table but that some record-locking protocol (which most DBM implementations lack) would be needed in order to write values safely.

Wrong! Even reading is unsafe, as I learned from Rob Hartill, who develops the Internet Movie Database and contributes frequently to the Apache/Perl mailing list (modperl@listproc.itribe.net, archived at http://outside.organic.com/mail-archives/modperl/). Under heavy multiuser load, Rob says, reading the same key twice can produce different results. I tried a test myself by running many concurrent instances of a script that exhaustively read a tied hash. Read errors appeared, and they multiplied in proportion to the number of concurrent scripts.

TOOLWATCH

EventSLog
(shareware)
http://www.adiscon.com/
Mixed Unix/NT installations can now centralize system logs using this nifty tool that pumps NT's System, Application, and Security logs out to a Unix syslog daemon.

How can this be? It's a consequence of the way Unix's fork mechanism works. It literally clones a process. If the instance of Perl in the master process has a file descriptor that governs access to a DBM file, children inherit that same file descriptor and can interfere with one another's positions in the file.

To safely read the same file from multiple children, you have to open the file once per child so that each child has its own independent file descriptor. The same rule applies to database connections. You could cache a database handle at server startup, but that wouldn't be very useful. What's needed is a way to cache a database handle once per child process. Happily, an indispensable module called Apache::DBI does exactly that.

Database Connection Caching, the Right Way

Once you've eliminated the overhead of process start-up, by locating Perl inside Apache, the next key performance issue becomes fast database access. The holy grail of script-driven Web pages that fetch SQL data is to maintain a persistent connection between the script engine and the database. Here's how:

1. Install and test the DBI module (see http://www.perl.com/CPAN/).

2. Install and test the DBD driver for your database. Your test script should begin with `use DBI;` and then open a connection and read and write some data. When run from mod_perl, this test script issues a sequence of calls like this:

```
my $dbh = DBI->connect(....
$dbh->prepare(...
$dbh->execute(...
$dbh->disconnect(...
```

3. Install and test the Apache::DBI module. Now configure httpd.conf like so:

```
PerlModule Apache::DBI
Apache::DebugDBI
```

Then remove `use DBI` from the test script, restart Apache, and repeat the test several times. Apache's error log should look like this:

```
new connect to ...
already connected to...
```

Here's what's happening. Apache::DBI filters all DBI requests. Once per httpd, it honors `DBI->connect`. Subsequently, it hands callers a cached database handle. (`Apache::DebugDBI` produces the audit trail; you can turn it off as soon as you've proved that things are working.) Note that the persistent handle must be established in a run-time script, rather than a start-up script. Nothing prevents you from opening a handle in startup.pl, and that handle indeed persists and is visible to all child processes. But it's a per-server handle, which can't reliably be shared by multiple children.

Using mod_perl and Apache::DBI, I've prototyped a Perl application that does multiple database lookups behind each dynamically generated Web page without the slightest hint of delay. I've wondered whether it would really be possible to bring Perl's power and productivity to bear on major-league Web applications. The work of the Apache/Perl integration project has brightened the picture considerably. B

Jon Udell is BYTE's executive editor for new media. You can reach him by sending e-mail to **jon.udell@byte.com.**

Rick Grehan

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Object Marries Relational

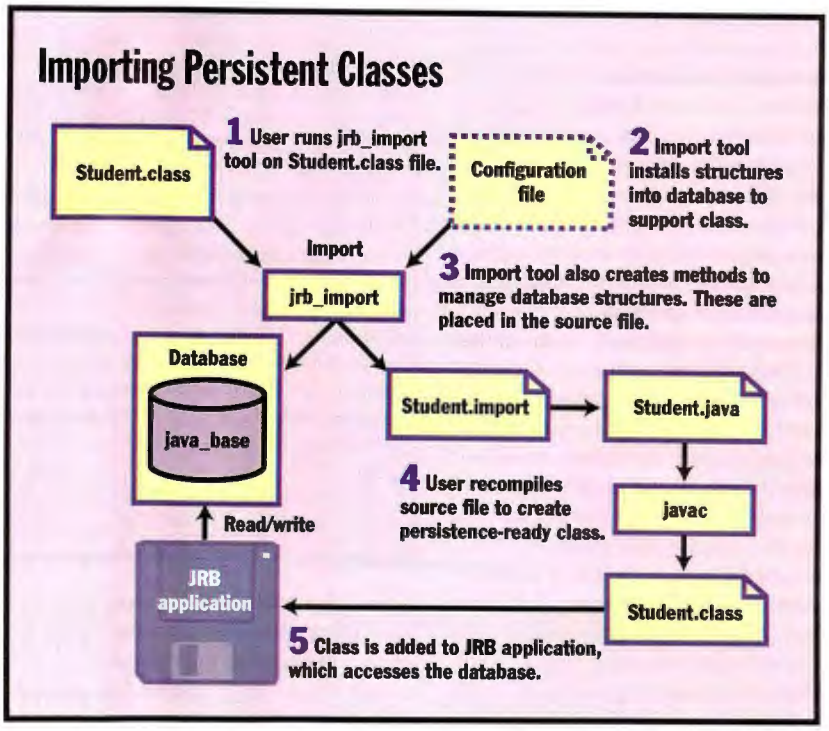
Ardent Software's JRB turns a relational database into a Java object-oriented database management system.

A truly unique entry into the growing cadre of Java-based object-oriented databases (which I've been looking at for the past three columns) is Ardent Software's Java Relational Binding (JRB). JRB's uniqueness is that it appears to implement an OO database, but it actually runs atop relational databases. The version I worked with is available in variations compatible with Oracle, Sybase, or any JDBC 1.2-compliant database package.

JRB is best described as a very thin object language binding between a JRB-compliant Java application and a relational database. With a relational database on the back end, it's reasonable to wonder how the multidimensional world of objects is mapped onto the two-dimensional world of tables and fields. The answer: The JRB run-time translates classes to tables; variables within a class become columns in the database. Object relationships (one object referring to another) are modeled using foreign keys. (Each object in the database is stored with a unique object ID, derived invisibly by JRB. These object IDs become the unique keys by which objects can be referred to—and therefore accessed—by other objects.)

JRB lets you store more than just classes in the database; you can also store Java bytecodes. Consequently, you can store a Java class wholesale in the database, and a JRB application can load the class at run time. The JRB API defines a `DatabaseClassLoader` class for doing this.

However, before your application can store any objects in a JRB-compliant database, you must first import the object's class into the database. You do this with the jrb_import tool, which reads the class definition (from a Java source file) and builds the necessary structures in the relational database.



Java Relational Binding uses an import tool (jrb_import) to process a class for use by a JRB application.

Any classes you intend on importing into a database must implement the `PersistentObject` interface, which defines the methods that JRB applications will ultimately use to store the objects in and retrieve them from the database. When you turn the jrb_import tool loose on the class to be imported, the tool creates a source-code file into which has been written the actual source code needed to manipulate objects of the imported class in the database.

Once you've imported a class into the database, you can begin storing objects in the database. Objects in a JRB application pass through several "states" as the application moves them in and out of the database. Objects can be transient, shadow, or persistent. A transient object is a "typical" Java object that your application has instantiated from some class. A persistent object is an object that has been stored in the database. (The JRB libraries include a variety of persistent classes from which you must derive all persistent objects.)

A shadow object is a partially loaded persistent object. That is, the shadow object has been instantiated, but its

component variables have been initialized by JRB library routines with nulls or zeroes (depending on the variable type). Consequently, a shadow object is a persistent object that has merely been instantiated, and not loaded from the database.

As with the previous OO database systems I've reviewed, access to objects in a JRB database occurs within the bounds of a transaction. (An application can read objects from the database outside of a transaction, but updates and deletes are not allowed.) Shared modification of objects is dealt with through locks, and JRB provides three locking levels: shared, update, and exclusive. A JRB application will automatically acquire locks—in this case, shared locks—on objects accessed from within a transaction. A shared lock, therefore, serves as a kind of signal to other JRB applications accessing the same database that the object has been accessed from within a transaction. Placing a shared lock on an object, then, prevents the object from being modified by another application. Any number of applications can hold a shared lock on an object.

Next up the locking ladder is the update lock. Only one transaction at a time, and therefore only one application at a time, can hold an update lock on an object. However, an update lock does not exclude a shared lock. A JRB application will place an update lock on an object to signal its intent to modify that object.

To actually modify the object, the transaction must obtain an exclusive lock on the object. Only one transaction can hold an exclusive lock on the object, and an exclusive lock (as its name suggests) excludes all other locks.

JRB provides a number of avenues a developer can follow to fine-tune an application's performance along the lines of both execution speed and memory consumption. For example, objects that are read from a JRB database are loaded into a cache maintained by the JRB run-time. This improves performance in cases where an unmodified object is reread from the database. The system can simply draw the object out of cache rather than read it from disk. Ordinarily, this cache is invisible to the programmer. However, JRB does allow some limited manipulation of the cache from your application. You can, for example, explicitly delete objects from the cache, allowing the application to run in a smaller memory footprint.

Additionally, JRB includes methods that permit your application to load only a portion of an array object. This allows the application to consume smaller amounts of memory (since less memory is allocated to the array at any given time).

Also, you can fine-tune the database's space consumption on disk. For example, suppose you've declared a persistent class such that one of the member variables of the class is used for computation only. Since that variable is needed only at run time (and holds no persistent information), storing it in the database is simply wasting disk space. JRB lets you define the member variable as being transient. Transient member variables of persistent objects are not stored in the database and therefore do not waste storage space.

JRB is an interesting implementation of persistent OO technology. Because it consists of a thin Java run-time (most of the heavy work of lock resolution and transaction management is taken over by the back-end database), it is simple to set up and administer. A developer license for JRB is $500 ($1000 for a three-developer license). Contact the company for run-time license details.

Hard-core OO developers will also be interested in Ardent's full-blown OODBMS product, O2. A binding for O2 that is syntactically equivalent to JRB is available, allowing migration of applications from a relational back-end arrangement to the O2 full OODBMS. B

Rick Grehan (**rgrehan@austin.metrowerks.com**) *works for Metrowerks' Discover Products division. He is coauthor of* The Client/Server Toolkit *(NobleNet, 1996).*

Sun's Activator

One of the troubles that arises from dealing with the rapidly evolving Java specification is the existence of extinct species (read: versions) that will not die. Simply put, it would be great if everything were compatible with the latest version of the Java Development Kit (JDK), but everything isn't. Such is the raison d'etre of Sun's Activator.

Activator allows you to run JDK 1.1-compliant applets in browsers that are not JDK 1.1-compliant (i.e., browsers whose Java virtual machines [JVMs] are not JDK 1.1-compatible). At the time of this writing, Activator was available for Internet Explorer 3.02 or later. Activator for Netscape's Navigator 3.0 or later was expected by mid-January.

Activator relies on Microsoft's ActiveX /Component Object Model (COM) technology and Netscape's plug-in architecture to extend the capability of the browser to include JDK 1.1 support. Unfortunately for some of us, this arrangement requires a device-specific implementation for the hardware platform and, consequently, Macintosh users are left out in the cold for now.

Another consequence of Activator's modus operandi is that it does not replace the browser's existing JVM. Instead, you must specify explicitly in HTML that a particular applet is to run in the Java run-time environment (JRE).

Ordinarily, you use the `<applet` tag to embed a Java applet in an HTML document. An Activator-run applet, however is encased in what amounts to a JavaScript wrapper. In IE, this wrapper calls the Activator ActiveX control, passing to it as an argument the path to the Java applet .class file. Upon execution of the HTML page, the Activator control wakes up, loads the applet into the JRE, and—voilà!—the client sees a JDK 1.1-compliant applet.

What this means, of course, is that if you have piles of HTML files that you want to make Activator-ready, you're going to have to spelunk through them and modify all the applet tags. To make that task less arduous and error-prone, Sun has made available the HTML converter. Turn the converter loose on an HTML file and it will replace any instance of an `<applet` tag it finds with the JavaScript wrapper. It also places any applet parameters in their proper locations in the wrapper. (For the untrusting, the HTML converter keeps a backup copy of all converted files.)

There's one final consideration: On the client side, a user of an Activator-based Web page must first download the Activator control(or plug-in). Agreed, this is a one-time penalty, but it's a 2.8-MB-download-time penalty, during which time a user sees only a status message: "Installing components." (In addition, for IE at least, the client must have the security setting such that downloaded controls are allowed to run.) Time will tell if the citizens of the Internet world are willing to take that hit to be JDK 1.1.x-compliant.

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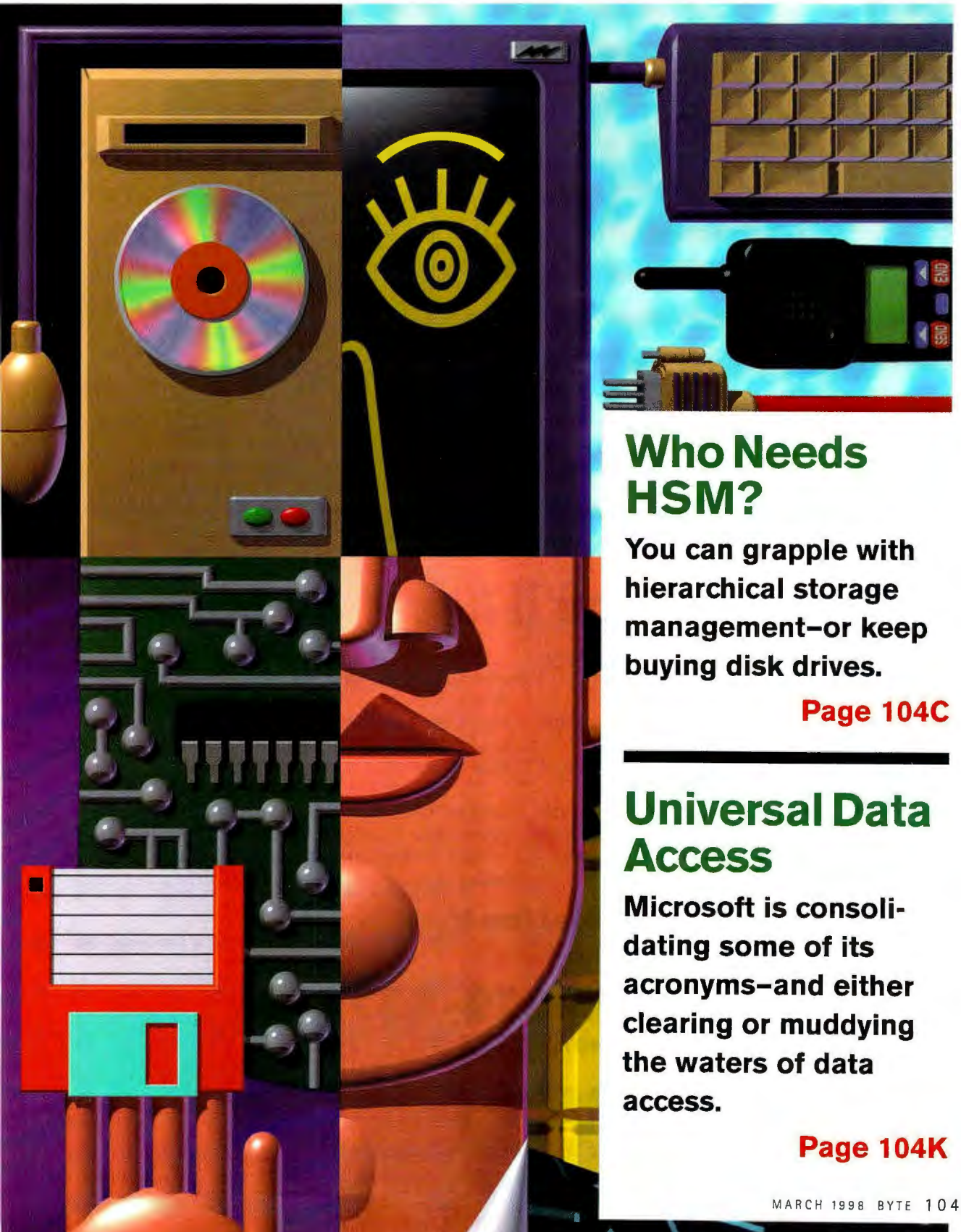

Who Needs HSM?

You can grapple with hierarchical storage management–or keep buying disk drives.

Page 104C

Universal Data Access

Microsoft is consolidating some of its acronyms–and either clearing or muddying the waters of data access.

Page 104K

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HSM saves costs, eases administration—and beats document management systems. ***By Mike Hurwicz***

Storing Smart Saves Space

A hierarchical storage management (HSM) system is like a robot housekeeper for network storage. It monitors hard drives for not-recently-used files and migrates them to a storage medium that has greater capacity and costs less per megabyte.

Typically, storage media are in this hierarchy:

- hard drive—most expensive, fastest
- optical—less expensive, slower
- tape—least expensive, slowest

Robotic library systems manage both optical drives and tapes, so no manual intervention is necessary for access.

Save It Smart

Consider a typical word processing file. It starts out on a hard drive and remains there as long as someone actively works on it. After it has been idle for six months or a year (depending on how the administrator configures the HSM system), the HSM system migrates the file to an optical library.

A *stub file* or placeholder remains on the hard drive. To users browsing file directories, the stub file looks like the original file. If the file remains idle in the optical library long enough (again, the administrator defines how long that is), the HSM system migrates it once again—to tape—still leaving a stub file on the hard drive. (HSM systems can also write directly to tape.)

If you access the stub file, the HSM system transparently restores the original file to the hard drive. The only clue that anything unusual has happened is the extra time it takes. (Well-designed HSM systems display a message for long waits, so you don't think the computer has crashed.) Early HSM systems lacked automatic recall, and many people considered them only semifunctional because of this omission.

HSM Simplifies Administration

There are two ways to think about the benefits of an HSM system. One is to think in terms of reducing your average cost per megabyte of data stored. The second is to think in terms of automating routine data-migration tasks and thus saving on administrative effort.

continued

"HSM as we know it may be a dinosaur."

–Ron Anderson

PHOTOGRAPH: DAVID REVETTE © 1998

The first perspective assumes that, without an HSM system, you would buy more hard drives as data accumulated. The second perspective assumes that you would migrate data to optical and tape storage manually. In the latter case, there would presumably be no stub files, and users—or the administrator—would have to keep track of the new location of the data, so they could retrieve it.

The dollars-per-megabyte argument has largely lost its punch, however, because of the plummeting cost of hard drive storage. It's true that the cost of optical and tape libraries has also come down. However, if you don't have any optical- or tape-library systems now, another hard drive will often be the easiest and most cost-effective fix to a shortage of disk space.

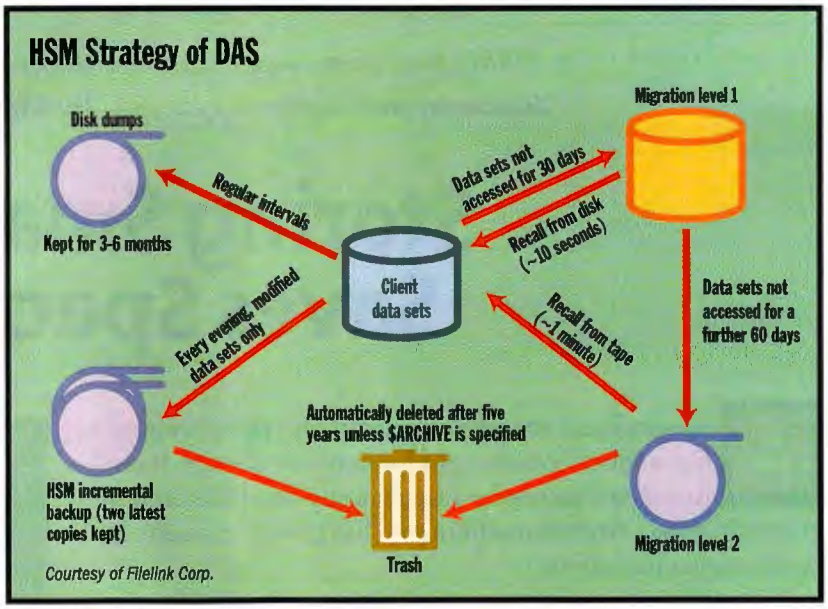
However, adding more disk space creates problems of its own. For instance, very large volumes take a long time to restore and mount after a crash. Backup becomes increasingly time-consuming. These kinds of considerations often lead IS professionals to delete old files that have been backed up. However, if users later need some of those files, retrieving them creates more work for the IS team.

But these arguments have not swayed huge numbers of organizations to buy HSM systems—or even to use NetWare's free one. However, for some data-intensive applications and environments, an HSM system may be natural or inevitable. This is particularly true where many files must be conveniently accessible over an extended period, even though any individual file is accessed infrequently.

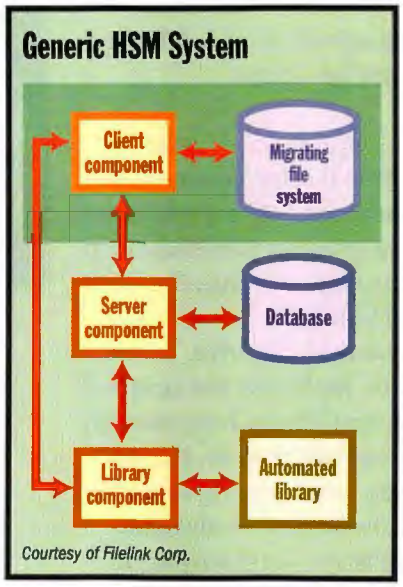
A perfect example would be an insurance company with digitized claim documents and photos. A typical claim is active briefly and then never seen again. A few claims may be referred to months or years later. Both the quantity of data and the access patterns would probably make an HSM system attractive.

Somewhere between 200 GB and a terabyte of data, you may hit a threshold where an HSM system becomes almost a necessity. A dedicated vertical application also makes an HSM system more practical. It is easier to prevent software behavior that cancels the benefits of the HSM system by causing massive numbers of unneeded files to return to hard drives.

Typical bad behavior is a word processor searching for a file based on text in the file. As it searches each file, that file must return to the hard drive. A search of thousands of files results in only one.



Australia's Commonwealth Department of Administrative Services' data backup/migration architecture uses disks and a tape library.



Most HSM systems consist of these parts.

Document Management or HSM?

You can avoid bringing back files unnecessarily by using a document management system that indexes all files. When you do a search, you access only the index, not the actual files. Only the required file actually returns to the hard drive. Also, the searches will go a lot faster.

Note, though, that some document management programs index all files regularly by default, in case something might have changed. While thoroughness is nice, it pretty much destroys the value of indexing, as far as efficient storage.

Also, a document management system is likely to be a large, expensive project in any environment that might justify an HSM system. Again, it may be cheaper and easier just to leave all files on the hard drive until they are so old you can delete them permanently after backing them up.

Other programs may bring back even more files than a word processor and even require the actual file—an index won't do. The classic example: a backup program that reads every file.

Use What Already Works

The most reliable solution to this problem is for the HSM system vendor to integrate backup, virus-scanning, and document management utilities. These utilities should recognize and ignore stub files. This eliminates your choice of separate backup, virus-scan, and document management products. Plus, nothing ensures that another program won't open every file on the disk—and everywhere else.

One solution preserves choice, but only a few network-aware programs support it: using special programming calls that open normal files on the disk but fail

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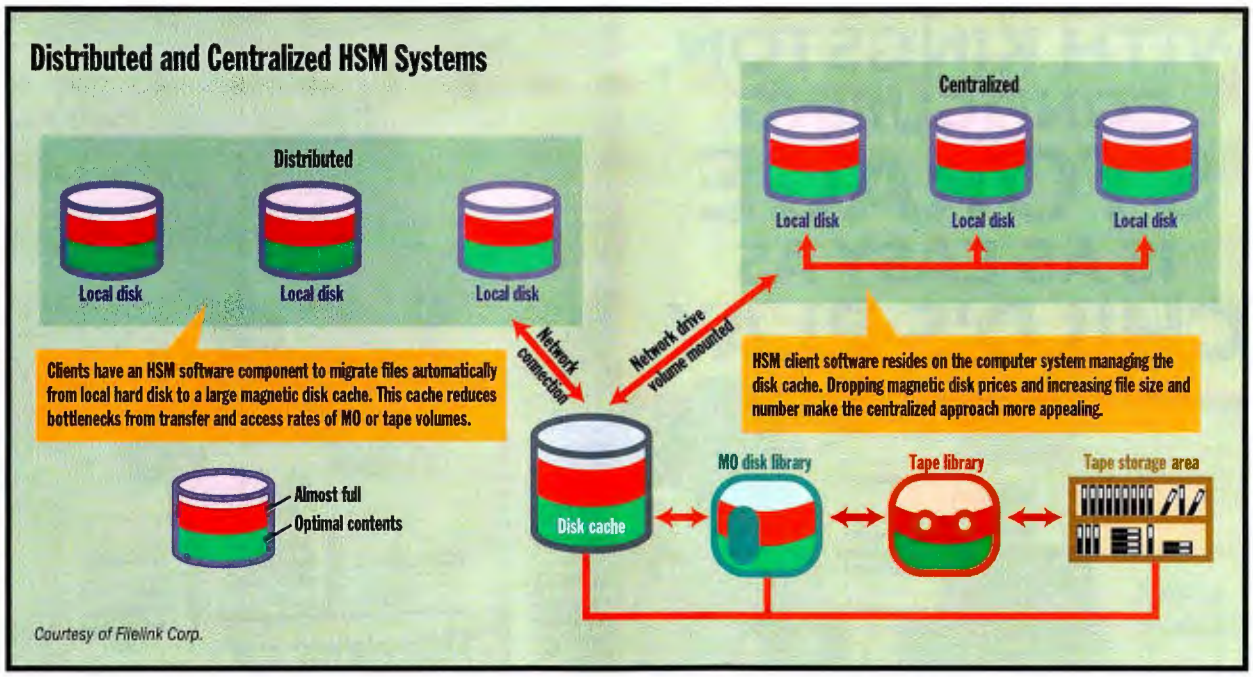

when they encounter a stub file. Examples are Unix's sopen (stream open) and NetWare's FEsopen (file engines open). Such calls may also leave the last access date unaltered on stub files—a plus, because compression and HSM systems often use this date to determine inactive files.

Few programs use such calls. Windows utilities, such as a file find done via My Computer in Windows 95, don't use them. Spreadsheets, word processors, and so on don't use them. However, some programs, such as network-aware virus scanners and backup programs are increasingly likely to use them.

Unfortunately, compatibility with HSM systems is the last thing on the minds of Windows programmers. The result: HSM systems are best suited to highly structured environments with predictable client behavior. Such an environment may be possible within a loosely structured LAN. The HSM system may operate only on servers, directories, or file types off-limits to most programs.

OS Boosts for HSM

More general solutions will depend on OS support. The earliest example is the Data Migration Interface Group (DMIG) API, which the IEEE Storage Standards Working Group (http://www/arl.mil/IEEE/ssswg.html) has adopted. DMIG created the DMAPI specification (Data Migration APIs), now part of Posix P1244.

The user interface is up to the implementer, but most implementations allow several ways to open a file, one of which fails if the file has migrated. You can set this mode as the default before running programs such as virus scanners, with no need to modify the application.

NetWare Does HSM

NetWare already includes HSM: High Capacity Storage Service (HCSS). Although free, it's not widely used, perhaps because it does not limit demigration (except by modifying programs to use the FEsopen call).

Mature HSM systems from companies such as Cheyenne and Seagate are based on Real-Time Data Migration (RTDM) APIs in NetWare. Optional client-side software limits demigration or advises you when a demigration will take a while.

NetWare's next release, code-named Moab and expected in the third quarter, will contain Novell Storage Services (NSS), including an improved foundation for HSM. With NSS, file opens can include quality of service (QoS) parameters that determine whether a migrated file should be demigrated. With Novell's improved Client32 (and possibly some help from applications), customers will get three choices in a pop-up: 1) demigrate while I wait; 2) demigrate, but let this open request fail (I'll open the file later); or 3) cancel this request (don't demigrate).

Handling migrated data this way is not new. It happens now if you load the extra client software with Cheyenne's and Seagate's HSM products. The difference: You only have to load Novell's Client32.

In addition, NSS will do away with some limitations of prior HSM systems (e.g., 16 million files per volume). Because mount times are only a few seconds, independent of the volume size, NSS may also eliminate the need for HSM for customers who implement it primarily to reduce

Microsoft NT 5.0 NTFS Reparse Point Flags

Flag name	What it means
FILE_FLAG_OPEN_REPARSE_POINT	When opening a file, inhibit any effects that may exist due to an associated reparse point.
FILE_ATTRIBUTE_REPARSE_POINT	The file has an associated reparse point.
FILE_SUPPORTS_REPARSE_POINTS	The volume supports reparse points.

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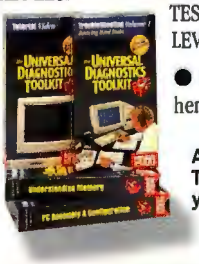

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volume sizes and mount times. With Novell's distributed file system (DFS), to be released later, the client can search remote replicas of a volume for one where a file is still on the hard drive.

NT and HSM, Too

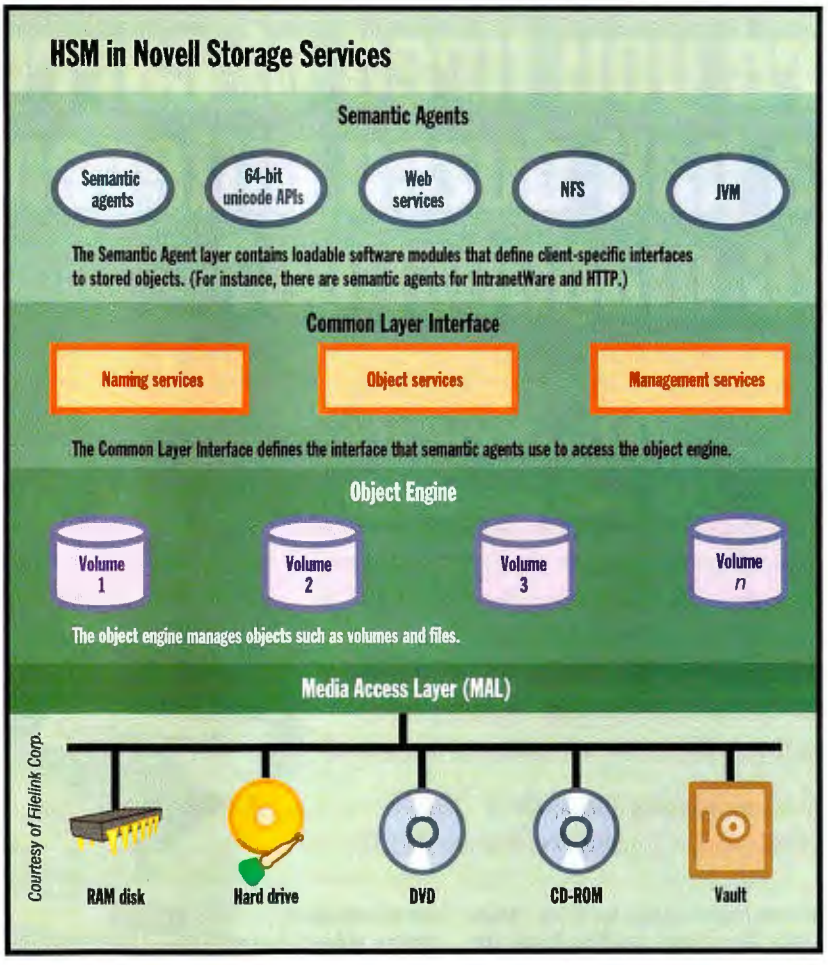
NT Server 5.0, expected this year, will be the first version with integrated HSM, Remote Storage Server (RSS), developed by Eastman Software. Eastman also makes Open/Stor and an advanced HSM system, code-named Phoenix, based on RSS. Open/Stor 2.1 for NT will contain a feature similar to the above pop-up.

Open/Stor offers two ways to prevent files from demigrating. Programmers can use special calls, similar to sopen and FEsopen, that do not demigrate files. Or the Open/Stor administrator can designate particular user IDs that cannot demigrate files. This prevents a virus scanner running under such a user name from demigrating files.

With RSS, programs will have to use special calls to prevent demigration. Microsoft is now evangelizing the use of such calls more than it ever did.

Also, Microsoft has built new HSM-friendly facilities into NT 5.0. NT File System (NTFS) *reparse points* are "extensible file system building blocks providing additional directory and file functions." Reparse points are special files that hold metadata about another file. The reparse point will provide a standard format for a stub file that HSM vendors can hook into using filter drivers.

If a file open request fails because the file is a reparse point of type HSM, the OS can pass the request to a filter driver. The HSM application can then handle the request, perhaps giving you options. One option might demigrate the file and return the open to the OS with a valid file handle. If filter drivers don't handle the reparse point, the request simply fails.



NSS's improved foundation for HSM functionality includes a QoS parameter to show if the file should be demigrated.

Today, both HSM and backup systems typically require a dedicated library system. Neither can share. NT Media Services (NTMS), which HighGround Systems is developing for NT 5.0, will allow applications to share tape and optical libraries. That's a big step forward.

Into the OS

Better HSM facilities in NT and NetWare will widen HSM's market significantly. The ultimate? To embed HSM so deeply in the OS that even LAN administrators could forget about it. "Novell is probably a year or two ahead of Microsoft in making all this a reality," says Daniel Blum, a principal with Rapport Communication (Silver Spring, MD).

However, integration with the OS is not the final step for HSM. "Ultimately, many users tell us that they want HSM integrated with applications," says Jeff Drescher, a product marketing manager with Eastman Software. Application integration will also mean new features such as migrating specific database tables. Now, if the database is a single large file, the HSM system must migrate either the whole file or nothing. Portions of the database not in use cannot be migrated.

In short, users want invisible HSM. "HSM as we know it may be a dinosaur," says Ron Anderson, manager of microcomputer network services at Syracuse University. Syracuse spent years looking at HSM systems for its NetWare-based LANs, only to conclude it was too costly and difficult. Anderson looks forward to HSM transparently embedded in the OS and applications. Until then, the university's strategy is more disk space. B

Mike Hurwicz is a writer and consultant in Brooklyn, New York. You can contact him at **mhurwicz@attmail.com.**

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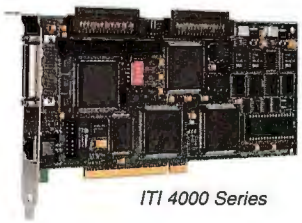

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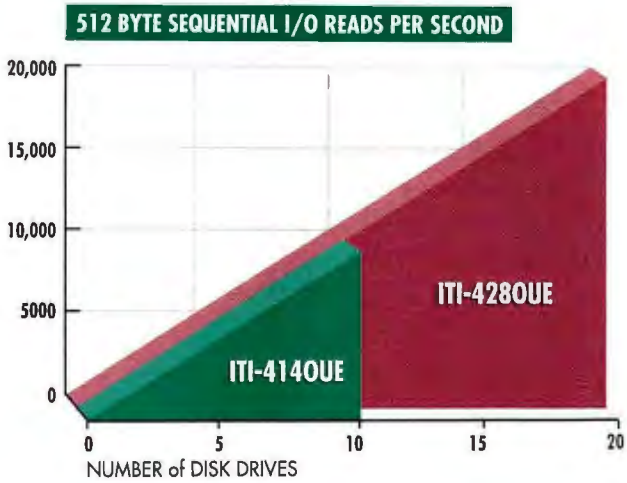

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A practical look at Microsoft's data-access strategy. ***By Rick Dobson***

Microsoft's Data-Access Directions

Data is good. Getting at it can be bad, however, particularly when you need to get at data in different formats from one application. Microsoft's ODBC has solved many data-access problems, and today Microsoft offers an array of database products and technologies that respond to the needs of different data-access scenarios.

But in any given situation, it's not always clear which is the right product or technology for the job. To further complicate matters, Microsoft is working toward a radically new data-access technology, called Universal Data Access (UDA), that will eventually make the company's traditional approaches obsolete. What follows is a look at Microsoft's current and future data-access technologies. This will help you to select the right ones for your particular data-access requirements.

ILLUSTRATION: GARRY COLBY © 1998

The DAO of Pooh

Currently, Microsoft offers at least seven data-access technologies that you can choose from: Open Database Connectivity (ODBC), Data Access Objects (DAO), Remote Data Objects (RDO), ODBCDirect, ActiveX Data Objects (ADO), OLE DB, and the upcoming UDA. (For a brief overview of these technologies, see the text box "The Seven Data Samurai" on page 104L.) DAO and RDO are the two main Microsoft data-access technologies today. They are stable, and many developers have experience applying them.

When you're working with indexed sequential-access method (ISAM) files, Jet files, or ODBC data sources, DAO is the right choice (and Microsoft recommends you access DAO through ADO). Its hierarchical object model (see the figure "Comparing Data Access" on page 104L) offers complete control over the Microsoft Jet database engine.

DAO actually performs two different kinds of functions. First, it permits the management of databases and their relationships to users. Second, it allows access to and maintenance of data. For ease of use, DAO collections and objects include properties and methods that mimic the Access user interface. However, DAO's programmatic interface to Jet also permits functions that aren't possible with the GUI; for instance, the Databases collection accommodates the concurrent availabil-

ity of two or more separate databases.

Introduced with Office 97, ODBCDirect is an RDO wrapper inside DAO. It delivers data access without the kind of data management that DAO delivers, so an ODBCDirect workspace contains fewer collections and objects; for instance, it has no collections or objects for security.

As its name implies, RDO explicitly targets remote ODBC data sources. RDO is not a simple extension of the traditional DAO object model, and therefore it takes more time to learn than ODBCDirect does. RDO removes the need to learn ODBC API calls while still delivering comparable performance.

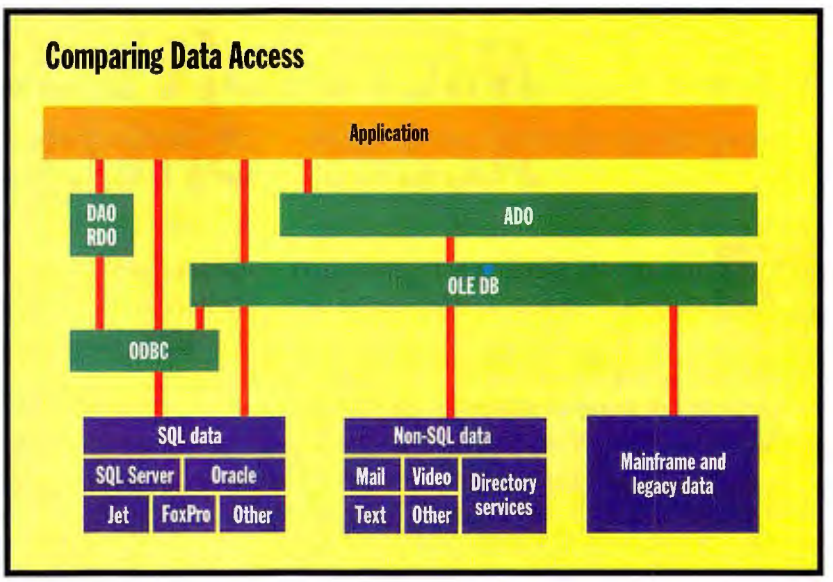
The figure at right shows the RDO object model. RDO performs the basic functions of submitting queries, creating cursors that are based on the result set, and processing the return set with database-independent code. The technology can also interact effectively with stored procedures.

The current version of RDO, RDO 2 (found in Visual Basic [VB] Enterprise Edition), offers event notification for common functions. ODBCDirect, on the other hand, does not provide this capability. The availability of events makes it possible to make better use of RDO's asynchronous connection capability.

Directions

As mentioned earlier, Microsoft calls its emerging data-access strategy Universal Data Access, or UDA. The UDA technology encompasses some of Microsoft's traditional data-access technologies, but it features some significant additions. Its scope includes relational data sources (through ODBC) as well as nonrelational data stores, such as media archives, hierarchical DBMSes, mail servers, file servers, and spreadsheets. UDA distinguishes itself by not requiring data to enter a common store—it makes data available from wherever it is already.

UDA builds on three component technologies that are items in the Microsoft Data Access Components (MDAC) version 1.5. These components are ADO, including RDS; OLE DB; and ODBC. They are available for downloading at http://www.microsoft.com/data/mdac15.htm. What follows is a closer look at the two key parts of UDA: ADO and OLE DB.



When you put together all of Microsoft's data-access technologies, it looks like this.

ADO will eventually replace all current data-access technologies for typical users, such as those currently using DAO, ODBCDirect, and RDO. ADO's object model (see the figure above) is substantially sparser than that of DAO, ODBCDirect, or RDO. All three of the earlier models are strictly hierarchical, while the ADO model includes nonhierarchical object relations.

There are only three elements necessary for a typical ADO application: the Connection object, the Recordset object, and the Field object. The Connection object interfaces with the data source. If an Execute command on the Connection object returns rows, ADO creates and returns a default Recordset object. The Field object supports the return of values from a recordset and their modification. The Field object also provides column metadata about a recordset.

The RDS element within ADO currently works with Microsoft Visual InterDev and Microsoft Internet Explorer (MSIE) 4.0's Dynamic HTML (DHTML). At the time of this writing, RDS serves a unique

The Seven Data Samurai

The database community has created a plethora of data-access acronyms. Are you finding yourself confused about them? What follows is the nickel tour of most of Microsoft's current offerings.

- ODBC is a C/C++ API designed to target different sources from the same source code by substituting different drivers. It provides access to server-specific extensions, and developers can write code to query which extensions are available. ODBC is at the core of many other Microsoft technologies.
- DAO is designed for desktop and decision-support access to data. It's based on Microsoft's Jet database-engine technology and uses Jet to gain access to other sources.
- RDO is an object interface to ODBC, and it's similar to DAO in its programming techniques.
- ODBCDirect integrates RDO methods directly into DAO.
- ADO is the high-level name for a group of extensible, object-oriented data-access technologies that are designed to simplify and extend data access. Here you'll find ADO in Microsoft Transaction Server 1.0 and Internet Information Server (IIS) 3.0.
- OLE DB is the C/C++ COM-based component architecture that underlies ADO. It provides access to all sorts of structured and nonstructured data sources using existing ODBC drivers for access to RDBMSes.
- UDA is Microsoft's future direction. This technology combines ADO, ODBC, and OLE DB.

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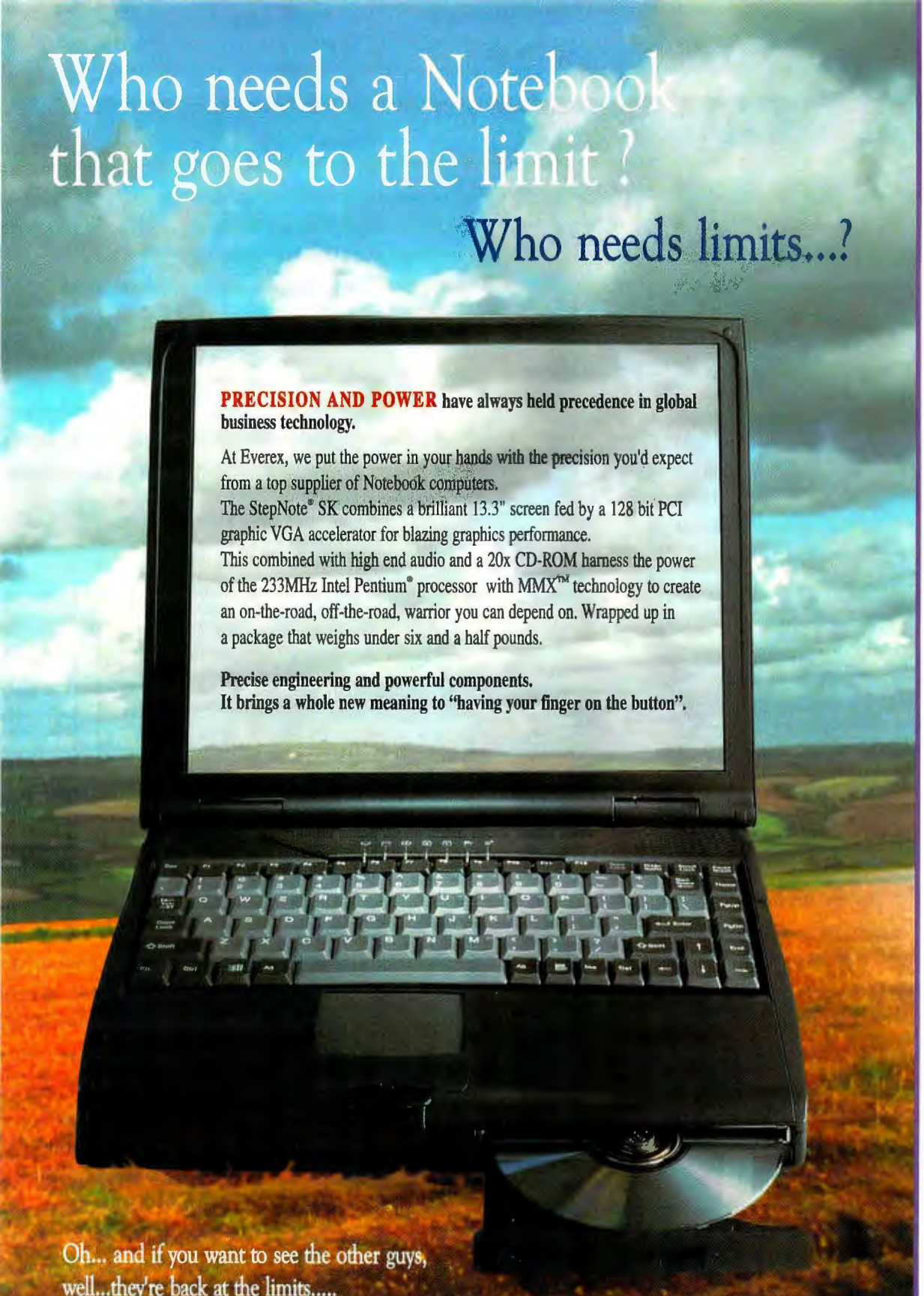

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Product	Department solution	Enterprise solution	Web-server-based solution	Web-client-based solution	Comments
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Office (excluding Access)	✔✔✔				Can bring a local ISAM database and a remote ODBC database into familiar Office applications.
Visual Basic	✔✔	✔✔✔✔			Can build Office solutions, but its relative strength is back-end solutions.
Visual InterDev	✔✔	✔✔✔	✔✔✔✔	✔✔	FrontPage on steroids; offers excellent database connectivity over the Web.
MSIE 4.0 (data binding)	✔	✔✔		✔✔✔✔	Allows the creation of a local data cache on a browser workstation; solutions require VBScript or JScript code.
SQL Server		✔✔✔✔	✔		Multithreaded, striped data access; client/server design facilitates large communities of users over WANs; SQL Server Web Wizard publishes static pages only (but developers can schedule regular updates).

✔✔✔✔ Excellent ✔✔✔ Good ✔✔ Fair ✔ Nominal

role as a data source object (DSO). In addition to storing server-based data in a local cache, it can also update the server from edited data in a local cache.

OLE DB targets data-access providers, such as those constructing ODBC drivers today. OLE DB extends and embraces ODBC. Just like ODBC, OLE DB is a low-level development environment that provides data for a higher-level development environment—in this case, ADO. OLE DB can work with existing ODBC data sources without adding a new layer. What makes OLE DB special is that it can also work with non-ODBC data sources, such as e-mail and file-system stores, ISAM and hierarchical databases, and eventually even spreadsheets.

Microsoft asserts in numerous documents that OLE DB will become the fundamental COM element for data access. OLE DB encapsulates core database-management services. A data-provider component contains and exposes data. The data-consumer component uses data. Various service components process and transport data. Microsoft explicitly mentions query processors and cursor engines as sample service components. This development promises more powerful data-access capabilities to non-SQL data sources that currently do not natively support these features.

For today, you should use DAO to control Jet and other ISAM sources. Use ODBCDirect for remote ODBC sources. Use RDO to access the events model that the ODBCDirect wrapper doesn't expose. And look for ways to apply the up-and-coming ADO technology.

Promises, Promises

UDA promises much in the future (i.e., two to four years from now). Right now, though, most of what we have is just a promise. For example, the support to non-ODBC data sources is still incomplete; an OLE DB provider for Excel is still to come. And Microsoft does not currently support UDA as much as it does traditional data-access technologies: The capability to surface RDO events is missing from ADO 1.5, although Microsoft promises it for version 2.0.

It's important to realize that there is a huge amount of database development in Access and the rest of the Office family using DAO; there are many fewer VB/RDO developers than there are Access developers. Furthermore, much VB database development relies on DAO technology. VB/RDO developers are more prevalent than SQL Server, C++, and ODBC API developers.

Microsoft needs to target UDA initially to this bulk of database developers. These developers are familiar with some nontraditional data stores, such as spreadsheets, and they have simpler needs that will not stress the emerging technology as severely as the enterprise applications of SQL Server developers. Introducing the emerging technology with low-end developers will enable both to mature as the technology grows up. B

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Rick Dobson (Louisville, KY) is president of CAB, Inc., a database and Internet development consultancy. You can reach him at his firm's Web site, **http://www.cabinc.win.net.**

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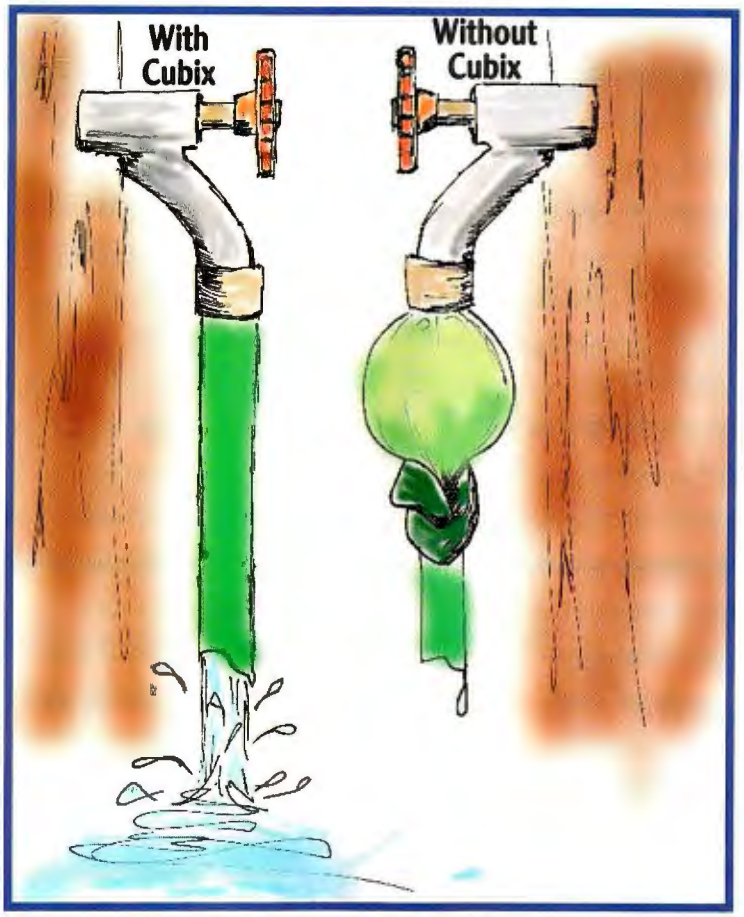

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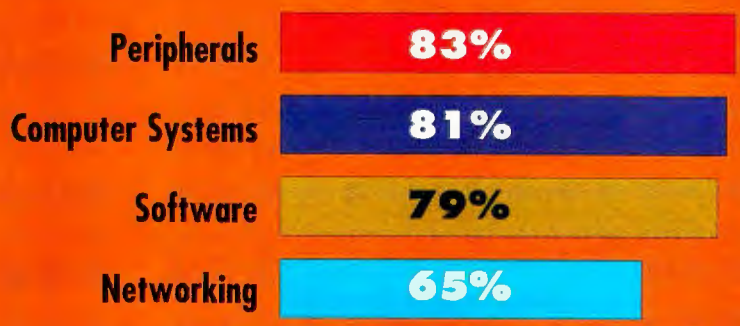

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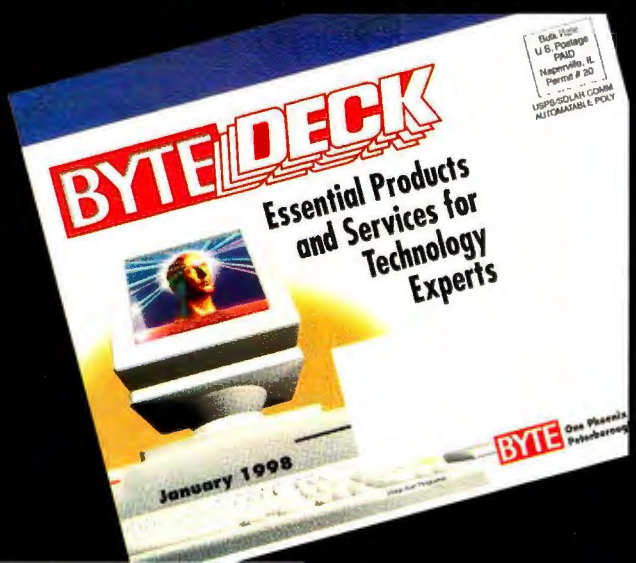

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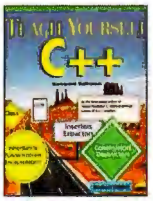

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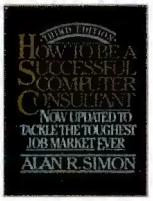

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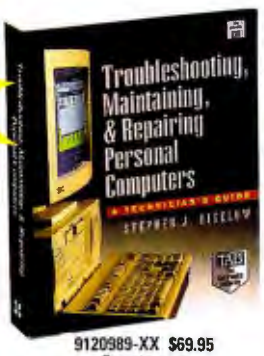

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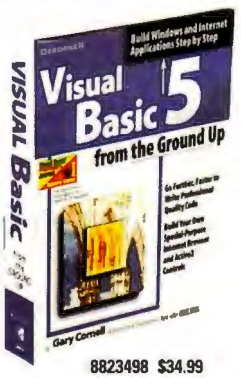

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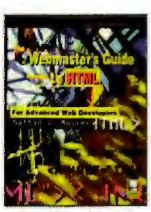

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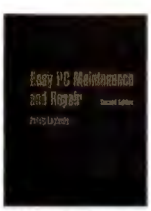

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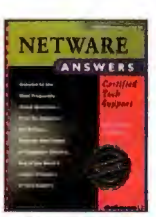

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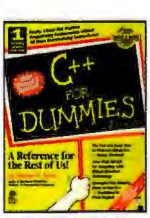

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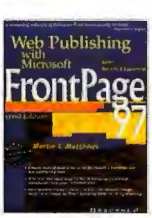

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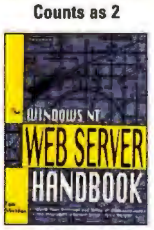

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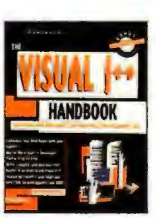

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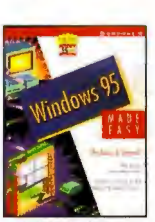

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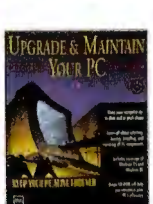
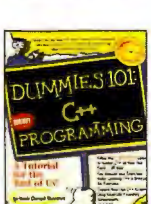
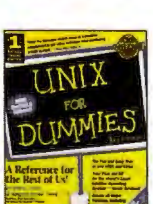


5877740 $39.95

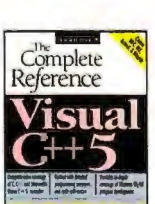


5876353 $24.99

9132286 $49.95



5879182 $19.95



8823919 $39.99

The Best OS for Web Serving: Unix or NT?

Which OS should you be running your Web server on? To find out, we tested NT and five flavors of Unix.
By Barry Nance

Choosing a Web-server platform is a big decision. Unfortunately, the choice isn't as simple as getting the right Web-server product and then buying the hardware and OS that it runs on. Apache, which is the most popular Web server today, runs on all flavors of Unix as well as on Windows NT. Netscape's FastTrack and Enterprise Web servers run on NT and many versions of Unix.

In fact, virtually all Web-server software is multiplatform, with the notable exception of Microsoft's Internet Information Server (IIS), which runs only under NT Server on a Pentium- or Alpha-powered machine.

Of course, if you've already purchased a specific NSAPI-based (Netscape) Web application that runs on a particular version of Unix, your software vendor has already told you which platform to buy. If you have an ISAPI-based (Microsoft) application to run, naturally you'll get NT Server.

However, life isn't always this easy. Perhaps you just want the best platform for publishing Web pages. Or you want the best platform for forms-based CGI processing. If three-tier Web applications are planned for your future, you need the best platform for developing (and running) your cutting-edge software, and one that has available the variety of tools you need.

We pitted NT Server 4.0 against five Unix variants to discover the strengths and weaknesses of each as OSes for hosting Web services. The versions of Unix were four high-end platforms and one low-end alternative: Sun's Solaris 2.6, Hewlett-Packard's HP-UX 11.0, Digital Equipment's Unix 4.0D, IBM's AIX 4.3, and Caldera's OpenLinux 1.1. You should note that in this Lab Report we're focusing solely on the OS alone and its ability to support Web serving, not on the specific hardware or on any particular Web-server software.

For each test, we used 200 clients connected via 100-Mbps 100Base-T Ethernet. Rather than trying to find a common hardware platform, we tested each OS on the kind of hardware it's most likely to be used on—or in some cases, is only available with (see the table "What We Tested On" on page 109).

BYTE BEST
WEB-SERVER PLATFORMS

Digital Unix 4.0D
It has the best I/O engine for pushing out Web pages, plus very good CGI performance. These made it the overall winner, even though it doesn't have as many tools available for developing three-tier applications as do some other Unixes.

We made no attempt to run benchmarks, because a level playing field was not possible with such disparate CPU architectures and computer hardware. Instead, we concentrated our evaluation on OS-specific criteria.

The ideal OS for Web serving will have excellent performance characteristics, easy and intuitive administration, one-OS-fits-all scalability, confidence-building reliability, and trustworthy security. Realizing that people put Web servers to different uses, after we concluded our testing, it became clear that these were all viable systems, but their strengths and weaknesses suited them to somewhat different purposes.

Therefore, we can name three of the OSes as the best in a particular category: three-tier Web-application computing, CGI-based forms processing, and Web-page publishing.

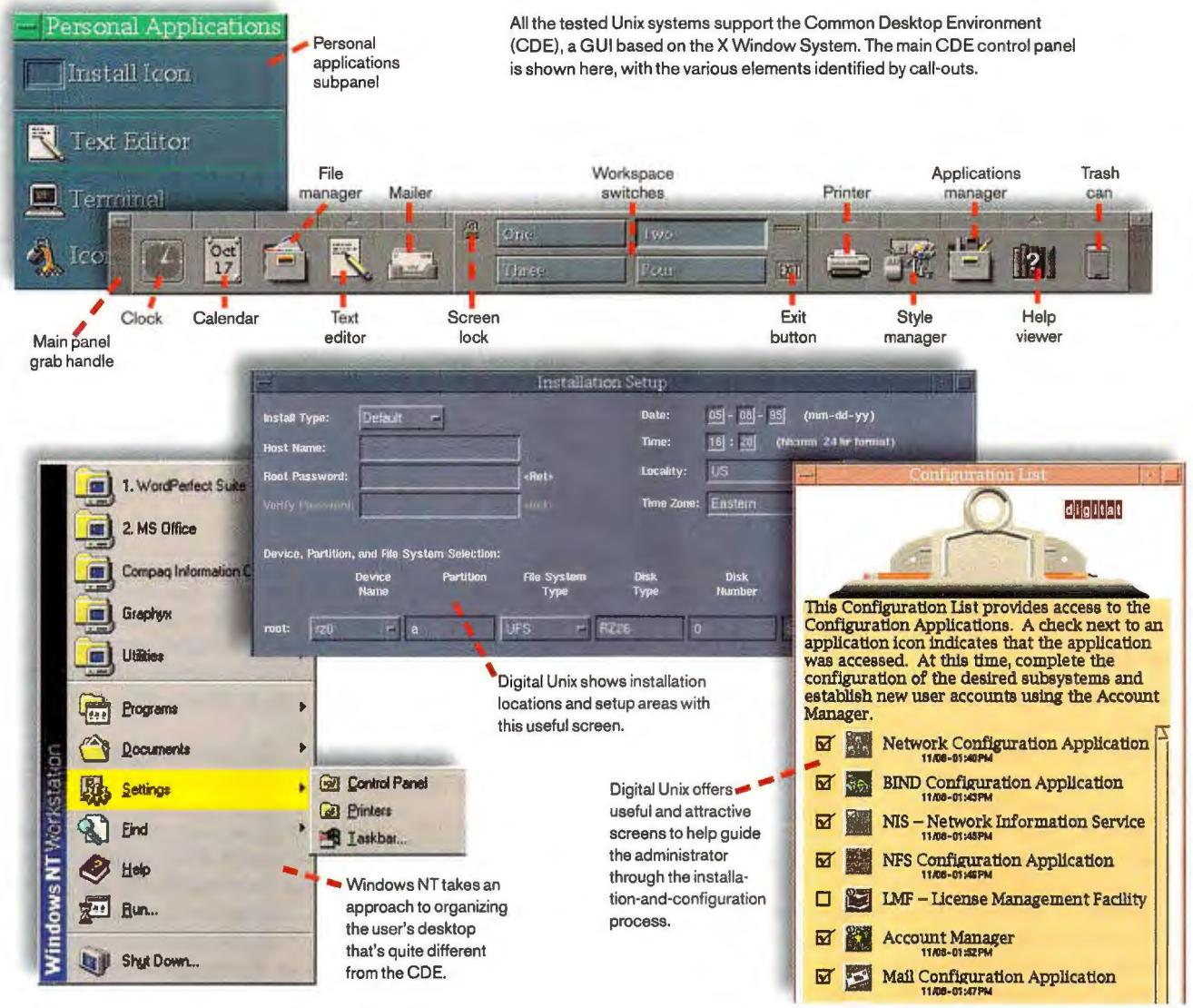
AIX

IBM's AIX provided us with a solid, reliable Web-server platform. Although this was an early innovator in Unix storage management with its Journaled File System (JFS) and system administration utility, SMIT, the competition has now caught up and generally passed it by. AIX is at present a rather unexceptional member of the Unix community.

The most recent version of AIX supports 64-bit applications. However, it's not itself truly 64-bit. Version 4.3 of the OS simply extends the buffers, kernel facilities, and utilities to be 64-bit, and adds 64-bit libraries to the existing 32-bit libraries that it already supplies with the OS.

Regardless of whether users choose to run the OS in either 32- or 64-bit mode, all the device drivers work without modification. IBM offers the 64-bit option despite the company's belief that, because of a lack of applications, 64-bit addressing won't become popular for at least two years.

We found IBM's SMIT, like HP's SAM, to be a decidedly nonstandard administration tool. Instead, we preferred to



While OSes generally don't lend themselves to interesting screens, we found the Unix world's CDE desktop a pleasant alternative to the familiar NT screen.

use the AIX Web-based system management tools, which let us configure AIX from anywhere on the network. But the Web-based tools need a Java 1.1–enabled browser. Also, the administration tool's Welcome Center uses a graphical "RS/6000 from Mars" theme to grab your attention, but we found those screens annoying and garish.

AIX supports Java quite well, and IBM bundles a Java Development Kit (JDK), a just-in-time (JIT) compiler, and several other Java tools with AIX.

Digital Unix

Digital Unix showed itself to be the best platform for publishing static Web content. This OS is, in essence, a turbocharged I/O engine. In our tests, it served up static Web pages nearly instantaneously. To discover why this was the case, we monitored the OS in detail as it processed requests from the Web server and found that Digital Unix's disk I/O drivers and TCP/IP stack drivers are blazingly fast. As a matter of fact, they're likely the best-written drivers in the industry.

In addition, because Digital Unix is a true 64-bit OS, it can (given sufficient RAM) cache ultralarge Web sites in memory and serve up Web pages without needing any disk I/O whatsoever. Symmetric multiprocessing (SMP) support is similarly optimized, and Digital Unix is efficient enough to act as a real-time OS (RTOS), a challenge that the other versions of Unix and NT wouldn't attempt.

System management, via Digital's SysMan user-friendly graphical interface, was quick and painless. We used Logical Storage Manager's drag-and-drop visual environment to easily configure Unix file systems. We put Internet AlphaServer System Software (IASS) to work whenever we needed to manage users, groups, and various system components, including security, Web servers, anonymous FTP, squid proxy/caching server, Internet news (INN), and mail.

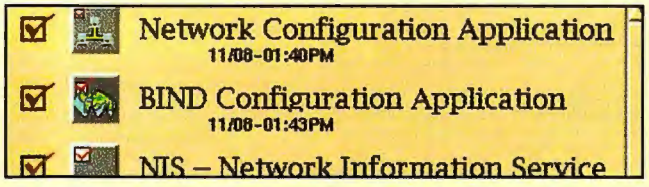
However, some of the Internet components that Digital provides with IASS cannot be configured using the IASS Administration utility. Thus, we had to resort to command-line utilities to enable and disable the Basic Merit AAA Radius authentication server, IMAP servers, Internet Relay Chat (IRC) server, LDAP server,

LAB RATING RESULTS

BEST OVERALL

Digital Unix 4.0D

With its combination of blazing I/O and excellent CGI support, Digital's 64-bit OS was the clear winner as the best OS platform on which to host a Web server.



	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	USABILITY	OVERALL RATING
Digital Unix 4.0D	★★★★	★★★	★★★★★	★★★	★★★★
Microsoft Windows NT 4.0	★★★★★	★★★	★★	★★★★	★★★★
Sun Solaris 2.6	★★★	★★★	★★★	★★★	★★★
Hewlett-Packard HP-UX 11.0	★★★	★★★★	★★★★	★★★	★★★★
IBM AIX 4.3	★★	★★★	★★★	★★	★★
Caldera OpenLinux 1.1	★	★★	★	★★	★★

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

POP-3 server, and the poppassd password-changing server.

HP-UX

HP-UX is nearly as good an I/O engine as Digital Unix, but it doesn't have the wealth of three-tier Web-application niceties that NT offers, and it's somewhat nonstandard (from a traditional Unix perspective) to administer. However, HP-UX is without a doubt the most secure Web-server OS of all those we tested for this report.

Virtually all versions of Unix now supply C2-level security. NT also offers C2 plus "Red Book" network extensions to those sites needing extra security. HP-UX takes security to the higher B1 level. To achieve this degree of protection, it uses a separate code base and disables some common features, such as the system administration module, SAM. With HP's Praesidium enterprise security framework, a Web site can be accessible to the public Internet without fear of malicious or even inadvertent damage.

HP Praesidium components include Authorization Server, Security Service, and Cryptographic Module. Security Service features authentication services for the Praesidium Authorization Server and provides a basic access-control list (ACL) that controls who can access specific applications and resources. Security Service also has a registry service for managing the security database, an audit service to track and record the use of security services, and data-encryption software to protect transmitted data.

HP-UX is also noteworthy for its reliability and recent embracing of the 64-bit Unix standard (in contrast, Digital Unix has been 64-bit for years). HP-UX integrates tightly with the PA-RISC computer hardware to gracefully avoid faulty processors, memory, and disk drives. In an SMP environment, it can take a faulty processor offline without rebooting and can similarly deallocate faulty memory.

HP claims that future descendants of HP-UX 11.0 will run on both HP's 64-bit PA-RISC 8x00 as well as the Intel Merced processor, which is based on an architecture jointly developed by HP and Intel.

OpenLinux

We liked Caldera's OpenLinux for its simplicity and robustness. Unfortunately, we cannot equate that robustness with the sort of reliability that the other products gave us. We never encountered an OS bug while testing OpenLinux, but it did terminate rather ungracefully when it was confronted with nontrivial processor, memory, and disk drive hardware failures. This OS provided us with more thrills than frills, reminding us of the "fun" we used to have with the plain, uncomplicated Unix implementations of years past.

OpenLinux is Caldera's value-added distribution of the shareware Linux. To the basic Linux kernel product, OpenLinux Standard 1.1 adds the X Window

Purchasing a Platform

Have you sometimes wondered why a large company would use its size as a club to buy desktop units at unbelievably low prices and then do an apparent about-face to spend hundreds of thousands of dollars on a midrange computer without negotiating just as hard? The inconsistency disappears when you stop to consider who's doing the purchasing and how much of a return the company expects on its computing investment.

Because they are now commodity items, desktop units typically come from a budget that's not all that different from the budgets for staplers, desk furniture, and telephones. A newly hired employee in the accounting department gets a desk, a PC, a stapler, and a telephone.

On the other hand, the head of the business organization who spends $100,000 or more on the midrange computer expects a 10-, 20-, or even 100-fold payback on his or her investment (with, naturally, the responsibility and accountability for actually realizing that payback). He or she negotiates with the computer vendor, but the chief concerns are issues such as uptime (will the vendor guarantee 99.5 percent?), training, administration, maintenance (will the company need to hire a person to care for the new system, as well as cross-train others?), and the useful life of the new computer (will the business community be able to sustain the rate of return from the investment over a long period of time?).

Because of the magnitude of the expected payback, the initial cost of the computer system is usually not the biggest concern to information technology (IT) management. The recurring costs (primarily in terms of people, downtime, and risk of erosion of the system's ability to satisfy future needs) are the most important factors affecting the purchase decision.

WEB SERVERS FEATURES

	Hewlett-Packard HP-UX 11.0	Digital Unix 4.0D ★B	IBM AIX 4.3	Microsoft NT Server 4.0	Sun Solaris 2.6	Caldera OpenLinux 1.1
Price	N/A	N/A	N/A	$809	$695	$399
PROCESSOR ENVIRONMENT						
Processor	PA-RISC	Alpha	PowerPC	Intel, Alpha	SPARC, Intel	Intel
Support 32-bit apps	✔		✔	✔	✔	✔
Support 64-bit apps, file system	✔	✔	Partially			
Maximum CPUs	16	12	8	4	64	1
Maximum RAM	16 GB	28 GB	3.75 GB	4 GB	30 GB	4 GB
Maximum addressable memory	18 EB	18 EB	4 GB	4 GB	4 GB	4 GB
Maximum shared memory	8 TB	4 GB	4 GB	4 GB	4 GB	4 GB
APPLICATION ENVIRONMENT						
Largest file system size	1 TB	512 TB	2 TB	18 EB	2 TB	N/A
Maximum file size	1 TB	17 TB	64 GB	18 EB	1 TB	N/A
NFS v3	✔	✔	✔	Optional	✔	
Posix-compliant kernel threads	✔	✔	✔	✔	✔	
Common Desktop Environment	✔	✔	✔		✔	✔

★B = BYTE Best ✔=yes; N/A=not applicable; EB=exabytes

System, developer tools, Apache Web Server, JDK, Netscape Gold, Netscape FastTrack Server 2.0, and HTML editing tools. Netscape FastTrack Server 2.0 is an entry-level Web server that is great for publishing static Web pages but less than useful for serious Dynamic HTML (DHTML) pages or three-tier Web applications. Late in 1997, however, Caldera announced plans to port Netscape's industrial-strength Web-server software, SuiteSpot 3.0, to OpenLinux. This should be a significant addition.

Unfortunately, installation and administration of OpenLinux is almost wholly manual compared to the other versions of Unix. For instance, OpenLinux required us to manually create the swap and primary Linux partitions, and, in contrast to the other versions of Unix, we also had to manually fine-tune our monitor, video card, and mouse settings before we could start the X server.

Sun Solaris

For running CGI-based Web applications (those with FORMS statements embedded in HTML), we found Solaris the best of the lot. Further investigation showed that its task and process management functions were notably quicker and more efficient than those of the other platforms, and CGI places a heavy burden on an OS's ability to launch programs. Solaris, not surprisingly, also has superior support for Java. We applaud Sun for offering Solaris for Intel machines as well as on its own SparcStations, a strategy that helps Solaris scale downward onto inexpensive desktop machines and that may be significant for many users.

Solaris was easy to configure in our tests, and the ability to remotely perform almost all administrative tasks was the icing on the cake. We used both command-line utilities and Sun's Web Start browser interface to manage system resources, including partition sizes, available sockets, maximum threads per user, and other parameters. The Java-based configuration utilities were generally intuitive in use, and, because of the effectiveness of Sun's JIT compiler, we found them to be highly responsive.

In our testing, we found that this newest version of Solaris is faster than its predecessors. Sun has improved the disk I/O code path as well as the TCP/IP stack drivers. Nonetheless, Solaris lagged behind both Digital Unix and HP-UX in sheer throughput.

Security is another area in which Solaris needs improvement. Version 2.6 has added the ability to use Plug-In Authentication Modules (PAMs) as well as Generic Security Services API (GSSAPI), and the OS offers virtual private network (VPN) security. However, Solaris 2.6 still lacks transport-layer security, and it cannot restrict access for specified hours of operation.

Microsoft Windows NT Server

So how well does Redmond's OS compare to this group of Unix products? Considering its usefulness as a Web-site host, we particularly liked NT's integration of Active Server Page (ASP) Web scripting, Web-server software (IIS), transaction processing (TP) monitoring (Transaction Server), message-oriented middleware (MOM, implemented as Microsoft Message Queuing, or MSMQ), and Microsoft Management Console (MMC).

These built-in features, along with NT Server's internal functions and graphical interface, make NT Server the only one of these six platforms for which designing a three-tier application would be easy and fun. Additionally, NT has the widest range of third-party development tools, including a remote Web management interface as well as a BASIC-like language for scripting configuration changes. NT also let us

What We Tested On

OS	Computer hardware	Number of CPUs	RAM
AIX	IBM R50 RS/6000	2	512 MB
Digital Unix	400-MHz Digital AlphaServer	2	512 MB
HP-UX	HP 9000 K460	1	1 GB
OpenLinux	300-MHz Pentium II	1	128 MB
Solaris	Sun Netra i20	2	128 MB
Windows NT Server	300-MHz Pentium II	1	128 MB

crash-protect Web applications by putting them in separate address spaces.

Unfortunately, NT still seems unable to gracefully survive machine checks, disk space exhaustion, and its own very rare OS bugs. Therefore, you'll need to keep a watchful eye on its day-to-day operation. (BYTE's Webmaster, Jon Udell, has commented that, in the village of servers that service the BYTE site, the NT servers occasionally go down... but the Unix machines have never failed.)

Clustering NT machines isn't yet a viable solution, because NT's clustering technology hasn't yet reached a level of reliability we'd call adequate. (With the exception of OpenLinux, all the Unix vendors offer robust clustering.) And too many kinds of NT configuration changes require rebooting the OS, which can be both annoying and disruptive. We find NT eminently suitable for running three-tier applications, as long as they don't require 24-hour, seven-day uptime.

In our tests, we found that NT ran slowest when configured to use its own NT File System (NTFS). NT's Web-page serving sped up considerably when we switched to NT's software-based disk striping. NT 4.0, updated by Microsoft's Option Pack, shows significant performance gains over earlier versions of NT, especially in its support of 100Base-T networking. However, the combination of NT and even a fast Pentium processor produced Web pages at a much slower rate than any of the other platforms we tested. Fortunately, Pentium-based machines are inexpensive commodity items.

At Your Service

No OS is a perfect platform on which to run a Web server, but because the basic function of most servers is to push out Web pages, we're picking Digital Unix as the best overall choice, despite its lack of available three-tier development tools. For those kinds of applications, our testing shows that NT is currently the best OS. For CGI-based processing, Solaris easily outshone the others. HP-UX deserves special mention for its high level of security, and it was very nearly as good as Digital Unix at serving up static Web pages.

Perhaps NT will someday offer the reliability of AIX or HP-UX. Or perhaps Solaris and OpenLinux will become 64-bit powerhouses for serving up ultralarge Web sites to a myriad of clients. Until then, however, you'll have to make compromises when you choose an OS for your Web sites. B

Barry Nance, a BYTE consulting editor and a computer analyst and consultant for 25 years, is the author of Introduction to Networking, *4th ed. (Que, 1997),* Using OS/2 Warp *(Que, 1994), and* Client/Server LAN Programming *(Que, 1994). You can reach him via the Internet at* **barryn@bix.com.**

TECH FOCUS: PERFORMANCE

Tuning Your Unix

If your Web site uses Unix-based servers, at some point you'll want to tweak the OS to improve performance. A good place to start is with the vmstat, iostat, netstat, and sar Unix utilities. These tools display statistics that can help you decide what you need to do.

The vmstat command shows utilization of system resources—memory, disks, interrupts, system calls, context switches, and CPU. It also shows paging activity and information on kernel threads in the run and wait queues. This command breaks down CPU activity by categories that include user mode, system mode, idle time, and waiting for disk I/O. You can use vmstat to find out whether a system is CPU-bound, memory-bound, or I/O-bound.

If you suspect a Unix machine is I/O-bound, the iostat utility can help you locate the problem. The tool reports CPU statistics and I/O statistics for TTY devices, disks, and CD-ROM drives. It monitors system I/O device use by relating the time each physical disk is active to its average transfer rate. The iostat utility can reveal, for example, whether a physical volume has become a performance bottleneck. You can use the tool's statistics to better balance the I/O work load among the system's physical disks.

The netstat utility shows network status and indicates the reliability of the local network interface. Classically, administrators use netstat more for problem determination than performance measurement. However, you can use its statistics to determine the volume of network traffic and thus get an indication of whether network congestion is causing performance problems.

For each network interface, netstat tells you the address of the protocol control blocks associated with the interface's sockets as well as the status of the sockets; the number of packets received, transmitted, and dropped; network routes and their status; and cumulative counts of error-collision packets.

Finally, sar is a popular Unix administrator's tool for gathering performance statistics. Be aware, however, that sar is somewhat intrusive and can skew the performance data by a small amount as it increases system work load. The utility offers a wide variety of command-line options that let you specify the kinds of system activities you're interested in monitoring. It can divulge, for instance, useful information about queuing, paging, and TTY events. For symmetric multiprocessing (SMP) systems, sar can typically also show CPU use globally, for all processors or individually by processor.

These tools can help you tune a Unix-based Web site to run smoothly and efficiently. Yes, they're a little like rocket science. So read the technical references and go launch a rocket.

PRODUCT INFORMATION

AIX 4.3
(available with RS/6000 systems)
IBM
http://www.rs6000.ibm.com/software

Digital Unix 4.0D
(available with Digital servers)
Digital Equipment Corp.
Maynard, MA
http://www.Unix.digital.com
Enter HotBYTEs No. 1055.

HP-UX 11.0
(available with selected PA-RISC systems)
Hewlett-Packard Co.
Palo Alto, CA
415-857-1501
http:// www.hp.com/computing
Enter HotBYTEs No. 1056.

OpenLinux 1.1
Caldera
Provo, UT
800-850-7779
801-377-7687
fax: 801-377-8752
http:// www.caldera.com
Enter HotBYTEs No. 1057.

Solaris Server 2.6
(available for SPARC- and Intel-based servers)
Sun Microsystems
Palo Alto, CA
800-786-7638
415-960-1300
http://www.sun.com/solaris
Enter HotBYTEs No. 1058.

Windows NT Server 4.0
(available for Alpha- and Intel-based servers)
Microsoft
Redmond, WA
425-882-8080
fax: 425-936-7329
http:// www.microsoft.com/ntserver
Enter HotBYTEs No. 1059.

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

3-D is ready—even if you aren't. Don't get left behind with a graphics engine that won't deliver.
By Rob Hummel

Render Benders: 26 Graphics Cards for Fast 3-D

Make no mistake: This is the year you will move to a 3-D video board—if you're not already there. The benefits are so compelling and the cost is so small that you'll be hard pressed to justify resisting the upgrade.

Support for OpenGL graphics, the sole province of $100,000 workstations just a few years ago, has moved so rapidly down the food chain that it's now built into every copy of Windows. To this mix, add emerging 3-D applications that go beyond games to enable the business use of rendering and visualization. Finally, factor in Intel's aggressive marketing of its new Accelerated Graphics Port (AGP) graphics bus and Microsoft's push for its Direct3D interface, and the conclusion is inescapable.

3DLabs: Market Leader

Faster, better, cheaper—the three horsemen of technological advancement—have ridden hard over the past year in an effort to move 3-D video forward to the same level as processor, memory, and mass-storage subsystems. The result has been superbly affordable 3-D chip sets tailored to varying levels of performance.

The boards that we selected for this round-up fall neatly into three different groups based on their core chip sets. Four of the five high-end boards are built around the Glint MX chip. The Glint MX, 3DLabs' third-generation graphics processor, combines workstation-class 3-D graphics with 2-D Windows acceleration. All four of these video boards paired the MX processor with the Glint Delta chip, a geometry processor that speeds OpenGL graphics performance by off-loading calculations from the host CPU. The sole independent in the high-end category was Intergraph, which uses a proprietary graphics processor.

Every one of the dozen mid-range boards we tested was based on the Permedia 2 chip set, also from 3DLabs. A second-generation low-cost processor targeted at the consumer market, the Permedia 2 integrates SVGA, 2-D and 3-D acceleration, and MPEG-2 video acceleration in a single device. The chip's architecture can accommodate from 2 to 8 MB of video memory (all the boards we tested were equipped with 8 MB) and a 16-bit z-buffer.

3DLabs also provides a set of reference drivers for OpenGL and Direct 3D under Windows NT and 95, making it easy for manufacturers to offer a low-cost 3-D video solution for both platforms. As popular as 3DLabs' chips are, they're clearly not for everyone. A third group of boards we tested used a variety of chips, developed either by the board's manufacturer or by other independent chip makers.

The nine independents we tested included three boards based on ATI's 3D Rage Pro, three using nVidia's Riva 128, and one each using Number Nine's "Ticket to Ride," 3Dfx's Voodoo Rush, and Matrox's MGA-2164W. The design goal for these chips must have been something other than speed, as they all turned in significantly lower 3-D performance scores than the Permedia 2–based boards.

Versatility

Some 3-D graphics board manufacturers define extremely narrow goals for their boards—to the exclusion of all else. High-end boards, for example, often emphasize speed when rendering 3-D images using OpenGL under NT. Applications that don't fit this narrow definition are simply unsupported, even to the extent that no driver support for running Windows 95 is provided. That's fine if your requirements are equally as narrow. But if, as a developer, you plan to dual-boot your system to test your new application under both OSes, for example, you'd best choose a different board.

Other boards take the opposite tack, trying to be all things to all users. In

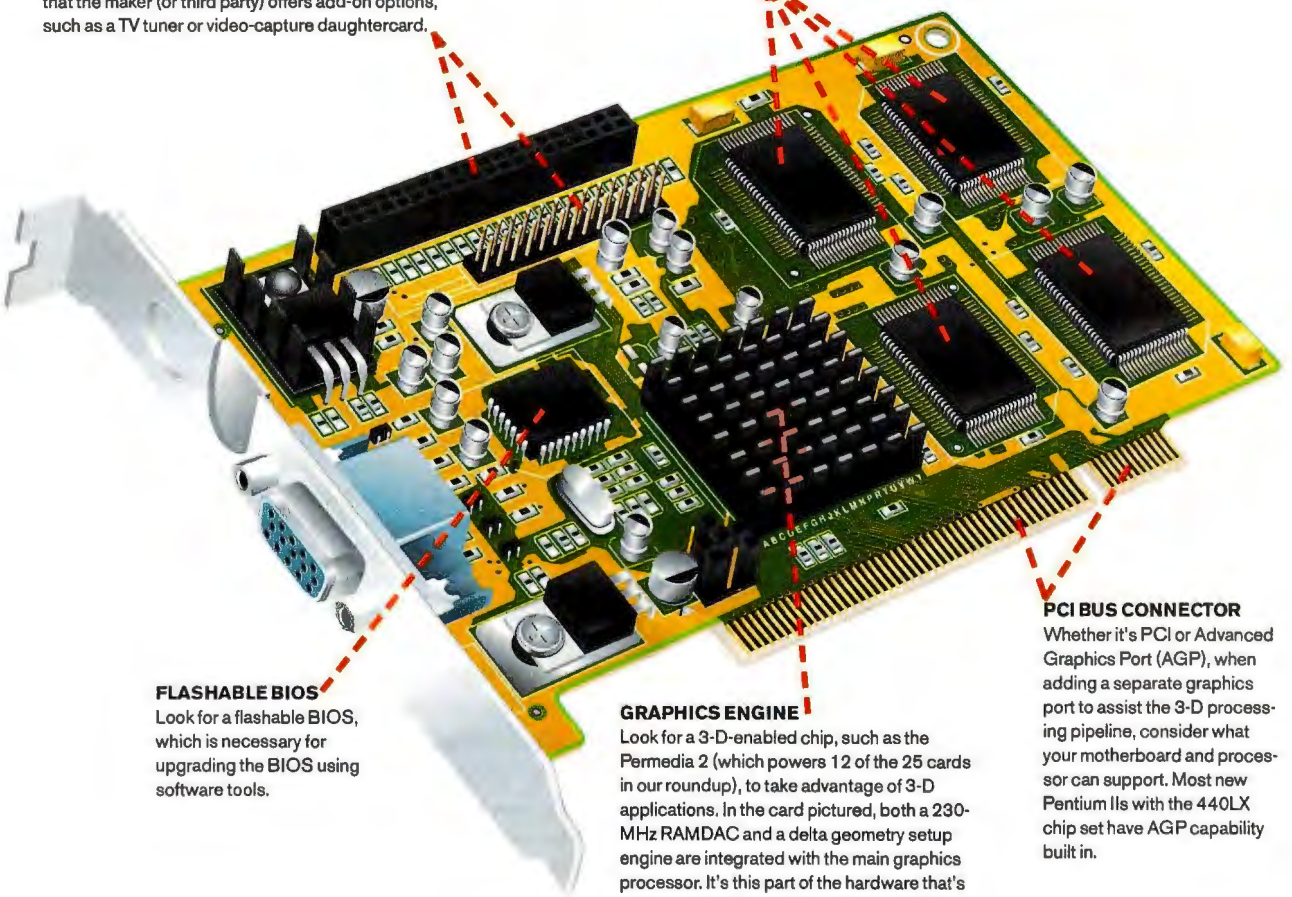
BYTE BEST
3-D GRAPHICS CARDS

Leadtek Research
WinFast 3D L2300
The WinFast 3D L2300 gets double honors for Best Overall and Best Value. At $169, it bested every other board in the 8-MB-and-less category, turning in top scores in both 3-D Viewperf tests. An outstanding value, it provides the most cost-effective performance of any board in this roundup.

Intergraph Computer Systems
Intense 3D Pro 2200S
This is the unabashed performance leader in the high-end category–and, at $2387, the most expensive board we tested. The Intense 3D Pro 2200S squeaked past its four companions, aided primarily by its extraordinary score on the Viewperf CDRS benchmark.

ADD-ONS
Check for a board that has a VMI connector, a new standard for future implementations of video-capture daughtercards, and/or a feature connector, another standard for video-input daughtercards. Also, check that the maker (or third party) offers add-on options, such as a TV tuner or video-capture daughtercard.

GRAPHICS RAM
8 MB of high-speed synchronous graphics RAM (SGRAM) powered many of the cards in our roundup, permitting 32-bit color at 1280 by 1024 resolution. The more RAM, the higher the resolution. In addition, some cards (like the one pictured) dynamically allocate their memory to include frame buffering, z-buffering, and texture buffering.



FLASHABLE BIOS
Look for a flashable BIOS, which is necessary for upgrading the BIOS using software tools.

GRAPHICS ENGINE
Look for a 3-D-enabled chip, such as the Permedia 2 (which powers 12 of the 25 cards in our roundup), to take advantage of 3-D applications. In the card pictured, both a 230-MHz RAMDAC and a delta geometry setup engine are integrated with the main graphics processor. It's this part of the hardware that's optimized for OpenGL (with the Installable Client Driver [ICD] driver) and Direct3D hardware acceleration, plus MPEG-2 acceleration.

PCI BUS CONNECTOR
Whether it's PCI or Advanced Graphics Port (AGP), when adding a separate graphics port to assist the 3-D processing pipeline, consider what your motherboard and processor can support. Most new Pentium IIs with the 440LX chip set have AGP capability built in.

Illustration is based on the Leadtek WinFast 3D L2300.

most cases, they trade off versatility for either performance, price, or both. If you really want video in, video out, MPEG acceleration, and a TV tuner to boot, you've got to be prepared to pay for these features in one way or another.

Defining the Field

When we asked the manufacturers of these 3-D graphics accelerators to provide hardware for this Lab Report, we gave them enough flexibility to squeeze in a variety of video offerings. As a minimum, each board had to support 1024 by 768 pixels with 24- or 32-bit color and 1280 by 1024 pixels with 16-bit color. A z-buffer of at least 16 bits and a refresh rate of at least 75 Hz were required at the 1024 by 768 resolution. The boards also had to support digital video acceleration for MPEG. If a manufacturer provided a board in both PCI and AGP configurations, it could submit one or both versions.

Most video board manufacturers responded with enthusiasm. In the low-end and midrange categories, 12 vendors submitted a total of 21 boards—13 based on PCI and eight based on AGP. All the midrange boards had 8 MB of video memory, while the low-end boards ranged from 4 to 8 MB.

Just as performance did not correlate directly with the amount of graphics RAM on a card, prices for the boards did not equate with performance or features. You can get the least costly board we tested in these two categories for under $170, while the most costly one is about $300.

Five vendors provided entries for the high-end category. These boards provided from 16 to 48 MB of video memory, supported 24- and 32-bit z-buffers, and ranged in price from $1200 to $2400.

Several boards we received from manufacturers could not be tested due to technical problems. A beta unit of Hercules' Thriller 3-D wouldn't run the Viewperf tests. We got two Righteous 3D boards from Micronics/Orchid but were unable to get them to work in our test system. We were also unable to get a Videologic Apocalypse 5D board to run under NT. A replacement board arrived too late to test.

Contributors
Steve Platt, Managing Editor/NSTL
Dorothy Hudson, Project Manager/NSTL
Michelle Campanale, Technical Editor/BYTE
Linda Higgins, Editorial Associate/BYTE

BEST OVERALL 3-D GRAPHICS BOARDS

3-D technology and the applications that use it are changing so rapidly that price, performance, and features won't stand still long enough to make for meaningful comparisons. That's the problem we faced when choosing our winners.

If you're looking for a 3-D graphics accelerator, it's safe to assume that your primary objective is performance. Therefore, we gave performance scores a hefty 50 percent weighting when determining our Best Overall winner.

Important as it is, performance isn't the whole picture. To differentiate their boards, vendors try to add value in the form of built-in or bundled features. Consequently, we allocated 20 percent of the Best Overall score to features.

Performance Leader

The unabashed performance leader of this group was the Intergraph Intense 3D Pro 2200S. Turning in the top score in the CDRS OpenGL viewset, which emphasizes texturing and modeling, the Pro 2200S's proprietary graphics engine beat its nearest competitors by more than 25 percent. Not coincidentally, the $2400 Intergraph is the most costly of the boards that we tested. Its performance wasn't as good on the OpenGL DX viewset, however, where 16 boards—some costing as little as $179—beat the Pro 2200.

But the composite performance scores (a combination of CDRS, DX, and Bapco) of the five top-tier boards varied only a few percent either way. Their overall scores were nearly identical as well. All other things being equal, this makes the $999 Symmetric GLyder MX GMX3A PCI board stand out as a bargain in the high-end group. Populated with 16 MB of video memory, this Glint MX–based board is a great value among the high-end 3-D graphics cards we tested.

First Among Peers

An old saw says that if you stand with one foot on a block of ice and the other in a fire, on average, you'll be miserable. That neatly sums up the pitfall in using a single average score for determining an overall winner. Nonetheless, despite wide and varied criteria, we picked the Leadtek Research WinFast 3D L2300 AGP board as the overall winner.

The L2300 turned in the best performance score of any board with 8 MB or less video memory, distinguishing it even among its Permedia 2–based cousins. Leadtek attributes much of this performance to aggressive reengineering of the stock 3DLabs board design. With an aggregate performance score only 6 percent behind that of the 40-MB Glint MX–based Elsa GLoria-XL, the L2300 is a potent solution for moderate graphics required by entry-level workstations.

Close behind the L2300 in overall score were the other members of the Permedia 2 pack. Buoyed by a high features score, the Creative Labs Graphics Blaster Exxtreme lagged behind by about 5 percent. The Hercules Dynamite 3D/GL and

TECH FOCUS CDRS COMPOSITE

A Better Measure of Value

In March 1996, a Hewlett-Packard J210XC/Freedom Series 3400 computer system with 64 MB of RAM and a 2-GB hard disk sold for $115,660 and posted a CDRS composite of 50.78—a cost of $2278 per composite. Today the situation is remarkably different. The top-rated system is a Hewlett-Packard 9000/782/C240 with a Visualize-Fx6 with texture option. For just $56,615, you get 512 MB of RAM, a 9-GB hard disk, and a CDRS composite of 200.00—a lot more performance, and at a cost of only $283 per composite. (For competitive comparisons, OpenGL performance is characterized in terms of dollar cost per CDRS composite.)

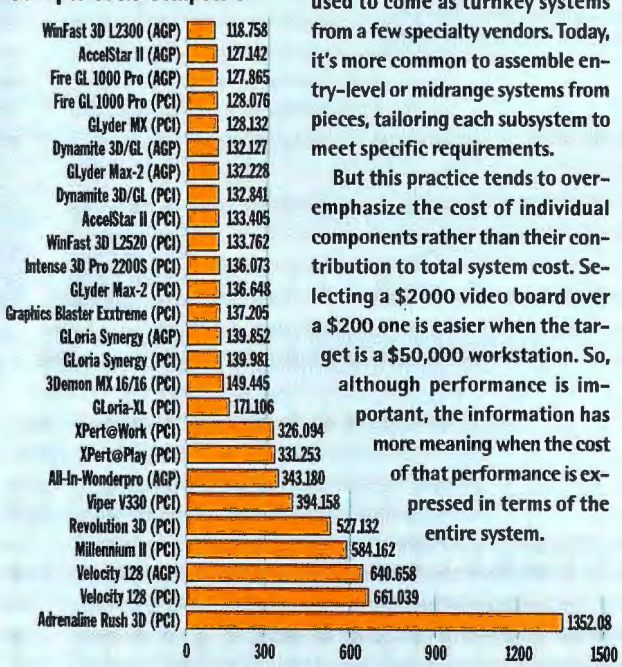
High Value, Low Cost

To make the performance ratings of the video boards in this roundup more meaningful, we've calculated the cost per CDRS composite of each of the boards installed in a system we consider an entry-level 3-D workstation: a $3000 300-MHz Pentium II with 128 MB of RAM, a 6-GB hard disk, and a 19-inch monitor (the same specifications as our test PC). We added in the cost of each video board and divided the total system cost by the board's CDRS composite score. The results are shown in the graph at right.

The WinFast 3D L2300 AGP card, for example, costs $169 and produces a system with a $119-per-composite cost. The Intense 3D Pro 2200S PCI board costs $2387—nearly 13 times the cost of the L2300. But its $136-per-composite cost is a more reasonable—and meaningful—increase of only 14 percent.

The impact of the more costly video boards is greatly moderated by the cost of the computer system. The more expensive the nonvideo components are, the more cost-effective it becomes to invest your money in a better-performing video board.

Cost per CDRS Composite



High-end graphics workstations used to come as turnkey systems from a few specialty vendors. Today, it's more common to assemble entry-level or midrange systems from pieces, tailoring each subsystem to meet specific requirements.

But this practice tends to overemphasize the cost of individual components rather than their contribution to total system cost. Selecting a $2000 video board over a $200 one is easier when the target is a $50,000 workstation. So, although performance is important, the information has more meaning when the cost of that performance is expressed in terms of the entire system.

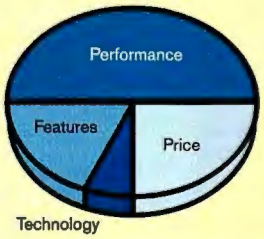
LAB RATING RESULTS

BEST OVERALL/BEST VALUE

Leadtek Research WinFast 3D L2300

Double honors for Best Overall and Best Value go to the Leadtek Research WinFast 3D L2300. The 8-MB WinFast 3D L2300 outperformed every other board in its class and came within a whisker of high-end boards costing over 10 times as much. At $169, it provides the most performance per dollar of any board in the roundup.

WEIGHTING



BEST PERFORMANCE

Intergraph Computer Systems Intense 3D Pro 2200S

In terms of aggregate performance, the Pro 2200S can't be beat. With the highest CDRS score, the Pro 2200S edged out every other card in this roundup. But unless money is no object, its $2387 price tag and high cost/performance ratio may have you looking elsewhere.

WEIGHTING

	PRICE	TECHNOLOGY	IMPLEMENTATION	PERFORMANCE	FEATURES	USABILITY	OVERALL RATING
Leadtek Research WinFast 3D L2300 (AGP)	**$169**	★★★★	★★★★	★★★★	★★★★	★★★	★★★★★
Creative Labs Graphics Blaster Exxtreme (PCI)	$200	★★★★	★★★★	★★★★	★★★★	★★★★★	★★★★★
Diamond Multimedia Systems Viper V330 (PCI)	$180	★★★	★★★	★★	★★★★	★★★★	★★★★
Diamond Multimedia Systems Fire GL 1000 Pro (AGP)	$225	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★★
Hercules Dynamite 3D/GL 6218GL (PCI)	$249	★★★★	★★★★	★★★★	★★★★	★★★★★	★★★★★
Hercules Dynamite 3D/GL 7218GLA (AGP)	$249	★★★★	★★★★	★★★★	★★★★	★★★★★	★★★★★
Symmetric GLyder Max-2 (AGP)	$229	★★★★	★★★★	★★★★	★★★★	★★	★★★★★
Symmetric GLyder Max-2 (PCI)	$229	★★★★	★★★★	★★★★	★★★★	★★	★★★★★
AccelGraphics AccelStar II (AGP)	$279	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
AccelGraphics AccelStar II (PCI)	$279	★★★★	★★★★	★★★★	★★★	★★★★	★★★★
Elsa GLoria Synergy (PCI)	$299	★★★★	★★★★	★★★★	★★★	★★★★★	★★★★
Elsa GLoria Synergy (AGP)	$299	★★★★	★★★★	★★★★	★★★	★★★★★	★★★★
Omnicomp Graphics 3Demon MX 16/16 (PCI)	$1700	★★★★★	★★★★	★★★★	★★★★	★★★	★★★★
Leadtek Research WinFast 3D L2520 (PCI)	$1199	★★★★★	★★★★	★★★★	★★★★	★★★	★★★★
Symmetric GLyder MX (PCI)	$999	★★★★★	★★★★	★★★★	★★★★	★★	★★★★
Elsa GLoria-XL (PCI)	$1799	★★★★★	★★★★	★★★★	★★★★	★★★★★	★★★★
ATI Technologies XPert@Work (PCI)	$169	★★★	★★★★	★★	★★★★	★★★★★	★★★★
Intergraph Intense 3D Pro 2200S (PCI)	$2387	★★★★★	★★★★	★★★★★	★★★	★★★	★★★★
Diamond Multimedia Systems Fire GL 1000 Pro (PCI)	$225	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★★
ATI Technologies XPert@Play (PCI)	$219	★★★	★★★★	★★	★★★★	★★★★★	★★★★
STB Systems Velocity 128 (PCI)	$199	★★★	★★★★	★★	★★★★	★★★★	★★★★
STB Systems Velocity 128 (AGP)	$199	★★★	★★★★	★★	★★★★	★★★★	★★★★
Jazz Multimedia Adrenaline Rush 3D (PCI)	$199	★★★	★★★★	★	★★★★★	★★★★★	★★★★
Matrox Graphics Millennium II (PCI)	$269	★★★	★★★★	★★	★★★★★	★★★★★	★★★★
ATI Technologies All-In-Wonderpro (AGP)	$279	★★★	★★★	★★	★★★★	★★★★★	★★★
Number Nine Revolution 3D (PCI)	$299	★★★	★★★	★★	★★★★	★★★★★	★★★

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

PHOTOGRAPHS: STEVEN GREENBERG © 1998

Diamond Fire GL 1000 Pro boards trailed by 7 percent and 8 percent, respectively. The Symmetric GLyder Max-2 and AccelGraphics AccelStar II boards were down by 10 percent and 13 percent, compared to the Leadtek L2300.

Given the relatively close overall and performance scores, choosing one of these boards over the others could be difficult. None offers video in or video out, and most implement some variation of the chip-enabled VMI interface bus. Only the Diamond Fire GL 1000 Pro breaks from the rest of the pack to offer a StereoGraphics port for 3-D glasses.

Value Leader

With little in the way of features, performance, or technology to distinguish the Permedia 2 boards, it should come as no surprise that price played a major role in establishing our value ratings. With a street price of $169, Leadtek's WinFast 3D L2300 AGP board was a shoo-in as the best value winner.

In terms of performance per dollar for entry-level and midrange 3-D graphics systems, the WinFast 3D L2300 handily beat every other board. Higher prices and lower performance eliminated the other boards in the 8-MB-and-less group. And those higher prices, coupled with little proportional gain on the Viewperf tests, make the high-end boards seem less attractive.

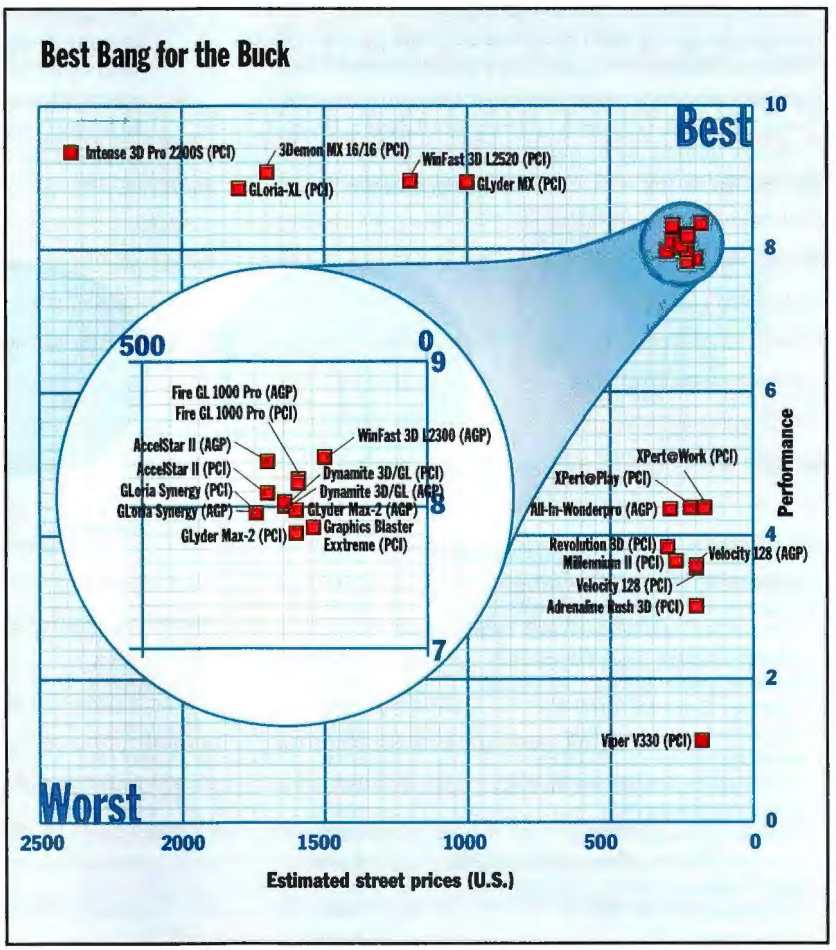
For our tests, we defined *value* as the cost of performance while running the Viewperf and Bapco tests. You'll have to toss your requirements into the mix to get the best board for your application.

Clearly, much of the confusion concerning 3-D solutions can be traced to the difficulty in defining the 3-D user. As recently as a year ago, there were two distinct 3-D markets. At the high end was professional-quality, real-time, 3-D image generation and rendering. Built around costly graphics boards and multi-CPU designs, these cards delivered performance at a price premium.

At the low end of the spectrum were the gamers. Because games demanded faster and more realistic imaging, texture-mapping, and special-image effects, affordable 3-D became associated almost exclusively with them. But advances in game-playing held little appeal for corporate IS. Business 3-D, representing the largest potential market, languished between the frivolous and the exorbitant.

Today, we expect a video board to deliver capable SVGA operation, including higher resolutions and refresh rates. We expect accelerated 2-D Windows graphics and MPEG video playback. On top of that, we now want Direct3D and OpenGL acceleration with rendering options in hardware—a must if you want to get the most out of polygon-intensive visualization and modeling applications and even 3-D Web browsers.

Simply supporting 3-D functions in software is not the same as providing on-board hardware acceleration. And tossing a hastily written video driver into the mix can seriously hobble even the fastest hardware.



How We Rated

Choosing a 3-D video board is a three-step process. First you look for the fastest board. Next, you look at the fastest one that you can afford. Finally, you make sure you choose one that supports all the functions you need. That's the same line of reasoning we applied when we rated these boards on performance, price, features, and technology.

We selected our winners with three themes in mind: best overall mix of price, performance, features, and technology; best-performing 3-D card, regardless of price; and best value for under $300. To determine the Best Value score, we took the overall composite performance score and divided it by the cost of the board. As the basis for the Best Performance score, we looked exclusively at each card's raw performance score.

The overall score comes from a 50:25:20:5 weighted rating of performance, price, features, and technology, respectively (see the pie chart on page 115). Because performance is the yardstick by which graphics acceleration is measured, we gave it the highest weighting in our overall rating. We judged the boards both on time to complete a task and on frames rendered in a fixed time period.

To get a features rating, we evaluated each board against a matrix of expected features. We verified the presence or absence of a feature by testing and by studying a board's documentation. We then organized the features into categories, with each category and each feature within a category given a weight that contributed to a board's final features score.

Test Methodology

Makers of high-end 3D graphics accelerators typically quote performance as the number of primitives (e.g., triangles) drawn per second. These are numbers that, in the absence of additional information, such as the context, size, shading, color depth, and the smoothing method used to draw those triangles, make direct comparisons difficult.

In contrast, low-end board makers have traditionally judged their products' performance using business application–based benchmarks or tests designed to show their products' particular strengths. As these markets converge and high-end applications are pulled down to the desktop, the need for comparable benchmarks becomes crucial.

We defined our target environment as a high-performance workstation. Although used primarily for 3-D graphics, we expected this workstation to sup-

port occasional use of a standard office suite of applications. We selected a CLR Infinity PT2-DAX PC powered by a 300-MHz Pentium II with 128 MB of RAM. The system supported AGP and PCI slots, allowing both board designs to be tested. Our OS was Windows NT Server Build 1381, service pack 3.

Given the growing importance of OpenGL on the desktop (see the text box at right), we chose to characterize 3-D performance using the Viewperf benchmark (available at http://www.specbench.org), developed by the OpenGL Performance Characterization subcommittee. A portable benchmark, it's the current industry standard for evaluating OpenGL performance. The Viewperf test does not benchmark individual primitives; instead, it measures how well a system accelerates actual application data sets, called *viewsets*.

The CDRS viewset is derived from Parametric Technology's modeling and rendering software for computer-aided industrial design. The test measures seven different operations on a model of a lawn mower. The DX viewset is based on IBM's Visualization Data Explorer, a general-purpose scientific data visualization and analysis package. The DX benchmark draws a set of particle traces thorough a vector-flow field. Viewperf measures frames per second for each component test. The single result for each viewset is a weighted geometric mean. Each viewset comprised 40 percent of our final performance rating.

To measure 2-D performance of the boards when running common business applications, we used Bapco SYSmark for Windows NT. This benchmark suite, which comprises five application programs, measures the speed with which a system under test executes predetermined scripts of user tasks typically performed when using these applications. Our final performance scores weighted the Bapco results at 20 percent.

The application programs that we used to run the tests were Microsoft Word 6.0, Excel 5.0, and PowerPoint 4.0; OrCAD Layout Plus 7.0; and Welcom Software's Texim Project 2.0e. All these programs run in native 32-bit mode except PowerPoint, which runs the application code in 16-bit emulation mode.

As a processor-bound 2-D test running on 3-D graphics cards, Bapco served more as a reality check than a benchmark. We expected all the graphics boards in this roundup to provide competent 2-D Windows acceleration—and we weren't disappointed. Regardless of the chip set, bus, or on-board memory configuration used, all the boards turned in Bapco scores that were within 2 percent of the average.

It's only fair to note that Matrox disagreed with our use of Viewperf to judge the Millennium II, saying that the primary demand of the Millennium's target market—entry-level to midrange users—is fast 2-D performance. Matrox believes Viewperf is best used to measure the 3-D performance of more expensive, high-end boards used by graphics professionals. We believe that Viewperf remains a valid performance measure of any board that claims to support OpenGL, which the Matrox Millennium II does.

Evaluations in this report represent the judgment of BYTE editors, based on tests conducted by NSTL, Inc., as documented in a recent issue of NSTL's monthly PC Digest. *To purchase a copy of the full report, contact NSTL at 625 Ridge Pike, Conshohocken, PA 19428; 610-941-9600; fax 610-941-9950; on the Internet, editors@nstl.com. For a subscription, call 800-257-9402. BYTE magazine and NSTL are both operating units of The McGraw-Hill Companies, Inc.*

Graphics APIs Converge

What will desktop computing be like when millions of multimedia authors have access to the same technology that drives the creative engine at Industrial Light and Magic? What will product design be like when designers everywhere have access to the same large-model visualization and virtual prototyping on their PCs that were used to design the Ford Taurus and the Boeing 777?

Microsoft and Silicon Graphics, Inc. (SGI) representatives posed these questions when they announced their common vision to redefine the way in which developers create graphics applications. Called Fahrenheit, this set of three new APIs is expected to eliminate the need for programmers to write to both OpenGL and Direct-3D or choose between the two APIs (or OpenGL Optimizer and Hewlett-Packard's Direct Model) to determine which markets to go after.

The first new API is Fahrenheit SceneGraph. Expected to ship in early 1999, it exists as a layer (typically) between an application and the low-level graphics API. SceneGraph isolates the application from hardware and system details that are relatively exposed at the low-level graphics API level. By providing that isolation, it leaves application developers free to focus on the application and leaves out a lot of messy details about how to optimally use underlying hardware and system resources. It can also make full use of multiple processors in machines. The technology for this API is COM based and has been derived from SGI.

The second new API, which is an extension to SceneGraph, is known as the Fahrenheit Large Model Visualization. Expected to ship early in 1999, it will enable applications such as 3-D CAD software packages to take full advantage of the SceneGraph API.

Derived from SGI's OpenGL Optimizer and Hewlett-Packard's Direct Model technology, SceneGraph will be relevant to a wide variety of applications. It addresses incredibly large, complex data sets that include tens or hundreds of millions of polygons or triangles—or, more typically, hundreds of thousands or millions of complex mathematical surfaces.

One of the core technologies in this extension is representation, which searches in mathematical form rather than in polygonal form, allowing a system do tessellation dynamically on the fly. The extension is expected to be generally applicable; however, it's primarily designed to deal with problems that relate specifically to product design (e.g., automobile prototyping) and digital prototyping.

The third new API is the Fahrenheit low-level API. Expected to be available sometime in the year 2000, it sits on top of the hardware and will support applications ranging from games and entertainment all the way to scientific and advanced technical applications. The low-level API will be derived from Microsoft's Direct 3D and Direct Draw technologies, as well as from OpenGL.

The low-level API will also be fully backward compatible with today's Direct X5, Direct draw, and Direct 3D technologies. But for applications to take full advantage of the new capabilities that will eventually be introduced in the API, they will have to go through some changes—similar to the ones required during the migration from DirectX 1 through Direct X 5.

—Michelle Campanale

3-D GRAPHICS BOARDS FEATURES

Company	Product	Street price as of 1/14/98	Overall rating	Bus	Video controller or chip set	3-D noninterlaced resolution supported at true color (32-bit) up to:	Installed/ maximum RAM	RAM type
AccelGraphics, Inc.	AccelStar II	$279	★★★★	PCI	3DLabs Permedia 2	1280×1024	8/8	SGRAM
AccelGraphics, Inc.	AccelStar II	$279	★★★★	AGP	3DLabs Permedia 2	1280×1024	8/8	SGRAM
ATI Technologies, Inc.	All-In-Wonderpro	$279	★★★	AGP	ATI 3D Rage Pro	1024×768	4/8	SGRAM
ATI Technologies, Inc.	XPert@Work	$169	★★★★	PCI	ATI 3D Rage Pro	1024×768	4/8	SGRAM
ATI Technologies, Inc.	XPert@Play	$219	★★★★	PCI	ATI 3D Rage Pro	1024×768	4/8	SGRAM
Creative Labs	Graphics Blaster Exxtreme Professional Edition	$199.99	★★★★★	PCI	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Diamond Multimedia Systems, Inc.	Viper V330	$180	★★★★	PCI	nVidia Riva 128	1152×864	4/4	SGRAM
Diamond Multimedia Systems, Inc.	Fire GL 1000 Pro	$225	★★★★★	PCI	3DLabs Permedia 2	1600×1200	4/8	SGRAM
Diamond Multimedia Systems, Inc.	Fire GL 1000 Pro	$225	★★★★★	AGP	3DLabs Permedia 2	1600×1200	4/8	SGRAM
Elsa, Inc.	Elsa GLoria Synergy	$299	★★★★	AGP	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Elsa, Inc.	Elsa GLoria Synergy	$299	★★★★	PCI	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Elsa, Inc.	Elsa GLoria-XL	$1799	★★★★	PCI	3DLabs Glint MX	1920×1080	40/56	VRAM, EDO DRAM
Hercules Computer Technology, Inc.	Dynamite 3D/GL 6218GL	$249	★★★★★	PCI	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Hercules Computer Technology, Inc.	Dynamite 3D/GL 7218GLA	$249	★★★★★	AGP	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Intergraph Computer Systems	Intense 3D Pro 2200S	$2387	★★★★	PCI	Intergraph	1280×1024	16/32	SDRAM
Jazz Multimedia, Inc.	Adrenaline Rush 3D	$199	★★★★	PCI	Alliance AT3D, 3Dfx Voodoo Rush	1152×864	6/6	EDO DRAM
Leadtek Research, Inc.	WinFast 3D L2520	$1199	★★★★	PCI	3DLabs Glint MX, Glint Delta	1152×870	25/25	VRAM, EDO DRAM
Leadtek Research, Inc.	WinFast 3D L2300	$169	★★★★★	AGP	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Matrox Graphics, Inc.	Matrox Millennium II	$269	★★★★	PCI	Matrox MGA-2164W	1600×1200	4 or 8/16	WRAM
Number Nine Visual Technology	Revolution 3D	$299	★★★	PCI	Number Nine "Ticket to Ride"	1280×1024	4 or 8/16	WRAM or SGRAM
Omnicomp Graphics Corp.	3Demon MX16/16	$1700	★★★★	PCI	3DLabs Glint MX, Glint Delta	1600×1200	16 or 32/48	VRAM, EDO DRAM
STB Systems, Inc.	Velocity 128	$199	★★★★	PCI	nVidia Riva 128	1600×1200	4/4	SGRAM
STB Systems, Inc.	Velocity 128	$199	★★★★	AGP	nVidia Riva 128	1600×1200	4/4	SGRAM
Symmetric (an STB company)	GLyder Max-2 GMA24A	$229	★★★★★	PCI	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Symmetric (an STB company)	GLyder Max-2 GMA24A	$229	★★★★★	AGP	3DLabs Permedia 2	1280×1024	8/8	SGRAM
Symmetric (an STB company)	GLyder MX GMX3A	$999	★★★★	PCI	3DLabs Glint MX, Glint Delta	1152×870	16/16	VRAM/DRAM

= BYTE Best

✔=yes; N/A=not applicable; INP=information not provided.

Warranty: P=parts; L=labor; F=freight to repair center; R=return to customer.

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

Supports DirectDraw	Supports Direct 3D	Supports OpenGL	Application drivers supported over 1024×768	Warranty	Toll-free phone	Phone	On-line address	HotBYTEs
Win 95, NT	Win 95	Win 95, NT	AutoCAD; Win 95, NT	3/P, L, R	800-444-5699	408-546-2100	http://www.accelgraphics.com	1074
Win 95, NT	Win 95	Win 95, NT	AutoCAD; Win 95, NT	3/P, L, R	800-444-5699	408-546-2100	http://www.accelgraphics.com	1075
Win 95	No	No	AutoCAD; Win 95	5/P	See Web site	905-882-2600 ext. 4	http://www.atitech.com	1076
Win 95	Win 95	Win NT	AutoCAD; Win 95, NT, 3.1; OS/2 Warp	5/P	See Web site	905-882-2600 ext. 4	http://www.atitech.com	1077
Win 95	Win 95	Win NT	AutoCAD; Win 95, NT, 3.1; OS/2 Warp	5/P	See Web site	905-882-2600 ext. 4	http://www.atitech.com	1078
Win 95	Win 95	Win 95, NT	Win 95, NT	3/P, L, R	See Web site	405-742-6655	http://www.soundblaster.com	1079
Win 95	Win 95, NT 4.0 (software only)	Win NT	AutoCAD; Win 95, NT	5/P, L, R	800-468-5846	408-325-7000	http://www.diamondmm.com	1080
Win 95, NT	No	Win 95, NT	AutoCAD; Win 95, NT	3/P, L, R	800-468-5846	408-325-7000	http://www.diamondmm.com	1081
Win 95, NT	Win 95, NT	Win 95, NT	AutoCAD; Win 95, NT	3/P, L, R	800-468-5846	408-325-7000	http://www.diamondmm.com	1082
Win 95, NT	Win 95	Win NT	AutoCAD; Win 95, NT; OS/2 Warp	5/P, L, R	800-272-3572	408-919-9100	http://www.elsa.com	1083
Win 95, NT	Win 95	Win NT	AutoCAD; Win 95, NT; OS/2 Warp	5/P, L, R	800-272-3572	408-919-9100	http://www.elsa.com	1084
Win 95, NT	Win 95	Win NT	AutoCAD; Win 95, NT; OS/2 Warp	5/P, L, R	800-272-3572	408-919-9100	http://www.elsa.com	1085
Win 95	Win 95	Win 95	Win 95, NT	5/P, L, R	800-532-0600	510-623-6030	http://www.hercules.com	1086
Win 95	Win 95	Win 95, NT	Win 95, NT	5/P, L, R	800-532-0600	510-623-6030	http://www.hercules.com	1087
No	No	Win NT	Win NT	3/P, 1/L	800-763-0242	205-730-5441	http://www.intergraph.com/ics	1088
Win 95	Win 95	Win 95	DOS; Win 95, NT, 3.1; OS/2 Warp; SCO Open Systems X Window	5/P, L, R	888-568-3676	See Web site	http://www.jazzmm.com	1089
Win 95	Win 95	Win 95	AutoCAD; Win 95	3/P, L, R	888-532-3835	510-490-8076	http://www.leadtek.com	1090
Win 95	Win 95	Win 95, NT	AutoCAD; Win 95, NT	3/P, L, R	888-532-3835	510-490-8076	http://www.leadtek.com	1091
Win 95	Win 95	Win NT	AutoCAD; Win 95, NT, 3.1; OS/2 Warp	3/P, L, R	800-361-1408	See Web site	http://www.matrox.com/mgaweb	1092
Win 95	Win 95	Win NT	Win 95, NT	INP	800-438-6463	781-674-0009	http://www.nine.com	1093
Win 95	Win 95	Win 95, NT	AutoCAD; Win 95, NT, 3.1	2/P, L, R	800-995-6664	713-464-2990	http://www.omnicomp.com	1094
Win 95, NT	Win 95, NT	Win 95, NT	Win 95, NT, 3.1	Life/P, L, R	888-234-8750	972-234-8750	http://www.stb.com	1095
Win 95, NT	Win 95, NT	Win 95, NT	Win 95, NT, 3.1	Life/P, L, R	888-234-8750	972-234-8750	http://www.stb.com	1096
Win 95, NT	Win 95	Win 95, NT	Win 95, NT	3/P, L, R	See Web site	972-931-5999	http://www.symmetric.com	1097
Win 95, NT	Win 95	Win 95, NT	Win 95, NT	3/P, L, R	See Web site	972-931-5999	http://www.symmetric.com	1098
Win 95, NT	Win 95	Win 95, NT	Win 95, NT	3/P, L, R	See Web site	972-931-5999	http://www.symmetric.com	1099

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Source Code: BW98

Multicast your data over IP waters and watch your bandwidth return manyfold. ***By Tom Shafron and Pete Loshin***

Multicast Offers Bandwidth Salvation

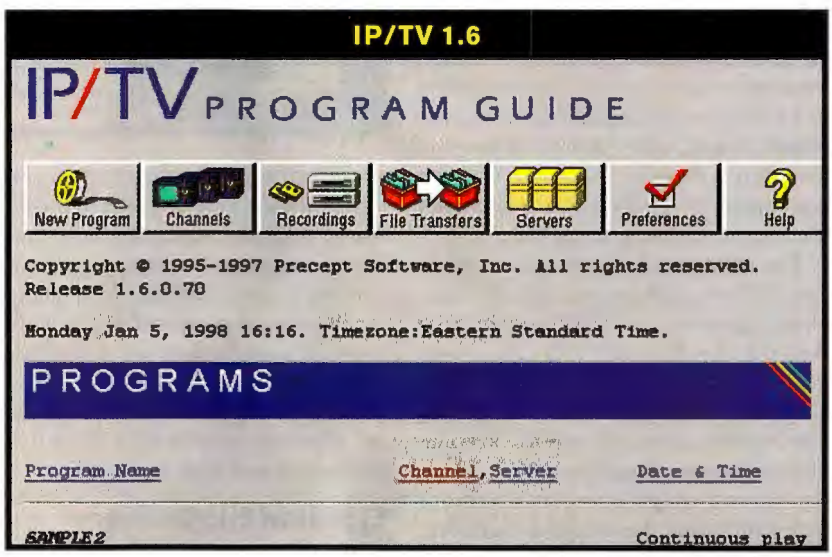
IP Multicast (see "Multicast to the Masses," June 1997 BYTE) offers network implementers a tool for curbing application-bandwidth piggishness. Although it's long been a part of the TCP/IP protocol suite (see the Tech Focus on page 124), it has also been hobbled by a catch-22: Network product vendors wouldn't always implement it correctly because there were no applications that required it, and application developers wouldn't build in support because users couldn't use it on their networks.

With the growing demand for bandwidth-hungry video and conferencing applications, things are now looking up for multicasting. IP Multicast offers the benefit of IP broadcasting—the ability to transmit data to lots of users in one fell swoop—without the disadvantages, which include the potential for monstrous network performance hits and the inability to cross IP routers.

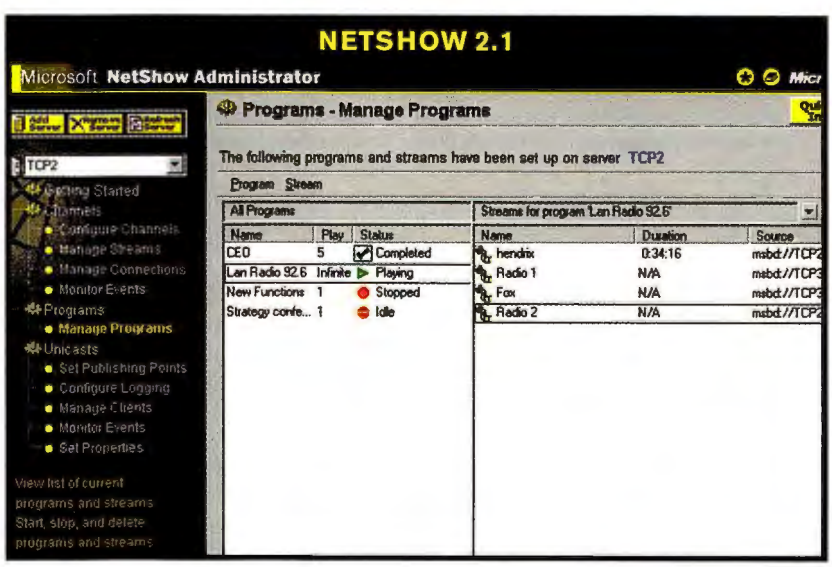
Any application that distributes lots of data can benefit from multicasting, but multicast-enabled products largely target the distribution of multimedia content, especially video. We looked at two products—Microsoft's NetShow 2.1 and Precept's IP/TV 1.6 suite—that offer video-content-publishing solutions. A third, StarBurst's Multicast 3.03, offers a heavy-duty solution for distributing meaty data files to lots of recipients without hacking away at the available bandwidth.

Let's Put On a NetShow

NetShow follows a Microsoft tradition: Build on what's available, make it yours, and make it less expensive. In this case, it's also free. To create NetShow, Microsoft bought all the code it could find, including codecs from Intel, Progressive Networks, VDONet, VIVO, and Voxware, and mixed them together with a splash of new Microsoft technology. This resulted in an effective content server, which is actually three separate servers: NetShow Server 2.0, NetShow Server with RealVideo, and NetShow Theater Server.



RATINGS	
TECHNOLOGY	★ ★ ★
IMPLEMENTATION	★ ★ ★



After using NetShow for a while, we got the feeling that these three products could have been integrated into a single, more effective content server. *continued*

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★

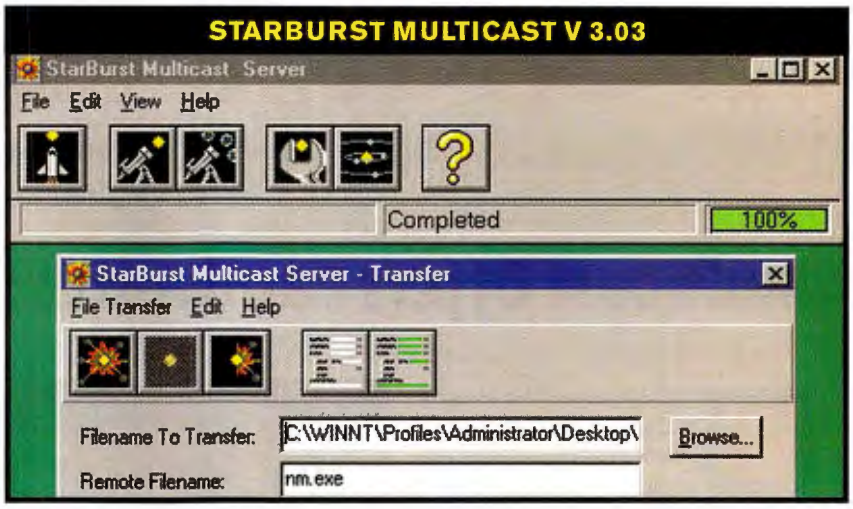
★★★★★ Outstanding ★★★★ Very Good ★★★ Good ★★ Fair ★ Poor

NetShow runs only on Windows NT 4.0 Server and can be administrated from any Windows 95/NT system. One computer serves as the administrator for all the NetShow Servers on a network, as long as they can be accessed via a machine name or IP address. This is useful when distributing content via multiple servers.

NetShow Server 2.0 handles most multicasting via channels, although RTP audio, as well as files, can be sent. Channels provide all the necessary data for a client to receive and decompress a streamed multicast. Channel streams are made up of either data received from the included real-time encoder or Active Streaming Format (ASF) files, which might contain audio, video, images, URLs, and/or scripts. For live events, the feed is sent directly from the encoder to the server, which eliminates the step of rendering an ASF file.

For a multicast to reach a client, every router between the server and the client must be multicast enabled, so NetShow Server 2.0 has the ability to distribute content to other NetShow servers via a unicast stream, from which point the stream can be multicast across a network. Using this technique, companies can, in effect, multicast through an extranet without worrying about the routers in between. Precept Software provides a similar capability with its IP/TV suite.

In sum, NetShow is another powerful package from Microsoft, but it has a somewhat thrown-together feel. Typical for Microsoft is the attempt to move the industry toward a new and proprietary standard for content (the ASF file) along with a high-value proposition (distributing NetShow for free). Dealing with a relative lack of integration is the price developers must pay for the opportunity to use NetShow as a development platform for more sophisticated multicast applications.



RATINGS

TECHNOLOGY	★ ★ ★
IMPLEMENTATION	★ ★ ★

Efficient File Delivery

Moving files from one system to another, which was once practically miraculous, now seems humdrum. StarBurst Communications makes file transfers interesting again for certain applications. Based on StarBurst's MFTP protocol, StarBurst Multicast 3.03 enables the "broadcast" of files from one source to any number of recipients without flooding intervening networks and systems with irrelevant traffic. MFTP reduces the time and bandwidth required to distribute files to many hosts.

MFTP relies on resource-hungry virtual circuits between the source and the destination to move data files. Each client makes a virtual circuit with the server, so even though file servers might handle 100 or more simultaneous sessions, each session gets only a fraction of the total bandwidth available. This causes problems when distributing a big file, such as a software upgrade or a price list, to many clients.

MFTP uses multicasting and UDP to effectively broadcast files to anyone who tunes in (or to only a predetermined group of recipients, if preferred). StarBurst Multicast servers send files to a multicast address once, and every system subscribed to that address receives the data. The protocol adds reliability—making sure that each recipient gets the whole file—by enabling recipients to report back to the server. After sending a file, MFTP provides a mechanism by which recipients negatively acknowledge (NAK) any part of the file they didn't get. The server resends those pieces that get NAKed and repeats the process until no one NAKs.

StarBurst Multicast was easy to install and simple to make work. However, the

Unicast, Broadcast, Multicast

IP defines three types of data transmission: unicast, broadcast, and multicast. Unicast, the direct transmission from one specific host to another, works well for reliable protocols, such as TCP.

Broadcasts originate from a particular host for reception by every other host on a network; once thought to be a good idea, the latest version of IP (IPv6) doesn't even support broadcasts. Every connected host on a network must process a broadcast, regardless of its relevance, which hurts the performance of individual systems. Furthermore, broadcasts work only on the local IP network because if routers forwarded them across an intranet or the Internet, the network would soon grind to a halt. Finally, broadcasts—which are easy to implement on Ethernets, where all hosts can sense a single transmission—chew through bandwidth on point-to-point networks. An example is ATM, where a special server retransmits the broadcast to every connected host.

Multicast uses a set of special addresses (see the Tech Focus on page 124) to which hosts listen for multicast packets. When a host sends a packet to a multicast address, all the hosts listening to that address get a copy of the packet. Thus, hundreds of hosts might receive a copy of a single packet sent by a server. This kind of setup works great on Ethernet LANs because any or all hosts on the LAN can listen to the multicast address, get the data being sent there, and keep the LAN traffic at a tolerable level.

Routing complicates matters, though, as routers must act on behalf of hosts listening to a particular multicast address when multicasts to the address occur outside the local network. The router becomes another host listening to the address, and other, more distant routers must also act on behalf of the local router to forward it copies of those multicasts. Despite routing issues, multicast more efficiently distributes data from one source to many, but not all, hosts in a network.

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package's GUI MFTP interface suffers from many of the same problems that early Windows-based FTP implementations had, including sometimes-unclear icons, a lack of drag-and-drop access to files, and a simplistic approach to GUI design. But according to StarBurst, most users bypass the relatively clunky GUI with scripts to automate their file transfers, or even to create their own UIs to handle, say, transfer-scheduling tasks.

Heavy-duty scalability (StarBurst claims to have simulated 50,000 clients in its labs) comes with a heavy-duty price tag, which starts at $40,000 for the server and 25 simultaneous client sessions. But if StarBurst Multicast has what it takes to get your job done, it's worth the price.

Precept IP/TV

Precept's IP/TV 1.6 suite includes IP/TV Program Guide, a program-administration tool accessed through a Web front end; IP/TV Video Server, a server that can multicast simultaneous video streams from canned AVI files or from live sources, including video cameras or videotape/disk players; and IP/TV Viewer, the client software that lets you select and view multicast video programs as well as manage your connections. The StreamWatch utility monitors live multicasts and provides tools for bandwidth control.

At first glance, IP/TV looks like another Windows-only product. The IP/TV Viewer and Video Server are available only for Windows 95/NT; the IP/TV Program Guide runs on either NT or Unix with a Microsoft, Netscape, or Apache Web server and provides access through any browser for administration. In fact, because IP/TV supports a full spectrum of standard video and multicast protocols, its components interoperate with any other platform that also supports standards such as the RTP protocol, which is used on the MBONE (the "multicast backbone" providing multicast services over the global Internet). This means that Macintosh users can access IP/TV programs with QuickTime TV and that any number of MBONE tools provide Unix accessibility.

The IP/TV Program Guide plays nicely with other multicasts, tracking MBONE or other RTP-compliant streams, listing them as programs, and pointing IP/TV Viewer users directly to their source. And the Viewer works not just with the IP/TV suite, but with MBONE and other RTP multicast streams. While the server interface is not always elegant, we installed Precept's complete IP/TV suite in less than an hour, with minimal help from the manuals.

While NetShow offers a good, solid foundation for building more-complicated video applications, IP/TV is a product that interoperates with non-Windows platforms and combines ease of use with sophisticated programming and scheduling features. For example, you can schedule programs for continuous play, use encryption and password authentication to protect your video streams, and even transmit application screens along with video for a simultaneous slide show with the SlideCast feature.

To Multicast or Not?

There might be only a few dozen multicast products commercially available right now, but the ranks are growing. The IP Multicast Initiative (IPMI), an industry group devoted to furthering IP Multicast, aids this growth. Its members include IBM, Microsoft, Netscape, Novell, Sun, 3Com, and many others.

The question is not whether you will use multicasting, but when. It will definitely be a part of your networked future. B

Tom Shafron is president of Polychrome Interactive, a New York new-media firm. Pete Loshin, a BYTE technical editor, is the author of Extranet Design and Implementation *(Sybex, 1997). They can be reached at* **ts@polyint.com** *and* **pete.loshin@byte.com**, *respectively.*

TECH FOCUS: ADDRESSING

Multicast Addressing

IP addresses fall into one of five categories. Classes A, B, and C refer to addresses within large, medium, and small networks, respectively; Class E addresses are reserved and currently undefined. Multicast, or Class D addresses, fall in the range from 224.0.0.0 to 239.255.255.255 and can be destination addresses only. No IP datagram can ever be originated from such an address; it can only be sent to it.

According to RFC 1112, which defines IP multicasting, the first address in the space, which is 224.0.0.0, is guaranteed to be unassigned; the next one, 224.0.0.1, is assigned permanently to all IP hosts and gateways with direct connection to the network. Furthermore, transmissions to multicast addresses from 224.0.0.0 through 224.0.0.255 are never forwarded by multicast-enabled routers.

The concept of multicast presupposes that hosts on the same link-layer medium (e.g., Ethernet) sense all network traffic and listen only to data addressed to them. Ethernet works this way; just as each host interface has a 6-byte media access control (MAC) address that becomes associated with the host's 4-byte IP address, there are also 6-byte Ethernet multicast addresses that can be associated with 4-byte IP multicast addresses. When routers forward multicast packets on an Ethernet network, they transmit to one of the Ethernet MAC addresses to which subscribers listen.

However, Ethernet is only one link-layer protocol. With the increasing popularity of point-to-point protocols, such as ATM, for IP networking an architecture must be created to allow connected hosts to use a server to mediate multicast reception. This mechanism uses a server that acts on behalf of connected hosts, registering multicast subscriptions by hosts on the network and relaying multicast transmissions directly to the subscribed hosts. Support for multicast over ATM relies on the Multicast Address Resolution Server (MARS), which is described in RFC 2022.

PRODUCT INFORMATION

IP/TV 1.6
$3995 for starter pack (includes 20 clients, server, guide, and streamwatch)
(Windows 95/NT for server; program guide on Unix/NT requires Web server)
Precept Software, Inc.
Palo Alto, CA
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fax: 650-845-5235
info@precept.com
http://www.precept.com
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NetShow 2.1
free
(Windows NT)
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Redmond, WA
425-882-8080
http://www.microsoft.com
Enter HotBYTEs No. 1064.

StarBurst Multicast 3.03
starts at $40,000 for server and 25 simultaneous clients
(Windows NT or Unix for servers [clients on Win32])
StarBurst Communications Corp.
Concord, MA
800-585-3889
978-287-5560
fax: 978-287-5561
info@starburstcom.com
http://www.starburstcom.com
Enter HotBYTEs No. 1065.

at http:www.byte.com/hotbytes/

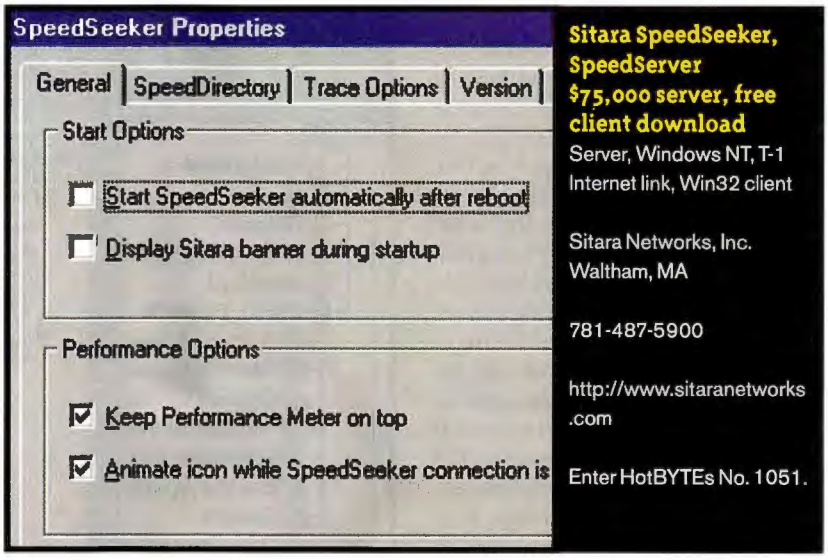
Sitara rewrites TCP to optimize Web transfers, offering ISPs a way to add value for a price. ***By Pete Loshin***

If You Build It, Will They Come?

The Internet world of open standards can sometimes be hard on software vendors. Wait patiently for finalization of the latest and greatest specification and you still have to slug it out with competitors who offer products that are essentially identical to yours. Vendors willing to gamble can score big if they sidestep the standards process by creating their own, as with Sun's Java, and hope the rest of the industry tags along for the ride.

Sitara Networks scrutinized the Transport Control Protocol (the TCP in TCP/IP) and decided there's a better way to deliver Web content. SpeedServer, Sitara's server product, and its client SpeedSeeker, incorporate a modified transport protocol that fixes some of TCP's more glaring performance problems (see the Tech Focus). Sitara, wagering that it can download Web content as much as three times faster than with traditional TCP—without adding bandwidth or using caches—hopes to win over Web publishers despite a proprietary solution and a high price.

The SpeedSeeker client, a free download, adds Sitara's new transport protocol to your system's network stack. The beta I tested, which includes Winsock 2.0, weighs in at around 2 MB, though the shipping version is expected to slim down to 850 KB. Publishers pay $75,000 for SpeedServer to operate between the Web server and clients and interface between the new transport protocol and HTTP.



Sitara's SpeedSeeker client software can supercharge downloads from enabled Web sites, but its interface is overly intrusive.

The server wasn't ready for review, so I tested with Sitara's SpeedServer-enabled Web site. Client installation (currently Windows 95 or NT only, with Netscape 3.x or 4.x and IE 3.x) was uncomplicated but intrusive. SpeedSeeker by default adds itself to the Windows taskbar and autostarts itself on boot-up (complete with an annoying splashscreen), but the user can modify that. Sitara needs to lower SpeedSeeker's profile even further to make it palatable to casual Web surfers.

Verifying Sitara's claims of up to three times faster downloads proved difficult due to what the company said were server problems. Results varied from as much as three times faster to as much as three times slower with SpeedSeeker. Once Sitara shakes the bugs out of the system, it should actually provide real value.

Should you try SpeedServer? The answer depends on several factors: how well the standards bodies fix HTTP, how many publishers and users take the Sitara plunge, and how much customers will pay for improved performance. The most important factor may be how many software vendors (particularly OS and browser vendors) incorporate Sitara's transport into products. By the end of the year we should know whether Sitara is insanely great or just another skid mark on the information superhighway. B

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★

TECH FOCUS

Doing a Job on TCP

TCP's performance with HTTP is hobbled by the way it ensures reliability. Hosts acknowledge (ACK) receipt of all TCP frames (which may be fragmented into several IP packets) by telling the sender the number of the last byte of data received. Any time a packet is dropped, all data since the last ACK is resent—even though most of that data might have already been received once. Sitara's transport protocol resends only the bytes that were missed.

Pete Loshin, BYTE technical editor for software reviews, wrote Personal Encryption Clearly Explained *(AP Professional, 1998). You can reach him at* **pete@loshin.com**.

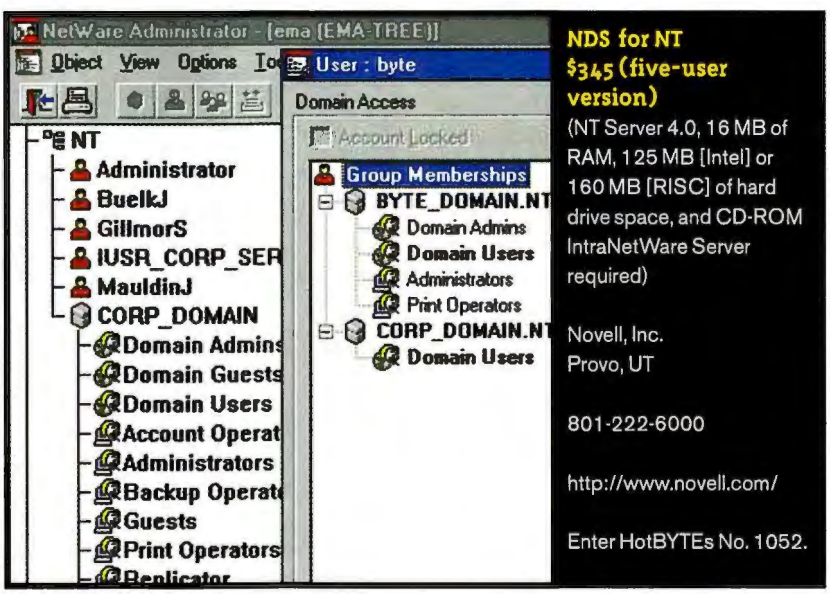
Novell goes for Microsoft's Active Directory jugular with an open solution to a big problem. By Steve Gillmor

Novell's New Directory Direction

With the active universe holding its breath waiting for Microsoft's NT 5.0 and its Active Directory, Novell's Directory Services (NDS) for NT seizes the day by cleverly extending and embracing NetWare's flexible directory services for use within existing NT networks. Simple and seamless, NDS for NT helps reduce busy network administrators' work loads. The initial release requires a NetWare server, but an NT-hosted version will follow.

When you replace a DLL on your primary and backup NT domain-controller servers, NDS for NT seamlessly diverts all NT domain changes to and from itself for a single point of directory administration.

NDS for NT migrates through Windows NT domains with a two-stage installation process. The auto-loading CD installs IntraNetWare Client for Windows NT, reboots the server to load the client, and then launches the Domain Object Wizard. This Wizard moves existing NT domain users into the NDS tree, replaces the DLL that NT uses to query its Security Accounts Manager (SAM) database, and reboots once again to load the new NDS for NT redirector.



You use Novell's NWAdmin and the NDS for NT snap-in to manage user access to multiple domains through simple group memberships.

With the original NT domain's information stored in an NDS distributed database, NDS captures all the calls originally destined for NT's SAM database. You can continue to manage your domain through native NT utilities, but you'll want to install Novell's NWAdmin and the NDS for NT snap-in to take advantage of combined NT/NDS administration. I created and managed users, groups, login restrictions, and passwords for IntraNetWare and NT resources alike.

Where NT administrators must add complex trust relationships to provide cross-domain access to their users, NDS for NT allows you to grant rights on a per-user basis. Moving a user from one domain to another no longer requires deleting and re-creating the account. Even better, you can provide access to multiple NT domains by adding users to an NDS domain object's group membership.

NDS for NT doesn't lack for compromises. For example, should an NT Service Pack overwrite the Novell-modified SAMSRV.DLL, NDS for NT reapplies the Novell version and eliminates any bug fixes in the Service Pack. Also, the extra round-trips to a NetWare server for login authentication increase network traffic, although this is offset somewhat by the lack of replication between NT's primary and backup domain controllers.

RATINGS	
TECHNOLOGY	★ ★ ★ ★
IMPLEMENTATION	★ ★ ★ ★

At $69 per user, NDS for NT deserves attention. It lets corporations continue to support NT utilities and adopt NDS strengths without costly retraining. B

Steve Gillmor is a consultant for Southern Digital, Inc. (Charleston, SC). You can reach him at **sgillmor@southerndigital.com.**

TECH FOCUS

Dealing with NT Domains

Windows NT denominates users by a security identifier (SID) for the NT domain plus a relative identifier (RID) for the user within that domain. NT grants access to resources based on the SID/RID pair, and NT resources migrating to NDS for NT retain their SIDs. NDS for NT generates a RID for each domain that an NT user belongs to and stores it under NDS's domain object. When the user logs in, NDS supplies the associated SID to authenticate the user. Administrators can manage multiple NT user instances as a single NDS user object.

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

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HLIW8SPA

Microsoft restores Mac/Windows file compatibility with the latest rev of Office for the Macintosh. By G. Armour Van Horn

OfficeMac: Worth Revisiting in 98

For a long time, Microsoft Word and Office were the essential cross-platform applications for workgroups that use both Wintel and Macintosh machines. Office 97 for Windows, with its incompatible file formats, ended the cooperation and left the Macintosh community waiting and wondering. After using a beta of Office 98 for the Mac, I'd say the wait was worthwhile.

Office 98 includes Word, Excel, PowerPoint, and Outlook Express, but not Access. Once again, the programs share file formats, and import and export filters are available on Microsoft's Web site. Microsoft has researched Mac users' needs, and the menus shouldn't upset the Macintosh faithful. Toolbars can be moved to any screen edge or configured as floating palettes.

Office 98 requires a PowerPC. I tested it under both System 7.6 and Mac OS 8. To be certain the code runs acceptably, the developers are benchmarking every build on the oldest and slowest Power Macintosh, the 6100/60.

There's a custom installer (plus an uninstaller), but you can also just drag a single folder from the CD to the hard drive. On first launch the program copies needed files to the System Folder. If any of those files are later damaged, Office replaces them on the fly.

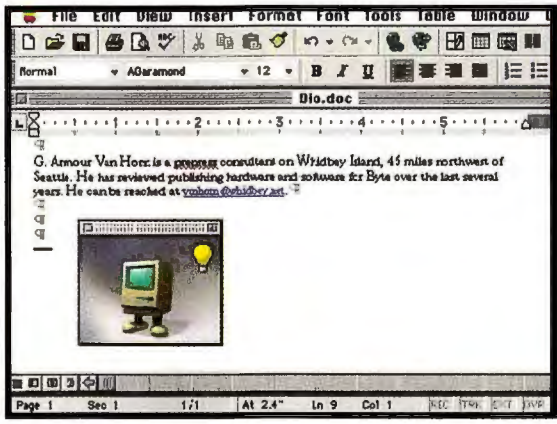
Few Office users know all that the programs can do. The Office Assistant and IntelliSense technology help by watching the user's actions and making suggestions. The Office Assistant gave me tips I would not have thought of by myself.

Several users can work collaboratively on a document, and Word preserves all versions, identifying each user's edits and providing a range of tools for combining revisions. Excel goes further, supporting shared workbooks so multiple users can open a single file; other users don't see updates immediately, but you can control the timing of saves.

Each Office application lets you "Save As HTML" and supports hyperlinks to other documents, document locations, or Internet URLs. Word can create, open, and edit HTML files; it won't replace dedicated HTML authoring tools, but it lets you prototype pages quickly.

The grammar checker, which operates during idle time, is the first I've seen that is consistently worth consulting. It identified my most frequent errors without flagging every sentence. Excel extends this to autocorrection of formulas.

Office 98 applications are large, but clever caching lets each start quickly. Word presents a quick WYSIWYG font menu, a pleasant departure from the previous version. In the early beta I tested, the product never seemed sluggish; it seemed to perform on par with the Windows version, Office 97. Loading HTML files was equally slow on both platforms. This new Mac release clearly matches the Windows version's functionality and restores the cross-platform operation we had with Mac Office 4.2.1 and Office 95. Those who held off moving to Office 97 to protect Macintosh compatibility can now move forward. B



Office 98 for the Macintosh
$499
(upgrade, $299)
(Power Mac)

Microsoft
Redmond, WA

425-882-8080
fax: 425-936-7329

http://www.microsoft.com/

Enter HotBYTEs No. 1062.

Word 98's UI is a Windows and Mac hybrid. Note the red-underlined dubious spelling and the automatically recognized Internet address.

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

TECH FOCUS

Installation and File Repair

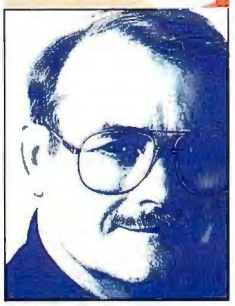
In the past, a program installer loaded specific files into specific places. Renaming a hard drive could break these links, as could a single corrupted file. When an Office 98 application is launched on the Mac, however, it scans the system for needed resources, and if it doesn't find them, it reinstalls them. The installation process, essentially, places an "installation toolkit" on the hard drive so that anything needed is always available. A full Office installation thus weighs in at over 100 MB, but reduced support costs readily justify this.

G. Armour Van Horn is a graphic arts consultant on Whidbey Island, northwest of Seattle. You can reach him at **vanhorn@whidbey.net.**

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

Jerry Pournelle

Chaos Manor



Doing Something About Microsoft

Jerry wants to leave the definition of "operating system" to Microsoft—but there's a catch.

Local and national papers are full of sound and fury denouncing Microsoft, but what it all signifies is a horse of another color. Unfortunately, it is very difficult to talk about Microsoft without triggering religious wars; but I don't think it can be avoided. There's too much pressure on government to "do something" about Microsoft, and that will affect all of us. Since whatever is done will be done on our behalf, it's important that we give this some thought and, with luck, come to some conclusions.

Start with my assumptions. They may not be yours, but think about them.

First, the industry has done pretty well without a lot of government intervention, and most government intervention in the computer business has done little good and much harm. This is hardly surprising given that most Congresscritters still don't know about e-mail.

Do you recall when the government poked around in the memory business? They ended up encouraging a cartel to charge us all higher prices for memory. Those were the days when clone makers competed by adding features to their systems. One feature was more memory. Higher memory prices helped keep computer prices up, aiding the big companies like IBM and hindering start-ups.

Fortunately, the government's effect was pretty short-lived. So far, Moore's law has guaranteed that computer capabilities have doubled every 18 months, and not even the FTC can do much about that, much as some of the old established outfits like the telephone companies wish they would.

Then there's the FCC, which insists that you meet its silly certifications for radio emissions, forcing us to have computer cases that seal up tight with stupid slots and grooves and slot covers. I say silly, because many of us run our machines with the covers off; but airplanes don't fall from the sky, and most of us don't even notice radio and television interference. If anyone has been arrested for running a machine without the cover on, I haven't heard about it.

The actual effect of the FCC regulations (besides providing jobs to regulators) is to make it much harder to enter the computer component business. Before you can sell anything, you must pay lots of upfront money to get FCC certification. This is good for the big established companies but hard on start-ups.

The industry has done pretty well without a lot of government intervention.

Adam Smith said that the worst enemy of capitalism is a successful capitalist, and the preferred method of capitalists who no longer love capitalism is to get the government to raise barriers to entry. Thus, my first assumption: we do not lightly invite the government into our industry. It's a lot easier to get the feds in our tent than to get them out again.

Second assumption: sometimes you have to invite the government in. David McCord Wright, one of my favorite economists, used to say that one reason Marx's analysis of the future of capitalism—more and more wealth concentrated in fewer and fewer hands—failed was the American antitrust actions. One need not be a big fan of government regulation to believe that monopolies are dangerous, and the government has both the right and duty to ensure competition. There's room for disagreement on just what constitutes a dangerous monopoly, but I think there's a wide consensus that sometimes there's a real need for trust-busting.

That doesn't mean you should lightly interfere with a successful company. Judge Learned Hand once said that having told a company to compete, we must not punish the company for successfully doing so.

Breaking up a successful company—say Microsoft, into Operating System and Applications companies—is not easy, involves massive confiscation of capital gains, and often leaves government watchdogs yapping at the heels of all the different branches. Witness Judge Green and the continuous involvement of the government in the affairs of the companies that used to be AT&T. You may have to resort to trust-busting, but it should be a last resort.

Third assumption: Microsoft's market share in the small computer world is getting up into the monopoly region. There's room for disagreement over whether it's at a critical point or not, but near universal agreement that any company with Microsoft's power in the OS field should not take unfair advantages in writing and marketing application programs.

In particular, Microsoft ought not use their dominance in the OS market to make it impossible for other companies to compete with Microsoft application programs. I've found there's surprisingly

little disagreement with that position.

If we can agree on those three assumptions, I have a proposition for the computer community. We ask the Department of Justice to lay off Microsoft. In return, Microsoft agrees to fully document all API calls in all OSes it actively sells. In particular, if any Microsoft application designer uses or seriously contemplates using an undocumented feature or call, that fact will instantly be published (on the Web). As soon as possible thereafter, that feature or call will be publicly documented; and all Microsoft programmers will be instructed to implement this.

Note that this isn't all that onerous for Microsoft: if they're going to *use* those calls, it's much to their own advantage that they be properly documented. By making sure that their application programmers understand this requirement, they help their technical-support and interface people.

On the other hand, it levels the playing field for application designers, something Microsoft have always said they want to do anyway. Realistically, competing with Microsoft is always going to be a tough proposition, but it shouldn't be made impossible by giving them a head start on using undocumented features of the OS.

Another advantage of my scheme is that it leaves the definition of OS to Microsoft. One of Microsoft's contentions is that they have every right to improve the OS by adding new features, and doing that can't be in violation of the rather loosely worded consent decree they signed the last time the feds paid them a lot of attention.

Microsoft has a long history of integrating new functions into the OS.

The consent decree says that Microsoft can't require a computer maker or reseller to buy an application as a condition of getting the OS. This sounds clear enough until you think about it; but can they require you to include Internet Explorer 4, which is free?

Microsoft has a long history of integrating new functions into the OS, and I for one am glad of it. It was hard lines for Novell and Artisoft when Microsoft incorporated peer-to-peer networking into all the shipping versions of Windows, but it certainly was a good thing for me.

Now what if Microsoft claims that proper integration into the Internet requires a browser—Internet Explorer 4, again—to be an integral part of the OS? Some say that's a reasonable thing to claim; others say that browsers are definitely applications and in no way belong in the OS.

My proposal would take care of that. If Microsoft insists that an application is part of the OS (and thus must be shipped with the OS whether the computer vendor wants to or not), it will have to be documented like the OS: file formats, hooks, calls, features, DLL hooks, the whole ball of wax must be published. (And here's an interesting wrinkle: at press time, Netscape announced plans to make their browser source code public, beginning with the first Communicator 5.0 developer release.)

I'll leave the details to people more technically competent than me; but it does seem to me this is one way to get the lawyers and the government and, worse yet, the government lawyers out of our business, so that the resources they absorb can go into making computers faster and better and cheaper. If you like my idea, let Microsoft know. Now back to computing at Chaos Manor.

This month's tale of hope and glory started when I came back from a series of trips and turned on my computers. Princess, my Compaq Professional Workstation 5000 with dual 200-MHz Pentium Pro processors, came up all right, but when I tried to access the Internet, she reported that she didn't have a modem.

I'm not used to problems with Princess. She runs Windows NT 4.0, and, except for trips, she's never turned off. She does all my communications and most of my calculations, serves as the master control station for my networked computers, designs my Web pages, stores my digital pictures, and in general has become indispensable.

At this point, I did a foolish thing: I forgot Pournelle's laws, one of which states that if you have a computer problem, check the cables first. I didn't do that. Instead, I went mucking about in the software trying to see what was going on.

I thought I hadn't changed anything, but

apparently I did. When I did come to my senses and checked cables, I discovered that while I was gone, the housekeeper triumphantly used the opportunity to get behind all my systems and thoroughly clean my office. In doing that, she managed to knock loose the cable that connects my U.S. Robotics 56-Kbps Sportster external modem to the serial cable port. Evidently, I hadn't screwed it in properly.

Both of Princess's serial ports are in use. One goes to the Sportster modem; the other goes to the Wacom ArtZ II drawing pad that serves as both an art input device and a mouse pad (both the mouse and the ArtZ II are connected; they don't fight unless you foolishly leave the Wacom pen on the pad and then try to control things with the mouse). I found the modem cable, reconnected it, tried the modem without success, and rebooted into NT.

NT is very good about reporting problems. "One or more processes did not start properly. Check the event log for details." The event log told me the modem software wasn't initializing properly; also that the serial ports were claiming overlapping I/O port numbers. I mucked about for an hour or so. At the end of that time, I was no better off than when I started.

Time to think. First thing: reboot Princess into Windows 95. Aha! Both the modem and the ArtZ II pad are working properly. There's no hardware problem. NT is just confused. Piece of cake. Only, of course, it wasn't: rebooting into NT left me where I'd been the last time, a conflict of serial ports and no modem.

Time to be systematic. First, remove the modem drivers and fool Princess into thinking she didn't have a modem. Next, reboot into Windows 95, see that both devices are working properly, go into System Manager, and record precisely which interrupt request (IRQ) and port number each wants. Then boot up in NT, reinstall the modem and pen devices, and manually force each into the values reported by Windows 95.

Reboot again.

Voilà. After working for what seemed like all day, I was back where I'd expected to be just after I turned Princess on.

Then I changed monitors on Fireball, and his Ethernet and sound cards both died. Fixing that one required physically removing those devices and reinstalling.

The moral of this story is that Plug and Play is not ready for prime time. Before shutting down any working computer,

make a rescue disk copy of all system software. Be prepared to use that disk. You have been warned.

Last month I told you about FreeSpace, from Mijenix. Since then, I've learned a bit more. FreeSpace is a selective file and folder compression program: you can use it on some files and not others. My recommendation is that until you're quite comfortable with it, don't use it on files you simply can't stand to lose.

If you are building a Pentium II system using the LX chip set, be extremely cautious.

It's a small memory-resident program that decompresses files on the fly. It does this so well that you don't really notice that it's there. Select and view those files with, say, Norton Commander for Windows 95 or Commander and QuickView, and you won't have any inkling that they're any different from any other files. You can edit them and run them if they happen to be programs; it won't matter.

I confess some residual doubts about the safety of compression programs. However, having said that, I've been running FreeSpace for six weeks now, and aside from having more disk space, I don't notice that it's there. I wouldn't recommend using it in systems with less than 32 MB, but then I don't recommend running Windows 95 with less memory than that anyway, and 64 MB is better.

FreeSpace is the second product from Mijenix; their flagship program is Zip Magic. Most of you know that I have long been a fan of WinZip; now it looks as if I'll be a convert to Zip Magic (hereafter referred to as ZM). ZM installs painlessly, with no need to reboot. When it's done, your ZIP files are transparent. Look at them with Explorer, and you'll see their constituent files. You can load, edit, execute, as if they weren't zipped at all.

Now true, you can do much of this with Norton Commander and WinZip. For that matter, Canyon Software's Drag and Zip utility has many useful features similar to ZM; but ZM, being memory-resident, makes it all even more transparent.

Moreover, it works with other compression formats, including the CAB format Microsoft uses for Windows components. If you double-click on a CAB file in Explorer, you'll see everything that's in it. If you need to restore a corrupted file, you can copy it, saving a lot of time over reinstallation. All told, ZM sets a new standard for archive management software.

The ZM manual says it requires 8 MB of memory. This is fine if it refers to running in Windows 3.1, but anyone running Windows 95 in 8 MB of memory is probably doomed to mysterious events, including crashes, even without adding a memory-resident program, however small. Of course, memory is cheap, and with 32 or more MB you won't have any problems, even with both ZM and FreeSpace installed; or at least I haven't.

Due to sloth (and that WinZip is pretty good) I came late to ZM, not trying it until I'd had experience with FreeSpace; but I have had no problems with ZM, and the few I've heard about from other users haven't amounted to much. Like FreeSpace, this seems to work like magic, and it won't take you long to forget it's there, even when you're using it. Mijenix seems to have a really good understanding of the way Windows 95 works.

Just be sure you have enough memory—but you should do that anyway. The real secret to painless working with Microsoft products (including plug-ins to Windows 95) is to have lots of memory. Fortunately, that's fairly easy to do now.

And having said that, let me add a caution. It used to be that memory was memory; so long as it met the timing specifications, it would work, especially if you bought from a brand name such as Kingston. No longer. Larry Aldridge of PC Power & Cooling warns that if you are building a Pentium II system using the LX chip set, be extremely cautious. Find out from your motherboard manufacturer precisely what make and model of memory-chip boards are known to work with that particular motherboard, and get that memory and no other. Note that memory that works with Intel motherboards very likely won't work with Hewlett-Packard boards, and vice versa.

Worse, the failure modes are intermittent and generally not repeatable. You may—probably will—get mysterious lockups and crashes and generally weird behavior, even with memory that seems to meet or exceed the SPD and JEDEC standards, if it's not the exact memory specified by the board manufacturer. If that's all Greek to you, don't worry about it. Just be very careful to get memory that has been tested and recommended by the motherboard maker.

If you're building a Pentium II system, you will also need an OS patch that will let it recognize the added controllers present in LX systems. As an example, without that patch, the system won't know about the universal serial bus (USB) and will often exhibit bizarre operating characteristics. The patch is usually supplied on a floppy disk by the motherboard maker; be sure to get and use it.

We're about to build a Pentium II system here at Chaos Manor. I'll have more to say on this after we've done it. If you get one running first, let me know what happened.

If you use NT, you need Diskeeper 3.0. It's the only disk defragmenter for NT that I currently recommend. Diskeeper installs simply and quickly, runs in the background, can be scheduled to run daily, and appears to be utterly safe. Clearly, I have no way to guarantee the safe part; but I have been using it for more than a year on my big server as well as on all my NT workstations, Alex has it going for most of his clients, and we have had no problems whatever, nor have I any reader reports of problems.

Disk defragmenters aren't very romantic, but they are necessary. Disk fragmentation can not only slow things down, but actually cost you disk space.

Diskeeper 3.0 is for NT only (there is a version 7.1 for VMS). As I have previously reported, for DOS and Windows 95, I like Golden Bow Systems' Vopt. There are probably other reliable defrag programs out there, but these are the ones I use, and they're good enough. Recommended.

The U.S. has more lawyers than the rest of the world. I don't have to join the ranks of the "Let's kill all the lawyers" crowd to think there may be a few of them interested in drumming up business. It's interesting that the vast increase in supply hasn't produced a corresponding fall in prices; if that reminds you of the Adam Smith quote I gave earlier, perhaps it should. In any event, it has long been in the interest of most members of the legal profession to restrict access to legal information not mediated by lawyers.

Of course, there are a few rebels. You

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Their latest is Small Business Legal Pro 3, a CD-ROM containing six legal books on small business activities, from tax law to marketing to using small-claims court. I'm not advising small business start-ups to do without legal advice, but I'm quite certain you can use these books as a good start. The best way to save money on legal fees is to have your case organized as well as you can before you start paying for billable hours; this CD is nearly certain to save you far more than it costs. Recommended, and while you're at it, get Nolo's catalog and get on their mailing list. It's worth it for the lawyer jokes alone.

I am still playing last month's runner-up game of the month, Interplay's Fallout, a post-atomic war role-playing game. I have to say it hooked me: my character is now powerful enough to not be in much danger, but I have acquired a nonplayer character dog. I seem to have made it a major goal to get through the game without letting the dog get killed, which isn't easy since he loyally attacks anything that menaces me.

When I wrote about this last month, I railed against DOS games now that Windows 95 exists. In fact, Fallout is a Windows 95 game that has a way of running on DOS machines. It runs right out of the box in Windows 95; right now, it is my choice of role-playing game of the year.

The game of the month is The Great Battles of Alexander, from Interactive Magic, the best classical era war game I've ever come across. It has all the look and feel of a good miniatures game, as well it should, since it's adapted from tabletop gaming rules.

In classical era warfare, the casualty counts were extremely one-sided, because the actual battles were rather short—hand-to-hand combat in bronze armor is tiring—and usually ended when one side broke and ran. Most casualties were then taken by the loser in the pursuit. (It's an old military maxim: battles are won in the battle line, but victories are won in the pursuit.)

Miniatures war games have very complex formulas for determining the outcome of battles through morale checks. Morale-check factors include such things as can you see enemies fleeing or friendly troops routed, are you in communication with your leader, etc., as well as how many losses the outfit has taken. All this tends to slow things down, so that tabletop games often consist of 10 minutes of movement and 40 minutes of calculations.

The Great Battles of Alexander keeps the complex calculations, but they're all done very rapidly behind the scenes; what you see is the clash of spears and push of pikes, and then the results: casualties (your formation gets smaller), and one side (rarely both) may break and run. The game is simple enough to play, but winning is none so easy: Alexander has better troops than his enemies, but usually fewer of them, and you can't afford to make many mistakes. If you like classical era war, you will love this.

Once you go to a 21-inch screen, you will never be satisfied with anything smaller.

The computer book of the month is the "Special Edition" series of Que's *Using* books. The one I have in mind is *Using Java* by Joseph Weber (ISBN 0-789709-368), but all of them are good. Books in the *Using* series tend to be rushed out at the same time as the products. While they're often quite good, I tend to find *Learn X in 21 Days* titles better organized for first looks. Later, though, when you need explanations and some of the professional-level details, the Special Edition *Using* books pull ahead; or so I find. Anyway, Special Edition *Using Java* is useful as a reference and a learning guide, with many examples.

The book of the month is by Chaim Herzog and Mordechai Gichon, *Battles of the Bible* (Greenhill Books, ISBN 1-85367-266-1), a 1997 reissue of an 1978 book. Herzog is a former Israeli general who made use of his Biblical knowledge in the Arab/Israeli Wars: the strategic terrain has not changed much in 2500 years. The book traces all the known Biblical battles, including some previously thought to be legendary, shows the terrain, and examines what may have happened. It's fascinating reading. One caution: there are some good detail maps, but there's no good strategic map. If you get this book, you may want a good Old Testament atlas.

Chaos Manor is filling up, mostly with excellent software and equipment. Prominent among new arrivals is a 21-inch Eizo monitor; you may or may not know that Nanao is the parent company of Eizo. For a long time, my 15-inch Nanao was the best monitor in the house. Then I switched to 21-inch ViewSonic monitors, a move I have never regretted. Now, Nanao/Eizo is doing a great job of winning me back. I'll do some more tests, but to me the bottom line is, if you mostly do text and line drawing (e.g., CAD), you'll find ViewSonic more than good enough; but if you need really great color fidelity, you may want to spend the extra bucks on Nanao/Eizo. Either way, once you go to a 21-inch screen, you will never be satisfied with anything smaller. Trust me.

Next month, the Chaos Manor Users Choice awards and the annual Orchids and Onions parade. Stay well. B

PRODUCT INFORMATION

Diskeeper 3.0
Server $399
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Executive Software
Glendale, CA
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818-547-2050
fax: 818-545-9241
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The Great Battles of Alexander $39.95
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Jerry Pournelle is a science fiction writer and BYTE's senior contributing editor. You can write to Jerry c/o BYTE, 29 Hartwell Ave., Lexington, MA 02173. Please include a self-addressed, stamped envelope and put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can contact him on the Internet or BIX at **jerryp@bix.com**. *Visit Chaos Manor at* **http://home.earthlink.net/~jerryp/**.

MARCH 1998, VOL. 23, NO.3

BYTE

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Essential Products and Services for Technology Experts

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Top mail-order vendors offer the latest hardware and software products at the best prices. Page 136

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Your full-color guide to in-demand hardware and software products, categorized for quick access. Page 144

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View of the circuit board

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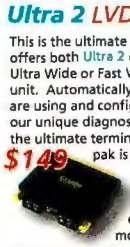

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- Triple Shielding (Unique Design)
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From: $39

Teflon® 90 Ohm External Cables

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Features:
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- Bay Coolers w / Brackets
- Temperature Alarm System
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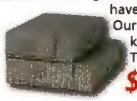

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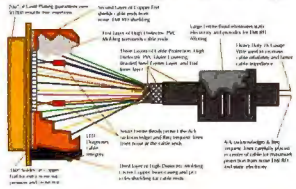

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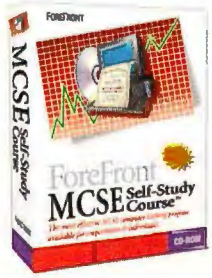

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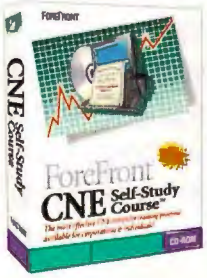

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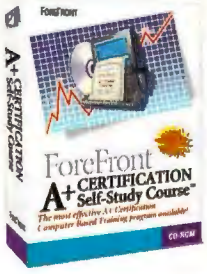

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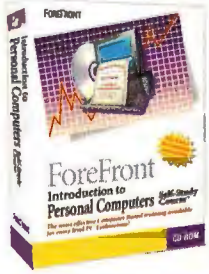

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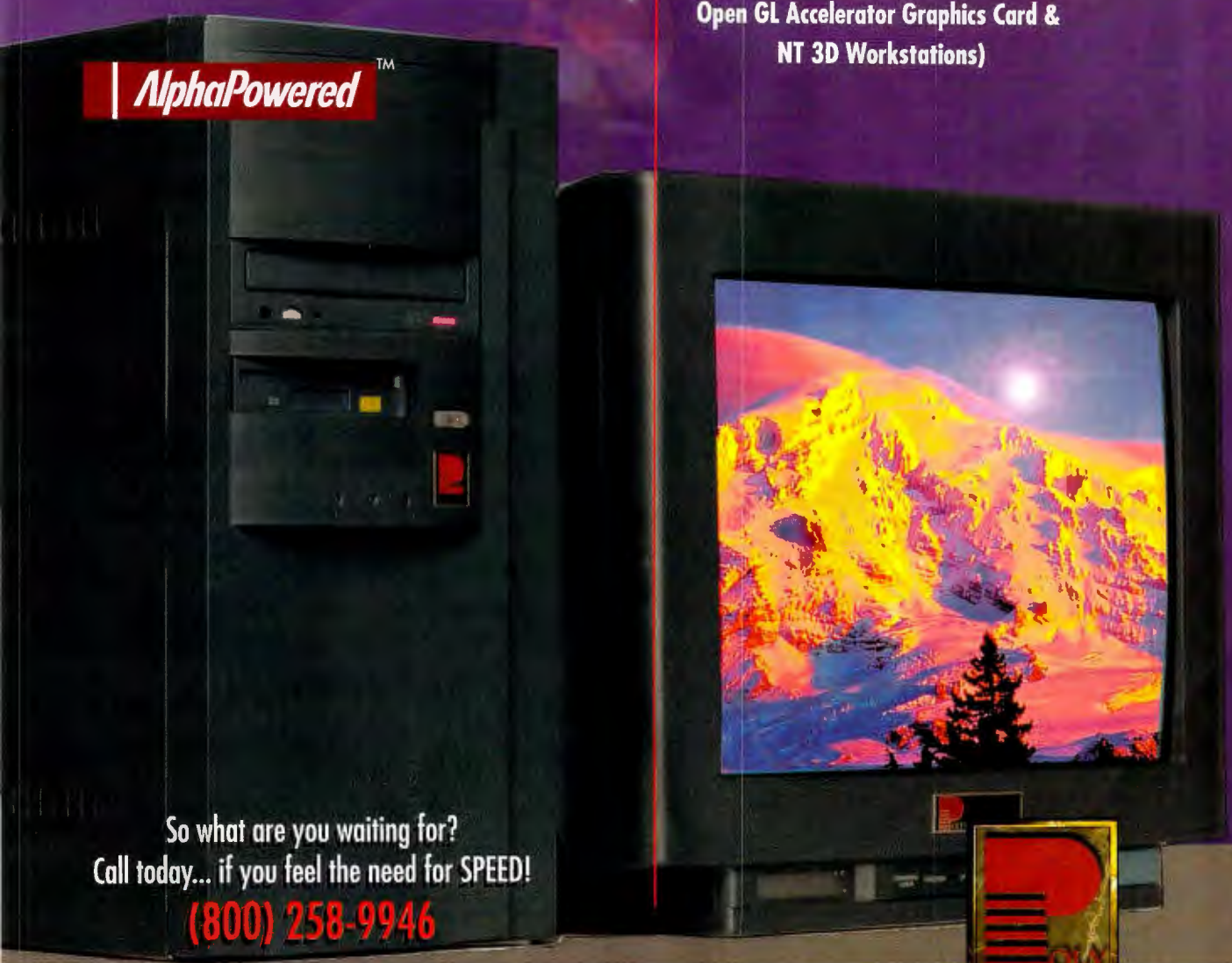

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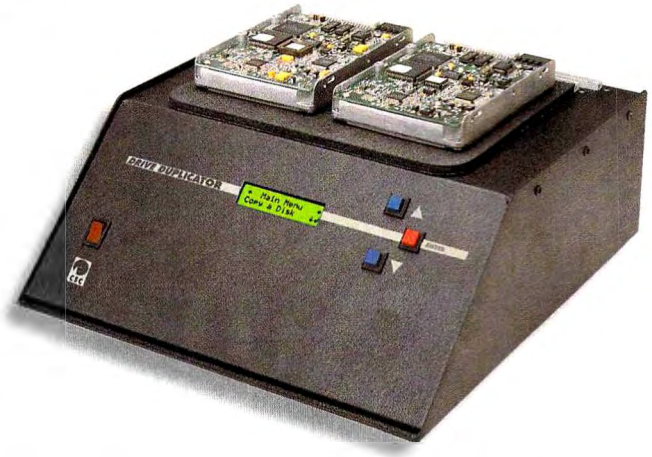

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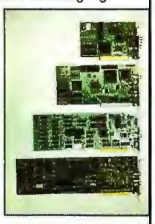

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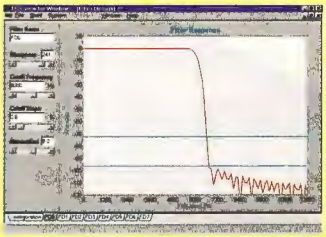

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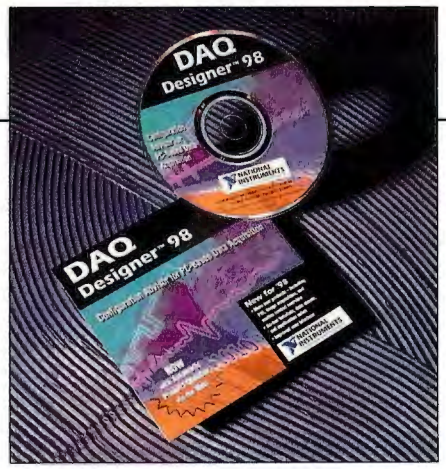

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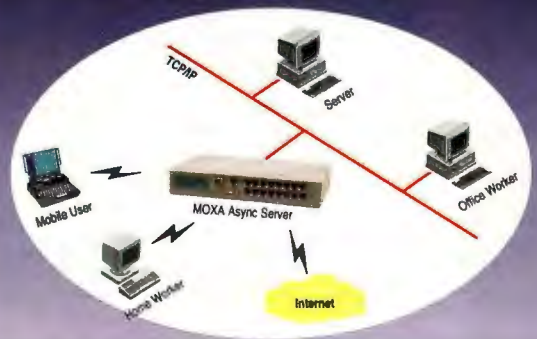

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120	SPOT TECHNOLOGY	86	+886-3-587-8966
110	STATSOFT	21	918-749-1119
	T		
90	TERN INC	148	530-758-0180
131	TRI-MAP INTERNATIONAL INC	138	510-447-2030
	V		
152	VECCOM CO LTD (IS)	40IS 6	+886-3-451-5217
94	VIOEX INC	145	541-758-0521
111	VIEWSONIC	67	800-888-8583 AGENT81109
	W		
114	WIBU SYSTEMS AG (IS)	78	+49-721-93172-22**
114	WIBU SYSTEMS AG (N.A.)	78	800-986-6578
113	WINBOOK COMPUTER CORPORATION (N.A.)	11	800-764-7285
	Z		
86	Z-WORLD ENGINEERING	144	530-757-3737

**Correspond directly with company* ***Indicates FAX Number*

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RAS – Ads only appear in Reseller Edition
EUR – Ads only appear in Europe Edition
IS – Ads only appear in International Edition
N.A. – Ads only appear in North American Edition
U.S. – Ads only appear in U.S. Edition
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BYTE ADVERTISING SALES STAFF

Michael P. Walsh, *Associate Publisher*
29 Hartwell Avenue, Lexington, MA 02173
Tel: 781-860-6714, Fax: 781-860-6179, mike_walsh@mcgraw-hill.com

Lori Silverstein, *Eastern Regional Sales Director*
921 Eastwind Drive, Suite 118, Westerville, OH 43081
Tel: 614-899-4908, Fax: 614-899-4999, lorisf@mcgraw-hill.com

Jim Hussey, *Western Regional Sales Director*
1900 O'Farrell Street, Suite 200, San Mateo, CA 94403
Tel: 650-513-6861, Fax: 650-513-6867, jim_hussey@mcgraw-hill.com

RESELLER ADVERTISING
Beth Dudas 714-443-9314
FAX: 714-443-9602
bdudas@mcgraw-hill.com

BUYERS MART & EURO-DECK
Mark Stone 603-924-2533
stonem@mcgraw-hill.com

BYTE DECK - East Coast
Phil Marshall 978-499-0900
phil_marshall@mcgraw-hill.com

BYTE DECK - West Coast
Debra Tseng 626-447-8578
debra_tseng@mcgraw-hill.com

NORTH PACIFIC
AK, Northern CA, HI, ID, MT, OR, Silicon Valley, WA, WY, Western Canada
Lisa Farrell 650-513-6862
lfarrell@mcgraw-hill.com
Matt Knuth 650-513-6951
matt_knuth@mcgraw-hill.com
Sarah McGregor 650-513-6952
sarah_mcgregor@mcgraw-hill.com
Chris Litchfield 650-513-6939
The McGraw-Hill Companies
1900 O'Farrell Street, Suite 200
San Mateo, CA 94403
FAX: 650-513-6867

SOUTH PACIFIC
AZ, Southern CA, CO, NM, NV, UT
Beth Dudas 714-443-9314
bdudas@mcgraw-hill.com
Geanette Perez 714-443-9314
gperez@mcgraw-hill.com
Debra Tseng 626-447-8578
debra_tseng@mcgraw-hill.com
The McGraw-Hill Companies
635 Camino de los Mares, Suite 212
San Clemente, CA 92672
FAX: 714-443-9602

MID WEST-SOUTHEAST
NEW MEDIA/ONLINE PRODUCTS
FL, GA, IL, KY, MI, MN, NC, SC, SD, WI
Neil Helms 404-843-4777
nhelms@mcgraw-hill.com
Lee Jaffe 404-843-4766
lee_jaffe@mcgraw-hill.com
The McGraw-Hill Companies
4170 Ashford-Dunwoody Road
Suite 520
Atlanta, GA 30319-1465
FAX: 404-256-5962

NEW ENGLAND/BYTE DECK
CT, MA, ME, NH, NY, RI, VT, Ontario, Canada, Eastern Canada
Edward Marecki 401-351-0274
ed_marecki@mcgraw-hill.com
Phil Marshall 978-499-0900
phil_marshall@mcgraw-hill.com
BYTE Magazine
One Richmond Square
Providence, RI 02906
FAX: 401-351-0276

PETERBOROUGH, NH OFFICE
One Phoenix Mill Lane
Peterborough, NH 03458
Sales FAX: 603-924-2683
Advertising FAX: 603-924-7507

MID ATLANTIC
DC, DE, IN, MD, Metro NY, NJ, OH, PA, VA, WV
Don Calamaro 212-512-4811
doncalamaro@mcgraw-hill.com
John Ferraro 212-512-2555
jferraro@mcgraw-hill.com
Jill Pollak 212-512-3585
jpollak@mcgraw-hill.com
The McGraw-Hill Companies
1221 Avenue of Americas, 28th Floor
New York, NY 10020
FAX: 212-512-2075

SOUTHWEST-MIDWEST
AL, AR, IA, KS, LA, MO, MS, ND, NE, OK, TN, TX
Jennifer Brinkman 214-688-5165
jen_brinkman@mcgraw-hill.com
Chrissy Copple 214-688-5171
ccopple@mcgraw-hill.com
The McGraw-Hill Companies
Mockingbird Towers, Suite 1104E
1341 W. Mockingbird Lane
Dallas, TX 75247-6913
FAX: 214-688-5167

ADVERTISING PRODUCTION

Advertising/Production
FAX: 603-924-7507

Advertising Production Manager:
Linda Fluhr 603-924-2551
lfluhr@mcgraw-hill.com

Senior Advertising Production Coordinator:
Lyda Clark 603-924-2545
lclark@mcgraw-hill.com

Advertising Production Coordinator:
Karen Cilley 603-924-2557
kcilley@mcgraw-hill.com

Senior Operations Coordinator:
Lisa Jo Steiner 603-924-2540
lisajo@mcgraw-hill.com

Advertising Graphics Manager:
Susan Kingsbury 603-924-2507
suekings@mcgraw-hill.com

MARKETING AND PLANNING

Marketing Director:
Mary Doyle 781-860-6283
FAX: 781-860-6307
mary_doyle@mcgraw-hill.com

Market Information Manager:
Edward Fielding 781-860-6344
FAX: 781-860-6822
fielding@mcgraw-hill.com

Market Information Coordinator:
Dylan DiGregorio 781-860-6267
FAX: 781-860-6822
digregor@mcgraw-hill.com

Assistant Manager, Trade Shows and Special Events:
Arja Neukam 781-860-6378
FAX: 781-860-6307
aneukam@mcgraw-hill.com

Marketing/Sales Information Associate:
Susan Monkton 603-924-2618
smonkton@mcgraw-hill.com
FAX: 603-924-2602

Marketing Services Coordinator:
Kate Woodhouse 781-860-6361
FAX: 781-860-6307
woodhous@mcgraw-hill.com

SUBSCRIPTIONS

Customer Service
U.S. 1-800-232-2983
Outside U.S. +1-609-426-7676

For a New Subscription
U.S. 1-800-257-9402
Outside U.S. +1-609-426-5526

INTERNATIONAL ADVERTISING SALES STAFF

Lori Silverstein, *International Sales Director, 921 Eastwind Drive, Suite 118, Westerville, OH 43081 U.S.A.*
Tel: +614-899-4908, Fax: +614-899-4999, lorisf@mcgraw-hill.com

BYTE ASIA-PACIFIC
AUSTRALIA, HONG KONG, INDIA, INDONESIA, KOREA, MALAYSIA, PAKISTAN, PHILIPPINES, OTHER ASIA AND PACIFIC COUNTRIES, SINGAPORE, TAIWAN
Weiyee In
weiin@dev5.byte.com
Jennifer Chen
jennchen@mcgraw-hill.com
#305 Nanking East Road,
Section 3, 10th floor
Taipei, Taiwan, R.O.C.
Tel: +886-2-715-2205
FAX: +886-2-715-2342

KOREA
Young-Seoh Chinn
JES Media International
6th Fl., Donghye Bldg.
47-16, Myungil-Dong
Kangdong-Gu
Seoul 134-070, Korea
Tel: +82-2-4813411
FAX: +82-2-4813414

GERMANY, SWITZERLAND, AUSTRIA
Jürgen Heise
jheise@mcgraw-hill.com
The McGraw-Hill Companies
Adam-Berg-Str. 115a
D-81735 Munich, Germany
Tel: +49 -89-680701-16
FAX: +49-89-680701-18

ISRAEL
Dan Aronovic
rhodanny@actcom.co.il
DARA International
11 Hasheldag Street
P.O. Box 2335
Kadima 60920, Israel
Tel: +972-9-8995813
FAX: +972-9-8995815

JAPAN
Akiyoshi Kojima
Japan Advertising Communications, Inc.
Three Star Building
3-10-3 Kanda Jimbocho
Chiyoda-ku, Tokyo 101 Japan
Tel: +81 3 3261 4591
FAX: +81 3 3261 6126

ITALY, FRANCE, SPAIN, PORTUGAL, SCANDINAVIA
Zena Coupé, Amanda Blaskett
A-Z International Sales Ltd.
70 Chalk Farm Road
London NW1 8AN, England
Tel: +44 171 2843171
FAX: +44 171 2843174

Emanuela Castagnetti
emanuela.a-z@wanadoo.fr
A-Z International Sales Ltd.
BP18 Les Bossons
31 rue du Lyret
74400 Chamonix, France
Tel: +33 (0)4 50 531339
FAX: +33 (0)4 50 531368

UNITED KINGDOM, BENELUX
Jonathan McGowan
jonmcgow@mcgraw-hill.com
Tel: +44 171 495 6781
Darren Sharp
Tel: +44 171 495 6780
The McGraw-Hill Companies
34 Dover St.
London W1X 4BR
England
FAX: +44 171 4956734

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.

What's New

Hardware

Notebooks aplenty, 3-D tools, multi-Pentium servers, VPNs for rent, and an NT-based video-editing workstation.

PREVIEW

Toshiba Satellite Pro 480CDT
$3999

Enter HotBYTEs No. 1053.

Toshiba Computer Systems Division
Irvine, CA
800-334-3445
http://www.computers.toshiba.com.

A Portable for the Real World

Notebook vendors are vying for your attention with ultrathin or ultralight laptops, tiny subnotebooks, or portables with brilliant 14-inch screens. While Toshiba's Satellite Pro 480CDT is none of those things, it is a safe, competent choice.

Starting at $3999, the 480CDT comes with a 233-MHz Pentium with MMX. It also has a 256-KB Level 2 cache and 32 MB of EDO RAM (expandable to 160 MB). The unit's 12.1-inch 800 × 600 TFT active-matrix color LCD has a narrow viewing angle but is a very capable screen. With two excellent built-in stereo speakers, the 480CDT becomes a competent multimedia machine. USB, parallel, serial, and infrared ports, as well as a 240-pin connector for port replication, offer the functionality a portable needs. Connections for SVGA video, PS/2 mouse, microphone, headphone, in-line jacks, and cellular round out the system's list of standard interfaces.

The unit measures 11.9 inches wide by 9.4 inches deep by 2 inches high and weighs 6.9 pounds, a workable size for use in a business-class airplane seat. Its case is sturdy, although it has a number of small plastic doors and hinges that seem prone to breaking. A 3.82-GB hard drive is standard, along with a 10X CD-ROM drive; like other Toshiba laptops, it has no internal floppy, but it does come with an external drive.

Until vendors find the ideal, next-generation form factor for laptops, a system like the Toshiba Satellite Pro 480CDT is an excellent choice for a complete, midrange portable. **– Jason K. Krause**

PHOTOGRAPH: STEVEN GREENBERG © 1998

Graphics Cards

3-D Gets a Dose of Reality

NUMBER NINE'S 9FX REALITY 334 graphics accelerator is a midrange ($129) add-in card with a full set of 3-D features and 64-bit 2-D graphics acceleration. The card works with PCI or systems built around Intel's LX440 AGP chip set. The card, which comes equipped with 4 MB of 100-MHz SGRAM graphics memory, delivers MIP mapping, trilinear filtering, perspective correction, and Z-buffering, as well as other 3-D rendering capabilities. It supports Windows NT's dual-monitor environment and includes Number Nine's Hawk-Eye display-control utility for adjusting image quality.
Contact: Number Nine Visual Technology, Lexington, MA, 800-438-6463 or 617-674-0009; http://www.nine.com.
Enter HotBYTEs No. 1012.

Sparc System

Sun Workstations for Less

NOT ALL HIGH-END APPLICATIONS DEMAND ultrahigh-end workstations. Sun's new Ultra 5, priced under $5000, is a 270-MHz UltraSPARC IIi-based system. It comes with 64 to 512 MB of ECC RAM, a 4-GB disk drive, three PCI I/O slots (33-MHz, 32-bit), and 8-bit integrated graphics; 24-bit graphics add-ins are also available. This midrange workstation targets applications like software development, finance, databases, or digital-content creation—applications that demand the speed of a workstation but don't need peripherals aimed at animation or MCAD.
Contact: Sun Microsystems, Menlo Park, CA, 650-960-1300; http://www.sun.com.
Enter HotBYTEs No. 1019.

Notebooks

If Kate Moss Were a Notebook

THIN IS IN, AND NEC'S VERSA 5080, AT 4.9 pounds and 1.5 inches thick, is a power user's full-featured laptop with a waifish form factor. The new

Versa has a 233-MHz Pentium with MMX mobile processor from Intel and comes with a 12.1-inch SVGA TFT or a 13.3-inch XGA TFT screen, up to 4 GB of hard drive space, 20X CD-ROM drive, and 16 to 144 MB of RAM. Prices start at $3700.
Contact: NEC Computer Systems, Mountain View, CA, 650-528-6000; http://www.nec.com.
Enter HotBYTEs No. 1008.

A Desktop in a Laptop

THE LINE BETWEEN PORTABLES AND DESKTOP systems is blurred by machines like Toshiba's Tecra 550CDT. For around $4000, this laptop offers desktop features like a 266-MHz Pentium with MMX, 3.83-GB hard drive, up to 160 MB of EDO RAM, and 4 MB

of SGRAM video memory. It runs for an estimated 3.5 hours on battery and has a hot-swappable secondary 2-GB hard drive, plus a voice/fax/data K56Flex modem for demanding use on the road.
Contact: Toshiba America Information Systems, Irvine, CA, 714-583-3000; http://www.computers.toshiba.com.
Enter HotBYTEs No. 1009.

Monitors

Unobtrusive LCD Monitor

ViewSonic's 15-inch LCD monitor, the VPA150 ViewPanel ($2450), can display full 8.5 × 11-inch pages. Its viewing area is comparable in

height to a 21-inch CRT monitor, but the unit has a mere 6.7-inch profile, 12.8-pound weight, and 40-watt power consumption. It has a resolution of 1024 × 768 and a refresh rate of 75 Hz.
Contact: ViewSonic, Walnut, CA, 800-888-8583 or 909-869-7976; http://www.viewsonic.com.
Enter HotBYTEs No. 1007.

Subnotebooks

Big CPUs Come in Small Packages

Nimantics' Persona T-150 is possibly the most powerful subnotebook available today. A 150-MHz Pentium processor with MMX, an 8.4-inch TFT active-matrix color screen, and up to 80 MB of EDO RAM make the 2-pound system a functional alternative to full-size notebooks. Priced between $2399 and $2999, it has a full 15.1-mm horizontal key travel, large enough for touch-typists to be comfortable, and includes an external floppy drive and up to 1.6 GB of hard drive space.
Contact: Nimantics, Tustin, CA, 888-664-6268 or 714-440-8164; http://www.nimantics.com.
Enter HotBYTEs No. 1011.

The Little Notebook That Can

Small enough to fit in a briefcase or purse, Hitachi's VisionBook Traveler is as powerful as some full-size notebooks. Its CPU is the mobile 133-MHz Pentium processor with MMX. The notebook weighs 2.7 pounds and measures 9.2 inches wide by 6.8 inches deep by 1.3 inches high. The 8.4-inch TFT active-matrix screen is wide enough to display a standard word processor page. With 8 to 40 MB of RAM, 1-GB hard drive, and external floppy, it has sufficient storage for portable computing, although no CD-ROM drive is currently available.
Contact: Hitachi PC (USA), Milpitas, CA, 800-555-6820 or 408-321-5000; http://www.hitachipc.com.
Enter HotBYTEs No. 1010.

Servers

It's Raining CPUs

NCR has linked two four-processor boards to give its WorldMark 4380 the strength of eight Pentium Pro processors. The server is capable of

hosting large-scale electronic commerce and Internet applications, a data warehouse, or a thin client environment. Prices range from $17,900 to $60,000. It is based on the 200-MHz Pentium Pro with 512 KB or 1 MB of cache per CPU. The system comes loaded with Windows NT and NCR's SMP Utilization Manager for consolidating it with other NT servers.
Contact: NCR, Dayton, OH, 800-225-5627 or 937-445-5000; http://www.ncr.com.
Enter HotBYTEs No. 1006.

Give Your Server a Free Hand

The Micron MV5000 I2O server, built around Intel's MB440LX server platform with the i960 RD I/O processor and dual Symbios Logic PCI Ultra SCSI controllers, offers enhanced processing power by offloading I/O and RAID functions from the host processor. This leaves the Pentium II CPU free to handle your high-end server applications. A base configuration comes with a single Pentium II (a dual-processor model is also available), 2-GB Ultra-Wide SCSI-3 hot-swappable SCA hard drives, and 32 MB of ECC SDRAM. Price is $5059.
Contact: Micron Electronics, Nampa, ID, 800-776-4518 or 208-898-3434; http://www.micronpc.com.
Enter HotBYTEs No. 1069.

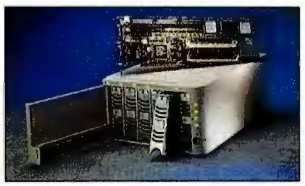
RAID

Keep Your Backup Covered

Artecon's LynxArray now gives enterprise networks up to 162 GB of backup RAID protection with 18-GB hot-swappable drives. These new drives employ IBM's magnetoresistive-extended head technology, giving them a 3.5-inch form factor. A 162-GB system with nine 18-GB disks is $64,995. LynxArray RAID systems are also available with 9-GB or 4-GB drives.
Contact: Artecon, Carlsbad, CA, 619-932-5500; http://www.artecon.com.
Enter HotBYTEs No. 1013.

Entry-Level LAN Storage

Storage Dimensions' 9.1-GB, 7200-rpm RAIDPro disk drives afford a PC LAN up to 45.5 GB of fault-toler-



ant storage with up to 64 MB of cache. It has a footprint the size of a legal pad and is only 6 inches high. Prices start at $7818.
Contact: Storage Dimensions, Milpitas, CA, 408-954-0710; http://www.storagedimensions.com.
Enter HotBYTEs No. 1071.

Scanners

Scanning Made Easy

The HP ScanJet 5100C Color Scanner reduces the scanning learning curve by automatically sharpening, adjusting, and tweaking anything you input. The unit costs $299 and includes Hewlett-Packard's Intelligent Scanning Technology, which adjusts the resolution for different individual elements on a page, like text, photos, line art, or logos, while automatically realigning images if they are scanned at an odd angle.
Contact: Hewlett-Packard, Palo Alto, CA, 800-527-3753 or 650-857-1501; http://www.hp.com.
Enter HotBYTEs No. 1014.

Mice

Mice Have Feelings, Too

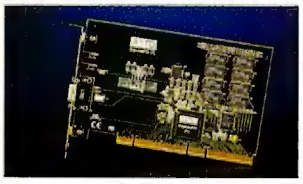
The Feelit Mouse ($139) simulates what it might feel like if your user interface had a three-dimensional, tactile surface. It pushes back

against your hand to approximate the sensation of textured backgrounds, the weight of a folder as you drag it across the screen, or your cursor bumping into the edge of the user interface. The Feelit mouse is already integrated into Windows 95 and allows you to customize how you want your desktop interface to feel. The software API is available for programmers who want to develop custom sensations for applications.
Contact: Immersion, San Jose, CA, 408-467-1900; http://www.force-feedback.com/feelit/feelit.html.
Enter HotBYTEs No. 1018.

PCI Host Adapter

The Fibre Channel Expressway

THE EXPRESSPCI FC ($995) IS A 64-BIT PCI bus Fibre Channel adapter with the ability to host up to 126 devices



on an arbitrated loop. Designed for I/O- and data-intensive applications, the ExpressPCI FC provides full-duplex 1.06-gigabit Fibre Channel performance, Atto says. The card has Media Interface Adapter-compliant ports for quick connections to copper cabling and fiber-optic cables.
Contact: Atto Technology, Amherst, NY, 716-691-1999; http://www.attotech.com.
Enter HotBYTEs No. 1070.

Networking

Fibre Channel Controllers

BY COMBINING 64-BIT PCI WITH ITS OWN Tachyonic architecture, Hewlett-Packard has made the TachLite IC ($150) an affordable Fibre Channel controller for building mass-storage systems. It provides throughput of 100-MBps and 10,000 I/O per second.
Contact: Hewlett-Packard, Palo Alto, CA, 800-537-3753 or 650-857-1501; http://www.hp.com.
Enter HotBYTEs No. 1017.

The Road to Bandwidthville

MATROX'S LATEST 100BASE-TX REPEATER hubs extend LAN capabilities with Fast Ethernet integration and up to 144 ports in a stackable architecture. The Fast Hub 8 ($499), Fast Hub 16 ($899), and Fast Hub 24 ($1299) offer 8, 16, and 24 ports. An MDI uplink port on each hub connects additional repeater hubs or switches, so you don't have to waste a port when adding a new hub to your network.
Contact: Matrox, Dorval, Quebec, Canada, 800-837-3611 or 514-969-6080; http://www.matrox.com.
Enter HotBYTEs No. 1015.

Ubiquitous Network Connection

YOU MAY KNOW THAT IT'S POSSIBLE TO RUN a network over the same wires that bring electricity to your toaster. Intelogis' Passport is a file/printer-sharing system that takes advantage of this possibility, delivering 350-Kbps throughput to small offices or

homes that need simple networking. Just plug one end of the unit into a parallel port and the other into the wall, install Intelogis' client software, and you can see workgroup networks through Windows Explorer. Prices for Passport products range from $49.99 to $239.99.
Contact: Intelogis, American Fork, UT, 888-756-5199 or 801-756-5199; http://www.intelogis.com.
Enter HotBYTEs No. 1016.

SOFTWARE

Work Flow

Make Work-Flow Work for You

INTEMPO, JETFORM'S WORKFLOW/ELECTRONIC-forms solution for native Windows, HTML, and Java-based clients, can reduce the time and expenses associated with traditionally paper-bound processes such as purchase requests, invoices, and expense reports. It now supports Microsoft Exchange Server 5.5 and messaging systems such as Lotus Notes, cc:Mail, SMTP/POP3, and Microsoft Mail systems. InTempo includes design tools that let users build applications graphically, plus time-based controls to improve expediency. The server component runs on NT. Prices vary depending on how many participants you have, but you can expect to pay $20,000 for 100 users.
Contact: JetForm, Ottawa, Ontario, Canada, 800-JET-FORM or 613-230-3676; http://www.jetform.com.
Enter HotBYTEs No. 1020.

Networking

Rent a Virtual Private Network

END-TO-END SERVICE GUARANTEES, A HIGH-performance IP backbone, and customer service support is more than many people expect of their networks, but that is what AT&T promises with the WorldNet Virtual Private Network. It's a service offering a VPN based on AT&T's own IP backbone, which can add frame relay networks, intranets, and extranets to your corporate LAN. The company claims the backbone is engineered for 99.7 percent network uptime, with dial-up access for remote users and planned international access from 35 countries. AT&T says it will offer guaranteed service to subscribers in 1998. Charges range from $103 for a 16-Kbps connection to $2366 for 1024-Kbps managed connections per month, with local dial access for $3 per hour or at a negotiated flat rate.
Contact: AT&T, 800-831-5259; http://www.att.net/worldnet.
Enter HotBYTEs No. 1021.

Work in Your Underwear

WORKING AT HOME OUGHT TO BE A VIABLE alternative to working in the office. Remote DeskLink from Traveling Software, priced under $50, automatically configures your home PC's modem and network devices for remote communications. The software supports TCP/IP or IPX networks and Windows 95 Dial-Up Networking for remote access to a PC at the office.
Contact: Traveling Software, Bothell, WA, 800-343-8080 or 425-483-8088; http://www.travsoft.com.
Enter HotBYTEs No. 1022.

3-D Drawing

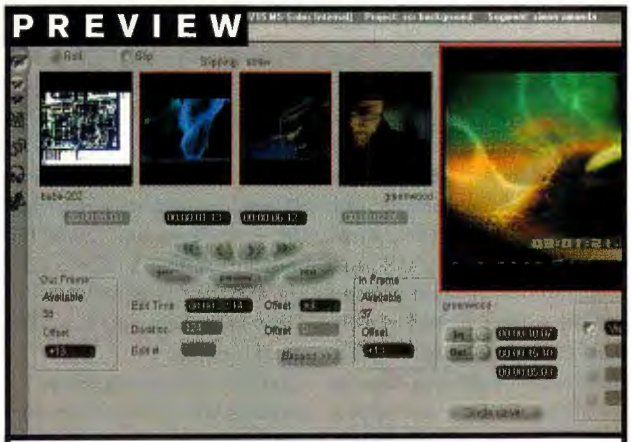
E-Z 3-D

3SPACE PUBLISHER ($129) IS A NEW ENTRY-level desktop tool designed for novice users to create 3-D images and animations. It has a simple drag-and-drop interface. The package includes templates with over 1000 predrawn objects and textures and can create shadows, reflections, fog, and other effects automatically. It offers 3-D VRML support; can automatically create animated GIF, VRML, and Java applets; and can handle video, JPG, BMP, and TGA files.

Contact: Template Graphics Software, San Diego, CA, 619-457-5359; http://www.tgs.com.
Enter HotBYTEs No. 1023.

Bryce Gets Animated

BRYCE 3D, FORMERLY A 3-D IMAGE CREation tool for two-dimensional print media, has been refurbished by MetaCreations as a 3-D animation tool for QuickTime or AVI formats. Bryce 3D costs $299 and gives animators tools for creating lighting and textures, plus updated atmospheric effects like rainbows that simulate actual water vapor refraction, volumetric properties for more realistic atmospheres, and random star-pattern generation.
Contact: MetaCreations, Carpinteria, CA, 805-566-6200; http://www.metacreations.com.
Enter HotBYTEs No. 1024.



Digital Studio
$100,000

Enter HotBYTEs No. 1005.

Softimage
Montreal, Quebec, Canada
800-576-3846
514-845-1636
http://www.softimage.com

Professional Video Editing at a Professional Price

Silicon Graphics (SGI) and other companies have been breaking the wall between professional-level, purpose-built video post-production equipment and desktop systems for several years. Now, with its long-awaited Digital Studio (DS), Softimage has demolished more of that wall, moving top-quality video post-production to Windows NT workstations.

Softimage, now a subsidiary of Microsoft, has long been an SGI staple. The first and only machine DS currently ships on is a dual Pentium II/300-based modified Intergraph StudioZ video-editing workstation running Windows NT 4.0. The developers claim the program code is extremely portable, so an SGI version might yet be on the horizon, but they also proudly tout how much performance they've wrung out of MMX instructions. It is clearly an NT-friendly application, with resizable panes and standard Windows tools.

At the rollout we saw full-resolution elements of a commercial re-edited, composited, color-corrected, remixed, and played back. Many steps were done nearly in real time, with none taking more than 30 seconds, even on 80-frame sequences. However, DS doesn't include Softimage 3D, the company's flagship 3-D animation package, and it leaves out any morphing tools.

This first version of DS, fully integrated, installed on-site, and with the computer, is $100,000. Yet the price compares well with top-end compositing and D-1 on-line editing systems.

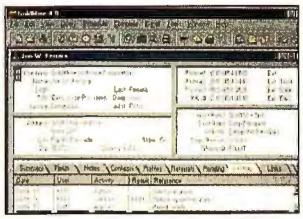
Time will tell how large Digital Studio's market in Hollywood is. But if the product's price comes way down, it could eventually compete with packages like Adobe Premiere in the news-gathering, corporate communications, and semiprofessional video markets.

– Alex Pournelle

Contact Manager

GoldMine 4.0 Digs Into SQL and dBase

TO MEET THE NEEDS OF DISTRIBUTED AND heterogeneous workgroup environments, version 4.0 of the GoldMine contact manager adds a new client/server for SQL databases ($1400). There's also a new dBase IV version of the product ($295 to $895). GoldMine can now communicate with any data source that is 32-bit ODBC-compliant. To



accommodate distributed network users, it has IP-to-IP connections for Internet replication, and it supports multiple, distributed SQL databases and POP3 messaging.
Contact: GoldMine Software, Pacific Palisades, CA, 800-654-3526 or 310-454-6800; http://www.goldminesw.com.
Enter HotBYTEs No. 1025.

The Web

Cut Download Time

GEO PUBLISHING CLAIMS ITS EMBLAZE WebCharger can compress 16- or 24-bit full-color images up to 400 percent more than JPEG can. WebCharger is JPEG-compatible, but it compresses a file before JPEG compression occurs. It defines areas in an image that can be compressed and those that should be untouched. The program won't degrade image quality, Geo says. It works with any GIF, BMP, JPEG, or PICT file.
Contact: Geo Publishing, Woodland Hills, CA, 800-576-7751 or 818-703-8436; http://www.emblaze.com.
Enter HotBYTEs No. 1027.

Security

Catch Hackers in the Act

AUDIT TRAILS ARE A GOOD WAY TO IDENTIFY illegal activity on a network, but they often waste disk space, are rarely utilized, and alert users to an intruder only after he has already gone. Intruder Alert 3.0 watches audit trails and informs network administrators in real time of illegal activity. It can detect over 100 illegal operations with no configuration necessary, and detects many more once basic parameters are set. The software deletes unsuspicious trails automatically.
Contact: Axent Technologies, Rockville, MD, 301-258-5043; http://www.axent.com.
Enter HotBYTEs No. 1031.

Gateway Guardian

SAFEGATE 1.1 ($2000 TO $9000) PROtects your network gateway(s) from Java applets, DLL and EXE files, or ActiveX components that fail to meet corporate security policies. It works on the fly and can verify digital signatures in ActiveX components.
Contact: Security-7, Boston, MA, 617-753-7380; http://www.security7.com.
Enter HotBYTEs No. 1032.

On-Line Analysis

A Reporting Tool with Less Baggage

APERIO IS AN OLAP REPORTING TOOL BUILT from the ground up with no client-side software. It resides on a Unix

or NT server and automatically turns queries to a database into HTML forms and sends them out to desktop Web browsers. The program can access reports and information from other programs like SAP R/3 or Crystal Reports (you can launch Aperio inside their client software). And because it treats reports like a Web page, you can bookmark reports, and you can drill down and then press your browser's Back button to undo an analysis. Aperio includes features for generating reports automatically. It is designed with a central management interface for governing access to reports. Aperio is priced at $20,000 for two concurrent users doing actual queries to the database and an unlimited number of users simply viewing reports. An unrestricted license is $400,000.
Contact: Influence Software, Sunnyvale, CA, 408-617-0268; http://www.influencesw.com.
Enter HotBYTEs No. 1067.

Software Updates

Cosmo Code is one of the most powerful Java programming tools around, but it has been limited by the fact that you need an SGI workstation to use it. With version 2.5 ($345), not only does it run on Windows 95 and Windows NT PCs, but it includes the latest JDK 1.1.4, a drag-and-drop WYSIWYG interface, and support for all JDK 1.1 layout styles and managers. It also comes with the Rogue Wave components JTools 2.0 , JWidgets 3.0, and JCharts.
Contact: Silicon Graphics Computer Systems, Mountain View, CA, 800-800-7441 or 650-960-1980; http://www.sgi.com.
Enter HotBYTEs No. 1033.

Inferno 2.0 makes hand-held devices into networked computer systems. The OS fits itself and an application in 1.5 MB of memory so it can run on wireless phones, personal digital assistants, or intelligent set-top boxes. The latest Inferno Developer's Kit, version 2.0 ($150), includes support for Sun's Personal Java programming language, a subset of the Java language designed for network-enabled mobile products. This latest release is compatible with soft modem technology, eliminating the need for hardware modems. Basic programs can run with as little as 512 KB of RAM and 256 KB of ROM.
Contact: Lucent Technologies, Murray Hill, NJ, 888-582-3688; http://www.lucent.com/inferno/.
Enter HotBYTEs No. 1034.

netViz creates illustrations representing physical and logical views of assets across an organization. The program turns abstract data types into comprehensible graphics. Not just a drawing tool, it can access spreadsheets and SQL databases with ODBC drivers. The latest release, netViz 3.0, costs $595 and includes new database interfacing and publishing capabilities, plus a library of over 3000 symbols. You use a drag-and-drop interface for creating representations.
Contact: netViz, Rockville, MD, 301-258-5087; http://www.netviz.com.
Enter HotBYTEs No. 1035.

SmartStream 5.0 (about $60,000 per module) is a comprehensive suite of business application modules for financial, procurement, human resource, and decision-support applications. It provides Java applets within each module, including employee self-service human resource apps and Web-based procurement forms. Each module has its own set of APIs for cross-platform capabilities. The latest release is Microsoft BackOffice-compliant. It comes with applications for supplies management, and it has a system verification tool for locating bottlenecks.
Contact: Geac Computer Systems, Atlanta, GA, 404-239-2000; http://www.smartstream.geac.com.
Enter HotBYTEs No. 1036.

Internet

Instant Internet: Just Add LAN

BAY NETWORKS' INSTANT INTERNET100 connects a whole small-office LAN with either analog or ISDN access to the Internet through a single dial-up account at a single IP address. The Instant Internet100 package, a scaled-down version of the Instant Internet 400, ships with the choice of three connectivity and price options: 33.6-Kbps analog modem ($750); 56-Kbps analog modem ($950); and 128-Kbps ISDN connection ($950).
Contact: Bay Networks, Santa Clara, CA, 408-988-2400; http://www.baynetworks.com.
Enter HotBYTEs No. 1026.

3-D Graphics

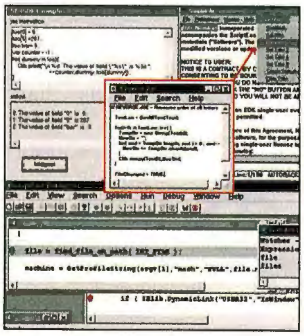
Taking Advantage of 3-D

3-D GRAPHICS ARE COOL TO LOOK AT, BUT can they make you more productive? VisiDrive is a visual file manager that offers a three-dimensional user interface for navigating and managing files on your desktop. You can view multiple directories, subdirectories, and files simultaneously, making it easier to find folders without scouring through scads of windows or scrolling through traditional two-dimensional views of your files.
Contact: S3, Santa Clara, CA, 408-588-8000; http://www.s3.com.
Enter HotBYTEs No. 1068.

Programming

Take JavaScript Beyond Browsers

BY MERGING ITS SCRIPTEASE SCRIPTING language with JavaScript, Nombas' ScriptEase: Integration SDK ($995) makes it possible to integrate JavaScript into all classes of software and embedded systems. The development kit enables programmers to quickly incorporate a fully functional scripting language interpreter into any C or C++ application, the company says. It works with the major C/C++ compilers.



The package includes 200 sample wrapper functions and 80 API functions. The SDK is compliant with ECMAScript. A "pure" Java version is planned for this year.
Contact: Nombas, Medford, MA, 781-391-6595; http://www.nombas.com.
Enter HotBYTEs No. 1030.

Making Visual Basic More Intuitive

VISUAL BASIC CREATES INTUITIVE APPLICATION interfaces, and Apex's True DBList Pro 5.0 ($179.95) add-on promises to extend that capability. It features styles that mimic popular Windows applications, and it offers newly invented styles, flexible data modes, data-sensitive object color and font control, and a host of new fonts, templates, layouts, display types, search capabilities, and graphics.
Contact: Apex Software, Pittsburgh, PA, 800-858-2739 or 412-681-4343; http://www.apexsc.com.
Enter HotBYTEs No. 1029.

improbable

Advances and Retreats in Computing

A product to end wasteful voice mail, and the death of all-natural PC accessories.

Get to the Point

Voice mail wastes a huge amount of everybody's time. The main problem is people who hem and haw. Rather than leaving a brief, clear message, they ramble, they hesitate, they talk in circles.

A new product from Zapff Telephonics solves the problem. Called "Get To The Point" (GTTP), it can be added to any voice-mail system. Zapff's researchers have accumulated data on the types of things time-wasters utter when they leave pointless phone messages. Zapff then used this data to give GTTP a highly specialized voice-recognition capability. Whenever a caller starts rambling, GTTP quickly emits a noise that sounds like a referee's whistle, and then a voice cuts in on the message and says, "Get to the point. You have 10 seconds." Ten seconds later, GTTP terminates the connection. Anything said prior to the warning is discarded, and an antiredundancy circuit disconnects the call if the same person calls again within the next 12 hours.

Tests indicate that if GTTP were installed in every current voice-mail system, it would free up nearly as much phone bandwidth as has been soaked up in the past decade by fax machines and Internet connections combined.

Recycling Scandal

The mouse-pad recycling industry is now kaput. Hand-To-Mouse, Inc., the San Jose–based animal-breeding laboratory that was the lone supplier of the raw materials used in the mouse-pad recycling industry, has closed its doors.

Hand-To-Mouse's Soothe-a-Mouse was the first computer accessory to be made from an actual animal carcass. It inspired fanatic, albeit not universal, acclaim. Those who liked it loved it, fondly caressing their little Soothe-a-Mouses all day long.

The company also did well with its Rug-a-Pad mouse pads. They were smooth and silky, and they looked for all the world like tiny bearskin rugs. Carpal-tunnel syndrome sufferers still swear by them. You can rest your wrist on the furry little head, removing any strain from the over-stressed tendons of your hand and forearm.

Hand-To-Mouse's downfall started when the company foolishly advertised the product as being made from "artificial materials." That untruth was the company's undoing. There's a market for all-natural products, and that market does not like being lied to. In addition, some Rug-a-Pad users were grossed out when they learned the true nature of its ingredients. The ensuing protests killed off an entire (very promising) product category. The Rug-a-Pad's working surface, made from vulcanized, ground mouse innards, is still the most efficient traction material ever put on the market.

Thus, real-mice components are now toast, and the whole Hand-To-Mouse affair will become just another dimly remembered Silicon Valley scandal. It's one more smudge on an industry that was once the very model of innocence and compassion.

Marc Abrahams is the editor of the Annals of Improbable Research. *You can contact him by sending e-mail to* **marca@improb.com.**

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